LEAGUE OF ARAB STATES

ARAB ORGANIZATION FOR AGRICULTURAL DEVELOPMENT

KHARTOUM

MORDILE-BARRIRE RICE PRODUCTION PROJECT IN DEMOCRATIC REPUBLIC OF SOMALIA

KHARTOUM JULY 1980

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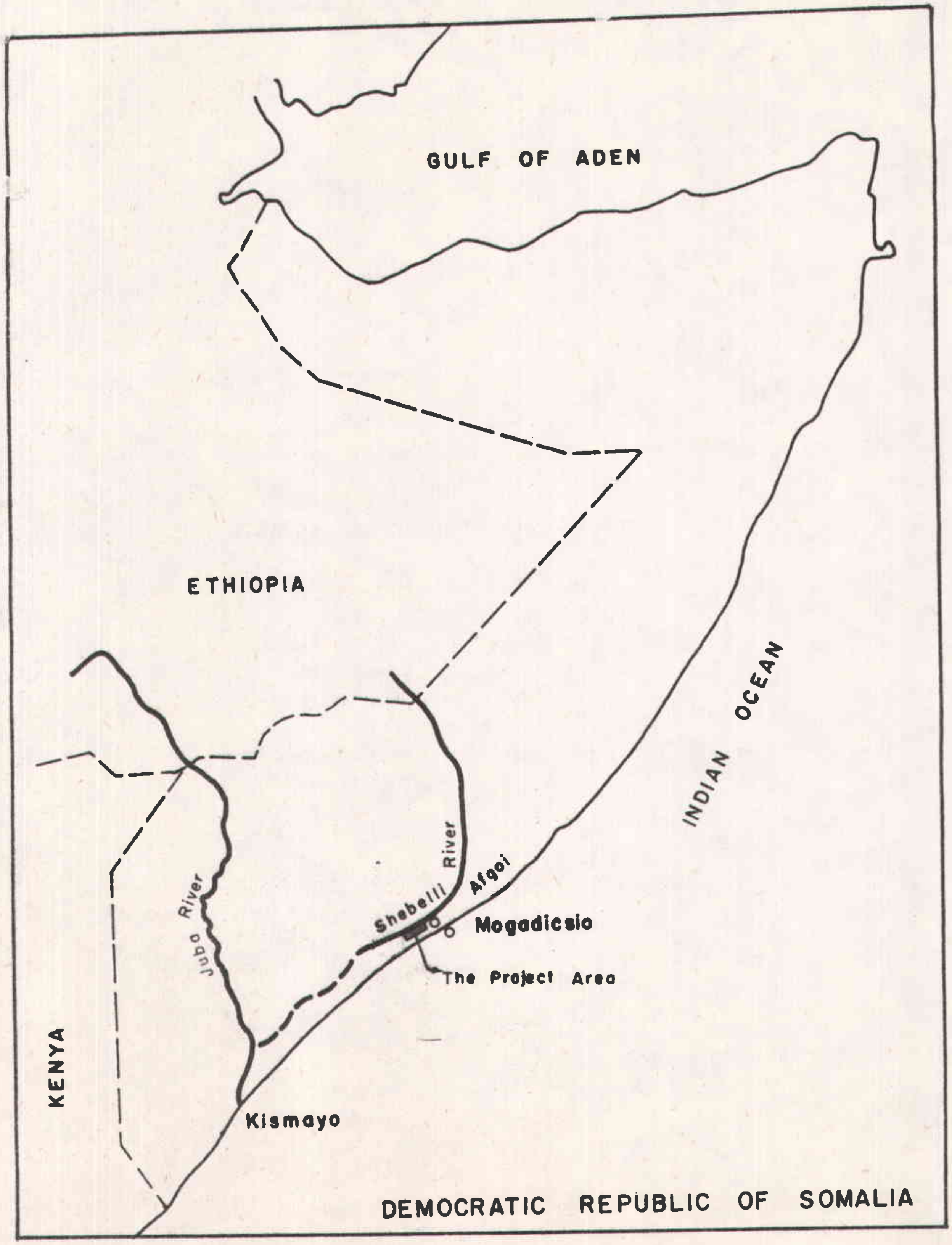
GULF OF ADEN
ETHIOPIA
INDIAN OCEAN
KENYA
Juba River
Shebelli River
Afgoi
Mogadicsio
The Project Area
Kismayo
DEMOCRATIC REPUBLIC OF SOMALIA

FORWARD

In response to the request of H. E. Ahmed Hassan Mousa, Minister of Agriculture, Democratic Republic of Somalia, from the Arab Organization for Agricultural Development (AOAD) to study the possibility of cultivating some ten thousand hectares of rice under controlled irrigation, AOAD formulated in 1978 a team of experts to undertake such a task. The study indicated the possibility to establish a rice farm of about 10,000 ha in the Shabelle valley.

In may 1980, AOAD recruited another team of experts for a more detailed study.

The team paid several visits to agencies related directly or indirectly to the project to look into the feasibility of setting up the project. The team also visited some agricultural development projects such as ; Cotton Irrigation Improvement Project in Balaad, Development of Oilseeds and Beans Production Project at Wanlowin, Chinese Rice Project in Jowhar and Libsoma Project in Afgoi. The team also conducted a series of discussions with experts in the Ministry of Agriculture and reviewed the available studies and plans for the improvement of field crop production.

The team briefed Dr. Mahmoud Nour, Vice-Minister of Agriculture, with the study findings.

The project site is about 43 km south of Mogadishu in Afgoi district. The total project area is about 13,000 ha of which 10,000 ha would be cultivated. It is proposed that this area would be reclaimed within six years and that land cultivation would start in the third year.

The proposed rice-based cropping pattern will include, maize, sesame and cowpeas for green manuring. At full maturity of the project in the seventh year the area would be cultivated with 10,000 ha of rice, 2,500 ha of maize, 2,500 ha of sesame and 5,000 ha of cowpea annually. Excluding cowpea as a green manure crop, cropping intensity would be 1.5 crops per year. Total project water requirement amounts to 105 mcum/year. The Total annual crop output would amount to 40,000 tons of rough rice 10,000 tons of maize and 2,000 tons of sesame.

Infrastructures including roads, offices, stores, workshops, houses and social utilities are proposed. A rice mill with a capacity of 100 tons white rice/24 hours is also proposed.

Total investment costs amount to about So. Sh. 258 million of which 80% is in foreign currency. About 56% of the investment costs are needed in the first two years. Using local prices the investment costs amount to about So. Sh. 286 million.

Annual operating costs at full maturity are about So. Sh. 56.0 million using import prices and about So.Sh.63.6 million using local prices.

Economic return amounts to So. Sh. 90.0 million while financial return amounts to So. Sh. 108 million. Economic rate of return amounts to 9.11%. It reaches 10.67% if the value of by-products is added. Benefit cost ratio is 1.038. Financial rate of return amounts to 9.24% and would increase to 10.65% if value of by-products is added.

The team feels that this project, in addition to other projects included in the Three Years Development Plan. Could contribute to the drive toward national self-sufficiency in cereals and particularly in rice. Moreover , the financial and economic analyses have indicated the viability of the project.

I would like to thank the experts for fullfilling their mission very efficiency. Deep gratitude is due to the Government of Democratic Republic of Somalia, H. E. Ahmed Hassan Mousa - Minister of Agriculture, and Dr. Mahmoud Nour - Vice-Minister of Agriculture for the courtesy and cooperation they extended to the AOAD team during the course of the study. I sincerely hope that this study will effectively contribute to the national development in Democratic Republic of Somalia.

Director General

Dr. Hassan Fahmi Jumah

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S U M M A R Y

SUMMARY

1. The main project goal is to develop an area of about 13,000 hectares for rice production.

2. The project site selected by the Ministry of Agriculture is about 43 km south of Mogadishu. It is located in Afgoi district on the main Afgoi - Merca road between the Mordile and Barrire villages.

3. Total gross area of the project is about 13,000 ha with natural vegetation of open steppe shrub type with low grasses in open areas. Only 15 - 20% of this area is at present cultivated mainly to maize and sesame.

4. Bush clearance, land levelling and suitable irrigation and drainage systems will be constructed according to the following schedule :-

Project Year	1	2	3	4	5	6
Reclaimed area (ha)	-	2900	700	2500	2200	1700
Build up (ha)	-	2900	3600	6100	8300	10000

5. The soil parent material is from the Shabelle alluvium. The soils are brown to dark brown fine textured ranging from clay loam to clay. The reconnaissance soil survey carried out was at the level of one observation pit every 140 hectares. A total of 83 sampling sites and 261 soil samples were taken and analysed at the Central Research Station in Afgoi. The soils in general are non-saline in the top layer with moderately saline sub-soil . The pH values range from 7.4 to 8.2 Calcium carbonate concretions and gypsum are present in

considerable amounts. The soils are poor in available phosphorus, nitrogen and organic matter contents.

6. Total project water requirement will be about 105 mcum/year, 45 mcum in the " Gu " season and 60 mcum in the " Der " season. Six units of pumps will be installed. Each pump has a maximum discharge of 2 cumecs, with about one-meter-diameter delivery pipe. The driving engines are diesel engines 240 hp each. The water distribution system is open unlined canal system. Three orders of canals will delivery the water. The main canal will have a capacity of 12 cumecs and a length of 23.5 km. The minor canals are night storage canals with a total length of 83 km. The laterals are field channels each with a capacity of 7000 cum/8 hours. They will irrigate 42 ha each. The number of laterals is about 275.

7. Surface drainage will be provided. Two types of drains are proposed. Minor drains will follow the minor canals with a total length of 83 km. The main collecting drain will carry the water outside, the project area. The length of the main drain is about 50 km. The total estimated excavation for both canals and drains is estimated at 2,000,000 cum.

8. The proposed rice-based cropping pattern will include maize, sesame and cowpea as follows :-

	Gu Season		Der Season	
	Area	Per Cent	Area	Per cent
Rice	5000	50	5000	50
Maize	2500	25	-	-
Sesame	-	-	2500	25
Cowpea (green manure)	(2500)	(25)	(2500)	(25)
Total	10000	100	10000	100

Excluding cowpea which will be planted as a green manure crops, the cropping intensity will be 1.5 crops per year.

9. Requirements of the major inputs (kg/ha) :

Crop	Seed	Urea	TSP	Stam	Sevin
Rice	100	200	100	10	4
Maize	30	200	100	-	4
Sesame	10	100	50	-	2
Cowpea	30	25	50	-	-

10. Most of the field operations will be mechanized. Thus the project will be supplied with the following agricultural machinery

Item	No. of Units
Tractors	252
Disc plough and harrow	99
Planters	54
Harvestors	34

Trailers	76
Sprayers	19
Weeders	42
Others (levelerrs, ditchers, balers,etc...)	35

11. Total casual labour requirements will be :-

Unskilled labourers	315,000	days/year
Women	610,000	days/year
Children	1,000,000	days/year

12. The project will be organized as a state farm. The over-all management will be established in headquarters centrally located at the project area. The 10,000 hectares will be divided into four production units each composed of two production farms. The production farm will be responsible for farming about 1250 hectares whose cropping pattern will follow the overall plan.

13. The total annual crop output at the full maturity of the project (year 7) will amount to 40,000 tons of rough rice, 10000 tons of maize and 2000 tons of sesame.

14. To transfer the rough rice produced into forms suitable for human consumption , a rice mill with a daily capacity of 100 tons (24 hours) of white rice and brokens and will be established.

15. The produce, white rice, maize and sesame will be delivered at the farm gate to the Governmental Agencies concerned ADC and ENC.

16. Infrastructure will include the following facilities :-

a - Offices : Two types of offices ; the main offices at the headquarters with a total area of 500 sq. m and five field offices 60 sq. m each in the four production units and the pump station.

b - Stores : Storage for all inputs. Storage of the products for one week at most, and rice sheds for 20 day mill output of white rice. Also general stores for spareparts and other items.

c - Workshops : Adequate workshops and sheds for tractors, vehicles and pumps.

d - Housing : Nine senior houses, 21 medium houses, 314 junior houses, 502 labourer houses and bachler quarters.

e - Social utilities : a primary school, a medical dispensary, a mosque, a guest house, a social club and a shopping center. Adequate roads, domestic water supply , electricity and a telecommunications network will also be provided.

17. Two approaches have been used in evaluating the project ; economic analysis and financial analysis, to reflect the view point of the economy and of individuals, respectively.

18. Investment costs amount to about So. Sh. 258 million of which 80% is foreign currency and 20% local currency when using import prices CIF Mogadishu (economic analysis).

About 56% of investment costs are needed in the first two years, mainly for the irrigation network, land reclaimation machinery and a part of the infrastructure. Investment cost per hectare is about $ 4300 or So. Sh. 25,790.

19. Investment costs in the financial analysis using local prices for the assets amount to about So. Sh. 286 million of which about 75% is foreign currency and 25% local currency, investment for hectare being about $ 4,770 or So. Sh. 28,616.

20. Operating costs in economic analysis amount to So. Sh. 56 million at full maturity of the project in year 7. They amount to about So. Sh. 63.6 million when using local prices (financial analysis).

21. Estimated economic returns from the crops produced amount to about So. Sh. 90 million divided into the crops as follows ; So. Sh. 72.0, 8.4 and 9.3 million for rice, sesame and maize, respectively.

Financial returns amount to So. Sh. 108 million divided into ; So. Sh. 92, 6 , and 10 million for rice, sesame and maize, respectively.

If by-products are evaluated they would amount to about So. Sh. 4.6 million.

22. Economic Analysis :

Basic case : Economic rate of return (ERR) = 9.11%
Benefit-cost ratio B/C = 1.038

If value of by-products is added, ERR = 10.67%

Sensitivity analysis :

a - Increasing costs 10% : IRR = 7.72% B/C = 0.999

b - Decreasing benefits 10% : IRR = 7.44

c - Shadowing foreign exchange 50% : IRR = 14.74,
B/C = 1.094

23. <u>Financial analysis</u> :

Financial rate of return (FRR) :

a - Basic case : FRR = 9.24%

b - Adding value of by-products : FRR = 10.65%

Financial situation at project maturity :

a - Gross revenue, without by-products = So. Sh. 108.4 millions

b - Gross revenue, with by products = So. Sh. 113.0 millions

c - Net revenue = So. Sh. 11.5 million in the first case and = So. Sh. 16.1 million in the second case.

CHAPTER 1
MAIN FEATURES
OF THE AGRICULTURAL SECTOR IN SOMALIA

CHAPTER I

MAIN FEATURES

OF THE AGRICULTURAL SECTOR IN SOMALIA

The democratic Republic of Somalia lies in the eastern extremity of the African Continent between latitudes 11° 30' North and 1° 30' South, occupying an area of 63.8 million hectares, with a coastal line stretching for about 3330 kilometers.

The topography varies from a coastal plain which gives way to sparsely wooded savannah to rugged mountains, agricultural plateaus and low lands of varying fertility and rainfall. The main part of Somalia is occupied by a large plateau which is the continuation Southward of the Ethiopian Highlands. The plateau gradually declines towards the Indian Ocean where a broad and thick alluvial stratum covers its coastal stretches.

The population was estimated in the 1975 census at 3.5 million, with a 2.6% annual rate of growth which recently rose to 2.9%. The unreliability of rainfall and water supplies necessitated a nomadic existence except in the areas where perennial rivers flow, surface storage of wells are assured. The agricultural sector represents 80% of the total population the vast majority of which are nomadic and semi-nomadic while 1% are engaged in fisheries and 19% in urban, industry and services.

Agriculture dominates the Somalian economy and seems likely to remain the backbone of the national income for the foreseable future. The total value of agricultural production represents two-thirds of the gross domestic product (GDP), absorbs 80 - 90% of the labour force (1,52 million) and accounts for more than 90% of the present foreign trade earnings, as it is obvious from Table 1-1.

1-1 Rainfall

Rainfall in Somalia has two distinct seasons, the "GU" season which starts in April and extends to June, and the " DER " season starting in September through November. Precipitation is highest in the " GU " season when most of the land is planted with crops.

Light showers can be expected along a narrow coastal belt in the " Hagai" season during July to August. Average annual rainfall shows wide variation over the country from less than 50 mm in the true desert to more than 600 mm in some parts of the inter-river areas.

Timely rainfall can make a significant contribution towards the crop irrigation requirements especially in the Gu-Hagi period.

1-2 Rivers in Somalia

The two rivers penetrating Somalia are the Shabelle and Juba, both originate in the Ethiopian Highlands. The Juba river enters the Indian Ocean at Gobwein about 8 km from Kismayu, while the Shabelle does not reach the sea but is lost in a depression near Haway forming a series of marshes.

The annual flow of the Juba river is 3.4 to 4.0 times

Table 1-1

Composition of Experts-Somalia, 1973 - 1977

(So. Shs. million)

	1973	1974	1975	1976	1977
Livestock	196.7	222.4	382.0	301.9	299.5
Bananas	67.8	79.8	64.3	88.2	53.0
Meat	22.6	35.7	44.1	37.1	32.1
Fish	13.5	15.2	11.6	23.3	21.2
Hides and Skin	13.1	14.1	26.2	44.4	23.6
Myrrh	11.5	10.8	8.0	11.3	11.9
Others	15.4	20.6	21.4	4.1	7.7
	340.6	398.6	557.6	510.3	449.0

Source : Central Statistical Department, State Planning Commission greater than that of the Shabelle. Most of high flows in the two rivers occur in the two distinct seasons, "GU" and " Der", with slightly different duration from the rainy seasons. Low monthly discharges in the Shabelle fall to less than 50 MCM in June-July and December, while from January to Mid-April normally fall to 10 - 20 MCM. Low flow in the Juba river lasts only two months, February and March, falling to 10 - 25 MCM and then rises again in April.

The specific conductivity in the two rivers should be within the tolerance of most crops. When exceptionally low flows occur in the Shabelle in April - May, conductivity over 2,500 micromhos/cm may be expected. In this case the river water is unsuitable for irrigation purposes, but most crops subsist on " GU " season rainfall.

Availability of water rather than land is the constraint determining the scope for irrigation development. To overcome water shortage in the dry seasons, storage reservoirs are either constructed or planned to be implemented on the two rivers, to conserve water during high flows and regulate its release to the rivers during low flows.

The Jowhar off-stream reservoir in the River Shabelle with 200 MCM capacity has been completed. As to Juba river, it is planned to establish the first phase of the Bardhere reservoir during the present T.Y.D.P., to enable, after its full completion, the irrigation of more than 150,000 hectares.

1-3 Land Potentiality :

The present cultivated area in Somalia is estimated at 700,000 hectares. Small rainfed or inundation-irrigated farms are scattered throughout the country comprising about 650,000 ha, while the irrigable land is about 50,000 ha of which 35,000 ha are on the alluvial soil along the Shabelle river and 14,000 ha are on the Juba river.

Various studies pointed to the availability of large areas of potentially productive land ; about 8.2. million ha were assigned as arable land, 30 million ha being suitable for extensive livestock production and 30 million ha as forest and bush.

The area between the two rivers Shabelle and Juba " Interriverine", comprises nearly 25% of the land suitable for cultivation, having rainfall between 400 - 600 mm per annum and offering great opportunities for dry farming and range production lands . The most promising area for expansion in rainfed crop production are the Bidoa-Dinsor area and some parts in the lower Shabelle and Juba valleys.

Some parts in the inter-river area and the remaining southern regions where rainfall annually ranges between 350 - 450 mm could be successfully developed for livestock grazing. At present most of these lands are covered with unproductive bushes.

A recent report by FAO/IBRD has suggested that there is a massive body of exploitable groundwater in the interriverine area, sufficient for low cost irrigation of up to 50,000 ha , but " Hunting" report in 1978* believes this suggestion to be unlikely. Groundwater development must be based on full technical studies of the size of the aquifers and the available potential, otherwise it will lead to depletion of resources, or wasteful expenditure or unproductive development.

In the Shabelle valley abundant irrigable land is available, some 1.2 million ha are being considered for irrigation but the water resources are almost fully used. In the Juba valley the resource base is different, more water being available but irrigable land is limited not exceeding 0.4 million hectares.

The estimated actual and potential areas of irrigated and rainfed farming are as shown in Table 1-2.

1-4 Cropping Patterns

Crop production in Somalia is based on bananas, sugar-cane and seasonal crops such as sorghum, maize and sesame.

Bananas (8000 ha) and sugar-cane (7000 ha) are at present the most important crops in the controlled irrigation areas. Banas exports represent 12% of the total value of experts.

Sorghum and maize are the most essential cereal crops representing about 74% of the total cropped area, sorghum

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* Inter-Riverine Agricultural Study, July 1977 by Hunting Technical Services Limited.

TABLE 1-2*

Actual and Potential Cultivated Area

(000 ha.)

	Actual	Potential
Controlled Irrigation :		
Shabelle River	35	86
Juba River	14	160
North West Region	1	4
	50	250
Uncontrolled Irrigation :		
Flood Irrigation	110	-
Rainfed Irrigation	540	7,950
	700	8,200

* Source : State Planning Commission (T.Y.D.P.)

constitutes 51% and is considered the stable food for the population. Sorghum is grown in drier areas because of its ability to withstand adverse moisture conditions, while maize is cultivated in wetter areas mainly in the south near the coast. Maize yield is higher and has better market value than sorghum but it requires reliable rainfall which is unperdictable in Somalia.

Rice has become an important stable food for the urban population. The rice acreage has increased from 1,000 ha in 1974 to 4,800 ha. in 1979 producing about 7,200 tons of rough rice. It is expected in the newly controlled irrigation areas that rice and maize will be the main grain crops.

Sesame is the most popular and preferable oilseed crop. Its acreage has gradually been increased from 20,000 ha. in 1970 to 92,950 ha. in 1979 representing about 20% of the total cultivated area.

Cropped area of cotton during the 1950's rose to a record of 25,000 ha. but was later on abandoned ; at present it does not exceed 3,200 hectares. It is assumed that cotton will be an important commercial crop, particularly after the full implementation of the Balaad Cotton Irrigation Project.

The area planned to be cultivated in 1980 with seasonal crops in both the " GU " and " Der " seasons " double cropping", the expected average yield per hectare and the estimated total production are shown in Table 1-3.

Low national average of crop yield can be attributed to insufficient water resources, unimproved crop varieties,

TABLE 1-3*

Planned Acreage and Expected Production

For Seasonal Crops in 1980

Crop	Planned Acreage 000 ha.	Expected Yield Tons/ha.	Estimated Production 000 Tons
Sorghum	237.6	0.4	95.0
Maize	109.0	0.8	87.2
Rice	4.9	1.5	7.4
Wheat	2.1	0.5	1.1
Sesame	94.8	0.3	28.4
Groundnut	2.5	0.7	1.7
Cotton	3.2	0.7	2.3
Beans	8.4	0.3	2.5
Vegetables	3.8	5.0	19.1

* Source : Ministry of Agriculture " Planning Section".

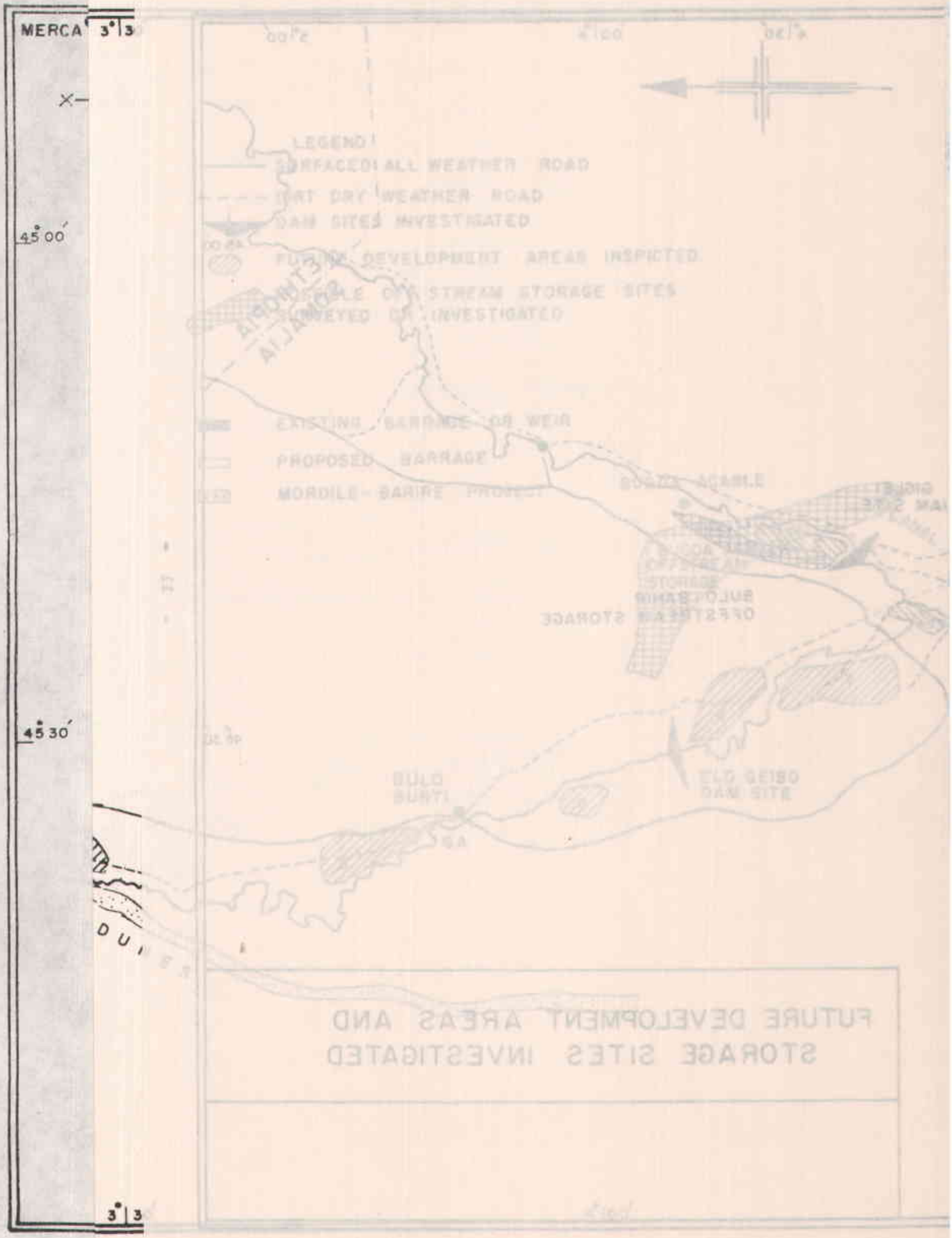
severe bird attacks and shortage in agricultural services.

1.5 Diversification of Agriculture :

In recent years a number of large irrigated schemes involving crop development have been started or in the planning stage. These schemes aim at increasing the controlled irrigation area from 50,000 ha. up to 143.000 ha. of which 88,350 ha. are in the Shabelle valley and 54,560 ha. in the Juba valley to be raised to 150,000 ha. after the construction of the Bardhere reservoir.

In the Shabelle valley, the main area of irrigation is between Jowhar and Flacherio (Map 1-1). Within this stretch there are areas such as Genale and Jowhar where development has been concentrated. Between Jowhar and immediately upstream of Genale the main development projects are, the SNAI Sugar project at Jowhar, the Balaad cotton scheme, the Afgoi-Mordile project and the many small pump schemes. The Genale reach comprises the banana plantations, the Qorioley Project, the Bulo-Mareta Grapefruit plantation and the Genale-Shalambod rice project. The schemes in the reach from Jenale to Haway are the Kurtun-Waarey and Sablaale settlements and the Haway rice project. Down stream from Haway, the river course is lost in the swamps near its junction with the Juba river.

The upper reaches of the Juba have a very narrow flood plain ; the only significant areas of controlled irrigation are the Dujuma settlement and some private schemes. In the lower Juba the flood plain is wider and more land is available for development . The largest schemes proposed for this reach are, the Juba Sugar cane scheme, the State Farms scheme and the Mogambo and Jorda irrigated projects.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LEGEND
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DAM SITES INVESTIGATED
FUTURE DEVELOPMENT AREAS INSPECTED
POSSIBLE OFF STREAM STORAGE SITES SURVEYED OR INVESTIGATED
EXISTING BARRAGE OR WEIR
PROPOSED BARRAGE
MORDILE-BARIRE PROJECT
BUGDA ACABLE
BUGDA OFFSTREAM STORAGE
BULO BANIN OFFSTREAM STORAGE
BULO BURTI
ELO GEIBO DAM SITE
DUNES
FUTURE DEVELOPMENT AREAS AND STORAGE SITES INVESTIGATED

Greater emphasis has been placed on dryland Agriculture which accounts for three-quarters of the present national production of cereals and oilseeds and in which the majority of farmers are engaged.

Among crops which are considered for expansion in these areas are cotton, rice, oiocrops, sugar-cane and grapefruit.

1-6 Self-Sufficiency Policy :

Somalia's annual imports of food amount to more than 25% of the total import value of the country. Maize and sorghum production covers the national needs during the so-called " normal " rainfall years, but in dry years Somalia has to import grains.

It has been estimated that the total supply of cereals amounts to 380,000 tons per annum, of which 250,000 tons, almost entirely maize and sorghum, are produced locally. The difference, about 130,000 tons, has to be made up for by imports, wheat and rice 80,000 tons while 50,000 tons from maize and other cereals.

Table 1-4 shows the annual imports of essential food-stuffs during the period 1974-1978.

The various large schemes in the T.Y.D.P. are expected to produce by 1981 remarkable amounts of different crops. Self-sufficiency in maize, cotton, vegetable oils and fruits is planned to be obtained, while for rice and wheat the plan is to increase their production and reduce imports. In addition to food crops the expansion of export crops such as bananas and grapefruit is likely to continue.

TABLE 1-4 *

Annual Imports of Essential Food Stuffs

(000 tons)

	1974	1975	1976	1977	1978
Wheat Flour	10.0	63.5	42.7	23.9	34.1
Rice	16.9	22.0	18.5	29.3	33.1
Maize	11.0	89.6	88.4	33.6	20.7
Vegetable oils	3.0	8.4	9.5	12.0	14.6
Sugar	11.9	12.4	24.5	23.2	95.0

* Source : A.D.C. for maize and E.N.C. for the rest of foodstuffs.

Similarly, crops which support agro-industries such as cotton and sugar-cane have priority because their production provides industry with the raw material and creates more employment opportunities. Self-reliance on cotton lint could be achieved when the Balaad Cotton Irrigation Project is completely implemented. The Juba Sugar Complex will enable the country by 1981 to stop imports of sugar and may provide a surplus for export.

To obtain high crop yields and be close to self-sufficiency it is of great importance to develop the efficiency of the labour force, provide essential farm inputs, combat bird attacks, adopt modern techniques in research and extension services and consolidate the role of agricultural cooperatives.

<u>Agricultural Services</u> :

Annex 1 explains functions and responsibilities of the bodies and institutions serving the agricultural sector.

CHAPTER 2

SOILS AND LAND RESOURCES

CHAPTER II

SOILS AND LAND RESOURCES

2-1 Selection and Location :

The project area was defined in a brief meeting with his Excellency the Minister of Agriculture and the Director General of Agriculture in Somalia.

The Mordile-Barrire area is a part of a previously identified (80.000 ha) area by HTS, 1977.

The project is situated on the left bank of Shabelle river adjacent to the western side of Lib-Soma project which was earlier identified as Afgoi-Mordile irrigation project. The area is delimated from the north and the west by the unpaved road, Afgoi-Audegli and the Barrire main flood irrigat-ion canal, respectively. The southern border is the paved road Afgoi-Merca on which the project begins at km 43 and ends at km 60 from Mogadishu.

The project lies at latitude 2^{o}N, and longitude 45^{o}E , and at an elevation of 75 to 80 meter above sea level.

2-2 General Description :

The area is a part of the flood plain of the Shabelle river. Its topography is nearly flat to gently undulating. The terrain gently slopes from the river to the Afgoi-Merca paved road. It is flat except when it is intersected by an old channel of natural levee of relatively lower or higher levels.

The soils are in general of clayey texture where rice, maize, and sesame can be cultivated. The soils consist of deep alluvial deposits containing considerable amounts of calcium carbonate and gypsum. The apparent drainage is good, and under-ground water is very deep. The top soil is in general non-saline while the subsoil is saline. The organic matter and nitrogen levels as well as phosphorus are not high.

Irrigation water will be lifted from the Shabelle river and distributed through a built-up canalization system.

The lands are moderately suitable for rainfed agriculture. Flood irrigation practice is more common on the reach adjacent and parallel to the river course.

Reliable supplies of irrigation water with adequate drainage, and good wind-breaks are essential for future controlled irrigation development.

2-3 Climate :

The project area lies just two degrees north of the Equator and consequently is in a zone of considerable atmospheric instability. The variability in the strength and position of the Inter-Tropical Convergent Zone (ITCZ) gives the project area a rather variable climate. A well-defined annual cycle of climatic conditions could be identified ; however this cycle is variable in length and amplitude from one year to another.

In the beginning three and half months of the year, the " Jilal" season, dry strong NE monsoon winds dominate with practically no rainfall.

Around mid April the winds subside and humidity increases with the beginning of the " Gu " rains which are intensified by coastal showers " Hagai" resulting from S and SW monsoon winds which prevail in May.

The S and SW winds finally fade away, with the approach of the ITCZ at the beginning of October when the second rainy season " Der " starts. This " Der " is much less significant than the " GU - Hagai" rainfall and is less reliable (Table 2-1).

In December the dry season starts again as the NE winds re-establish themselves.

The main climatic features are the very consistent temperatures, the uniformly high humidities except in the dry season, and the fairly windy conditions prevailing in most months. The climate is tropical semi-arid and the climatic elements could be summarized as follows :-

1. Rainfall is distributed in two seasons April to June " Gu", and October through November " Der " (Table (2-2).

2. Temperatures remain relatively uniform throughout the year. The hotest periods are February to April, and October to November. The mean maximum and mean minimum temperatures range from 30 to 35 and 21 to 24^{o}C, respectively (Table 2-3).

3. Relative humidity is highest during the rainy seasons

April - June and October-November, and also during the July-August (Hagai) season with monthly means ranging from 65 to 75% (Table 2-4).

4. Recorded wind velocities give monthly averages ranging from 150 to 350 km/day with highest intensity in February - March and July - September.

5. Sunshine average varies from 4 - 5 h/day during rainy seasons to 9 h/day in dry months.

6. Open water evaporation is of the order of 5.5 mm/day during the rainy season and increases to 9 mm/day in the dry months.

2-4 Natural Cover :

Open steppe shrubs are common with Acaccia sp. being the most dominant. Low grasses cover the open area but they are either overgrazed or are being put under rainfed cultivation.

The project area could be classified into the following bush classes :-

1-15-20% of class I.

At present is under cultivation. It contains 4 - 6 trees per hectar.

2-15-20% of Class II.

