UNITED NATIONS DEVELOPMENT PROGRAM
(SPECIAL FUND)

PROJECT FOR THE WATER CONTROL AND MANAGEMENT OF THE SHEBELLI RIVER SOMALIA

EXECUTING AGENCY
FOOD AND AGRICULTURE ORGANISATION OF THE UNITED NATIONS

VOLUME IIIA

THE AFGOI - MORDILE CONTROLLED IRRIGATION PROJECT FEASIBILITY STUDY TECHNICAL ANNEX

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Symbols and Units Used

Distance, Area, Volume and Weight

Metric measurements have been used throughout the report.

Monetary Units

The Somali Shilling or Somalo is the local unit of currency and is abbreviated "Shs" throughout the report. At the time of the study the foreign exchange rate was:-

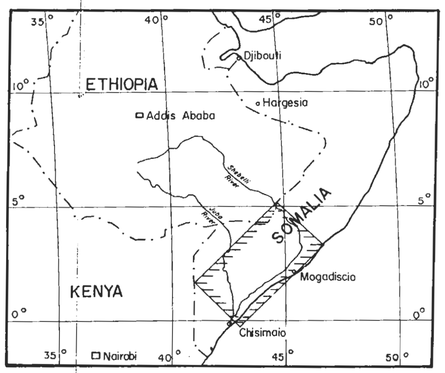
Shs 7.14	=	U. S. $ 1.00

Conversion Factors

1 mm	=	0.039	in.
1 m	=	3.28	feet
1 km	=	0.621	mile
1 ha	=	2.47	acres
1 m^3	=	35.3	cu. ft.
1 kg	=	2.046	lbs.
1000 kg	=	0.984	ton

GLOSSARY OF LOCAL TERMS

'Azienda'	Farm or concession holding.
'Der'	The rainy season October-November.
'Faf'	The farming or pasture areas inundated by flood flows.
'Far'	A natural channel from the river to lower ground in the flood plain used for inundation watering.
'Gu'	The rainy season April-June.
'Hagai'	The season of coastal showers July-August.
'Jambo'	A short handled hoe used for traditional hand tillage.
'Uebi'	(= Wadi) A non-perennial stream.



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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS	
LOCATION MAP	
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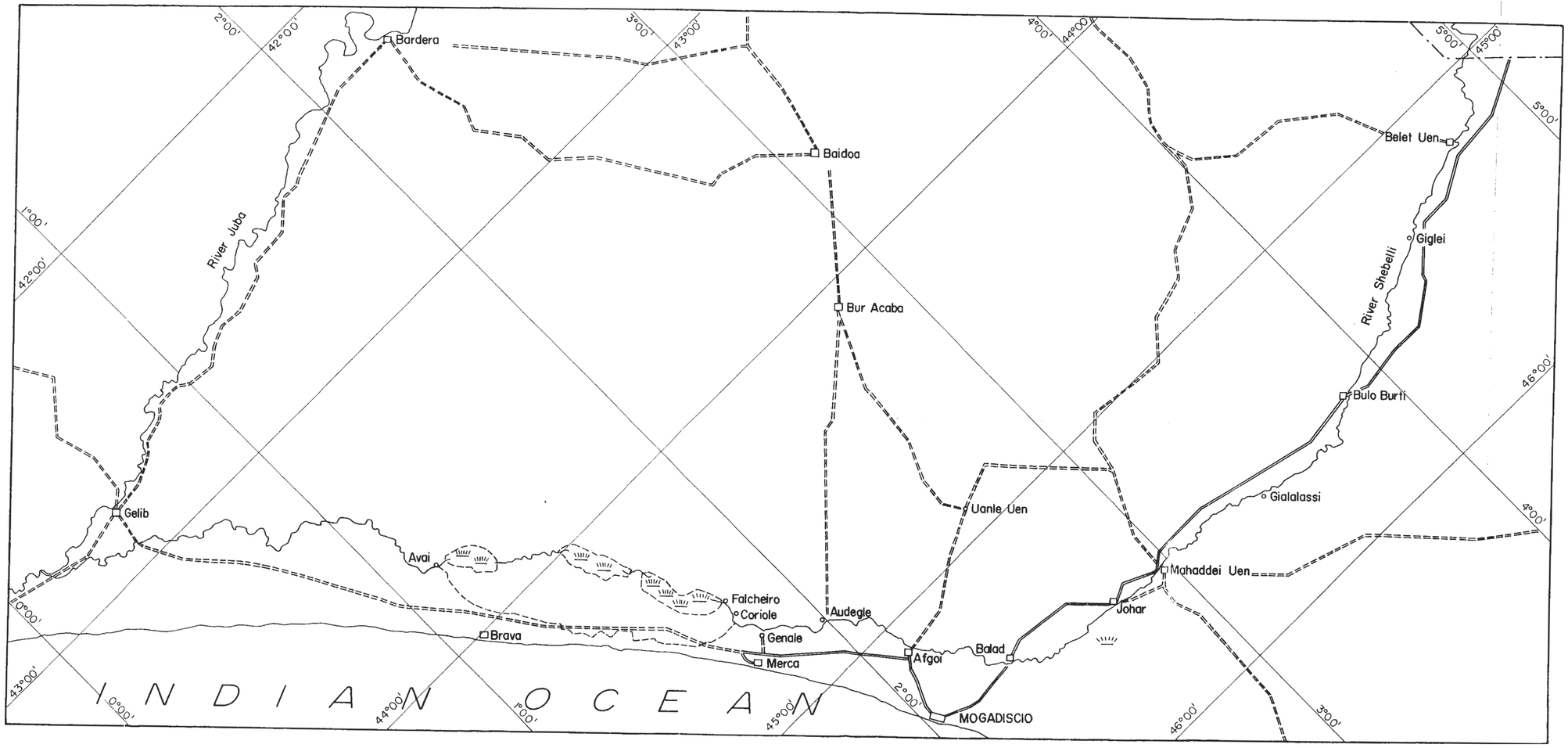


CHAPTER 1

INTRODUCTION

1.1 Background

The need for detailed feasibility studies of possible development projects in the Shebelli River Flood Plain was recognised during the course of the UNDP/SF Agriculture and Water Surveys Project 1962-1966. A formal request for assistance in such studies was made by the Somali Government to the U.N.D.P. early in 1966. The project for the Water Control and Management of the Shebelli River was established as a follow-up in 1967 to execute these feasibility studies and to make recommendations on the overall management of the Shebelli River Waters.

1.2 Terms of Reference for the Feasibility Study

The Project for the Water Control and Management of the Shebelli River required the selection of an area of 3,000 ha. suitable for controlled irrigation and the execution of a feasibility study for development of this area.

The Statement of Work and Specification which was the basis of the study, specified the following surveys and investigations:-

a) Preparation of topographic maps of the area, using ground survey methods and air photo-interpretation.

b) A semi-detailed soil survey of the area and preparation of soils and land class maps.

c) Hydrological studies to determine the quality and availability of river water for irrigation.

d) Hydrogeological studies to ascertain whether ground-water could be used to supplement the irrigation supply at times of low river flows.

e) Agronomic studies leading to proposals for cropping patterns and cultural requirements, together with an assessment of labour and machinery inputs and management and advisory services required.

f) The preparation of irrigation engineering designs in sufficient detail to permit the calculation of quantities and cost estimates required for economic feasibility analysis.

g) Economic studies to include an assessment of potential markets, an economic and financial appraisal of the proposed project and an analysis of the effects of development on the national and regional economies.

1.3 Execution of the Project

The F.A.O. Resident Engineer arrived in Somalia in December 1966 to set up the Project Headquarters. Vehicles and equipment required for the project were ordered during 1967 and in September 1967, the Plan of Operations for the project was signed. In the following December, the first members of the Consultants' team arrived to start field operations.

During the project, difficulty was experienced in obtaining suitable counterpart professional staff due to a shortage of technically competent personnel in Somalia and the demands of other U.N. Projects running concurrently. Difficulty was also experienced over the supply, maintenance and efficient operation of drilling equipment provided under the counterpart agreement and required for the groundwater studies. As a result, the groundwater investigations were severely curtailed. In all fields of investigation, the severe lack of basic data resulted in the need to make a number of assumptions in the feasibility analysis based upon experience and judgements and which may require verification in the future.

In spite of these difficulties, progress was satisfactory in all fields, except the groundwater studies, the Consultant having completed the necessary field work by July 1969.

In January 1969 an Interim Report was submitted to F. A. O. by the Consultant, in which the proposed project was described and a preliminary economic analysis presented based on the information available at that time.

CHAPTER 2

THE SETTING

A. The National and Regional Setting

2.1 General

Somalia is a country of some 637,660 square kilometres, situated at the eastern extremity of the African Continent. The people are traditionally pastoralists and subsistence grain farmers. The land is semi-arid to arid and the unreliability of rainfall and water supplies have necessitated a nomadic existence, except in areas where perennial river flows or year round water supplies from surface storage or wells is assured. As a result, life for a considerable proportion of the population is precarious and loss of crops and livestock in drought years with resulting famine, occurs all too frequently.

Natural resources other than abundant land and scarce and localised supplies of water are few. Recent surveys executed with the assistance of the United Nations Development Programme Special Fund have revealed the existence of mineral deposits and exploration for possible reserves of oil and natural gas are in progress. It is not possible, at present, to estimate how soon or to what extent these potential sources of national wealth may be exploited. In the immediate future, therefore, development and extension of existing agricultural production will remain a major factor in national development.

The two major rivers of Somalia are the Juba and Shebelli. The Shebelli River has its source in Ethiopia near the town of Yirgalem, some 250 km south of Addis Ababa. It flows at first in a direction north of east for some 325 km then turns to flow south-east for about 650 km to the International Boundary with Somalia, 30 km north of Belet Uen. The course of the river is then south through Bulo Burti, Mahaddei Uen and Johar to Balad, where it turns south-west and runs roughly parallel to the coast from which it is separated by a range of

sand hills about 25 miles wide. After passing through Afgoi, Audegle and Coriole, the river flows into the first of three swamp basins, which extend to Avai. Below Avai, the river assumes a defined channel, but flows are much reduced and it is only in seasons of exceptionally high and sustained flows that water discharges into the Juba river at the confluence, south of Cansuma and thence to the Indian Ocean at Kismayu.

2.2 The National Economy

Somalia depends on exports of agricultural produce to provide most of its foreign exchange income. In the past, this has not been sufficient to pay for imports and the country has had to rely largely on grants and assistance and long term capital inflow to balance its external payments. Although this is quite normal in a newly independent country, Somalia is facing extreme difficulties in generating both the external and internal revenues which are necessary to attract and pay for the capital required for development in the future. The situation would be alleviated should the exploitation of the mineral mining concessions prove profitable, thereby generating substantial foreign exchange and internal revenue.

2.3 The People and Economy of the Shebelli River

The Shebelli River Valley above Mahaddei Uen is sparsely populated, except for the townships of Bulo Burti and Belet Uen. The people are predominantly of hamitic origin and are mainly nomads engaged in live-stock farming and the seasonal cultivation of rainfed crops where the accumulation of surface run-off behind low bunds provides adequate soil moisture for plant growth. Between Mahaddei Uen and Coriole, the Valley is more densely populated by tribes of both hamitic and negro origin. The former are predominantly nomadic herdsmen and the latter generally settled cultivators living in villages close to the river. Besides the cultivation of rainfed maize, sorghum and sesame, flood irrigation is practised generally in small basins on bends in the river. These are planted to a range of subsistence and cash crops. Besides working on

their own and neighbouring farms, some of the people find seasonal employment on the irrigated sugar and banana plantations and in the townships, giving rise to a complex income structure.

In the villages, the houses are generally of adobe construction, with a grass thatch. The average household consists of a man and his wife with between 2 and 4 children and sometimes other relatives. Health is generally poor, particularly in the more intensely irrigated areas, due to the prevalence of Schistosomiasis, ascaris and helminthes infestations and malaria.

Both rainland and flood irrigation farmers suffer as a result of wide variation in yields and prices resulting from the uncertain rainfall and variation in flood levels from year to year. Attempts to improve yields and stabilise prices through the creation of the Agricultural Development Agency and the Grain Marketing and Storage Project have met with little success.

Besides banana production for export, the major industries contributing to the economy of the area are the Sugar Industry at Johar, which by 1970 plans capacity to produce approximately 200 tons of sugar per day; the recently completed Balad Textile Factory with an ultimate planned input of 1, 500 tons lint cotton per year; the Italso Meat Factory at Mogadiscio with an annual throughput of 50, 000 head to produce corned beef and gelatine; and the Mogadiscio Milk Factory with capacity to handle 20, 000 litres of milk per day. Two oil seed processing plants have also been established in Mogadiscio and although it has proved difficult to obtain an exact estimate of capacity this is thought to be of the order of 7, 000 tons of oil seeds per year, although present production is small and spasmodic. The Mogadiscio Cotton Ginnery equipped with ten saw gins produces some 200 tons lint cotton per year, which is well below capacity; a smaller ginnery at Afgoi is equipped with eight roller gins.

2.4 Future Development Plans

The revised planned development expenditure for Somalia's First Five-Year Plan published in 1963 totalled Shs. 2, 427 million. Incomplete

estimates show an actual expenditure of Shs. 631 million in the planned period of which 272 million shillings was spent on completed projects, largely in the industrial and transport sectors and Shs. 360 million on projects still to be completed.

The Short Term Development Plan 1968-1970, which follows on from the first development plan lists the major objectives during the period as:

a) Completion of ongoing projects.

b) Introduction of basic structural changes in the administrative organisation with a view to gear it to the needs of rapid development.

c) Closing the existing budgetary gap and the mobilisation of more domestic resources for development.

Deficiencies in the administrative machinery of government were considered by the Short Term Development Plan to be "probably the most important factor responsible for the disappointing performance of the first five-year plan. These deficiencies are due not only to the complicated and ponderous machinery brought about by lack of adequate delegation of authority, but also to the fact that a large proportion of civil servants have not yet received the fundamental education and specialised training to carry out their assigned tasks". On the appointment of civil servants the plan states that:-

> "Currently political influence plays a major role ------- and very little consideration is given to merit, experience or qualification. Proper discipline is lacking and rigid personnel regulations coupled with political influence have the effect of protecting the inefficient."

In addition to the objectives of this consolidatory programme, two other elements are considered to be of prime importance in the current development strategy. Firstly, the integration of the Somalia economy into the East African Economic Community, and secondly, the initiation of the steps necessary for the integrated development of the Juba River Valley.

The proposed allocation of expenditure on agricultural and related activities for the present programme amounts to 7.7 per cent of the total proposed outlay of Shs. 698 million and a further 0.5 per cent on the irrigation sector, in which the present survey of the Shebelli River is incorporated. Although there are no allocations for the development of the Juba River, negotiations for finance have been undertaken.

The specific objectives of the short term development programme commit Somalia to heavy development expenditures in the next few years, 80 per cent of which are in the essential, but not directly revenue producing infrastructural sector. It is hoped that revenue will be produced by consolidation and rationalisation of existing projects and enterprises and by attracting foreign finance for major investments for exploitation of the mineral deposits and for irrigation projects on the Shebelli and Juba Rivers.

2.5 Problems in Implementing Planned Development

Somalia's key problems are shortages of local funds and skilled manpower, which make effective organisation of the resources for development difficult, while the immediate prospects for increased exchange earnings, on which ultimately depends the ability to pay for borrowed capital, are not bright. The future export possibilities for livestock are good, but the prospects of increasing the supply quickly are not, since there are considerable problems of land tenure, animal health, nutrition, management and marketing which have to be overcome before higher annual take-off can be achieved as well as the problems of quarantine control, which would be necessary should health and quality regulations in the traditional livestock markets become more stringent.

The banana industry is facing severe difficulties at the present time. Production, transport and ship loading costs are high and although freight rates around the Cape are now lower than immediately after the closure of the Suez Canal, they present an added difficulty to the competitive position of Somali bananas, which is at the moment entirely

dependent on the preference given in the Italian market. The preference has been re-negotiated from year to year for the last two years and it is hoped it will be extended to the end of 1970. Latest reports are that the growers in the Juba river area are able to repay debt commitments and maintain sufficient income to remain in production. On the other hand the Shebelli growers cannot meet debt obligations, in addition considerable new investment on handling facilities is required if costs are to be reduced and the present high port charges at Merca absorbed.

The situation of large investment needs and inability to raise exchange earnings quickly in the short term requires very careful selection and effective co-ordination and implementation of all projects. It also requires careful consideration of the logistics of development in order that the correct balance is maintained between non-direct revenue producing projects and those which not only pay their way but produce a surplus. The presentation of the Short Term Development Programme has been a major accomplishment by the Planning Commission and all Government personnel involved. But it must be pointed out that the problems of the First Development Plan, shortage of local finance, deficiencies in the administrative machinery and lack of basic information still exist and these make effective planning very difficult.

2.6 The Need for Development of Agriculture

Somalia's primary resource at present lies in 8 million hectares of cultivable land and a further 12 million hectares suitable for grazing. Of the cultivable area, approximately 1 million hectares are estimated to be productive at the present time. Agriculture and related activities provide income for at least 90 per cent of the population and virtually all exchange income is dependent on the export of agricultural produce. A large part of exchange expenditure on the other hand is on agricultural commodities, an appreciable proportion of which it is technically possible to produce in the country.

Although it is hoped that the country's mineral resources will make a substantial contribution to national income in the future, agriculture will remain the primary source of national wealth.

Sustained agricultural development will require substantial expenditure on research, extension, marketing organisation, imported physical inputs, irrigation facilities, infrastructure and all the ancillary pre-requisites for development. As there is little prospect of surplus domestic revenues being generated, most of the expenditure for financing development will have to be from foreign sources. As a result, not only will agricultural activity be required to provide an income which will allow for an increased per capita income level, but also eventually pay for the investment necessary to bring about that increase. Under these circumstances, development of agriculture in Somalia will require very effective planning since the present paucity of domestic finance leaves little margin for error in the estimation of economic viability of development proposals.

B. The Project Area

2.7 Location and Reasons for Selection

Following a brief soils and engineering reconnaissance during December 1967 and January 1968, an area of 4,500 ha. was selected for the Controlled Irrigation Feasibility Study. The area is located on the left bank of the Shebelli River about 19 km downstream of Afgoi and lies between the Afgoi to Merca main road and the Afgoi to Barire earth road running close to the river. Alternative locations on the right bank of the river downstream of Balad, on the left bank immediately downstream of Afgoi and in the Fornari area downstream of Genale were considered. Soils of the Balad area appeared inferior and the location formed part of the area eventually selected for a flood scheme feasibility study (see Volume II the Balad Flood Irrigation Project Feasibility Study). The area immediately downstream of Afgoi was already extensively developed for agriculture and the West German assisted dairying enterprise located some 4 km west of Afgoi would have

-necessitated dividing the irrigation scheme into two halves lying either side of that project. The soils and topography of the Fornari area appeared to offer no advantages over the area selected and as continguous development in that area was restricted to about 3,000 ha. there was no opportunity for future expansion should hydrological studies indicate sufficient water being available. Furthermore, the Somalia Government had expressed a preference for selection of a site outside the Genale-Bulo Mererta area to avoid possible difficulties over requisition of abandoned Italian concessions in that area.

Irrigation water for the scheme will be abstracted at a site on the river near the village of Mordile and for this reason the scheme was called the Afgoi-Mordile Project.

2.8 Climate

The climate of the Shebelli Valley in the vicinity of Afgoi is tropical semi-arid. Rainfall is very variable in both quantity and distribution from year to year and is often very local in occurrence. Table 2.1 shows the mean monthly and annual rainfall and maximum and minimum amounts recorded at Afgoi over 31 years.

TABLE 2.1 Mean, Maximum and Minimum Monthly and Annual Rainfalls at Afgoi in mm

	Months												Total for Year
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Mean	2.3	0.1	4.4	91.7	81.1	59.0	56.1	24.7	15.1	60.0	83.2	30.0	502.6
Highest	28	5	66	230	283	233	213	124	153	166	245	110	975
Lowest	0	0	0	0	0	0	0	0	0	0	0	0	192

Sources: 1. 'Contributo alla Climatologia della Somalia' Fantoli A. Ministero degli Affari Esteri, Rome.

2. 'Annual Reports of the Afgoi Research Station.

As shown in the table, rainfall occurs mainly in the two seasons April-June and October-November, locally called the 'Gu' and 'Der' seasons respectively. These seasons are associated with the passage of the intertropical front. Coastal showers locally called 'Hagai' rains occur in July and August, amounts being greatest on the coast but appreciable as far inland as Afgoi. Due to the showery nature of the rainfall and virtual absence of continuous recording gauge records, it is impossible to establish any reliable estimate of short term rainfall intensities. Amounts in excess of 75 mm in 24 hours are, however, unusual.

The fact that rainfall is distributed in two seasons, the relatively small amounts of rain at these seasons and the great variation in rainfall from year to year, place a severe limitation on crop production under rainfed conditions. An analysis of the rainfall expectation for each of the two cropping seasons was made and the results are shown in Table 2.2

TABLE 2.2 Expectation of Accumulated Rainfall in mm at Monthly Intervals Over the 'Gu' and 'Der' Cropping Seasons

Season	Period	Accumulated rainfall normally exceeded	
		5 years in 10	9 years in 10
'Gu'	April	95	0
	April-May	170	40
	April-June	225	85
	April-July	285	135
'Der'	October	35	0
	October-November	125	25
	October-December	155	55

Source: Derived from same source as Table 2.1.

Temperatures in the Shebelli Valley remain relatively uniform throughout the year, the hottest periods being February to April and October to November. Mean monthly maximum and minimum temperatures for Afgoi are shown in Table 2.3.

TABLE 2.3 Mean Monthly Maximum and Minimum Temperatures in °C for Afgoi

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Maximum	33.7	34.4	34.8	34.1	31.7	30.5	28.4	30.1	31.1	32.0	31.9	32.5
Minimum	21.7	21.9	23.0	23.6	23.2	22.7	21.5	21.5	21.8	22.1	21.9	21.7

Sources: Agriculture and Water Surveys Project Report.
Contributo alla climatologia della Somalia.

Relative humidity is highest during the April-June and October-November rainy seasons and during the July-August 'Hagai' season. Mean relative humidity is shown in Table 2.4.

TABLE 2.4 Mean Monthly Relative Humidity per cent for Afgoi

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
65	64	66	69	73	75	74	72	69	68	68*	68*

Source: 'Contributo alla Climatologia della Somalia'
- Fantoli, A.

* These values are low compared with records at other locations in the Shebelli Valley.

As few reliable records of solar radiation and evaporation were available, the meteorological station at the Afgoi Research Station was resited and equipment installed to provide records of all the climatic parameters necessary for the computation of estimated open water evaporation by the Penman method. Observations of wind speed at Afgoi during 1968-1969 were appreciably higher than previously recorded values and as the winds experienced during that period were not considered abnormal by local residents, the earlier records are suspect. An evaporation pan was installed at the Afgoi Research Station during the period over which observations were made and the measurements corrected for advected energy are in agreement with the estimated evaporation.

Mean monthly values for observations at Afgoi during 1968-69 are shown in Table 2.5. Rainfall at Afgoi during 1968 was higher than average, totalling some 267 mm in the 'Gu' season, 436 mm in the 'Der' season and an unusually high Hagai rainfall of 160 mm. This would account for the recorded temperatures being generally lower than normal and humidity appreciably higher over much of the period.

TABLE 2.5 Total Monthly Rainfall and Mean Monthly Values of Temperature, Humidity, Wind, Solar Radiation and Evaporation at Afgoi during 1968-69

Month	Rain-fall mm	Max. Temp. °C	Min. Temp. °C	Rel. Hum. %	Wind km/day	Sunshine hrs/day	Radiation Langleys /day	Evaporation mm/day	
								Computed	Pan
1968									
March	24.9	34.4	22.6	71	306	8.1	575	7.8	
April	164.8	32.0	23.4	81	196	5.2	470	5.7	
May	70.1	30.9	23.2	85	205	6.4	484	5.7	
June	32.4	30.7	21.7	81	267	6.9	511	5.7	
July	128.8	28.2	21.2	83	324	5.9	481	5.4	
August	31.2	28.2	19.6	77	305	8.0	533	5.7	6.0
September	1.5	29.3	19.7	69	312	8.9	575	6.8	6.8
October	92.0	30.2	20.8	72	248	6.8	522	6.6	6.7
November	242.8	28.8	20.7	83	144	4.5	409	4.6	4.4
December	101.9	29.9	20.5	84	204	6.5	425	5.2	-
1969									
January	9.7	31.3	19.3	79	269	8.2	580	6.1	5.7
February	-	31.5	21.4	78	347	9.1	611	7.6	
March	6.6	32.2	22.4	75	282	9.1	600	7.5	
April	24.6	32.4	22.4	68	256	9.1	603	7.3	
May	227.1	29.8	22.7	89	210	6.7	508	5.5	

2.9 Topography

A grid of traces was cut at 1 km intervals, the traces being approximately parallel with or perpendicular to the Afgoi to Merca main road. Tacheometric traverses were made using these traces together with a tellurometric traverse round the perimeter of the area and along the central cross traces. Subsequent plotting at 1:20,000 scale revealed no major discrepancies. Using existing undisturbed benchmarks along the Afgoi to Merca and Afgoi to Barire roads for datum references, spot heights were measured at 200 m intervals, except where appreciable changes of slope required closer spacing. After plotting these spot heights, existing uncontrolled air photography was used to draw approximate contours at 0.5 metre vertical intervals over the entire area. The air photography was inadequate to permit contouring to this accuracy without the ground survey detail, due to its scale and unacceptable tilts of adjacent photographs and variations in scale of as much as 10 per cent.

The topographic map, Plate 1 shows a general slope of about 30 centimetres per kilometre parallel to the river. The area is slightly undulating with ridges of higher ground along the Afgoi to Barire road and at the eastern corner of the area near the village of Idamoun.

A sample area of 100 hectares was levelled in greater detail along traces cut at 200 metre intervals in order to provide information on local variations in level required for engineering design and estimation of quantities. The sample area is shown on Plate 5.

Data from the survey including a list of permanent benchmarks installed are given in Appendix I.

2.10 Soils

A semi-detailed soil survey of the area was made at a density of 7 sites per square kilometre, 109 of these sites being sampled and 475 samples taken at fixed depths and later chemically analysed. In addition, at selected sites, core samples were taken for laboratory analysis of soil physical characteristics.

TABLE 2.6 Soil Classification

Landform Subdivision, Order, Series and Subseries	Mapping Symbol	Texture	EC mmhos/cm
FLOOD PLAIN MEANDER			
VERTISOLS			
CHROMUSTERT (Recent Alluvial)	Gl		
Udic Chromustert: hue 10YR.	Gl 1a		
	Gl 1a11	medium/fine overlying medium/coarse	<4
	Gl 1a21)	medium/fine overlying	<4
	Gl 1a22)	fine	>4
	Gl 1a31	medium/fine overlying stratifications	4
Udic Chromustert: hue 7.5YR.	Gl 1b		
	Gl 1b11	medium/fine overlying medium/coarse	<4
	Gl 1b21	fine	
	Gl 1b31	medium/fine overlying stratifications	<4
Udorthentic Chromustert	Gl 2		
	Gl 211	medium/fine overlying medium/coarse	<4
	Gl 221	medium/fine overlying fine	<4
PELLUSTERT	Gl		
Udorthentic Pellustert	G 13		
	Gl3 11	medium/fine overlying fine	<4
CHROMUSTERT (Old Alluvial)	Sr		
Udic Chromustert	Sr 1		
	Sr 111)	medium/fine overlying	<4
	Sr 112)	fine	>4
Udorthentic Chromustert	Sr 21		
	Sr 211)	medium/fine overlying	<4
	Sr 212)	fine	>4
FLOOD PLAIN SLACKWATER			
VERTISOLS			
PELLUSTERT	Sc		
Udorthentic Pellustert	Sc 11		
	Sc 111	medium/fine overlying fine	<4
CHANNEL REMNANT (Levée Soils)			
ENTISOLS			
USTORTHENT	C		
Typic Ustorthent	C 11		
	C 111	coarse/medium throughout profile	<4
	C 121	coarse/medium overlying fine	<4
	C 131	coarse/medium overlying stratifications	<4

The soils were classified on the basis of the U.S. Department of Agriculture Soil Classification 7th Approximation (1960) and subsequent Supplements (1964 and 1967) using field profile descriptions and chemical analysis results. Two soil orders were identified in the area, namely Entisols and Vertisols and the soils map, Plate 2, shows the distribution of these orders and the subdivisions of each order based on soil texture and electrical conductivity. This soil classification is shown in Table 2.6.

Vertisols occur in flat areas and slight depressions, are brown to yellowish brown in colour and of fine texture, ranging from clay loam to silty clay to clay, in some cases, overlying moderate or coarse textured horizons or stratified material. The surface consists of a soft mulch or semi-hard to hard crust. These soils have no salt or sodium hazard in the topsoil but may have a slight to moderate or occasionally severe salt hazards in the subsoil.

Entisols occur as isolated patches or narrow relatively high ridges corresponding to former river levées. They have coarse to moderately fine textures and are generally more saline and alkaline than the vertisols.

Hydraulic conductivity tests carried out on undisturbed core samples indicate that, in general, the soils have no irrigation or drainage problems except for the Udorthentic Chromusterts, which need careful management under irrigation due to their rather low hydraulic conductivities. Soils overlying stratified material may also suffer some degree of reduced conductivity.

Previous studies of infiltration at the Afgoi Research Farm indicated a steady infiltration rate of approximately 0.4 cm/hour after rapid initial infiltration in dry soil through cracks. Two further tests in the Afgoi Project area confirmed infiltration to be of this order. It is not possible to forecast accurately the effects of irrigation on the soils over a long period. The possibility of changes arising in hydraulic conductivity due to the presence of salts or sodium in the irrigation water must be borne in mind.

Soil moisture retention characteristics were measured on undisturbed core samples from six sites typical of the more important soil series. Available moisture is defined as the difference in moisture content of the soil between Field Capacity and Permanent Wilting Point. A soil suction of 0.3 atmospheres is frequently accepted as representing the field capacity condition and a suction of 15 atmospheres is taken as equivalent to the permanent wilting point. The soils of the Afgoi-Mordile area can retain 10 to 15 per cent v/v available moisture or between 10 and 15 cms of moisture per metre depth of soil.

The Land Classification Map, Plate 3, has been prepared, based on the U.S. Bureau of Reclamation Standards Specification, modified to suit prevailing local conditions. In the classification, the following criteria were used:-

a) Depth of soil to horizons likely to limit root development.

b) Salinity expressed in mmhos/cm electrical conductivity (EC).

c) Exchangeable Sodium Percentage (ESP) a value of 15 being taken as critical.

d) Texture, Five textural classes are recognised.

e) Topography. Former river channels being excluded from cultivable land.

f) Profile characteristics affecting drainage and root development.

The characteristics of each land class are shown in Table 2.7.

For further details of the soils of the Afgoi-Mordile area and similar soils studied in the Balad area, the reader is referred to Volume V - 'Soils and Agriculture'. Results of individual analyses and all profile descriptions are included in the Data Annex reproduced to accompany the report Volumes 4 and 5.

TABLE 2.7 Land Classification Applicable to Controlled Irrigation Schemes

Class	1	2	3	4	6	Symbol
Minimum soil depth to different texture class (cms)	100	60	60	50	50	d
Salinity						
E. C. in mmhos at fixed depths						
0- 50 cm	< 4	<4	4-8	8-12	unlimited	s
50-100 cm	<4	<4	<8	8-12	unlimited	
100-150 cm	<4	4-8	<8	unlimited	unlimited	
Alkalinity						
ESP at fixed depths						
0- 50 cm	<15	<15	<15	15-25	unlimited	a
50-100 cm	<15	<15	<15	<25	unlimited	
100-150 cm	<15	<15	<15	unlimited	unlimited	
Texture	sandy loam to friable clay	loamy sand to permeable clay	loamy sand to moderately permeable clay	loamy sand to clay	unlimited	b = stratifications v = very coarse texture l = moderately coarse texture m = moderately fine texture h = very fine texture

Table 2.7 Land Classification Applicable to Controlled Irrigation Schemes (cont'd.)

Class	1	2	3	4	6	Symbol
Topography	little gilgai formations or no restrictions	moderate gilgai formation or no restrictions	moderate gilgai formation or moderate restrictions	severe gilgai or moderate restrictions	unlimited	g = gilgai t = topography
Profile Characteristics	no limit to water movement or root development. Well structured	water movement and root movement a little impeded. Well to moderately structured.	water movement and root development restricted moderately structured.	water movement and root development moderately to severely restricted moderately to poorly structured	unlimited	p

2.11 Vegetation and Bush Clearance

A classification of the vegetation over the area was made by means of visual observation and photo-interpretation. The vegetation comprises grasses and herbs, shrub and tree species. The following four categories were used as a basis for the estimation of clearance requirements.

Class I — Land at present under cultivation carrying only scattered shade trees, usually Dobera glabra, and Acacia bussei or land recently abandoned with only light regeneration of bush.

Class II — Land cultivated in the past, but with considerable regenerated bush largely Comiphora spp. with some Acacia nubica and A. nilotica and scattered specimens of Dobera glabra. Open grassy areas are common and constitute about 50 per cent of the area covered by this class.

Class III — Dense bush comprising Acacia nubica, A. nilotica, A. bussei, A. seyal, Comiphora spp., Cordia gharaf, Dobera glabra, Grewia spp., Dichrostachys glomerata, Euphorbia spp. and Salvadoria persica with less than 25 per cent of the area constituted by open grassy areas.

Class IV — Impenetrable heavy bush with few open spaces with Dichrostachys glomerata being the dominant species.

Mechanised clearance will involve the use of crawler tractors of 100 H.P. or larger, preferably equipped with a front mounted rock rake to uproot and windrow the bush for burning. The operation should be followed by root ploughing. Mechanised clearance should not be necessary for vegetation Class I. The areas of each vegetation class and the estimated tractor hours required for clearance and subsequent root ploughing are shown in Table 2.8.

TABLE 2.8 Vegetation Class, Areas and Estimated Tractor Hours Required for Bush Clearance and Root Ploughing

Bush Clearance Class		Estimated Area ha.	Estimated Tractor hours per ha.	Total Hours
I	Cultivated or abandoned with little regeneration and scattered trees	1010		
II	Light Bush and scattered trees	760	$2\frac{1}{2}$	1900
III	Moderate bush and frequent trees, some large	890	5	4450
IV	Dense thicket	1140	4	4560
			Sub-Total	10910
	Root ploughing	2790	2	5580
			Total	16490

Estimated cost based on the prevailing hiring charge of Shs. 52. per hour for the type of equipment required is Shs. 1,020,000 including a contingency factor of 20 per cent or Shs. 369 per hectare cleared. This compares with costs of Shs. 270 per hectare for recent clearance at Johar and Shs. 300 to 500 for recent work at Afgoi.

Following mechanical clearance, collection and burning of remaining débris by hand will be necessary before subsequent ploughing operations to prepare the land for planting.

2.12 Population and Source of Settlers

Two villages, Idamoun and Bulo Shan lie within the proposed Afgoi-Mordile project area. The village of Mordile on the Shebelli River at the proposed site for diversion of irrigation water is very close to the edge of the project as are the villages of Feda Musse and Rahole to the south-west

of the project, near the Afgoi-Merca road. Further from the area are the villages of Booro, Buslow and Daarta, lying near the Merca road and Merere, Zabed and Beled el Amin on the river.

A population census was carried out in two villages in the project area and at Mordile; the results are shown in Table 2.9.

TABLE 2.9 Population statistics of three villages in or adjacent to the Afgoi-Mordile Project

Village	Number of Households	Number of Adults[1]			Children	Total	Average number per household
		Male	Female	Total			
Idamoun	39	44	46	90	105	195	5.0
Bulo Shan	9	9	9	18	10	28	3.1
Mordile	63	58	77	135	100	235	3.7

[1] Adults were defined as persons judged to be 16 years old or over and able to undertake all types of work on a holding.

In 1966 a census for tax purposes of all villages gave the number of households as shown in Table 2.10.

As these figures were for taxation purposes, the return may be expected to be low and in fact, the total households for the three villages in Table 2.9 are some 15 per cent higher than for the previous census. The total number of families in the villages listed in Table 2.10 is therefore assumed to be of the order of 750.

A survey of the Afgoi Municipality made by the Statistical Department of the Ministry of Planning in 1964 indicated a population of 5009 engaged in agriculture of which 2552 were farmers and 2101 agricultural workers.

The proposed Afgoi-Mordile Project will require some 750 settlers. The great majority of the population of the area are presently engaged in raingrown agriculture as are the people in the surrounding district. The people interviewed in the course of the census were generally enthusiastic

about the proposed scheme, which would provide a higher income albeit with a more extended and regular work input requirement. Whilst a sufficient number of potential settlers should be found without difficulty, the success attained and their recruitment to the scheme will ultimately depend on the willingness of such settlers to accept the inevitable discipline on which an irrigation scheme depends. The necessary reallocation of the present cultivation rights in the project area may result in problems. Those who cannot be allocated land or do not wish to join the scheme, in particular older farmers and widows who would be unsuitable as settlers, would require either alternative land outside the scheme or compensation for the land which they presently cultivate within the project area.

TABLE 2.10 Population statistics of villages in and around the Project Area from 1966 Census

Village	Administrative District	Number of Households
Beled el Amin	Afgoi	99
Booro	"	8
Buslow	"	31
Daarta	"	30
Idamoun	"	30
Merere	"	248
Mordile	"	57
Zabed	"	115
Bulo Shan	Audegle	9
Feda Musse) Rahole)	Merca	55
	Total:	682

2.13 Present Agriculture

Agriculture within the selected project area is restricted to rainland cultivation at present but small areas of irrigated (inundation) agriculture exist near villages along the river.