It was cultivated in the recent past but with considerable. regeneration of shrubs.

3-60-70% of Class III.

Dense patches with open spaces. It includes trees up to 6 meters in height.

2.5 Soils :

2.5.1. Materials and Methods of Study :

The team visited the project area, the Lib-Soma controlled irrigation project, and the Afgoi Research Center. The available reports of different projects in Somalia were reviewed.

The review and discussions with the national specialists in soils and agronomy revealed that the general area Afgoi - Audegli is nearly of the same type of formation, and the project of Lib-Soma is a good example that could be used as a guide for future development.

The visit to Lib-Soma revealed that the soils are of clayey texture where corn and rice are cultivated. Groundnut was excluded from the crop rotation due to the rust disease and heavy soils. The drainage is good and under ground water is fairly deep. Soil salinity hazard is still limited and seemed under control. Irrigation water is drawn from the Shabelle river and is conveyed through a system of canals.

2.5.2. Soil Reconnaissance Survey :

The maps provided by the Ministry of Agriculture were of scale 1:100.000. Topographic maps of suitable scale as well as aerial photographs were not available.

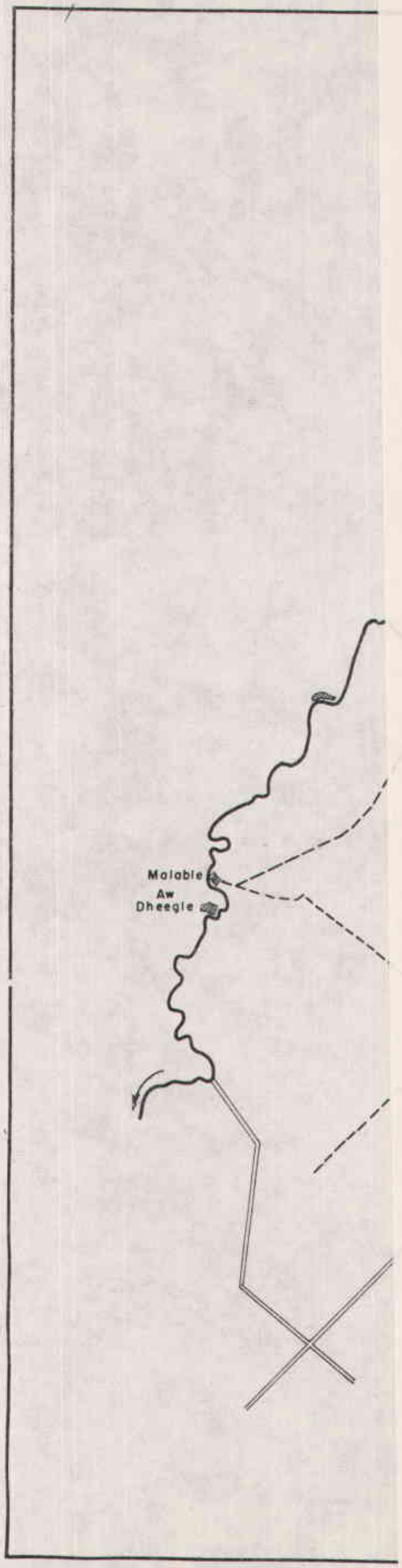
On the basis of the former study carried out in 1978, and with regard to the comments of the Ministry of Agriculture in Somalia more investigations and observations sites were carried out in the project area.

The field work began in June 1980 to the first week of July. The base map used in this study was of scale 1 : 100.000. The project area was covered by eight traverses beginning from the main road Afgoi-Merca northward. Seventy-five auger pits were sited along the field traverses. This represents an approximate density of one site per 140 hectars (Map 2-1).

The profiles were described to a depth of 150 cm., and all sites were sampled. The sites were placed on the basis of field inspection and accumulating new knowledge.

All field observations were recorded during the field work in relation to each sample site. Elevation relative to each other, topographic features as well as the natural cover or agricultural activities and population densities were all taken into consideration.

The soil samples collected during the field work reached 227, and were sent to the Afgoi soil research laboratory for chemical analyses. Due to lack of equipment and shortage of time 26 soil representative samples were sent to Egypt for the estimation of phosphorus, nitrogen, organic matter, and hydraulic conductivity.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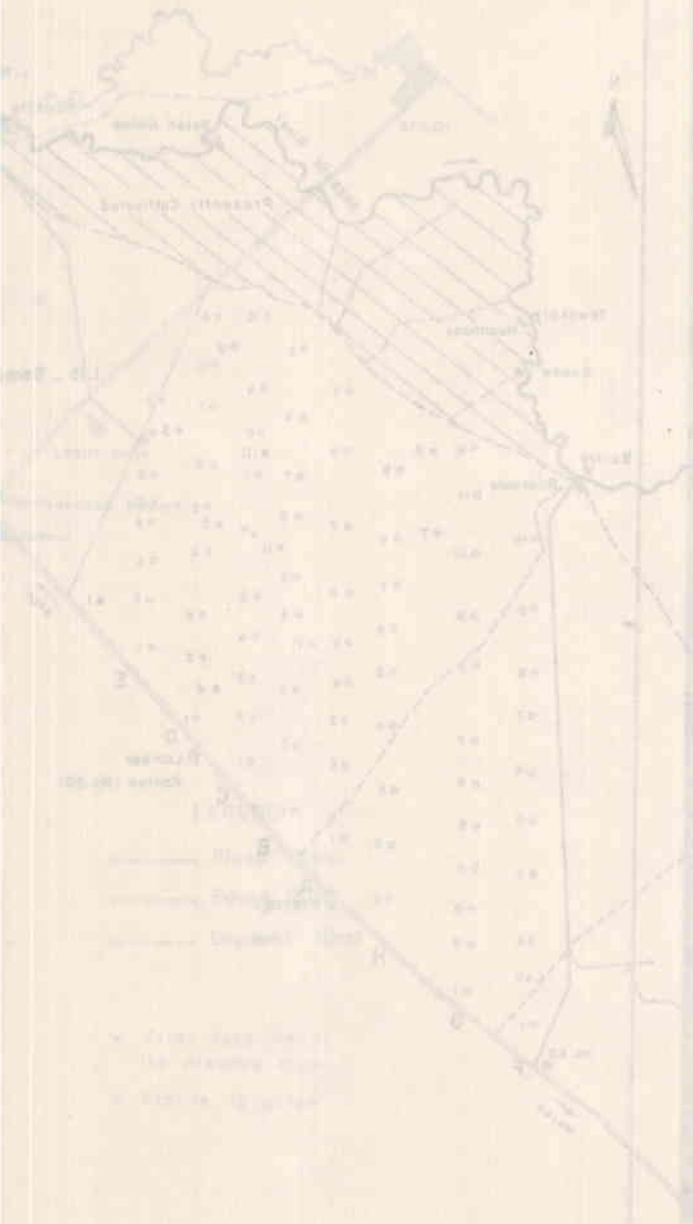


Sample Index Map

2.5.3. Soil Parent Material and Mode of Formation :

The soils are derived from flood deposits of the Shabelle river. The deposits are generally calcareous and predminantly clayey in texture . The profiles are deep and commonly well drained. The terrain in general is level to very gently undulating.

Some Gelgai formation as well as deep wide cracks (features of Vertisols) are common with variable degrees of development. Recent alluvium is confined to the levee of the present course of the river. Semi-recent alluvium deposits overlie the old alluvium of the lands parallel and adjacent (2 - 3 km) to the present river stream. Old alluvium is mainly found in the reaches far from the river (4 - 10 km) and in shallow low-lying areas of the flood plain meander. Reddish brown colours dominate the surface layers especially those of recent alluvium. Dark greyish brown to brown clay of the old alluvium dominates most of the project area.

The most effective factors and processes of soil formation in this area are the tropical semi-arid climate, the five texture of the calcareous parent material, and the relatively level topography. The alternating wet and dry conditions reflected and enhanced the formation of Vertislos on these clayey-textured parent material. It is suggested that these soils within the depth of 150 cm. investigation are despositional rather than pedogenic although some symptoms of pedogenic action have taken place in the downward movement of clay.

The steppe type of vegetation with low shrubs and grasses of light to medium density gave low influence of vegetation on organic residues under these semi-arid conditions.

2.5.4. Soil Properties :

The soils of the project area are formed in deep sediments of calcareous fine texture ranging between clay loam and clay.

The clay fraction is dominantly composed of expanding clay minerals. Self mulching and hard crust formation with deep cracks (more than 50 cm) larger than one centimeter in width and slickenside formation due to alternating wet and dry conditions are factors which made these soils belong to the Vertisols soil group. Slickensides are more developed in the subsoils and in the old alluvium sediments.

The soils are dominantly well drained. Only low lying areas show the tendency of water logging, specially in the existing scattered cultivated areas. This hazard may be due also to the misuse of irrigation water during high river flows, and should not be allowed under better water management in future development. Water rights regulations regarding water use should be enforced to minimize the misuse of the limited water resources and to ensure both water and soil conservation.

Water logging and imperfect drainage are likely to occur on these fine textured soils upon irrigation for annual crop production, especially if rice is to be considered. A drainage system is required to maintain deep drainage and to secure salt leaching. Soil-water relationships should be carefully studied during the detailed soil survey prior to irrigation project development.

Entisols occur as isolated patches or norrow relatively high ridges corresponding to former river levee and have coarse to medium-fine texutred materials.

The surface, generally, consists of a soft mulch or semi-hard to very hard crust. The top soils are commonly salt-free while salt hazards occur in the subsoil with no sodium hazard. Shell fragments are observed on the surface as well as in the different layers.

The soil pH values range from 7.4 to 8.1. Fine calcium carbonate concertions occur throughout the profiles especially in the subsoil and the soil reacts strongly to dilute hydrochloric acid. The calcium carbonate percentage varies from 13.9 to 31.3% being dominated by the 24% range. Fine gypsum crystals are common in subsurface layers and subsoil.

The analysis of the representative soil samples shows that the soils of the project area are poor in the organic matter, available phosphorus and available nitrogen.

The hydraulic conductivity estimated on the disturbed soil samples shows that the permeability of these soils is high.

2.5.5. Soil Classification :

The FAO-UNESCO system of the soil map of the world (UNESCO-Paris, 1974) is applied for soil classification in this report.

Two main soil units are mapped in the project area at this level of reconnaissance survey.

1. Fluvisols which are calcareous and are designated Jc (Entisols).

2. Vertisols which could be pellic Vertisols (VP) or chromic Vertisols (VC) with cromas of less or more than 1.5 throughout the 30 cm, respectively.

The soils are mainly chromic Vertisols and were previously classified as Grumosols of the Goluen soil series (Map 2-2).

2.5.6. <u>Land Suitability Classification</u> :

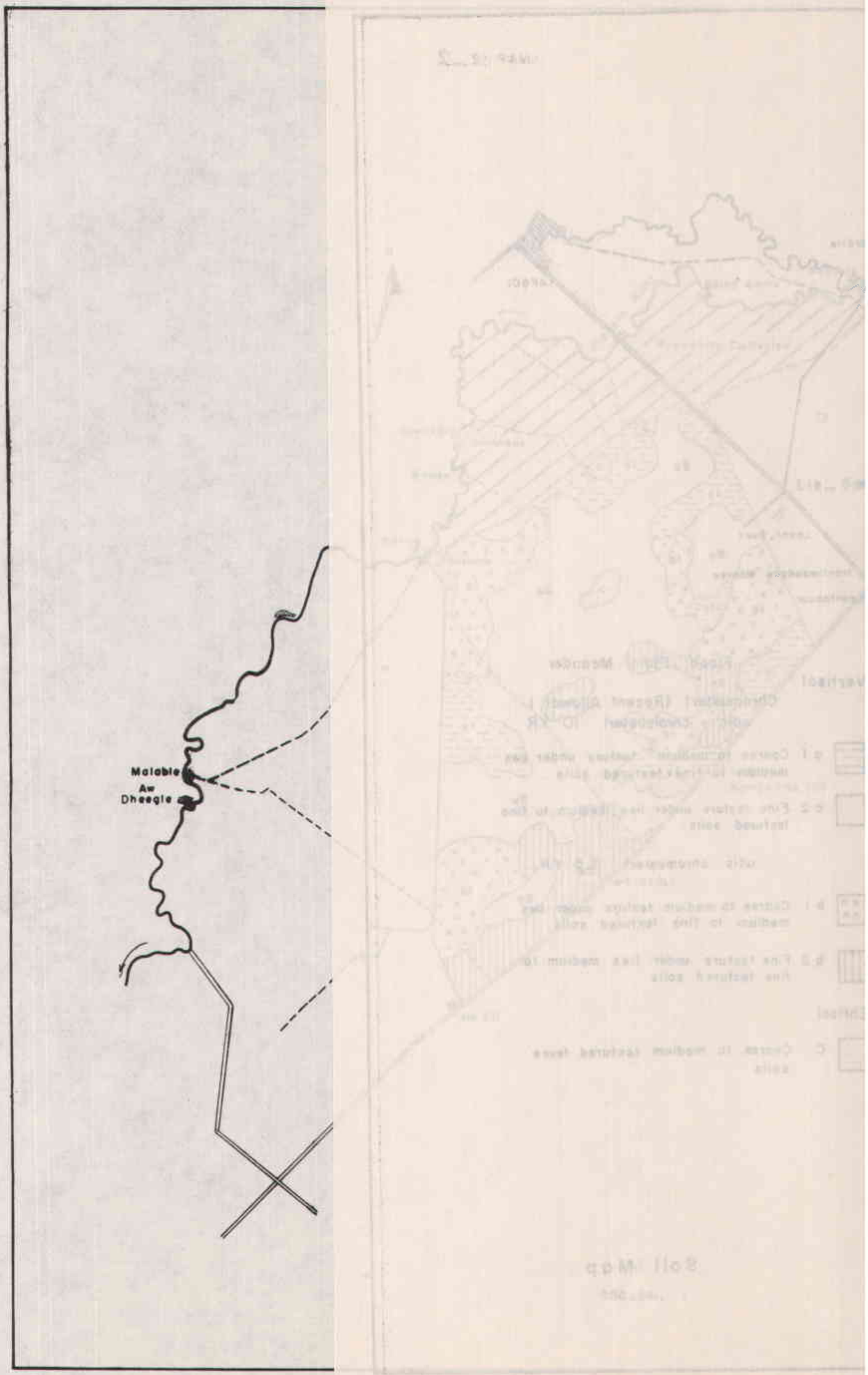
The classification is based mainly on technical considerations, and on the assumption that an adequate irrigation and drainage system can be provided to this area. It also assumes that the irrigation water will be of low salt content. Relief also plays a role in this classification as it is a factor of great importance in preparing the land for irrigated agriculture.

Most of the lands in the project area are either suitable or moderately suitable for production of irrigated crops.

Two soil classes cover the project area decreasingly suitable for irrigation agriculture. Further subdivisions are based on apparent need for levelling and increasing management limitations under irrigation due to soil propoerties.

<u>CLASS II</u> : Soils suitable for irrigated agriculture.

Class IIa : (These lands may be considered a transtional class to class I).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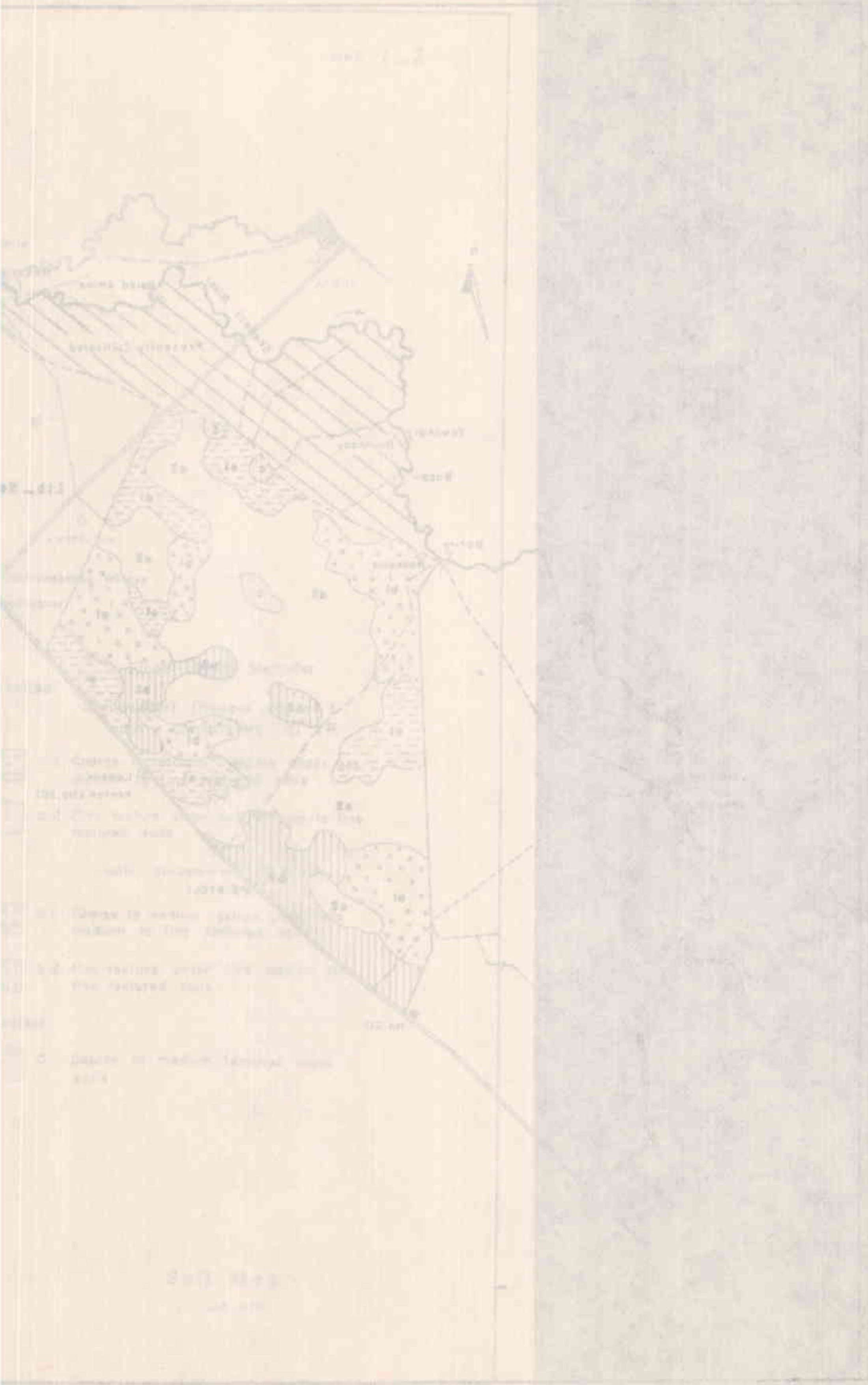
Soil Map

The soil in this subclass are deep and of medium texture. The hydrological profile properties are favourable and the topography is nearly flat. It will be possible to grow a wide variety of crops and the annual return is expected to be high.

Class II b :

These lands are more common on soils formed on recent alluvium. The soils are deep and of either medium or fine texture. The hydrological profile properties are less favourable . Other limitations may also be present, such as salinity of subsoil and/or topography deficiencies.

Class III :

These lands occur on soils derived from old alluvium, deficiencies of both profile properties and drainability are present. Most of these soils suffer from salinity hazard specially in the subsoil. Also, all area subject to flood hazards, water logging (swamps) or poor topography are included in this class (Map 2-3).

Land use classification system for irrigation purposes is used in this report. The proposed system is based on the FAO Soils Bulletin No. 32. Few necessary adjustments were needed to make the a symbols more connotative of the property or the limitation factor.

The following land classification system is adopted :
Seven suitability subclasses are designated by a small letter suffix and a number which represent the critical soil


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property and its degree of severity, respectively.

The suffix letters are connotative of the soil property as follows :-

1. (t) for soil texture of the top soil :

t_1 clay loam, loam.

t_2 clay.

t_3 sand

2. (p) for soil profile depth to gravel, cemeneted or compacted layer or rock.

p_1 the depth is less than 90 cm.

p_2 the depth is less than 60 cm.

p_3 the depth is less than 30 cm.

3. (r) for microrelief :

r_1 variations of less than 50 cm.

r_2 variations up to 100 cm.

r_3 variations of more than 100 cm.

4. (S) for soil salinity :

S_1 slightly saline.

S_2 moderately saline

S_3 Saline or strongly saline.

5. (d) for internal drainability :

d_1 good drainage.

d_2 imperfect drainage.

d_3 free drainage.

6. (e) for erosion :

e_1 slight probability.

e_2 moderate probability.

e_3 high probability.

7. (f) for flood hazards :

f_1 infrequent

f_2 frequent

f_3 every year.

Recommendations

1. A detailed contour map.
2. A detailed soil survey with detailed work on soil-water relationships.
3. Periodic analyses for the water of Shabelle river.
4. A pilot area for the various research activities serving the project requirements.

TABLE 2-1 : Rainfall at selected Stations

Station	Years of record	Mean Rainfall (mm.)				
		Gu season	Der season	Annual	Wettest	Driest
Belet Uen	34	106	85	227	446	44
Bulo Burti	25	144	161	349	711	96
Mahaddei Uen	10	163	192	459	1171	226
Johar	40	206	209	497	1089	236
Balad	25	209	220	507	959	276
Áfgoi	26	237	173	503	975	192
Genale	20	230	112	472	1045	149
Gelib (Alessandra)	20	304	183	586	944	415

Table 2.2 : Mean maximum and minimum monthly and annual rainfall

Afgoi in mm over 31 years

Value	Months												Total of 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	56.1	24.7	15.1	60	83.2	30	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

Table 2-3 : Mean maximum and minimum monthly temperatures

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Belet Uen :												
Maximum	34.5	35.4	36.7	36.9	34.9	34.0	33.0	33.8	35.8	34.4	34.8	34.5
Minimum	22.0	22.0	23.4	23.9	23.4	22.8	22.6	21.6	22.7	22.6	22.3	22.3
Afgoi :												
Maximum	33.7	33.4	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	23.6	22.7	21.5	21.5	21.8	22.1	21.9	21.7
Average	27.3	27.9	28.7	28.7	27.7	26.5	25.5	25.7	26.5	26.9	26.8	27.1
Gelib (Alessandra)												
Maximum	35.1	35.6	36.0	35.5	33.4	32.1	30.5	31.5	32.4	33.1	33.8	34.5
Minimum	22.2	21.8	22.4	23.1	23.0	21.4	20.3	20.3	20.4	21.5	22.1	21.9

Table 2-4 : Monthly mean relative humidity % for selected stations

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
Belet Uen	58	57	57	60	64	61	65	64	59	64	63	62
Afgoi	65	64	66	69	73	75	74	72	69	68	68	68
Gelib	68	67	66	72	78	78	77	75	72	73	76	74

CHAPTER 3

I R R I G A T I O N

CHAPTER 3

IRRIGATION

3.1 Introduction :

The climate of Somalia is tropical and semi-arid to arid with average rainfall varying from 150 mm in the extreme north and increasing southwestwards to 600 mm. This rain extends over two main seasons, the first locally called " Gu" extends over 60 to 70 days (April 0 June) and the second, locally called " Der " extends over 100 days (September to December). The main usually comes in showers. Rainfall intensities in excess of 75 mm per hour is most uncommon.

Very few crops can be sustained entirely by such rainfall. The main rainfed crop is sorghum. Other rainfed crops include sesame, maize, groundnuts and cotton. All other crops need irrigation in addition to rain. The degree of such supplement or irrigation depends on the type of the crop, the duration and growing season. Also better yields are usually expected in most of the rainfed crops if put under irrigation.

The main constraint in irrigation development is the availability of irrigation water. Land is much more abundant than water. The main source of irrigation water in Somalia is the surface water, while ground water is the principal source for domestic and livestockuse. It is also marginally used to supplement seasonally deficient surface water sources. Its low quality, high cost and limited quantity give it a low priority for irrigation development.

The main source of surface water is only the major

Table 3-1 : Salient Point in River Juba & Shabelle Flows (Source - Hts, 1977)

	Shabelle	Juba
Max. annual flow	2740×10^6 M3.	11080×10^6 M3.
Mean annual flow	1800×10^6 M3.	6420×10^6 M3.
Min. annual flow	965×10^6 M3.	2690×10^6 M3.
75% reliable year	1480×10^6 M3.	4900×10^6 M3.

rivers ; the Shabelle and Juba. The Shabelle has two distinct seasonal peaks, the first smaller peak is in May and the second longer and higher peak is in Sept - Nov. ; while high flows in Juba generally occur through 250 - 260 days beginning late April to mid January.

The most salient characturistics of the flows of the two rivers are shown in the following Table 3-1.

As regards land resources it is estimated that there are about 1.25 million hectare of suitable land for irrigation (classes I & III) in Shabelle valley and about 0.4 million hectare in Juba valley. The water available for irrigation is considered to be sufficient to irrigate about 100,000 hectare in the Shabelle valley and about 200,000 hectare in the Juba valley, and as such land will not be a major constraint on future irrigation development.

There are two main distinct systems of irrigation in Somalia ; flood irrigation and controlled irrigation. The flood irrigation is much more limited in extension than the controlled irrigation. Water during the high peaks of the flood is diverted through flood channels into the low areas of the flood plains of the rivers which are then used for cultivation. By this way only one crop could be cultivated each flood season. The extent of flood irrigated area depends on the level and duration of the flood peak. The controlled irrigation on the other hand is of a more permanent and more reliable nature.

Water is diverted through the irrigation canals by pumping or by a structure across the river that builds a water level in the river high enough to admit the water to the canals by gravity. By this method more intensive cultivation can be achieved in all seasons depending on the availability of the water in the river.

It is estimated that there are about 35,000 hectare under controlled irrigation of which 27,000 hectare are on the Shabelle and about 8,000 on the Juba.

3-2 Water Resources :-

The project water requirement will be provided from Shabelle River only. The use of ground water has been eliminated due to its low quality and quantity and its high abstraction cost.

Accordingly this section will concentrate on the hydrology of River Shabelle and its water balance.

The River Shabelle originates from the Ethiopian plateau and 90% of its flow is attributed to that plateau. The length of the River inside the Somalia land is about 1100 km. Its total catchment area is about 300,000 km2.

The flow of the river has two distinct flood seasons. The first season is short less reliable and with relatively less discharges and levels. On the average it starts on the third or fourth week of April and continues for about 70 days. The other seasons is a longer season with more reliable higher discharges. On the average it starts the last week of July and lasts for about 170 days ; more than 70% of the annual flow occurs in this season as gauged at the border station of Belet Weyn.

Table 3-2 shows the monthly discharges of River Shabelle at Belet Weyn in the periods 1950 - 52 and 1954 - 79. Table 3-3 shows the summary of these discharges and table 3-4 shows the river flood periods. These tables show the following :-

a) The maximum discharge ever recorded in River Shabelle is 378.2 cumecs which is equivalent to 32.76 million cubic meters per day.

b) The maximum monthly discharge in the period of record is 278. cumecs equivalent to 24.1 MCM per day .

c) The river may dry up in low years in the period from January through March.

d) the highest yielding year was 1968. The total annual discharge was 3215 MCM.

e) The lowest yielding year was 1955. The total annual discharge was 1017 MCM.

f) The mean annual discharge computed from the mean monthly discharge is 2122 MCM.

h) The 75% reliable year discharge is 1370 MCM. This is the discharge that will be used as reliable discharge for irrigation supply.

3-3 River Shabelle Potentialities :

The 75% reliable amount of Shabelle is calculated as 1370 million cubic meters. Assuming an average irrigation water requirement of 10,000 cubic meters per hectare per

TABLE 3-2 : RIVER SHEBELLI DISCHARGE AT BELET WEYNE STATION

MEAN MONTHLY FLOW IN CUMEES 1951 - 52, 54 - 1979

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1951				161,6	201,7	160,7	24,6	61,9	81,2	72,5	179,2	97,2
1952	10,40	8,0	8,0	8,0	87,3	23,6	10,0	26,90	125,9	84,5	41,9	8,80
1953												
1954	10,00	10,00	10,00	89,0	59,2	25,6	6,6	102,3	153,0	190,6	76,8	34,9
1955	8,0	7,5	9,0	9,5	44,1	13,6	7,5	22,9	77,7	135,9	42,5	8,5
1956	8,0	7,5	9,5	33,2	195,4	29,2	25,3	98,8	151,2	142,7	185,6	29,4
1957	11,39	8,2	20,3	59,7	184,9	106,3	51,8	124,5	130,0	52,7	56,4	42,1
1958	9,6	8,0	44,6	20,6	63,1	10,9	13,7	117,6	160,9	170,4	81,6	17,0
1959	8,90	8,2	7,5	7,5	73,6	22,0	12,0	76,8	142,7	122,7	111,7	22,2
1960		24,2	9,0	19,6	65,8	38,8	16,6	41,3	87,9			
1961	10,5	10,5	7,8	9,3	52,6	14,5	46,3		184,1	190,5	191,0	211,7
1962	15,19	7,11	7,16	13,6	58,9	17,5	8,7	30,9	75,7	88,4	157,0	75,1
1963	22,98	9,28	4,46	60,6	234,8	125,3	63,0	108,1	158,3	99,5	54,9	79,5
1964	39,3	15,0	6,6	23,3	32,4	16,16	23,7	122,7	158,5	156,9	97,3	29,5
1965	50,43	13,5	5,2	8,7	45,8	10,7	3,8	30,95	70,6	85,16	93,97	9,0
1966	1,3	6,1	28,3	40,0	89,2	38,6	38,2	77,9	125,8	101,0	62,3	8,8
1967	2,04	1,97	1,66	47,35	124,6	54,1	28,5	113,4	173,6	191,7	139,1	
1968	25,79	12,86	74,67	93,60	279,0	135,68	87,70	127,79	143,20	117,43	60,01	59,16
1969	20,07	24,05	117,31	103,06	139,61	45,86	61,77	133,71	155,92	83,23	42,46	13,66
1970	7,5	24,02	65,8	104,05	162,03	27,80	25,29	124,16	218,07	172,74	95,78	15,63
1971	8,49	5,70	4,50	50,65	93,51	46,98	81,86	104,66	143,35	105,40	74,88	31,80
1972	101,4	21,65	15,00	51,94	173,64	65,40	83,06	47,89	144,39	111,36	71,58	17,86
1973	7,36	4,51	3,01	6,75	58,19	24,10	27,71	90,14	127,19	100,42	25,87	4,58
1974	0,96			69,6	62,11	70,22	75,33	106,14	131,73	78,52	19,00	5,51
1975	2,93			51,04	78,98	43,30	64,72	126,96	208,71	125,98	33,74	7,99
1976				87,68	179,33	162,63	76,0					
1977				101,37	197,53	63,00	78,66	139,30	147,17	164,96	248,32	129,76
1978	27,00	11,40	82,83	49,39	86,72	30,78	64,50	137,50	194,13	158,76	110,27	28,17
1979	19,70	65,70	51,40	75,98	83,11	104,40	64,02	111,07	71,62	82,25	52,6	
Max.	82,4	213,0	130,0	200,00	379,2	259,6	119,8	205,0	227,8	219,0	326,7	211,7
Mean	17,57	13,73	25,81	52,02	114,54	54,53	42,14	92,55	138,61	122,55	92,53	41,18
Min.	0,00	1,32	1,75	0,00	6,50	2,50	1,95	2,50	55,00	29,80	7,90	1,40
75%	8,0	7,50	7,16	13,60	62,11	23,60	16,60	77,90	130,00	88,4	60,01	19,65

Table 3-3 : River Shabelle Summary of Discharges (1951-1979)

MCM/ Month at Belet Weyn

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Year
Highest Year (1968)	69	31	200	251	474	352	235	342	371	304	155	158	3215
Mean Year (Computed)	47	33	69	135	307	141	113	248	359	328	214	128	2122
Lowest Year (1955)	21	18	24	25	118	32	20	61	201	364	110	23	1017
75% valiable Year (Computed)	21.4	18.2	19.2	35.4	116.5	61.2	44.3	208.6	336.8	236.8	168.3	52.7	1369.5

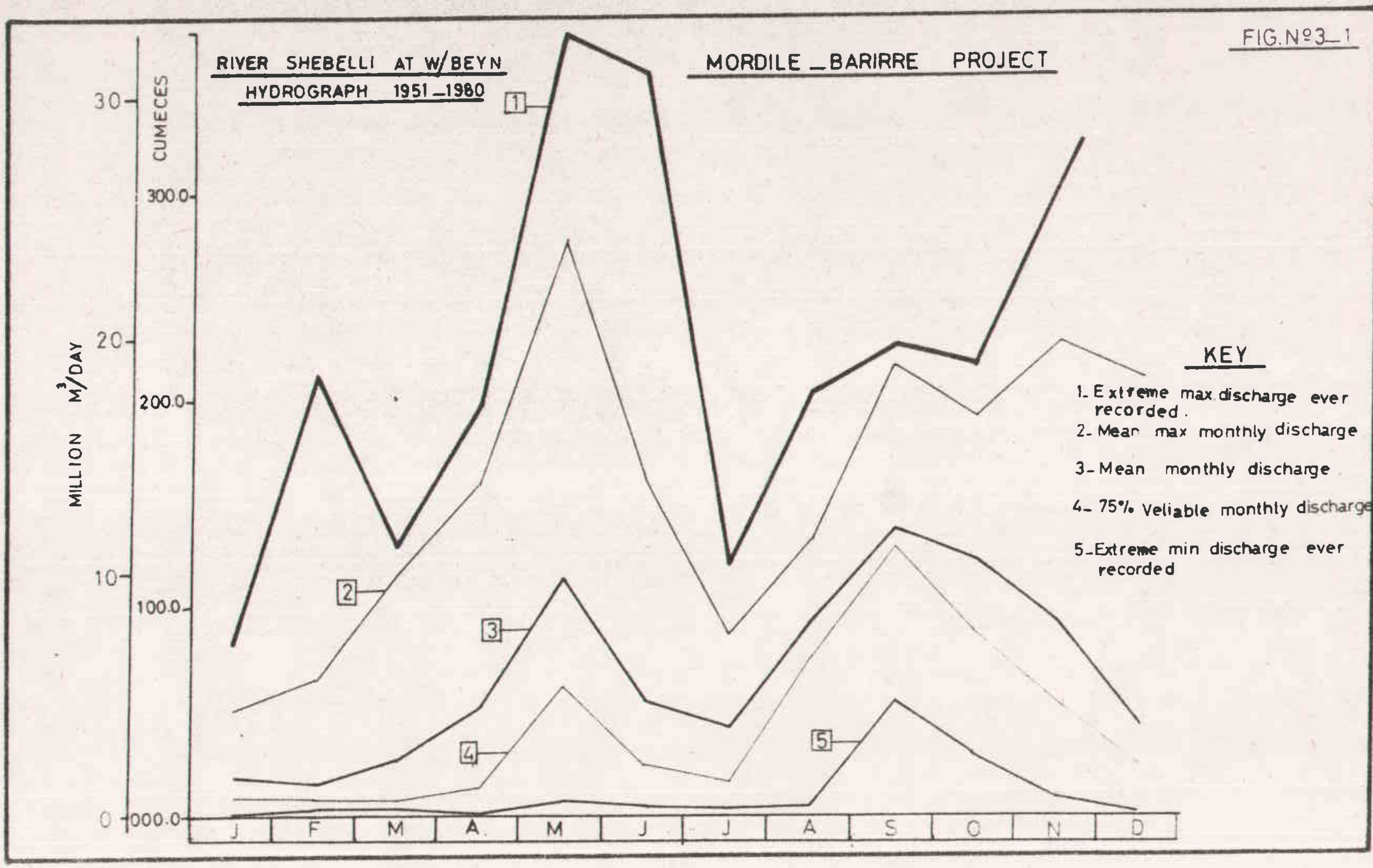
Table 3.4

River Shabelle Flood Periods

		Gu	Der
Start	1 Year in 4	4th April	12th July
	Average	18th April	24th July
	75% reliable	2nd May	5th August
Duration			
	1 Year in 4	90 - 95 days	180 - 185 days
	average	70 days	155 - 160 days
	75% reliable	45 - 50 days	130 - 135 days

Sources : H.T.S. 1977 from IRAS

FIG.Nº3_1


RIVER SHEBELLI AT W/BEYN
HYDROGRAPH 1951_1980
MORDILE _ BARIRRE PROJECT
MILLION M^3/DAY
CUMECES
0
10
20
30
000.0
100.0
200.0
300.0
J
F
M
A
M
J
J
A
S
O
N
D
1
2
3
4
5
KEY
1. Extreme max discharge ever recorded.
2. Mean max monthly discharge
3. Mean monthly discharge
4. 75% Veliable monthly discharge
5. Extreme min discharge ever recorded

year which is the amount calculated for this project. The full flow, if fully utilized, will irrigate about 130,000 ha. Unfortunately this is not possible. The river flow has to be fully regulated in order to store the flood water to be distributed according to the requirement. There are no storage sites to accommodate this full discharge.

Recently an off-stream storage reservoir has been constructed in Jawhar up-stream of the project area. This reservoir has a capacity of 200 million cubic meters. It has now been tried and commissioned. It has not yet been fully operational. The seepage and evaporation losses from this reservoir is estimated as 10 million M3/month. It is designed to release downstream into the river according to the irrigation requirement. It releases during the low flows from January through April and fills in May and releases again in June and July. This reservoir will be a major step toward the regulation of the river flow and is expected to solve an acute shortage of water in the low flow stream.

It is estimated that if the cropping pattern is intensified in " Der " season when there is high enough flow in the river, it would be possible to irrigate up to 88,000 ha in Shabelle.

3-4 Project Water Requirement :

Table 3-5 shows the total project water requirement calculated at 50% irrigation efficiency. The projects total annual requirement is 105 X 10^6 M3. In total there will be no problem to supplying this amount but the problem is in the dry months of April, June, July and December. The present water situation is shown in table 3-6. It clearly shows

Table 3-5 : Project Irrigation Water requirements and pumping required

Details	A	M	J	J	A	S	O	N	D	Year
Rice (10000/ha)	5.0	10.0	10.0	10.0	-	10.0	15.0	15.0	10	85.0
Maize (2500/ha)	2.5	2.5	2.5	-	-	-	-	-	-	7.5
Sesame (2500 / ha)							2.5	2.5	2.5	7.5
Cow pea (5000 /ha)		2.5						2.5		5.0
Total Project Water requirement (MCM)	7.5	15.0	12.5	10.0	-	10.0	17.5	20.0	12.5	105.0
Total pumping unit hours (each unit 2)	1044	2154	1740	1432	-	1386	2864	2430	1798	14848
Average working unit hours/day	34.8	69.5	58	46.2	-	46.2	92.4	81	58	-
No. of Units required	3	5	4	3	-	6	6	6	4	-
No. of working hours required/Day	11.6	13.9	14.5	15.4	-	15.4	15.4	13.5	14.5	-

FIG Nº 3 _ 2

MORDILE _ BARIRRE PROJECT

RIVER SHEBLLI AT B/WEYR

75 % REBABALE FLOW & PROJECT REGVIRMENT

HISTOGRAPH

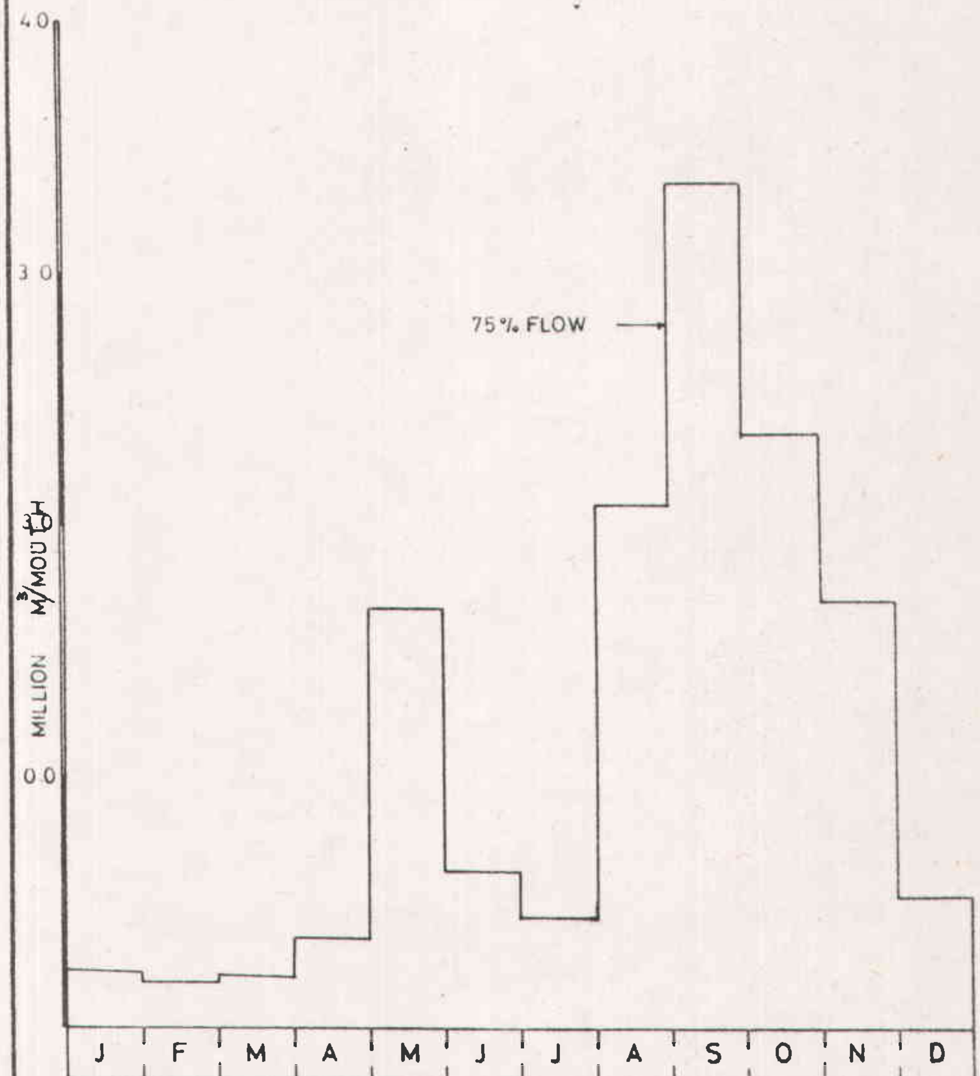


Table 3-6 : Present Riiver Shabelle Water Balance

MCM/ Month

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Present Irrigation Requirement 27000 Ha (1)	56	44	51	33	44	59	55	44	57	63	65	61	630
75% reliable Riverflow at Balet Weyn (2)	21	18	19	36	166	61	44	209	337	237	168	53	1369
The Balance)3)	-35	-22	-32	+4	+122	+2	-11	+165	+280	+164	+103	-8	+739

(1) Source : HT. S IRAS

(2) Source : Basic data supplied by Hydrological Section of the Ministry of Agriculture

(3) - ve means deficite i.e. the project is taken less than their requirements

+ ve means surplus.

that there is a constraint in April and June and there is a shortage in July and December. But it is expected with the full operation and good management of Jowhar off-stream reservoir this deficit can be reduced and it will be possible to satisfy the water requirement of the project. But it must be noted that this will be at the expense of other proposed projects. Water allocation should be given in low flow period according to project priorities. If this project is given a high priority the water can be satisfied.

This leads to a very important issue of water allocation. Up to now there is no water authority in Somalia to approve water allocation to the different projects. With the acute shortage of water in the rivers during the low flow period, the establishment of such an authority is overdue.

It is strongly recommended to establish a water authority to approve any further allocation of water according to the specific crop pattern of each project. Any changes in the crop pattern or its water requirement has to be approved by this authority. This authority will also undertake the survey work of the present water abstraction, legalize it and keep record of it.

3.5 Further Irrigation Development :

Table 3-7 shows the proposed irrigation development in river Shabelle. Such further development of controlled irrigation depends on further regulations work to improve the natural distribution of reliable river flow.

A second off-stream reservoir has been proposed above Jowhar to store water spilled by Duduble flood relief channel.

Preliminary studies (HTS - IRAS) indicate a capacity of 200×10^6 M3.

Another margin of water saving is by the improvement of field irrigation management. The current estimate of the overall irrigation efficiency is about 45%. It could be easily raised to 55%. This will have a saving of more than 18% of the current water use.

The reuse of the drainage water is another way of reducing water shortage. More studies are needed in this respect, specially in draining back into the river.

3-6 Generation of the Water Level at the Pump Sites :

There is no water level gauge at the proposed site at El Sheikh Mukhtar. The nearest upstream water level gauge is at Afgoi and the nearest downstream water level gauge is at Audeglei. Taking the levels at these two stations, monthly mean water level and maximum and minimum level were generated at El Sheikh Mukhtar. As there are no falls or cataracts in the reach between Afgoi and Audeglei it is assumed that on the basis of monthly means the water level in the river will have one gentle continuous slope. It is assumed that this is also valid in the maximum and minimum levels.

The distances between Afgoi and El Sheikh Mukhtar and between El Sheikh Mukhtar and Audeglei are measured along the river channel. They are found to be 34 and 36 km. respectively.

Accordingly the following equation has been dervied

KH - 0.51 Af + 0.49 Au

Where :

KH = Generated level at El Sheikh Mukhtar

Af = Mean monthly level at Afgoi

Au = " " " " Audeglei

from the monthly water level maximum and minimum water levels at Afgoi and Audeglei provided by the Hydrology section of the Ministry of Agriculture the table 3-8 has been prepared.

3-7 The Pumping Station :

As stated previously the whole of the project irrigation water requirement will be abstracted from River Shabelle.

After a general reconnaissance of the river reach at the project site. El Sheikh Mukhtar village has been selected as the point of abstraction from the river. It is recommended for the following reasons :

1. It is the nearest point along the river to the project starting point which command all of the project area.

2. It has a good definite section with steep banks.

3. It has a deep channel which will provide enough water depth as long as there is flow in the river.

Alternative ways of abstraction have been considered. The first one is by constructing a barrage across the river to raise the water level in the river to enable the water to flow at all times into the canalization system by gravity.

Table 3.7 : Present and proposed Shabelle River Water Utilization

MCM / Month

Project	net area Ha	J	F	M	A	M	J	J	A	S	O	N	D	Year
Smell Schemes (Jowhar)	1250	0.68	-	-	0.08	1.2	3.3	2.6	1.2	3.0	2.9	3.3	2.4	21
Jowhar Sugar Estate	8300	36	30	37	23	24	27	26	30	34	24	26	33	350
Balad Scheme	10000	12	-	-	-	2.3	7.9	7.1	3.6	19	25	27	21	120
Smell schemes (Balad Audeglic)	8900	7.1	2.8	3.2	1.7	6.4	14	11	5.1	8.5	15	19	14	110
Afgoi - Mordile	4000	-	-	-	0.51	4.4	8.6	7.3	2.4	3.0	4.0	3.2	1.1	35
Genale - Bulo Mererta	31500	28	21	24	15	29	32	26	24	59	81	73	58	470
Kurlun Waary Settlement (1)	9200	2.5	-	-	-	5.6	7.8	5.1	3.1	15	23	22	15	99
Sablaala Settlement	10200	3.0	-	-	-	2.7	9.0	6.7	8.4	21	25	29	16	120
Avai	5000	-	-	-	-	0.89	5.2	5.1	8.1	19	19	16	5.9	79
Whole River	88350	90	54	64	40	76	120	97	86	180	220	220	170	1400
75% reliable Riverflow		21	18	19	36	166	61	44	209	337	237	168	53	1369
The Balance		-69	-36	-45	-4	+90	-59	-53	+123	+157	+17	-51	-117	-

(1) The settlement schemes have been reduced to a total of 6000 ha instead of the proposed 19400 ha new project may introduced in their place.

(2) Source of all the project information and their water requirement is HTS IRAS 1977.

The other alternative is by pumping from the natural river level into the canalization, system.

The first alternative is similar in initial capital cost to the second alternative but its annual operation cost is much less. In addition to that it could include a birdge for easy accessability to the other bank. But due to the land topography of the river bank in that reach this alternative is not practical. The river banks are at the level of 79 M. AMSL, while the full supply level in the head of the main canal is 81 M. A.M.S.L. So to build a barrage to that level means the full flooding of the banks for a depth of two meters for the whole of the agriculture resources. Also most of the project area will be under water for the whole of the seasons. To prevent this, river banks should be raised to above that level for more than 25 km. to reach. Bank level of 81 A.M.S.L. This will make it economically inviable.

A pumping station with a gated flood channel has been considered in order to reduce the pumping cost during the flood season where some of the water can be admited to the system by gravity, but as the flood is less than the highest full supply level in the main canal even this combination is not possible. Full pumping in all the seasons is the best possible alternative.

Considering the maximum discharge required and the heads, two possible types of pumps have been investigated conventional Vertical Shaft mixed flow type or inclined flood lifter type. The first type is cheaper but requires much more civil work structure. The second one is more expensive but requires very simple structure. In total the initial cost of the second alternative is less and also the operation cost is less. It provides better accessability for maintenance and repair. It is also more flexible in moving or resetting. For all these reasons inclined axial pumps are recommended.

Regarding the positioning of the pumps in the river bank, two options were considered ; either to excavate an inlet channel and install the pumps at the end of the channel. The water will then be pumped from the channel. This will be a safe guard against bank erosion, but this inlet channel is expected to be silted in one or two seasons.

Its clearance will be a problem in addition to operation cost. The other option is installing the pump directly on the river banks. This is a better option but needs protection against bank erosion. The second option is recommended.

The proposed scouring protection measures are :-

i - construction of a toe wall of steel sheet piles to stablise the sloping banks of the river.

ii - The slope of the bank where the shaft is placed should be very gentle.

iii- Stone pitching should cover the entire sloping banks and extend to both ends far up stream and down stream the pumping station.

In addition to that it is important to carry regular inspection for scour and appropriate action of remedy should

Table 3.8 : Syntically generated water level at Pump Site at El Shiekh Mukhtar .

Month	J	F	M	A	M	J	J	A	S	O	N	D
Monthly mean	75.71	75.27	75.48	76.38	77.73	76.88	76.15	77.71	78.64	78.34	77.94	76.89
Max. expected	78.47	78.86	78.77	79.34	79.42	79.72	79.15	79.57	79.57	79.38	79.55	79.04
Min. expected	74.45	74.14	74.23	74.32	75.07	74.85	74.69	74.52	76.55	76.18	75.03	74.67

∴ max. expected level at pump site is 79.72 m A. M. S. L.
min. max expected level at pump site is 78.47 m.
min. expected level at pump site is 74.14 m.
max. min expected level at pump site is 76.55 m.

be taken immediately.

According to the project irrigation water requirement (Table 3-3) the peak demand is 20 million cubic meters per month in October. This means that the pumps should be designed to deliver this peak discharge. Assuming that the normal pumping period is 16 hours/day, the maximum required discharge is 11.6 M3/sec.

It is proposed to have six units of pumps, each with a capacity of 2 M3/Sec. The stand-by will not be an additional pump but additional working hours per day. According to the generated levels at the pumps site the minimum expected water level is 74 M. A.M.S.L. and as the main canal maximum full supply level is 81 M. A.M.S.L. the total head is 7 M.

The driving engines are Diesel engines with a power of 240 HP each considering the efficiency of the pump as 0.80.

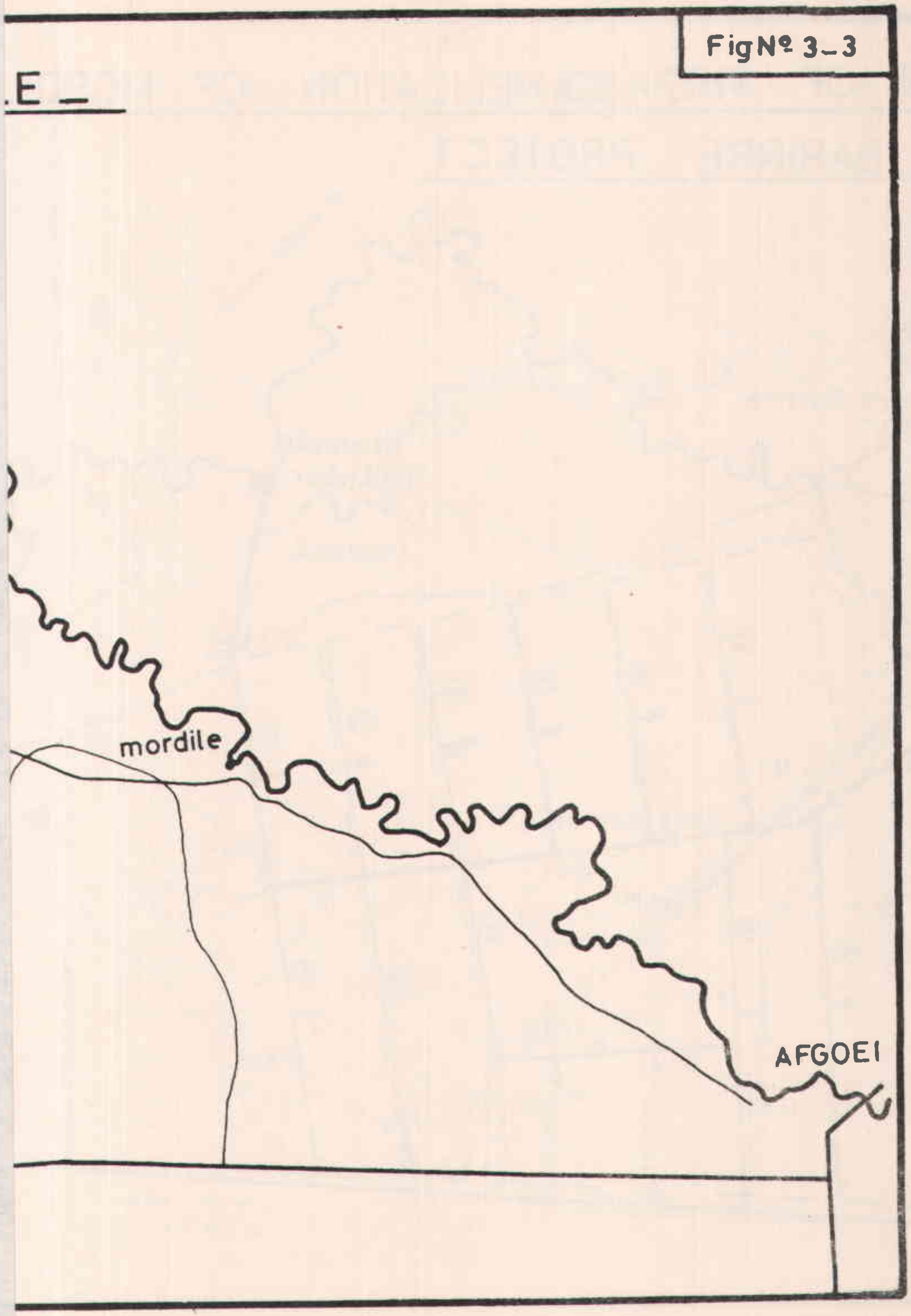
The estimated cost of the pump plant kncludes the supply of the pumps, delivery to the site erection, testing, commissioning and providing of an expert to supervise the operation and train the local staff for 12 months.

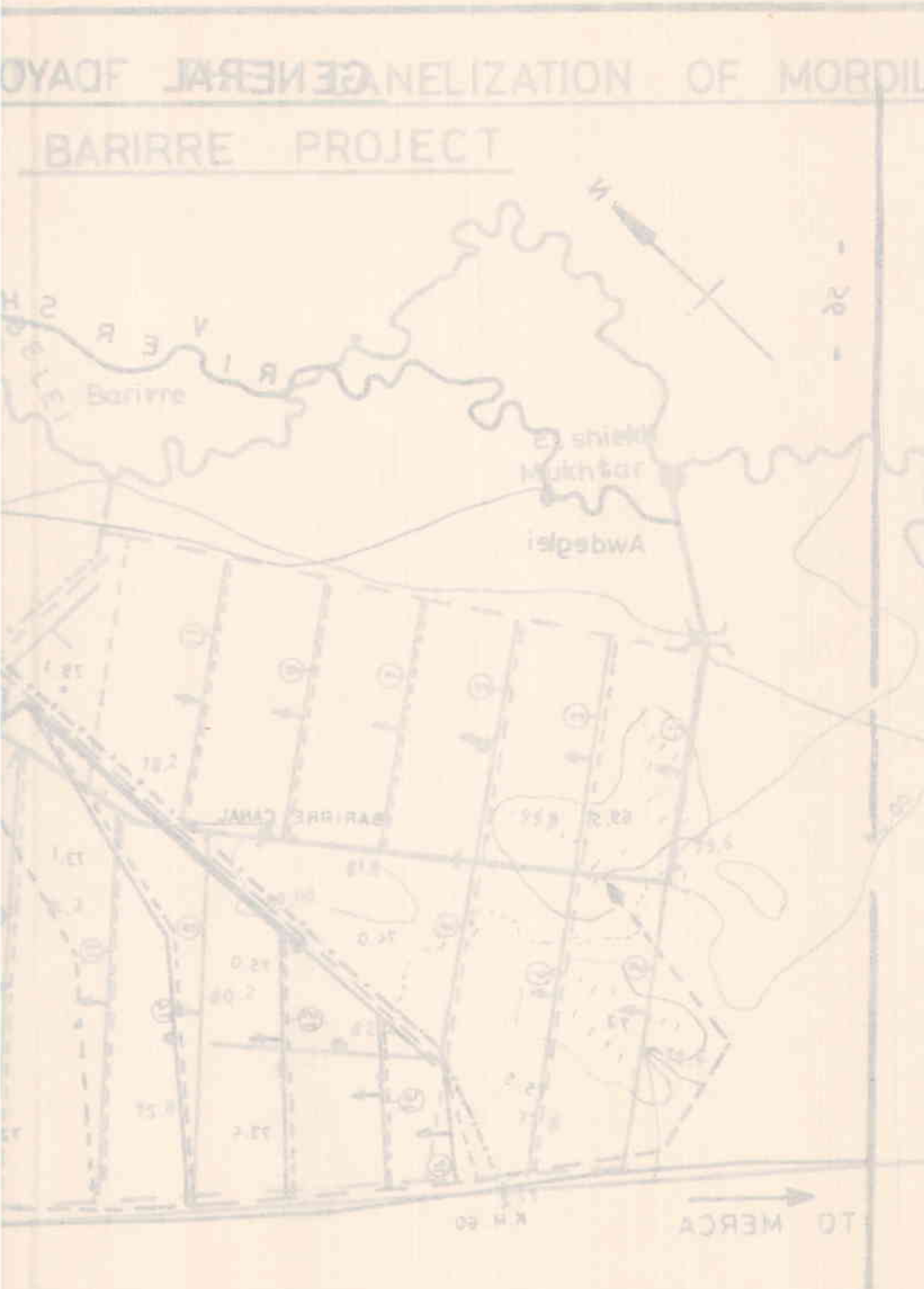
3.8 THE CANALIZATION SYSTEM :

The proposed system is an open earth canal system, the system will receive the water from the pumping station into its main canal. The main canal will distribute the water into the minor canals, then the minor canals will feed the laterals and from the laterals the water goes into the field. After the pump station the water in the canalization system

Fig Nº 3-3

.E _





BARIRRE PROJECT
Barirre
Mukhtar
BARIRRE CANAL

will flow by gravity . Due to the clay nature of the soil being of relatively low permeability no canal lining is proposed. It is proposed that the canalization system be designed as night storage system. This system will encounter the difficulty in watering the field during the night. The field watering will be in the eight hours of the day, but to reduce the pumping capacities it is proposed that the pumps operate for 16 hours in two shifts each for 8 hours. The water pumped during the night will be stored in the minor canals hence banks of the minor canals are to be designed to accomodate this water. During the day the field will receive its water from this stored water in addition to the water being pumped during that day. This system will reduce the cost of both the pumping and the canalization earthwork, and to some extent solve the problem of the shortage of the water in the river.

Consideration has been given to the installation of automatic water control system in the canals, but the manual system is found to be more advantageous in this project. It is cheaper, more reliable and easier to operate and maintain. Water control observers will be stationed and living at the key points in the system to observe, operate and maintain the water level and flow in the system according to the requirements.

3-8-1. The Main Canal :

The proposed project main canal will start from the discharge basin of the pumping station at El Sheick Mukhtar. Then it will go southeastward for 6 km. then it will follow the ridge southwestward for another 10.5 km. to the far west end of the project (near Barrire canal). Then the main canal will go south-west-ward to feed the last three minor canals west of the project.

In the first reach of the main canal, km 0.0 to km. 6.0 the land slope is in the opposite direction of the canal bed slope, km. 6 is at contour 80 M. while km. 0.0 is at a level of about 79 M. A.M.S.L. In this reach, the main canal will be on selected compaced fill. The height of the fill at km. 0.0. may be about 2.0 M. above the ground level and the fill will end gradually at km. 6 giving the canal a slope of 15 cm/km. In the second two reaches of the canal from km/ 6 to km. 23.5 (the tail of the canal), it will be excavated in cut.

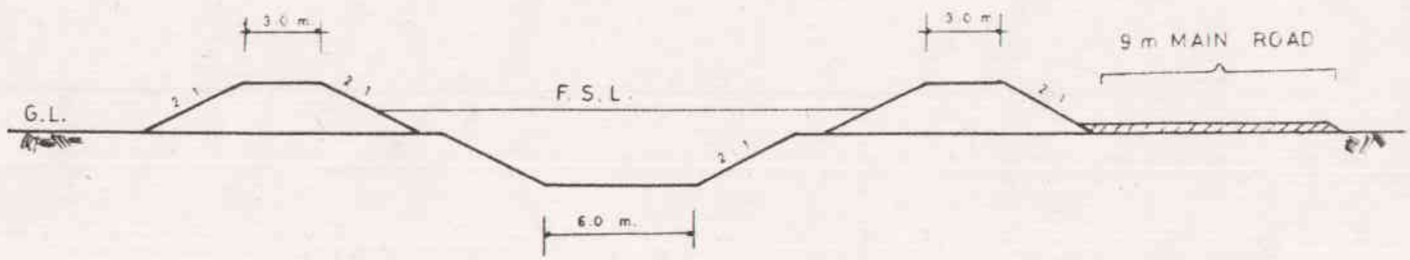
The main canal is to be designed to carry the full maximum discharge of the pumps which is estimated as 12 cumces. The capacity of the main canal will be gradually reduced as it distributes the water into the minor canals.

To command all the minor canals the designed full supply level in the main canal will not be less than 0.8 m. but it should not exceed 1.5 m. above the ground level except in the fill reach it should not exceed 0.8 m. above the bed level.

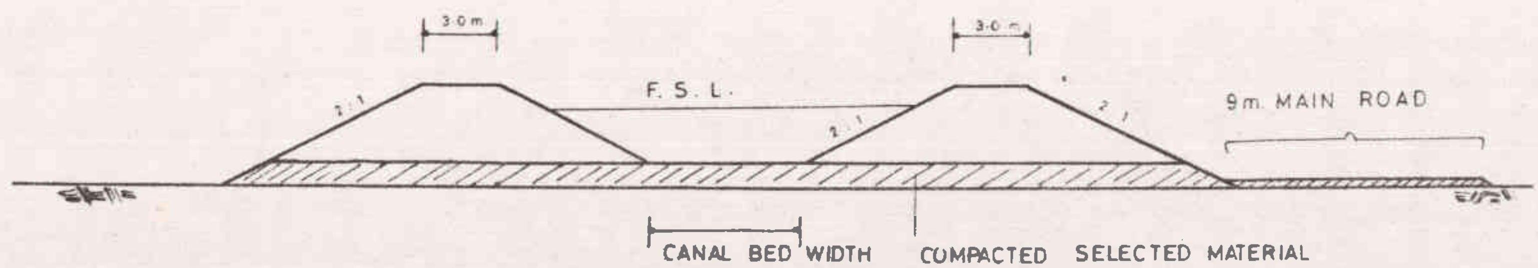
To maintain the above condition and design criteria many control regulating structures will be constructed across the main canal. It is proposed to use the Roller Sluice Gates System. It is simple, easy to operate and maintain and with reliable and durable discharge calibration. Those regulaters will be designed with heavy traffic bridges to have easy accessability within the project. It is estimated that the main canal will have about 6 of those regulators, the size of each will depend on the designed downstream require flow.

FIG Nº 3-4

MORDILE — BARIRRE PROJECT



TYPICAL MAIN CANAL SECTION - CUT (FROM K.m. 6.0 TO TAIL)



TYPICAL MAIN CANAL SECTION IN FILL (K.m. 0.0 TO K.m. 6.0)

Typical cross sections of the main canal are shown in Fig. 3-4.

3-8-2. The minor canals

It is proposed to have 17 minor canals in the project. The preliminary designed main features of the these canals are shown in Table 3.9.

As mentioned above the minor canals will be designed as a night storage system. They are hydraulically designed on " Manning Formula " :-

$$V - \frac{1}{n} \quad R \quad S^{1/2}$$

where

V = non silting - non scouring velocity in m^3/ Sec.

R = the hydraulic radius

$$= \frac{A}{p} = \frac{\text{cross section of wet area in M2}}{\text{wetted permater in ml.}}$$

S = the water slope

$\frac{1}{n}$ = the manning coefficient (roughness).

Each minor canal takes off the main canal through a movable weir. The size of each movable weir depends on the maximum discharge capacity of the minor canal.

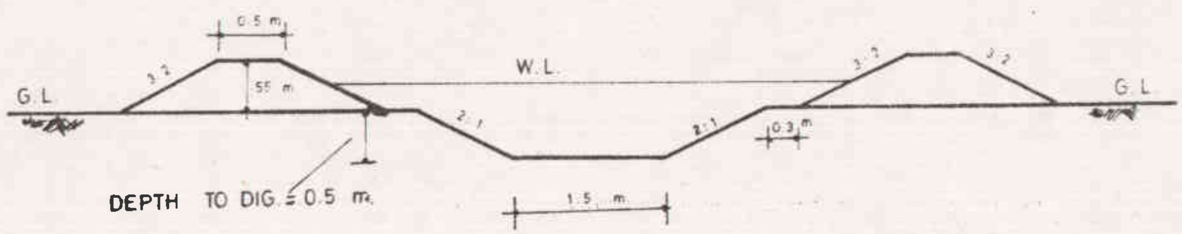
To command the laterals the full supply level of the canal should not be less than 30 cm. above the ground level but it should not exceed 60 cm. To ensure this, cross regulators have to be constructed in the appropriate places

TABLE 3.9 : Preliminary design of the main features of the minor canals .

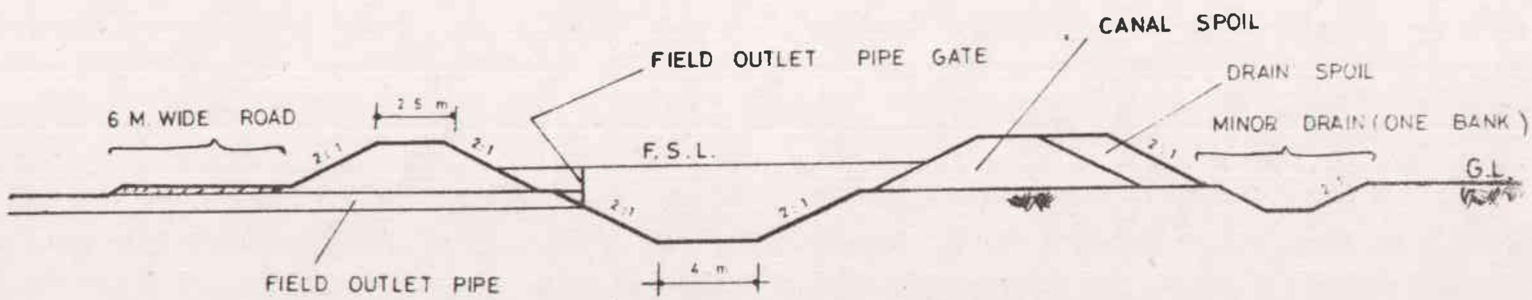
Minor Canal No.	length km.	No. of Laterals	Net irrigated area Ha	Max discharge capacity cumecs
1	3.600	12	504	0.60
2	4.200	14	588	0.70
3	3.600	12	504	0.60
4	4.500	15	630	0.76
5	3.600	12	504	0.60
6	7.500	25	700	0.84
7	3.600	12	504	0.60
8	5.400	18	756	0.91
9	3.600	12	504	0.60
10	6.000	20	840	1.00
11	3.600	12	504	0.60
12	2.700	23	741	0.89
13	6.900	9	210	0.25
14	8.100	27	1134	1.25
15	9.000	30	885	1.06
16	4.500	15	411	0.49
17	2.400	8	212	0.25
Total	82.8	275	10131	

FIG Nº 3_5

MORDILE _ BARIRRE PROJECT



TYPICAL LATCRAL (FIELD CHANNEL) CROSS SECTION



TYPICAL MINOR CANAL CROSS SECTION

along the minor canals. As the system is a night storage system regulators will be gated with night storage weirs. Additional pipe regulators or pipe hidges may be required.

The minor canals will be excavated in cut, in certain cases there may be over excavation as borrow needed for the proper banks. A four meters bed width is considered as the optimum width in minor canals for most of the hydraulic excavators and draglines. The side slope of both the cut and the banks is 2:1. The height of the banks must be at least 30 cm. above the full supply level. The top width of the bank crest is about one meter. A typical cross section of a minor canal is shown in Fig. 3-5. The proposed distances between the minor canals is 1516 m. from the centre lines of the canals.