During the census carried out in the project area and referred to in 2.12 above, an inquiry was made into the farming activities of people resident, particularly in the villages of Idamoun and Bulo Shan. The questionnaire referred specifically to the previous year's activities as it was unlikely that accurate data would be given over a longer period. Many of those interviewed experienced difficulty in giving precise quantitative answers to questions on area cultivated and crop yields. In view of this problem and the natural suspicion of strangers coupled with the reluctance to provide information which might be used for taxation purposes, the result of the enquiry must be looked upon as giving only a general indication of family activities in agriculture and the results should be interpreted with caution.

A total of 63 farmers were interviewed of which 45 were from Idamoun village and the remainder from 4 adjacent villages. Farmers may cultivate more than one holding and the 63 farmers interviewed cultivated a total of 92 holdings, the holdings not necessarily being close to the farmer's village. Land is traditionally held on a tribal basis and each member of a tribe has a right to cultivate land in his sub-tribal area. Members of other tribes are allowed to cultivate within an area if adequate land is available, and providing they conform to the customs of the host tribe.

Cultivation rights assigned to individual plots are in general inherited through the male line but women also hold rights to cultivate. Sale of land is rare but renting is more common, a normal rent being Shs. 5 per ha. per year. Re-distribution of land within the proposed irrigation development will give rise to claims for compensation both for land presently in use and for other uncultivated areas to which members of the local tribe can lay claim.

In order to assess the area cultivated by a family the holdings of persons interviewed were inspected and the areas estimated by pacing. In Idamoun village, the average area cultivated by a farmer was 2.3 ha. and the largest area cultivated as one enterprise was 5.7 ha. These areas are much below the 15 ha. average quoted by the Agriculture and Water Surveys Report for the Inter-River area as a whole.

The customary cropping pattern consists of maize in the 'Gu' season which is interplanted with sesame shortly before harvesting. The sesame crop depends on the amount and distribution of the 'Hagai' rains in July and August. Sorghum is usually grown in the 'Der' season but some maize is also grown. These principal crops may also be interplanted with soya and castor beans. Water melons, tomatoes and papaya are also grown.

Yields quoted for the major crops in 1968-69 are shown in Table 2.11, the figures being in quintals which generally represents a weight of 94-96 kg.

TABLE 2.11 Approximate yields of major rainland crops grown in 1968-69 in the Afgoi area

Crop	Season	Total Area (measured) ha.	Total Quoted Production in quintals	Average Yield in quintals ha.	Crop failures quoted % (all farms)
Maize	Gu	122	493	4	34
	Der	30	92	3	35
Sesame	Hagai	70	52	0.75	36
	Der	11	14	1.25	27
Sorghum	Der	85	354	4	2

The year 1968-69 was generally considered a poor one by the farmers although rainfall in both 'Gu' and 'Der' seasons was up to or above average. Low yields were possibly associated with poor distribution of rainfall during the rainy seasons and with pest and disease incidence which was high.

Crops over and above the subsistence needs of the family are normally sold to merchants but some are exchanged for goods supplied by local shopkeepers. Prices quoted for 1968-69 sales were as shown in Table 2.12.

TABLE 2.12 Quoted Afgoi prices 1968-69

Crop	Season	Price Shs/quintal	No. of deals
Maize	Gu	39	26
	Der	55	5
Sesame	Hagai	168	12
Sorghum	Der	37	20
Beans		61	5

Work on the holdings is normally undertaken by the farmer assisted by his family.

The labour provided by women in villages away from the river is limited by their having to carry water from the river during dry periods of the year. Labour peaks occur during pre-planting cultivation, weeding and harvesting of the crops and at these times additional labour may be needed. Normally this extra labour is hired, 41 of the farmers interviewed having hired labour during the past year. The normal daily rate for such labour is Shs. 2.50 plus food for working between 6 a.m. and midday. If the labourer also works in the afternoons the normal rate is Shs. 5.00. At busy times the rate may be appreciably higher.

Approximately half the farmers interviewed used private contractors for ploughing during 1968-69, the normal rate being Shs. 25 per hour. Frequently the farmer borrowed money for the hire of machinery and there is a strong desire among farmers for machinery to be more readily available on credit terms.

Few settled farmers in the area earn any appreciable income from livestock. Cattle may be bought after a good harvest and are often kept by a paid herdsman outside the Afgoi area and subsequently sold if money is required due to a crop failure.

Of the 63 farmers interviewed 23 stated that they owned cattle, the number owned varying from 1 to 28 but being generally less than 5 head. These figures are probably conservative due to a traditional reticence in giving details of livestock ownership. Most families own poultry, and goats are kept in and around the villages. Eggs may be sold at Shs. 0.10 to 0.15 each. Milk when produced in excess of family requirements is sold at Shs. 0.30 to 1.00 per litre.

The income from such dry land farming is low and the small margins coupled with the uncertainty of rainfall and frequency of crop failure suggests that the introduction of improved techniques will be hazardous. The increased production costs resulting from such new methods, whilst being compensated by higher yields in good seasons might prove disastrous in years of partial or complete crop failures.

One of the most industrious farmers in the area cultivated 5.7 ha. with the assistance of his son, he kept one cow to provide milk for the family and some 30 chickens. Besides producing the family's grain requirements, sales of grain, maize and sorghum straw and surplus eggs were estimated to give a return of Shs. 1000-1200 per year from which hired labour charges of some Shs. 300 per year must be deducted. A net cash income of Shs. 700-900 remains or Shs. 60 to 70 per month for household expenditure for a family of 6.

2.14 Surface Water Resources

The expectation of seasonal river discharge quantities at the Afgoi gauging station are shown in Figure 2.1 and these apply to the site at which water would be abstracted for the Afgoi-Mordile project. Present use and possible future demands for irrigation water in the Genale area downstream must be allowed for when assessing the availability of water

for an irrigation project at Afgoi. The flows during the September-November period are consistently high with flows in December and January being lower and less reliable. The February-March period is marked by low flows and at this time existing cultivation of perennial crops at Afgoi and Genale already has to rely on groundwater from tubewells or limited quantities of river water stored in ponded areas. The April-May flood season is less reliable than that of September-November and river levels are seldom as high. During June-August flows are usually low. The cultivation of perennial crops requiring year-round irrigation is not possible without provision of expensive storage reservoirs or use of groundwater. The reliable river flows of the 'Der' season would enable the cultivation of annual crops at this time providing the cropping season is so arranged as to keep the requirements for water during the late December-January period as low as possible. Availability of water for the irrigation of annual crops cultivated in the 'Gu' season is less reliable but the greater reliability of rainfall at this time does to some extent offset the risk of irrigation supplies being seriously inadequate for the crops' moisture needs.

In subsequent chapters of this report a suitable annual cropping rotation is recommended and the seasonal water requirements are estimated. The water requirements for the 'Der' season from the second week in August to the second week in January (see Figure 4.2) can be met 3 years in 4 without any difficulty, (see Figure 2.1). The peak water requirement is 238,000 cumecs or 2.76 cumecs river flow.

If the project could be given priority over other users, such as the banana growers at Genale who have tubewells, then even in a minimum year the main crop areas could be irrigated during the low flows in December and January.

If the offstream storage proposals discussed in Volume IV are implemented then the water supply is assured for the whole cropping season in every year.

The 'Gu' season water requirements for median and 10 per cent dry years are shown in Figure 4.3; the peak demand is approximately 1.35 cumecs, although normally 1.20 cumecs is considered sufficient. The demands in April, May and the first half of June can be met 3 years in 4 when the flow is greater than 8 cumecs. If priority use is established then the demands for the whole season can be met three years in four, but the river flows are at times so small that a low gabion weir may be necessary to maintain the required river level for pumping. The stage discharge relationship for the pump site is shown in Figure 5.1, but the lower section of the curve could not be checked during 1968 as there were no low flows. From an inspection of the recorded monthly rainfall figures for Afgoi and the recorded monthly river flows it is considered that there will be an adequate water supply three years in four for most of the season without the priority use being established.

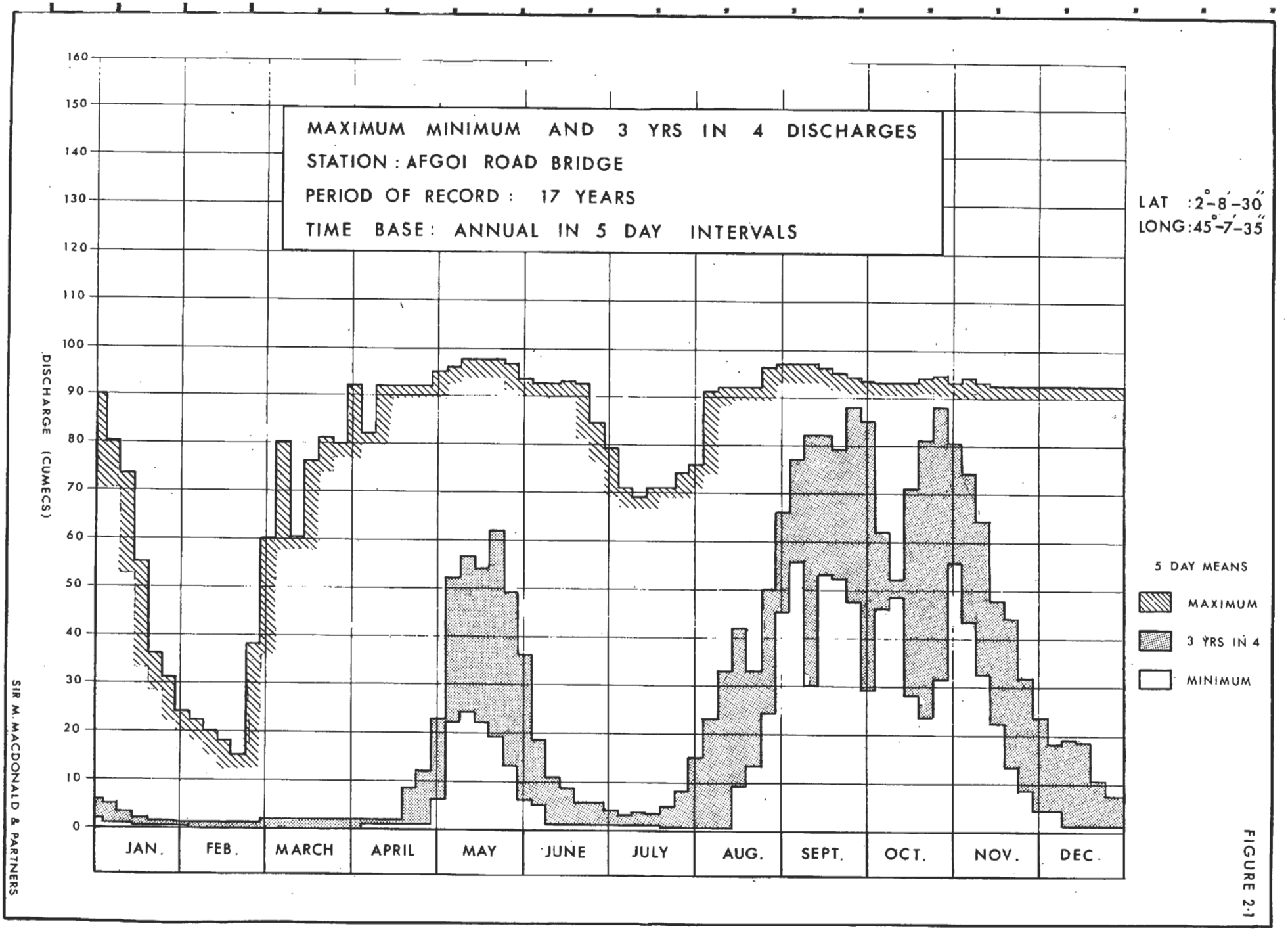
The quality of the river water is discussed in Volume IV and the main conclusions as they affect the Afgoi-Mordile Project are as follows:-

i) The silt content is unlikely to cause serious problems provided that the first ten days of the 'Gu' flood water are allowed to pass and that the canals are properly maintained.

ii) The water salinity is generally low and the first few days of the 'Gu' flood is the only period in which the water may prove unsuitable with salinity in excess of 1000 ppm.

2.15 Groundwater Resources

The first stage in the investigation of groundwater resources in the project area consisted of a detailed resistivity survey. The results of this investigation indicated that coarse sand and gravel were likely to be present below the water table in the southern and central parts of the project area, but that in the rest of the area the alluvial deposits were likely to be extremely variable. Well site locations were selected where the resistivity measurements indicated the presence of good quality groundwater. Only one of the recommended locations was drilled; this borehole


MAXIMUM MINIMUM AND 3 YRS IN 4 DISCHARGES
STATION : AFGOI ROAD BRIDGE
PERIOD OF RECORD : 17 YEARS
TIME BASE : ANNUAL IN 5 DAY INTERVALS
LAT : 2°-8'-30"
LONG : 45°-7'-35"
DISCHARGE (CUMECS)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
JAN.
FEB.
MARCH
APRIL
MAY
JUNE
JULY
AUG.
SEPT.
OCT.
NOV.
DEC.
5 DAY MEANS
MAXIMUM
3 YRS IN 4
MINIMUM
SIR M. MACDONALD & PARTNERS
FIGURE 2-1

confirmed the presence of gravel and useful aquifers below the water table - 66 per cent of the strata between depths of 50 and 145 metres below ground level were permeable.

The depth to water table increases away from the river Shebelli. The static water level in a tubewell near Mordile, less than a kilometre from the river, was reported to be 38 metres below ground level. At the project's test tubewell (T. W. 1), and the tubewells across the Afgoi-Merca road the static water level is 58 metres or more below ground level. The resistivity measurements indicated the water table at depths of over 40 metres below ground level, at distances greater than 2 kilometres from the river.

The water pumped from the test tubewell had an electrical conductivity value of 2500 micromhos per centimetre. Water of this quality is classified, under the United States Salinity Laboratory classification for irrigation water, as being in the high salinity-medium sodium (alkali) hazard range, and should be used directly only on salt-tolerant plants and where drainage is unrestricted.

Test pumping of T. W. 1 gave a specific capacity value of 1. 25 cubic metres per hour per metre, and the coefficient of transmissibility was calculated to be approximately 36. 1 cubic metres per day per metre. Both these figures are thought to be low, however, since the well was not hydraulically efficient. From other well data a value of 70-110 cubic metres per day per metre for transmissibility is considered to be more realistic.

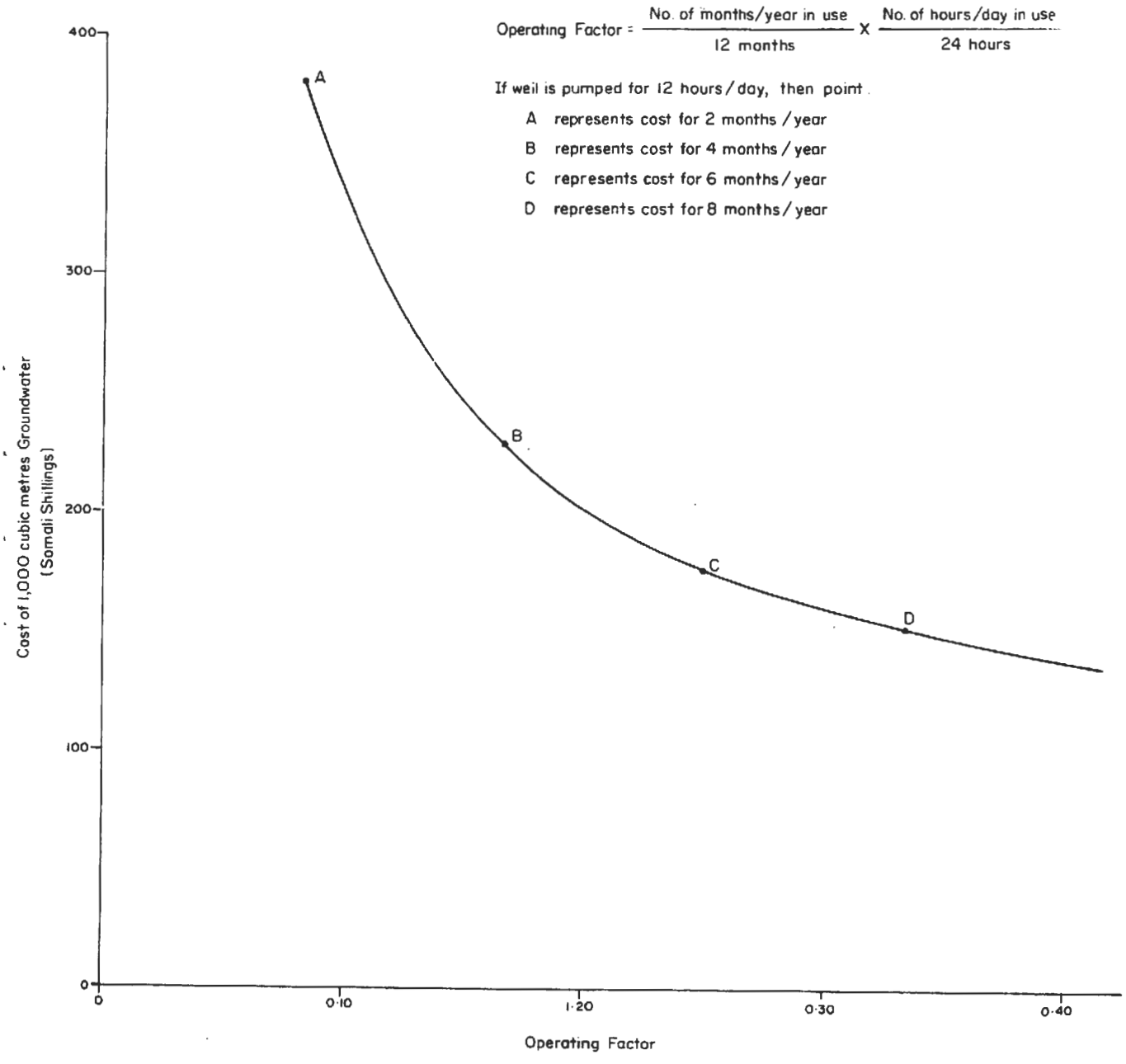
Groundwater recharge within the project area is considered to be minimal because observation wells in the Afgoi region gave no indication of seasonal recharge except during years of very high river flows.

Figure 2. 2 shows the estimated costs of extracting 1, 000 cubic metres of groundwater from a well, with a discharge rate of 65 cubic metres per hour, using different operating factors. The diagram shows that the cost of groundwater increases rapidly as the period of operation decreases.

Since, in certain years, groundwater would only be required for a maximum period of 2 months during the 'Der' cropping season it is apparent that providing satisfactory yields of short season crops irrigated solely from river water supplies can be obtained, the use of supplementary groundwater to extend the growing season would be financially unattractive except for very high value crops. Increasing the period of operation to, say, 4 months or more would probably result in large scale depletion of the groundwater reserves and hence a progressive increase in annual costs of exploitation. It appears, therefore, that groundwater would be too expensive for utilisation on this project for irrigation of crops.

ESTIMATED COST OF GROUNDWATER EXPLOITATION

Total depth of well = 125 metres; Length of screen = 20 metres
Diameter of well string = 20 centimetres; Discharge = 65 cubic metres/hour
Static water level = 60 metres; Estimated drawdown = 25 metres



CHAPTER 3

AGRICULTURE

3.1 Potential Markets for Crops and Livestock

In selecting crops for the project, it is essential that availability of a reliable marketing outlet for the produce is assured, that a further demand can be clearly foreseen and that production will give a reasonable return to the farmer.

Assessment of the potential export market is difficult, because apart from bananas and livestock and small quantities of cotton, there has been no sustained export of agricultural produce over the past ten years. There are prospects for the exportation of certain agricultural commodities primarily to Middle Eastern markets, but there has, as yet, been no investigation into the potential volume required of such commodities and for this reason immediate possibilities for export have to be discounted. On the other hand past import trends give a clear indication of potential future demand for crops, which can substitute for these imports.

Of the current agricultural exports, the perennial banana and citrus crops are experiencing difficulty, due to uncertain markets, production problems and in the case of bananas,high costs. The export of livestock has greater future promise providing certain problems can be overcome. This has been the fastest growing sector of exports during recent years, exports of live animals having risen from 448, 000 in 1958 to 1, 151, 000 in 1966. Although, few reliable figures on total livestock production are available, the Agriculture and Water Survey report estimates that some 60 per cent of production is consumed internally and the balance exported. Export demand for livestock is expected to remain buoyant especially in Saudi Arabia which currently takes approximately 60 per cent of Somalia's livestock exports. Present substantial but unrecorded exports to Kenya are expected to decrease with a corresponding increase in throughput at the Mogadiscio and Kismayu meat factories, the latter being hopeful of

developing a market for its products in Pakistan. Internal consumption of livestock is expected to rise by about 3 per cent annually. All livestock marketing in Somalia has, so far, been by private trading and the fact that exports have increased each year since 1958, indicates this to be a reasonably well organised and successful business. This success has been achieved despite the great distances over which animals have to be moved, inadequate port and shipping facilities and liveweight prices which are not unduly high. The present policy of the Livestock Development Agency (LDA) is limited to introducing buying by weight and auction and to establishing minimum prices in areas particularly in the south where present prices to the farmer are unattractive. Should Somalia, in the future, be able to meet the health and quarantine requirements for exports to markets for higher quality meat the L. D. A. may have to play a more active role in providing the facilities required in order to sell meat on these markets.

Statistical records of internal crop marketing operations in Somalia are sparse and it is, therefore, difficult to assess the capability of the private trading structure to handle substantial volumes of produce efficiently to allow a reasonable handling margin, an attractive price to the farmer and a competitive price to the consumer. The Government has tried to establish regularised marketing outlets for the major grain crops through the establishment of the U. N. D. P. / F. A. O. Grain Marketing, Storage and Price Stabilisation Project and for cotton through the activities of the Agricultural Development Agency. Marketing of sesame, the other major crop, is left entirely to the private trader.

The grain marketing project was established with the aim of providing a stable market for the farmer and a reasonable price to the consumer. It has been found that low farm gate prices for grain relative to high wholesale prices at certain times of the year were due more to fluctuations in grain supply, poor access to grain growing areas and scarcity of transport facilities, than to monopolistic and inefficient trading. Moreover, the prices paid to farmers for sorghum grain and

maize are at times above the c. i. f. price for these commodities in European ports. The operations of the Grain Marketing project have been temporarily suspended, pending the development of a new strategy to improve the marketing structure. The indications are that the project organisation will remain as an advisory and research body to assist and regulate the private trading sector and only itself undertake trading operations where it is proved that the private sector cannot dispose of produce efficiently.

Seed cotton is presently bought and ginned by private merchants and the Agricultural Development Agency; the latter is intended to be the sole supplier for the Balad Textile Mill and purchases lint cotton from these merchants. The price of lint delivered to the Balad Mill during 1969 has been equivalent to the average projected c. i. f. price in European ports for top quality cotton. This high price has largely resulted from high collecting, transport and ginning charges. The Agency has agreed to waive its commission charges, but even allowing for this it is unlikely that the newly established textile mill can pay more for its local cotton supplies than the projected f. o. b. price. If a reasonably attractive price to the farmer is to be maintained, ginning and marketing costs must be appreciably reduced.

It will be necessary to resolve these uncertainties in the future marketing situation in order to ensure satisfactory disposal of produce for internal markets from new development projects.

Apart from bananas and small exports of cotton and citrus, external marketing of crops has not been developed. Part of the function of the National Agency for Foreign Trade (ENCE) is to undertake export promotion of agricultural produce. To date ENCE has only dealt with imports and administration of commodity aid items. The organisation is keenly interested in developing exports, but although enquiries regarding importation of Somali produce have been received mainly from Middle Eastern markets, the lack of a sound production base for the commodities has prevented viable export promotion. Although the short term possibilities for the export of produce are remote, schemes

such as the Afgoi-Mordile project, if implemented, might provide the sound base on which future exports markets might be developed.

The following are assessments of the potential for expansion of production of individual agricultural crop products considered for the Afgoi-Mordile Project.

a) Perennial Crops

i) Bananas

Although it is technically possible to reduce the cost delivered to the ship of export bananas grown in the Genale area of the Shebelli Valley, the industry faces considerable difficulties in doing so. At the production stage, fairly far reaching reorganisation of management and farm operations has to be undertaken, which would lead to considerable social conflict and upheaval, especially in the present critical marketing situation. The banana estates have heavy debt obligations which they are presently unable to meet and further expenditure would be necessary to rehabilitate and improve irrigation facilities, consolidate production units and improve access roads, in order to increase yields and reduce transport costs and packing house delays. Packing and inspection are well organised, but cost of boxes is high, due mainly to high shipping and handling charges. Road conditions from packing house to the port are reasonable. Reduction in ship loading costs seems unlikely until better harbour facilities are available. Shipping costs around the Cape are now not unduly high but they, along with the increased wastage during the longer sea passage, are an added burden to an industry whose competitive position in the Italian preference market is at the moment precarious.

In view of the possibility of more efficient production in the Genale area, the considerable investments which have

already been made and the present difficult market situation, an expansion of banana growing elsewhere on the Shebelli River cannot at the moment be recommended.

ii) Grapefruit

Approximately 70 ha. of grapefruit is cultivated in Somalia at present. It was planned to expand through the planting of a further 1,500 ha. by local farmers, finance being provided from the European Development Fund, but the present marketing difficulties are delaying implementation. When the Suez canal was open, some 200 tons of grapefruit were exported annually to Italy, but since the closure of the canal all production is sold on the domestic market at a price which barely covers costs.

If Somalia is to break into the citrus export market, considerable effort will have to be put into market promotion and although present production costs are competitive, the need to eliminate skin diseases could increase these costs appreciably. Since grapefruit takes some 10 years from planting to reach full production any uncertainty as to future markets imposes considerable risk on the grower. Further planting of grapefruit beyond the extensions already planned is not recommended until the problems of producing a fruit quality acceptable to the oversea's market have been solved and the needs of a viable marketing organisation examined.

iii) Sugar Cane

Projected sugar output from the Johar sugar estate would meet the F.A.O. projected demand on the low gross domestic product (GDP) assumption beyond 1975. Production could be expanded to meet the projected demand for 1985 on the low G.D.P. assumption by reclaiming saline areas and by extending cultivation in the Johar area. In view of the present

low world market price for sugar, the high cost of setting up a new estate and the likelihood that Johar can meet the domestic requirements, cultivation of sugar elsewhere in the Shebelli Valley is not recommended.

b) Annual Crops

i) Rice

Rice at present constitutes the largest single import into Somalia, on average, just under 8 per cent of the total annual value of imports over the years 1962-1966. Annual quantities for this period are shown in Table 3.1.

TABLE 3.1 Rice Imports 1962-66

Year	Quantity metric tons	Value Shs. '000	% of Total Imports by Value
1962	16.774	18,984	7.0
1963	22,804	21,749	6.8
1964	36,618	38,535	9.9
1965	28,795	29,793	8.4
1966	22,078	22,498	7.5

Source: Somalia Statistical Abstracts 1967.

F.A.O. projections of rice consumption in Somalia range from approximately 29,000 tons on a low G.D.P. assumption to 40,000 tons on a high G.D.P. assumption by 1975. Under controlled irrigation yields of the order of 2.5 tons per ha. would not appear unrealistic and at this yield level rice gives one of the highest gross returns of all annual crops considered. It is therefore recommended for cultivation in the Afgoi-Mordile Project. Since the Grain Marketing Project which was interested in developing and marketing the crop is in the process of being reorganised, the choice of marketing arrangements must await further developments.

ii) Cotton

The commencement of production at the Somaltex Cotton Factory at Balad in July 1968 provided for a substantial expansion in the domestic market for cotton. The Factory will produce cheap dyed or bleached cloth for domestic consumption from medium staple cotton which at present, is only grown in small quantities. Production will need to be expanded considerably to provide the 1,500 tons of lint per year required by the factory when operating to capacity, without the need for imports.

Cotton fabrics presently constitute a substantial percentage of total imports.

TABLE 3.2 Imports of cotton fabrics 1964-66

Type of Material	Year	Metric Tons	Value (million Shs.)	% Total Imports by Value
Grey unbleached	1964	635	4.813	1.2
	1965	361	2.429	.8
	1966	320	2.315	.8
Bleached, dyed, etc.	1964	1,725	22.588	5.8
	1965	1,208	14.199	4.0
	1966	1,946	18.539	6.2

Present plans by ADA to supply the requirements of the factory through promotion of cotton production under both rainfed and irrigated cultivation by established farmers could result in production over and above domestic needs if the Afgoi-Mordile Project and a flood irrigation project at Balad were also implemented and produced cotton in substantial quantity. Under existing farming conditions, however, considerable difficulties are foreseen in producing cotton efficiently, particularly in view of pest and disease problems. In the event of a domestic surplus arising,

it is likely that the relatively small amounts of cotton involved could be exported as in the past.

Because of the reasonable market prospects and its relatively high value, production of cotton is recommended for the Project.

iii) Oilseeds

F.A.O. Agricultural Commodities projections for 1975 and 1985 estimate consumption of vegetable oils in Somalia will be between 10,000 and 13,000 metric tons by 1985. Imports of vegetable oils into Somalia in recent years are shown in Table 3.3.

TABLE 3.3 Imports of vegetable oils 1963-66

Year	Weight (metric tons)	Value (million Shs.)	% Total Imports by Value
1963	n.a.	6.234	2.0
1964	4,901	13.335	3.4
1965	5,765	15.241	4.3
1966	4,128	8.958	3.3

The major importer of refined oils in Mogadiscio has indicated imports during 1967 and 1968 as being well over 5,000 tons each year.

There are two local oil crushing plants in Mogadiscio and the owner of one has expressed strong interest in processing oil seeds from new development projects.

There is a strong local preference for sesame oil and at present sesame seed and oil are scarce and expensive. Although no difficulties are foreseen in disposal of this crop, yields under

controlled irrigation are unlikely to give an attracive return in relation to capital investment. It is considered to be a more suitable crop for rainfed or flood irrigation production.

Groundnuts would command a useful local market provided a good quality nut with a high oil content can be grown. The price will depend to a large extent on the cost of local crushing which must compete with cheap refined oil imports and is rather lower than a hypothetical export price. The prices assumed for cotton seed are low compared with the world market price because of doubts about the market for cotton oil cake.

iv) Vegetables

Import demand for onions is about 500 tons annually, mostly in the northern region. Considerable seasonal shortages of fresh vegetables occur, especially in Mogadiscio and there is a possibility of developing exports by air to the Persian Gulf in the future.

It is not possible to make an accurate assessment of the amount of additional production necessary to keep the domestic market in long term equilibrium but present vegetable growers at Afgoi estimate that with efficient marketing services, approximately 25 ha. of intensive production would meet Mogadiscio requirements for some time to come. Promotion of vegetable growing in other areas by A. D. A. are likely to meet any foreseeable deficits outside Mogadiscio.

In view of the present production deficits and the attractive return to intensive vegetable production, together with the future possibility for exports, a very limited development of intensive vegetable cultivation outside the main arable rotation is recommended for the Afgoi-Mordile scheme on an experimental or pilot basis.

c) Livestock Products

i) Meat

The F.A.O. Agriculture and Water Survey reported evidence of heavy overselling of male stock from Somalia cattle herds. The number of cattle which can be carried on the range as it is grazed at present is apparently nearing its limit. If Somalia is to maintain her position in traditional markets, an extensive range management programme will have to be implemented to increase grassland production, since export prices are unlikely to rise sufficiently to meet the cost of intensive beef production until the health and quality requirements of higher priced markets can be attained. This programme will involve the provision of watering facilities in dry areas, eradication of tsetse fly, expansion of the veterinary programme, reduction of the number of herdsmen on the range and the alteration of present herd structures. There is also need for finishing facilities since there is a growing shortage of finished stock, which can command a premium price in the present export market. The Afgoi scheme offers only a limited quantity of crop residues suitable for stock feeding and little grazing potential within the scheme. The utilisation of these resources for beef production is unlikely to provide an attractive economic return at currently prevailing prices.

ii) Milk

Insufficient statistics are available on milk production and consumption to state with any degree of certainty what increases in production the domestic market could absorb, while there has been insufficient development in the industry to consider processing for export. The milk factory at Mogadiscio is having considerable difficulty in obtaining supplies, but even if this problem is overcome, there is no

way of determining the potential of the market at the present time to absorb the factory's designed throughput of 20,000 litres per day without considerable market survey work. General indications are that present retail marketing is weak, although the reasons are not clear. Possibly, the public are not yet ready to consume processed milk in any considerable quantity and even with a reduction in price, a fairly intensive promotion campaign would be required to increase sales appreciably. In these circumstances, the integration of milk production into the Afgoi-Mordile scheme cannot be recommended.

Consideration was given to a number of other possible crops including lemons, limes, pineapples, papaya, avocado pear, coconuts, soyabean, kenaf, sisal, maize and tobacco, none of which can be recommended due to marketing problems, lack of information on local production potential and ability to meet the required quality standards, slow maturity, and poor economic return in relation to the level of investment required.

3.2 Producer Price Projections

The following price calculations are hypothetical since they depend on assumptions about future world and local markets, national infrastructure and processing efficiencies. They are intented to be interpreted as an indication of the average price the farmer may expect for his produce in the future. Projecting prices is a hazardous procedure; although a certain pattern can be discerned from past trends, changes in taste, technology, (especially in tropical agriculture), international trading policies, the system of internal settlements, sea freight rates and other extraneous factors to the market such as political upheaval can radically alter such a pattern in the future.

There is a tendency to presume, especially in the case of cotton and oilseeds, which face stiff competition from substitutes, that long term alterations in price will be downwards in real terms. With rice, on the

other hand, there is a presumption that the future prices to the producer should remain fairly stable since the increased production possibilities afforded by improved technology are counterbalanced by the possibility of greatly increased demand in conditions of rapidly rising population. The long term prospect for meat prices are good, since technical considerations alone do not influence the supply to the same extent as for crops and demand tends to rise with rising income. Sorghum as a food grain is not traded internationally to the same extent as other grains. The price received by the farmer is thus much more dependant on the strength of local consumer preference and on farming conditions. These factors are also of major importance in determining the price to the farmer for sesame in Somalia. Export markets could be found for these crops providing the prices were right but this would necessitate a high level of productivity coupled with low costs of production. Under the present conditions of production for the local market there is little information on which to base reasonable projections for these crops.

The off farm costs of transport, processing, handling and port charges are based on the rates quoted by various sources and adjusted where applicable in the light of experience elsewhere. All tend to be high because of the limited development of the country's infrastructural resources. In the long run, improvements in these facilities, especially of the Mogadiscio port will tend to reduce these costs and therefore, from the point of view of export price calculation it should be possible to offer the farmer a higher price. But high freight rates, port handling and transport charges also insulate the domestic producer to a certain extent from international competition.

This allows the price for domestic processing of, for example oilseeds, to be higher than it would be under fully competitive conditions on the assumption that newly established domestic processing will not be as efficient as larger established facilities elsewhere. This means that farm price policy, whether freely competitive or controlled is a matter

for continual review and adjustment in the light of changing actual conditions in the marketing complex. The projected prices for the selected crops for the Afgoi-Mordile Scheme have been assessed as follows:-

a) Groundnuts

There are two approaches to determining the projected farm gate price for groundnuts in Somalia. One is to net back to the farm gate the projected world market price, on the assumption that the groundnuts could be competitively exported. The other is to examine the maximum price a local oil miller could pay and still meet the projected landed price for refined oils.

F.A.O. 'Agricultural Commodities Projections for 1975 and 1985' indicate under certain assumptions that world demand and supply of fats and oils would be in equilibrium in 1975 at 46 to 49 million tons. The critical assumption on which this projection is based is that a large part of the projected increase in world supplies will be absorbed as imports by the centrally planned economies. Should this assumption not hold and the projected effective demands for fats and oils fail to materialise, this would exert considerable downward pressure on prices. Annual oilseed crops are particularly vulnerable to this kind of pressure, since technical considerations do not prevent fairly rapid increases or decreases in production and therefore any excess of supply over effective demand can be quickly adjusted by a decrease in price.

The prevailing average price for groundnuts of fair to average quality, c.i.f. European ports has fluctuated during the last nine years at around $ 187 per ton. However, in view of the highly competitive nature of the fats and oilseeds markets and the doubts concerning the future role the centrally planned economies will play on the world market, it cannot be safely assumed that the price will remain at the above figure. During 1962/63 the world market for fats and oils was in equilibrium when prices reached their lowest

level since 1955. For a country which has not previously produced groundnuts on any considerable scale, it is safer to assume that the average prevailing price will remain nearer to the 1962/63 levels than to the present levels.

In 1962/63 the average price per metric ton of groundnuts was $165 c.i.f. European ports which is approximately equivalent to 1180 So. Shs. Present freight rates are relatively high and quotations for produce such as oilseed, difficult to obtain. It is thought that at present rates, the freight cost would be approximately 140 shillings per ton, although this would be reduced if the Suez Canal were reopened and better port facilities were available. The net-back price, can, therefore be calculated as follows:

		Shs/metric ton
Projected c.i.f. price European ports		1180
Present average freight rates	140 Shs.	
Port charges	40 "	
Transport charges Afgoi/Mogadiscio Shs. 0.95 per ton/km	36 "	
Handling and Storage beyond farm gate	20 "	236
Net farm gate price		944

The above calculations are somewhat theoretical since Somalia is not at present exporting, and no very thorough examination of the possibility of export production in the future has so far been made. The above projected farm gate price, therefore, can only serve as an indication of the average price a farmer could expect to obtain, if competing on the world market under present infra-structural conditions and in the event of no taxes or commissions being levied on production.