3-8-3. THE LATERALS :

The laterals are the field channels or more commonly known as field water courses. It is proposed that each lateral will irrigate 42 ha. in 8 hours operation. The lateral takes off the minor canal by a field outlet pipe (F.O.P.). It is proposed to be a concrete pipe of 0.5 m. diameter. The first pipe will be fitted with steel pipe lining with a gate.

These pipes will be about 0.5 m. below the ground level. They will run across the minor canal bank and the side road along the minor canal into the field channels.

The field channel will be excavated in cut. The typical field channel proposed is shown in Fig. 3-5. This section is capable of carrying up to 7,000 M3 in 8 hours.

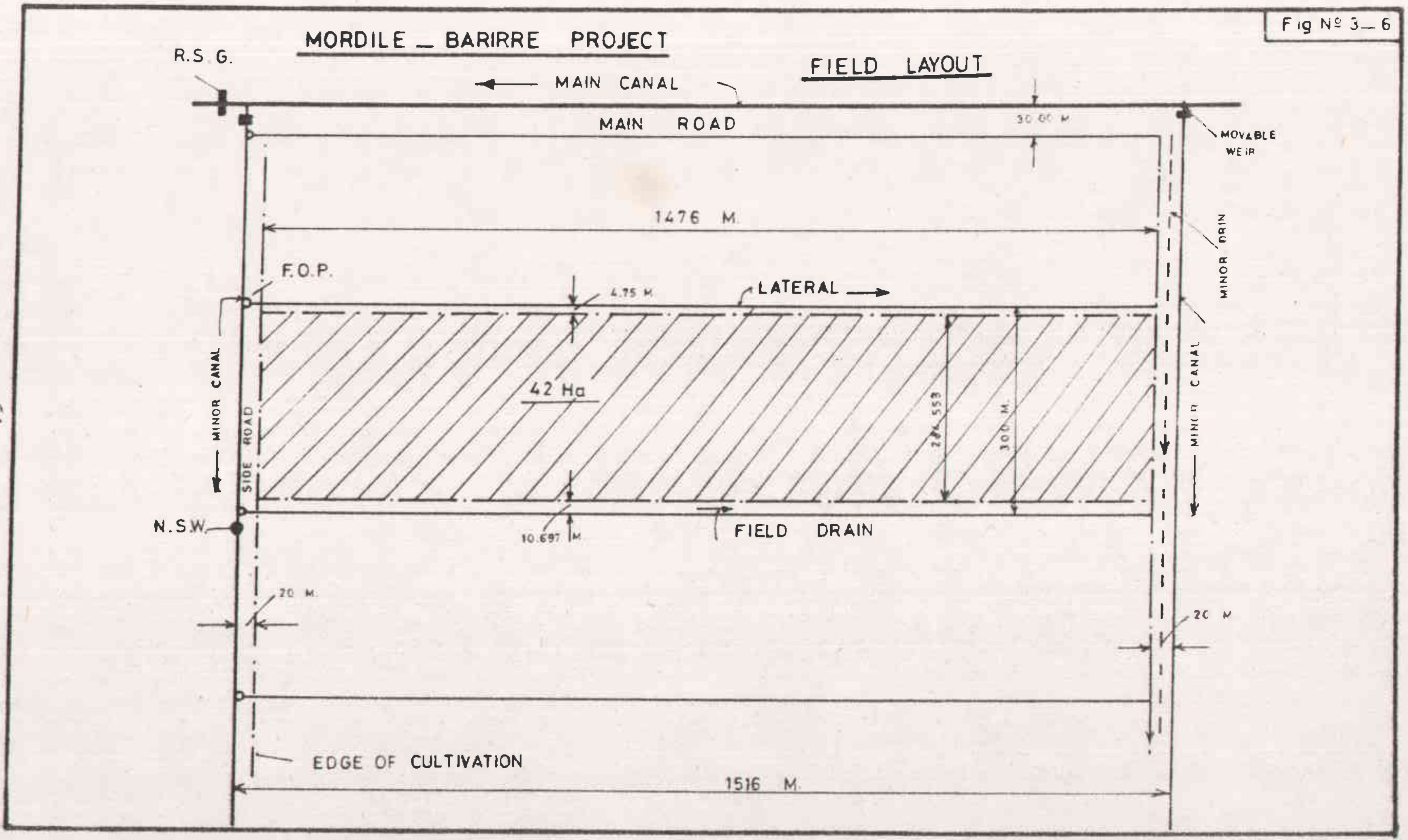


Fig Nº 3 — 6
MORDILE _ BARIRRE PROJECT
FIELD LAYOUT
R.S.G.
MAIN CANAL
MAIN ROAD
30.00 M
MOVABLE WEIR
1476 M.
MINOR DRIN
F.O.P.
4.75 M
LATERAL
MINOR CANAL
42 Ha
SIDE ROAD
300 M.
N.S.W.
10.697 M.
FIELD DRAIN
20 M.
20 M
EDGE OF CULTIVATION
1516 M.

The minimum command in this field channel is 15 cm. There are no cross regulators in the laterals. It will be designed to follow a very gentle slope in the land. The length of each lateral is about 1496 M from the centre line of the feeding minor canal. The distance between the laterals is 300 m. centre to centre.

3-8-4. THE FIELD LAYOUT :

According to the above design of the minor canals and the laterals the field layout will be as follows :-

A : From centre line of minor canals

to the bank outer toe	=	11.5 m
same for the outer minor canal	=	11.5 m
Side road	=	8.0 m
Minor drain at tail of the laterals	=	9.0 m
Total	=	40.0 m
The distance between the minor canals	=	1516 m
Net length of the field 1516 - 40	=	1476 m

B : From centre line of lateral to the

bank toe	=	4.75 m
Same for the next lateral	=	4.75 m
field drain	=	5.947.
Total	=	15.447
The distance between laterals	=	300.0 m
Net width of the field = 300.-15.447	=	784.553 m
Thus the net area of the field	=	1476X284.553
	=	420,000 M2
	=	42 Hectar

Fig. 3.6 illustrates this.

3-8-5 THE DRAINAGE SYSTEM :

The provision of adequate drainage system in any irrigation scheme is of vital importance. It proved to be a major factor in crop yields.

Only surface drainage is proposed in this project. Subsoil drainage is not needed at this stage of development. The type of the soil is clay with relatively high permeability. This type of soil is not expected to build a water table in the project in the near future. But with the proposed high intensity of irrigation, keen observation of the water table is needed and the installation of subsoil drainage could be considered if there is a sign of any water logging caused by continuous irrigation.

The proposed surface drainage system is to be designed to remove the following waters and of the field :-

a) Surface run-off caused by excess rain fall storm.

b) Excess irrigation water.

c) Any intentional drainage of the field needed for any agricultural operation.

Accordingly the proposed drainage design formula is as follows :-

$$Q = EIW + (R - SMD - E) + K.$$

where :-

Q = designed drainage discharge

EIW = Excess irrigation Water. It is assumed that about 20% of the designed canals discharges goes to the drainage system as excess irrigation waters due to low field irrigation efficiency.

R = 1 in 5 year two consecutive days max rainfall.
SMD = Soil moisture deficit precedent to the rainfall.
E = Evapotranspiration
R = SMD - E = Run-off
K = The field intentional drainage, which fortunately does not usually occur during the rainy days.

This drained water has to be removed efficiently out of the field. The following drainage net-work system is proposed. The field will drain into field drains which go paralled to the laterals. The field drain will drain into excavated minor drains going paralled to the minor canals as shown in the general layout of the project (Fig. 3.3) The minor drains will drain into excavated major drains which will carry this collected drained water out of the project area. Three options have been considered regarding where to drain this water. Those options are :-

a) to be reused in the irrigation system, or
b) back to the river, or
c) to the sea, or
d) to a depression nearby the project.

It is not practical to reuse the drained water due to the topography of the land. Due to salinity the water of the river and as a measure against polution, there is a law that prohibitts the discharge of the irrigation drainage water with its chemical contents into the river. This is a wise rational law. As regards drainage into the sea, this is practical not possible as there is high sand dunes between the project area and the sea. There is no natural drainage line crossing this high land. The only left option is to drain this water into the depression to the west of the project through a natural drainageline called " Togga Forta Jowhar " which is a swampy depression as shown in the general layout (Fig. 3-3).

Accordingly, there will be two major drains. The first one will collect the drainage of the north part of the project (Minor canals 1,3,5,7,11,13) and will go southwards along Barrire canals. The other major drain will follow the general slope of the land going west-south-wards at the south boundry of the project parallel to the main public road from Afgoi to Merka. The two major drains will meet at the south-west corner of the project then one big major drain will carry the drained water to that natural drainage line then to the depression.

There are no control structure in the drains, but according to the land topography, certain fall structure may be needed to regulate the slope in the drains.

Appropriate adequate crossing will be provided in the drains where it is intersecting any side or main road.

It must be noted that the canalization and drainage systems proposed were designed according to the very meagre scanty and insufficient topographic maps available. These available maps are the general maps of the country to scale 1 : 100,000 showing very dispersed contour lines and scattered spot level points which show the general nature of the land topography. These were only sufficient to indicate the possible canalization and drainage system layout.

Prior to the proper detailed design of the canalization and drainages systems, detailed topographic survey will be needed.

3-9 OPERATION AND MAINTENANCE :

It is proposed to establish an irrigation division as part of the general organization of the project management. This division will be headed by a chief irrigation engineer (C.I.E.) responsible directly to the project general Manager (P.G.M.).

The responsibility of the irrigation division will be as follows :-

a) To operate and maintain the pumps and the pump house and all associated part and structures.

b) To operate, control and maintain the main canal, the minor canals and the drains and their structures.

c) To secure the delivery of the daily irrigation water as required by the agricultural division, starting from the pumps into the main canal and the minor canals. The operation and maintenance of the laterals is the responsibility of the field irrigation section under the Agricultural division.

d) To operate and maintain the project domestic water supply system.

e) To operate and maintain the internal project-owned electrical supply system.

f) To maintain all the project buildings.

g) To maintain all the project owned roads.

h) To maintain all the project cars and vehicles.

i) To operate and maintain the project tele-communication system.

k) To maintain all the project cars and vehicles.

To operate the irrigation division and the fullfill all these responsibilities and function efficiently , it is proposed to organize the division as follows : The Project is to be divided into 2 irrigation sub-divisions each under an assistant engineer. Each of these subdivision will be responsible for the irrigation division responsibilities shown as items b and c above with its sub-division.

Each irrigation sub-division will receive the daily water indents from the concerned Agriculture division in its area. These indents will be pooled in the irrigation Division Headquarter and then one order of water indent for the whole of the project will be sent to the pump operation division to deliver the required amount of water into the system and then each irrigation sub-division will receive its required amount in its system at the proper time.

The division will also have a mechanical subdivision under an assistant mechanical engineer to be responsible for

Fig Nº 3-7

PROJECT IRRIGATION DIVISION

ORGANIZATION CHANT

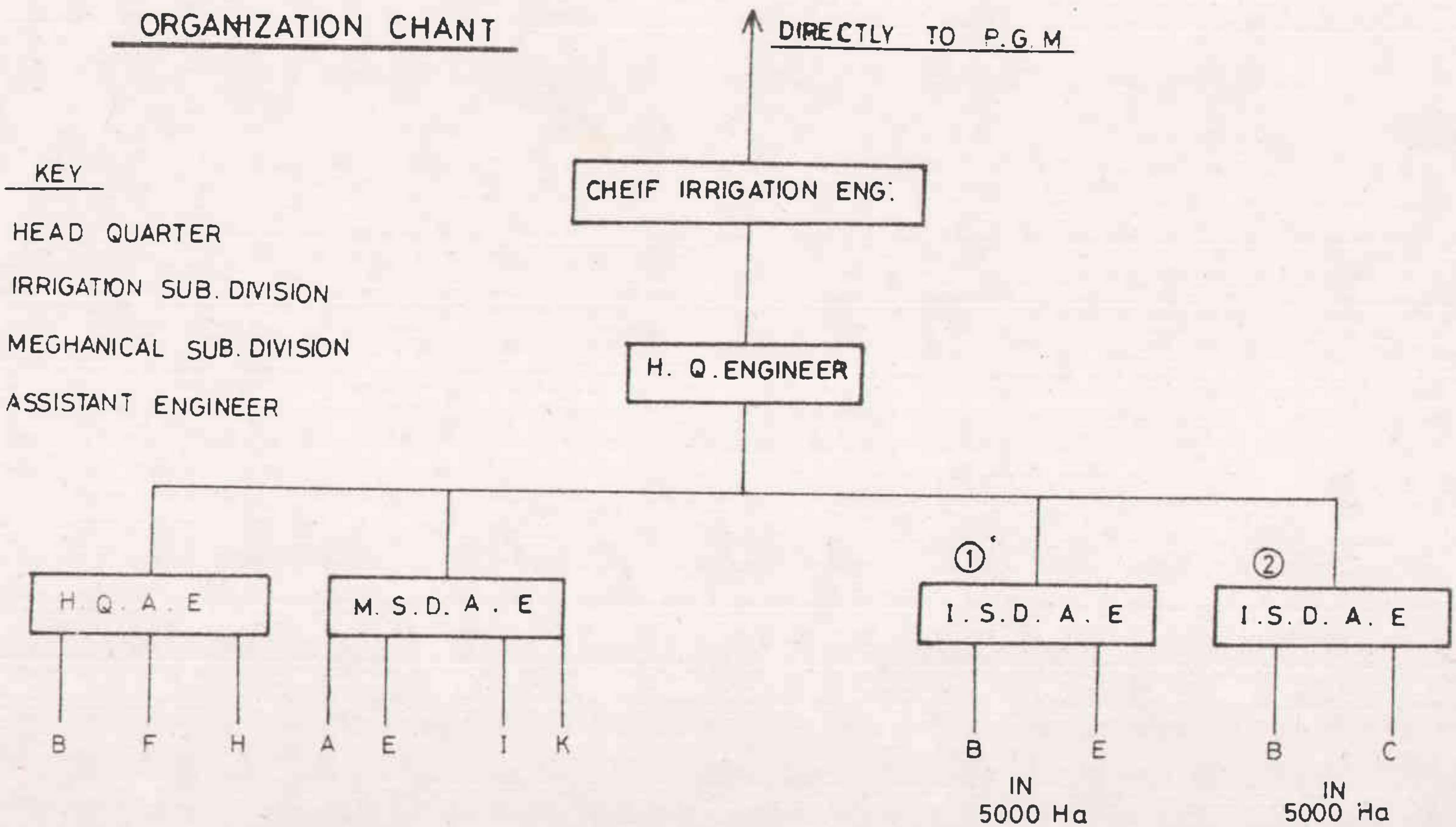
KEY

H.Q = HEAD QUARTER

I.S.D = IRRIGATION SUB. DIVISION

M.S.D. = MEGHANICAL SUB. DIVISION

A.E. = ASSISTANT ENGINEER



A TO K = THE DIFFERENTNT RESPONSIBILITIES OF THE IRRIGATION DIVISION AS SPECIFIED IN THE REPORT.

operating and maintaining the pumps (item - a) in addition to the responsibilities shown in item (e-i-k).

Another subdivision, under an assistant civil engineer, will operate the project domestic water supply system (item - d) and maintain the project buildings and roads (items -f and -h).

To co-ordinate all these activities and to deputize the C.I.E., it is proposed to have a Headquarter Engineer senior to all subdivision assistant engineers.

This organizational arrangement is shown in the organization chart in Fig. 3-7.

As to the daily continuous regulation and operation of the system it is proposed to station a water control man in each minor canal to be responsible for all the control structures and regulators in that canal, also a water control man will be stationed in each of the main canal groups regulators.

These water controlment will be under the direct responsibilities of the irrigation subdivision assistant engineer and they receive the daily orders of the operation from him. They will be in direct continuous contact with the assistant engineer all day through the tele-communication network to inform him of the situation specially if it is not going in order.

The other responsibility of the subdivision is the maintenance of the irrigation system. The canals have to be surveyed during the off-season to estimate the volume of the silt deposited in each of them and then arrange to excavate them back to the designsection. The actual excavation can be done during the year while the canals are in operation. But the survey is best done when the canals are not in operation and are dry.

All the canal structures has to be inspected and maintained continuously. A schedule or oiling, greasing and painting of the steel parts of the gates has to be drawn.

The proposed labour force of the irrigation division for efficient operation is as follows :-

Division H. Qrs.

1	Chief Engineer
1	H. Qrs. Engineer
1	Clerk Typist
2	Messengers
2	Vehicle drivers.

H.Qrs. Subdivision

	1	Assistant Engineer
Building Maintenance	1	Building supervisor
	1	Mason
	1	Carpenter
	1	Plumber
	1	Electrician
	4	Labourers
Water Supply System	1	Water supply supervisor
	3	Mechanics (3 shifts)
	3	Labourers

Road Maintenance	(	1	Road supervisor
	(	1	Motor Grader driver
	(	1	Buldozer driver
	(	2	Lorry drivers
	(	10	Labourers

1 Car driver

1 Lorry driver

Mechanical Sub-Division

1 Assistant Engineer

Pump Operation	(	1	Pump Station Supervisor
	(	6	Mechanics (2 shifts)
	(	6	Labourers

Car Mainten-ance	(	1	Head mechanics
	(	3	Mechanics
	(	3	Labourers

1 Telecommunication trained labourer

1 Car driver

1 Lorry driver

Two Irrigation Sub-Division

2 Assistant Engineers

20 Water control men

1 Head chairman

4 Chairman

10 Labourers

2	Car drive
2	Dragline operators
2	Hydraulic excavator operators
2	Buldozer operators
2	Lorry drivers
4	Fitters

The summary of this labour force is as follows :-

1	Chief Engineer
1	Engineer
4	Assistant Engineers
6	Senior technicians
18	Skilled labourers
8	Heavy machine operators
40	Semi-skilled labourers
11	Vehicle drivers
26	Unskilled labourers

3.10 Summary of Irrigation Work Costs :

A. Capital Cost

1. Topographic survey	780,000
2. Pump Station	11,000,000
3. Earth work in canals and drains	36,160,000
4. Canals and drains structures	14,230,000
5. Engineering	4,974,000
	67,144,000

B. Machines and Equipments for Maintenance

Workshop Equipments	3,030,000
Staff Heavy machines	4,260,000
4 wheel Drive cars	492,000
Lorries	768,000
Mobile workshop	420,000
Mobile crane	900,000
	9,870,000
Charges	198,000
Total	10,068,000

C. Fuel, Lubrication & Spare parts (Annual)

Machines & vehicles	2,880,000
Pump station	2,558,000
	5,438,000

D. Staff (Annual)	876,000

CHAPTER 4

A G R I C U L T U R E

CHAPTER 4

AGRICULTURE

4-1 Background Information :

1. Recently the area planted to rice in Somalia has increased to about 5,000 ha. producing nearly 8,000 tons of paddy rice. The annual local consumption is about 30,000 tons of white rice, while the national output is estimated at 5,500 tons, the balance being imported from China and Tailand. The present development plan aims at national self-sufficiency in cereals including rice as one of the main objectives.

2. The main goal of the project is to develop an area of about 13,000 ha. of partially irrigated land for intensive rice production. The output from this project will help meet the increasing local demand.

3. The project site selected by the Ministry of Agriculture is in the District of Afgoi at the Mordile-Barrire area. It is located at about 43 km from Mogadishu. Afgoi district depends on Shabelle river for irrigation.

4. The natural vegetation of the Mordile - Barrire area presently consists of open shrubs and low grasses cover the open areas. About 15 - 20 per cent of the area is under-cultivation.

5. The climate, in general, is tropical semi-arid with about 500 mm rainfall per year. Roughly two-thirds of the mean annual rainfall is recorded in the Gu season (April - August). The shorter rainy season, the Der, lasts from

September - November, while the period from December - March is usually completely dry.

The mean monthly air temperature does not vary much throughout the year, the range being between 25 C in July and August to 28 C in February to April and October to November.

Relative humidity is highest during the wet seasons, especially during the Gu (April - June) and Hagai (July - and August) seasons when it is around 80%. Humidity drops to 72 per cent in February and March.

6. Field crops grown in the Afgoi district include mainly banana, maize, sesame, sorghum, pasture and vegetables (tomato, onion, water melons). Fruit trees (coconuts, mangoes, soursap, citrus) are also planted. Maize is predominantly a Gu season crop, while sesame, utilising stored soil moisture, in planted mainly in the der season from November to January or even later.

7. The soils are brown to dark brown with fine texture ranging from clay loam to clay. In general the top layer is non-saline while the subsoil is moderately saline . The p^H values range from 7.4 to 8.2 Calcium carbonate and gypsum are present in considerable amounts.

8. Fertility in terms of the soil's capacity to retain and supply bases is moderate. The overall organic matter and nitrogen levels are not high and crop responses to these inputs can be expected. Response to large doses of phosphorus is unlikely.

9. Shabelle river is the main source of irrigation water in the valley, flood and controlled irrigation are practiced. The maximum, and minimum river flow at Mahaddoay Weyn as derived from local records between 1951 and 1975 are 2750, 1800, and 965 mcm, respectively (HTS 1977). Peak flows in the river occur mostly in May and September/October each year. January to April are normally low flow months.

10. Grain eating birds are the major problem facing rice growers in Somalia. Other cereals are also attacked but rice in particular is the prime target for this destructive pest. The species Quelea quelea intermedia can be found at all times of the year south of Mogadishu. The greatest numbers of birds occur in August and September and again in December and January.

11. Crop yields are very low in comparison to the world averages because the present crop management is very poor, crop varieties are mostly traditional, no fertilizers or pest control measures are practiced, nearly all field operations are done by hand labour and moisture inavailability.

4.2 Proposed Cropping Pattern :

Factors affecting cropping intensity and crop selection are water availability, soil properties, climatic conditions and natural hazards that limit crop production. Also the National Agricultural Policy and primary objectives of the project should be considered.

Since the land of the project is mostly not cultivated it is recommended in the first year of cultivation to plant paddy rice to 50 per cent of the newly reclaimed area and cowpea to the other 50 per cent each season as follows :-

	Gu	Der	
50%	Rice " Paddy"	Cowpea " Green manure"	50%
50%	Cowpea " Green manure "	Rice " Paddy"	50%

(Proposed cropping pattern in the first year of cultivation)

Covering the whole area in the first year of cultivation by paddy rice will help to leach salts and store water in lower horizons and cowpea as a green manure will help to increase the level of soil fertility.

After the first year of cultivation, on the basis of available, water, climate and soil data, the following rice-based cropping pattern is proposed:

	Gu	Der	
50%	Rice	Sesame	50%
		Cowpea (Green manure)	25%
25%	Maize	Rice	50%
25%	Cowpea (Green manure)		

(Proposed rice based cropping system)

Accordingly, rice will occupy 50 per cent of the proposed project area (5,000 ha.) in each of the Gu and Der seasons. Table 4-1 shows build-up of the cultivated area and Table 4-2 shows the area assigned to each crop according to the proposed cropping pattern. Taking into consideration the availability of irrigation water, the present rice varieties need about 120 days from seed to seed and to avoid the advance of migrating birds, the Gu crop should be planted in April and harvested in August and that of the Der should be planted in September and harvested in December/January.

Maize is suggested to be planted to 25 per cent of the area (2,500 ha.) only in the Gu season. The present varieties need about 110 days from seed to seed. Therefore, maize should be planted in late April or early May to be harvested in August.

Sesame, occupying 25 per cent of the area in the Der season, can be planted during late September/October but there is considerable flexibility in its planting date apparently without deterimental effect on yields which is a great advantage.

4-3 Crop Rotation :

The project will be organized as a state farm. The cultivated area will be divided into four production units. Each production unit will include two production farms. Each of the eight production farms will be responsible for working about 1,250 ha. The production farm will have its own two-year crop rotation following the overall proposed cropping pattern.

The two year crop rotation will be arranged as follows :-

Table 4-1 : Build-up of the cultivated area in hectares

	Year 1	Year 2	Year 3		Year 4		Year 5		Year 6	
			Gu	Der	Gu	Der	Gu	Der	Gu	Der
Area reclaimed	-	2,900	-	700	1,500	1,000	1,100	1,100	1,700	-
Area Cultivated	-	-	2,900	3,600	5,100	6,100	7,200	8,300	10,000	10,000

Table 4-2 : Area assigned to each crop according to the proposed cropping pattern (ha.)

Crop	Year 3		Year 4		Year 5		Year 6		Year 7	
	Gu	Der	Gu	Der	Gu	Der	Gu	Der	Gu	Der
1. Rice	1,450	1,800	2,550	3,050	3,600	4,150	5,000	5,000	5,000	5,000
2. Maize	-	-	,900	-	1,525	-	2,075	-	2,500	-
3. Sesame	-	-	-	1,275	-	1,800	-	2,500	-	2,500
4. Cowpea	1,450	1,800	1,650	1,775	2,075	2,350	2,925	2,500	2,500	2,500
Total	2,900	3,600	5,100	6,100	7,200	8,300	10,000	10,000	10,000	10,000

	First year		Second year	
	Gu	Der	Gu	Der
25%	Rice	Sesame	Cowpea	Rice
25%		Cowpea	Maize	
25%	Maize	Rice	Rice	Cowpea
25%	Cowpea			Sesame
	75%	75%	75%	75%
Cropping intensity	150%		150%	

Accordingly, rice will be grown in both the Gu and Der seasons covering annually the whole cultivated area.

The maize crop which will be used as a rotational crop with rice is limited to 25% of the cultivated area in Gu season only.

In the Der seasons sesame as a rotational crop with rice will be planted to 25% of the cultivated area.

Cowpea as a green manure crop will be planted to 25% of the cultivated area in each of the Gu and Der seasons. Thus the whole area will be green -manured every two - year period to restore soil fertility.

Excluding the cowpea as a green manure crop , cropping intensity will be 1.5 crops per year.

4-4 Justification of the Proposed Cropping Pattern :

1. The main goal of this project is to produce as much rice as possible from 10,000 ha. To reach that goal a rice based cropping pattern is proposed to plant rice to the whole project area, 50% in the Gu and 50% in the Der season.

2. Other crops such as maize and sesame are rotational crops with rice. Maize is the staple food in Somalia and sesame because of its short duration and low production requirements, is the dominant oilseed crop.

3. In each season 25% of the cultivated area will be planted to cowpea as a green manure crop instead of fallow to restore soil fertility to the whole area every two years.

4. The continuous growing of rice on the same land should be avoided , but growing one or two crops of rice on the same land within a 12-month period is usual in many areas of South-east Asia (India, China, Tailand Taiwan ... etc.) with climate and soil conditions similar to Somalia.

5. Grain legumes such as cowpea or mung beans, can be planted in small family plots. The present varieties are not amenable to machine harvesting because of their uneven ripening and seed shattering. Also there will be big problems of their storage and marketing if they are planted in a large area. Cowpea, mung beans and crotalaria are included in the proposed rice based cropping pattern as green manure crops.

6. Cotton is suitable for these heavy soils. However, the

inclusion of cotton in such rice based cropping pattern is not beneficial for the following reasons :-

- Cotton is a long duration crop (5 - 6 months).
- Labour for its picking is a big problem.
- Pest control will be necessary for the American boll-worms, jassids and cotton stainers.
- The Balaad Cotton Irrigation Project when it is fully implemented will meet the local demand for cotton.

7. Peanut is not suitable for these heavy soils specially that it is not salt tolerant and needs longer duration than sesame. Moreover, peanuts has the problem of some fungal diseases.

4-5 Crop Management and Production Requirements :

Recommendations concerning the crop management and production requirements are based on research results obtained from the " Central Agricultural Research Station " in Afgoi as well as information obtained during the team visits to :-

a - Afgoi Agricultural District Office,
b - Libsoma Project in Afgoi,
c - Chinese Rice Project in Jowhar,
d - Cotton Irrigation Improvement Project in Balaad,
e - Seed Production Center in Afgoi,
f - Development of Oilseeds and Beans Production Project at Wanlawim District.

a : **Tillage** :

Wheeled tractors of about 90 hp are recommended. One tractor can plough 3 ha/day. Disc ploughs are suggested since they incorporate trash well and penetrate hard soils better and quicker than mould-board ploughs.

Land levellers, disc harrows and ditchers will be needed for land preparation. Table 4-3 gives the list of agricultural machinery required for crop cultivation.

b : **Sowing** :

Rice will be combine-drilled at the rate of 100 kg/ha of paddy. Sesame can be planted by the row seeder at the rate of 10 kg/ha. Maize and cowpea can be mechanically seeded using the corn planter and different seed plates. Seed rate for maize and cowpea is 30 kg/ha. All seeds should be cleaned and treated with chemicals before planting. Table 4-4 shows seed rates and total seed requirements for rice, maize, sesame and cowpea.

c : **Fertilizer applications** :

Table 4-5 gives the rates and total requirements of the nitrogen and phosphorus fertilizers. Urea (46% N) and trisuperphosphate - TSP (46.5% P_2O_5) are recommended. For rice, basal application will be made at the planting time and top dressing at 50 - 60 days after planting. The recommended rates are 200 kg urea/ha and 100 kg TSP/ha.

The same rates and split applications will be practiced with maize.

Table 4-3 : List of Agricultural Machinery required for Crop cultivation

No.	Machinery	Year 2	Year 3	Year 4	Year 5	Total
1	Wheel tractor 150 HP	9	3	3	3	18
2	" " 90 HP	73	26	37	22	158
3	" " 60 HP	8	12	24	32	76
4	Disc plough	33	12	16	8	69
5	Disc harrow	10	3	5	3	21
6	Land leveller	9	3	3	3	18
7	Seeder	20	7	9	6	42
8	Planter	-	5	3	4	12
9	Disc bedder	4	1	3	1	9
10	Ditcher	4	1	3	1	9
11	Weeder	16	8	9	9	42
12	Sprayer	10	2	5	4	19
13	Agricultural trailer (5 tons)	8	12	24	32	76
14	Combine harvester (rice)	7	5	5	7	24
15	" " (maize)	-	4	3	3	10
16	Baler	2	2	2	2	8

Table 4-4 : Seed Rate and Total Seed Requirements

Crop	Rate kg/ha	Total requirements (ton)									
		Year 3		Year 4		Year 5		Year 6		Year 7	
		Gu	Der	Gu	Der	Gu	Der	Gu	Der	Gu	Der
Rice	100	145	180	255	305	360	415	500	500	500	500
Maize	30	-	-	27	-	46	-	62	-	75	-
Sesame	10	-	-	-	13	-	18	-	25	-	25
Cowpea	30	44	54	50	53	62	71	88	75	75	75

Rates for sesame could be 100 kg urea/ha and 50 kg TSP/ha. One half of the quantities will be added at planting time and the other half at 40 days after planting.

Cowpea, as a green manure leguminous crop, needs small doses of nitrogen (25 kg urea/ha) and phosphatic (50 kg TSP/ha.) fertilizers to be added at the planting time.

d : Weed Control :

Early and timely weeding are extremely important for the direct seeded rice. The use of herbicides such as stam F-34 or Propanil during the early growth period is recommended (Table 4-6). The application of this herbicide may be followed by one or two hand weedings at intervals of approximately 3-4 weeks.

e : Insect Control :

In general, chemical control is not envisaged. As a precaution, two applications of Sevin or Diasinon (Table 4-6) will be provided for rice and maize and one for sesame.

f : Bird Control :

Bird control on rice will be by scaring with harvesting completed before the advance of migrating birds.

Small sprayers beside the tractor-mounted boom sprayers are recommended for pest control.

Table 4-5 : Rates and total requirements of Nitrogen (urea 46% N) and Phospharus (TSP 46.5% P_2O_5) Fertilizers

Crop	Rate kg/ha	Total requirements (ton)									
		Year 3		Year 4		Year 5		Year 6		Year 7	
		Gu	Der	Gu	Der	Gu	Der	Gu	Der	Gu	Der
a: Urea (46%)											
Rice	200	290	360	510	610	720	830	1000	1000	1000	1000
Maize	200	-	-	180	-	305	-	415	-	500	-
Sesame	100	-	-	-	128	-	180	-	250	-	250
Cowpea	25	36	45	41	44	52	59	73	63	63	63
Total Urea		326	405	731	782	1077	1069	1488	1313	1563	1313
b : TSP(46.5%)											
Rice	100	145	180	255	305	360	415	500	500	500	500
Maize	100	-	-	90	-	153	-	208	-	250	-
Sesame	50	-	-	-	64	-	90	-	125	-	125
Cowpea	50	73	90	83	89	104	118	146	125	125	125
Total TSP		218	270	428	458	617	623	854	750	875	750

Table 4-6 : Rates and total requirements of herbicides (Stam F-34) and insecticides(Sevin)

Crop	Rate kg/ha	Total requirements (100)									
		Year 3		Year 4		Year 5		Year 6		Year 7	
		Gu	Der	Gu	Der	Gu	Der	Gu	Der	Gu	Der
a: Stam F-34:											
Rice	10 lit	145	180	255	305	360	415	500	500	500	500
b: Sevin :											
Rice	4 kg	58	72	102	122	144	166	200	200	200	200
Maize	4 kg	-	-	36	-	61	-	83	-	100	-
Sesame	2 kg	-	-	-	26	-	36	-	50	-	50
		58	72	138	148	205	202	283	250	300	250

Table 4-7 : Estimated consumptive use of water for the different crops and irrigation needs

Crop	Season	Duration (Days)	Consumptive use mm.	Effective rainfall mm.	Net Irrigation mm.	Crop Irrigation wu 50% mm.	Water Require- ments cum/ ha.	No. of Irrigation
Rice	Gu	120	600	250	350	700	7,000	7
Rice	Der	120	600	100	500	1000	10,000	10
Maize	Gu	110	400	250	150	300	3,000	3
Sesame	Der	80	250	100	150	300	3,000	3
Cowpea	Gu	50	180	130	50	100	1,000	1
Cowpea	Der	50	180	130	50	100	1,000	1

Source : FAO Pilot Project for Agricultural Development on the Shabelle River (Somalia),1975 g : Irrigation :

Table 4-7 gives the estimated consumptive water use and quantity of irrigation water needed for the different crops in the Gu and Der seasons.

Maize, Gu season crop, requires 3,000 cum/ha.
Sesame , Der season crop, requires 3,000 cum/ha.
Cowpea, as a green manure crop needs 1,000 cum, in each of the Gu and Der seasons.

h : Harvesting :

Rice will be harvested by self prepolled combines and maize with corn harvesters (Table 4-3). One combine can harvest 10 ha/day. Sesame will be harvested manually. Cowpea as a green manure crop will be incorporated into the soil at the maximum vegetative growth stage (50 days).

i : Casual Labour Requirements :

Most of the field operations will be mechanized, however, the following operations have to be done manually :-

- Seed treatment in the stores,
- Replanting the missing places,
- Some weeding,
- Hoeing in maize and cowpea,
- Irrigation,
- Some fertilizer application,
- Spraying with portable sprayers,
- Guarding the crops during harvesting time,
- Bird scaring in rice, and
- Harvesting sesame.

The estimated casual labour requirements for the different crops and operations are given in Table 4-8. Apart from skilled workers such as tractor drivers, mechanics, irrigation workers and plant protection workers who will be permanently employed, the annual casual labour requirement for the full project operation amounts to :-

Unskilled men	315,000	days/year,
Women	610,000	days/year, and
Children	1,000,000	days/year.

The peak months for casual labour requirements will be June, July and August in the Gu season and December and January in the Der season.

4-6 : Project Organization and Management :

The project will be organized and operated as a state farm. The overall project management will be established in headquarters centerally located in the project area. The eight top level management staff (Table 4-9) constitutes the headquarters. The 10,000 ha. will be divided into four production units of about 2,500 ha. each with its complement of lower level management officers. Each production unit would be completely self-contained with machinery and office and storage facilities. The housing facilities and social utilities as well as the central workshops and the rice mill will be located near the headquarters. The four production units will keep their own production records and basic accounts.

The 2500 ha. production unit would be in turn subdivided into two production farms. Each production farm would be

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Table 4-8 : Requirements of Casual Labour

Crop	Rate/ ha			Total requirements (1000 days)														
	Man	Woman	Child	Year 3			Year 4			Year 5			Year 6			Year 7		
	(M)	(W)	(C)	M	W	C	M	W	C	M	W	C	M	W	C	M	W	C
Rice																		
Gu	16	42	100	23	61	145	41	107	255	58	151	360	80	210	500	80	210	500
Der	16	42	100	29	75	180	49	128	305	66	174	415	80	210	500	80	210	500
Maize																		
Gu	36	12	-	-	-	-	32	11	-	55	18	-	75	25	-	90	30	-
Sesame																		
Der	14	52	-	-	-	-	18	66	-	25	94	-	35	130	-	35	130	-
Cowpea																		
Gu	6	6	-	9	9	-	10	10	-	13	13	-	18	18	-	15	15	-
Der	6	6	-	11	11	-	11	11	-	14	14	-	15	15	-	15	15	-
Total				72	156	325	161	333	560	231	464	775	303	608	1000	315	610	1000

responsible for working about 1,250 ha. whose crop management would follow the overall plan. Thus each of the eight production farms would follow identical production cycles and crop rotations. A list of regular employees required for the project headquarters, production units and production farms is given in Table 4-9.

It is suggested that a long term expatriate specialist in the field of rice production be employed for three years. Also four short term expatriate specialists in the fields of agronomy, agricultural economics, soils and agricultural engineering would be employed for 1-2 months every year.

4-7 Crop Production :

In general crop yields are very low in Somalia in comparison to the world averages. So for as rice in concerned, the top national average yields could reach 6.00 tons/ha in Japan, Spain, South Korea and Egypt and the world average yield is about 2.50 tons/ha. while the national average yield in Somalia is about 1.70 tons/ha.

Factors which considerably reduce crop yields are :-

- unimproved crop varieties,
- unreliable water resources,
- severe bird attack,
- no fertilizers or pest control measures are used,
- nearly all field operations are done by hand labour, and
- insufficient services in research and extension.

The establishment of a state farm of about 10,000 ha. would permit the use of modern technology to improve crop yields

Table 4-9 : Regular employees required for the project headquarters, production units and Production farms

No.	Assignment	Level	Years 1	2	3	4	5	6	7	Location
1	Project Manager	B.Sc.	1	1	1	1	1	1	1	Headquarters
2	Administrative assistant manager	B.Sc.	-	-	1	1	1	1	1	"
3	Administrative officer	B.Sc.	-	1	1	1	1	1	1	"
4	Chief Production agronomist	B.Sc.	-	-	1	1	1	1	1	"
5	Chief plant protection specialist	B.Sc.	-	-	1	1	1	1	1	"
6	Chief irrigation engineer	B.Sc.	1	1	1	1	1	1	1	"
7	Procurement officer	B.Sc.	1	1	1	1	1	1	1	"
8	Accountant	B.Sc.	1	2	2	2	2	2	2	"
9	Clerk-typist	High school	4	4	6	8	8	8	8	"
10	Janitor	Unskilled lab.	2	3	6	8	10	10	10	"
11	Car-driver	Skilled lab.	1	4	6	6	6	5	5	"
12	Chief Farm manager	B.Sc.	-	1	3	4	4	4	4	Units
13	Farm manager	B.Sc.	-	2	4	8	8	8	8	Units-Farms
14	Assistant farm manager	Agric. H. S.	-	2	6	8	8	8	8	" "
15	Assistant irrigation eng.	Agric. H. S.	-	-	2	6	8	8	8	" "
16	Irrigation supervisor	Skilled lab.	-	2	6	8	8	8	8	" "
17	Clerk-Typist	High School	-	5	8	8	8	8	8	" "
18	Irrigation Worker	Unskilled lab.	-	-	30	90	120	120	120	" "
19	Farming Worker	" "	-	-	30	90	120	120	120	" "
20	Plant Protection Worker	" "	-	-	10	30	40	40	40	" "
21	Car Driver	Skilled lab.	-	2	4	6	6	8	8	" "
22	Store keeper	High School	-	2	6	8	8	8	8	" "
23	Chief mechanical engineer	B.Sc.	1	1	1	1	1	1	1	Headquarters
24	Operator engineer	B.Sc.	1	1	1	1	1	1	1	
25	Operator- Buldozer	Skilled lab.	7	7	14	15	17	17	17	"

Table 4-9 : Cont.

		Level	Years							Location
			1	2	3	4	5	6	7	
26	Operator-wheel tractor	Skilled	1	1	92	133	198	255	255	Units-Farms
27	" -Combine harvestor	"	-	-	7	16	24	34	34	" "
28	Mechanic (A)	"	2	2	17	25	37	43	43	" "
29	Mechanic (B)	"	4	4	34	50	74	86	86	" "
30	Mechanical Engineer	B.Sc.	1	1	1	1	1	1	1	Central Work-shop
31	Technician (Smith, Welder, Operator Etc.)	Skilled Lab.	11	11	17	17	19	19	19	" "
32	Assistant Technician	Unskilled Lab.	17	17	28	28	32	32	32	" "

through :-

1. Introduction of drought tolerant, short duration varieties (90 - 100 days).

2. Adoption of improved package of practices suitable for the new high yielding varieties.

3. Mechanization of field operations.

The team, during his visit to the Chinese rice farm in Jowhar, was informed that rice yields of 6-7 tons/ha are possible by direct seeding of the Chinese paddy variety " Kindo 2 " and improving water management and cultural practices.

The potentials of the project area can fully be exploited through improved varieties, efficient water management, mechanization, fertilizer use and efficient pest control. Estimates of yields in the first year of cultivation (third year of the project) are :-

- 2.00 tons/ha. of rice,
- 2.00 tons/ha. of maize, and
- 0.40 tons/ha. of sesame.

During the period from the 3rd to the 6th year of the project, adoption of the integrated modern technology would eventually lead to double crop yields as follows :-

	Year 3	Year 4	Year 5	Year 6
Rice	2.00	2.50	3.00	4.00
Maize	-	2.00	3.00	4.00
Sesame	-	0.40	0.60	0.80

Table 4-10 shows the production build-up for the different crops. It is clear from the table that in the 7th year when the project will be fully implemented the total annual crop production will amount to 40,000 tons of rice, 10,000 tons of maize and 2,000 tons of sesame.

Table 4-10 Crop Production Build-up

Year	Crop	Season	Yield (ton/ha)	Acreage (ha)	Production (ton)	Annual Production (ton)
3	Rice	Gu	2.0	1450	2900	6500
		Der	2.0	1800	3600	
	Maize	Gu	-	-	-	-
	Sesame	Der	-	-	-	-
4	Rice	Gu	2.5	2550	6375	14000
		Der	2.5	3050	7625	
	Maize	Gu	2.0	900	1800	1800
	Sesame	Der	0.4	1275	510	510
5	Rice	Gu	3.0	3600	10800	23250
		Der	3.0	4150	12450	
	Maize	Gu	3.0	1525	4575	4575
	Sesame	Der	0.6	1800	1080	1080
6	Rice	Gu	4.0	5000	20000	40000
		Der	4.0	5000	20000	
	Maize	Gu	4.0	2075	8300	8300
	Sesame	Der	0.8	2500	2000	2000
7	Rice	Gu	4.0	5000	20000	40000
		Der	4.0	5000	20000	
	Maize	Gu	4.0	2500	10000	10000
	Sesame	Der	0.8	2500	2000	2000

CHAPTER 5

R I C E   M I L L   P L A N T

CHAPTER 5

RICE MILL PLANT

The estimated annual production of Mordile-Barrire project is about 40,000 tons of rough rice in the seventh year. This production has to be milled in local mills to be transfered into white rice.

Presently in Somalia two rice mills only exists in Shalambod at a distance of about 40 km from the project site. The total milling capacity per year of each of these two rice mills is 5,000 tons of rough rice. Subsequently the existing rice milling capacity is not sufficient to meet the increasing local production or milling the project rice production.

In addition, each of these mills charges So. Sh. 300 per ton milling, thus the project expenditures in the seventh year will afford high expenses totalling So. Sh. 12,000,000 for rice milling plus transportation expenses (So. Sh. 0.6 per ton/km.).

Due to the above-mentioned facts it is necessary to establish a new rice mill attached to this project for milling its production. The required capacity for this mill should be 100 tons of white rice and brokens per day (24 hours) i.e. 40,000 tons of rough rice per year.

Drawings 5-1, 5-2, 503, 504, 5-5 show the flow sheet diagram, Sectional plans and elevation and side views of the plant, rice mill building and silos, respectively. The dimensions of the building, all different machines and equipment and their arrangements with respect to each other are clearly fixed in these drawings. More details concerning such equipment, different milling sections, utilization of by-products, some comments about tender conditions are mentioned in Annex 4.

It is also proposed to have automatic packing machines for weighing and packing white rice produced in small bags up to 5 kg for easy handling.

For operating the plant (rice mill and silos) two diesel generating sets 300 K.W. each are required. One of these shall be sufficient for operation and the other shall be as standby.

To maximize utilization of the electric generating sets two ice making plants with a daily capacity of 25 tons each are included in the project. Their working period is proposed to be four months per year and shall be operated by one of the diesel generating sets.

The Total Investment of the Plant :

As indicated in Table 5-1 the estimated investments for the construction of a rice mill with a daily capacity of 100 tons white rice and brokens and two ice making plants with a daily capacity of 25 tons each shall be So. Sh. 31,357,000 itemized as follows :-

	So. Sh. 000
Machines and equipment	24,684
Buildings	5,427
Erection and training	1,246

The total value of machines includes all costs of the rice mill machinery, dryers, silos, diesel generating sets, two ice making plants, and the steel structure buildings of the rice mill, ice making plants, offices, a workshop and a spare part store. It also includes spare parts sufficient for two years.

The storage capacity of silos shall be 15,000 tons of rough rice out of the total production of rice 20,000 tons in each of the " Gu and " Der " seasons. The difference i.e. 5,000 tons is to be delivered from the farm to the mill during harvest time.

The value of buildings includes all costs for foundations of different buildings. Such foundations must be prepared according to the suppliers' drawings and civil engineers designs and should be executed before the delivery of machines and equipment. The foundations of all the storage silos should be completed in the third year before starting the delivery of silos, while the delivery and erection of the silo bins can be executed according to the expected rough rice production of the project in its different stages.

It is recommended to have a rice milling specialist for training the local personnel for a period not less than one year starting three months before handing over of the plant. Training shall include operation, maintenance of machines and equipment and the proper utilization of dryers and silos to avoid deterioration of the grains.

Meanwhile two Somali technicians may be having training in some operating mills in A.R.E. The suitable time for such visit is from April to September to ensure attending both running and maintenance of the rice mills. It is proposed that the expenses of such training can be afforded through AOAD technical assistance.

Operating Costs :

Table 5-2 indicates the rice mill operating costs. These costs represent only the industrial expenditures which will reach So. Sh. 144 per ton milling in the seventh year.

The required number and annual costs of the permanent staff are shown in Table 5-3 and personnel chart 5-1. Suitable skilled mechanical and electrical labourers should be appointed for the erection and start up of the machinery and equipment to get experience and to be well acquainted with the machines.

The fuel consumption for the diesel generating sets is calculated on the basis of 250 gm.k.w.h. X loading factor (0.7 - 0.8) i.e. 250 X 300 X (0.7 - 0.8) = 54 kg/hr.

The annual maintenance of the machines and equipment shall start at the end of the second year after operating the plant it needs a stopping period of about two months / year. The maintenance expenses include all costs for adjusting, repairing and renewal of machines and parts to ensure efficient running of the plant in perfect order and good condition.

Miscellaneous costs included in the operating costs include travel expenses, per dium allowance, water and electricity consumption, cleaning tools, fringe benefits granted for labourers and post, telephone expenses .... etc.

Table 5.1 : Rice Mill Investments

Capacity 100 tons hours White rice and brokens per 24 hours

So. Sh. 000

Year	Machines			Buildings			Erection & Training			Total investments		
	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign
1												
2	12931	128	12803	5427	2727	2700				18358	2855	15503
3	1623	16	1607				1246	249	997	2869	265	2604
4	3649	36	3613							3649	36	3613
5	6481	64	6417							6481	64	6417
6												
	24684	244	24440	5427	2727	2700	1246	249	997	31357	3220	28137

Table 5-2 : Rice Mill Operating Costs

So. Sh. 000

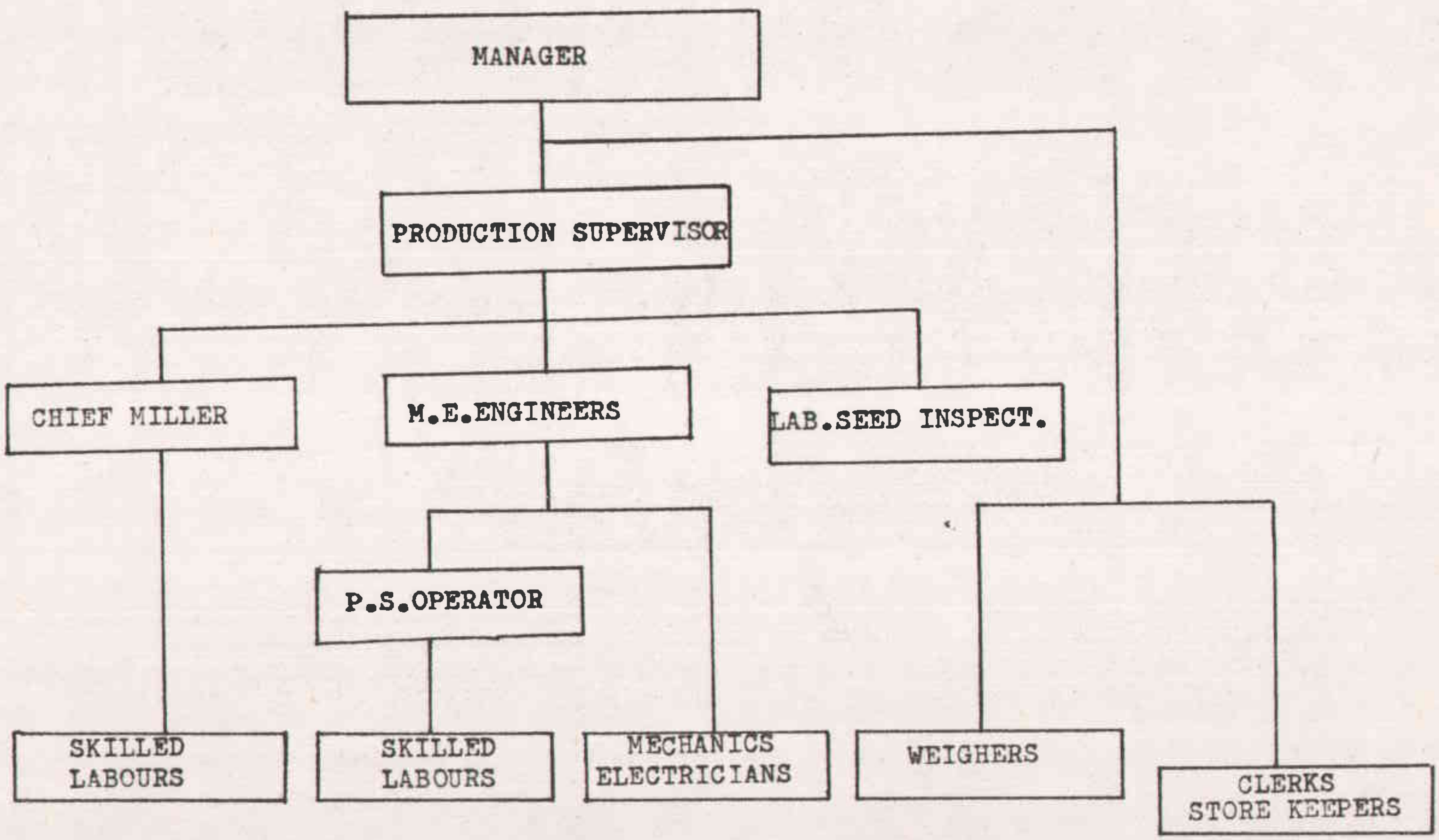
Year	Permanent staff	Temporary labourers	Fuel	Spare parts	Annual maintenance	Miscellaneous	Total
1							
2	114					20	134
3	325	25	111			50	511
4	343	25	211	140	500	120	1339
5	481	40	363	140	500	150	1674
6	579	50	632	140	500	190	2091
	1842	140	1317	420	1500	530	5749

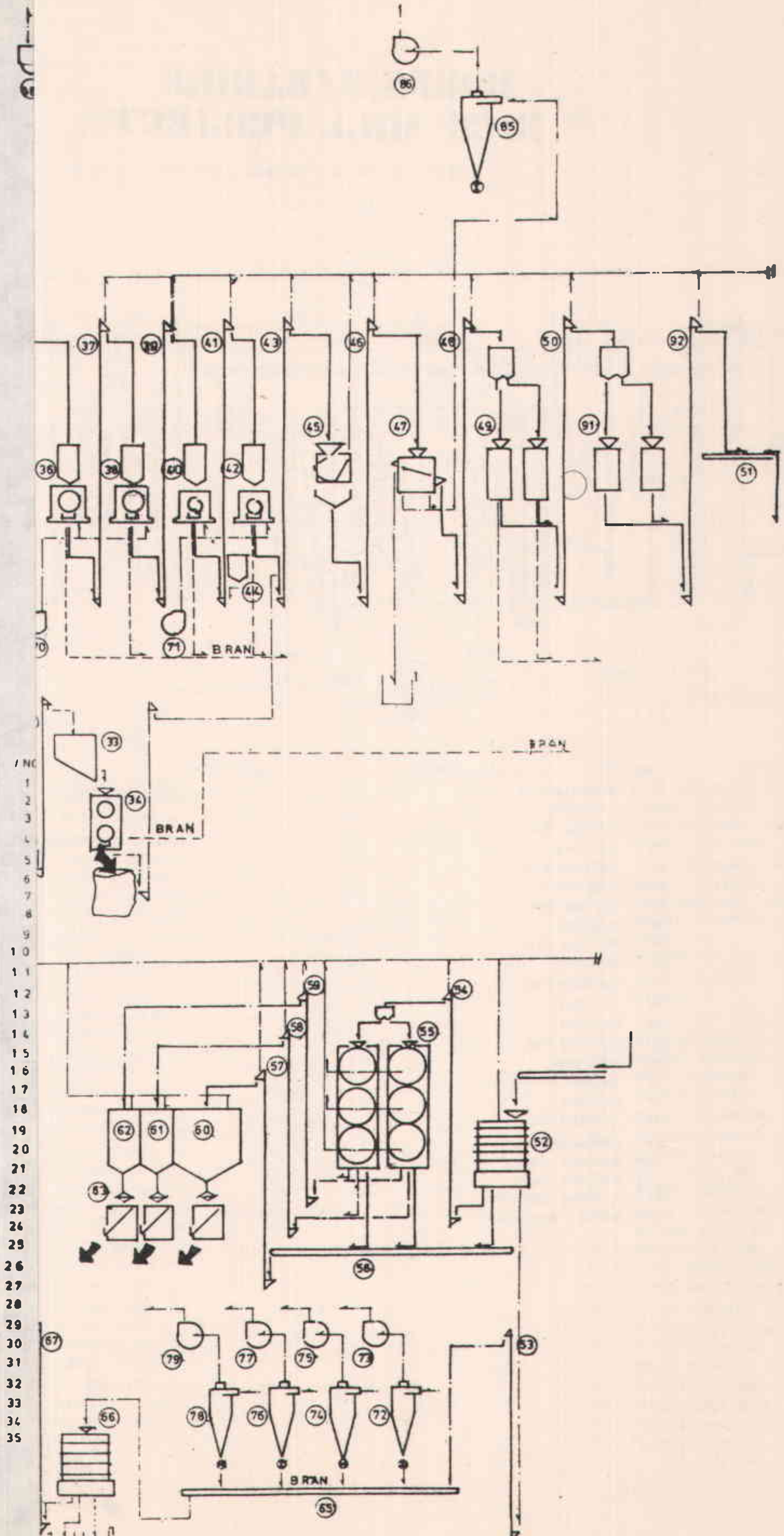
Table 5-3 : Total Requirements of Personnel and costs - Mordile- Barrire rice mill

Assignment	Annual Salary and No. of Person-nel	Year 1	Year 2		Year 3		Year 4		Year 5		Year 6	
	So. Sh. 000	No.	No.		No.		No.		No.		No.	
Manager	24	1	1	24	1	24	1	24	1	24	1	24
Production supervisor	20	1			1	20	1	20	1	20	1	20
Chief Miller	18	3			1	18	2	36	3	54	3	54
Engineers (mech. & elec.)	18	2	2	36	2	36	2	36	2	36	2	36
Laboratory seed Inspector	14	2			1	14	1	14	2	28	2	28
Power Station Operator	10	4			2	20	2	20	3	30	4	40
Clerks	7	4	1	7	4	28	4	28	4	28	4	28
Store Keepers	7	3	1	7	3	21	3	21	3	21	3	21
Skilled Labourers Operation	8	9			3	24	3	24	6	48	9	72
Power	8	3			1	8	1	8	2	16	3	24
Mechanics	8	6	3	24	3	24	3	24	4	32	6	48
Electricians	8	3	2	16	2	16	2	16	3	24	3	24
Weighers	8	2			1	8	1	8	2	16	2	16
Watchmen	4	6			6	24	6	24	6	24	6	24
Unskilled Labourers	4	30			10	40	10	40	20	80	30	120
				114		325		343		481		579

CHART 5-0

PERSONNEL CHART
MORDILE BARRIRE RICE MILL PROJECT





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MORDILE/BABIRE RICE MILL PROJECT

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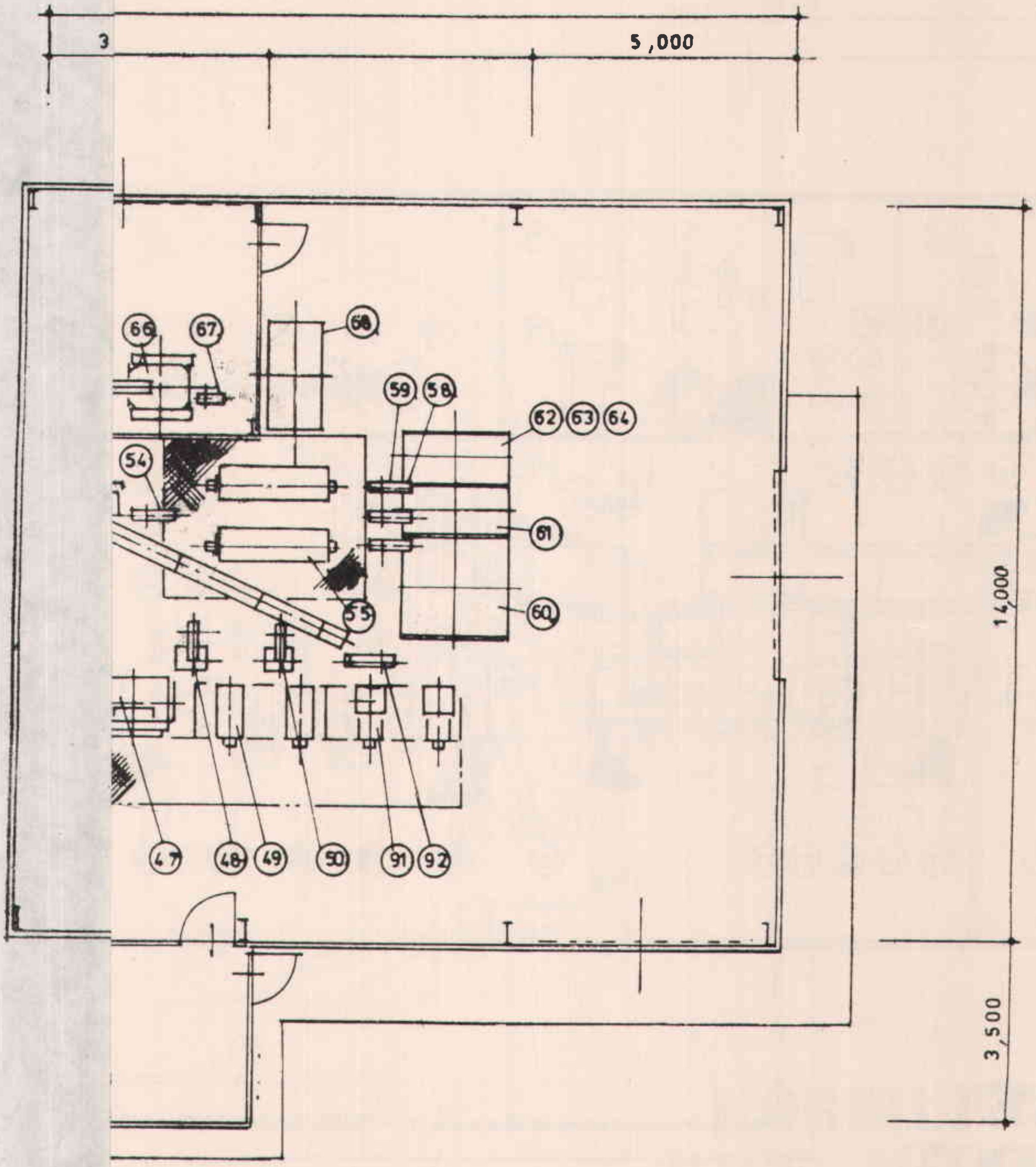
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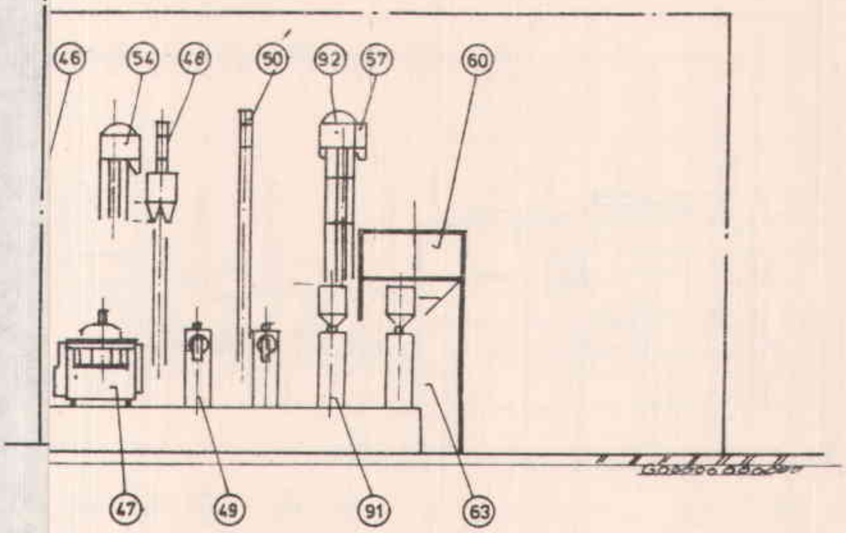
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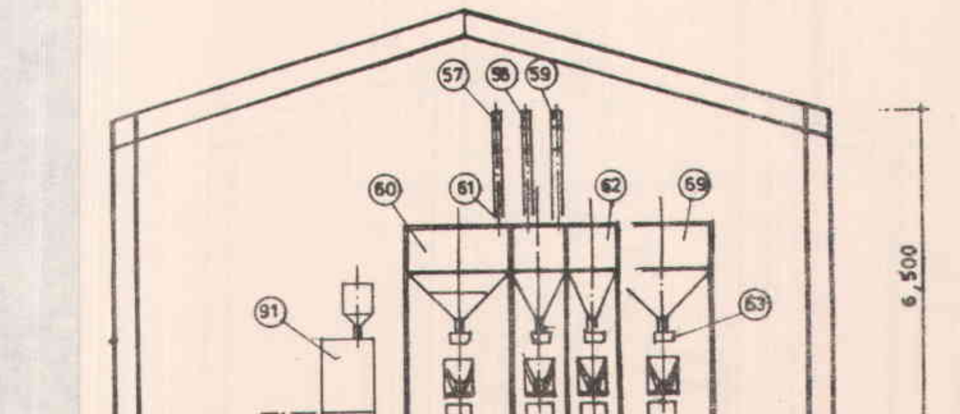
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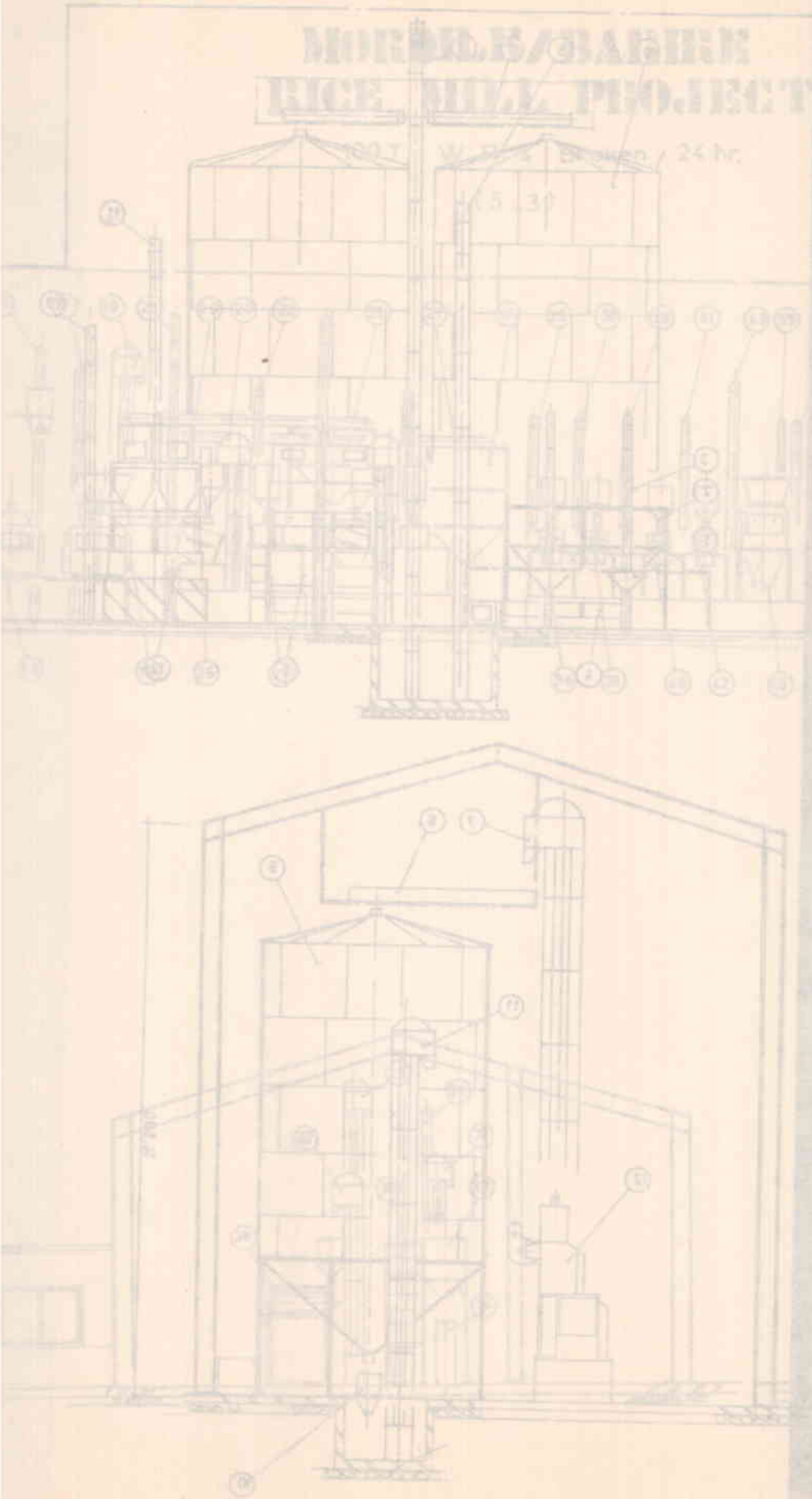
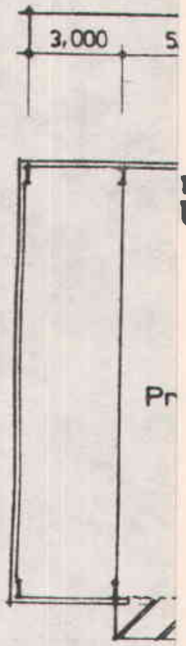
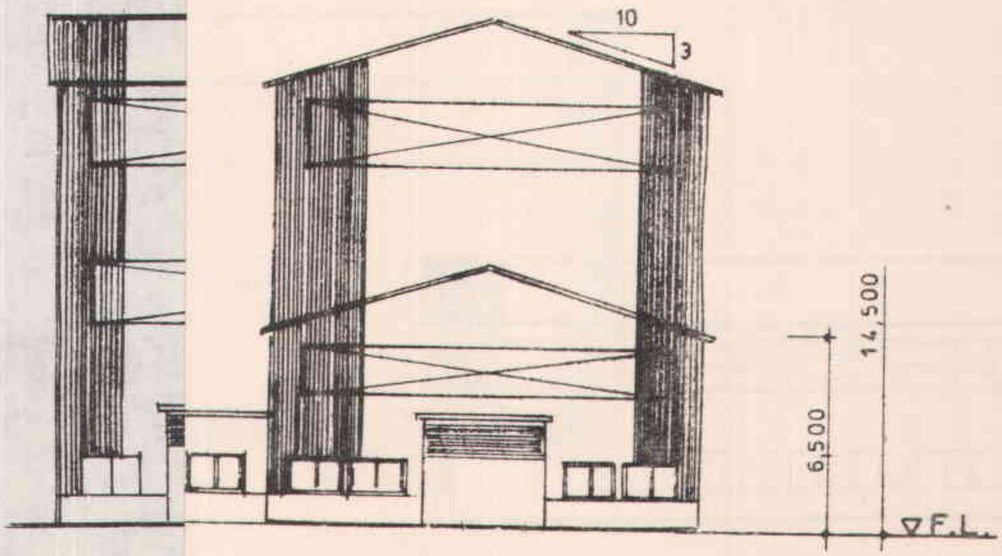

RICE MILL PROJECT
24 hr.