When determining the price of groundnuts for local oil extraction, the picture becomes more complicated since the price the local producer can pay depends upon the efficiency of processing

and the processing cost, the consumer preference for different types of oil, the landed price for those oils and the price that can be obtained for oilseed cake. The price for groundnut oil fluctuates much more than that of groundnuts, as can be seen from Table 3.4.

TABLE 3.4 Wholesale price of groundnut oil in Somalia 1967-68 in shillings per Ton

	1967	1968
January	3430	3960
February	3570	4300
March	3730	4300
April	3690	3940
May	3790	3540
June	4000	3470
July	4030	3240
August	3870	3160
September	3750	3150
October	3830	3340
November	3900	3030
December	3930	3100

The consumer preference in Somalia is for sesame oil, but local crushers and importers state that beyond this preference, highly refined oils are bought primarily on price. The lowest price for groundnut oil, c.i.f. European ports in the last twenty years was the 1963 average of 1914 shillings equivalent per metric ton. The price of refined oils imported into Somalia in the last six months has been as low as 1800 shillings per ton c.i.f. and the average landed price including import duty in the last year has ranged between 2400 shillings and 2900 shillings.

One local crusher has stated that he would be willing to pay 750 shillings per ton of good quality nuts assuming an average extraction rate of 30 per cent based on the following calculation:-

Production costs		
1 ton of groundnuts	750 Shs.	
Processing costs per ton	200 "	
Total Production Cost		950 Shillings
Operating revenue		
300 kg of oil at Shs. 2.90 per kg.	870 Shs.	
600 kg of cake at 30 cents " "	180 "	
Total Operating Revenue		1,050 Shillings
Operating profit per ton of nuts		100 Shillings

In effect the farmer would receive less than Shs. 700 per ton of nuts after deduction of transport, handling and storage charges.

However, this calculation overstates the economic return to local processing since there is a 30 per cent duty included in the landed price of oil and local processing if it is not be subsidised must be able to meet the landed price without duty. In order to do this processing cost must be reduced and present extration rates considerably improved. According to a preliminary study, details of which are shown in Appendix XI, the processing cost per ton of a 6,000 metric ton integrated oil mill generating its own electricity is approximately 80 shillings per ton of oilseed processed. If payment for the mill over 10 years is included the processing cost is approximately 115 shillings. This last cost averaged over a plant life of 25 years gives an average processing cost of 90 shillings per ton. If the present mill in Mogadiscio, which is interested in the potential Afgoi oilseed output, were to be expanded to absorb that output, capacity would have to be increased to approximately 4,500 tons. This latter capacity would give a processing cost including re-equipment charges of approximately 100 shillings per ton. With good quality seed from a controlled irrigation project an extraction rate of 40.5 per cent refined oil should be obtained and under these assumptions a local processor could compete with

a landed price for refined oil of 2,000 shillings as follows:

Production Costs		
1 ton groundnuts	750 Shillings	
Processing cost per ton	100 "	
Total Production Cost		860 Shillings
Operating Revenue		
405 kg. of oil @ 2.00 shillings per kg.	810 Shillings	
500 kg. of cake @ 30 cts per kg.	150 "	
		960 Shillings
Profit per ton of nuts processed		100 Shillings

In these assumptions the price to the farmer for decorticated nuts would be 760 shillings less 56.00 shillings for transport and landing or approximately 700 shillings per metric ton. Although the processing costs are fairly high and the groundnut cake price low compared with the net world market price of 40-50 cents per kilogramme, it is doubtful if the farmer could expect to receive very much more for his seed from local processors. Conceivably, in the longer terms with higher capacity utilisation of crushing machinery, processing costs can be reduced and a higher price can be obtained for cake. But most of the revenue comes from oil which has to compete with cheap imported rapeseed and soya bean oil.

b) Cotton Seed

The export price for white cotton seed projected on the same basis as for groundnuts gives a price of approximately 320 shillings per ton at the ginnery in Mogadiscio. Allowing a 14 per cent extraction rate and a price of 30 cents per kilogramme for cake and 850 shillings per ton for oil an Oil Mill could just pay this price and obtain the same profit levels as on groundnuts. The projected price of white cotton seed ex-ginnery in Mogadiscio has been taken as 300 shillings per metric ton.

c) Cotton

The cotton variety proposed for the project is the medium staple Acala variety. The world market price for shorter staple cottons is largely determined by the price for American Middling Cotton, which in turn is determined by legislation in the U.S. in the light of the current supply and demand situation. In 1966/67, legislation was implemented and a cotton programme announced for 1967/68, which will keep the U.S. production at predetermined level and maintain a minimum export price of 22 U.S. cents a pound. In fact, the c.i.f. Liverpool price for American Middling cotton has fluctuated around this level, in the past six years at 53-57 U.S. cents per kilogramme or 3786 to 4072 Somali shillings equivalent per ton.

The long term outlook for cotton prices would indicate that the price of shorter staple cottons is not likely to rise in real terms above present prevailing prices and in fact, may fall in the face of stiff competition from man-made fibres and the possibility of a 38 per cent export surplus in excess of import requirements developing by 1975. The future outlook for cotton producers is summed up by F.A.O. Agricultural Commodities - Projections for 1975 and 1985 as follows:-

> 'Like producers of other agricultural raw materials for which man-made substitutes exist, cotton growing countries will find it impossible to raise their export earnings from cotton and cotton textiles by restricting supplies and so raising prices. In fact, in order to keep cotton competitive with man-made fibres, they will have to make every effort to reduce costs of production and improve quality. On the basis of recent trends, yields per hectare will almost certainly continue to rise during the next decade, so that less land may have to be devoted to cotton cultivation; classing and growing practices especially in developing

regions can also be expected to improve further. If such gains in productivity materialise, farmers may continue to find cotton growing profitable, even in the face of more intensive competition from man-made fibres which is likely to determine the future course of cotton prices[1].

Good quality Acala cotton can command a slight premium over short staple varieties and assuming the Project produced acceptable qualities, then the net-back price to the ginnery would be as follows:

		Shs/metric ton
Acala Cotton c.i.f.		4,100
Sea freight	280 Shs.	
Port charges	80 "	
Transport from Ginnery to port	27 "	
Handling, Storage, etc.	20 "	407
Price of lint at Ginnery		3,693

Assuming a processing cost plus profit of 300 shillings for collecting and ginning and a 35 per cent ginning out-turn, the price to the farmer would be calculated as follows:

Income from sales	Shs.
350 kilos of lint @ 3.69 per kilo	1,293
640 kilos of seed @ 31 cents per kilo	192
Total Income from sales	1,485
Less collecting, processing and profit	300
Price to farmer per ton of seed cotton	1,185

At the moment, the farmer receives 800-1200 shillings per ton of seed cotton, collection, processing and storage costs amount to between 600 and 700 shillings. The price of lint cotton delivered to the Balad Textile mill, including transport and commission charges to the Agricultural Development Agency was originally

negotiated at 4200 to 5120 shillings per ton according to grade and staple length. This price is equivalent to the world market price for good quality cotton delivered to the mill.

It is extremely unlikely that a newly established mill could compete at this price for raw material. In fact, it is unlikely that the price delivered to the mill could be more than the net-back export price of lint from the ginnery plus transport charges. This means that present ginning, collecting and storage costs must be reduced from their present level of 600-700 shillings per ton, to the hypothetical level of 320 shillings (300 processing + 20 shs. handling and storage) per ton in the above calculation, if a price of 1, 200 shillings per ton of seed cotton is to be maintained to the farmer. It should be possible to substantially reduce ginning cost with intensive centralised production of seed cotton, since collection would be very much easier than at present and a larger guaranteed throughput should enable unit costs of ginning and storage to be reduced.

Reduced freight rates and handling charges would mean a higher hypothetical export price eventually, but in view of the need to improve competitiveness at all stages of growing, ginning, handling and manufacture, it is not expected that in the long term, the price range for the different grades of cotton in Somalia can rise much above the present level of 800-1200 shillings per ton without subsidy. An average price to the farmer, assuming he will supply a mixture of grades has therefore been projected as Shs. 1000 per ton.

d) Rice

The c.i.f. London price for Siam Patna No. 2 rice averaged 160 dollars per metric ton from 1955 to 1965. Since then the price has been around 180 dollars per ton. The F.A.O. export price index for rice rose from an average figure of 104 for 1963-65 to 153 in April 1968. This rise has largely been occasioned by

poor crops in 1965 and 1966, and although there was a substantial improvement in output in 1967, prices have remained high, especially for long/medium grain varieties, because the demand for current consumption and stockbuilding is high. The price of rice from Thailand, Somalia's largest supplier in 1966, dropped after February 1969.

The long term supply and demand prospects for rice depend upon a number of factors. On the future supply side, one of the most important is the increased production possibilities provided by high yielding varieties and the degree to which these are exploited. If the major Asian importers achieve their production goals by exploitation of these varieties, the demand on the international market could be severely limited. On the other hand, failure to meet these targets does not automatically imply that demand on the international market will increase, since shortage of foreign exchange might lead to restriction of imports, while domestic production continues to be built up by allowing internal prices to rise. Another important factor affecting domestic production is the terms on which food aid is given, especially wheat.

Less food aid could lead to greater imports of rice at the expense of wheat, which is normally only imported into rice eating countries when it is supplied on concessional terms. This would tend to encourage greater domestic production of cereals, which would lead eventually to lower imports of both wheat and rice.

The F.A.O. agricultural commodity projections for 1975 and 1985 show the prospects for international trade in rice to be reasonable, provided the means can be devised to solve the problem of lack of foreign exchange in the deficit countries. Should this problem remain unresolved then the introduction of higher yielding varieties could lead to a downward pressure on export prices.

In general, the indications are that import prices for rice are unlikely to drop significantly below their existing levels, but

it is impossible to state with any certainty that they will rise. The largest supplier of rice to Somalia in 1966 was Thailand (11,000 tons), and the current c.i.f. price from that source is Shs. 1114 per metric ton (5 per cent broken). This gives a landed price of approximately Shs. 1.20 per kilo. Both cheaper and more expensive rice is imported, the latter mainly under commodity aid agreements and the wholesale price ranges from approximately Shs. 1.70 to 2.20 per kilo. Rice has only been cultivated on a small scale in Somalia in the past and there are no records of the acceptability of local rice of hulling costs and efficiencies. The landed price at the lower end of the price range has been taken as the price with which a local mill will need to compete. Assuming an average out-turn of 51 per cent whole rice and 19 per cent broken with an acceptance of 5 per cent broken at the wholesale level, the price of unhulled rice per ton may be calculated as follows:

Income from Sales		Shs.
560 kg. @ 1.20 sh. per kg.		672
140 kg. @ 60 shs. per kg.		84
		756
Less transport charges to Mogadiscio on 700 kg.		25
Total income from sales		731
Processing cost per ton of unhulled rice	Shs. 50	
Transport farm gate to mill per ton	10	
Total cost	60	
Net income from sales		671
Allow profit per ton processed of 71 shillings		71
Farm gate price of unhulled rice		600

N.B.1. See Appendix X.

Taking into consideration the unknown potential of local rice and the uncertainty concerning future world demand and supply conditions, it seems unlikely on the basis of the above calculation that the farmer could receive a price much above Shs. 600 per ton without substantial restrictions being placed on imports of rice.

3.3 Proposed Agricultural Production

The object of the Afgoi-Mordile Scheme is to resettle Somali farmers, most of whom are at present engaged in dryland subsistence farming. The scheme will be divided into small holdings, managed in a manner similar to that practised on the Gezira Scheme in the Sudan, with the management providing the services necessary for organised irrigated agriculture. To date, no attempt has been made in Somalia to settle indigenous farmers on such an organised scheme, recent Government policy having been directed towards the establishment of State farms. In the selection of suitable crops and cropping patterns, the requirements of such a highly organised and strictly controlled system of farming has been taken into account.

In view of the marketing limitations on the expansion of crops discussed in Section 3.1 a) i-iii) the selection of a suitable rotation has been limited to those annual crops which can be produced during the seasons when rainfall or irrigation supplies from the Shebelli River are reasonably assured.

Of the annual crops, cotton, groundnuts and maize were grown on the Italian concessions until 1960 when their production was discontinued. At the Afgoi Research Station, upland rice, safflower, soyabeans, sunflower, sesame, castor and various leguminous food crops have also been grown under irrigation in trial plots, but so far no attempt has been made to assess these crops on a commercial field scale. Although some of these crops have proved promising in trials, there was insufficient evidence to support their recommendation for

inclusion in the cropping pattern with the exception of upland rice which has been shown to have good prospects. Based on available yield data and an assessment of economic potential, upland rice, cotton and groundnuts proved to be the most profitable crops.

Upland rice variety trials at Afgoi Research Station produced two American varieties, Dawn and Saturn, giving yields of between 2, 000 and 3, 000 kg. per ha. At Johar, where Chinese varieties of paddy rice are being cultivated, yields of 4, 000 - 5, 000 kg. per ha. have been produced using transplanting techniques, but the limited availability and large volumes of water required for paddy cultivation coupled with high costs of pumping more than offset the yield advantage of paddy rice over upland rice. The incorporation of upland rice into a rotation with other crops is somewhat easier than in the case of paddy rice and for these reasons, upland rice was selected as the more suitable crop to meet the increasing local demand for rice, which is at present dependent on imports.

The recently completed textile factory at Balad has resulted in an increased local demand for cotton. Whilst the rainfed and flood irrigation sectors will be developed to help satisfy this demand, the higher yields and lower yield fluctuation from year to year make the cultivation of cotton under controlled irrigation attractive, assuming that a portion of the factory's total cotton requirements will be regularly met. As the factory will be producing a cheap, relatively low quality cloth, medium staple varieties will be the most suitable for cultivation. Recently introduced Acala 4-42 and Carolina Queen varieties have performed reasonably well in trials at the Afgoi Research Station, where it was possible to provide adequate pest control. Yields of over 2, 500 kg. per ha. seed cotton have been obtained under irrigation. Unfortunately no information on lint quality and ginning out-turn of these varieties under local conditions is available.

Groundnuts have given yields of up to 4, 500 kg. per ha. in shell in one exceptional trial at the Afgoi Research Station and yields well in excess of 2, 000 kg. per ha. have been produced in other trials. Italian

concessions in the Genale area are described as producing yields in excess of 1,500 kg. per ha. during the 1950's. This crop appears particularly well suited to cultivation in the 'Gu' season and providing a variety with a short growing season is selected, it can be harvested in sufficient time to permit cultivations for the succeeding 'Der' season crop to be completed.

Because of assured supplies of good quality irrigation water during the September to December period, low risk of delays to plantings due to rain in August-September, and ideal harvesting conditions from mid-December onwards, the 'Der' season has considerable advantages over the 'Gu' season for cultivation of the rice and cotton crops. 'Gu' season planting of rice has resulted in poor pollination and low yields probably due to the high winds which occur during the June-July season and 'Der' season planting of cotton results in better germination, due to lower temperatures at planting time and a lower incidence of pests and diseases.

The selected rotation over a 2 year cycle is as follows:

Year 1	'Gu' season	- Groundnuts planted in April
Year 1	'Der' season	- Cotton planted in September
Year 2	'Gu' season	- Fallow
Year 2	'Der' season	- Upland rice planted in late August to early September.

The fallow has been included to allow time for land preparation necessary for the rice crop and also to permit weed control operations to be carried out, particularly spraying of herbicides for grass control if this proves necessary before the rice crop is planted. Germination of weeds would be assured by the 'Gu' season rains which occur during the fallow period.

Although soil differences do occur over the scheme area, these differences are not sufficiently great to warrant any modification to the standard cropping pattern.

In order that the settlers on the scheme may have the opportunity to cultivate vegetables to meet the needs of their family, separate areas will be set aside for this purpose, each settler being allocated 0.1 hectare. This is preferable to having such 'free cropping' included in the arable rotation. Although the local market for vegetables is unable to absorb any appreciable increase in production without resulting in a marked fall in prices, certain crops, especially onions, do offer a limited potential for expansion of production and their cultivation could prove very rewarding to the grower, providing current price levels are maintained. It has been assumed that 10 per cent of the area allocated for vegetable production will be utilised by more progressive farmers in intensive cultivation for the local market. Production will, however, be limited by the seasonal water supplies available.

3.4 Recommended Cultural Practices and Anticipated Yields

a) Groundnuts

Precise information on the performance of groundnut varieties grown in the 'Gu' season is not available so that further trials are necessary before definite recommendations as to variety can be made. The need for a variety maturing in about 100 days in order to avoid delaying land preparation for the succeeding crop limits the field of choice as does the need for a variety resistant to Cercospora Leaf Spot and Rosette virus diseases. Of the varieties tested at the Afgoi Research Station, but grown in other seasons of the year, the best suited seems to be the one known locally as Sudan I.

The crop will normally be preceded by Rice and it will be necessary to burn off the straw before land preparation commences. Ploughing with a chisel plough to a depth of 15-20 cm is recommended, followed by discing with wide level discs to break down the soil clods. Levelling will then be performed to eliminate any irregularities resulting from bunds put up for the preceding rice crop and to achieve a uniform slope to facilitate furrow irrigation. The land will then be

ridged, the ridges being spaced 75 cm apart and planting will be undertaken by hand on the tops of the ridges. Two seeds per hole will be planted with a spacing of 15 cm between holes in the row. Careful shelling of nuts for planting is necessary to avoid mechanical damage and the seed nuts should be dressed with an insecticide/ fungicide preparation to guard against attacks by fungi and termites. If the Sudan I variety is grown, a seeding rate of about 100 kg per ha. will be necessary. Sowing will begin in mid-April and should be completed in 20 days, individual farmers operating within one field being required to complete their sowing in 10 days, in order to accommodate the irrigation regime.

Responses to Phosphate and Potash fertilisers have not, so far, been demonstrated and responses to Nitrogen are likely only during the early stages of growth. A preplanting application of Urea at up to 100 kg per ha. is recommended and should be applied using a tractor front-mounted distributor at the time of the ridging operation.

In normal years, rainfall during April/May should be adequate for germination, but in years of low rainfall irrigation may be commenced after planting if water is available and of sufficiently good quality.

Weeding will be essential if good yields are to be obtained. A re-ridging operation is recommended about 30-40 days after planting and thus will assist in controlling weed growth between the rows. Hand weeding will be required in the rows and two rounds of weeding are likely to be necessary. The use of herbicide in this crop is not recommended.

To facilitate harvesting, an operation with a groundnut lifter, the blade of which loosens the plants in the ridges, is recommended. The plants will then be lifted by hand and loosely stacked for a period of 10-15 days to ripen. The nuts will then be stripped from the haulm by hand and bagged for transport to a collecting centre.

If shortage of labour for hand stripping arises, the use of the simple Ramleh stripper developed in the Sudan may be necessary. If carefully handled to avoid excessive loss of leaves the haulm is a valuable fodder and should find a ready market for feeding to dairy cattle in Mogadiscio, some 3 tons per ha. being anticipated. Yields of nuts in shell are conservatively estimated as 1, 500 kg. per ha. in the first year, rising to an ultimate yield of 2, 200 kg. per ha. by the fifth year of operation equivalent to 1, 000 to 1, 500 kg/ ha. of shelled nuts respectively, assuming an approximate shelling-out percentage of 70 per cent.

b) Cotton

Cultivation of medium staple cotton varieties in Somalia was not seriously undertaken until the 1950's. Results of variety trials, executed by the Italian administration, are unfortunately no longer available apart from some general comments. Recent trials at the Afgoi Research Station have been poorly managed and inadequately documented. As a result, no recommendations as to the most suitable variety for cultivation under controlled irrigation is possible. Seed of the varieties Pima S1, Carolina Queen and Acala 4-42 has been imported by the Agricultural Development Agency and comparison of these under good management conditions, particularly in respect of pest and disease control are urgently required. In view of the good results obtained in the Sudan and Kenya with the Acala 4-42 variety, this would at present appear most likely to meet the requirements for local cultivation. Its open growth habit, facilitating efficient insecticide application, and its large bolls and short opening period giving increased picking efficiency, would be of particular value under local conditions.

Following the harvesting of the preceding groundnut crop the soil will be in a loose and friable condition. It is recommended that a single land preparation operation should be performed entailing chiselling along the old furrow bottoms, followed by split ridging

resulting in ridges being set up over the site of the old furrows. These ridges will be spaced at 75 cm as in the case of the groundnut crop. Planting should be by hand on the tops of the ridges. Holes should be spaced 30 cm apart in the row and 6-10 seeds planted in each, giving a seeding rate of 25-30 kg. per ha. if untreated fuzzy seed is used, or 20 kg. per ha. if the seed is delinted. Seed should be treated with a fungicidal preparation, control of bacterial blight being particularly important. The need to maintain pure line seed through strict control of seed production and particularly of privately owned ginneries, where in the past much seed mixing has occurred, must be stressed. Adequate storage for seed will be necessary, it being claimed that seed stored in the humid coastal climate loses its viability in 5-7 months.

Sowing will take place during September and will be completed in 18 days, individual farmers operating within one field being required to complete their sowing in 10 days, in order to comply with the 15 day cycle of the irrigation regime.

No records are available of cotton responses to fertiliser application in Somalia. Results for other crops suggest that only nitrogenous fertilisers are likely to give a significant yield response on the soils of the project area. The application of 100 kg. per ha. of Urea is recommended and should be applied using a tractor front-mounted distributor at the time of the ridging operation.

An irrigation application should be made immediately after planting and river water supplies are almost invariably adequate at that time. Pre-planting irrigation could be given if water is available earlier but is not considered essential.

Some 2-3 weeks after planting, thinning to 2 plants per hole will be necessary and any gaps should be resown at the same time. Hand weeding will commence at the same time and at least two weeding rounds will be necessary.

Re-ridging is recommended about 30-40 days after planting and this operation will assist in controlling weed growth between the rows.

Insect damage is by far the most important factor limiting cotton yields at the present time. During 1968, damage was caused to the cotton crop by pink, spiny, and American bollworm, two species of stainers, leaf eating beetles, jassids and aphids, whilst reports record damage from the Egyptian cotton worm, army worm and red bollworm in other years. No study of the relative importance of these pests has been made, but observations during 1968 on raingrown cotton on which no insecticide treatments had been applied, indicated that bollworms and stainers were the more serious pests.

Although legislation exists in Somalia necessitating the uprooting and burning of cotton stalks after harvest, it is not enforced and to date the pest problem in cotton has received little attention. It is essential that both on the Project and in the surrounding area, no sowing of cotton later than 15th October should be permitted and all residues should be uprooted and burned before 15th April. This restriction is possible under the existing legislation and its enforcement lies with the Ministry of Agriculture.

Prevention of insect carry-over from season to season would also be greatly facilitated by the destruction of alternate host plants of cotton pests, and this would be possible within and immediately adjacent to the project area. In countries where plant sanitation measures such as these have been practised, the incidence of pink bollworm infestation in particular is greatly reduced and if a similar situation were achieved in Somalia, the prospects for cotton production would be greatly improved.

Apart from sanitation measures, the control of pests will depend on the efficient use of insecticides. No reliable research work has been done on the use of insecticides for cotton in Somalia so that results from other countries must be used in making a

preliminary recommendation for pest control spraying. The urgent need for local applied research into the effects of presently available insecticides, the optimum frequency and timing of applications and the response in yield from their use must be stressed.

A D. D. T./Sevin mixture is recommended containing equal parts of 100 per cent D. D. T. and 85 per cent Sevin, applied at the rate of 3 kg. per ha. The D. D. T. will control American Bollworm, whilst Sevin will control Spiny Bollworm and stainers. Spraying should begin some 60 days after planting and continue at 8-10 day intervals, 5 or more applications probably being necessary. When sufficient experience with the pest problem has been acquired this purely routine programme may be abandoned in favour of regular inspection and specific pesticide applications suited to the actual pest complex present.

It is important that insecticides be applied evenly and that the timing should be correct. Applications must continue even when rain makes soil conditions difficult. For these reasons, aerial application is strongly recommended and has the advantages of causing no physical crop damage, low application cost and avoiding high capital outlay on spraying equipment. Facilities already exist in Somalia for aircraft spraying of bananas.

In the event of cutworms proving a serious pest, control may be achieved by pre-planting applications of 3 per cent BHC dust at 4 kg. per ha.

Harvesting of the cotton crop should begin towards the end of December and continue until the end of February. Weather conditions at this time are favourable although field edges adjacent to roads may be affected by dust. The Acala Variety should require some 3 pickings at 2-3 week intervals. Picking will be by hand and the picker should be supplied with two bags, one for good clean cotton and the other for stained or insect damaged cotton, so that

picking and grading is completed in one operation. As the cotton is picked, it will be weighed and transported to collecting centres.

When picking is completed all cotton plants must be uprooted with a cotton root puller of the type used in the Sudan. The plants must be burned together with all other residues which, if left, could harbour pests to reinfest cotton in the following year.

Although the soils are well suited to cotton, yields of both rain-grown and irrigated cotton have in the past been generally poor due primarily to mixed seed of poor quality, failure to control insect pests and poor husbandry standards generally. Provided the recommended cultivation techniques are properly executed and in particular, the necessary pest control measures are rigorously enforced, yields of 700 kg. seed cotton per ha. in Year 1 rising to an ultimate yield of 1, 500 kg. per ha by the fifth year of operation should be achieved. Existing ginning facilities are at present operating inefficiently, but with increased production giving a more regular throughput and with supervision by the Agricultural Development Agency (who would be buying agents for the textile factory) considerable improvements in efficiency should be possible. A conservative ginning out-turn of 35 per cent is estimated, which may be compared with an out-turn of 40 per cent achieved with Acala cotton in the Sudan.

c) Upland Rice

As yet no proven and accepted cultivation methods for upland rice have been developed in Somalia so that recommendations for this crop are based on results obtained on trial plots at the Afgoi Research Station and on experience in other countries. The varieties Dawn and Saturn which have been successful at Afgoi should be grown.

After the preceding cotton crop has been cleared the land should be ploughed using a chisel plough and disced with wide level discs to produce a loose tilth. These operations should be completed during April. May. The rainfall which occurs at this time of year will result in rapid germination of weed seeds and if weeds and particularly grasses

prove troublesome, they should be destroyed by a weedicide application, using a tractor mounted boom sprayer. Where only broad leaved weeds occur, an application of 2:4D at the rate of 3 kg. acid equivalent per ha. should prove adequate, but where grasses and sedges occur, either Paraquat or Dalapon applications will be necessary. The destruction of grassy weeds during this fallow season will greatly facilitate subsequent weed control in the growing rice crop.

Unlike the groundnut and cotton crops, the rice will be grown under border irrigation. Land smoothing to eliminate ridges set up for the preceding crops will be necessary and at the same time low bunds will be constructed where necessary to facilitate the even application of irrigation water. The correct siting of these bunds in each field can only be achieved through experience.

It is recommended that the rice is planted in the dry soil and irrigation applied immediately after planting. In order to reduce the number of machinery operations, the use of wide level discs equipped with seed and fertiliser attachments is recommended to produce the seed bed tilth, distribute fertiliser and sow in one operation. This equipment would override the previously constructed bunds, without destroying them and only a small amount of hand labour for bund reshaping would subsequently be required. A pre-planting application of 50 kg. per ha. of Urea is recommended with an additional similar application, some 40 days after planting, distributed by hand. A seeding rate of 100 kg. per ha. is recommended. Seed should be dressed with a fungicidal preparation which as well as controlling diseases will reduce losses due to birds and rodents. Sowing will take place during late August and early September and be completed in 20 days.

As soon as the crop is established, a weedicide application should be made. At the Afgoi Research Station, the weedicide Propanil has given encouraging results when applied at 4-5 kg. per ha.

and is likely to prove effective in controlling grasses and sedges. Further work is necessary on herbicide treatments for weed control in Upland Rice. Hand weeding will be necessary to control re-infestation in the growing crop.

No serious pest or disease problems have, so far, been noted in the rice crop. Both varieties mature in approximately 120 days after sowing. Harvesting by combine harvester is recommended to eliminate the large losses which can occur due to shattering as a result of hand harvesting, and bird and rodent damage when the rice crop is left standing for any length of time in the field. To avoid excessive bird damage, the farmers will have to spend a number of days engaged in scaring birds from their fields before harvest.

Yields of Upland rice in trials at the Afgoi Research Station have been reasonably consistent at around 2-3,000 kg. per ha. and a commercial yield of 1,000 kg. per ha. in year one rising to 2,500 kg. per ha. at maturity in the fifth year of operation is anticipated. Milling percentages are likely to be of the order of 51 per cent whole grains and 19 per cent broken grains, although difficulty has been experienced in milling on an experimental scale and care will be necessary over grain moisture content during milling to avoid an excessively high proportion of broken rice.

d) Vegetables

A wide range of vegetable crops may be grown successfully on the proposed vegetable plots. Where production for sale in Mogadiscio market is undertaken, onions, tomatoes, cucumber, pumpkin, cabbage, carrots, green peppers and beans are especially suitable for cultivation. Initially, irrigation will be limited to those seasons when river flows permit abstraction of water and this will prevent regular supplies of vegetables being produced throughout the year. As vegetable production, particularly during the dry months, could prove very lucrative on a limited scale, it is possible that at a future date a progressive group of farmers wishing to

specialise in such production would be prepared to finance their own well to supplement river water supplies in order to facilitate year round production.

e) Livestock

The rainland cultivators who are likely to become farmers on the project, seldom at present own cattle in appreciable numbers. When cattle are owned they are frequently grazed away from the villages, probably due to the prevalence of tsetse fly in the area adjacent to the river. The farmer and his family will be fully occupied on the agricultural holding throughout the year and they will have little time to devote to the care of livestock. The economics of integrated milk or beef production within the project are not attractive and the problems of eradication of tsetse fly and control of diseases, including rinderpest, bovine pleuropneumonia and anthrax, are considerable. For these reasons, livestock are not recommended for inclusion in the controlled irrigation project. There should, however, be no objection to individual farmers maintaining one or more cows for milk production as a back-yard enterprise, should they wish to do so.

3.5 Irrigation Requirements

In the absence of reliable information on crop water use under local conditions, the irrigation requirements have been calculated from estimates of evaporation. Meteorological data recorded at the Afgoi Research Station during 1968-69 was used to estimate theoretical evaporation from a uniform turf sward (Et) by a method developed by Penman and subsequently modified by Mc Culloch for conditions in East Africa. The E_t value theoretically applies to any other uniform crop cover having the same surface characteristics and may be modified to suit other surface conditions by the application of an empirical crop factor (k) to give the theoretical evaporation from a specific crop (E_c) at a particular stage in its development. The E_c value

assumes the crop is able to draw its moisture supply from a soil in which moisture stress is not a limiting factor. It has been shown by Denmead and Shaw that under conditions of soil moisture stress within the root zone, evaporation from a crop is reduced, but the extent of this reduction depends not only on the degree of stress, but also on the potential evaporation rate of the crop under the prevailing climatic conditions. The mathematical model used to derive an estimate of daily water balance throughout the crop season takes account of these factors and assumes irrigation to take place when a predetermined level of moisture stress occurs, this critical level being dependent on the crop growth phase.

The amount of water required at each irrigation is that needed to return the soil within the crop root zone to field capacity, plus amounts to successively wet deeper soil layers within the ultimate zone of root exploitation. Before this zone is fully wetted, an irrigation field efficiency factor of 85 per cent has been applied to allow for losses during irrigation. Subsequently, a factor of 66 per cent has been used to allow for such losses and also for deep percolation beyond the root zone.

Because of the unreliability of the 'Der' season rains, these have been ignored in assessing the irrigation needs of cotton and upland rice during this season. Rainfall during the 'Gu' season is more reliable and river flows will in some years be inadequate, especially during the early part of the season. Rainfall has, therefore, been taken into account in assessing the irrigation needs of the groundnut crop.

The estimated irrigation requirements of the recommended crops are shown in the following Tables - 3.5, 3.6, 3.7 and 3.8. Because of the limited climatological data available on which to base irrigation requirement calculations and the lack of local information on crop water use, it was considered advisable to add a 20 per cent contingency allowance which is included in the figures given in these Tables.

The applications of irrigated water should be spaced as uniformly as possible to facilitate simple operation of the irrigation system and as far as possible, applications should be reasonably uniform to avoid undue peaks in irrigation demand, which would result in unnecessarily large canals and pumping capacity. Small adjustments to the figures initially calculated have been made to achieve such uniformity.

TABLE 3.5 Estimated irrigation requirements of Groundnuts in a year of median rainfall during the cropping season

Crop planted 15 Apr. - 5 May Harvested 25 July - 13 Aug.

Irrigation No.	Days after Planting	Field Irrigation Requirement	
		cms	m^3 per ha.
1	37	8.0	800
2	52	8.0	800
3	70	8.0	800
	Total:	24.0	2,400

TABLE 3.6 Estimated irrigation requirements of Groundnuts in a year when rainfall during the cropping season is insignificant as is likely to occur once in 10 years

Crop planted 15 Apr. - 5 May Harvested 25 July - 13 Aug.

Irrigation No.	Days after Planting	Field Irrigation Requirement	
		cms	m^3 per ha.
1	1	6.0	600
2	11	5.0	500
3	21	6.0	600
4	33	8.0	800
5	45	9.0	900
6	57	9.0	900
7	69	8.0	800
8	81	8.0	800
	Total:	59.0	5,900

TABLE 3.7 Estimated irrigation requirements of cotton ignoring rainfall

Crop planted 3 Sept. - 20 Sept. - Harvested 20 Dec. - 28 Feb.

Irrigation No.	Days after Planting	Field Irrigation Requirement	
		cms	m^3 per ha.
1	1	7.5	750
2	13	8.0	800
3	25	9.5	950
4	40	10.0	1,000
5	55	10.0	1,000
6	70	10.0	1,000
7	85	8.5	850
8	100	8.5	850
	Total:	72.0	7,200

TABLE 3.8 Estimated irrigation requirements of rice ignoring rainfall

Crop planted 24 Aug. - 15 Sept. - Harvested 1 Jan. - 20 Jan.

Irrigation No.	Days after Planting	Field Irrigation Requirement	
		cms	m^3 per ha.
1	1	5.5	550
2	11	6.0	600
3	21	6.0	600
4	31	6.0	600
5	41	6.5	650
6	51	7.0	700
7	61	7.5	750
8	71	7.0	700
9	81	6.0	600
10	91	6.0	600
11	101	5.0	500
	Total:	68.5	6,850

As a check on the method of estimation, the seasonal irrigation requirements for the crops were also calculated by Blaney and Criddle's method. The comparative figures are given in Table 3.9, and show close agreement.

TABLE 3.9 Comparison of previously estimated irrigation requirements with seasonal requirements calculated by Blaney and Criddle's method

Crop	Previously estimated	Blaney & Criddle estimated requirements cms
Groundnuts	59.0	56.0
Cotton	72.0	72.0
Rice	68.5	72.0

Due to the short season during which irrigation water is available in many years, no pre-planting irrigation has been allowed for in the estimates. Although not essential, a pre-planting irrigation would be beneficial both in improving the tilth of the seedbed and in ensuring rapid germination after planting. It is recommended that a pre-planting irrigation be applied in those years when water is available. In the event of a pre-planting irrigation being possible, the early post-planting irrigations will be reduced in volume. The amount applied prior to planting should not exceed the maximum post-planting irrigation on which canal design is based.

Irrigation water for the proposed vegetable plots will be available during the irrigation seasons for the field crops. Uniform applications of 5.0 cm equivalent to 500 m^3 per ha. at 10 day intervals has been assumed to allow for the requirements for these plots.

3.6 Farm Layout and Field Irrigation Techniques

The proposed field layout has been designed to facilitate the uniform application of irrigation water and the operation of mechanical cultivation equipment. The scheme will be divided into fields, which

will, as far as possible, be of a standard size measuring 1285 metres by 310 metres equivalent to 39, 84 ha. of which 36 ha. will be the cropped area. Each field will at any one time be uniformly planted to one crop, two adjacent fields being planted in turn to the recommended crops in the rotation over a period of 2 years.

Each will be served by a watercourse from which field lateral channels will deliver water for irrigation. Where ground slopes do not exceed 6 cm in 150 m, these laterals will be spaced at 138 m intervals dividing the field into 9 uniform 4 ha. plots. Where slopes greater than 6 m in 150 m occur, the laterals will be spaced at 69 m intervals. The 4 ha. plot will be divided into two halves and an individual farmer will crop one of the resulting 2 ha. areas in each of 2 adjacent fields usually on the same watercourse. A typical field layout is shown in Figure 3.1. By planting contiguous fields on successive watercourses to the same crop spraying by aircraft will be facilitated.

It is recommended that during initial land levelling operations, soil is dumped at the approximate location of each lateral. Subsequently, this soil will be used to form a lateral channel similar to that shown in section in Figure 3.2. This operation can be undertaken by the lateral forming implement illustrated diagramatically in Figure 3.3. By this technique, the lateral channel is entirely above the level of the surrounding ground and will not retain ponded water after an irrigation. Rapid drying out of laterals after irrigation will greatly facilitate the passage of tractors engaged in interrow cultivations between irrigations. The lateral forming implement is so designed that it can also be used to break down the banks of laterals and also fill them in to form a low ridge of dry soil. It is recommended that laterals be filled in, so that they may be crossed by tractors during cultivation operations and subsequently reformed, an operation which the lateral former can execute quickly and cheaply.