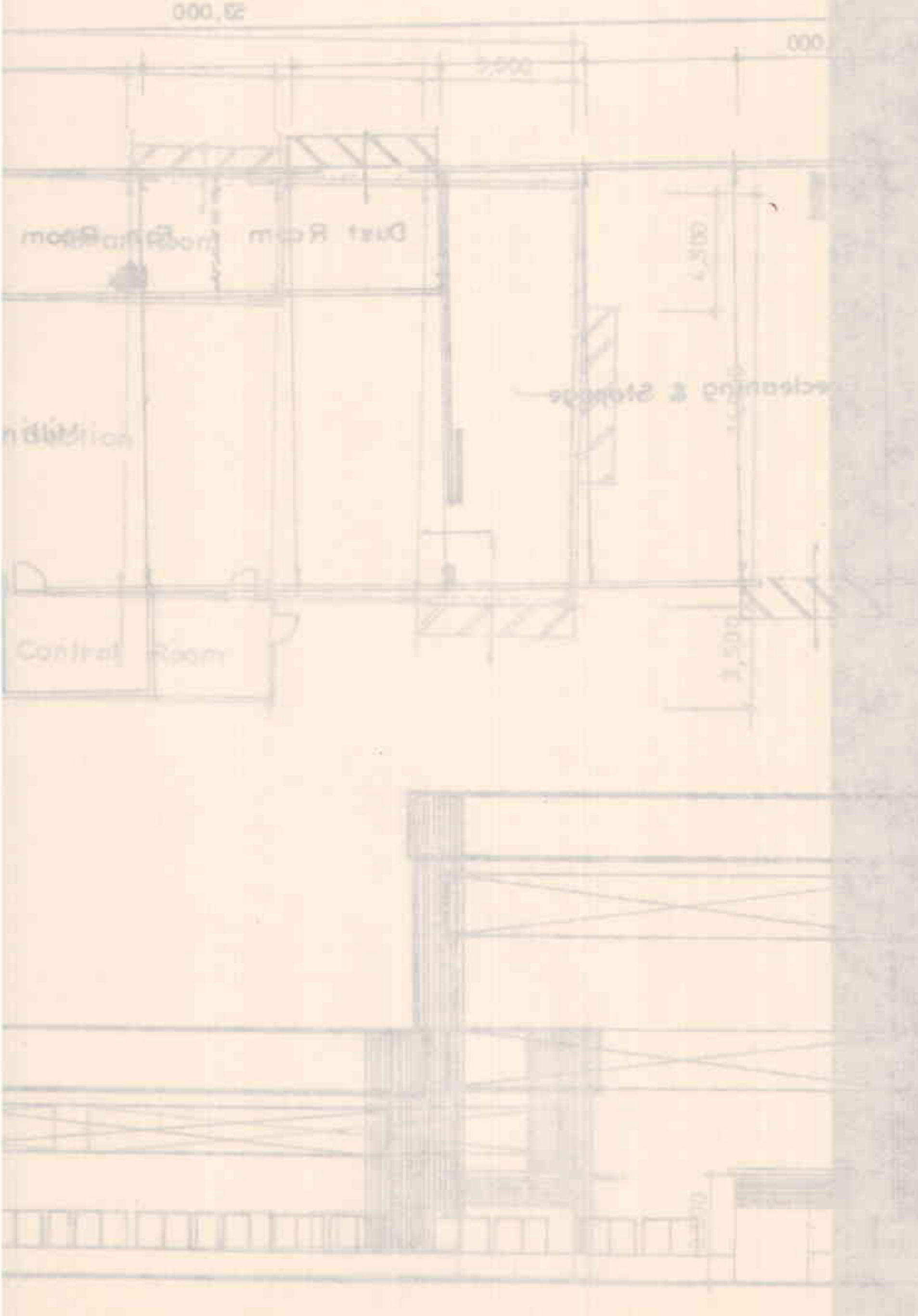
MORDILE/BARRE
RICE MILL PROJECT

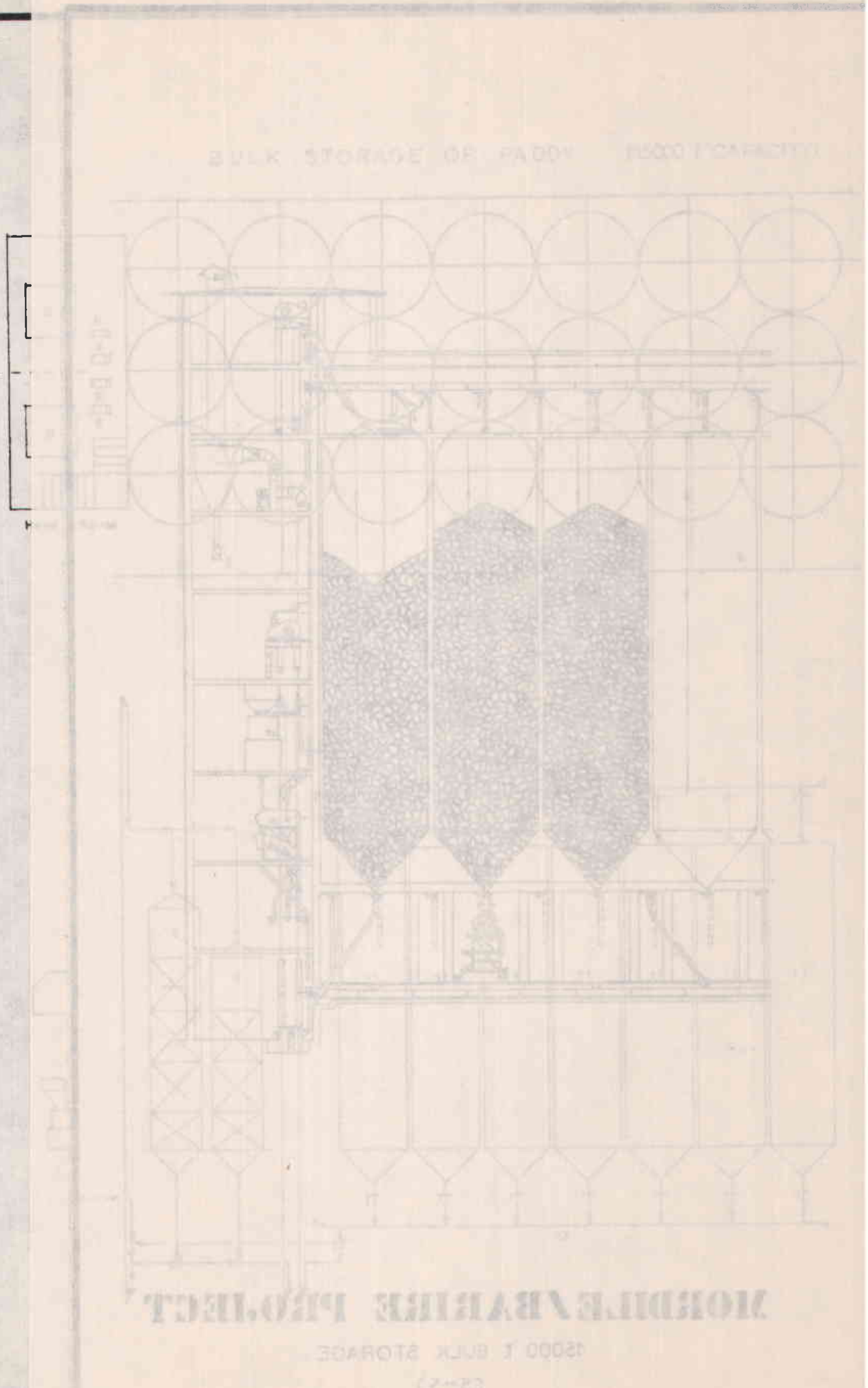
100 T W.R. & Broken / 24 hr

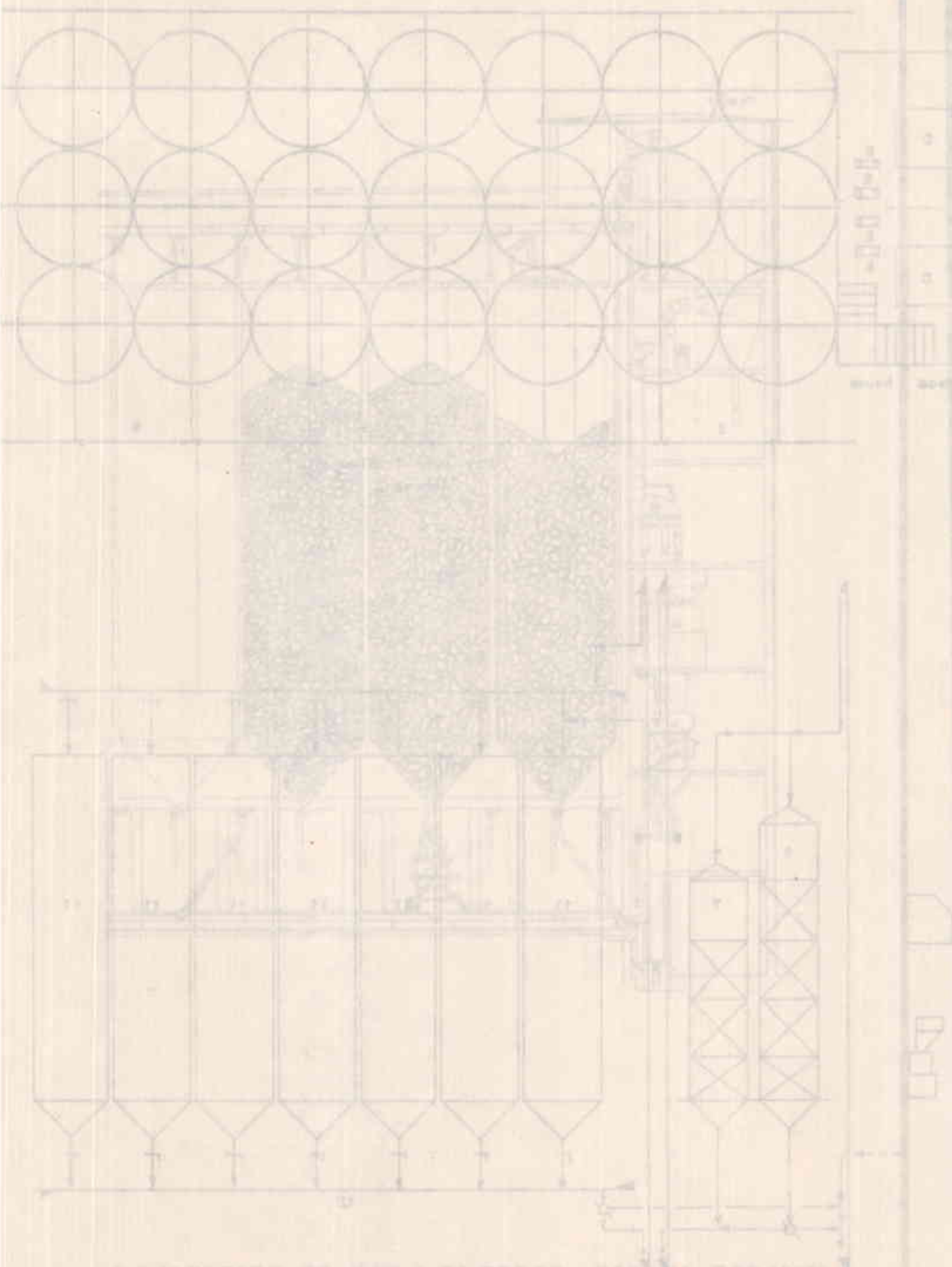
(S-4)






Control Room


BULK STORAGE OF PADDY 15000 T CAPACITY



MORDILE/BARIRE PROJECT

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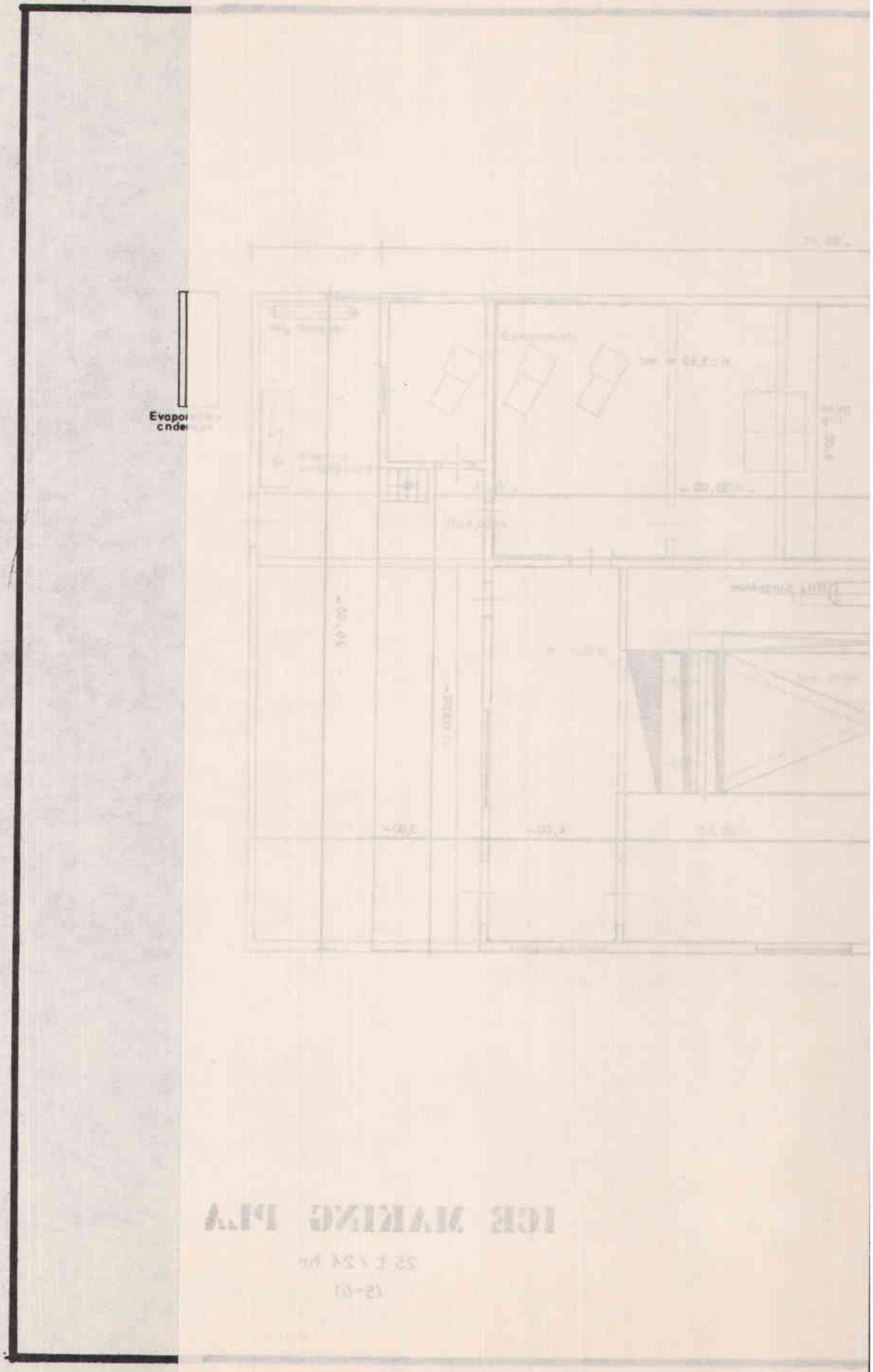
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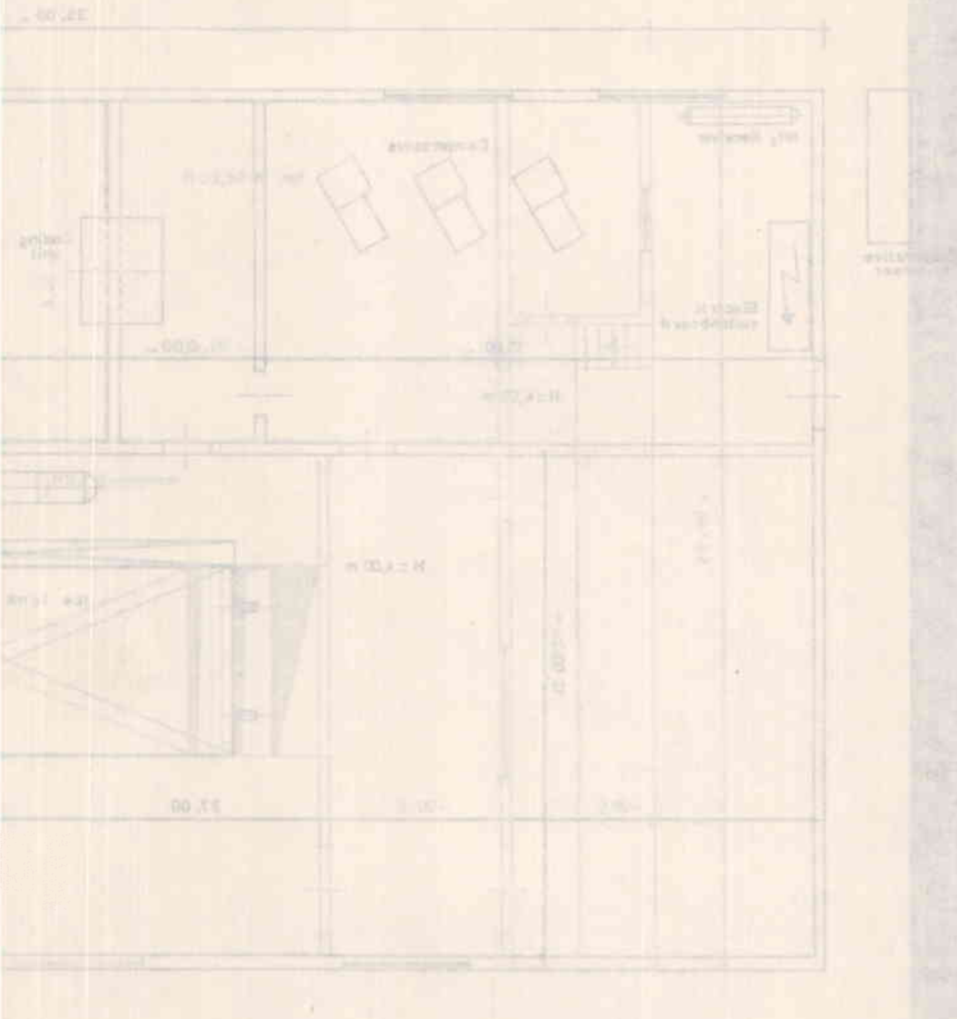


ICE MAKING PLA

CHAPTER 6

INFRASTRUCTURES AND IMPLEMENTATION

CHAPTER 6

INFRASTRUCTURES AND IMPLEMENTATION

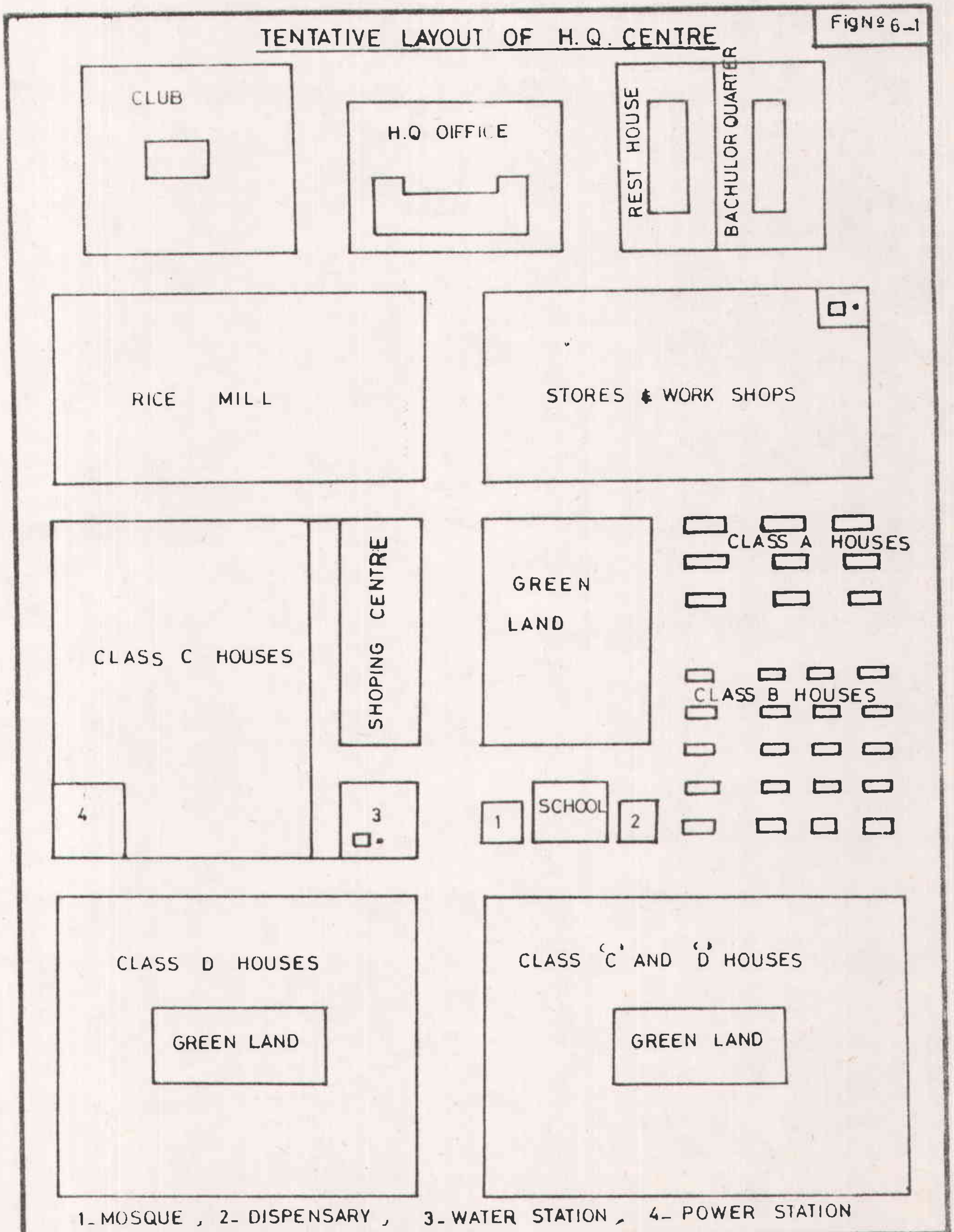
6.1 Infrastructures :

The main criteria in planning the infrastructure for this project is to provide the optimum supporting elements at the least possible costs. Economication should not be at the expense of the safty of the structure, but should be on the selection and the finish of the structure local materials should be used as much as possible. Another way of reducing cost is by reducing the number of management centres. It is proposed to have six centres in this project. The first is the main Headquarter centre. It is proposed to be the high land in the centre of the project. This land is cut out of the irrigation system being too high to irrigate by gravity from the canals. Another smaller centre is proposed near the pump station at El Sheick Mukhtar. This constitute the minimum possible infrastructures. The other four centres are agriculture centres one in each farm with no body living there except the watchman. Each has only an office and some stores.

6.1.1. Housing :

The provision of adequate housing for the staff will be one of the main elements of the project success. Good calibre of staff could not be attracted if no adequate housing is provided.

Four types of housing are proposed. The houses are typed A.B.C. and D in addition to accommodations in the bachelor quarter for bachelor junior management staff.


Fig№ 6_1
TENTATIVE LAYOUT OF H.Q. CENTRE
CLUB
H.Q OIFFICE
REST HOUSE
BACHULOR QUARTER
RICE MILL
STORES & WORK SHOPS
CLASS C HOUSES
SHOPING CENTRE
GREEN LAND
CLASS A HOUSES
CLASS B HOUSES
4
3
1
SCHOOL
2
CLASS D HOUSES
GREEN LAND
CLASS 'C' AND 'D' HOUSES
GREEN LAND
1_MOSQUE , 2_ DISPENSARY , 3_WATER STATION , 4_ POWER STATION

Type " A " house is the senior type house with an area of 132 M2 comprising three bed-rooms , a saloon, a living hall, a bath-room and a kitchen. (Fig. 6-2). The soil being heavy clay of swelling nature, it is advisable to build the house on a reinforced concrete frame structure with deep column footing and reinforced concrete slab roofing. The partition walls proposed are hollow concrete blocks, with smooth internal and external finish the floor is cement tiles.

Type " B " house is a medium type house with an area of 113 M2 having the same feature as type " A " except it has two bed-rooms. The structural design and the finish is the same as type "A" (Fig. 6-2). The sewage system for both types A and B will be a flushing system disposing into a septic tank connected to a percolation pit. Each two adjacent houses will have one unit of septic tank and percolation pit.

Type "C" house is a traditional Somali type of building. It is for junior staff and is composed of two circular huts connected with a living hall. The structure will be of local wood and plain concrete raft as floor. The wooden structure will be inside mud walls to be internally and externally plastered and have white wash. The roof will be corrugated iron sheets with a grass layer on top. The iron sheets will act as a water-proof strong layer. It is proposed that they have common bath rooms and W.C. The W.C. will be aqua prive type.

Type "D" is labourer housing. It is a single but of the same structure as type " C " common bath rooms and aqua prive W. C. will be provided.

Type A, B and C. will be provided with electricity and

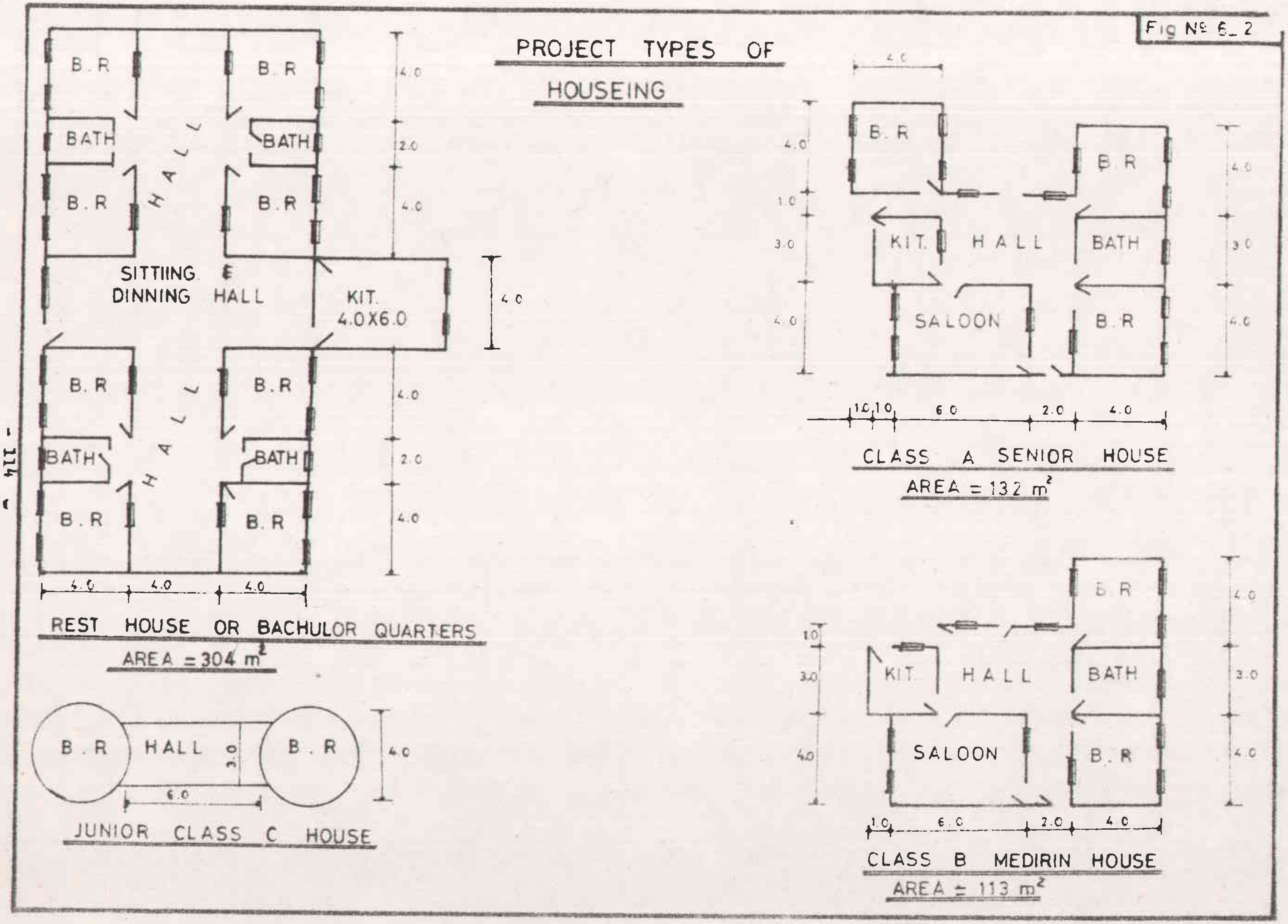


Fig № 6_2
PROJECT TYPES OF HOUSEING
B.R
BATH
HALL
SITTIING & DINNING HALL
KIT. 4.0X6.0
4.0
2.0
REST HOUSE OR BACHULOR QUARTERS
AREA = 304 m²
B . R
HALL
3.0
6.0
JUNIOR CLASS C HOUSE
KIT.
SALOON
1.0
CLASS A SENIOR HOUSE
AREA = 132 m²
CLASS B MEDIRIN HOUSE
AREA = 113 m²

water. For type " D " common water points and light will be installed in the streets in their area.

All the permanent staff will be provided with housing. Most of the staff will have separate house each, the type will be according to seniority. It is considered that some of the staff will be bachelors. The senior staff bachelors will be accommodated in the bachelor quarters where each one will have a separate room, and each two rooms will have a separate bathroom. They will share the kitchen, the sitting , living and dinning halls. The junior bachelor staff will share houses.

6.1.2. Domestic Water :

The domestic water will be from tube wells tapping the under-ground water. It is proposed to have two systems, one large system in the H. Qrs. centre and another small one at the pump site . The unit will be composed of a tube well with adequate pumping, a ground storage reservoir and a high tank connected with a pipe distribution system to the houses building and watering points. It is proposed have two such units in the centre to be inter-connected. Another unit will be at the pump site.

6.1.3. Health :

It is proposed to have a simple dispensary building having an area of 64 M2 to provide the basic treatment for the project staff. It will be in the H. Qrs. centre. It will be handed to the health authorities to run it. The project will provide only the building.

6.1.4. Education :

It is proposed to build a primary school for about 200 students. It is to be built from the local materials same as most of the schools in that area. It will be handed to the education authorities to run it. The project will provide only the building. It will be in the H. Qrs. centre.

6.1.5. Mesque :

It is proposed to build a Mesque in the H. Qrs. Centre. It will be of local materials with mud walls and fine internal and external finish and local material roofing in an area of 80 M2. It will be left for the staff to run it.

6.1.6. Roads :

It is recognized that the provision of all-weather servisable roads is an important factor in the efficient running of the project. There will be intensive traffic, in the peak season of harvest. It is proposed to have a main road running along the main canal with a branch connecting the H. Qrs. Centre to the main national paved road from Afgoi to Merca. The length of the project main road is about 35 km. It will be an unpaved road. It will have a well compacted layer of selected materials with a top layer of gravel and sand with a width of about 9 meters.

Project side roads will run along the minor canals. The length of these roads is about 80 km. They are of the same design as the main road except in width which is only 6 m. and smaller layers depths.

6.1.7. Electricity :

It is proposed to have a separate electricity generator for internal use in the project H. Qrs. and in the pump station but not in the other field centre.

The project electricity will be mainly for the residential areas, offices and social buildings. The rice Mill and workshops will have their own separate generation systems.

6.1.8. Offices :

It is proposed to have a central office in the Headquarters and then 5 field offices, one in each of the 4 farms and the fifth at the pump site. For safety it is proposed to be a reinforced concrete structure with reinforced concrete slab and cement blocks as partition and cement tiled floor. The finish is similar to the houses types " A " and " B " . The proposed area of the central office is 600 M2 comprising about 30 rooms in addition to other facilities. The field office is only 64 M2.

6.1.9. Telecommunication :

For the proper management control of the canalization system good communication with all the control structure and points is essential. A telecommunication system is recommended. There will be about 15 points in addition to the central station at the head-quarter. The most important point is the pump station where urgent orders of more supply or cut may be needed.

6.1.10. Stores :

There are many types of stores suggested in this project. Full storage will be provided for all agricultural inputs. These stores will be of steel truss structures, with brick side walls and plain concrete floors. Forty of these stores will be needed, each with an area of 144 M2. They will be distributed in the farms and the headquarters.

Similar storage will be provided for products other than rice which will have a separate system of storage. The storage of these products will be for seven days only after harvest after which they will go to the marketing agencies. This type of stores is similar to the input stores. Twenty stores with an area of 288 M2 will be provided. Also sheds are provided for the finished rice until it goes to the marketing agencies.

Other stores for spare parts and general items will be provided.

6.1.11. Workshops :

Adequate workshops will be provided. There will be a separate workshop for the agricultural tractors at the headquarters. Another workshop for vehicles is proposed. A separate workshop is proposed at the pumps and small items like electric generating small pumps ... etc.

Summary

- of Infrastructure Cost -

	So. Sh.
Housing	15,850,300
Offices	1,600,000
Stores	13,219,200
Roads	14,000,000
Social buildings	428,000
Water Supply	2,000,000
Electricity	4,000,000
Workshops	2,645,000
Telecommunications	600,000
	54,342,500

6-2 Implementation :

There are many option and methods to implement this project. The construction could either be on contract basis or direct labour. The contracts could be local contracts or through international bidding. The local contracts could be negotiated with the public sector or open for both public and private sectors. There are no competent local private contractors capable to carry out such job, so the last option can be deleted.

The actual method of construction will depend very much on the financial arrangements. This discussion is to indicate the possibilities and their implications.

The construction of such a project may not be very attractive for international contractors to come from outside to country unless there are some international contractors already involved in some other jobs ; they may be interested in parts of or the whole project.

The supply, delivery, and errection of the pumps should be on international competitive bidding which is expected to give better offers than any other methods.