Irrigation of cotton and groundnuts will be by means of syphons delivering water from the lateral into the furrows, which in a standard field will be 135 m long. In order to achieve an even application of irrigation water, the slope must be uniform along the length of the furrow.

FIGURE 3·1

TYPICAL FIELD LAYOUT

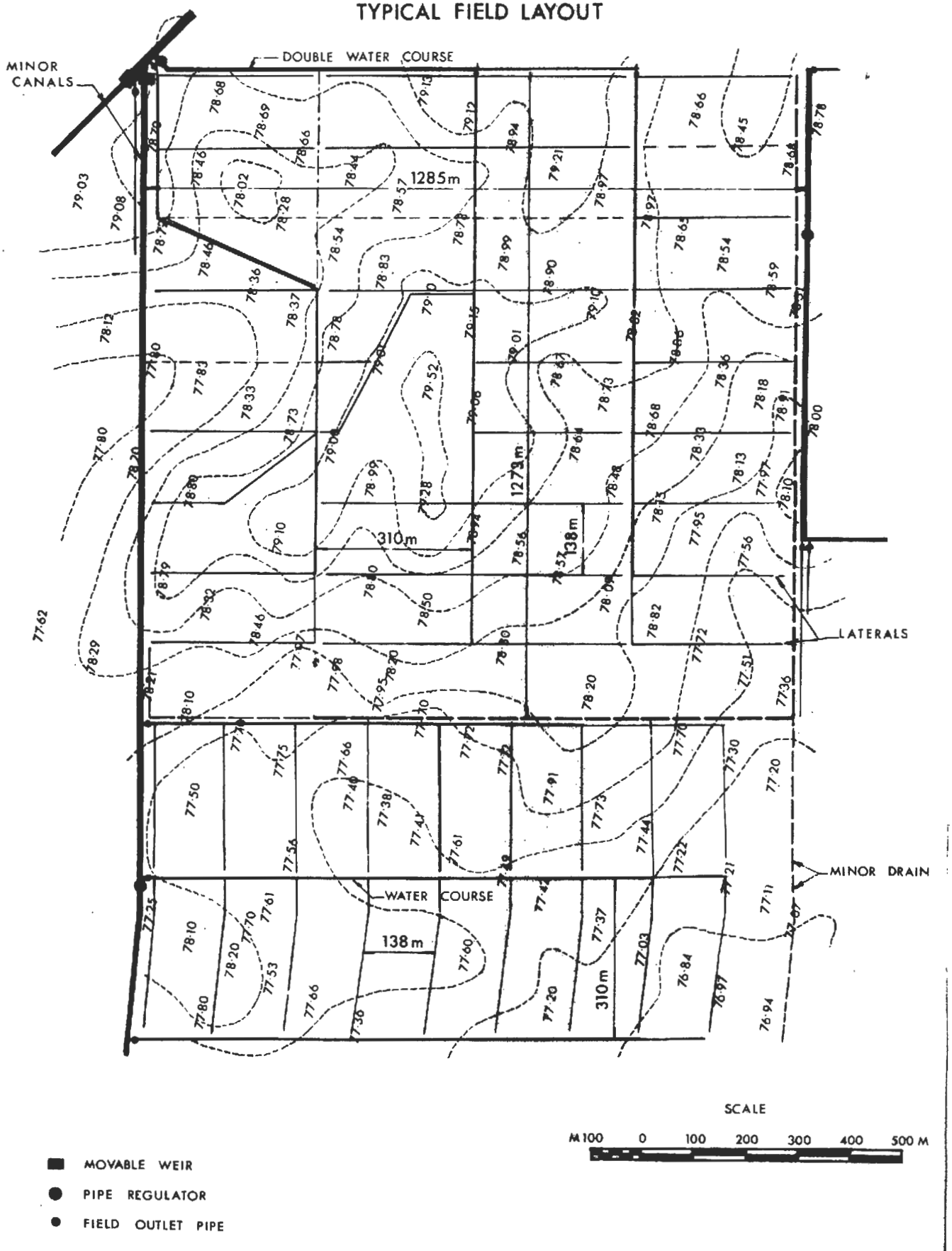


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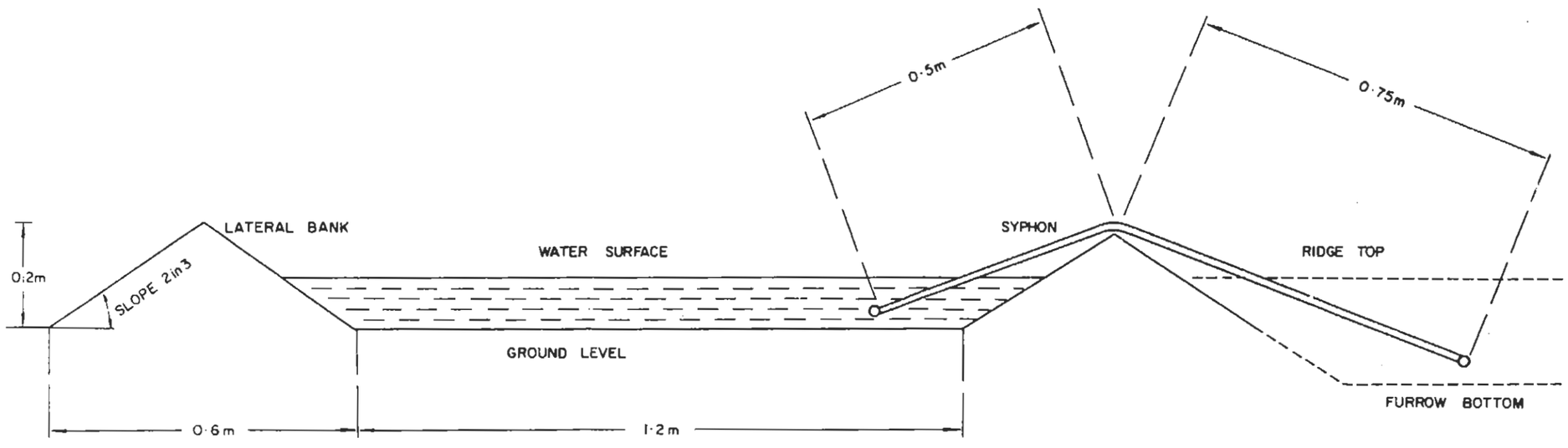
FIGURE 3·2

DIAGRAMMATIC CROSS SECTION OF A LATERAL

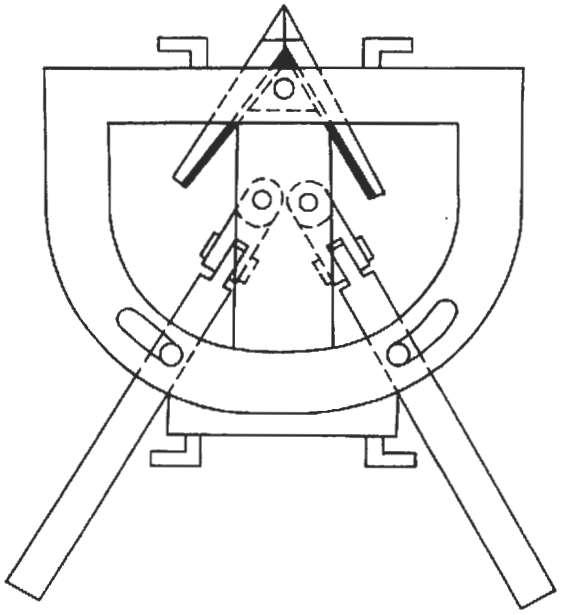


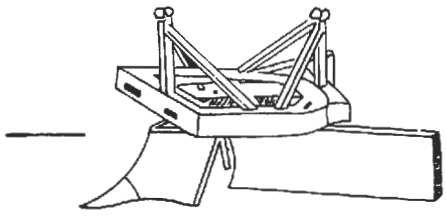
SCALE 1:10

SKETCH OF IMPLEMENT FOR FORMING AND SMOOTHING LATERALS

DIRECTION OF PULL

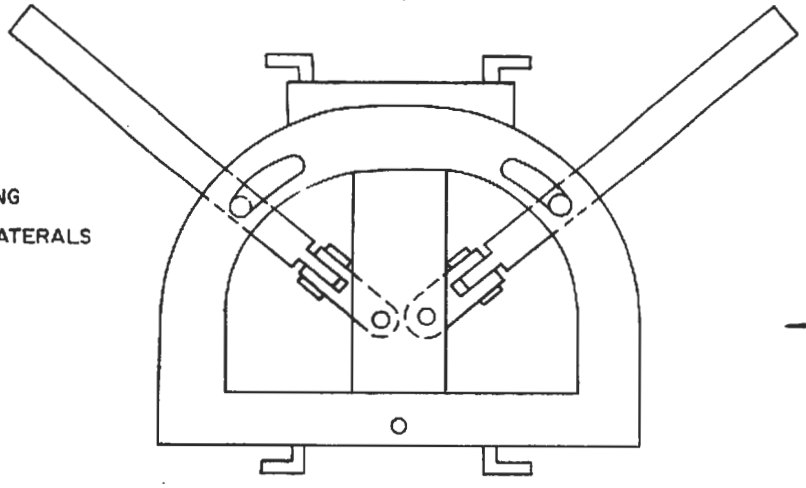
FORMING
LATERALS

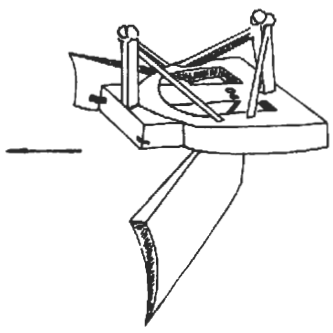




DIRECTION OF PULL

FILLING
LATERALS





A 4 cm (Internal diameter) plastic syphon will deliver approximately 4 m^3 per hour at 8 cm head and will thus apply a 10 cm irrigation application in $2\frac{1}{2}$ hours to a furrow 135 m long and 75 cm wide. It is considered that this rate of application will not cause serious erosion on slopes of less than 6 cm per 150 m. On steeper slopes, where laterals are spaced at 69 m intervals, 3 cm I. D. plastic syphons delivering 2 m^3 per hour are recommended, the time required to irrigate one furrow again being $2\frac{1}{2}$ hours. The farmer's 2 ha. plot in one field will contain 200 rows which may be irrigated in 20 hours using 25 syphons, each syphon being moved to another furrow when one furrow has been watered. Allowance must be made however for time lost when moving syphons and other delays.

The border method of irrigation is considered most suitable for the upland rice crop. With this method it is essential to provide an even surface over which water can flow down the slope at a nearly uniform depth. It is recommended that bunds be constructed at right angles to the laterals to form borders measuring 20 m by 135 m. Where the land is particularly level, the width of borders may be increased to 30 m; where fields are very uneven, smaller borders may be necessary and infield ditches may be required to distribute the water to these borders.

The flow of water must be regulated so that all parts of the border are covered for the length of time necessary for the required water application to infiltrate into the soil. Syphons will be used to transfer the water from the lateral into the borders.

3.7 Labour Inputs and Machinery Requirement

The proposed 4 ha. holding constitutes the largest area which an average family could manage to operate following the proposed cropping pattern with a minimum of assistance from hired labour during peak seasons. Whilst there would be no objection to a farmer operating more than one 4 ha. holding, providing that he possessed the necessary management skills, the second and subsequent holdings would be cultivated entirely

by hired labour and the return to the farmer from additional plots would be considerably reduced due to this increased production cost. Difficulties may arise through shortage of labour at peak seasons and during the early years of development, when yields may be expected to be low. It is recommended that in the early years of the project each family is limited to one 4 ha. holding. This restriction might be removed later when the skills needed to operate a larger holding have been acquired and if the acquisition of multiple holdings by one family were considered expedient.

An assessment of the labour requirements for each cultural operation for the recommended crops has been made and the total labour input for each ten day period throughout the year calculated. It has been assumed that a farmer will work up to eight days in any ten day period and that his family could provide the equivalent of five man days for planting, weeding and groundnut harvesting operations and eight man days for cotton picking in a similar period, the balance of labour required being hired. Most of the hired labour is required for cotton picking and for the subsequent uprooting operation, which latter being a strenuous task is unsuitable for family labour. A little hired labour may be necessary at planting times and during the peak weeding season of cotton and rice. The total labour input required for a 4 ha. holding is estimated to be 414 man days per year of which the farmer would provide 242 days and his family 106 with 66 man days being provided by hired labour. The total labour inputs for the individual crops are shown in Table 3. 10.

TABLE 3.10 Crop Labour Requirements per Hectare (Man days)

Operation	Groundnuts	Cotton	Rice
Field preparation	3	3	3
Sowing	7	7	1*
Resowing and thinning		5	
Irrigating	4	4	6
Weeding	18	18	18
Lifting and stacking groundnuts	4		
Stripping groundnuts	12		
Harvesting cotton		52	
Bagging and transporting	5	7	1
Uprooting and burning cotton		25	
Burning rice straws			4
Total:	53	121	33

* Assistance during tractor sowing.

The distribution of this labour between the farmer, his family and hired labour for the individual crops is shown in Table 3.11 for a 4 ha. holding.

TABLE 3.11 Distribution of Labour for a 4 Hectare Holding

	Groundnuts	Cotton	Rice
Labour per ha.	53	121	33
Labour per holding	106	242	66
Source			
Farmer	74	114	54
Family	28	78	-
Hired	4	50	12

In a settlement scheme of this nature in which few high valued cash crops can be included, it is essential to utilise as fully as possible all the available manpower of the farmer and his family. Mechanisation

should only be introduced for the essential land preparation operations and to supplement the available manpower to complete tasks, when labour becomes a constraint and timeliness is of vital importance.

Considering the type of mechanisation, equipment chosen should have a large output and should as far as possible be standardised for all crops. The use of a standard tool bar to which implements can be attached for ridging and interrow operations is preferable to having separate equipment for each operation.

The following are prerequisites for the efficient use of machinery in an agricultural system:

a) The size of field must be sufficiently large to avoid excessive loss of time due to frequent turning.

b) Adequate headlands are necessary to facilitate turning with minimum loss of time and damage to irrigation and drainage channels.

c) Obstacles such as irrigation channels must be kept to a minimum.

d) As far as possible, uniformity of row width and cultural operations for crops to facilitate transfer of tractors and implements from one crop to another.

The field layout described in 3.5 and the proposed agricultural system fulfils these requirements. The 36 ha. fields permit cultivation operations to be carried out over 1,242 m runs, providing intervening irrigation laterals are constructed in such a manner that they dry out rapidly after irrigation and may be filled in to facilitate the passage of the tractors and equipment and subsequently reformed. A standard row width of 75 cms for the cotton and groundnut crops has been recommended.

The recommended mechanised cultivation operations and equipment proposed are as follows:-

a) Ploughing

Ploughing will be necessary to break the soil in order that subsequent land preparation operations may proceed. A chisel type plough is recommended, as it is simple to operate and maintain and reduces the risk of developing a plough pan. This type of equipment has good penetration and ploughing to a depth of at least 25 cm is recommended. Should subsoiling become necessary, subsoil tines can be mounted on the same tool carrier.

b) Discing

After ploughing, the soil will require discing to break up clods and produce a satisfactory tilth. Wide level discs will be suitable and have a high rate of work.

c) Smoothing

In order to achieve the uniform slope essential for satisfactory border or furrow irrigation, careful land smoothing will be necessary. During initial construction of the scheme, it is recommended that large graders of the type used for construction work be hired and following the bush clearance and root ploughing operations should complete preliminary levelling.

Agricultural land levellers are recommended for final smoothing and will subsequently be used for re-smoothing before planting of the groundnut and rice crops. It is essential that a uniform slope along the entire length of each furrow or border be maintained.

d) Ridging and re-ridging

Ridger bodies mounted on a standard rear mounted tool bar will be necessary to prepare the ridges for planting of groundnuts and cotton and will also be used for re-ridging during the

growth of these crops. A four row unit will be operated and for cotton ridging, a mid-mounted tool bar equipped with tine cultivators could also be carried to loosen the soil in the old furrow bottom or the cultivators and ridger bodies might both be rear mounted.

e) Fertiliser application

Pre-planting application of fertilisers for the groundnut and cotton crops may be done at the same time as ridging, using a front mounted fertiliser spreader. This is preferable to application of fertiliser by hand as a much more even distribution is usually achieved.

f) Sowing of rice

It is recommended that for fertiliser application and sowing of rice, the wide level disc equipment be used with the necessary attachments to distribute the fertiliser and seed. Thus the final preparation of the seed bed, application of fertiliser and sowing is completed in one operation, using relatively low priced equipment and a high tractor utilisation peak at this season avoided.

g) Herbicide spraying

The use of a boom sprayer treating a swathe some 10 m wide is recommended to enable weed control treatments to be applied quickly and cheaply.

h) Groundnut lifting

In order to ease the lifting of the groundnut crop, a preliminary blading operation is recommended to loosen the plants in the ridge. A blade to cut below two ridges at a time may be attached to the ridger body shanks and mounted on the standard tool bar.

i) Rice harvesting

Bagger combines are recommended; timeliness of this operation being essential to avoid undue crop losses.

j) Transport

Transport of crops from field to collecting centres will require the use of 5 ton trailers. It is estimated such trailers will carry up to 3 tons of bagged groundnuts, 2 tons of bagged cotton or 4. 5 tons of bagged rice. They will also be used for distribution of seed and fertilisers to the fields and for general transportation. ;

It has been assumed that equipment will be operated 8 hours per day, except at peak seasons when 10 hours per day for certain operations will be required. In the event of field operations being unduly delayed by unusually wet weather or by mechanical breakdowns, operation of equipment for 12 hours per day would be possible in order to achieve timely completion of cultivations.

The rate of work for the recommended equipment for the proposed cultural operations has been assessed in Table 3. 12.

TABLE 3. 12 Assessed outputs for operations by agricultural machinery

Operation	Tractor Speed K. P. H.	Width of equipment in metres	Operating hours/ day	Completed ha/ day	Days to complete 1, 500 ha.
Chisel plough	4. 5	2. 40	8	6	250
Disc	6. 0	3. 00	8	12	125
Smooth			8	4. 5	350
Ridge	4. 5	2. 25	8	6	250
Re-ridge	6. 0	2. 25	8	10	150
Disc & sow rice	6. 0	3. 00	10	12	125
Spray	6. 0	9. 00	8	30	50
Blade groundnuts	6. 0	1. 50	10	8	200
Combine rice	4. 5	3. 00	8	8	200

The capacity of trailers for transport of crops has been estimated on the basis of an average round trip from field to collecting centre being 10 km and assuming a tractor and trailer could complete 4 such journeys in one day. The number of tractor days for transporting each crop are assessed in Table 3.13.

TABLE 3.13 Tractor days required for transport of crops

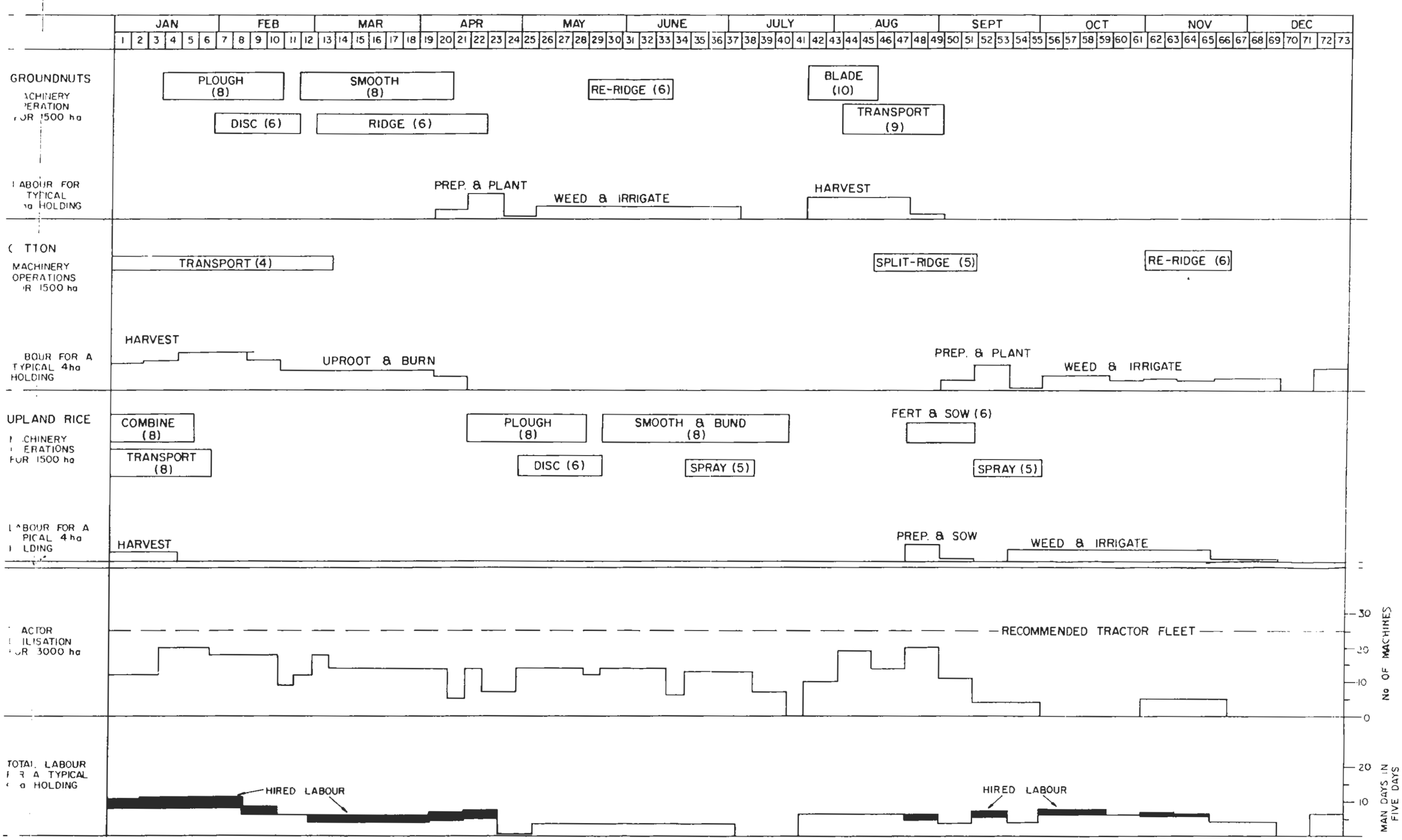
Crop	Yield from 1,500 ha. tons	Average load tons	Tractor & Trailer days required
Groundnuts in shell	3,300	3.0	275
Cotton	2,250	2.0	280
Rice	3,750	4.5	210

The schedule of machinery and hand operations throughout the year is shown diagramatically in Figure 3.4 based on the labour requirements and machinery outputs in the above tables. In drawing up the cultivation programme for the machanical equipment, care was taken to maintain uniform utilisation of tractors as far as possible throughout the year.

In order to keep the tractors in the field supplied with fuel and water, tanker trailers of 2,000 litres and 1,000 litres capacity respectively will be required. The positioning of these tankers in the field each day will require careful planning to facilitate rapid refuelling of all tractors. The tankers will be moved either before field operations begin each day or else by tractors not otherwise required in the field.

Besides the tractor drawn machinery described above, hand operated cotton root pullers for the cotton uprooting operation and syphons for the application of irrigation water will be required. The cotton root pullers will be of the same type as used in the Sudan Gezira Scheme and one will be required for each farmer. Plastic irrigation syphons of 4 cm and 3 cm internal diameter will be required, the smaller size being used only where steeper furrow slopes occur and having half

igure 3·4 ESTIMATED MACHINERY AND LABOUR REQUIREMENTS FOR THE RECOMMENDED ROTATION



the output of the larger. The greatest number of syphons will be required at the irrigation peaks for cotton and rice. The 1, 500 ha. of cotton will be irrigated on a 15 day cycle so that 100 ha. will be irrigated each day. A 4 cm I. D. syphon irrigates one furrow or 0. 01 ha. in $2\frac{1}{2}$ hours applying 10 cm of water. Consequently if irrigation continues for 10 hours per day, 2, 500 syphons are required for 100 ha. Similarly for rice irrigated on a 10 day cycle and applying 7. 5 cm of water, 3, 000 syphons are required making a total of 5, 500 syphons. In addition, a reserve of some 20 per cent should be allowed bringing the total to 7, 000 syphons, if all are 4 cms I. D. The area on which the smaller syphons will be required cannot be accurately assessed at the present time. It is suggested for estimation purposes that 6, 000 4 cm I. D. syphons and 2, 000 3 cm I. D. syphons be taken as a reasonable proportion.

The total recommended requirements for agricultural machinery and equipment are shown in Table 3. 14. The number of implements and machines have been derived from the diagram of machinery operations Figure 3. 4 but includes reserve equipment to allow for sub optimal machinery performance and for unserviceable machinery. Seasonal shortage of machinery and delays in cultural operations could prove disastrous, therefore any proposal to economise in the proposed scale of mechanisation should be resisted.

TABLE 3.14 Machinery and equipment requirements

Items	No. Required		Replacement life years
	Theoretical	Recommended	
Combine harvesters	8	8	8
Tractors wheeled 70 H. P.	20	25	6
Chisel Ploughs 2.4 m width	10	12	6
Wide level discs sets 3 m wide	10	12	6
Fertiliser attachments for discs	10	12	6
Seeding attachments for discs	10	12	6
Toolbars mid-mounted	10	12	6
Cultivator tines - sets of 5	10	12	6
Fertiliser spreaders front mounted	10	12	6
Toolbars rear mounted	10	12	6
Ridger bodies - sets of 4	10	12	6
Groundnut blades - 2 row	10	12	6
Boom sprayers	5	6	6
Land levellers	8	9	6
Lateral formers	2	2	6
Trailers 5 ton capacity	12	15	8
Fuel trailers, 2,000 litre	3	3	8
Water trailers, 1,000 litre	3	3	8
Cotton root pullers		750	
Syphons 4 cm I. D. plastic		6,000	
Syphons 3 cm I. D. plastic		2,000	

CHAPTER 4

THE IRRIGATION AND DRAINAGE SYSTEM

4.1 Water Requirements and Crop Factors

The cropping pattern and rotation is described in Chapter 3, Section 3 and 4 and the irrigation requirement is discussed in Chapter 3, Section 5. The canalisation has been designed for the maximum irrigation demand which occurs during the 'Der' season, when the cropping is as follows:-

Rice (Upland)	1,500 ha.
Cotton (Medium Staple)	1,500 ha.
Vegetables	75 ha.

The peak crop factor is the maximum watering rate for the crop and is measured in cubic metres per hectare per day (m^3/ha/day).

The peak water requirement for cotton, from Table 3.7, is 100 mm applied in 15 days. This gives a peak crop factor of 66.7. The watering schedule is given in Figure 4.1 and shows that the peak crop factor is maintained from 26th October to 9th December. During this period the daily discharge for a 36 ha. field of cotton is 4,800 m^3 which can be supplied from a standard watercourse in $11\frac{1}{2}$ hours.

The peak water requirement for rice is 75 mm applied in ten days giving a crop factor of 75. However, owing to the short duration of the peak and to the phasing of the irrigation, shown in Figure 4.1, the peak crop factor is reduced to 72.5 and is effective from 31st October to 19th November. The maximum daily discharge for a 36 ha. field of rice is 5,400 m^3. This can be delivered by a standard watercourse in 13 hours. This is longer than recommended but each field is only affected for one 5 day period.

The 75 ha. of vegetables are irrigated at a uniform rate of 50 mm every 10 days. Half the area is watered at one time and hence the crop factor is 50. This factor is not included when calculating the gross factors because it only occurs on one minor canal and it would reduce the gross factor on canals which are not affected.

The total 'Der' season water requirements are shown in Figure 4. 2.

During the 'Gu' season 1, 500 hectares of the scheme are planted with groundnuts and 1, 500 hectares are fallow. From Table 3. 6 the peak water requirement for groundnuts in a 10 per cent dry year is 90 mm to be applied in a 12 day period. If half the groundnuts are watered at a time, then the peak crop factor is 75. The maximum daily discharge to a standard 36 hectare field is 5, 400 m^3 which can be supplied from a standard watercourse in 13 hours. This is the same discharge as for the rice fields during the 'Der' season but in this case, the peak lasts for two 12 day periods during June. However, this peak only occurs in dry years. The peak for a median year is 80 mm in 12 days which gives a crop factor of 66. 7 and a daily field discharge of 4, 800 m^3, the same as for cotton during the 'Der' season. The requirements for vegetables and other garden crops are the same as during the 'Der' season.

The total 'Gu' season water requirements for median and 10 per cent dry years are shown in Figure 4. 3.

4. 2 Transmission Losses and Design Factors

a) Transmission Losses

The evaporation losses are based on a daily evaporating rate of 7 mm per day on a water surface width of approximately 12 m over the total length of minor canals. This represents a loss of less than 1. 5 per cent of the full supply at farms.

Some allowance must be made for seepage losses in the

'DER' SEASON WATERING SCHEDULE

CROP	SECTION	AREA ha	WATER REQUIREMENTS IN $m^3/ha/day$											
RICE	1	375	46	110	120	120	120	130	140	150	140	120	120	100
	2	375	46	110	120	120	120	130	140	150	140	120	120	100
	3	375	46	110	120	120	120	130	140	150	140	120	120	100
	4	375	46	110	120	120	120	130	140	150	140	120	120	100
	TOTAL	1500	35·0	27·5	57·5	60·0	62·5	67·5	72·5	65·0	60·0	55·0	25·0	0
COTTON	1	750	133·3	125·0	123·0	126·6	133·3	133·3	133·3	113·4	113·4			
	2	750	133·3	125·0	123·0	126·6	133·3	133·3	133·3	113·4	113·4			
	TOTAL	1500	0	66·7	0	62·5	61·5	63·3	66·7	56·7	0			
GARDENS	TOTAL	75	50 m^3/ha constant throughout the season											
			MONTH	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.					

PRE-PLANTING IRRIGATION

NON-ESSENTIAL IRRIGATION

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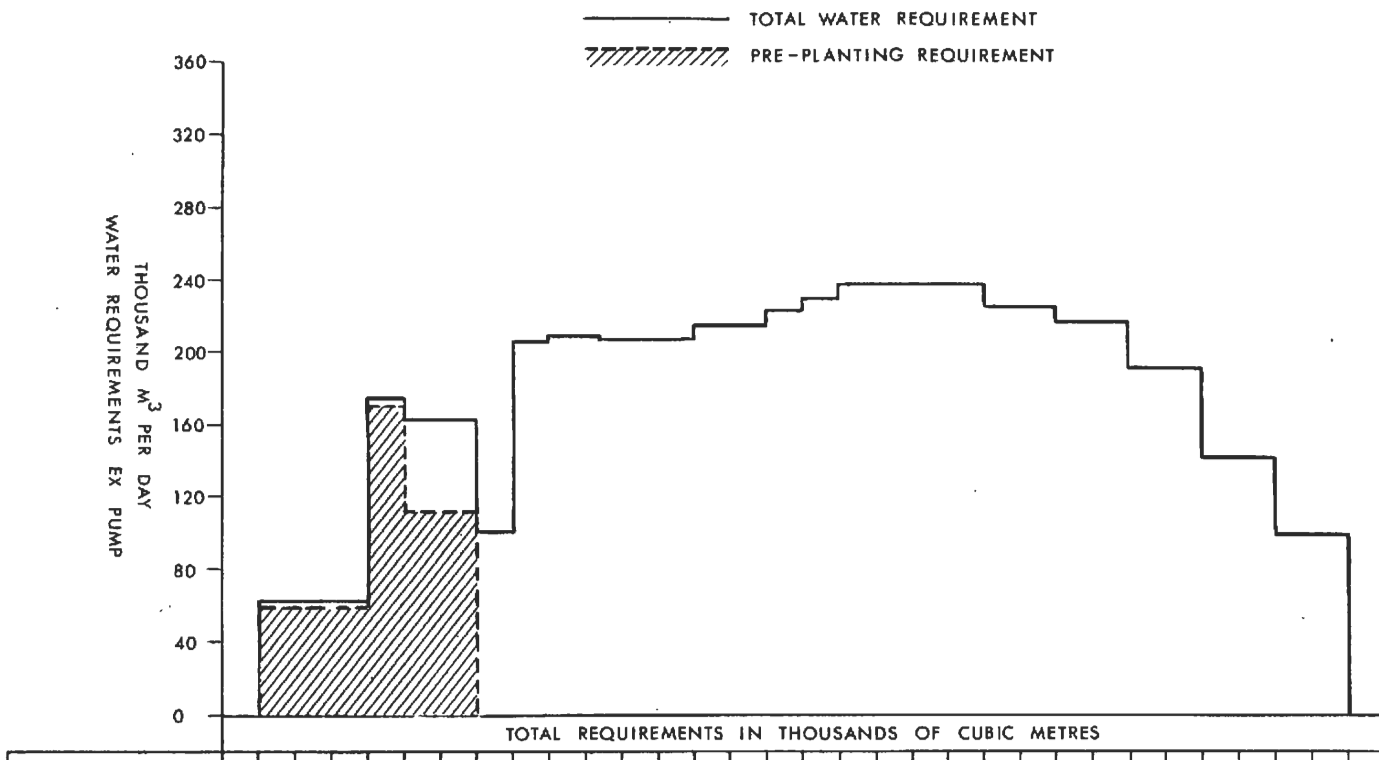
FIGURE 4·1



MONTH	AUG					SEPT						OCT						NOV						DEC						JAN			SEASON
RICE	–	294·0	294·0	294·0	294·0	231·0	231·0	483·0	483·0	504·0	504·0	504·0	504·0	524·8	524·8	566·8	566·8	609·0	609·0	609·0	609·0	546·0	546·0	504·0	504·0	462·0	462·0	210·0	210·0	–	–	–	12 683·2
COTTON	–	–	–	–	560·0	560·0	560·0	–	525·0	525·0	520·0	517·0	517·0	531·0	531·0	531·0	560·0	560·0	560·0	560·0	560·0	560·0	560·0	560·0	560·0	476·0	476·0	476·0	476·0	476·0	476·0	–	13, 773·0
GARDENS	–	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	19·5	–	585·0
TOTAL	–	313·5	313·5	313·5	873·5	810·5	810·5	502·5	1027·5	1048·5	1043·5	1040·5	1040·5	1075·3	1075·3	1117·3	1146·3	1188·5	1188·5	1188·5	1188·5	1125·5	1125·5	1083·5	1083·5	957·5	957·5	705·5	705·5	495·5	495·5	–	27,041·2

'DER' SEASON WATER REQUIREMENTS

FIGURE 4·2

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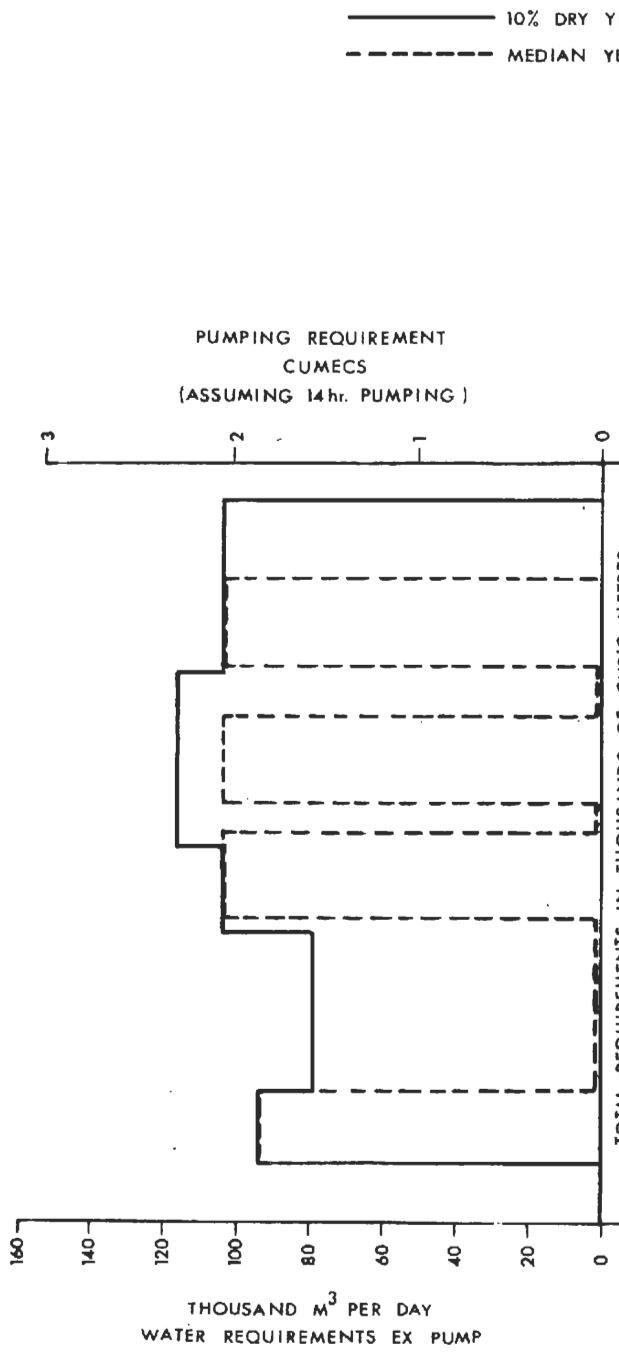
FIGURE 4 · 3

'GU' SEASON WATER REQUIREMENTS



TOTAL REQUIREMENTS IN THOUSANDS OF CUBIC METRES

MONTH	GROUNDNUTS	GARDENS	TOTAL
APRIL	–	–	–
	180·0	7·8	187·8
	450·0	19·5	469·5
	420·0	19·5	439·5
MAY	375·0	19·5	394·5
	375·0	19·5	394·5
	375·0	19·5	394·5
	375·0	19·5	394·5
	500·0	19·5	519·5
	500·0	19·5	519·5
	537·5	19·5	557·0
JUNE	562·5	19·5	582·0
	562·5	19·5	582·0
	562·5	19·5	582·0
	562·5	19·5	582·0
	512·5	19·5	532·0
JULY	500·0	19·5	519·5
	500·0	19·5	519·5
	500·0	19·5	519·5
	–	–	–
SEASON	8 850·0	358·8	9 208·8

10% DRY YEAR

GROUNDNUTS	GARDENS	TOTAL
–	–	–
180·0	7·8	187·8
450·0	19·5	469·5
270·0	11·7	281·7
–	–	–
–	–	–
–	–	–
–	–	–
300·0	11·7	311·7
400·0	15·6	415·6
500·0	19·5	519·5
500·0	19·5	519·5
200·0	7·8	207·8
400·0	15·6	415·6
500·0	19·5	519·5
300·0	11·7	311·7
–	–	–
400·0	15·6	415·6
500·0	19·5	519·5
300·0	11·7	311·7
–	–	–
4 500·0	179·4	4 679·4

MEDIAN YEAR

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new canal system and since the canals are only in operation for 14 hours per day or less, it is considered that the infiltration rate given in Chapter 2, Section 10 of 4 mm/hr is an adequate allowance. The seepage losses are about 10.5 per cent of the full supply at farms.