It is not advisable to construct this project by direct labour. This will require creation of a massive organization with well experienced staff. It will neither be practical nor economical except in land levelling and bush clearance which would be advisable to do by direct labour. They do not require a massive organization. All they require is the management of the machines and qualified surveyers. The cost is estimated on this basis. The project will provide the require machines and operate them.

It is recommended that all other works be on contract basis. The cost is estimated accordingly. It is advisable to divide the work into many contracts as follows, open for both public agencies as well as international contractors :

1. Pump house and pump colony
2. Canalization and drainage earthwork and roads
3. Canal and drain structures
4. Houses, offices and public buildings
5. Stores, workshops and sheds
6. Water supply systems
7. Internal electrical grid.

The supply of all equipments, vehicles and machines would be according to the general procurement regulations of the country.

6.2.1. Implementation Programme :

The detailed proposed programme of implementation is shown in the bar-chart (Fig. 6-2). The year "0" is the pre-construction period. In this period the detailed topographic survey of the area would be made according to the specifications required for the detailed design of the canal and drainage systems. Also the design of the project components, the specifications of pumps and equipment and all tender documents would be prepared in this period. At the end of this period tenders would be announced, processed and awarded.

The construction programme of the irrigation works and infrastructure is proposed to be as follows :-

(A) Irrigation Works :

1. In the first two years of construction year 1 and 2 the work will be concentrated in the construction of the pump house, errection of the pumps, excavation of the main canal, the main canal structures, the excavation of some minor canals and the construction of their structures, complete to the laterals, bush clearance and land levelling. So by the end of the second year those minor canals would be completely ready for cultivation with an area of 2900 ha, 29% of the project area.

2. Then the work on the other minor canals would continue in such a way that at each agricultural season

complete new minor canals would be ready for irrigation, and could be added to the cultivated area. All the irrigation work would be completed by the end of the 5th year. The work on the drainage system and roads will go in parallel.

(B) The Infrastructure :

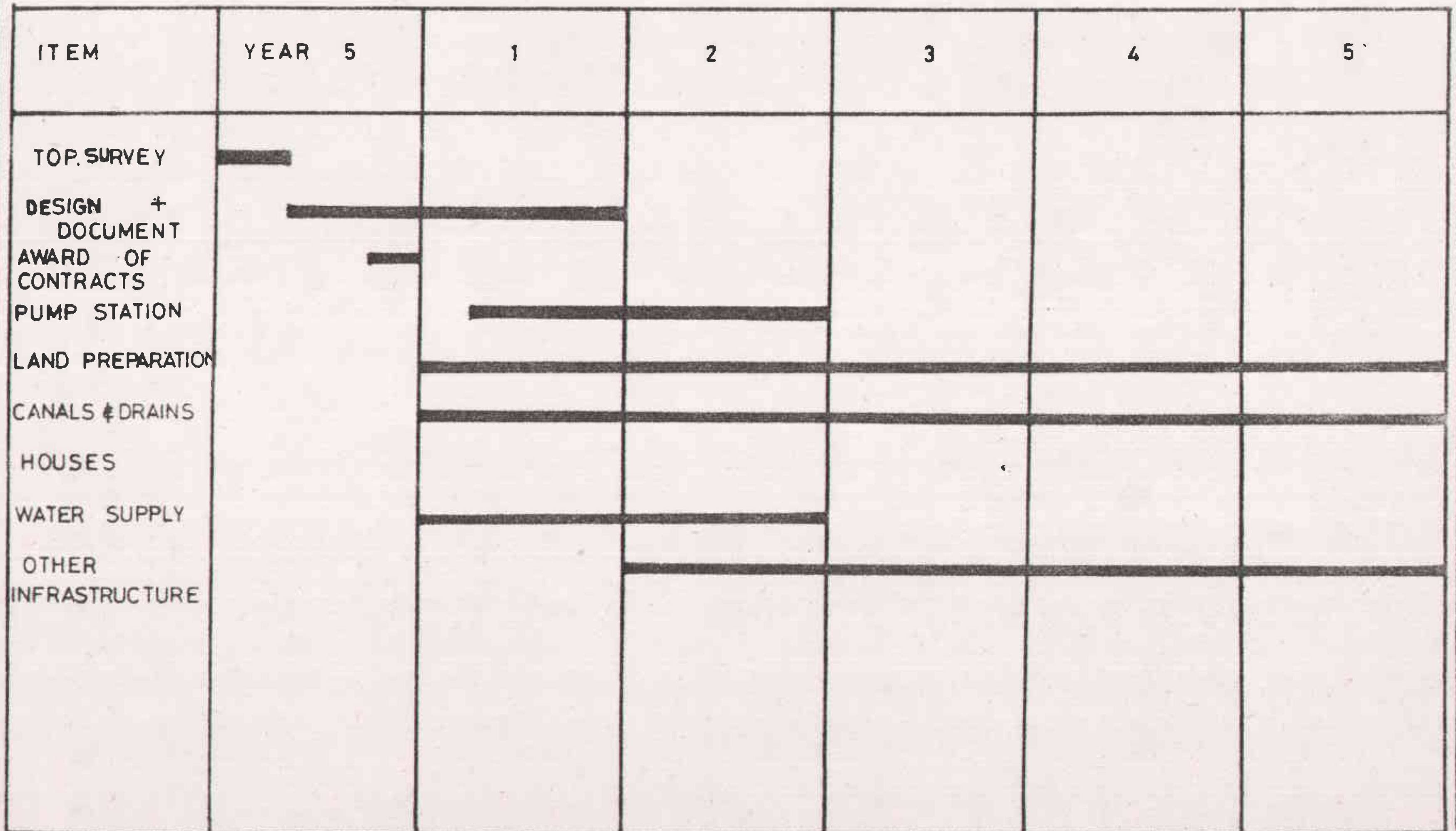
1. It is proposed that the construction work in infrastructure will follow approximately the pattern of the irrigation work so as to provide the necessary infrastructure for the area to be cultivated. So it is proposed in the first two years to complete 30% of the houses stores, sheds workshops in addition to the water supply system.

2. Then the work will continue so that at the end of the 3rd year 45% of the houses, stores sheds would be completed. Another 15% would be completed by the end of the 4th year.

3. The remaining of the work in addition to the offices and all other public buildings would be completed by the end of the 5th year.

Fig№ 6 _ 3

TENTETIVE CONSTRACTION PROGRAMME



CHAPTER 7

EVALUATION OF THE PROJECT

CHAPTER 7

EVALUATION OF THE PROJECT

The project will provide by adequate proportion food crops such as rice and maize. In the meantime they are import substitute crops. It has been considered to keep technological change to a minimum, while mechanization will take place for most agricultural operations, i.e. capital intensive project.

This aspect is a must in the light of shortage of labour force especially in the seasons' peaks.

7.1. Project Costs :

Investment and operating costs have been calculated in two cases ; the first, in terms of import prices and the second using local prices.

7.1.1. Investment costs :

A summary of the project capital costs is given in Table (7-1) and Annexes (3,6). Calculations of costs of imported goods or foreign component are based on (C I F) Mogadishu prices, the capital costs of the proposed project amount to about So. Sh. 258 Million. The main capital assets are irrigation network, agricultural machinery, rice mill and infrastructure. Their cost amounts to So. Sh. 67.14, 43.22, 24.68, 54.3 million representing about 26%, 17%, 9.5%, 21% of the total cost for the same order respectively.

The foreign component in the capital costs constitutes

Table 7-1 : Composition and Phasing of Investment Outlay
(So.Sh. 000) (Economic Prices)

	Years						
	1	2	3	4	5	6	Total
Irrigation network	40380	10100	5700	6050	4914	-	67144
Irrigation machinery, equipment and vehicles	-	184	377	229	1307	4880	6977
Land reclaimation machinery	4787	3636	3575	1212	-	-	13210
Agricultural machinery	-	13049	9260	9578	11328	-	43215
Workshop	-	1377	-	612	1102	-	3091
Rice mill machinery	-	12931	1623	3649	6481	-	24684
Rice mill buildings	-	5427	-	-	-	-	5427
Vehicles for farm	472	169	321	218	6	-	1186
Infrastructure for the project	25962	11770	9970	3794	2846	-	54342
Spare parts for Development Period							
Land reclamation	724	545	1172	722	186	-	3349
Irrigation	-	14.5	47	66.5	114	568	810
Agric. machinery	-	-	1304	1111	1149	1358	4922
Pump Station	-	-	254	401	557	635	1847
Expatriates and training							
For the farm	-	-	600	600	600	-	1800
For the rice mill	-	-	1246	-	-	-	1246
Compensation	1200	-	-	-	-	-	1200
Sub total	73525	59202.5	35449	28242.5	30590	7441	234450
Contingencies 10%	7352	5920	3545	2824	3059	744	23444
Grand total	80877	65122.5	38994	31066.5	33649	8185	257894

Source : Annexes 3, 4, 6 - ONAT, WAGAD

Table 7-2 : Investment cost by currency economic prices (So. Sh. 000)

	1		2		3		4		5		6		Total	
	L	F	L	F	L	F	L	F	L	F	L	F	L	F
Irrigation network	5030	35350	3350	6750	2700	3000	2650	3400	3867	1047	-	-	17597	49547
Irrigation machinery, equipment and vehicles	-	-	4	180	7	370	5	224	26	1281	95	4785	137	6840
Land reclamation machinery	47	4740	36	3600	35	3540	12	1200	-	-	-	-	130	13080
Agricultural machinery	-	-	129	12920	92	9168	94	9484	12	11216	-	-	427	42788
Workshop	-	-	27	1350	-	-	12	600	22	1080	-	-	61	3830
Rice mill machinery	-	-	128	12803	16	1607	36	3613	64	6417	-	-	244	24440
Rice mill building	-	-	2727	2700	-	-	-	-	-	-	-	-	2727	2700
Vehicles for the farm	4	468	1	168	3	318	2	216	-	6	-	-	10	1176
Infrastructure for the Project	8000	17962	8870	2900	2940	7030	3280	514	1561	1285	-	-	24651	29691
Spare parts for development period														
Land reclamation	14	710	5	540	12	1160	2	720	6	180	-	-	39	3310
Irrigation	-	-	0.5	14	3	44	3.5	63	14	100	10	558	31	3310
Agric. machinery	-	-	-	-	12	1292	11	1100	11	1138	13	1345	47	4875
Pump station	-	-	-	-	14	240	21	380	47	510	35	600	117	1730
Expatriates and training														
For the farm	-	-	-	-	168	432	168	432	168	432	-	-	504	1296
For the rice mill	-	-	-	-	249	997	-	-	-	-	-	-	249	997
Compensation	1200	-	-	-	-	-	-	-	-	-	-	-	1200	-
Subtotal	14295	29230	15277.5	43925	6251	29198	6296.5	21946	5898	24692	153	7288	48171	186279
Contingencies 10%	7352		5920		3545		2824		3059		744		23444	
Grand total	80877		65122.5		38994		31066.5		33649		8185		257894	

L = Local currency F = Foreign currency

Siurce : Table (7-1) and Annexes 3, 4, 6.

Table 7-3 : Replacement cost over project lifetime

(000 So. Sh.)

	Irrigation machines, equipment, and mobile workshop		Agricultural machines and workshops		Transportation vehicles for the farm		T o t a l	
	A	B	A	B	A	B	A	B
5								
6								
7								
8								
9	184	234					184	234
10	377	481	12920	16796			13297	17277
11	229	291	9168	11918	472	472	9869	12681
12	328	426	9483	12329	169	169	9980	12924
13	168	218	11216	14580	321	321	11705	10119
14	612	795	-	-	218	218	830	1013
15	-	-			6	6	6	6
16	612	795					612	795
17	377	481	12920	16796			13297	17277
18	229	291	9168	11918			9397	12209
19	648	842	9483	12329			10131	13171
20	1881	2445	11216	14580			13097	17025
21	4284	5569			472	472	4756	6041
22	-	-			169	169	169	169
23	184	234			321	321	505	505
24	377	481	12920	16796	218	218	13515	17000
25	229	291	9168	11918	6	6	9403	12215

Source : Table 7-1 and Annexes 3, 4, 6,

a = Replacement with economic prices.

b = Replacement with financial prices.

about 80% while the local component constitutes about 20% of the total capital costs (Table 7-2).

The implementation of the project is scheduled to be completed by the end of the year 6. About 57% of investment costs however, will be spent in the first two years. This is mainly because of the irrigation network, land reclamation machinery and infrastructure. Starting from year 9 replacement costs will take place according to the life time of each assest (Table 7-3).

7.1.2. Operating Costs :

These expenses comprise mainly the agricultural inputs (seeds, fertilizers, insecticides, herbicides,), fuel and labour force, permanent or casual. According to the build-up of the agricultural rotation and the technical coefficient needed from each input, total quantities of inputs have been calculated (Table 7-4) and Annex 6). Seeds will be purchased locally while fertilizers, pesticides and fuel are imported goods. All these inputs are duty free except fuel. Costs of these inputs are calculated CIF Mogadishu plus handling and transportation costs till the site of the project [1]. The operating costs using import prices amount to about So. Sh. 56 million at the full maturity of the project in the year 7.

The main items constituting operating costs are agricultural inputs which amount to So. Sh. 16 million, fuel expenses amount to about So. Sh. 11 million, casual and

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(1) The center of the project site will be about 50 km. from Mogadishu transportation costs per ton/km will be So. Sh. 6.

Table 7-4 : Total quantities of inputs needed for the agricultural rotation

Item / Years	3	4	5	6	7
Seeds (Ton)					
Rice	325	560	775	1000	1000
Maize	-	27	45.8	62.3	75
Sesame	-	12.8	18	25	25
Cowpea	97.5	102.8	132.8	162.8	150
Urea (Ton)					
Rice	650	1120	1550	2000	2000
Maize	-	180	305	415	500
Sesame	-	127	180	250	250
Cowpea	81	85	110	135	125
Tsp (Ton)					
Rice	325	560	775	1000	1000
Maize	-	90	152	207	250
Sesame	-	63	90	125	125
Cowpea	162	170	220	270	250
Stam (000 liter)					
Rice	32.5	56	77.5	100	100
Sevin (Ton)					
Rice	13	22.4	31	40	40
Maize	-	3.6	6.1	8.3	10
Sesame	-	2.55	3.6	5	5
Labour requirement :					
Man	71500	160400	230650	302250	315000
Woman	156000	332850	463950	607450	610000
Child	325000	560000	775000	1000000	1000000

Fuel amounts are indicated in Annex (6).

Source : Agricultural Section Chapt. (4) and Annex (6).

Table 7-5 : Composition of annual operating expenses (000 So. Sh.
(Economic prices)

Item \ Years	1	2	3	4	5	6	7
Fuel and Lubricant for:							
Irrigation machinery	-	60	184	259	684	2294	2294
Earth moving and L. R.	740.5	740.5	1890.4	2141.7	2327.5	-	-
Agricultural machinery	-	-	1891.1	3194	4549	6137	6167
Pump Station	-	-	771	1248	1615	1923	1923
Rice Mill	-	-	111	211	363	632	632
Farm vehicles	-	3.2	5	8	10	10	10
Agricultural Inputs Seeds	-	-	870.5	1383.5	1895.5	2430.7	2404
Fertilizers:							
Urea	-	-	1337	2765	3924	5123	5259
TSP	-	-	915	1658	2324	3011	3051
Insecticides	-	-	520	1142	1628	2132	2200
Herbicides (stam)	-	-	975	1680	2325	3000	3000
Spare parts :							
For irrigation	-	-	-	-	-	-	568
For pump operation	-	-	-	-	-	-	635
For rice mill	-	-	-	140	140	140	140
For agric machinery	-	-	-	-	-	-	4278
Wages of labour force							
a- Permanent							
Irrigation :							
Skilled	-	64	226	342	540	734	734
Unskilled	-	24	56	84	112	144	144
Agriculture :							
Skilled	100	238	566	788	896	904	904
Unskilled	8	12	304	872	1160	1160	1160
Field operation & workshop							
Skilled	435.6	435.6	2088.6	2853	3930.6	4710.6	4710.6
Rice mill skilled	-	114	325	343	481	579	579
Unskilled	-	-	25	25	40	50	50
b- Casual labour							
Unskilled	-	-	3588	7065	9891	12881	13030
Maintenance							
Infrastructure 1%	260	377	477	513	543	543	543
Rice mill	-	-	-	500	500	500	500
Sub Total	1534	2068.3	17125.6	29216	39888.5	49038	54915.6
Overheads 2%	31	42	343	584	798	981	1098.4
Grand Total	1565	2110	17468	29800	40686	50019	56014
Operating cost with economic prices	1561	2092	15482	25778	35085	42902	48822

Source : Table (7-4) and annexes (3, 4, 6,)

Table 7-6 : Composition and phasing of investment outlay

(So. Sh. 000)

(Local Prices)

Year	1	2	3	4	5	6	Total
Irrigation :							
Network	43380	10350	4700	6050	4914	-	70394
Machinery :							
Irrigation+	-	234	481	291	1665	6220	8891
Earth moving	6162	1080	4602	1560	-	-	13404
Agriculture	-	16796	11918	12329	14580	-	55623
Rice Mill	-	16643	2089	4696	8342	-	31770
Workshop Equipment	-	1755	-	780	1404	-	3939
Vehicles for the Farm	472	169	321	218	6	-	1186
Rice Mill Building	-	5427	-	-	-	-	5427
Infrastructure	25962	11770	9970	3794	2846	-	54342
Spare Parts++							
Earth moving	724	545	1172	722	186	-	3349
Irrigation	-	14.5	47	66.5	114	568	810
Agriculture	-	-	1304	1111	1149	1358	4922
Pump Station	-	-	254	401	557	635	1847
Expatriates :							
For the farm	-	-	600	600	600	-	1800
For rice mill	-	-	1246	-	-	-	1246
Compensation	1200	-	-	-	-	-	1200
Sub Total	77900	64783.5	39704	32618.5	36363	8781	260150
Contingencies (10%)	7790	6478	3970	3262	3636	878	26014
Grand Total	85690	71261.5	43674	35880.5	39999	9659	286164

\+ Irrigation machinery include vehicles for irrigation work.

++ Spare parts indicated here will be brought with the machinery.

Source : Annex (6) - ONAT, WAGAD.

Table 7-7 : Financial analysis composition of annual operating expenses

Item / Years	1	2	3	4	5	6	Total
Fuel and lubrication							
Irrigation	-	75	231	326	861	2890	2890
Earth moving	932	932	2381	2698	2932	-	-
Agric. machinery	-	-	2383	4024	5744	7732	7770
Pump Station	-	-	971	1752	2035	2423	2423
Rice Mill machinery	-	-	140	266	457	796	796
Farm vehicles	-	4	6	10	13	13	13
Agricultural Inputs							
Seeds	-	-	1023	1633	2241	2875	2850
Urea fertilizer	-	-	1688	3491	4954	6446	6465
TSP fertilizer	-	-	1251	2267	3177	4116	4171
Herbicides (stam)	-	-	1300	2240	3100	4000	4000
Insecticides (sevin)	-	-	715	1570	2238	2931	3024
Permanent labour							
Irrigation	-	88	282	426	652	878	878
Agriculture	108	250	870	1660	2056	2064	2064
Field operation and workshop	435	435	2088	2853	3931	4710	4710
Earthmoving+							
Rice Mill	-	114	350	368	521	629	629
Casual labour	-	-	3588	7065	9891	12881	13030
Spare Parts++							
Irrigation	-	-	-	-	-	-	568
Pump Station	-	-	-	-	-	-	635
Rice Mill	-	-	-	-	-	-	140
Agric. machinery	-	-	-	-	-	-	4278
Maintenance Rice mill	-	-	-	500	500	500	500
Infrastructure	260	377	477	514	543	543	543
Sub total	1735	2275	19744	33483	45846	56427	62377
Over heads	34.7	45.5	395	670	917	1129	1248
Grand Total	1770	2321	20139	34153	46763	57556	63625

\+ Earth moving fuel and labour force in the first years of development.

++ Spare parts for the first 6 years are included in investment.

Source : Annex 6.

permanent labour force amounts to So. Sh. 22 million of which about So. Sh. 13 million are casual labour. However, casual labour wages are shadow priced in economic analysis. When using local or selling prices in cost estimates for capital assets and operating costs, the total investment costs amount to about So. Sh. 286.2 million (Table 7-6). This increase is due to the margins charged from some items mainly agricultural machinery. The total operating costs in this case amount to about So. Sh. 63.6 million (Table 7-7).

Investment costs per/ha range between So. Sh. 25.8 and 28.6 thousand using import and local prices respectively.

7.2. Labour Force :

The number of families inside the project area has been estimated at about 400 household families. The villages close to the project area include about 866 families. These families constitute about 4361 [1] members, i.e. the average size of the family is 5.03 comprising on the average two adults, two children below the age of 14 and one or two other non-adults[2].

The 400 families inside the project area assumed to be included in the project will be provided with houses and other infrastructure needed ; however, a compensation of So. Sh. 3000 per family has been include in the investment cost. These families will cover a part of the labour force needed for the project[3]. The remaining needs of the labour force can be

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(1) Agricultural district office - Afgoi.

(2) Jenale Bualo Marerta Report Annex III, IV population 1978.

(3) Labourers needed for the project are indicated in Annex (6).

covered from the villages close to the project or the nearby villages.

With respect to permanent staff needed, Tables (7.9 and 7-10) and Annex (6) indicate the number needed from different jobs in irrigation, agriculture, field operations and workshops and their wages annually.

The tables show the build-up of the number needed annually till the full maturity of the project.

7.3 Revenue Estimates :

The project income is based mainly on sales of produce to the Agricultural Development Corporation (ADC) and National Trade Agency (INCH). The projected maximum yields is expected to be realized in the year 7 of the project implementation for the three merchandizing crops in the rotation, rice, maize and sesame.

The yields are expected to be stablized after that throughout the life time of the project. In the first year of cultivation (3rd year of project implementation) about 65,000 quintals of paddy rice will be produced. At project full maturity (year 7) the projected quantities of produce are 400,000 quintals of rice, 20,000 quintals of sesame and 100,000 quintals of maize (Table 7.8).

The anticipated revenue achieved has been calculated using economic prices (import price CIF Mogadishu 1980) after drawing it back to farm gate prices (Table 7-8, Annex 6). For the purpose of financial analysis selling prices prices have been used to calculate the anticipated revenues (Table 7-9).

Table 7-8 : Total Production (quintals)

	3	4	5	6	7
Rice :					
Rough	65,000	140,000	232,500	400,000	400,000
Milled	42,900	92,400	153,450	264,000	264,000
Sesame	-	5,100	10,800	20,000	20,000
Maize	-	18,000	45,750	83,000	100,000

Source : Chapter 4.

Table (7-9) **Total Revenue (000 So. Sh.)**

1. Financial Prices
2. Economic prices

1+ - **Financial Prices**

	3	4	5	6	7
Milled rice	15,015	32,340	53,708	92,400	92,400
Sesame	-	1,530	3,240	6,000	6,000
Maize	-	1,800	4,575	8,300	10,000
Total	15,015	35,670	61,523	106,700	108,400

2++ **Economic Prices**

	3	4	5	6	7
Milled rice	11,755	25,318	42,045	72,336	72,336
Sesame	-	2,147	4,547	8,420	8,420
Maize	-	1,663	4,158	7,669	9,240
Total	11,755	29,128	50,750	88,425	89,996
					- 1,500
					88,496

++ Economic Prices

1 US $ =	6.23	or 12
Rice	274	523
Maize	92.4	173.6
Sesame	421	838

+ Financial Prices

1980
350
100
300

Source : Annex 6.

The total revenues amount to So. Sh. 11.7 million in the 3rd year, they are estimated at about So. Sh. 90 million at full maturity in the seventh year using import prices. When using local selling prices, the net revenues amount to about So. Sh. 15 million in the 3rd year and about So. Sh. 108.7 million in the year of full maturity, the value of rice production representing about 86% of total revenue in that year.

7.3.1. By-products :

Following harvesting a number of valuable by-products will be available for livestock feeding ; the fattening station in Afgoi can be provided by these by-products or a livestock herd can be established on the farm after project implementation to benefit from these by-products such as rice husks, rice straw and sesame and maize straw. Bran and germs, the secondary products of rice milling, will be valuable feed to livestock.

The expected total revenue attained is estimated to be So. Sh. 1.339 million in the year 3 ; it reaches about So. Sh. 7.24 million in year 7. The net revenue of these by-products after deducting costs of collection and transportation amounts to Sh. Sh. 845 thousand and 4.6 million in the third and seventh year respectively (Table 7-10).

As an incentive to the workers in the project, they can be provided with their needs of maize and rice at farm gate prices which are less by about 30% than the retail prices.

Coefficients of quantities of by-products produced and estimated prices are indicated in Table (7-10).
Estimated collection costs are about 40% of the value of by-products.

Table 7-10 : Value of by-products over project lifetime (000 So. Sh.)

Y e a r	3	4	5	6	7
Rice husk	200	560	930	1600	1600
Rice Straw	975	1680	2325	3000	3000
Sesame straw	-	510	720	1000	1000
Maize straw	-	360	610	830	1000
Secondary products					
Bran + germs	104	224	372	640	640
Total	1339	3334	4957	7070	7240

+ Costs of collecting by-products = 40% of total value of by-products.

Net revenue	845	2090	3123	4498	4600

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1. Quintal rough rice gives 20 kg husk
   Quintal rough rice gives 8 kg bran + germs
   One hectare rice gives 3 tons straw

2. One hectare of maize and sesame gives 10 tons straw for each
   Price of quintal of husk about So. Sh. 20
   Price of 1 ton rice straw So. Sh. 100
   Price of 1 ton of maize and sesame straw So. Sh. 40
   Price of quintal of bran + germs So. Sh. 20

Source : Estimation of the team experts.

CHAPTER 8
ECONOMIC AND FINANCIAL ANALYSIS

CHAPTER 8

ECONOMIC AND FINANCIAL ANALYSIS

The strategy adopted to implement the project has been motivated by the urgency to increase food production which is one of the main development objectives in Somalia. The direct measurable benefits of rice production project in Somalia consist of gross value of the crops produced less economic costs of producing them. The other direct benefits are net foreign exchange savings as a result of the crops produced as import substitutes. Benefits also include the net increased factor income (to labour, management, and capital) of the external servicing organisation(transport, processing, suppliers ... 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 which creates an increased demand on goods and services. It in turn leads to a secondary increase in income to the suppliers of these goods and services and so on. It is not easily measureable in the absence of adequate statistical information. There are many indirect benefits such as the impact upon the general levels of development and the infrastructure that will be realized as a result of the project implementation, the experience of settled farms and training that will provide the basic skills and attitudes for further expansion in commercial farming. More specially if the scheme is viable, it will require efficient marketing, processing, supply services and if these are provided this will have a considerable impact on agriculture adjacent to the project area.

8.1 Basis of economic analysis : Economic analysis has been carried out on the following assumptions :-

1. Production has been valued at the shadow prices (import prices CIF Mogadishu). This price is an attempt to provide a competitive form in the light of knowledge of current world and domestic situation.

2. Duties and tariffs have been excluded in the import price calculation since they are not a benefit to the economy but just a transfer payment from the consumer to the government which may in practice, if local production displaces imports, be passed on to the producer by allowing him to charge higher prices. Such an inflated price does not represent the real benefit from domestic production to the economy.

3. Input prices have been valued at their CIF cost plus handling charges in the port and transport charges to the project area.

4. Hired labour force or unskilled labour has been shadowed at 50% of the current wage rate to represent its opportunity cost to the economy. The opportunity cost of labour is an indicator of agricultural production which will be lost to the economy of Somalia if labourers are withdrawn from their present employment and devoted to the project since the wage of unskilled labour could be calculated at zero opportunity costs except at periods of excess demand for labour. As a result the opportunity cost of wage rate is assumed at a cost of 50% of current wage rates.

5. Foreign exchange has not been shadow prices in the basic analysis but shadow priced at 50% in the sensitivity

analysis *.

6. The analysis takes the net value of present production as the opportunity cost of land to arrive at the net incremental benefit of the project, i.e. returns are calculated on the basis of with and without the project.

7. Replacement costs have been taken according to the lifetime of each asset.

8. No salvage values have been taken into consideration. The economic rate of return will be little higher if these values have been considered but as the salvage value has to be calculated at the end of thelifetime of the project it will have relatively little effect on the rate of return.

9. Sensitivity analysis is carried out to test the sensitivity of the project to changes in costs and returns.

8.2. Internal Economic rate of Return : For the purpose of calculation the lifetime of the project is assumed to be 25 years.

In Internal Economic Rate of Return (IRR) in the basic analysis amounts to 9.11 (Table 8-1) which seems to be reasonable for agricultural projects in Somalia **. The returns do not include the value of by products. The benefit-cost ratio in this case amounts to 1.038 at 8% opportunity cost of capital (Table 8-2) opportunity cost of capital in the

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* Justification of shadowing is indicated in sensitivity analysis.

** Agricultural project includes the rice mill.

developing countries usually ranges between 8% - 12)* . When including value of by-products IRR amounts at 10.67 (Table 8-3).

8.2.1. The sensitivity analysis for the project shows that increasing costs , (capital and operating) by 10% result in decreasing IRR to 7.72 which is still considered reasonable however benefit - cost ratio amounts to almost 1 (.99). Tables (8-4) and (8-5) show that decreasing benefits by 10% gives IRR 7.44** .

<u>Shadowing foreign exchange rate</u> :

The Somali shilling is pegged to the US dollar, the present rate of approximate 6.23 Somali shilling per one US Dollar has been in effect since 1972. As there is a considerable foreign exchange element in the development of this region (in terms of inputs and outputs) and as foreign exchange is scarce, it is appropriate to investigate the sensitivity of the currently proposed developments to changes in the foreign exchange rates. There is evidence to suggest that the current fixed exchange rate considerably overvalues the Somali shilling as demonstrated in the livestock Sector Review (Hunting Technical Services 1977).

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* Evaluation of agricultural projects : price gittinger Agricultural Project Evaluation.

** In all cases of economic analysis foregone benefits from the existing cropping pattern are deducted from the benefits of the project to reach incremental benefits.

Table 8-1 : Economic rate of return case I (000 So. Sh.)

Year	Investments	Replacement costs	Total	Operating Costs	Total	Total revenues	Net Cash flow	8%	10%
1	80877		80877	1561	82438	(1500)	(83938)	(77727)	(76299)
2	65122		65122	2092	67214	(1500)	(68714)	(58888)	(56758)
3	38994		38994	15482	54476	10255	(44221)	(35111)	(33210)
4	31066		31066	25778	56844	27628	(29216)	(21473)	(19955)
5	33649		33649	35085	68734	49250	(19484)	(13269)	(12100)
6	8185		8185	42902	51087	86925	35838	22578	20213
7			-	48492	48822	88496	39674	23130	20353
8			-	48822	48822	88496	39674	21424	18528
9		184	184	48822	49006	88496	39490	19745	16744
10		13297	13297	48822	62119	88490	26377	12213	10182
11		9869	9869	48822	58691	88496	29805	12786	10432
12		9980	9980	48822	58802	88496	29694	11789	9473
13		11705	11705	48822	60527	88496	27969	10293	8111
14		830	830	48822	49652	88494	38844	13207	10216
15		6	6	48822	48828	88496	39668	12495	9481
16		612	612	48822	49434	88496	39062	11406	8516
17		13297	13297	48822	62119	88496	26377	7122	5223
18		9397	9397	48822	58219	88496	30277	7569	5450
19		10131	10131	48822	58953	88496	29903	6937	4904
20		13097	13097	48822	61919	88496	26577	5714	3960
21		4756	4756	48822	53578	88496	34918	6949	4714
22		169	169	48822	48991	88496	39505	7269	4859
23		505	505	48822	49327	88496	39169	6659	4387
24		13515	13515	48822	62337	88496	26159	4133	2668
25		9403	9403	48822	58225	88496	30271	4420	2785
								(206468)	(198322)
							+	227838 +	181199
								21370	17123

$$(IRR = 8 + 2 \left(\frac{21370}{38493}\right) = 9.11$$

Table 8-2 : Benefit cost ratio : B / C

Economic Case (1)

Year	Discounted costs	Discounted revenues
1	76338	1389
2	57662	1285
3	43254	8142
4	41780	20307
5	46808	33539
6	32185	54763
7	28463	51593
8	26364	47788
9	24503	44248
10	28761	40974
11	25178	37965
12	23344	35133
13	22274	32567
14	16882	30089
15	15381	27876
16	14435	25841
17	16772	23894
18	14555	22124
19	13677	20531
20	13312	19027
21	10662	17661
22	9014	16283
23	8386	15044
24	9849	13982
25	8501	12920
	629179	652241

B/C = 1.038

Table 8-3 : Economic rate of return, revenues including value of by - products.

(000 So. Sh.)