The total transmission losses in the project canal system have been assumed to be about 12 per cent of the full supply at farms.

b) Design Factors

The peak gross factor is the maximum water use per day on the available cultivable area in the project. The peak gross factor at farm outlets is 69.6 m^3/ha/day. These values occur during the first 20 days of November.

The recommended gross factors for design are given below. The factors assume that the canals will be operated for 14 hours per day and the factor for structures allows for a 15 per cent overload to permit an increase in the water requirement in the future.

Description	Design Factor m^3/ha/day
Canal excavation in dry and pump station	134
Canal Structures	154

4.3 System of Watering

The irrigation system has been designed so that the fields are watered only during the daylight hours. Whilst longer watering hours permit larger areas to be irrigated during the watering period from each watercourse and reduce canalisation costs due to a reduction in watercourses and field outlet pipes, night irrigation is extremely difficult even in countries with long traditions of irrigation. It is normally inefficient and results in overwatering and in a scheme with inexperienced settlers night watering would be almost impossible to institute. Moreover the settler is expected to do more work during the day than is customary in traditional agriculture and he can hardly

be expected to work periodically at night having already completed a day's work.

4.4 Canalisation

a) Field Dimensions

The layout of the field channels and minor canals is based on the dimensions of the standard field which has been selected for the scheme. The following factors were considered in fixing the standard field dimensions:-

i) The field must not exceed the area which can be watered in $7\frac{1}{2}$ days, when planted with cotton, or 5 days, when planted with rice, at the peak watering period. This limitation on watering time is important as time is needed after irrigation has been completed for the field to dry out so as to permit inter-row operations with tractors to be carried out.

ii) The dimensions of the field should be arranged so as to provide as long a run for mechanised farming operations as possible.

iii) The division of each field by laterals should be such that each farmer's holding of 2 hectares in each of two fields is confined to one lateral.

iv) The size of laterals and watercourses is limited by the amount of water which can be controlled efficiently. It is considered that no more than 3 laterals should be operating simultaneously since even distribution of the supply becomes increasingly difficult if longer reaches of the watercourses are in use. Not more than two farmers' plots per lateral are recommended since these channels have very low command limits and it is the responsibility of the farmers to see that they

are maintained. Thus six farmers may be supplied at one time. The peak requirement for cotton lasts for six weeks and for this each farmer requires 2,000 m^3. In Chapter 3, Section 6 it is stated that this can be distributed in 20 hours but when allowances are made for interruption of flow when moving syphons and for blockages or non-availability of syphons it is considered that 30 hours or $2\frac{1}{2}$ days is a reasonable time for efficient distribution. Thus in $7\frac{1}{2}$ days 18 farmers are supplied and the total water delivered by a watercourse will be 36,000 m^3. This is equivalent to a rate of 4,800 m^3/day. A standard watercourse delivering 5,000 m^3 per 12 hours day has been used successfully in the Sudan for many years and this size has been adopted for the project.

Thus the standard size of field is 36 hectares and the field is divided into nine 4 hectare plots each plot being served by a lateral which is fed through a pipe from the watercourse. The furrows in the 4 hectare plots are 135 m long. The typical field layout is shown in Figure 3. 1.

b) Proposed Layout

The proposed layout shown on Plate 4 is based on a one kilometre square grid of levels covering the whole area and a 200 metre square grid covering 10 per cent of the area. It is recommended that the whole area be surveyed at the latter intensity after bush clearance and before the final layout is prepared.

The minor canals have been aligned along the ridges where possible and arranged so that the maximum number of standard 36 ha. fields can be accommodated. The standard distances have been arranged so that the water-

courses can be aligned either parallel or normal to the minors with a minimum wastage of land.

The usual arrangement is for the watercourses to be normal to the minor canals but on steeper slopes this may not be suitable. In these circumstances it may be better to align the watercourses parallel to the minors and then a double watercourse is required to carry the water from the minor to the 3 fields parallel to but distant from the minor. The double watercourse will be supplied through a 0.50 metre outlet pipe from the minor canal and its discharging capacity will be 10,000 m^3 per 12 hours. This is the capacity required to supply two watercourses simultaneously and provision is made for this discharge to be conveyed over the first 620 metres of the channel to the outlet to the third field. An additional length of standard watercourse section is needed from the tail of the 'double' to the edge of the fourth field.

The detailed layout for 10 per cent of the area surveyed on a 200 m square grid is shown on Plate 5 and this shows both the normal and the double watercourse layouts.

Full details of the standard dimensions for the proposed layouts together with design criteria to be followed are given in Appendix II.

The proposed layout shown on Plate 4 covers a gross area of 3,800 hectares. The net canalised area is 3,250 hectares the remaining 500 hectares being used by canals, roads and drains or being undeveloped. An estimate of the percentage of canalised area which will be out of command after levelling was made for the 10 per cent area. The results of this indicate that a total of 175 hectares will be out of command and thus the net irrigable area is 3,075 hectares. The peak gross factor for design is 134 and thus

the peak pump requirement for the proposed layout is 4.75 cumecs.

4.5 Drainage Requirement

The climate in and around the project area is described in Chapter 2, Section 8 where it is stated that amounts of rainfall in excess of 75 mm in 24 hours are unusual. However, storms of over 100 mm in 24 hours have been recorded. In Section 10 of the same chapter an infiltration of 4 mm/hour is considered to be the effective rate on existing land which is not irrigated but which has already absorbed some moisture. This suggests that most storms are absorbed within 24 hours and that there is little run-off. Under these conditions it is considered that the drainage requirement is small. However ground slopes vary considerably and several low areas are known to collect water after heavy rain. Also field observations have shown that the existing roads in the area quickly become impassable after rain and may remain so for considerable periods due to frequent showers. The poor state of the roads is partly caused by the local practice of grading the roads during the dry season, pushing the soil to the edge of the road instead of building up the camber at the centre. Each time the roads are scraped they get further below the surrounding ground levels and hence they become natural drainage lines and collect water. This condition must be avoided in the scheme so that farming operations can continue during the wet season.

It is considered that the maximum drainage requirement is of the order of 18 m^3/ha/day. The ground slopes of the minor drains vary but average about 0.5 m/km. Allowing for structures and reaches with flatter slopes a water slope of 20 cm/km is easily obtainable. Since the catchment areas of the minor drains is generally below 1,000 hectares the size of drain required is usually very small.

4. 6 Drainage System

No field drains will be provided as the small amount of run-off from one field will run along the side of the access road adjacent to the watercourse without causing serious damage. If it is later decided to drain some fields then these ditches may be dug by tractor drawn ploughs along the edge of the field roads. However, it is essential that a system of relatively dry roads adjacent to minor canals is maintained so that supervision and movement of plant from place to place within the scheme during wet weather is not seriously interrupted. Therefore all the minor drains will be dug and the spoil used to raise the level of the adjacent roads above the natural ground level. Where a minor canal is adjacent to a drain the road will be between them and where there is no minor canal a road will be on one side of the drain. In both cases the spoil from the drain will raise the road above ground level. When a minor canal has no adjacent drain the soil to raise the road must be collected during the levelling operations. A drain section of 1. 50 m^3/m is adequate for the drainage requirement outlined in the previous section of this chapter. This will raise a 6 m wide road an average of about 0. 25 m above ground level.

The water collected from the scheme in the minor drains must be removed from the scheme area and therefore allowance has been made in the estimates for 3 kilometres of outfall drains. Additional survey work will be required to define these but most of the area drains naturally to a depression on the west side of the scheme and a short channel to the lower parts of this depression will be sufficient. The southern part of the scheme can be drained to the other side of the Afgoi-Merca road and into an excavated pool if necessary. However, this should not be provided unless it is shown to be necessary after implementation of the scheme.

CHAPTER 5

IRRIGATION WORKS

5.1 The Mordile Pump Station

The proposed pump station site is upstream of Mordile on the left bank of the river. The maximum irrigation requirement is 4.75 cumecs. for a pumping period of 14 hours per day. This could be supplied using four pumping units; three units would then be capable of supplying the same quantity of water in under 19 hours in case one pumping unit were to break down or if it should prove more convenient to pump at this reduced rate over a long period.

The lift of the station, which has a head pool level of 85.0 m A.S.L., can vary from zero to 4.0 metres, see Figure 5.1, the latter when the river discharge is at the minimum permissible for extraction. For short periods the river level may actually exceed the level in the head pool, but this excess appears to be too small and it occurs with insufficient frequency to justify the provision of a free flow channel and water control gate so that pumping will be necessary whenever water is required.

The principal problem in the design of this station is how best to cater for the wide variation in water level on the suction side of the pumps, which not only affects the working conditions and efficiency of the pumps, but also the rate of discharge from individual pumps. It also has a very pronounced effect on the cost of constructing the pump station. Pumping with single lift pumps is possible, but they would be subject to relatively poor average performance since they can be designed to work at maximum efficiency only at one particular value of lift for a given rate discharge. Pumping in two lifts has been seriously considered but the capital cost is high both for the plant and for the structure: detailed estimates of the expected performance based on the river hydrographs for the last 17 years have been made

and the conclusion has been reached that in this case the advantage, if any, to be expected in reduced fuel costs would not justify the adoption of this method. Theoretically, the problem could be overcome with single stage pumps working with both variable speed and variable impeller pitch control which would be very expensive, require highly skilled maintenance, and depend on electricity supply from a generator to operate the control system.

With all the foregoing methods, river-borne animal or vegetable trash could stall or damage the pumps and it would be necessary to provide a bar screen on the inlet side of the pumps which, on account of the level variation, would need to be about 6 metres in length; for such a screen it is recommended that a mechanical rake is fitted to ensure that it is effective. This is another complication and potential cause of maintenance difficulties and even then extraction of all the trash cannot be guaranteed.

There is still another possibility and that is to use Archimedean screw pumps which, although very large for the output required, are virtually indestructible and are quite extensively used for the pumping of sewage and other difficult liquid/solid mixtures. Their maximum working efficiency is almost as high as that of conventional pumps, though the efficiency will fall off progressively as the screws are drowned by the rising river level. They will, however, be most efficient when operating at the highest lift so that the driving engines will need to be of no greater power than those which would be required to drive conventional pumps. Also the quantity pumped will not depend on the lift and this will permit better control of the quantity of water being pumped into the system. No screens would be necessary on the inlet side of these pumps: however, a shallow bar screen should be provided in the delivery channel downstream of the screws as a safeguard to stop any excessively large item of trash entering the irrigation system.

Some preliminary prices have been obtained both for conventional pumps and for screw pumps and the capital cost of a screw pump

MAXIMUM MINIMUM AND 3 YRS IN 4 RIVER LEVEL

STATION : AFGOI / MORDILE CONTROLLED IRRIGATION PROJECT OFFTAKE

PERIOD OF RECORD : 17 YEARS (1951–1968)

(Adjusted values from Afgoi Road Bridge Station)

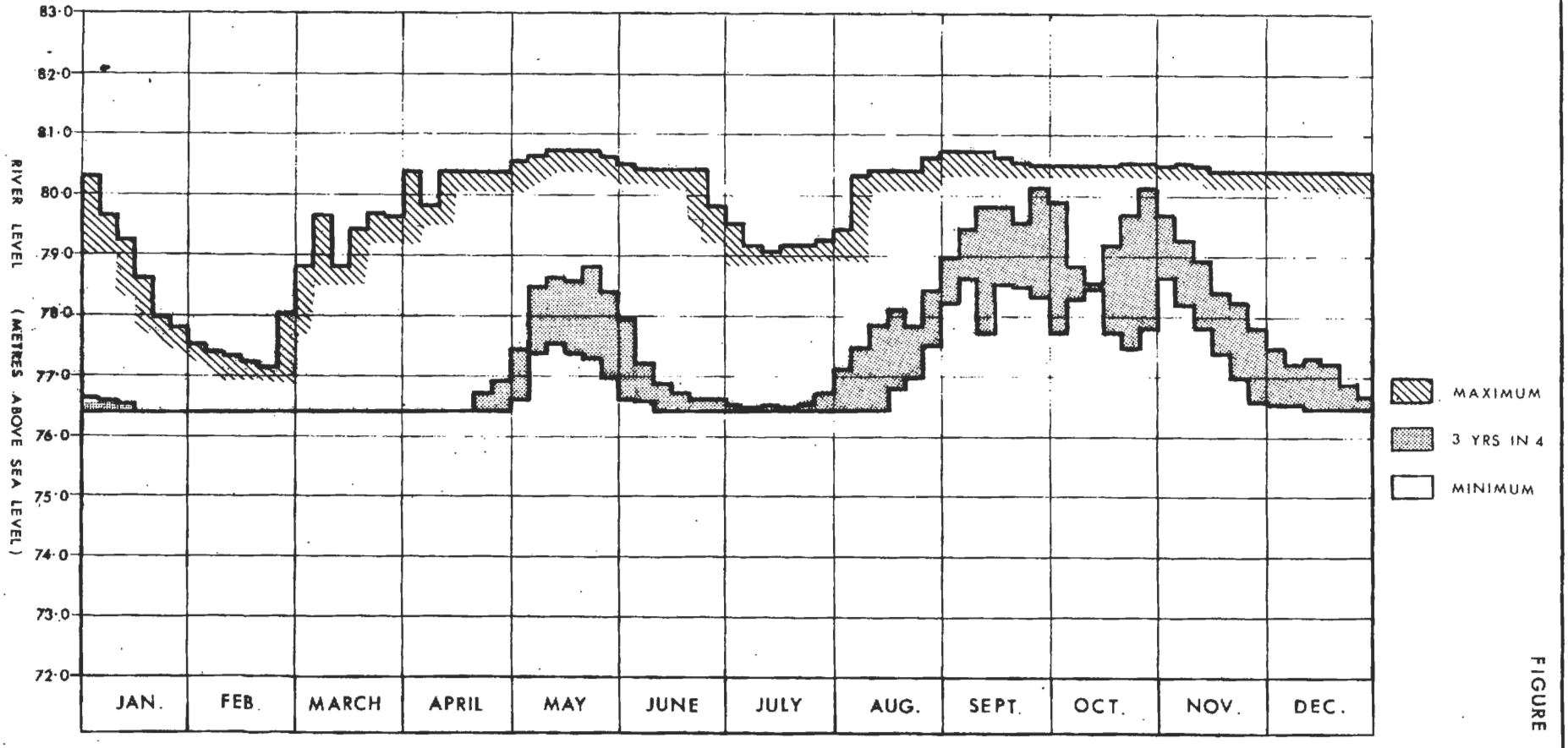

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FIGURE 5.1

installation is unlikely to be very different from that for a conventional pumping installation with mechanically raked screens. On this assumption the use of screw pumps is recommended in preference to conventional pumps protected by mechanical screens for this station, mainly on the grounds of improved reliability, minimum maintenance requirements and better control of the rate of flow of water into the system.

In view of the considerable size and weight of this type of equipment it is recommended that, before specifying the plant, enquiries should be made to ensure that the size and weight of the individual screws, or components of screws, does not exceed the limitations of the local transport and handling facilities. If the size or weight limitations are very critical it might be advantageous to supply a greater number of small screws for the same total output.

The recommended pump station is shown in Plate 6. This shows twin intake culverts, 2. 0 m wide by 1. 6 m in depth, discharging into the screw bays. The screws are mounted at an angle of 30 degrees to the horizontal and the flow for each screw is isolated by dividing walls until it reaches the stilling basin downstream of the pump house. Each flow section is fitted with a flap gate at the entrance to the stilling basin to prevent reverse flow through a screw which is not in operation. There are four screws of 1. 9 m diameter and each is driven by a 89 KVA diesel engine and the screw speed is approximately 33 r. p. m. The two intakes are fitted with vertical lifting gates so that the screw bays can be drained.

It is recommended that there should be sufficient capacity in the fuel tanks on the site to supply the pumps for 3 months. Also there should be at least two fuel tanks so that in the event of one being inoperative, then there is still 6 weeks supply. Thus the estimates include two 115, 000 litre tanks which will be sited in bunded pits, so that the fuel is confined in the event of a leak.

It is recommended that a separate building is provided for the use of the operating staff that this building should contain a small

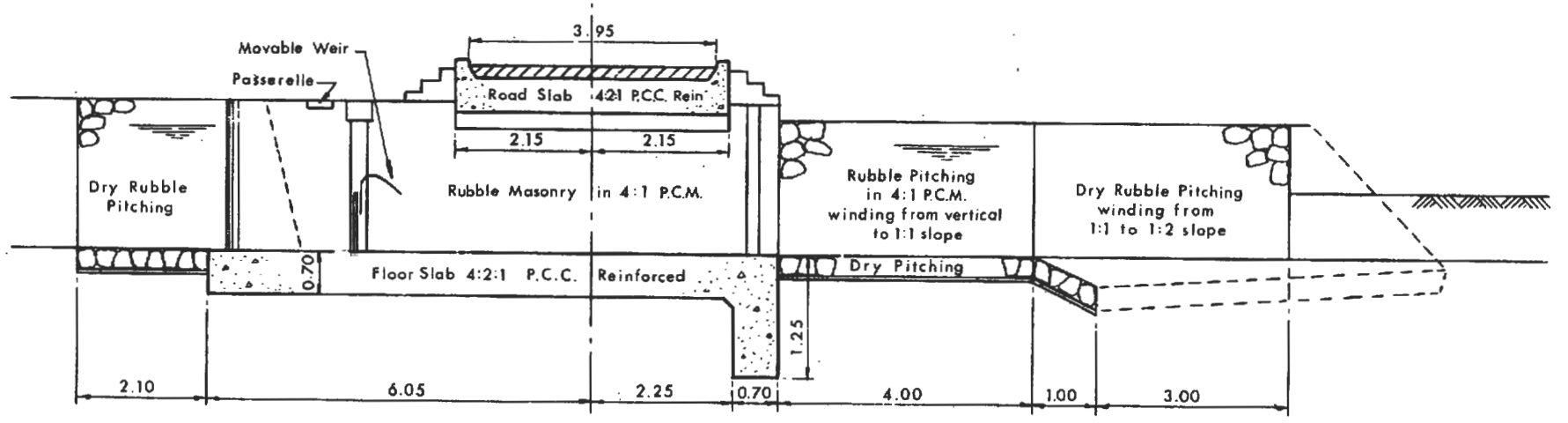
office, a workshop for maintenance work, a mess and kitchen, a store and a toilet. There should also be an access road to the pump house, the fuel tanks and the office building. The site plan of the pumping station and the canal headreach and pool is shown in Plate 7.

5.2 Water Control Structures

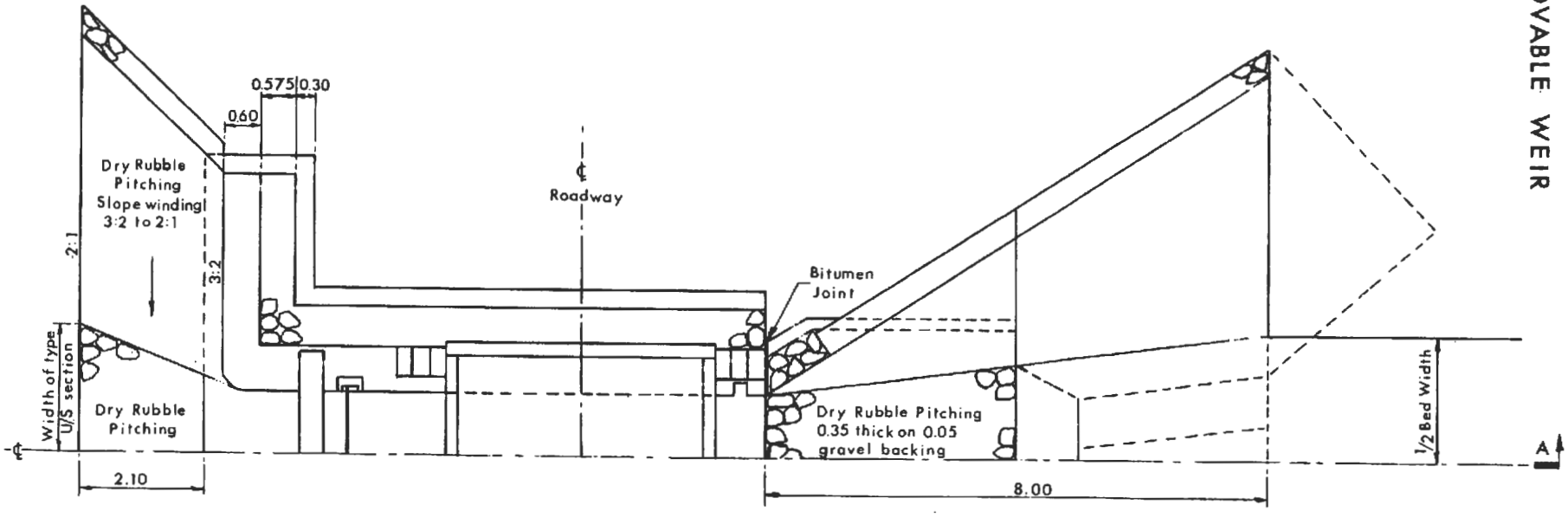
The water leaves the pump station at Mordile and flows along a short length of pump channel to the head-pool. At this point, four minor canals off-take through movable weirs. These weirs have the advantage that provided the minimum head condition is fulfilled, then the discharge is independent of the downstream level; thus, once the weir has been set to a particular flow it need not be adjusted provided the upstream level is constant. The series I weirs vary in width from 0.45 m to 1.30 m and can pass discharges up to 1.0 cumec with a minimum head of 0.20 m. The series II weirs vary from 0.80 m to 3.00 m in width and can pass discharges up to 5.0 cumecs with a minimum head of 0.30 m. The movable weirs are also placed at the division of minor canals, where accurate measurement of flow is required. A typical movable weir is shown in Figure 5.2.

The intermediate regulators on the minor canals are of the pipe regulator type. The regulators consist of steel pipes with a plate valve on the upstream end; a typical pipe regulator is shown in Figure 5.3. There are five sizes of pipe varying from 0.50 m to 1.24 m diameter. The smaller pipes will operate on a head of 0.05 m and the larger ones on a head of 0.10 m. The flow from the minor canals into the watercourses is by means of field outlet pipes; these are concrete pipes 0.35 m in diameter and 12 m long which pass the water under the canal banks and adjacent roads. Each pipe is fitted with a flap valve at its upstream end to control the flow. There are four settings on these valves and for various field requirements the opening time can be varied as well as the opening.

The flow in the watercourses is controlled by 'Bombas'; these are short pipes laid in the watercourse and their position may be



SECTION A-A



HALF PLAN

SCALE

M 1 0 1 2 3 4 5M

MOVABLE WEIR

FIGURE 5·2

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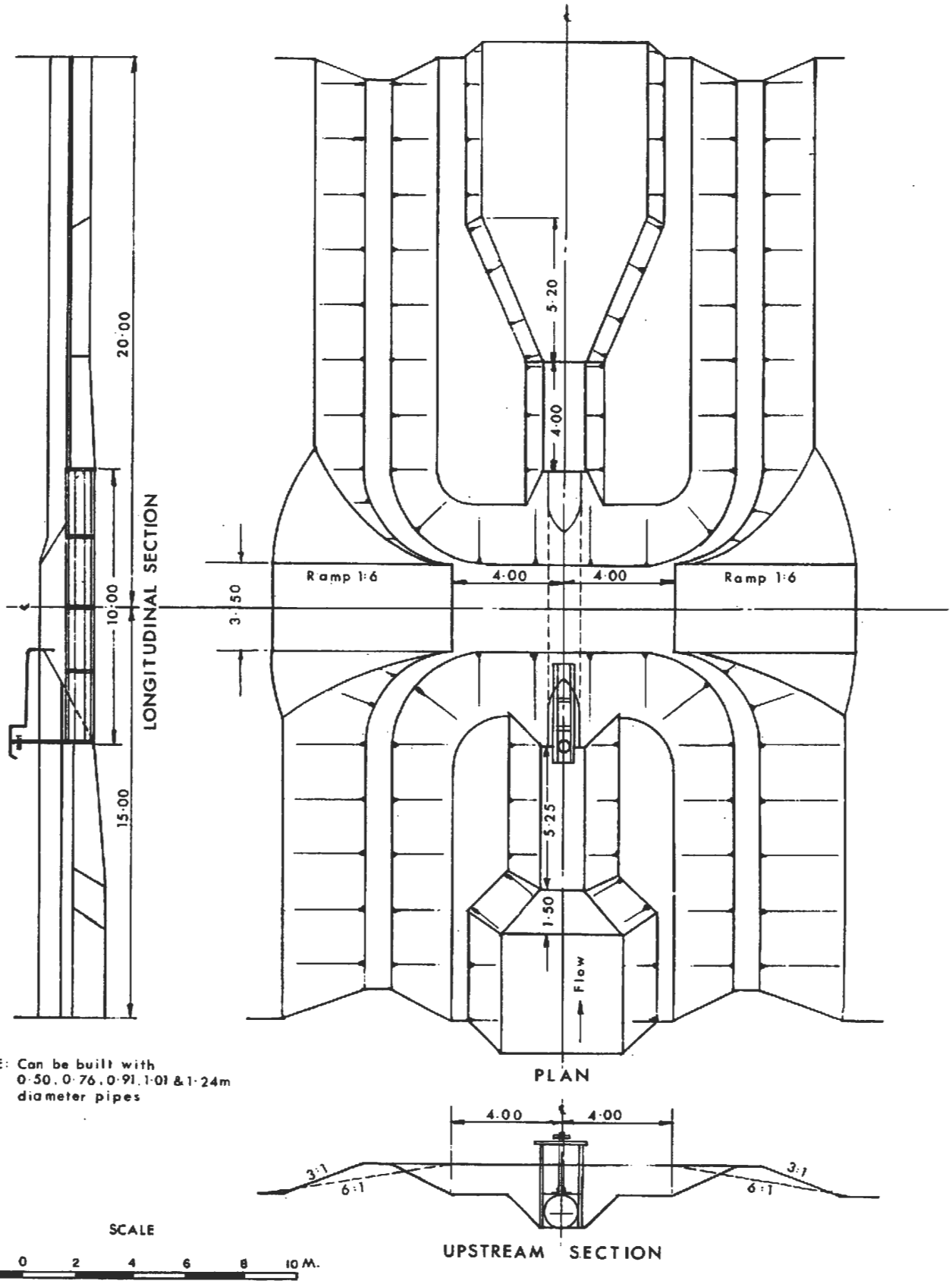
FIGURE 5·3

PIPE REGULATOR



NOTE: Can be built with 0·50, 0·76, 0·91, 1·01 & 1·24m diameter pipes

SIR M. MACDONALD & PARTNERS

arranged to suit the field requirements. The water is passed from the watercourses to the laterals by lateral pipes buried in the banks of the watercourse and the water is then conveyed to the plots by means of short plastic pipe syphons, which pass over the banks of the laterals and are moved along the lateral as watering proceeds.

CHAPTER 6

ORGANISATION AND MANAGEMENT

6.1 The Recommended Management Structure

A sound management structure is essential if the implementation and operation of the project is to be successful. The success of an irrigation scheme depends not only on the rate at which land is canalised, levelled and settled, but on the rate at which crops of acceptable yields are harvested.

The efficient organisation of crop production is thus of paramount importance.

The project whilst having a significant influence on the welfare of the local population should be operated on accepted business lines as a financially viable economic proposition. In order to achieve this the managing authority should have the maximum degree of autonomy compatible with wider national interests. The ultimate responsibility for the project must rest with the Somali Government as the body responsible for negotiation of development finance.

In establishing a managing body for the project the Somali Government would establish the necessary legislation on which the authority of such management will be based in order that the required discipline in the agricultural activities of the tenants may be maintained.

The project management will be responsible for:

a) The organisation of crop production and processing.

b) The operation and maintenance of the irrigation system.

c) The maintenance of satisfactory tenant-management relations.

d) The collection of revenues and disbursement of the proceeds from sale of produce.

e) Co-ordination with the Somali Government and the supporting services of the government, Ministries, particularly the Ministry of Agriculture and its research service.

The great importance of agricultural development to the national economy of Somalia makes it essential to give careful consideration to the formation of the upper management structure which will be responsible for basic production policy and for high level project staff matters and finance.

The present chronic staff shortage within Ministries precludes the setting up of a separate development board or similar body. In view of the importance of co-ordinated development it is recommended that a Ministerial Project Committee be established within the Ministry of Planning on a bilateral or multilateral basis to provide for representation of both the Somali Government and the country or organisation which finances the project. The Project Committee would include representatives of:

Ministry of Planning.
Ministry of Finance.
Ministry of Agriculture (and Agricultural Development Agency).
Ministry of Public Works, Department of Irrigation.

Other persons with special knowledge and experience such as prominent business men could also be co-opted from time to time but the committee should not become too large. When necessary the Project Manager's attendance would be invited.

The Committee should have a secretary for co-ordination who would deal directly with the Project Manager.

The Committee would issue directives for the efficient operation of the project and would be responsible for the approval of financial estimates, the authorisation of charges and payments to tenants in respect of crop production and the award of contracts for major project

works. The Committee would provide liaison with the Government Ministries and organisations providing services to the project including the necessary social services, and with any commodity marketing organisations which may be established. Such a committee might serve as a policy formulating body for a number of projects.

The supervision and co-ordination of project activities would be the responsibility of the Project Management Staff who together with local representatives of the Ministries of Agriculture, Natural Resources and Public Works and with representatives of local government and the project tenants would form a small management committee in which such matters as tenant management disputes may be settled.

It is recommended that the project management staff should comprise:-

a) The Administrative Manager who would be the senior official in overall executive charge of the project. Besides overall management he would have specific responsibility for office, stores, accounting and sales activities. The person appointed would require qualifications or extensive experience in these specific fields and considerable experience of administration preferably in the tropical agriculture sector. Personnel management experience would be an asset and the ability to maintain good relations with staff and tenants would be vital.

b) The Field Manager would be responsible for all agricultural activities and farming operations, ensuring the timely availability of equipment, materials, seeds and fertilisers and deciding on daily requirements of irrigation supplies. The person appointed would require extensive experience in the large scale production of tropical field crops; especially cotton, groundnuts and rice.

c) The Engineer who would be responsible for the operation and maintenance of the irrigation facilities, the workshops, electricity and water supplies and building maintenance.

Experience in these fields will be required by the person appointed.

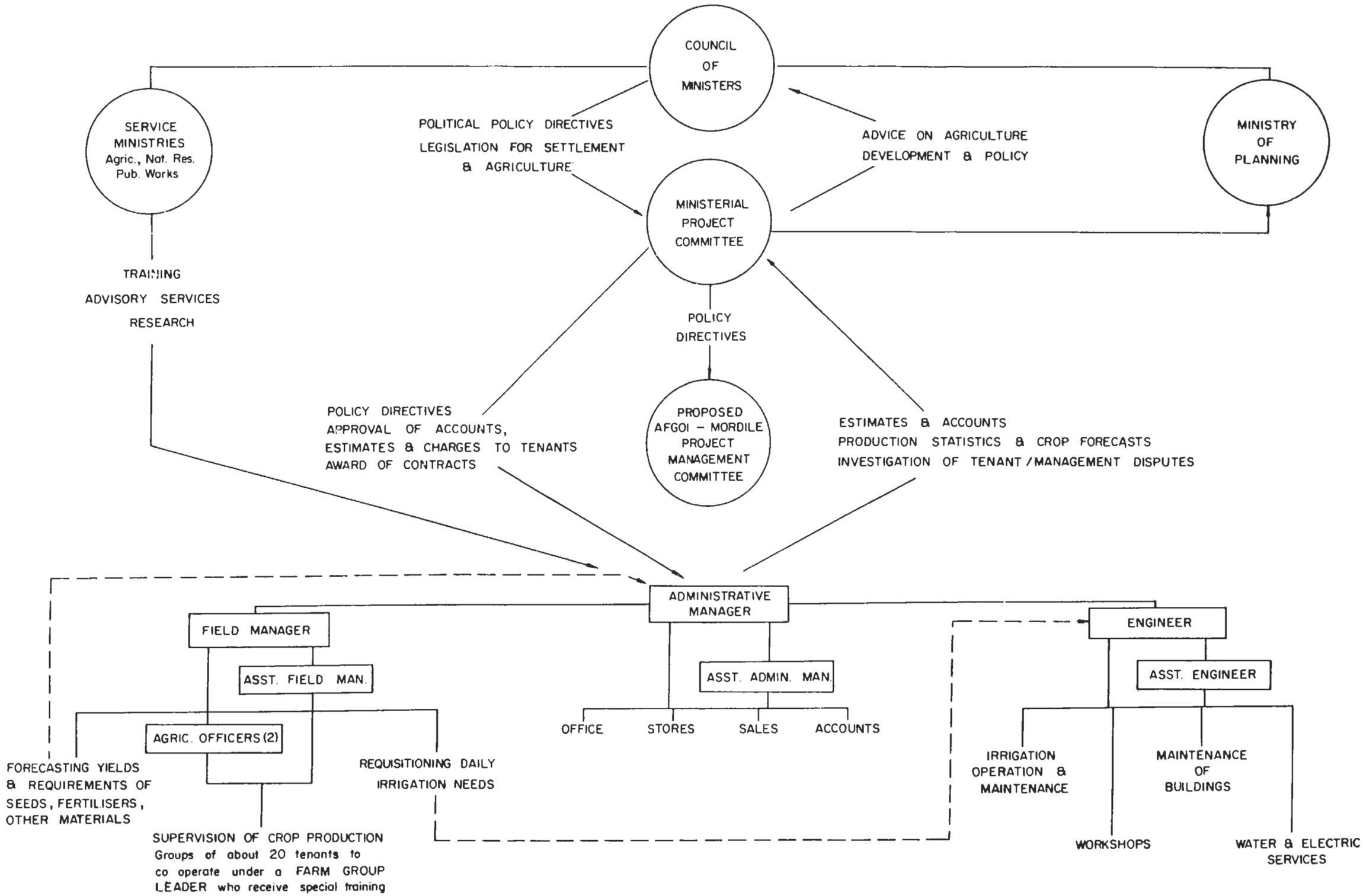
Each of the above staff will have an assistant. Because of the acute shortage of qualified and experienced local personnel in Somalia in all disciplines it is anticipated that the above posts will require to be filled by expatriates. Suitably qualified local personnel selected as assistants will in time acquire sufficient experience to take over the senior posts. In view of the considerable practical experience necessary and taking into account the likely continued shortage of experienced local personnel due to the need to staff other developments in the future, it has been assumed that expatriate senior staff will be required for at least ten years from the inception of the project and that their phasing out will be gradually completed over the following ten years.

The Field Manager and his assistant should have at least two agricultural officers, each responsible for direct supervision of the tenant farmers in his section of the project. Experience on tenant farming enterprises in other countries would indicate that an officer can supervise effectively only some 150 tenants or about 600 ha. of irrigation. It is assumed however, that the Field Manager and Assistant Field Manager would themselves directly supervise some of the tenants of the project. In view of the shortage of experienced personnel and the needs of other organisations such as the extension services for staff it would probably be unrealistic to assume that more than two Agricultural Officers could be made available.

The proposed management structure is shown diagramatically in Figure 6.1 and Appendix V gives a list of management personnel with appropriate scales of salaries and wages. These have been set

FIGURE 6-1

PROPOSED MANAGEMENT STRUCTURE



at a level which although higher than salaries for equivalent grades in government services are considered to be the minimum required to attract personnel of the required calibre.

Staff other than the senior levels of management are available locally although the supply is limited and technical ability and experience often lower than desired. An inservice training scheme could however raise the standard and efficiency of technical personnel. The technician's conditions of service in the project must be sufficiently attractive to avoid undue wastage to private employers who might compete for the limited supply of these skilled personnel.

6.2 Crop Production Management

The Field Manager, his assistant and the Agricultural Officers will supervise all aspects of crop production by the tenant farmers. It is recommended that groups of about 20 tenant farmers should be formed and one of their members selected as a Group Leader. The selected farmer should be above average ability, and would form a link between management and tenants. It is proposed that group leaders would be given some special training and would then explain to the tenants who are members of the group the reasons for new innovations and translate to management the problems and grievances of the tenants. The leaders would need to be acceptable both to management and to tenant farmers of the group they represent.

In addition to the returns from his holding which are likely to be above average the Group Leader would receive an annual payment for his management services, an amount of Shs. 1000 being recommended.

The senior field management staff will be required to provide the Administration Office with estimates of their requirements for seeds, fertilisers and other materials for the year's production so that these may be available when required. They will supervise the operation of the agricultural machinery and ensure the timely completion of all cultural operations. Maintenance of the machinery will

be the responsibility of the engineer. The field management staff will assess the daily requirements for irrigation water and advise the engineer of the following day's needs. They will ensure that each tenant maintains the required standards of husbandry on his holding and performs the necessary cultural operations on schedule; they will take appropriate steps to ensure that tenants fulfil their obligations. Such action would normally entail employing labour to execute the uncompleted task and subsequently charging the tenant at a rate higher than the equivalent local cost for providing the service, the cost being recovered at the same time as other management charges. Tenants who repeatedly failed in their obligations should under their tenancy agreements risk forfeiting their holdings.

Field management personnel will require to estimate the current year's crop at the start of the season and update these estimates as the season proceeds in order that the administration may have the necessary information for control of project finances.

The Engineer will be responsible for maintenance and operation of all crop processing equipment installed on the project, maintenance of buildings and operation and maintenance of water and electricity supply installations.

6.3 Irrigation Operation and Maintenance

The small size and compact layout of the project results in the operation of the irrigation system being less complex than on a large scheme. It must be emphasised however, that in almost any country the successful implementation of an irrigation settlement scheme is never simple in the early years. The major problem of irrigation operation lies in getting the required quantity of water from the field channels to the plant. Only by trial and error can the local variations in slope and permeability affecting uniformity of application be identified and remedied and experience gained by the individual irrigator.

The degree of supervision over the tenant farmer, his training

in the techniques of crop irrigation and his successful motivation to produce high returns through the application of approved crop husbandry methods constitute important factors in the ultimate success of a project.

The daily water requirements estimated by the field staff and passed to the Engineer will be used to compute discharges required in each minor canal and hence the total discharge required from the pump station. These requirements and the required settings of movable weirs and regulators will be passed to the pump foreman and head waterguard respectively. The latter will instruct the Class I water guards of the required settings for the movable weirs and regulators under their control. The requirements for individual fields will be passed to the Class II water guards through the Agricultural Officers.

The settings on the structure gauges should be read at least 3 times daily to ensure steady operation of the system.

The regular inspection and survey of silting and weed growth in minor canals and drains, the head pool and that stretch of river adjacent to the pump station will be the responsibility of the surveyor who will report to the Engineer. In areas where irrigation proves difficult the surveyor will be required to execute a survey and report on the cause of the difficulty.

The water guards will be responsible to the engineer for inspection and maintenance of the irrigation structures and gauges and for weed clearance. During periods when canals are dry weed growth will be removed by the water control staff and should further clearance be required during the irrigation season hired labour will be employed under the supervision of the head water guard. Floating weeds are not known to be a problem but the water control staff should collect any floating material.

Silt clearance from minor canals, bank dressing, road

maintenance and watercourse rebuilding will be done by local contractors when necessary under the supervision of the assistant engineer.

Laterals will be reformed by the tractor drawn implement described in Section 3. 6 following completion of agricultural machinery operations and will be maintained by the farmer during irrigation. Lateral pipes are likely to be frequently broken and stocks of these should be kept and distributed by the Engineer to the water guards when replacements are required.

The pump station staff will be responsible for the routine servicing and maintenance of the mechanical equipment whilst for serious breakdowns assistance will be provided by the project workshops. The pump station staff should also take responsibility for clearance of floating debris from the river and regular clearing of the trash screens.

6. 4 Annual Costs of Management Staff and Operation and Maintenance Costs

The annual costs of the management services and the operation and maintenance of the project described in this and preceding chapters has been assessed. Appendix V shows the annual gross salaries for each category of staff and includes allowances for statutory bonuses and holidays payable together with some overtime. Table V. 1 shows the build up of staff costs anticipated over the first two years of construction and settlement, the estimated annual staff costs after year two and indicates the changes in costs associated with the proposed phasing out of expatriate management between years 10 and 20.

Appendix V, also shows the estimated annual recurring charges for operation and maintenance of the irrigation system, workshops and agricultural equipment, buildings, water and electricity supplies, communications, crop processing and miscellaneous equipment and services. The transport, workshops, electricity and water supply and pump station costs include spares, fuel and lubricants but no

labour as this has been included in the preceding table of staff salaries. The estimated costs are summarised in Table 8. 2.

6. 5 Recovery of Management Costs

Marketing of the main crops produced on the project will be one of the functions of management and will provide an income from which both a fixed annual charge to meet the project's loan servicing commitments and a variable amount covering management expenses will be deducted. The management expenses will include the costs of management personnel and the operation and maintenance costs of irrigation, machinery, crop spraying and similar services for the farmer. After these deductions the balance will be distributed to the farmers, the amount in each case being related to the individual farmer's crop yields. In order that the project should be attractive to the industrious farmer it is considered that the income of a farmer after deduction of charges should be of the order of Shs. 2, 500 per year from a 4 ha. holding, including the value of any produce he sells or consumes himself from his vegetable garden.

CHAPTER 7

INFRASTRUCTURE

7.1 Transport of Produce and Supplies

Within the project, transport to and from the fields will be by tractor drawn trailers and if necessary these may be supplemented by hired trucks during the dry seasons.

Transport to and from Afgoi and Mogadiscio is facilitated by the existing all weather road passing the southern boundary of the scheme and from which an all weather road will be constructed to the project headquarters. These two centres will take all the produce of the project and transport will be by large trucks and trailers already available for hire.

Supplies will be transported either by project vehicles or by hired lorries. Imported materials including seeds, fertilisers, agricultural chemicals, tools, machinery, spares, etc. will be brought in through the port of Mogadiscio and in the event of produce being sold for export this also would probably be shipped from Mogadiscio. The feasibility of constructing a deep water harbour at Mogadiscio is presently being investigated.

The international airport at Mogadiscio provides the possibility of airfreighting urgent consignments should it prove economic to do so.

7.2 Headquarters Buildings

The headquarters for the scheme will be sited within the Project village and will consist of an office, a store and workshops.

The office building will accommodate the administrative, field and account staff. These offices will form the headquarters of the scheme and the store and workshops will be located nearby.

No storage facilities will be provided on the scheme for the

agricultural produce, the intention being that this will be transported from the area to Afgoi or Mogadiscio as soon as possible after harvesting. However, a store 20 m by 10 m will be built to take the agricultural items such as sacks, fertilisers and seeds, etc. This store will be sub-divided so that a small part will be available to house the irrigation stores and tools.

Repair facilities exist for tractors, vehicles and heavy earth-moving plant in the central workshops of the Ministry of Public Works located in Mogadiscio but it is felt that these facilities are situated too far away from the scheme and could cause undue delay in having repairs completed. The provision of the workshop on the scheme will permit rapid attention and should result in the outage time for the plant, vehicles and tractors being reduced to a minimum. This is essential especially during the ploughing and planting schedules when all the tractors are fully utilised. Another advantage of having a skilled foreman and fitters on the scheme is that they will be able to assist in servicing the pumping plant at Mordile and ensure continuous maintenance by mechanics familiar with the installation.

The workshops on the Afgoi/Mordile Scheme would carry out the normal daily maintenance, repairs and top overhauls. Any extensive repairs would be referred to the Ministry's workshops in Mogadiscio.

7.3 Agricultural Processing Plant

The ginning capacity that exists within easy reach of the scheme on all-weather roads is considered to be adequate. For this reason no provision has been made in the estimate for the construction of any new ginning facilities for the cotton crop.

In the 'Gu' season one half of the scheme, 1,500 hectares, will be planted with groundnuts. If after harvesting the crop could be decorticated in order to separate the nuts from the husks, a considerable saving could be made in transportation costs. A lorry which can load

30 tonnes of shelled nuts is only capable of carrying approximately 13 tonnes of nuts in the shell.

The decortication plant has been included in the estimate for the Afgoi/Mordile Scheme consisting of a single decorticating machine. This unit would be able to handle over two tonnes of nuts in shell per hour.

7.4 Project Village

The project village will be located at the south-eastern corner of the canalised area and no building will be sited within 500 metres of any canal. Most of the scheme's employees will live in this village and also a large proportion of the farmers working on the scheme.

Plate 8 shows the proposed layout for the village which will be joined to the main Afgoi/Merca road by a surfaced road some 1.1 kilometre long. The earth roads within the village would be regularly graded and be built with a drain along one side, provision being made for the run-off to be carried beyond the village to drain into the drainage system of the irrigation area.

The basic block size within the village would be 90 m by 50 m as shown and the minimum building lot would be 15 m by 25 m. The surveying, layout and marking of lots and blocks within the village are expected to be done by the staff of the Survey and Mapping Department of the Somali Government. The village layout includes space for a school, mosque, market and other requirements of a well planned community.

Two other villages would be established for farmers one on the south-western and the other on the north-western edges of the scheme. These villages would be laid out in building blocks and lots as within the project village but would not be as large or have the community facilities shown for the project headquarters village. Probably the only building other than a few shops that will be necessary in the immediate future in either of these villages will be

a small mosque.

The three small villages at present within the proposed scheme boundary will be removed. This recommendation follows discussions with experts of the World Health Organisation assigned to study health aspects of irrigation development in the Shebelli Valley. The villagers will be rehoused in the new villages and a small allowance has been made in the estimate to compensate them for the loss of their homes.

7.5 Housing

The only houses included in the estimates for the Afgoi/Mordile Scheme are three to accommodate the expatriate staff necessary to operate the scheme during the formative years and five for the senior Somali staff.

The estimate for the houses for the expatriates includes a sum sufficient to supply the furniture and fittings. A drawing of a suitable 3 bedroomed house is shown on Plate 9.

No provision has been made in the estimates for housing either the other members of the staff of the scheme or for the farmers. However, to assist the headquarters employees in building a house on the lot they will be allocated in the Project village each will receive as an advance the equivalent of three months basic salary in the form of materials required for construction. Possibly the scheme should buy these materials in quantity and the staff will in turn receive the advantages of bulk buying. Some safeguard to ensure that staff receiving the materials remain in the employ of the scheme for a specific length of time or repay the advance will need to be evolved. The cost of providing this material for 90 employees is estimated at Shs. 97, 140.

The occupiers of lots within the Project village will be required to give an undertaking that after an initial 'settling in' period of say two to three years that they will not build any further temporary structure (adobe or grass) on their lot. This is an attempt to try and make the villagers replace their initial homes with permanent ones.

To help them in their task assistance would be provided through the National Housing Agency which specialises in low cost housing and also by the supply of building materials at cost. By providing his own labour, it is hoped that a farmer or staff member will eventually be able to build himself an acceptable permanent dwelling on his lot.

7.6 Roads

As already mentioned in Section 4 an all-weather road will be provided from the Afgoi-Merca road to the Project Headquarters village situated in the south-eastern corner of the scheme. This road is approximately 1.1 kilometre long and will be provided with a cross drainage structure.

Other important roads adjacent to the scheme will receive a dressing of coral rock which will be well watered and rolled. These are as follows:-

a) Along the eastern perimeter of the Scheme to join the all-weather road into the village with the Afgoi-Barire dirt road.

b) The section of the Afgoi-Barire road along the northern boundary of the Scheme to join the road mentioned in (a) above to the new farmers village north of the Scheme.

c) The short length of new road from the Afgoi-Merca road to the new farmers village west of the Scheme.

All these roads will be raised 0.5 metres above natural ground level. These roads should be passable after rains but in the event of very heavy storms some restriction may be necessary for a short time after the storms to ensure the road surface is not destroyed by heavy trucks or tracked vehicles.

The construction of the roads within the canalised area is described in Chapter 4, Section 6.

7.7 Electricity, Water and Telephone Services

The only electricity supply planned for the Afgoi-Mordile Scheme is a 50 KW set to serve the eight senior staff houses, the administration offices and the two tubewells proposed for the water supply. The estimate includes a sum sufficient to provide a suitable building and oil storage tank.

The estimates include the cost of drilling and fully developing two tubewells at the Project village and one at each of the two farmers villages which are to be established.

A tubewell exists near the proposed scheme village but it has not yet been fully developed. Some saving may result if this existing well can be used in place of drilling a completely new well.

Provision has been allowed for a 75 millimetre plastic ring main and an elevated reinforced concrete tank of 225, 000 litres capacity at the project village and for ground level concrete tanks of 22, 500 litres at each of the other two villages.

The telephone lines costed in the estimate includes a line from the pump house at Mordile to the headquarters office, from the office to the main Merca/Afgoi road and then using the existing telephone poles to both Afgoi and Mogadiscio. A line does exist along both these routes to these two centres but it is considered desirable to provide a line for the Scheme to ensure availability at all times. A sum has been included for the provision of a small telephone exchange at the Headquarters Office.

7.8 Social Services

Whilst the provision of social services such as a dispensary with the services of a doctor and staff, an animal health clinic, a community centre and an abattoir are highly desirable, the costs of such services should be met from government finances for the extension of such facilities and should not be a direct charge against the project. Such costs have not therefore been included in the project estimates.

CHAPTER 8

CONSTRUCTION PROGRAMME AND ESTIMATES

8.1 Programme of Works

The suggested programme of construction is shown in Figure 8.1 and indicates that work should start on January 1st of year 1. This assumes that the contractors and the supervisory staff, including the Scheme management, are in position at that date. The Scheme area should be dry at this time and the river level will be low and hence conditions will be suitable for land clearance and commencement of foundation works for the pump station. The Scheme buildings, workshops, surfaced roads and electricity and water supplies should be completed as early as possible so that the Scheme management can proceed with recruitment and training of staff and so that equipment is properly stored on arrival. The bush clearance should proceed as quickly as possible and the survey teams should operate close behind the clearance teams so that the final canalisation layout can be drawn up and detailed designs completed. The clearance teams should first clear the village and pump station areas so that the works on these sites may proceed and also so that the farmers living within the Scheme area may be moved as soon as possible. Earthworks and minor structures are scheduled so that they avoid the months with the highest rainfall and so that sufficient of the works are completed in time for the groundnut crop in the 'Gu' season of year 2. The government buildings, the processing plant and the drains are the last items to be completed in time for the 'Der' season 20 months after starting construction. The decortication plant is then required for the first groundnut harvest and the complete Scheme will be under crops in September.

8.2 Estimates

There are several contractors in Somalia who are capable of carrying out the earthworks and there are also contractors who could construct the structures, pump station, roads, buildings and services. It is recommended that the works are let as two contracts, one for the earthworks, bush clearance and land smoothing and one for the other works as the whole of the works is too large an undertaking for one contractor within the time allowed. It is considered desirable that the engineering and supervision of construction is carried out by a firm of international repute and that there is specialist supervision of the installation of the mechanical equipment for the pump station.

The construction rates shown in Tables III. 1 and III. 2 of Appendix III are based on quotations received from local contractors. These rates include allowances for customs duty and although agricultural development is exempt from these duties at the present time, it is not likely that contractors will alter their rates since their plant and existing stocks of material have already had duty levied on them; also it is not certain that they will obtain duty free fuel since all their work is not necessarily for the scheme. No figures for customs' duty have been included in the detailed estimates. The item for telephones is based on a quotation from the Ministry of Communications who have indicated that they would be willing to carry out the work. The foreign exchange figures given in the estimates are not the direct foreign exchange costs of the scheme but include contractors' foreign exchange requirements for fuel, lubricants, spares and depreciation or replacement of their plant. Hence they represent the total foreign exchange cost to the national economy.

The detailed estimates are given in Appendix IV and a summary of estimates is shown in Table 8. 1.

FIGURE 8.1 Construction Programme Chart

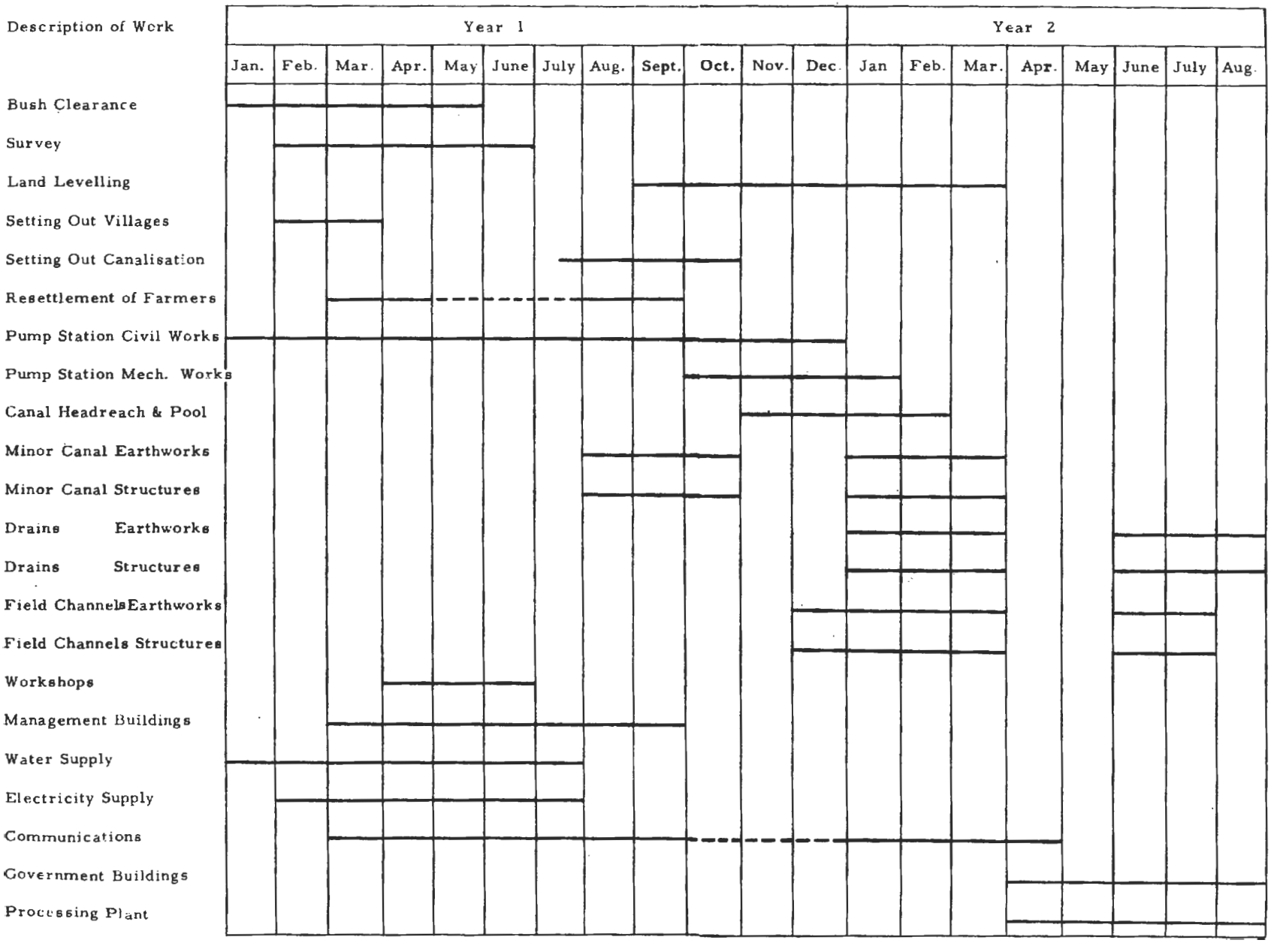


TABLE 8.1 Summary of Estimates

Item No.	Description	Amount 000 Sh.	Foreign Exchange 000 Sh.
I.	IRRIGATION WORKS, BUILDINGS AND SERVICES		
I.A	Preparatory Work	58.6	35.2
I.B	Purchase of Land & Compensation	160.0	-
I.C	Pump Station	1,561.5	1,157.8
I.D	Canal Headreach and Pool	57.6	10,0
I.E	Distributaries Earthworks	1,179.6	530,8
	Structures	607.8	334.3
I.F	Drains	415.8	200.9
I.G	Workshops	100.0	80.0
I.H	Management Building	759.9	384.0
I.J	Other Buildings (1)	(57.3)	(24.6)
I.K	Water Supply	411.8	226.5
I.L	Electricity Supply	134.5	108.8
I.M	Communications	695.0	364.8
II.	AGRICULTURAL PROCESSING PLANT	150.0	132.0
III.	LAND PREPARATION	2,651.0	1,325.5
IV.	AGRICULTURAL EQUIPMENT	2,292.3	2,240.3
V.	CONTINGENCIES (2)	1,123.5	713.1
VI.	ENGINEERING AND SUPERVISION (3)	1,336.0	890.7
	PROJECT TOTAL:	13,694.9	8,734.7

FOOTNOTE: (1) Other Buildings are supplied by Government and are not included in the project total.

(2) 10% on Items I, II, III and IV.

(3) 15% on Items I, II and III.

8.3 Annual Costs

The annual costs of the Scheme for years 1, 2 and 3 are summarised in Table 8.2. The costs for year 3 are the annual charges for the fully developed Scheme.

The breakdown of these costs is presented in Appendix V. Table V.1 shows the nominal roll of staff from year 1 to year 3 and Table V.2 lists the annual costs, other than staff for the fully developed Scheme.

In Table V.2 the annual costs for silt clearance, bank dressing, making up and grading roads and drain clearance assume that these jobs will be done by a local contractor under the supervision of the Scheme management. The costs of silt clearance and bank dressing assume that one third of the total length of canals are cleared and dressed each year. The cost of grading the roads assumes they are reformed twice a year. The weed clearance cost assumes that all the canals are cleared of fixed weeds once each year. A small sum has been allowed for tests, emergency bank repairs, and other sundries.

The charges for canal structures are low but this is because there are only a small number of structures and they require little maintenance. The charges for replacing pipes are additional to normal life replacement.

The charge to Workshops is the maintenance charge for combines, agricultural equipment, land rovers and lorries, plus a 25 per cent charge for running costs.

TABLE 8.2 Annual Costs Year by Year. Shs.

Year	1	2	3
Permanent Staff			
Expatriate and Senior Management[1]	350,200	350,200	350,200
Local	196,700	494,400	517,600
Sub-Total:	546,900	844,600	869,800
Works			
Pump Station	-	56,200	56,200
Distributary canals	-	50,930	50,930
Drains	-	18,000	36,000
Workshops, Buildings	-	54,420	54,420
Sub-Total:		179,550	197,550
Services			
Water and Electricity Supply	7,000	21,130	21,130
Communications	3,000	21,300	28,400
Decortication Plant	-	13,000	13,000
Agricultural Equipment	50,000	73,560	73,560
Miscellaneous	-	25,000	25,000
Sub-Total:	60,000	153,990	161,090
Total:	606,900	1,178,140	1,228,440

1. Variations in expatriate and senior management costs after year ten are shown in Appendix V, Table V.1.

CHAPTER 9

ECONOMIC AND FINANCIAL EVALUATION

9.1 Benefits

The direct measurable benefits of the Afgoi controlled irrigation scheme to the economy of Somalia consist of the gross value of the crops produced less the economic cost of producing them. Other direct but not easily measurable benefits are the net foreign exchange savings generated by domestic production and the net increased factor (labour, management, capital) income of the external servicing organisations (transport, processing, suppliers of agricultural inputs, etc.) to the project. Finally there is the multiplier effect on the community income as a result of the initial increase in income generated by the project. The initial income to the farmers from the project leads to an increased demand for goods and services by the farmers which in turn leads to a secondary increase in income to the suppliers of these goods and services which results in a further increased demand. However, without adequate statistical information it is not possible to put a numerical factor to this multiplier effect and it can only be stated generally that to the extent the increased income from the project does not lead to import buying and non-productive saving the investment will have a multiple effect on the income of the community.

The indirect benefits are the impact the project will have if successfully implemented upon the general level of development. It is difficult to anticipate what this impact will be since it depends upon the quality of the response to the opportunities opened up by the project, by the people involved both directly and indirectly. Generally it can be stated that the Afgoi scheme will provide the Somali farmer with experience of controlled irrigated farming of rice, cotton and groundnut. Successful growing of these crops on one scheme could have a significant impact on the whole farming community in both rainland and

irrigated sectors by demonstrating the advantages of new techniques. Sustained production of these crops would also require that crop handling, processing and marketing facilities are efficiently run. Efficient organisation of these facilities is difficult at the moment because production is poorly organised. In turn production is inhibited due to lack of adequate transport, processing and marketing facilities. If the latter are provided with a production base on which to organise effectively this could also benefit producers outside the Afgoi area. Profitable growing, milling and marketing of rice from the Afgoi scheme would be of particular importance as there is a large import demand for rice and there is a strong interest among the farming community in promoting domestic production.

9.2 Valuation of Direct Measurable Benefits

Benefits have been valued at the shadow prices discussed in Chapter 3. The shadow price is an attempt to provide a competitive norm in the light of present world and domestic market conditions, around which, it is thought the price for produce will tend to fluctuate in Somalia. Distortions due to present high sea freight costs, and lack of efficient harbour facilities are difficult to compute. Possibly, in the future, freight and harbour handling costs will be reduced resulting in a higher theoretical export price. The import price of competitive commodities would at the same time be lowered and since the Afgoi output will be consumed domestically no adjustment has been made to present costs. A risk factor should also be incorporated in the shadow prices to allow for unforeseen circumstances in world markets which could lead to a depression in price. It is important that the net benefits of the scheme in the early years, when the major difficulties of successful implementation are faced, should not be overstated.

The economic rate of return is calculated in terms of the present value of benefits and costs over the project life. The present value of benefits in the earlier years are greater than later years and it is

therefore essential that benefit valuation should allow for the period when the risk of failure to attain projected yields is greatest. The shadow price selected therefore tends to be the most conservative value of the calculated range.

9.3 Valuation of Costs

a) Internal Costs

(i) Imported Inputs

These have been valued at their current c. i. f. cost, plus a dealer margin and transport charges to the project area. This slightly overstates the cost to the economy since there is an element of increased factor earnings which should be included as a benefit. It has not been possible to separate these increased earnings from cost and only in the case of fertilisers where the quoted delivered price is high compared with c. i. f. cost has an adjustment been made to allow for bulk deliveries.

(ii) Labour

Preliminary investigations indicate that hired labour is relatively scarce in the riverain areas, although preliminary statistical surveys carried out by the Ministry of Planning indicate considerable under employment in certain areas to the south and west of the Afgoi-Genale area. The norm quoted for hiring a man for 6 hours in the Afgoi area is 3. 50 shillings although in times of scarcity it is claimed labour can cost 10. 0 shillings for a ten hour man-day. The cursory socio-economic survey of the project area found that during slack periods farmers would accept casual labour employment for Shs. 2. 50 per day. From the findings of this study an average man-day input and an average income from 2. 3 hectares of cultivation was calculated as shown in Table 9. 1. This income

divided by the man-day input gives a cost of approximately 2.50 shillings per man-day. It has been assumed that this figure represents the opportunity cost of labour which indicates the value of farm production which will be lost to the economy of Somalia by withdrawing farm labour from the present occupation and resettling on the Afgoi Irrigation Scheme.

TABLE 9.1 Farm Income and Labour Inputs Afgoi Area

	Average Yield kg. per hectare	Project Price Shs. per 100 kg.	Average hectares cultivated	Average crop income	Total man-day input of 6 hrs.
Maize	400	35	2.3	322)	
Sorghum	400	35	2.3	322)	340
Sesame	100	120	2.3	120)	
Other Products	-	-	-	50)	
			Total:	814	340

(iii) Local Management Personnel

Managerial staff recruited locally have been charged at current market rates. As there is an acute shortage of skilled staff at almost all levels, which is likely to grow in the short term, the salary scales used may understate their opportunity cost to the economy. As it is impossible to state what the true opportunity cost is, the current market rates have had to be used. To a certain extent this understatement of costs is balanced by a corresponding overstatement of costs discussed below under external costs.

(iv) Depreciation of equipment has not been deducted as a current cost but is included in the internal rate of return calculations when the net benefits are compared with the initial investment and the annual cost of replacement.

b) External Costs

These have been overstated since there is a factor income element which, although it is a cost to the project, it is also a benefit to the economy. In the case of new processing facilities for the project (rice milling) or industries which have to be substantially re-equipped (cotton ginning) it has been assumed, where the throughput is small, that the ratio of profit (benefit) to the extra cost involved will be the same as the ratio of benefit to cost on the project and will thus not significantly alter the rate of return. The case of oilseed processing is different since present capacity is underutilised and costs of processing will not rise in proportion to increased throughput. Processing costs have therefore been adjusted to what is thought to be reasonable levels compared with experience elsewhere for the assumed level of throughput.

Transport rates quoted vary considerably according to road conditions and the facilities provided by the haulier. There is no evidence that present facilities are underutilised and Shs. 0. 95 per ton kilometre has been taken as the competitive rate for carrying produce from the Afgoi scheme.

9.4 Crop Returns per Hectare

The crop returns per hectare given in Appendix VI show the gross revenue per hectare less the direct crop production costs and therefore indicate the relative profitability of different crops. These crop returns should not be confused with the financial return to the farmer since they represent the net direct benefit before the deduction of the annual charges of the scheme. Thus although the opportunity cost of the farmer's labour is deducted from the gross returns, since there is a cost of withdrawing him from his previous employment, it is not a deductable cost to him personally and is therefore added back in the analysis on farm income. Depreciation of agricultural and

irrigation equipment is also ultimately charged to the farmer but this is taken into account in the discounting procedures of replacement and annual costs and are not therefore itemized in the crop returns for the economic analysis. In calculating the returns, maximum inputs have been assumed from the first cropping year but it has been assumed that maximum yields will not be achieved until the fifth cropping year. This allows for a running-in period during which the farmer can develop the aptitudes and skills necessary for controlled irrigation farming and will enable management to overcome any organisational problems. The variable costs of mechanical operations have been assessed in Appendix VII and are allocated to the individual crops.

9.5 Internal Rate of Return

The internal rate of return is calculated by projecting the direct benefits and costs including the initial investment and replacement costs and selecting the discount rate which equalizes the present discounted values of these benefits and costs over the project life. This discount rate is the internal rate of return of the project and expresses the ratio of benefits to costs over the project life in terms of an annual rate of interest earned on capital and thus provides some measure of the efficiency of the investment.

Table 9.2 shows the net cost/benefit stream projected over the life of the project. The gross benefit streams have been calculated by multiplying the gross revenue per hectare from cropping years 1-5, assuming that 50 per cent of the cultivable area will be settled in each of the project years 2 and 3. The equivalent net return of produce from the homestead lots for the farmers own consumption has been assumed as Shs. 2000 per hectare and to this has been added a net return of Shs. 4000 per hectare for the 7 hectares of intensive vegetable production. Crop production costs for cotton, rice and groundnuts have been similarly derived and have been deducted from the total benefit stream. The cost of the investment, replacement of equipment and the annual costs of irrigation and agricultural management, as summarised in Appendix VIII

TABLE 9.? Afgoi-Mordile Project Internal Rate of Return

Cropping Yr.	Farm gate value rice	Farm gate value cotton	Farm gate value groundnut	Net Benefits Homestead Lots	Total Benefits	Crop Production		Costs	Total	Net Benefits	Annual Management cost	Investment	Replacement	Net cost/ benefit
						Labour	Mechanisation	Other						
1	450,000	525,000	456,750	68,000	1,499,750	238,500	203,250	731,250	1,273,900		649,400	13,694,900		-14,344,300
2	1,080,000	1,125,000	913,500	136,000	3,224,500	691,500	406,500	1,419,750	2,517,750	366,750	1,294,240			- 927,490
3	1,440,000	1,425,000	1,029,000	164,000	4,058,000	717,750	406,500	1,410,750	2,535,000	706,750	1,380,640			673,890
4	1,800,000	1,725,000	1,144,500	164,000	4,833,500	740,250	406,500	1,449,000	2,595,750	1,523,000	1,383,840			139,160
5	2,115,000	2,025,000	1,260,000	164,000	5,564,000	765,500	406,500	1,458,000	2,630,000	2,237,750	1,357,040		285,200	595,510
6	2,256,000	2,250,000	1,375,000	164,000	6,039,000	778,500	406,500	1,467,000	2,652,000	2,934,000	1,285,440			1,648,560
7										3,387,000	1,278,740		1,341,680	766,580
8											1,247,440			2,139,560
9											1,247,440			2,139,560
10											1,271,440		435,800	1,679,760
11											1,221,840			2,165,160
12											1,221,840		665,460	1,499,700
13											1,221,840			2,165,160
14											1,221,840		1,341,680	823,480
15											1,245,840		285,200	1,855,960
16											1,140,240			2,226,760
17											1,140,240			2,226,760
18											1,140,240			2,226,760
19											1,140,240			2,226,760
20											1,184,240		1,662,900	539,860
21											1,091,240		1,341,680	954,080
22														2,295,760
23														2,295,760
24													680,000	1,615,760
25													285,200	2,010,560
26														2,295,760
27														2,295,760
28													1,341,680	954,080
29														2,295,760
30													435,200	1,860,560
31														2,295,760
32														2,295,760
33														2,295,760
34														2,295,760
35													1,626,880	665,910
36													484,000	1,811,760
37														2,295,760
38														2,295,760
39														2,295,760
40														2,295,760

Internal Rate of Return = 8 per cent.

are then deducted from the net benefit stream to give the net cash flow of the project. These net disbursements and receipts over the project life are converted to their present value using compound interest factors and the rate of interest which equalizes the present value of disbursements and receipts is the internal rate of return.

9.6 Financial Evaluation

The total net farm income in project year 6 is shown in Table 9.3 below. To establish the level of farm income which will attract a settler to a controlled irrigation project is difficult in Somalia because there is so little information on present farm incomes. A net farm income of Shs. 2,500 has been selected as the minimum level, compared with the level reported in the Afgoi Socio-economic survey, which will give the settler the incentive to make the additional effort required. If this minimum level is acceptable this would leave a surplus from the sixth project-year of Shs. 709 annually, per holding, which could be assigned to debt service of the loan required for the project, and would give a total annual surplus including income from 7 hectares of vegetable production of Shs. 560,000 annually.

TABLE 9.3 Farm Income from a 4 ha. holding in the 5th Cropping Year

	Shillings
Net revenue Groundnuts	944
Net revenue Cotton	1,548
Net revenue Rice	1,812
Net revenue Homestead lots	181
Add back cost of family labour	873
Total Farm Income	5,358
Deduct Irrigation, Management and Replacement costs	2,149
Total Net Farm Income	3,209

In view of the present difficulties in raising local finance as stated in the Short Term Development Plan, it has been presumed

that foreign exchange will be required for the total investment. If such a loan were negotiated on normal terms for long term development capital this would mean that Somalia would have to find Shs. 1, 027, 254 annually in foreign exchange to meet project debt service commitments. A very preliminary estimate (Appendix IX) of the exchange saving generated by the Project shows an amount of approximately Shs. 3, 300, 000 annually, sufficient to cover these commitments.

At the present time however it is extremely difficult to raise revenues from domestic taxation, the internal budget is balanced with grant aid from abroad and implementation would lead to a loss of Shs. 1, 500, 000 in revenue from import duties. The project would therefore, if financed on normal loan terms, place a further burden in the early years on Somalia's already difficult internal revenue and foreign exchange position. Even in the sixth year of development when the project could develop a surplus sufficient to meet approximately 50 per cent of debt service requirements this would still leave Shs. 457, 000 annually to find from other sources as well as the loss in import duties to make up. Presumably the main tax burden would have to fall on the external facilities directly benefiting from the project. Even assuming an efficient tax collection system is in operation by that time it is unlikely that the processing facilities would be competitive enough to absorb that burden.

Since Somalia's debt service ratio is extremely high it has been argued in the Short Term Development Plan that foreign debt will need extensive rescheduling and further debt commitments will have to be negotiated on concessionary terms. If the Afgoi Controlled Irrigation Project were considered as a soft-loan project on terms of a $1\frac{1}{2}$ per cent service charge on loan capital the annual debt service requirements would be Shs. 457, 820. If a loan could be negotiated for the project on these terms, this would mean, given satisfactory performance on implementation, that the project would be self-financing.

9.7 Conclusion

At an 8 per cent rate of return the Afgoi controlled irrigation scheme is only of marginal viability in present economic conditions in Somalia, where, because of difficulties in raising revenues through general taxation and heavy foreign debt service commitments, projects should as far as possible be self-financing. Even on soft-loan terms there is little margin for error between projected and actual performance upon implementation. Little recorded knowledge of present farming conditions exists and agricultural research is only in the early stages. This makes projection of performance under improved conditions hazardous, while the ability of the external servicing facilities to meet the projected farm performance has also yet to be proved.

For the above reasons it is recommended that a pilot project should be implemented initially. This would provide both the opportunity to check actual performance and time to recognise and examine any major problems which might arise in connection with the introduction of the proposed system of controlled irrigated farming and thus minimise the risk of making an uneconomic full scale investment.

CHAPTER 10

PREREQUISITES FOR SUCCESSFUL DEVELOPMENT

10.1 Priorities for Development

In view of the limited resources available for agricultural development in Somalia, and particularly the scarcity of capital and skilled manpower, it is necessary that development planning should channel these resources into those projects giving the best and quickest economic return. Since present data on which to determine such priorities is often lacking it is essential that the relevant data be collected in order that the Ministry of Planning may establish priorities between development projects for the allocation of the nations resources.

Within the Shebelli Valley a number of development alternatives require to be considered in deciding the priority of the Afgoi-Mordile Project. The possibility of an off-river storage scheme above Johar for irrigation and flood control has been investigated. This scheme would extend the irrigation season, provide irrigation water for about 11 months for the banana crop in most years and permit the development of an additional area of 30,000 ha. of irrigated crops similar to those proposed for Afgoi-Mordile. This storage would maintain appreciably higher flows in the river during the period when natural flow is low thus appreciably reducing the required maximum pump lift and resulting in some economies in the capital cost and operation of pumps for the Afgoi-Mordile Project. There would thus be an advantage in delaying development until completion of the storage project.

The Balad Flood Irrigation Project which has been studied appears economically as attractive as the Afgoi-Mordile Project but its implementation is likely to raise problems of settlement and farmer training and as it is wasteful of water appears less attractive than

controlled irrigation. Its implementation would be impossible if the Johar storage and flood control proposal were implemented so that a 7,000 ha. flood irrigation development would preclude the development of some 20,000 ha. of controlled irrigation without a significantly higher internal rate of return.

It is only within the national and regional context that the place of the Afgoi-Mordile project, in terms of development priority, can be considered but whether or not the project should proceed in the near future could have important repercussions on subsequent development.

10.2 Land, Water and Crops Legislation

No land law has yet been approved by the Somali Government although the need for such a law has been stressed many times by previous development studies. Any attempt to limit the area which an individual may own is certain to meet with opposition from the present influential owners of very extensive areas. Traditional cultivation rights over considerable areas are also claimed by tribal groups although only a small proportion of such areas are cultivated at any one time. In order to increase productivity the reallocation of at least part of the presently uncultivated areas is desirable but would meet with considerable opposition.

A satisfactory land law should result in an increase in the area available for cultivation and protect the interests of both landlord and tenant cultivator in order to promote greater productivity. To do so it should provide for:

a) The classification of land suitability and in the case of land suitable for crop production establish state powers to requisition and redistribute such land if crops have not been grown during a statutory period of time, perhaps 2 years.

b) The right of land-owners and tenants to compensation when land under cultivation is requisitioned by the government for any purpose and to provide the machinery for assessing the level of such compensation and for arbitration in cases of dispute.

c) The need for tenants on cultivated holdings to achieve a satisfactory standard of crop husbandry and where this is not done to enable landlords to take necessary measures including possible eviction.

d) The right of tenants who follow good husbandry practices and cultivate their holdings in accordance with the conditions laid down in their tenancy agreement to security of tenure.

Unless such legislation is passed by the government the establishment and operation of the Afgoi-Mordile Project as envisaged in this report is unlikely to prove successful.

A law No. 13 dated August 1, 1966 concerning the Organisation of Water at present exists.

This law was the result of a study carried out on behalf of the United Nations in 1963/64 by Dante A. Caponera whose report to the Government of Somalia on Water Legislation and Administration was published by F. A. O., in Rome in 1964.

Although the law was drafted in Italian an English translation was obtained and studied during the course of the present project. The law is fairly comprehensive but there is no evidence that any attempt has been made to carry out the provisions it contains.

Had the suggested Register of Users Article 7 been prepared by the Water Department an accurate assessment of the present use or entitlement could have been made.

Article 10 allows for a water permit to be revoked if amongst other reasons the user misuses his right, abandons it for more than

one year or fails to pay the required water fee. Had these conditions been observed a number of existing users would already have forfeited any rights they may have held in the past.

The Regulations that accompany the law have been drafted but so far have not been issued. It is essential that these are put into force as soon as possible so that water use along the Shebelli River can be rationalised. The Law and the Regulations must be enforced to ensure that users with the prior right receive a supply. It is appreciated that during the initial years an Irrigation Department established on the lines proposed in Volume IV is going to experience difficulty in providing the degree of control required along the river. However without control the planning of any major irrigation project cannot proceed with any certainty of successful implementation.

The point has been reached where the water control and management of the Shebelli River must now become effective to allow any major development of irrigable land for the benefit of the population along the river and to the advantage of Somalia as a whole.

The fees received each year from the farmers would assist in supplying the revenue necessary to administer the proposed Irrigation Department.

The control of pests, diseases and pernicious weeds in crops is essential to maintain high levels of productivity. Failure by a farmer to execute control measures can often prejudice not only his own crop but those of neighbouring farmers. In the case of more serious pests and diseases on crops of national importance legislation regarding control of pests and diseases is from time to time necessary. Such legislation is however useless unless the personnel are available to ensure enforcement. The existing legislation restricting the cotton season and requiring adequate clearing of the crop residues should be modified to suit the conditions of the proposed Afgoi-Mordile Project and the machinery for its enforcement established.

10.3 Improvement of Government Services

At present the agricultural extension, training and crop protection services are relatively ineffective. This is due to:

a) Shortage of trained and experienced field staff and lack of motivation among staff generally.

b) Lack of funds to provide transport and essential facilities for staff to execute their duties in the field.

These are problems which affect the Civil Service to a greater or lesser extent throughout government. In Somalia financial stringency is likely to continue in the foreseeable future and improvement must be brought about, by the concentration of available resources in those fields of production which will give the greater return. The elimination of unproductive staff, continued training with an emphasis on practical rather than theoretical aspects, establishment of discipline and motivation of individuals with a sense of responsibility and a desire for progress is essential if an effective service is to be provided.

Besides the direct crop production field of Government services the Afgoi-Mordile Project will require assistance from Government Departments dealing with Local Government, Health, Housing, Water Supplies, Communications and Commerce and Industry. Such a wide range of activities must result in some degree of conflict between departments but such disagreements must be overcome to enable problems to be solved expediently.

10.4 Agricultural Research

At present agricultural research as concentrated on the selection of crops and varieties suitable for cultivation and relatively little data is available on production techniques and their cost effectiveness. The investigation of irrigation practices under local conditions of soil and climate should be accorded a high priority in view of the general lack of information at present on crop water requirements.

During the course of agricultural development including the establishment of the Afgoi-Mordile Project numerous practical problems in the field of crop production will arise and the research services must be ready to utilise their resources in the solution of these difficulties as rapidly as possible.

The recognition of such problems, the execution of research into possible solutions and the dissemination of resulting new and improved methods of crop production requires the closest possible liaison between production management and the research and extension services.

It is unfortunate that at the United States A. I. D. participation in the operation of the Afgoi Research Station is being withdrawn over the next three years. Sufficient local staff with suitable experience and qualifications to operate the research station are not available, especially in view of the need for such personnel in other fields of agricultural development. The present uncertainty over the future of the Afgoi Research Station and agricultural research in Somalia generally could have an adverse effect on agricultural development. It would be expedient for international assistance to be provided to ensure the continuation of the research services and avoid any rundown during the period when the present Wyoming University team withdraw.

10. 5 Co-operatives and Credit

A law on Co-operative Societies was promulgated early in 1969 which defines a Co-operative Society as:

> "An association of persons ---------- in which members actively participate.
> Except as provided otherwise in the ordinance -------- the village shall be the natural unit on which the co-operatives shall be based. A co-operative may cover one or more villages."

With certain outstanding exceptions it would appear that co-operatives formed in the past were never based on the philosophy and

organisation normally associated with the movement. Groups of people formed associations with the main object of receiving financial assistance, either from foreign agencies or from the Government. Money was allocated more in faith than on the submission of a technically and economically sound development plan. Even when the enterprise was reasonable, a large proportion of the funds allocated were never used for the purpose for which they were intended.

In the more isolated areas away from the impact of the entrepreneur associations have however begun to develop which, providing they can be transformed into co-operatives within the meaning of the Ordinance (and entrepreneurs excluded) may flourish, assuming individual and collective responsibilities are recognised and where technical guidance is given.

It must be emphasised that although a great deal has been written in the past about the place of co-operatives in development in Somalia the concept of co-operatives in the real sense of the word is new to Somalia. Under the law providing it is scrupulously implemented and a co-operative advisory service is built up, a sound co-operative movement could be established. This will however take time and co-operatives are unlikely to become a major instrument for development in the foreseeable future.

At present no adequate arrangements exist for the provision of credit facilities to farmers. An Agricultural Credit Bank has been established but the Somali farmer generally lives in such poor circumstances that he is unable to find the security for loans without which any sound banking operation cannot operate. When credit has in the past been given without proper security for such things as seeds, fertilisers and pest control services by various government organisations, failure to repay has been the rule rather than the exception. The project envisaged in this report, giving as it does greater control over marketing of the farmers' produce opens up greater possibility for satisfactory credit arrangements and the farmer's tenancy

agreement could include a clause requiring him to meet his credit liabilities with the ultimate threat of eviction in the event of his failing to do so.

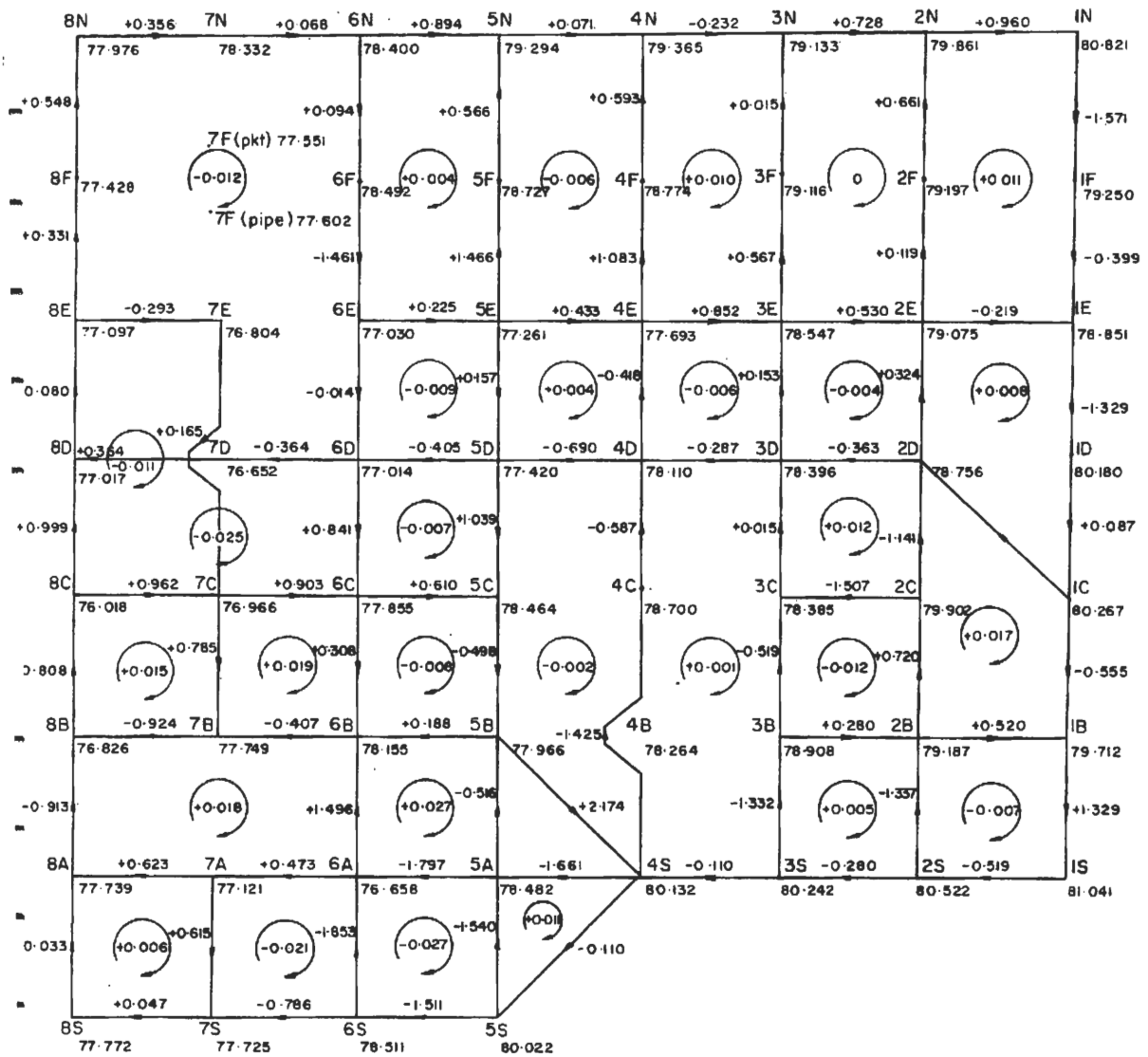
Initially the advance of sufficient funds to meet the farmer's needs against completion of various cultural operations on the crops is envisaged together with provision of seeds, fertilisers and other necessities by the project, the advances being recovered when final payments for the farmer's produce are made at the end of the season. Allowance for these has been included in the economic assessment as an interest charge on working capital. It is hoped however that as the farmer's standard of living rises and his agricultural techniques become more advanced he will learn to appreciate the value of satisfactory credit arrangements to finance improvements to his holding and increase its productivity. In order to promote such borrowing special arrangements might be made by the Credit Bank whereby preference ratios of interest on loans might be given to tenants whose application was supported by the project management committee.

APPENDIX I

TOPOGRAPHIC SURVEY DATA

GRAM OF CIRCUIT CLOSURES SHOWING REDUCED LEVELS OF JUNCTIONS

(Outer circuit previously adjusted between B.M.'s)



BENCH MARK LIST FOR AFGOI PROJECT AREA

Point	Picket	Pipe	Buried Picket	Concrete Block	Remarks
8N	77.976	77.450	-	-	Book 1 pp 9 & 67
7R	77.853	77.651	-	-	1 67
7N	77.332	77.962	-	-	1 8 & 67
6N	78.400	78.063	-	-	1 8 & 68 2 20
5N	79.294	79.35 (mean value)	-	-	1 7, 55, 68
4N	79.365	78.972	-	-	1 7, 70
3N	79.133	78837	-	-	1 7, 70
2N	79.861	79.573	-	-	1 7, 71
1N	80.821	80.866	-	-	1 6, 59
8F	-	77.428	-	-	1 9
7F	-	77.602	-	-	1 43
6F	-	78.492	78.089	78.206	1 64 2 20
5F	-	78.727	-	-	1 23 2 11
4F	78.774	78.867	78.592	-	1 21, 57
3F	79.116	-	-	-	1 2 10
2F	79.197	79.404	79.185	-	1 25, 59, 65
1F	79.250	79.141	-	-	1 6, 59
8E	-	77.097	-	-	1 9
7E	-	76.804	-	-	1 43
6E	-	77.030	-	-	2 21
5E	77.261	-	-	-	1 18 2 12
4E	-	-	77.552	-	1 56
3E	78.547	-	-	-	1 37
2E	-	-	-	79.080	
1E	78.851	-	-	-	1 19
8D	77.017	76.971	-	-	1 19, 54
7D	-	76.768	76.480	-	1 62
6D	-	77.014	-	-	1 62 2 22
5D	-	77.420	-	-	2 16
4D	-	78.259	77.909	78.054	1 56

Point	Picket	Pipe	Buried Picket	Concrete Block	Remarks
3D	-	78.396	-	-	Book 1 pp 28
2D	78.752	-	-	78.580	1 28
1D	80.177	80.316	-	-	1 28, 55
8C	76.018	76.118	-	-	1 40, 52
7C	-	76.996	-	-	1 44
6C	-	77.855	-	-	2 13
5C	-	78.464	-	-	1 22 2 17
4C	78.700	78.781	78.465	-	1 20, 56
3C	-	78.385	-	-	2 24
2C	79.902	-	-	79.827	1 24
1C	80.267	80.328	-	-	1 5, 55
8B	76.826	76.945	-	-	1 40, 53
7B	-	77.749	77.498	-	1 61 2 48
6B	(wooden stump) 78.155	-	77.946	-	2 53
5B	77.966	-	77.764	-	1 22 2 17
4B	-	78.318	78.051(west) 78.124(north)	78.176	1 60 2 51
3B	-	78.908	78.690	-	1 60 2 6
2B	79.187	-	-	-	2 27
1B	79.712	79.721	-	-	1 5, 55
8A	-	77.749	-	-	2 33
7A	-	77.121	-	-	2 32
6A	-	76.658	-	-	2 31
5A	-	78.482	-	-	2 30

Point	50 m. marker N. side 2D	Govt. S. M. No.	R. L.	Pipe
8S	77.772	-	-	78.868
7S	77.725	-	-	77.680
6S	78.489	365	78.511	-
5S	80.022	-	-	-
4S	80.132	-	-	-
3S	80.349	364	80.242	-
2S	-	-	-	80.522
1S	-	-	-	81.041

Miscellaneous Govt. Marks		S. Load
Km 8	363	80.929
Km 17	366	78.067

Miscellaneous Govt. Marks		N. Load
60	60	80.330
62	62	79.871
63	63	78.275

COORD. LIST FOR AFGOI PROJECT AREA

Point	E	N
8S	5000.00	0.00
7S	5639.42	769.24
6S	6261.54	1494.74
5S	6919.48	2252.50
4S	7593.01	2989.41
3S	8312.89	3688.55
2S	9038.40	4375.54
1S	9766.44	5062.38
1B	9266.66	5732.95
1C	8695.95	6499.86
1D	8154.14	7228.82
1E	7566.07	8018.52
1F	6900.73	8906.32
1N	6354.69	9633.67
2R	5777.86	8457.72
2N	5431.40	9125.23
3N	4882.17	8581.82
4N	4011.40	7738.29
5R	3733.53	7468.94
5N	3172.70	7310.43
6R	2122.26	7019.12
7N	1552.40	6705.25
7R	942.89	6369.20
8N	369.56	6049.33
8F	1295.57	4840.60
8E	1930.09	4012.23
8D	2494.53	3273.68
8C	3118.15	2460.57
8B	3658.03	1756.92
8A	4351.41	849.93

Point	E	N
6N	1996.46	6947.67
2D	7325.40	6649.00
3D	6566.21	6118.79
4D	5693.82	5509.69
5D	4910.75	4962.65
6D	4040.73	4354.96
7D	3480.01	3964.00
4B	6824.85	4006.88
4C	6269.15	4746.22
4E	5115.93	6275.22
4F	4462.68	7140.75

N.B. All co-ordinates are measured in metres. Azimuth taken as approximate magnetic North June 1968.

APPENDIX II

CANALISATION LAYOUT DESIGN AND DIMENSIONS

1. Standard layout with 36 hectare fields.
2. Modified layout for areas with less uniform topography.
3. Standard distances for Canalisation layout.

CANALISATION LAYOUT, DESIGN AND DIMENSIONS

II.1 Standard Layout with 36 Hectare Fields

(a) Canals and field channels may not cross a natural drainage line.

(b) Minors are spaced 1285 metres apart and, as far as possible, should follow an overall ground slope of 20 cm per km.

(c) The lines of watercourses should have slopes of at least 5 cm per km and not exceeding 45 cm per km. The upper limit is considered the maximum permissible for the full length of field furrows which are normally parallel to the watercourses (see paragraph II.2(b)).

II.2 Modified Layout for Areas with less Uniform Topography

In order to achieve as regular a layout as possible, the above criteria may be relaxed when necessary as follows:-

(a) A watercourse line may rise up to 10 cm and a lateral may rise up to 5 cm.

(b) When it is not possible to align the watercourses with slopes within the upper limit described in paragraph II.1 (c) above, then the field layout may be modified as follows:-

(i) Where the watercourse is aligned on ground with a slope between 45 cm and 90 cm per km the spacing of the laterals should be reduced to 69 m. This will provide plots of 2 hectares and the furrows will be 66 metres long. The fall over the length of a furrow will not exceed 6 cm.

(ii) On steeper ground where the watercourse is aligned with a slope between 90 cm and 180 cm per km the spacing of the laterals should be maintained at the standard distance of 138 m. The plots will be divided into borders by small banks and additional field channels will be provided to convey

the irrigation water from the laterals to the borders. For a ground slope of 1.8 m per km the furrow length in the borders will be reduced to 33 metres so that the fall over this length will not exceed 6 cm.

(c) The slope of minor canal lines may be reduced to 10 cm per km.

II.3 Standard Distances for Canalisation Layout (All distances are given in metres)

(a) Distance between Field Laterals

4 hectare plot = 135 x 297

Width of lateral = $\frac{3}{138}$

(b) Distance between Watercourses

4 hectare plot = 297 x 135

Width of watercourse = 7

Width of road = $\frac{6}{310}$

(c) Distance between Minor Canals

1. Spacing for 36 hectare field length between adjacent minors.

Centre line of minor to outer toe	10.5	
Width of road	6.0	
½ width of field lateral	1.5	
Centre line of minor to centre line of lateral		18.0
8 plots @ 138 m		1,104.0
9th plot to edge of cultivation		136.5
Width of bank	1.0	
Minor Drain	9.0	
Width of road	6.0	
Outer toe to centre line of minor	10.5	26.5
Distance between centre lines of minors		1,285.0

2. Spacing for 4 No. parallel 36 hectare fields between adjacent Minors

Centre line of Minor to outer toe	10. 5	
Width of road	6. 0	
½ width of watercourse	3. 5	
Centre line of Minor to centre line of watercourse		20. 0
3 No. Fields @ 310		930. 0
4th Field to edge of cultivation		306. 5
Width of bank	3. 0	
Minor Drain	9. 0	
Width of road	6. 0	
Outer toe to centre line of Minor	10. 5	
		28. 5
Distance between centre line of minors		1, 285. 0

(d) Distance between Double Watercourses

½ width of double watercourse	4. 0
Width of road	6. 0
9 No. plots @ 138 m	1, 242. 0
Width of bank	2. 0
Drain	9. 0
Width of road	6. 0
½ width of double watercourse	4. 0
	1, 273. 0

APPENDIX III

RATES FOR ESTIMATING

1. Construction Rates
2. Engineering and Supervision Costs
3. Assumed Life of Project Works

RATES FOR ESTIMATING

III. 1 Construction Rates

a) The rates used in estimating costs for the main construction items for structures are given in Table III. 1. The rates were based on materials being obtained as follows:-

1. Cement ex Mogadiscio by lorry.
2. Sand ex Gesira, approximately 10 kilometres south-west of Mogadiscio by lorry.
3. Coral rock ex Gesira by lorry.
4. Crushed hard coral rock ex Gesira by lorry.
5. Hollow concrete blocks to be manufactured at the proposed site of the Scheme village with water obtained from existing tubewell.

Contractors and government departments were consulted during the investigation into local construction rates and from the information received the following rates for the scheme were prepared. In most cases the rates are approximately 10 per cent higher than those prevailing in Mogadiscio to allow for the location of works being some 30 to 40 kilometres from Mogadiscio.

The coral rock proposed is the better hard quality type. It is possible to obtain limestone some 30 kilometres south of Bulo Burti but the cost of transportation would be prohibitive. Local contractors successfully use coral rock and aggregate in all types of construction work.

b) A summary of the rates used in the estimates for cost of buildings is given in Table III. 2. The rates are based on those quoted by contractors in Mogadiscio with an addition of approximately 10 per cent which most contractors estimated they would require for work in the Afgoi-Mordile area.

c) At the present time in Somalia there are two main earth-moving contractors. These are:-

(a) O.N.A.T. A private company but with Somali Government participation. Has a large amount of plant located in various depots in the Shebelli River valley.

(b) C.I.E.F.F.E. A private contractor with headquarters in Scialambot. Does a considerable amount of work for S.A.C.A. in the Genale area and S.N.A.I. at Johar.

Discussions were held with both these contractors before and after the actual quantities were known. The rates which were used in the earthwork estimates are shown in Table III 3. These rates are based on the assumption that the minor distributing canals will be excavated using elevating graders. The smaller field channels including watercourses and laterals will be excavated by tractor drawn ploughs. The rate for the double watercourse assumes that the excavations will be by hand as the channel size is too large to dig by plough and too small for dragline or elevating grader.

d) An addition of 10 per cent has been included to the direct costs as a contingency item in the estimate.

III.2 Engineering and Supervision Costs

An addition of 15 per cent has been included to the total estimated cost for the preparation of designs, contract drawings and supervision of the works.

III.3 Assumed Life of Project Works

In computing the replacement charges to be made in the economic analysis the assumed life of project works is given in Table III.4.

TABLE III.1 Construction Rates for Structures

Item	Unit	Rate Sh
Earthwork		
Excavation for foundations	m^3	8.00
Earthwork filling for roads, ramps, etc.	m^3	10.00
Excavation for canal block	m^3	5.00
Concrete		
6:3:1 Mass in foundations	m^3	350.00
4:2:1 Mass in foundation rafts and cut offs	m^3	390.00
3:2:1 Reinforced in road slabs & curbs (Incl. Formwork)	m^3	460.00
3:1½:1 Reinforced in slabs (incl. Formwork)	m^3	500.00
Masonry (Coral Rock)		
Rubble masonry in 4:1 PCM in walls, piers, Abutments	m^3	80.00
Rubble masonry in 3:1 PCM	m^3	100.00
Cut water block masonry in 3:1 PCM	m^3	160.00
0.40 Cm Rubble masonry pitching in 4.1 PCM 10cm booking	m^2	40.00
0.40 Dry rubble Pitching on 10 cm gravel booking	m^2	30.00
Hollow Concrete Blocks		
H.C.B. in 4:1 PCM	m^3	200.00
Pointing and Rendering		
Pointing in 2:1 PCM in exposed masonry surfaces	m^2	10.00
Rendering shop log groves in 2:1 PCM	m^2	12.00
Jointing		
2 cm bitumen joint between adjacent faces	m^2	30.00
1 cm bitumen joint between adjacent faces	m^2	15.00
Steelwork		
Supply, cut bend and fix M.S. bars	tonne	2150.00
Supply and erect handrails including two coats of paint	m run	22.00

TABLE III. 2 Construction Rates for Buildings

Item	Unit	Rate Sh.
Earthwork		
Excavation in foundations	m^3	8.00
Earthwork under floor and around walls including ramming, ,etc. .	m^3	8.00
Concrete		
6:3:1 Mass in foundation	m^3	350.00
4:2:1 Reinforced in lintals, roof slabs and floor	m^3	480.00
8:3:1 Lime concrete under floor well rammed	m^3	190.00
Masonry (Coral rock)		
Rubble masonry in 3:1 PCM	m^3	100.00
Hollow Concrete Blocks		
H.C.B. in 4:1 PCM	m^3	200.00
Roofing (Timber)		
Supply, working and fixing timber of required size in rafters	m^3	1250.00
Provide and fix C.G.I. Sheets including fixing complete	m^2	25.00
Joinery		
Provide and fix outside panelled door	m^2	140.00
Provide and fix inside flush door	m^2	130.00
Provide and fix window with bars and louvred shutters	m^2	170.00
Provide and fix window glazed, with bars and louvred shutters	m^2	260.00
Decoration		
Inside paste 6:1 PCM 0.25 cm thick	m^2	11.00
Lime or colour wash 2 coats	m^2	9.00
Bistumastic paint on C.G.I. sheets 2 coats		
Approved paint on ceiling and timber 3 coats	m^2	10.00
Reinforcement		
Supply, cut, band and fix M.5 bars	kg	2.00

TABLE III.3 Excavation Rates for Canals

Item	Unit	Rate Sh.
Minor Distributary		
Earth excavation forming banks by elevating grader	m^3	3.50
Double Watercourse		
Earth excavation and forming banks	m^3	2.75
Watercourse		
Earth excavation	m^3	2.50
Drains		
Earth excavation in drain and forming roads	m^3	5.00

TABLE III.4 Assumed Life Project Works

Description	Life Years
Earthworks in canals and roads	80
Bridges, Steel work or reinforced concrete. Irrigation structures on minor canals	50
Buildings and workshops. Steelwork in canal regulators Electricity and Telephone transmission lines Water supply installations	40
Mechanical Plant for pump station, domestic water supply and telephone exchange equipment	20
Groundnut decortication plant	10

APPENDIX IV

DETAILED ESTIMATES

I. Irrigation Works, Buildings and Services

	Description	Qty	Unit	Rate Sh.	Amount 1000 Sh.	Foreign Exchange 1000 Sh.
A.	Preparatory Work					
1.	Survey area after clearing and Beacon area.	3800	ha	12.00	45.6	-
2.	Survey all canal lines and drain lines for scheme Canalisation	3250	ha	4.00	13.0	-
3.	Survey Project HQ Village and demarcation of building plots*		ha	-	Nil	-
	Sub-Total				58.6	35.2
B.	Purchase of Land and compensation					
1.	Settlement of farmers in new villages			sum	150.0	-
2.	Compensation for Buildings removed			sum	10.0	-
	Sub-Total				160.0	
C.	Pump Station					
1.	Mechanical Plant			sum	815.9	
2.	Substructure			sum	445.3	
3.	Buildings and road			sum	128.7	
4.	Bank protection			sum	29.6	
	Contingencies 10%				142.0	
	Sub-Total				1561.5	1,157.8
D.	Canal Headreach and Pool					
1.	Excavation in headreach and forming banks	1196	m^3	3.50	4.2	
2.	Excavation in head pool forming banks and disposal of surplus in bund	3174	m^3	5.00	15.9	

* Survey to be carried out by the Survey and Mapping Department of the Somali Government.

I. Irrigation Works, Buildings and Services (Continued)

	Description	Qty	Unit	Rate Sh.	Amount 1000 Sh.	Foreign Exchange 1000 Sh.
3.	Dry rubble pitching with gravel backing	1,076	m^3	30.00	32.2	
	Contingencies 10%				5.2	
	Sub-Total				57.6	10.0
I. E.	Distributaries					
1.	Earthworks					
	Minor canals	187,138	m^3	3.50	655.0	
	Double water-courses	10,460	m^3	2.75	28.8	
	Watercourses	72,218	m^3	2.50	185.5	
	Laterals	81,225	m^3	2.50	203.1	
	Add Contingencies 10%				107.2	
	Sub-Total				1179.6	530.8
2.	Structures					
	Minor canals					
	Movable weirs Series II	3	No.	Sum	189.1	
	Movable weirs Series I	5	No.	Sum	117.3	
	Pipe Bridge	1	No.	Sum	14.5	
	Pipe Regulators	16	No.	Sum	143.5	
	Field Outlet Pipes					
	a. Full length with Valve	90	No.	1000	90.0	
	b. Half length with Valve	8	No.	600	4.8	
	c. Full length with no Valve	9	No.	660	5.9	
	Bombas	272	No.	37.5	10.2	
	Lateral Pipes	1083	No.	30	32.5	
	Sub-Total				607.8	334.3
I. F.	Drains					
	Earthworks					
	Minor Drains	50,400	m^3	5.0	252.0	
	Structures					
	50% of Earthworks cost	-	-	Sum	126.0	
	Add contingencies (All items) 10%				37.8	
	Sub-Total				415.8	200.9

I. Irrigation Works, Buildings and Services (Continued)

	Description	No.	Unit Cost 1000 Sh.	Amount 1000 Sh.	Foreign Exchange 1000 Sh.
IG.	Workshops				
	Scheme Workshops 33m x 5m including tools	1	100.0	100.0	80.0
IH.	Buildings for Agricultural & Irrigation Management				
	Scheme Office	1	65.0	65.0	
	Storeshed	1	70.0	70.0	
	Houses for expatriate staff	3	sum	312.2	
	Houses for local staff	5	sum	205.0	
	Materials in lieu of housing to local staff	102	sum	107.7	
	Sub-Total	-	-	759.9	(384.0)
IJ.	Other Buildings (To be provided by Somali Government)				
	Dispensary	1	30.0	30.0	
	Veterinary clinic & Holding Compound	1	23.3	23.3	
	Slaughter Area		4.0	4.0	
	Sub-Total	-	-	57.3	24.6

	Description	Qty	Unit	Rate 1000 Sh.	Amount 1000 Sh.	Foreign Exchange 1000 Sh.
IK.	Water Supply					
1.	Tubewells fully developed	4	No.	70.0	280.0	
2.	Reinforced concrete elevated tank (225,000 litres)	1	No.	77.0	77.0	
3.	Reinforced concrete tank at ground level (22,500 litres)	2	No.	10.0	20.0	
	7.6 cm plastic ring main			sum	34.8	
	Sub-Total				411.8	226.5

I. Irrigation Works, Buildings and Services (Continued)

	Description	Qty	Unit	Rate 1000 Sh.Sh.	Amount 1000 Sh.Sh.	Foreign Exchange 1000 Sh.Sh.
IL.	Electricity Supply					
	Main supply to Project Buildings		-	sum	134.5	
	Sub-Total				134.5	108.0
IM.	Communications					
1.	All weather road Project H.Q. village to Merca Road	1.1	km	sum	173.5	
2.	Access road to other two farmers' villages	11.1	km	sum	350.0	
3.	Bridge over pump canal	1	No.	sum	103.6	
4.	Telephone line Project H.Q. to pump station and exchange	km	6.8	sum	14.2	
5.	Telephone line Project H.Q. to Afgoi and Mogadiscio	km	35.8	sum	53.7	
	Sub-Total				695.0	364.8

II. Agricultural Processing Plant

	Description	Qty	Unit	Rate 1000 Sh.Sh.	Amount 1000 Sh.Sh.	Foreign Exchange 1000 Sh.Sh.
	Groundnut Decortication Plant					
	Plant consisting of one unit with decorticating machine	1	No.	150.0	150.0	
	Sub-Total				150.0	132.0

III. Land Preparation

	Description	Qty	Unit	Rate 1000 Sh.	Amount 1000 Sh.	Foreign Exchange 1000 Sh.
a)	Bush Clearance	3,800	ha Gross	270	1,026.0	
b)	Land Levelling	3,250	ha N. C. A.	500	1,625.0	
	Sub-Total				2,651.0	1,325.5

IV. Agricultural Equipment		No.	Unit Cost	Amount Sh.	Foreign Exchange Sh.
a)	Transport				
	Cylinder Stn Waggons	6	29,150	174,900	170,400
	Pickups	2	23,150	46,300	44,900
	$2\frac{1}{2}$ ton lorries	2	32,000	64,000	62,200
b)	Tractors				
	70 HP tractors	25	29,920	748,000	733,130
c)	Combine Harvesters				
	Combine & Rice Conversion	8	74,210	593,680	584,310
d)	Implements				
	Chisel ploughs	12	4,746	56,950	55,880
	W. L. Discs	12	2,010	24,120	20,010
	Seed Attachments for W. L. Discs	12	4,335	52,020	51,200
	Tool carriers & attachments	12	4,300	51,600	50,500
	Fert. Distributor (front mounted)	12	1,750	21,000	20,450
	Trailers	15	4,750	71,250	69,300
	Land levellers	9	14,650	131,850	129,100
	Boom Sprayers	6	5,650	33,900	33,200
	Fuel Trailers	3	10,000	30,000	28,800
	Water Trailers	3	8,000	24,000	23,000
	Cotton Root Pullers	750	65	48,750	42,750
	Plastic Syphons 4 cm	6000	15	90,000	87,850
	Plastic Syphons 3 cm	3000	10	30,000	28,850
	Sub-Total			2,292,300	2,240,300

	Description	Qty	Unit	Rate 1000 Sh.	Amount 1000 Sh.	Foreign Exchange 1000 Sh.
V.	Contingencies					
	10 per cent added to total cost of all items (excluding item IJ)			Sum	1,123.5	713.1
VI.	Engineering and Supervision					
	15 per cent added to the total estimate costs of Items I, II & III to cover the costs of designs, documents and supervision of the works			Sum	1,336.0	890.7

APPENDIX V

OPERATION AND MAINTENANCE ANNUAL CHARGES

1. Nominal Roll and Charges.
2. Estimate of Annual Recurring Charges.

TABLE V. 1 Nominal Roll and Charges

Designation	So. Sh. Basic Pay Per Mth	'000 Sh. Total Annual Pay	Year 1		Year 2		Year 3
			No.		No.		No.
Admin. Manager	-	-	1	107. 0	1	107. 0	
Field Manager	-	-	1	85. 6	1	85. 6	
Engineer	-	-	1	85. 6	1	85. 6	
Asst. Admin. Manager	-	24. 0	1	24. 0	1	24. 0	
Asst. Field Manager	-	24. 0	1	24. 0	1	24. 0	
Asst. Engineer	-	24. 0	1	24. 0	1	24. 0	
Sub-Total				350. 2		350. 2	
H.Q. Staff							
Book-keeper	750	10. 0	1	5. 0	1	10. 0	As for Year 2
Clerk/Typist	450	6. 2	1	6. 2	1	6. 2	
Storeman	450	6. 2	1	3. 1	1	6. 2	
Tele Operator/ Typist	300	4. 0	-	-	1	4. 0	
Messenger	250	3. 3	1	3. 3	1	3. 3	
Caretaker	200	2. 9	-	-	1	2. 9	
Watchman	200	2. 9	2	5. 8	2	5. 8	
Car Drivers	350	5. 8	4	20. 3	10	58. 0	
Labourers	180	2. 8	2	2. 8	6	16. 8	
Survey Staff							
Surveyor	600	8. 4	1	8. 4	1	8. 4	
Head Chairman	350	5. 0	1	5. 0	1	5. 0	
Chairman	180	3. 0	2	6. 0	2	6. 0	

Designation	Basic Pay Per Mth Sh.	Total Annual Pay '000 Sh.	Year 1		Year 2		Years 3-9	
				'000 No. Sh.		'000 No. Sh.		'000 No. Sh.
AGRICULTURAL								
STAFF								
Agricultural Officers	-	15. 0	2	15. 0	2	30. 0	2	30. 0
Agricultural Sheiks	-	1. 0	-	-	40	40. 0	40	40. 0
Tractor Drivers	350	5. 8	15	58. 0	28	(139. 2) 18. 4	28	(162. 4) 41. 6
Decortication Plant Checker	450	6. 2	-	-	1	6. 2		
Decortication Plant Operator	350	5. 0	-	-	1	5. 0		
Decortication Plant Labourer	180	2. 7	-	-	3	8. 1		
MECHANICAL								
Workshops Foreman	700	10. 8	1	5. 4	1	10. 8		
Electrician	600	8. 9	1	4. 5	1	8. 9		
Fitter Class 1	600	9. 2	1	4. 6	2	18. 4		
Fitter Class 2	450	6. 9	1	6. 9	2	13. 8		
Storeman	450	6. 4	-	-	1	6. 4		
Watchman	200	2. 9	-	-	2	5. 8		
Labourers	180	2. 8	2	2. 8	3	8. 4		
Artisan	450	6. 4	-	-	1	6. 4		
Artisan's Mate	350	5. 0	-	-	1	5. 0		

As for Year 2

Designation	Basic Pay Per Mth Sh.	Total Annual Pay '000 Sh.	Year 1		Year 2		Year 3
			No.	Sh.	No.	Sh.	
WATER CONTROL STAFF							
Pump Foreman	700	10.4	1	5.2	1	10.4	As for year 2
Pump Operator	600	8.9	1	-	2	17.8	
Labourer/Greaser	350	5.0	-	-	2	10.0	
Well Pump Attendant	450	6.2	1	6.2	4	24.8	
Asst. Well Pump Attendant	350	5.0	1	5.0	4	20.0	
Head Water Guard	600	9.6	1	4.8	1	9.6	
Water Guard Cl. 1.	450	7.2	3	5.4	3	21.6	
Water Guard Cl. 2.	350	5.6	5	7.0	10	56.0	
Total Staff				546.9		844.6	867.8

Notes:-

1) Years 3-9 are the same.

2) In year 10 new assistant engineer arrives.

3) In year 11 expatriate engineer leaves and counterpart salaries rise to 36,000 Sh. per annum.

4) In years 15 and 16 the field manager hands over.

5) In years 20 and 21 the Admin. Manager hands over.

Years	1-9	10	11-14	15	16-19	20	21-40
Managerial Costs	350.2	374.2	324.6	348.6	263.0	287.0	194.0

TABLE V. 2 Annual Recurring Charges

Item	Description	Quantity	Unit	Rate Sh.	Amount Sh.
1.	Pump Station				
	Plant Maintenance	815, 870	%	1	8, 200
	Building Maintenance	574, 000	%	2	11, 500
	Running Cost	-	-	Sum	36, 500
	Sub-Total				56, 200
2.	Distributary Canals				
	a) Earthworks				
	Bicycle Allowance	10	No.	300	3, 000
	Silt Clearance				
	1) Minors	11	Km.	1, 200	13, 200
	2) Double Water-courses	2. 5	Km.	200	500
	Bank Dressing	11	Km.	80	880
	Making up and grading roads	194	Km.	120	23, 280
	Fixed Week Clearance	33	Km.	50	1, 650
	Sundries	-	-	Sum	2, 000
	Sub-Total				44, 510
	b) Structures				
	Bicycle Allowance	4	No.	300	1, 200
	Ramps at Regulators	25	No.	40	1, 000
	Structure dry inspection and repairs	-	-	Sum	1, 400
	Gauges			Sum	200
	Daily paid labour	20	Man/day	6	120
	Replacements for F. O. P. s			Sum	500
	Field channel pipes			Sum	1, 000
	Sundries			Sum	1, 000
	Sub-Total				6, 420
3.	Drains				
	Silt Clearance				
	1) Minor Drains	5, 400	m^3	5	27, 000
	2) Major Drains	1, 600	m^3	5	8, 000
	Structures	-	-	Sum	1, 000
	Sub-Total				36, 000
4.	Workshops				
	Equipment			Sum	35, 220
	Sub-Total				35, 220

Item	Description	Quantity	Unit	Rate Sh.	Amount Sh.
5.	Buildings	859,900	%	2	17,200
6.	Water Supply				
	Plant Maintenance	280,000	%	1	2,800
	Structural "	131,800	%	2	2,640
	Running Cost	-	-	Sum	3,000
	Sub-Total				8,440
7.	Electricity Supply				
	Plant maintenance	134,500	%	2	2,690
	Running Cost	-	-	Sum	10,000
	Sub-Total				12,690
8.	Communications				
	Surfaced Road & Road Bridge	277,100	%	2	5,540
	Canal Roads Maintenance	350,000	%	5	17,500
	Posts & Telegraph Maintenance	67,900	%	2	1,360
	Running Cost	-	-	Sum	4,000
	Sub-Total				
9.	Decortication Plant				
	Maintenance				9,000
	Running Cost				4,000
	Sub-Total				13,000
10.	Agricultural Equipment(1)				
	a) Transport				
	1) Land Rovers				
	Maintenance				(23,320)
	Running Cost				16,160
	2) Lorries				
	Maintenance				(6,400)
	Running Cost				(5,100)
	b) Equipment				
	Maintenance				(5,500)
	Running Cost				52,300
	Sub-Total				73,560
	To Workshops				(35,220)
11.	Miscellaneous				
	Bilharzia Spraying			Sum	20,000
	Office Equipment			Sum	3,000
	Tools			Sum	2,000
	Sub-Total				25,000

(1) Excludes charged directly to crop production.

APPENDIX VI

CROP RETURNS AND PRODUCTION COSTS

TABLE VI. 1 Cotton Crop Returns and Production Costs in Somali Shillings (Rounded Figures) per Hectare

Cropping Year	1	2	3	4	5
Yield (kg/ha)	700	800	1,100	1,200	1,500
Price (So. Sh. kg)	1.00	1.00	1.00	1.00	1.00
Gross revenue (So. Sh. per ha)	700.00	800.00	1,100.00	1,200.00	1,500.00
Production Costs					
Seed (25 kg/ha @ 40 cts/kg)[2]	10.00	10.00	10.00	10.00	10.00
Fertiliser (100 kg/ha @ 850 Sh. MT)[3]	85.00	85.00	85.00	85.00	85.00
Spraying (based on Kenya figures of 150 sh. per acre) for four cereal sprayings	180.00	180.00	180.00	180.00	180.00
Bags @ 3 shillings each[4]	57.00	36.00	54.00	54.00	60.00
Interest on working capital[5]	19.00	19.00	19.00	19.00	19.00
Labour (96 MD family; 25 MD hired @ 2.50 per day	223.00	255.00	270.00	285.00	303.00
Mechanisation[6]	69.00	69.00	69.00	69.00	69.00
Total cost per hectare	643.00	654.00	687.00	702.00	726.00
Profit per hectare (before deduction of annual management charges)	57.00	146.00	413.00	498.00	774.00

TABLE VI. 2 Groundnut Crop Returns and Production Costs in Somali Shillings (Rounded Figures) per Hectare

Cropping Year	1	2	3	4	5-40
Yield (kg/ha shelled)[1]	870.00	870.00	1,090.00	1,090.00	1,310
Price (So. Sh. kg)	0.70	0.70	0.70	0.70	0.70
Gross Revenue	609.00	609.00	763.00	763.00	917.00
Production Costs					
Seed (100 kg/ha @ 90 cts kg)[2]	90.00	90.00	90.00	90.00	90.00
Fertiliser (100 kg @ 850 sh. M. T.)[3]	85.00	85.00	85.00	85.00	85.00
Bags @ 3 sh. each[4]	60.00	30.00	45.00	45.00	45.00
Interest on working capital[5]	14.00	14.00	14.00	14.00	14.00
Labour (51 Man days family 2 man days hired @ 2.50 P. M. D.	133.00	133.00	133.00	133.00	133.00
Mechanisation[6]	78.00	78.00	78.00	78.00	78.00
Total Cost	460.00	430.00	445.00	445.00	445.00
Profit per hectare (before deduction of annual management charges)	149.00	179.00	318.00	318.00	472.00

TABLE VI. 3 Rice Crop Returns and Production Costs in Somali Shillings (Rounded Figures) per Hectare

Cropping Year	1	2	3	4	5
Yield (kg/ha)	1,000	1,400	1,800	2,200	2,500
Price (So. Sh. per kg)	0.60	0.60	0.60	0.60	0.60
Gross Revenue per Hectare	600.00	840.00	1,080.00	1,320.00	1,500.00
Production Costs					
Seed (100 kg/ha @ 80 cts kg)[2]	80.00	80.00	80.00	80.00	80.00
Fertiliser (100 kg/ha @ 850 sh. MT)[3]	128.00	128.00	128.00	128.00	128.00
Herbicides	100.00	100.00	100.00	100.00	100.00
Bags @ 3 sh. each[4]	48.00	42.00	54.00	60.00	60.00
Interest on working capital[5]	19.00	19.00	19.00	19.00	19.00
Labour (27 MD family, 6 MD hired @ sh. 2.50 per day)	83.00	83.00	83.00	83.00	83.00
Mechanisation[6]	124.00	124.00	124.00	124.00	124.00
Total Cost	582.00	576.00	588.00	594.00	594.00
Profit per hectare (before deduction of annual management charges)	18.00	264.00	492.00	726.00	906.00

Notes on Crop Costs and Returns

1. The shelling out percentage for groundnut has been taken as 618.
2. Seed has been charged at the farm gate price plus a margin for storage and treatment.
3. Fertiliser has been charged at the bulk delivery rate excluding duty.
4. Bags have been costed on the assumption that approximately 50 per cent will be replaced each year.
5. Working capital charges based on 600 shillings annual subsistence plus credit for seed, bags, fertiliser and chemicals.
6. Mechanisation charges include hourly variable costs only (see Appendix VII for calculation). All earlier mechanisation costs are included in scheme annual charges.

APPENDIX VII

VARIABLE MECHANISATION COSTS

1. Equipment utilisation on 4, 500 cultivated ha. per annum (for reference see Tables 3.12 and 3.13, Chapter 13).

A. CULTIVATION

(i) All crops

Equipment	Total hours used	
Chisel ploughs	6,000	
Disc Harrows	3,000	
Levellers	8,400	
Ridgers	9,600	
Total		27,000 hours

(ii) Rice

Sprayers	400	
Harrows	1,250	
Total		1,650 hours

(iii) Groundnuts

Lifting Blades	2,000	2,000 hours

B. TRANSPORT

Groundnuts	2,750	
Cotton	2,800	
Rice	2,100	
Total		7,650 hours

Total Tractor Running Hours Cultivation and Transporting	38,300 hours
Add 10% to cover extra running, fuel and water hauling, etc.	3,830 hours
Chargeable to Crops	8,640 hours
Total annual tractor running hours	50,770

Total annual running time per tractor = $\frac{50,770}{25}$ = 2,030 hrs.

2. Hourly Running Costs

	Shs.
(1) Tractors	
Fuel 8 litres @ 48.6 per litre	3.84
Oils 39 gals. @ 10/- per gal = 390 shillings hourly cost $\frac{310}{2030}$	.19
Spare parts 7% of retail price per annum	
Hourly cost $\frac{29,920 \times 0.7}{2030}$	1.03
Driver including overtime	2.66
Total hourly running cost tractors	7.72
(2) Chisel Ploughs	
12 ploughs for 6,000 hrs. = 500 hours per plough	
Spare parts 1.7% of retail price per annum	
hourly cost $\frac{4746 \times 0.17}{500}$	.16
(3) Harrows	
12 harrows for 4,250 hrs. = 354 hrs. per harrow	
Spare parts 1.7% of retail price per annum	
hourly cost $\frac{2,010 \times 0.17}{354}$	.10
(4) Levellers	
9 levellers for 8,400 hrs. = 933 hours per leveller	
Spare parts 1.7% of retail price per annum	
hourly cost $\frac{14,647 \times 0.17}{933}$	.30
(5) Tool Bars and Attachments	
12 Tool bars for 14,600 hrs. = 1,217 hrs. per tool bar	
Spare parts 1.7% of retail price per annum	
hourly cost $\frac{4,300 \times 0.17}{1,217}$	.06

(6) Sprayers

6 sprayers for 400 hours % 67 hrs. per sprayer

Spare parts 1.7% of retail price per annum

Hourly cost $\frac{5,650 \times 0.17}{67}$ 1.43

(7) Seeding Units

12 Units for 1,250 hours = 104 hrs.

Spare parts 1.7% of retail price per annum

Hourly cost $\frac{4,335 \times 0.17}{104}$ .71

(8) Front mounted fertiliser distributors

12 Units for 1,250 hours = 104 hours per unit

Spare parts 1.7% of retail price per annum

$\frac{1,750 \times 0.17}{104}$ .30

(9) Trailers

15 trailers for 7,650 hours = 510 hrs. per trailer

Spare parts 1.7% of retail price per annum

Hourly cost $\frac{4,750 \times 0.17}{510}$ .16

(10) Combines 8 for 1,600 hrs. = 200 hrs. per combine

Fuel 10 litres per hour @ 48 cts per litre	4.80
Spare parts, oils etc. 10% of retail price per annum i.e. per hour	37.00
Driver including overtime	1.80
	43.60

3. Cultivation Costs per Hectare

(a) Common to all Crops		Shs. per ha.
Ploughing	$\frac{.16 \text{ sh.} \times 2,000 \text{ hrs.}}{1,500 \text{ ha.}}$	.21
Harrowing and	$\frac{.94 \text{ sh.} \times 1,000 \text{ hrs.}}{1,500}$	.63
Levelling	$\frac{.30 \text{ sh.} \times 2,000 \text{ hrs.}}{1,500}$	.30
Ridging	$\frac{.06 \text{ sh.} \times 2,000 \text{ hrs.}}{1,500}$	.08
Re-ridging	$\frac{.06 \text{ sh.} \times 1,800 \text{ hrs.}}{1,500}$	.05
Tractors	$\frac{7.72 \times 9,000}{1,500}$	46.32
3 Fuel Trailers		
Spare parts 1.7% of retail price per annum cost per cultivated hectare =	$\frac{30,000 \times .017}{4,500}$	.11
3 Water Trailers		
Spare parts 1.7% of retail price per annum cost per cultivated hectare =	$\frac{24,000 \times .017}{4,500}$	.09
Total		47.79

Add 10% of total tractor running hrs.
to all crops for extra running for fuel and water trailers
etc. i.e. $\frac{3,830 \times 7.72}{4,500}$ 6.57

(b) Additional hire cultivation costs	
Combines	43.60
Spraying herbicide $1.43 + 17.72 \times \frac{8}{30}$	2.44
Sowing and fertilising $7.72 + 304.71 \times \frac{10}{12}$	7.28
Total	59.89

(c) Additional Groundnut Cultivation Costs	Shs. per ha.
Blading . 06 + 17. 72 x $\frac{10}{8}$	9. 73

4. Transport Cost per Hectare

(a) Groundnut

$$\frac{2,750 \text{ hrs. x } (7.72 + .16)}{1,500} = 14.44$$

(b) Cotton

$$\frac{2,800 \text{ hrs. x } (7.72 + .16)}{1,500} = 14.66$$

(c) Rice

$$\frac{2,100 \text{ hrs. x } (7.72 + .16)}{1,500} = 11.06$$

6. Total Crop Mechanisation Costs per Hectare

	Rice	Cotton	Groundnuts
Cultivation	47. 49	47. 49	47. 49
Spraying, sowing, combining	59. 89	-	9. 73 (Blading)
Transport	11. 06	14. 66	14. 44
Extra tractor running	6. 57	6. 57	6. 57
	124. 01	68. 72	78. 23

APPENDIX VIII

SUMMARY OF COSTS

TABLE VIII. 1 Capital Costs

		Total Cost '000 Shs.	Foreign Exchange Cost '000 Shs.
1.	Irrigation Works, Buildings and Services	6, 142. 1	3, 433. 1
2.	Agricultural Processing Plant	150. 0	132. 0
3.	Land Preparation	2, 651. 0	1, 325. 5
4.	Agricultural Equipment	2, 292. 3	2, 240. 3
5.	Contingencies	1, 123. 5	713. 1
6.	Engineering Supervision	1, 336. 0	890. 7
	Project Total:	13, 694. 9	8, 734. 7

Summarised from Appendix IV.

TABLE VIII. 2 Annual Management Costs (Shs.)

	Managerial Staff	Other Staff	Works	Services	Int. on[1] Working Capital	Total
1	350, 200	196, 700		60, 000	42, 500	649, 400
2	350, 000	494, 400	179, 550	153, 990	106, 100	1, 284, 240
3	350, 200	517, 600	197, 550	161, 090	154, 200	1, 380, 640
4	350, 200	517, 600	197, 550	161, 090	157, 400	1, 383, 840
5	350, 200	517, 600	197, 550	161, 090	130, 600	1, 357, 040
6	350, 200	517, 600	197, 550	161, 090	59, 000	1, 285, 440
7	350, 200	517, 600	197, 550	161, 090	52, 300	1, 278, 740
8	350, 200	517, 600	197, 550	161, 090	21, 000	1, 247, 440
9	350, 200	517, 600	197, 550	161, 090	21, 000	1, 247, 440
10	374, 200	517, 600	197, 550	161, 090	21, 000	1, 271, 440
11-14	324, 600	517, 600	197, 550	161, 090	21, 000	1, 221, 840
15	348, 600	517, 600	197, 550	161, 090	21, 000	1, 245, 840
16-19	263, 000	517, 600	197, 550	161, 090	21, 000	1, 140, 240
20	287, 000	517, 600	197, 550	161, 090	21, 000	1, 184, 240
21-40	194, 000	517, 600	197, 550	161, 090	21, 000	1, 091, 240

Summarised from Appendix V.

N. B. 1. Based on yearly net cash requirements at 7% until year 7 and on net cash requirements in per season only thereafter.

TABLE VIII. 3 Equipment Replacement Schedule Shs.

Year	Agric. Equipment	Decortn. Plant	Mech. Plant and Water Supply	Total
1				
2				
3				
4				
5	285, 200			285, 200
6				
7	1, 341, 680			1, 341, 680
8				
9				
10	285, 200	150, 000		435, 200
11				
12	665, 440			665, 440
13				
14	1, 341, 680			1, 341, 680
15	285, 200			285, 200
16				
17				
18				
19				
20	285, 200	150, 000	1, 227, 700	1, 662, 900
21	1, 341, 680			1, 341, 680
22				
23				
24	680, 000			680, 000
25	285, 200			285, 000
26				
27				
28	1, 341, 680			1, 341, 680
29				
30	285, 200	150, 000		435, 200
31				
32				
33				
34				
35	1, 626, 880			1, 626, 880
36	484, 000			484, 000
37				
38				
39				
40				

APPENDIX IX

ANNUAL IDENTIFIABLE FOREIGN EXCHANGE COSTS AND RETURNS

(Current C. I. F. Prices)

TABLE IX. 1 Annual Identifiable Foreign Exchange Costs & Returns
(Current c. i. f. Prices)

1. Project

Costs	Shs.		Import Substitution Saving Shs.
Fertiliser	338,000	Rice	2,339,400
Bags	165,000	Cotton	3,152,000
Herbicides	145,000	Groundnut oil	1,572,000
Agric. Equipment		Cotton seed oil	416,000
Running & Maintenance	500,000	Total gross saving	7,479,400
Cereal spraying	270,000		
Expatriate staff	270,000	Loss of revenue	
Replacement	400,000	from Import duties	1,542,000
Running & Maintenance			
Mech. Plant	90,000		
	2,178,000		

2. External Facilities

Re-equipment, running and maintenance Processing facilities	500,000
Other	500,000

3. Estimated Increased Import buying 1,000,000

Total estimated increase in Foreign Exchange outflow 4,178,000

APPENDIX X

RICE HULLING INSTALLATION

Introduction

The attached proposals are put forward assuming that:

1. Annual intake of Paddy is from 2, 000 to 4, 000 tons.
2. Paddy is delivered in sacks.
3. Storage is required for sacked Paddy before processing. Alternative prices for 1, 000 and 2, 000 ton storages are included.
4. Storage for 50 tons of sacked Rice is required.
5. Hulling can be spread over 200 to 250 working days.
6. Casual labour is available to receive and store sacked Paddy.
7. Storage of Paddy in sacks rather than in bulk reduces the risk of deterioration due to high moisture content.
8. Minimum capital cost is essential and that unskilled labour for handling sacks is available.

Rate of Working

Estimate based on a daily throughput of Paddy of 15 tons i. e. $7\frac{1}{2}$ working hours per day and a throughput of 2 tons per hour.

Thus at 3, 000 tons per annum, 200 working days are forecast and at 4, 000 tons, 270 working days.

Labour Force

One local manager, one skilled plant operator and three labourers will be needed for day to day operation of the plant, but additional labourers will be needed to receive and store sacked Paddy for part of the year.

Building

The processing machinery, office accommodation, stores and 50 ton Rice store will require an area of 160 square metres i. e. 8M x 20M

(Plan A). Storage area for 1000 tons of sacked Paddy, stacked 3M high requires 560 square metres or 4 bays at 8M x 20M including allowance for access gangways (Plan B).

If storage is required for 2000 tons, a further 4 bays at 8M x 20M would be needed (Plan C).

The net area required for the hulling machinery is 10. 5M x 7M with a maximum headroom of 7. 25 M.

A minimum of three ingoing and one outgoing loading ramps would be needed for Plans B or C and skylights on the North slopes should be provided.

Depending on local weather conditions, walling may not be required on all sides of the storage areas, but would be necessary for the processing area.

Processing Plant

A six cylinder air cooled diesel engine rated at 80 b. h. p. provides all the power necessary to operate the plant via shafting and belt drives and has sufficient additional capacity to drive a 5 KVA alternator to provide lighting and power outlets for fans, small tools, etc. However, no financial provision has been made for an alternator or wiring of lighting and power circuit.

A current estimate has been received covering all the necessary machinery and components which can be assembled to form a complete working installation. The price quoted is Shs. 215, 000 c. i. f. Mogadiscio and covers the following:-

Ironwork for sunken Intake Hopper comprising steel grating to prevent entry of large impurities and slide to control feed to intake elevator.

One Paddy Cleaner with two balanced trays to remove large and small impurities, the top tray having a combined aspirator and feed spreader box, and the final aspiration being done in a metal aspirator with built on fan, and including air ducting.

One Automatic Bulk Weigher for weighing Paddy.

One Magnetic Separator, chute type, to remove wire, nails, etc.

Two 7" Roller Shellers mounted on top of a Husk Aspirator (without shaker), with built on fan.

One 60 Compartment Separator fitted with sheet iron side doors and with underdrive. Equipped with variable Speed Drive (enclosed type).

Two 30" diameter Whitening Cones mounted on cast iron stools and with cones covered with emery composition. Fitted with ball bearing neckbush and footstep.

Cone Suction Fan with suction ducting between Cones and Fan with branch to aspirate Rice at entry to final Elevator.

One 6'0" Cyclone for collecting meal from the Cone Suction Fan discharge, including air duct from Fan to Cyclone.

One Vibratory sieve for grading Rice into whole grains, large brokens and small brokens.

One sack Weigher for weighing Rice into sacks.

Steel Bins above Shellers and Cones.

Elevators with steel trunking, pressed steel buckets and rubber belting.

Bagging Board with spouts for bagging off whole Rice, large brokens and small brokens.

Transmission comprising shafting mounted in ball bearing plummer blocks, pulleys and rubberised belts for driving the above machines.

Spouting consisting of straight lengths of steel spouting and rubber bends and connecting pieces to allow of the spouting being fitted up during erection on site.

Steel Framework to carry the machines including staircase, wooden flooring and handrails.

Cone Mould.

Slide Rest for turning Cones with tool holder and tools (2 dozen sets star cutters and 4 pairs finishing cutters).

Mill pick.

Hydrometer.

Lifting Bar and Cones.

Set of Spanners.

Grease Gun.

60 Covers for each Roller Sheller.

One Lister HR6 Engine with electric starting and clutch.

Foundation and Holding Down Bolts.

Arrangement and Foundation Drawings.

It is recommended that a skilled expatriate foreman is employed to supervise the erection, fitting and testing of this equipment and that he is assisted by the local staff that will eventually operate the plant. Three months will be required for erection on a prepared concrete floor and allow a sum of £2, 000 for the foreman's services and expenses.

Estimated Costs

(a) Capital Costs		Somali Shillings (at 17. 143 = £1)	
Complete Processing Plant		216, 000	216, 000
C. I. F. Mogadiscio			
Port Landing Charges			
47 tons at 30 Sh/ton		1, 410	4, 650
1. 5% tons on C. I. F. value		3, 240	4, 650
Road Transport Charges			
at 95 cts. per ton km			
47 tons over 35 km		1, 565	1, 565
Erection Costs			
Expatriate Foreman	3 months	34, 286	
Mill Staff	3 months	14, 750	49, 036

(b) Building Costs

Plan A

To house machinery, offices, stores and 50 tons rice store		
160 square M at 350 sh/Sq. M.	56,000	

Plan B

A plus 1,000 tons Paddy storage		
Total 800 square M at 350 sh/Sq. M.	280,000	

Plan C

A plus 2,000 ton Paddy Storage		
Total 1440 square M at 350 Sh/sq. M.	504,000	

Sundries

Office partitions, furniture, etc.	8,500	
Fuel Storage	17,000	
Sack handling equipment	8,500	34,000
Total Costs		305,250

Plan A	361,250 Somali Sh.
Plan B	585,250 Somali Sh.
Plan C	809,250 Somali Sh.

Annual Processing Costs

Salaries and Wages	Shs.
Manager	36, 000
Plant Operator	15, 000
Permanent Labour	18, 000
Casual Labour	9, 000
Fuel	11, 000
Building and Plant Maintenance	5, 000
Office Expenses	5, 000
Repayment of Capital Cost and Interest Averaged over 10 Yrs. period	89, 000
Total:	188, 000

Processing cost per ton of paddy $\frac{185,000}{3,750}$ = 50 Shs.

APPENDIX XI

OIL MILL AND REFINERY

VIABILITY STUDY

OIL MILL AND REFINERY VIABILITY STUDY

(Original estimate made in £ sterling and converted to approximate equivalent in SHS at the exchange rate of SHS 17.143 = £1)

1. Seed Processed Annually:

		SHS '000
2,250 tons groundnut kernel at £37.5/ton	=	1,447
1,500 tons cottonseed at £15/ton	=	386
2,000 tons sesame at £75/ton	=	2,571
5,750 tons total		4,404

2. Yields of Oil, Cake and Lint:-

Groundnut kernels: 50% solids, 50% oil

White Cottonseed: Ginned seed: 10% lint, 36% husk, 34.2% meat solids, 19.8% oil

Hence bare seed: 40% husk, 38% meat solids, 22% oil.

Black Cottonseed: 40% husk, 38% meat solids, 22% oil

Sesame: 50% solids, 50% oil

Milling and Moisture loss: 5%

Refining loss: 5%

Performance:-

Groundnut cake will contain an average of 5% oil.

Cottonseed cake will contain an average of $4\frac{1}{2}$% oil.

Sesame cake will contain an average of 6% oil.

Groundnut Kernels:

Consider 100 tons seed
- 5 tons (5% milling and moisture loss)
95 tons seed effectively processed.

Cake produced: 47.5 tons solids
2.5 tons oil in cake
50.0 tons cake (containing 5% oil)

Crude oil produced: (47.5 - 2.5) = 45.0 tons

Refined oil produced: (45.0 - 5%) = 42.75 tons

Cake yield: 50%
Crude oil yield: 45%
Refined oil yield: 42.75%

Annual Yields:-

Cake:	(2250 x 0.5)	=	1125 tons
Crude oil:	(2250 x 0.45)	=	1013 tons
Refined oil:	(2250 x 0.4275)	=	961 tons

White Cottonseed: -

Consider 100 tons ginned seed
- 5 tons (5% milling and moisture loss)
95 tons seed effectively processed.

Lint produced: (95 x .08) = 7.6 tons

Cake produced:
1.90 tons lint
34.20 tons husk
32.50 tons meat solids
3.20 tons oil in cake
71.80 tons cake (containing 4½% oil).

Crude oil produced: (18.8 - 3.2) = 15.6 tons

Refined oil produced: (15.6 - 5%) = 14.82 tons

Lint yield:	7.6%
Cake yield:	71.8%
Crude oil yield:	15.6%
Refined oil yield:	14.82%

Annual Yields:-

Lint:	(1500 x 0.076)	=	114 tons
Cake:	(1500 x 0.718)	=	1076 tons
Crude oil:	(1500 x 0.156)	=	234 tons
Refined oil:	(1500 x 0.1482)	=	222 tons

Black Cottonseed:-

Consider 100 tons seed
- 5 tons (5% milling and moisture loss)
95 tons seed effectively processed.

Cake produced:
38.0 tons husk
36.1 tons meat solids
3.5 tons oil in cake
77.6 tons cake (containing 4½% oil).

Black Cottonseed (Cont'd)

Crude oil produced:	(20.9 - 3.5)	=	17.4 tons
Refined oil produced:	(17.4 - 5%)	=	16.53 tons

Cake yield;	77.6%
Crude oil yield:	17.4%
Refined oil yield:	16.53%

Annual Yields:-

Cake:	(1500 x 0.776)	=	1164 tons
Crude oil:	(1500 x 0.174)	=	261 tons
Refined oil:	(1500 x 0.1653)	=	248 tons

Sesame:-

Consider 100 tons seed
- 5 tons (5% milling and moisture loss)

95 tons seed effectively processed

Cake produced: 47.5 tons solids
3.0 tons oil in cake

50.5 tons cake (containing 6% oil)

Crude oil produced:	(47.5 - 3.0)	=	44.5 tons
Refined oil produced:	(44.5 - 5%)	=	42.28 tons

Cake yield:	50.5%
Crude oil yield:	44.5%
Refined oil yield:	42.28%

Annual Yields:-

Cake:	(2000 x 0.505)	=	1010 tons
Crude oil:	(2000 x 0.445)	=	890 tons
Refined oil:	(2000 x 0.4228)	=	845 tons

3. Plant Annual Revenue:-

Groundnut Kernels:-				SHS '000
Cake:	1125 tons:	(1125 x SHS 240)	=	270
Refined oil:	961 tons:	(961 x SHS 2487)	=	2,390
				2,660

White Cottonseed:				
Lint:	114 tons:	(114 x SHS 857)	=	97
Cake:	1076 tons:	(1076 x SHS 240)	=	258
Refined oil:	222 tons:	(222 x SHS 2487)	=	522
				907

Black Cottonseed Alternative:-				
Cake:	1164 tons:	(1164 x SHS 240)	=	279
Refined oil:	248 tons:	(248 x SHS 2487)	=	617
				896

Sesame:-				
Cake:	1010 tons:	(1010 x SHS 240)	=	242
Refined oil:	845 tons:	(845 x SHS 2487)	=	3,259
				3,501

Revenue Processing Groundnuts, White Cottonseed and Sesame:-

SHS '000
2,660
907
3,501
7,068

Revenue Processing Groundnut Kernels, Black Cottonseed and Sesame:-

SHS '000
2,660
896
3,501
7,057

4. Plant Capital Cost:-

20/25 ton/day Delinting Plant	£ 25,000 FOB	
Delinint Plant Building	£ 3,000 FOB	
Lint Store Building	£ 2,000 FOB	
	£ 30,000 FOB	
C.I.F. Charges	£ 4,000	
	£ 34,000 CIF =	SHS 583,000
20/24 ton/day Oil Mill	£ 45,000 FOB	
10 ton/day Refinery (including deodorising)	£ 16,000 FOB	
Boiler and Diesel Generating	£ 20,000 FOB	
Mill Building	£ 3,000 FOB	
Refinery Building and Supporting Steelwork	£ 10,000 FOB	
Cooling Towers	£ 2,500 FOB	
Seed and Cake Store Building	£ 3,000 FOB	
Tanks	£ 3,500 FOB	
	£101,000 FOB	
C.I.F. Charges	£ 15,000	
	£116,000 CIF =	SHS 1,989,000

Capital cost groundnut, white cottonseed, sesame plant: £150,000 CIF = SHS 2,572,000

and capital cost groundnut kernel, black cottonseed, sesame plant: £116,000 CIF = SHS 1,989,000

Interest Charges:-

Assuming that plant is bought on credit terms thus: 10% deposit, 10% on shipment, 80% over 4 years in 8 equal instalments, interest 6½% p.a. then total interest charges will be:-

£150,000 CIF:-

$$\text{Interest} = £\frac{(150,000 \times 0.8 \times 0.0325 \times 36)}{8} = £17,550 = \text{SHS } 300,000$$

£116,000 CIF:-

$$\text{Interest} = £\frac{(116,000 \times 0.8 \times 0.0325 \times 36)}{8} = £13,600 = \text{SHS } 233,000$$

Erection and Transhipment Costs:-

Say 20% of CIF costs:-

White Cottonseed Plant:	£30,000	= SHS 514,000
Black Cottonseed Plant:	£23,000	= SHS 398,000

Local Building Costs:-

Office, Laboratory and Lavatory Buildings - say £4,000 = SHS 69,000

Total Cost:-

		SHS '000
White Cottonseed Plant:	Delinting Plant	583
	All other plant	1,989
	Interest	300
	Erection etc.	514
	Local Buildings	69
	TOTAL :	3,455
Black Cottonseed Plant:	Plant	1,989
	Interest	233
	Erection etc.	398
	Local Buildings	69
	TOTAL :	2,689

5. Cake Oil and Lint Produced Annually:-

White Cottonseed Plant:-

Cake:-

Groundnut:	1125 tons
Cottonseed:	1076 tons
Sesame:	1010 tons
TOTAL :	3211 tons

Crude oil:-

Groundnut:	1013 tons
Cottonseed:	234 tons
Sesame:	890 tons
TOTAL :	2137 tons

Refined oil:-

Groundnut:	961 tons
Cottonseed:	222 tons
Sesame:	845 tons
TOTAL :	2028 tons

Lint:-

114 tons

Black Cottonseed Plant:

Cake:-

Groundnut:	1125 tons
Cottonseed:	1164 tons
Sesame:	1010 tons
TOTAL :	3299 tons

Crude oil:-

Groundnut:	1013 tons
Cottonseed:	261 tons
Sesame:	890 tons
TOTAL :	2164 tons

Refined oil:-

Groundnut:	961 tons
Cottonseed:	248 tons
Sesame:	845 tons
TOTAL :	2054 tons

6. Power and Steam Costs:-

Power:-

Delinting uses about 74 KWhrs/ton seed processed.
Milling and refining uses about 112 KWhrs/ton seed processed.

Steam:-

Milling uses about 800 lbs steam/ton seed processed.
Refining (including deodorising) uses about 2700 lbs steam/ton oil processed.

(1 lb fuel oil produces about 15 lbs steam).

White Cottonseed Plant:-

Power used:	delinting:	(1500 tons x 74)	=	111,000 KWhrs
	milling and refining:	(5750 tons x 112)	=	643,000 KWhrs
		TOTAL:		754,000 KWhrs
Power cost:	delinting:	(111,000 x 20 cents)	=	SHS 22,000
	milling and refining:	(643,000 x 20 cents)	=	SHS 128,000
		TOTAL:		SHS 150,000
Steam used:	milling:	(5750 tons x 800)	=	4,600,000 lbs steam
	refining:	(2137 tons x 2700)	=	5,770,000 lbs steam
		TOTAL:		10,370,000 lbs steam
Boiler fuel used:		$\frac{10,370,000 \times 4.55}{15 \times 9}$	=	35,000 litres
Steam cost:		35,000 @ SHS 1.00	=	SHS 35,000

Black Cottonseed Plant:-

Power used:		643,000 KWhrs		
Power cost:		SHS 128,000		
Steam used:	milling:	(5750 tons x 800)	=	4,600,000 lbs. steam
	refining:	(2164 tons x 2700)	=	5,840,000 lbs steam
		TOTAL:		10,440,000 lbs steam
Boiler fuel used:		$\frac{10,440,000 \times 4.5}{15 \times 9}$	=	35,250 litres
Steam cost:		35,250 @ SHS 1.00	=	SHS 35,000 approx.

Total Power and Steam Costs:-

		SHS
White Cottonseed Plant:	power cost:	150,000
	steam cost:	35,000
	TOTAL:	185,000
Black Cottonseed Plant:	power cost:	128,000
	steam cost:	32,000
	TOTAL:	160,000

7. Profit:-

Assumptions:-

Labour cost for delinting, milling and refining taken as: SHS 70/ton seed processed.

Labour cost for milling and refining taken as: SHS 60/ton seed processed.

Cost of maintenance for delinting, milling and refining taken as: SHS 10/ton seed processed.

Cost of maintenance for milling and refining taken as: SHS 8/ton seed processed.

Cost of plant, interest and erection and transhipment spread over 10 years to give average profit over 10 year period.

White Cottonseed Plant:

Annual Revenue SHS 7,068

		SHS '000
Annual Outgoings:	Power and steam (section 6)	185
	Labour	403
	Maintenance	58
	10% of capital cost (section 4)	346
	Office expenses	200
	Seed cost	4,404
		5,596

	SHS
	7,068,000
	-5,596,000
PROFIT	1,472,000

Black Cottonseed Plant:-

Annual Revenue: SHS 7, 057

		SHS '000
Annual Outgoings:	Power and steam (section 6)	160
	Labour	345
	Maintenance	46
	10% of capital cost (section 4)	269
	Office Expenses	200
	Seed cost	4, 404
		5, 424

	SHS
	7, 057, 000
	-5, 424, 000
PROFIT:	1, 633, 000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