Year	Costs	Revenue	Cash flow	10%	12%
1	82438	1500	83938	76300	74957
2	67214	1500	68714	56758	54765
3	54476	11100	43376	32575	30884
4	56844	29718	27126	18527	17252
5	68734	52373	16361	10160	9277
6	51087	91423	40336	22750	20450
7	48822	93096	44274	22713	20012
8	48822	93096	44274	20676	17887
9	49006	93096	44090	18694	15916
10	62119	93096	30977	11957	9975
11	58691	93096	34405	12042	9874
12	58802	93096	34294	10940	8814
13	60527	93096	32569	9445	7458
14	49652	93096	43444	11426	8906
15	48828	93096	44268	10580	8101
16	49434	93096	43662	9518	7117
17	62119	93096	30977	6133	4523
18	58219	93096	34877	6278	4534
19	58953	93096	34143	5599	3961
20	61919	93096	31177	4645	3242
21	53578	93096	39518	5335	3675
22	48991	93096	44105	5425	3661
23	49327	93096	43769	4902	3239
24	62337	93096	30759	3137	2030
25	58225	93096	34871	3208	2057
				(194320)	(187135)
				+ 205403	+ 165432
				11083	21703

$$10 + 2 \left(\frac{11083}{32786} \right) = 10.67\ \%$$

Table 8-4 : Economic rate of return - Sensitivity analysis

Year	Increasing costs 10%					Decreasing benefits 10%				
	Cost	Revenue	Cash flow	6%	8%	Costs	Revenue	Cash flow	6%	8%
1	90682	(1500)	(92182)	(86928)	(85361)	82438	(1650)	(84088)	(79295)	(77865)
2	74682	(1500)	(76182)	(67802)	(65288)	67214	(1650)	(68864)	(61289)	(59016)
3	59923	11100	(48823)	(41011)	(38765)	54476	9990	(44486)	(37368)	(35322)
4	62528	29718	(32810)	(25985)	(24115)	56844	26746	(30098)	(23838)	(22122)
5	75607	52373	(23234)	(17356)	(15822)	68734	47136	(21598)	(16134)	(14708)
6	56195	91423	35228	24836	22194	51087	82281	31194	21992	19652
7	53704	93096	39392	26196	22966	48822	83787	34965	23252	20385
8	53704	93096	39392	24699	21272	48822	83787	34965	21923	18881
9	53906	93096	39190	23200	19595	49006	83787	34781	20590	17391
10	68331	93096	24765	13819	11466	62119	83787	21668	12091	10032
11	64560	93096	28536	15038	12242	58691	83787	25096	13226	10766
12	64682	93096	28414	14122	11280	58802	83787	24985	12418	9919
13	66588	93096	26516	12436	9758	60527	83787	23260	10909	8559
14	54617	93096	38479	17008	13083	49652	83787	34135	15088	11606
15	53711	93096	39385	16424	12406	48828	83787	34959	14578	11022
16	54377	93096	38719	15255	11306	49434	83787	34353	13535	10031
17	68331	93096	24765	9188	6687	62119	83787	21668	8039	5850
18	64041	93096	29055	10169	7264	58219	83787	25568	9076	6392
19	64848	93096	28248	9350	6554	58953	83787	24834	8220	5761
20	68111	93096	24985	7795	5372	61919	83787	21868	6823	4762
21	58936	93096	34160	10043	6798	53578	83787	30209	8881	6012
22	53896	93096	39206	10899	7214	48991	83787	34796	9673	6402
23	54260	93096	38836	10175	6602	49327	83787	34460	9028	5858
24	68571	93096	24525	6058	3875	62337	83787	21450	5298	3389
25	64048	93096	29048	6768	4241	58225	83787	25653	5977	3745
				(239082)	(229351)				(217924)	(209033)
				283478	222175 +				+ 250617	+ 196345
				44396	7176				32693	12688

$$6\% + 2\,\frac{(44396)}{51572} = 7.72$$

$$6 + 2\,\frac{(32693)}{45381} = 7.44$$

Table 8-5 : Benefit - Cost 8% ratio

Year	Case of increasing cost 10% discounted cost	Discounted revenue
1	83972	1389
2	64002	1285
3	47579	8813
4	45958	21843
5	51488	35666
6	35403	57596
7	31309	47758
8	29000	50272
9	26953	46548
10	31637	43103
11	27697	39938
12	25678	36959
13	24501	34259
14	18570	31653
15	16919	29325
16	15878	27184
17	18449	25136
18	16010	23274
19	15044	21598
20	14643	20016
21	11728	18526
22	9916	17129
23	9224	15826
24	10834	14709
25	9351	13592
	691743	680723

B/C = 0.99

There are large illicit exchange markets in Jeddah, Djibouti and the Gulf arising from the wish of Somalis working abroad to repatriate their money, the exchange rate varies between So. Sh. 12 and 15 to the US dollar . Other free markets exist in Djibouti and Jeddah where livestock exporters buy cheap consumer goods to import into Somalia using hard currency earned from their exports. As this market appears to be large and relatively free it can be used to assess the true exchange rates. In the present study a sensitivity analysis of the exchange rate reduced by about 50% will be carried out. The need to make this analysis is because an overvalued domestic currency will understate the importance of the foreign exchange element in the project being assessed. IRR in this case amounts to 14.47 which shows to a great extent the real benefits from the project to the economy. Benefit-cost ratio = 1.094 (Tables 8-6. and 8-7).

8.3 Financial Analysis :

As mentioned before the market selling prices for inputs and outputs are used to calculate the financial indicators. The financial rate of return (FRR) amounts to 9.24 in the basic analysis without the value of by-products and amounts to 10.66 including the value of by-products (Tables 8-8 and 8-9). This result does not differ significantly from (IRR). This may be due to the overvaluation of the official farm gate price of rice which is the main crop of the project.

The paying back period which is the length of time from the beginning of the project before the net benefits return the cost of capital investments is about 13 years (Table 8-10).

To indicate the financial situation of the project at full maturity (year 7), depreciation of capital assets and in interest rate of 6% (the relevant rate of interest for the farmers) have been added to the operating cost (Table 8-12). The total financial costs amount to about So. Sh. 96.94[1] million annually of which the fixed costs amount to about So. Sh. 42 million while variable costs amount to about So. Sh. 54.9 million. The total revenue amounts to So. Sh. 108.4, 113 million without and with value of by-products respectively. This means that a net revenue which can be achieved amounts to about So. Sh. 11.5, 16.1 million in the two cases respectively.

(1) Depreciation costs are calculated in Table (8-11) according to the lifetime of each asset.

Shadowing foreign exchange rate

US $ 1 = So. Sh. 12

Year	Operating cost	Investments
(1)	2249	128609
(2)	2839	100052
(3)	23479	62603
(4)	39213	48652
(5)	53591	53553
(6)	65596	14219
(7)	76868	-

* Inputs which have been shadowed are the imported inputs in operating costs such as fuel, agricultural, inputs, spare parts ... etc.

* With respect to investments, the foreign component only has been shadowed.

* Replacement costs have been shadowed.

Table 8-6 : Economic Rate of Return : Shadowing

Foreign exchange at 5% (000 So.Sh.)

Year	Investments	Replacement	Operating Costs	Total Cost	Incremental benefits	Net Cash flow	16 %	14 %
1	128609	-	2249	130858	(2895)	(133753)	115295	117301
2	100052	-	2839	102891	(2895)	(105786)	78595	81349
3	62603	-	23479	86082	19542	(66540)	42652	44914
4	48652	-	39213	87865	52834	(35031)	19337	20738
5	53553	-	53591	107144	94351	(12973)	6089	6639
6	14219	-	65596	79815	166346	86531	35478	39458
7	-	-	76868	76868	169297	92429	32720	36972
8	-	-	76868	76868	169297	92429	28191	32443
9	-		76868	77223	169297	92074	24215	28359
10	-		76868	102531	169297	66766	15156	18027
11	-		76868	95915	169297	73382	14310	17392
12	-		76868	96129	169297	73168	12292	15219
13	-		76868	99458	169297	69839	10127	12711
14	-		76868	78469	169297	90828	11353	14533
15	-		76868	76879	169297	92418	9981	12939
16	-		76868	78049	169297	91248	8486	11224
17	-		76868	102531	169297	66766	5341	7211
18	-		76868	88426	169297	80871	5580	7683
19	-		76868	96420	169297	72877	4373	6049
20	-		76868	102145	169297	67152	3425	4902
21	-		76868	86047	169297	83250	3663	5328
22	-		76868	77194	169297	92103	3500	5158
23	-		76868	77842	169297	91455	3018	4481
24	-		76868	102951	169297	66346	1858	2853
25	-		76868	95015	169297	74282	1783	2823
							(261968)-	(270941)
							234850 +	286765 +
							27118	15824

$$IRR = 14 + 2\left(\frac{15824}{42942}\right) = 14.74$$

Table 8-7 : Benefit / Cost ratio

Shadowing exchange rate 50%

Year	Discounted cost	Discounted return
1	116856	2585
2	82004	2307
3	61290	13914
4	55882	33602
5	60751	53497
6	40466	84337
7	34744	76522
8	31055	68395
9	27878	61116
10	33015	54514
11	27528	48588
12	24705	43509
13	22776	38769
14	16086	34706
15	14069	30981
16	12722	27595
17	14969	24717
18	11495	22009
19	11184	19638
20	10623	17607
21	8002	15745
22	6407	14052
23	5760	12528
24	6795	11174
25	5606	9989
	742668	812612

B/C 1.094

Table 8-8 : Financial Analysis : Financial rate of return, basic case (000 So.Sh.)

Year	Investment costs	Replacement Cost	Total	Operating costs	Total costs	Revenue	Net Cash flow	8 %	10%
1	85690	-	85690	1770	87460	-	(87460)	(80988)	(79501)
2	71261	-	71261	2321	73582	-	(73582)	(63059)	(60779)
3	43674	-	43674	20139	63813	15015	(48798)	(38746)	(36647)
4	35880	-	35880	34153	70033	35670	(34363)	(25257)	(23470)
5	39999	-	39999	46763	86762	61523	(25239)	(15598)	(15673)
6	9659	-	9659	57556	67215	106700	39485	24875	22270
7		-	-	63625	63625	108400	44775	26104	22970
8		-	-	63625	63625	108400	44775	24179	20910
9		234	234	63626	63859	108400	44541	22271	18885
10		17277	17277	63625	80902	108400	27498	12732	10614
11		12681	12681	63625	76306	108400	32094	13768	21233
12		12924	12924	63625	76549	108400	31851	12645	10160
13		15119	15119	63625	78744	108400	29656	10914	8600
14		1013	1013	63625	64638	108400	43762	14879	11509
15		6	6	63625	63631	108400	44769	14102	10700
16		795	795	63625	64420	108400	43980	12842	9588
17		17277	17277	63625	80902	108400	27498	7424	5445
18		12209	12209	63625	75834	108400	32566	8142	5862
19		13171	13171	63625	76796	108400	31604	7332	5183
20		17025	17025	63625	80650	108400	27750	5966	4135
21		6041	6041	63625	69666	108400	38734	7708	5229
22		169	169	63625	63794	108400	44606	8208	5487
23		555	555	63625	64180	108400	44220	7517	4953
24		17495	17495	63625	81120	108400	27280	4310	2783
25		12215	12215	63625	75840	108400	32560	4754	2996
								(223648)	(216070)-
								250671	199512 +
								27023	16558

$$IRR = 8 + 2 \; \frac{(27023)}{43581} = 9.24$$

Table 8-9 : Financial a rate of return addition value of by-products to returns

Year	Costs	Revenue	Cash flow	10%	12%
1	87460	-	87460	79501	78102
2	73582	-	73582	60779	58645
3	63813	15860	47953	36013	34143
4	70033	37760	32273	22042	20526
5	86762	64646	22116	13734	12529
6	67215	111198	43983	24806	22299
7	63625	113000	49375	25329	22318
8	63625	113000	49375	23058	19948
9	63859	113000	49141	20836	17740
10	80902	113000	32098	12390	10336
11	76306	113000	36694	12843	10531
12	76549	113000	36451	11628	9368
13	78744	113000	34256	9934	7845
14	64638	113000	49369	12984	10121
15	63631	113000	48580	11611	8890
16	64420	113000	48580	10590	7919
17	80902	113000	32098	6355	4686
18	75835	113000	37165	6689	4831
19	76796	113000	36204	5937	4200
20	80650	113000	32350	4820	3364
21	69666	113000	43334	5850	4030
22	63794	113000	49206	6052	4084
23	64180	113000	48820	5468	3613
24	81120	113000	31880	3252	2104
25	75840	113000	37160	3419	2192
				(212069)	(203955)
				223851	180419
				11782	23536

$$IRR = 10 + 2 \left(\frac{11782}{35318} \right) = 10.66$$

Table 8-10 : Paying- back period : Costs and Benefits

(000 So. Sh.)

Year	Depreciation	Operating & maintenance	Total	Gross benefits	Net benefits
1	1599	1770	3369	-	3369
2	4486	2321	6807	-	6807
3	6038	20139	26177	15015	11162
4	7717	34153	41870	35670	6200
5	9626	46763	56389	61523	5134
6	10075	57556	67631	106700	39069
7	10075	63625	73700	108400	34700

Investments

1	2	3	4	5	6	Total
85690	71261	43674	35880	59999	9659	286163

Paying-back period <u>13 years</u>

Source : Tables (7-7), (7-9) and '8-11).

Table 8-11 **Depreciation costs of the project**

(000 So. Sh.)

Years	1	2	3	4	5	6
Agricultural machinery (10-15 years)	-	1399	2392	3419	4634	4634
Irrigation machinery and workshop (7 - 15 years)	494	605	673	751	997	1446
Rice mill machinery (25 years)	-	665	749	1140	1474	1474
Rice Mill building (25 years)	-	217	217	217	217	217
Infrastructure (25 years)	1038	1509	1870	2022	2136	2136
Vehicles (7 years)	67	91	137	168	168	168
Total	1599	4486	6038	7717	9626	10075

Depreciation has been calculated according to the lifetime of each asset, build and infrastructure are assumed to last 25 years because of the maintenance devoted each year.

Source : Tables of investment costs and replacement costs and Annex (6).

Table 8-12 : Financial analysis - financial situation at full maturity

	(10,000 ha)
	(000) So. Sh.
Operating cost	63625
Depreciation	10075
Interest rate (6%)*	18623
Overheads and contingencies (5%)	4616
Total expenditures	96939
Total revenue	
1. Without by-products	108400
2. With by-products	113000
Net revenue	
1. Without by-products	11461
2. With by-products	16061

* Interest rate includes interest on operating costs in the first three years till the starting of full production.

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A N N E X E S

ANNEX 1

AGRICULTURAL SERVICES

The agricultural sector is supported by services provided by government units and cooperatives. Each agency has its definite responsibility towards the improvement of the agricultural production.

The Agricultural Development Corporation (A.D.C) is in charge of imports, exports, storage and national distribution of sorghum, maize and oilseeds. All maize, sorghum, sesame and groundnuts must be sold to the A.D.C. Purchase prices of these commodities are fixed after consultation with the Ministry of Agriculture.

The Farm Machinery and Agricultural Service Organization (O.N.A.T) has the responsibility of the procurement and distribution of all essential farm requisites including seeds, chemical fertilizers, insecticides, herbicides and spraying equipment. O.N.A.T. has several service stations for machinery located in the agricultural regions for initial land reclamation, bush clearing, ripping, levelling, canal embankment, construction and primary tillage. Also it provides tractors with drivers for hire on an hourly basis to both private and governmental units.

The basic functions of the National Agency for Commerce (E.N.C) are to import food commodities and export gum and olibanum. In addition, it is responsible for the distribution of import goods all over the country.

The Trade Agency for Vehicles and Spare Parts (W.A.G.A.D) is in charge of importing machines, vehicles, buses, tractors water pumps ... etc. It is also responsible for repairing all the machinery.

At Afgoi exists the Central Agricultural Research Station (C.A.R.S.). It possesses 400 ha of irrigable land at Afgoi on the Shabelle river, 40 ha at Ymnte on the Juba river, 40 ha of rainfed land at Bonka in the upper Juba and 80 ha in the northwest of Somalia.

The Faculty of Agriculture and the Agricultural Secondary School are located in Afgoi ; each enrolls some 30 - 40 students every year. The aim is to provide Somalia with specialized graduates and well-trained medium level agricultural technicians who would contribute to the development and progress of agriculture in Somalia.

The Agricultural cooperatives are considered to have the greatest potential for future agricultural development. Their formation is being encouraged to facilitate the supply of inputs and marketing of the crops. It is planned that during the T.Y.D.P. the number of societies would increase from 270 to 340 and the membership from 27,250 to 33,000.

ANNEX 2

SOILS

Profile No. F 1

Soil Unit	:	b 2
Topography	:	Flat
Vegetation	:	Low grass, shrubs , and few trees
Date of record	:	28.6.1980.

Profile description.

White shell fragments on the surface.

0 - 50 cm	:	Soft clay, friable, granular structure develops to subangular blocky with depth ; sticky and plastic. Very rich in line. Deep wide cracks. Colour (7.5 YR 3/2 moist).
50 - 100 cm	:	Clay, subangular blocky, friable, soft and hard concretions of 2-3 mm ($CaCO_3$). Fine roots and cracks. Rich in lime.
100 - 150	:	Clay, subangular blocky. Fine cracks. Soft and hard concretions. Apparant slickensides.

Profile No. F 2

Soil unit	:	b 1
Topography	:	Gently undulating
Vegetation	:	Dense shrubs and bushes.
Date of record	:	28. 6. 1980.

Profile Description

0 - 50	:	Clay loam, friable ; granular to subangular blocky structure. Deep wide croaks. Colour 7.5 YR 4/2 moist.
50 - 100	:	Clay loam , subangular blocky. Common fine roots. medium and fine pores. Rich in lime.
100 - 150	:	Clay loam, subangular blocky structure. Rich in lime.

Profile No. F 3

Soil unit	:	b 1
Topography	:	Gently undulating to flat.
Vegetation	:	Dense shrubs and bushes, few trees.
Date of record	:	28.6.1980.

Profile Description.

0 - 50	:	Soft clay, friable, sticky and plastic. Colour (7.5 YR 3/4 m). Hard, subangular blocky, common fine roots and pores. Medium reaction with dilute HCl.
50 - 100	:	Ditto, soft clay, subangular blocky, sticky and plastic. Common fine pores and medium roots. Common carbonate concretions and some gypsum crystals. Strong reaction with HCl.
100 - 150	:	Soft clay, subangular blocky, with common carbonate concretions and gypsum crystals. Strong reaction to the dilute acid.

Profile No. F 4

Soil unit	:	b 1
Topography	:	Flat
Vegetation	:	Medium density of shrubs and bushes.
Date of record	:	28.6.1980

Profile Description

0 - 50	:	Clay, subangular blocky. Colour 7.5 YR 4/3 moist. Friable sticky and plastic. Deep wide cracks. Moderate reaction to dilute HCl.
50 - 100	:	Friable clay, plastic, common fine and medium pores and few fine roots. Spots of calcium carbonate and very few gypsum crystals. Strong effervescense.
100 - 150	:	Ditto.

Profile No. F 5

Soil unit	:	a 2
Topography	:	Flat
Vegetation	:	Prepared for sesame cultivation
Date of record	:	28. 6. 1980

Profile Description

0 - 50	:	Friable clay, subangular blocky, common fine pores and fine roots. Colour (10 YR 3/3 m).
50 - 100	:	Friable clay, subangular blocky structure. Common fine and medium pores. White spots of calcium carbonate. Very few crystals of gypsum.
100 - 150	:	Friable clay, subangular blocky. Common white spots of calcium crabonate and gypsum crystals. Strong reaction to dilute HCl.

Profile No. F 6

Soil Unit	:	a 2
Topography	:	Flat
Vegetation	:	Low grasses
Date of record	:	28. 6. 1980

Profile Description

0 - 50	:	Clay, slightly hard, subangular blocky. sticky and plastic. Wide cracks. Common fine roots. Colour (10 YR 3/3 moist). Medium reaction to dilute HCl.
50 - 100	:	Clay, subangular blocky clay. Friable when moist, sticky and plastic wet. Common crystals of gypsum and CaCo3 concretions. Strong reaction to dilute HCl.
100 - 150	:	Hard subangular blocky clay. Friable when moist. Sticky and plastic wet. Common crystals of gypsum and $Caco_3$ concretions. Strong reaction to dilute HCL.

Profile No. F 7

Soil Unit	:	a 1
Topography	:	Flat
Vegetation	:	Medium density of shrubs.
Date of record	:	28. 6. 1980

Profile Description

0 - 100	:	Clay loam of granular to subangular blocky structure ; sticky and plastic. Fine to medium cracks. Common fine and medium peres. Colour (10 YR 3/4 moist). Medium to Hcl.
100 - 150	:	Clay, slightly hard, weak subangular blocky structure. Common soft and hard concretions of calcium carbonate and crystals of gypsum. Strong effervescence.

Profile No. F 8

Soil unit	:	a 1
Topography	:	Flat
Vegetation	:	Medium dense shrubs and low grasses, rainfed corn.
Date of record	:	28. 6. 1980

Profile Description

0 - 100	:	Clay loam, granular to subangular blocky. Fine to medium cracks. Common fine and medium roots and pores. Colour (10 YR 3/4 moist). Moderate effervescence.
100 - 150	:	Clay, slightly hard, plastic and sticky. Common white spots and few gypsum crystals.

Profine No. F 9

Soil unit	:	b 1
Topography	:	Flat and nearly level.
Vegetation	:	Dense shrubs and bushes with few trees.
Date of record	:	28. 6. 1980

Profile Description

0 - 50	:	Clay loam of subangular blocky structure Fine to medium cracks. Common fine and medium roots. Colour (7.5 YR 3/2 moist). Medium effervescence.
100 - 150	:	Clay loam, friable, sticky and plastic ; subangular blocky. Common fine and medium pores. Medium reaction to the dilute acid.

Profile No. F 10

Soil unit	:	bl
Topography	:	Gently undulating
Vegetation	:	Dense shrubs and bushes.
Date of record	:	28. 6. 1980

Profile Description

0 - 50	:	Clay loam, subangular blocky, friable. Common fine pores and roots. Fine cracks. Medium reaction to HCl.
50 - 100	:	Loamy sand, structureless, sticky. Common fine pores. Medium reaction to the dilute HCl.
100 - 150	:	Hard clay, subangular blocky structure. White spots of calcium carbonate. Sticky and plastic. Fine pores, medium effervescence.

Profile No. G 1

Soil unit	:	b 2
Topography	:	Undulating
Vegetation	:	Medium dense shrubs and bushes. Few trees.
Date of record	:	30. 6. 1980.

Profile Description

0 - 50	:	Clay loam, subangular blocky, friable, and plastic. Deep wide cracks. Common fine and medium roots. Colour (7.5 YR 4/4 moist). Medium effervescence.
50 - 100	:	Sandy loam to loamy sand, structureless, sticky. Common fine and medium pores, medium effervescence.
100 - 150	:	Dark clay, hard, sticky and plastic. Common fine concretions of calcium Carbonate and gypsum crystals.

Profile No. G 2

Soil unit	:	a 2
Topography	:	Undulating. Flat depression.
Vegetation	:	Dense shrubs and bushes.
Date of record	:	30. 6. 1980.

Profile Description

0 - 50	:	Friable clay, subangular blocky structure, Deep wide cracks and holes. Common fine roots . Colour (10 YR 3/3 moist). Medium reaction to dilute HCl.
50 - 100	:	Slightly hard clay, subangular blocky, sticky and plastic. Common fine pores. Stickensides formation. Moderate reaction to dilute HCl.
100 - 150	:	Clay,hard, subangular sticky and plastic. Fine concretions of calcium carbonate and gypsum. Stickensides formation. Medium reaction to HCl.

Profile No. G 3

Soil Unit	:	bl
Topography	:	Flat to V. gently undulating
Vegetation	:	Dense shrubs and bushes.
Date of record	:	30. 6. 1980.

Profile Description

0 - 50	:	Clay loam, friable, subangular blocky. Deep wide cracks. Common fine roots and pores. Colour (7.5 YR 4/2 moist). Medium reaction to dilute HCl.
50 - 150	:	Ditto, clay loam with weak structure and soft white spots at 100 - 150. Fine and medium pores. Fine gypsum crystals. (100 - 150 cm) and dark mottles. Medium reaction to HCl.

Profile No. G 4

Soil Unit	:	bl
Topography	:	Flat to gently undulating
Vegetation	:	Medium dense shrubs and bushes.
Date of record	:	30. 6. 1980.

Profile Description

0 - 50	:	Clay loam, friable, subangular blocky, sticky and plastic. Fine to medium cracks. Colour (7.5 YR 3/2 moist) medium reaction to dilute HCL.
50 - 100	:	Ditto, clay loam, with some gypsum crystals. Moderate effervescence.
100 - 150	:	Ditto, clay loam with common fine and soft crystals of gypsum. Common soft and hard concretion of calcium crabonate.

Profile No. G 5

Soil unit	:	a 2
Topography	:	Undulating. Dunes 0.5 meter.
Vegetation	:	Dense shrubs and bushes.
Date of record	:	30. 6. 1980.

Profile Description

0 - 50	:	Friable clay, subangular blocky structure, sticky and plastic. Colour (10 YR 3/2 moist). Wide cracks, fine and medium pores. Few soft concretions of calcium carbonate. Moderate reaction to dilute HCl.
50 - 100	:	Ditto, clay with common concretions of calcium carbonate.
100 - 150	:	Clay, mixed stratifications, common concretions of calcium carbonate and gypsum crystals.

Profile No. G 6

Soil Unit	:	a 2
Topography	:	Flat. Dunes of 0.5 m.
Vegetation	:	Medium dense shrubs.
Date of record	:	30. 6. 1980.

Profile Description.

0 - 50	:	Clay, friable, subangular blocky structure, sticky and plastic ; calcareous. Deep cracks of medium width. Common fine roots. Colour (10 YR 3/2 moist).
50 - 100	:	Ditto, clay , subangular blocky, compacted, cracked with fine gypsum crystals.
100 - 150	:	Ditto, but stickensides are clear. Common soft and hard concretions of calcium carbonate. Common gypsum crystals. Dark mottles. Strong reaction to dilute HCl.

Profile No. G 7

Soil Unit	:	al
Topography	:	Flat. Dunes 0.5 m.
Vegetation	:	Regeneration of bushes and shrubs.
Date of record	:	30. 6. 1980

Profile Description.

0 - 100	:	Clay loam, granular to subangular blocky structure, medium deep cracks. Common fine roots and pores. Colour (10 YR 3/4 moist). Moderate reaction to dilute HCl.
100 - 150	:	Clay, subangular blocky, very hard, sticky and plastic. Common soft and hard concretions of calcium carbonate and fine gypsum crystals. Strong effervencence.

Profile No. G 8

Soil Unit	:	a 2
Topography	:	Flat. Several basins.
Vegetation	:	Scattered shrubs.
Date of record	:	30. 6. 1980.

Profile Description

0 - 50	:	Friable clay, granular to subangular blocky structure, hard, sticky and plastic. Deep wide cracks. Common fine and medium roots. Common fine pores. Colour (10 YR 3/4 moist). Strong reaction to dilute HCl.
50 - 100	:	Clay, hard to very hard, weak subangular blocky structure. Colour 10 Yr 2/2 dry. Strong reaction to HCl.
100 - 150	:	Ditto, clay but with common soft and hard concretions of calcium carbonate. Common soft crystals of gypsum. Dark mottles and stickenside formation.

Profile No. G 9

Soil unit	:	a 2
Topography	:	Flat. Low lying
Vegetation	:	Very dense shrubs and bushes.
Date of record	:	30. 6. 1980

Profile Description

0 - 100	:	Friable clay, granular to subangular blocky structure, sticky, Deep wide cracks. Common fine roots and pores. Colour (10 YR 3/4 moist). Medium reaction to dilute HCl.
100 - 150	:	Clay, hard, weak subangular blocky, sticky and plastic. Common concretions of calcium carbonate and gypsum crystals.

Profile No. G 10

Soil Unit : a 2
Topography : Flat.
Vegetation : Dense shrubs.
Date of record : 30. 6. 1980.

Profile Description.

0 - 50	: Clay, friable, weak subangular blocky structure, sticky and plastic. Deep wide cracks. Common fine roots. Colour (10 YR 3/4 moist). Moderate efferves-cence.
50 - 100	: Clay, slightly hard, subangular blocky structure, common fine pores, stickenside formation. Soft concretions of calcium carbonate.
100 - 150	: Clay, hard, subangular blocky structure. Stickensides are clearer. Common con-cretions of calcium carbonate and gypsum crystals.

<u>Profile No. G 11</u>

Soil unit	:	b 1
Topography	:	Flat and nearly level.
Vegetation	:	Medium dense shrubs.
Date of record	:	30. 6. 1980

Profile Description

0 - 50	:	Clay loam, friable, granular to sub-angular blocky structure. Deep cracks. Common fine and medium roots and pores. Colour (7.5 YR 3/2 moist). Moderate reaction to dilute HCl.
50 - 100	:	Clay loam, friable, subangular blocky, sticky and plastic. Fine and medium pores and cracks.

Profile No. G 12

Soil unit	:	a 2
Topography	:	Flat
Vegetation	:	Low grasses and scattered shrubs.
Date of record	:	30. 6. 1980.

Profile Description

Shell fragments on the surface.

0 - 50	:	Clay, friable, subangular blocky structure. Deep wide cracks. Colour (10 YR 3/4 moist).
50 - 10	:	Clay, friable, sticky and plastic. Common soft and hard concretions of CaCO3. Few crystals of gypsum. Stickenside formation.
100 - 150	:	Ditto, but stickensides are clearer. Common gypsum crystals and calcium carbonate concretions. Strong reaction to dilute HCl.

Profile No. H 1

Soil unit	:	b 2
Topography	:	Very gently undulating
Vegetation	:	Overgrazed.
Date of record	:	30. 6. 1980.

Profile Description

0 - 50	:	Clay, subangular blocky structure, friable, sticky and plastic. Deep wide cracks. Colour (7.5 YR 3/2 moist). Moderate effervescence.
50 - 100	:	Clay, friable, plastic, subangular blocky structure. Moderate reaction to dilute HCl.
100 - 150	:	Clay, hard, sticky and plastic. Moderate reaction to dilute HCl.

Profile No. H 2

Soil unit	:	**a 2**
Topography	:	**Flat**
Vegetation	:	**Scattered shrubs.**
Date of record	:	**30. 6. 1980.**

Profile Description

0 - 50	:	**Clay, friable, subangular blocky, sticky and plastic. Deep wide cracks. Colour (10 YR 3/3 moist). Moderate reaction to dilute HCl.**
50 - 100	:	**Clay, slightly hard, subangular blocky. Some soft concretions of calcium carbonate. Stickenside formation.**
100 - 150	:	**Ditto, but stickensides are clearer. Moderate reaction to dilute HCl.**

Profile No. H 3

Soil unit	:	a 2
Topography	:	Flat
Vegetation	:	Overgrazed.
Date of record	:	30. 6. 1980.

Profile Description.

0 - 50	:	Clay, subangular blocky, friable, sticky, plastic, cracks of medium size. Colour (10 YR 3/4 moist).
50 - 100	:	Ditto, clay, subangular blocky structure, very few soft concretions of $CaCO_3$. Moderate effervescence.
100 - 150	:	Ditto, clay, friable, subangular blocky, sticky, and few crystals of gypsum. Moderate reaction to dilute HCl.

Profile No. H 4

Soil Unit	:	a 2
Topography	:	Flat. Flood basins.
Vegetation	:	Regeneration of shrubs and grass.
Date of record	:	30. 6. 1980.

Profile Description

0 - 50	:	Clay, friable, subangular blocky, sticky, plastic. Colour (10 YR 3/4 moist). Deep cracks. Moderate reaction to HCl.
50 - 100	:	Clay, friable, subangular blocky, sticky and plastic. Soft and hard concretions, of $CaCO_3$, Few gypsum crystals.
100 - 150	:	Ditto, but with stickenside formation and brown mottles.

Profile No. H 5

Soil unit	:	b 2
Topography	:	Nearly level.
Vegetation	:	Dense shrubs and bushes.
Date of record	:	3. 7. 1980.

Profile Description

0 - 50	:	Friable clay, subangular blocky structure. Deep wide cracks. Colour (7.5 YR 3/2moist). Moderate reaction to dilute HCl.
50 - 150	:	Clay, slightly hard, sticky and plastic. Concretion of calcium carbonate and gypsum crystals are more common with depth. Very fine cracks and slickensides are clearer with depth.

Profile No. H 6

Soil Unit	: a 2
Topography	: Flat
Vegetation	: Dense shrubs and scattered trees.
Date of record	: 3. 7. 1980.

Profile Description.

0 - 50	: Clay, friable, sticky and plastic, subangular blocky structure. Deep wide cracks. Rich in lime. Colour (10 YR 2/2 moist).
50 - 150	: Clay, slightly hard, subangular blocky. Common fine concretions of calcium carbonate and gypsum crystals. Strong reaction to dilute HCl.

Profile No. H 7

Soil unit	:	a 2
Topography	:	Flat and level.
Vegetation	:	Low grasses and scattered shrubs.
Date of record	:	3. 7. 1980.

Profile Description

0 - 50	:	Clay, friable, subangular blocky structure. Deep wide cracks. Colour (10 YR 3/3 moist), Fine and medium roots and pores are common.
50 - 150	:	Clay, slightly hard, sticky and plastic. Common fine roots. Medium and fine pores. Moderate reaction to dilute HCl.

Profile No. H 8

Soil Unit	:	a 2
Topography	:	Flat Flood basins
Vegetation	:	Low grasses
Date of record	:	3.7.1980

Profile Description

0 - 50	:	Clay, friable, subangular blocky structure. Sticky and plastic. Colour (10 YR 3/3 moist). Deep cracks and soft concretions of calcium carbonate. Medium effervescence.
50 - 150	:	Clay, friable, subangular blocky structure. Common concretions of CacO3 and gypsum crystals with depth. Strong reaction to dilute HCl.

Profile No. H 9

Soil unit	:	a 2
Toppgraphy	:	Nearly level
Vegetation*	:	Scattered shrubs, low grasses and dense bushes.
Date of record	:	3. 7. 1980.

Profile Description

0 - 50	:	Friable clay, subangular blocky structure, sticky and plastic. Colour (10 YR 3/2 moist). Deep cracking to 70 cm. Fine and medium roots Common fine pores. Medium reaction to dilute HCl.
50 - 100	:	Clay, slightly hard, sticky, subangular blocky. Medium reaction to dilute HCl.

* The site area will be ploughed for rainfed sesame cultivation in the Der season.

Profile No. A 1

Soil unit	:	b 2
Topography	:	Nearly level
Vegetation	:	Low grasses and scattered bushes, Over grazed.
Date	:	16.6.1980.

Profile Description

0 - 50	:	Dark brown (7.5 YR 4/2 moist) clay, friable, subangular blocky structure, hard when dry. Deep cracks (30 - 40 cm) and wide (5-7 cm). Many fine roots, fine and medium pores. Moderate reaction to dilute HCl.
50 - 100	:	Clay, hard, subangular blocky, sticky and plastic, common fine roots, fine and medium pores. Moderate effervescence.
100 - 150	:	Clay, very hard.

Profile No. A 2

Soil unit	:	a 2
Topography	:	Very gently undulating.
Vegetation	:	Low grasses and shrubs.
Date of record	:	16. 6. 1980.

Profile Description

0 - 50	:	Very dark gray (10 YR 3/1 moist) clay, slightly hard, subangular blocky structure. Deep wide cracks. Few shell fragments. Moderate reaction to dilute HCl.
50 - 100	:	Ditto, clay, hard, friable when moist. Few shell fragments. Few hard concretions (3 mm) of calcium carbonate. Moderate reaction to dilute HCl.
100 ———	:	Very hard clay.

Profile No. A 3

Soil unit	:	a 2
Topography	:	Nearly level
Vegetation	:	Low grasses and shrubs
Date of record	:	16. 6. 1980

Profile description.

0 - 50	:	Very dark grayish brown (10 YR 3/3 moist) clay, friable, sticky, subangular blocky structure. Few white shell fragments. Deep cracks. Moderate to strong reaction to dilute HCl.
50 - 150	:	Ditto, with some gypsum veins (100 - 150 cm), and some salt crystals.

Profile No. A 4

Soil unit	:	a 2
Topography	:	Undulating.
Vegetation	:	Scattered shrubs and bushes.
Date of record	:	17.6.1980.

Profile Description

0 - 50	:	Very dark brown (10 YR 3/3 moist) clay, friable, sticky and plastic, subangular blocky structure. Some shell fragments. Moderate reaction to dilute HCl.
50 - 100	:	Clay, slightly hard, subangular blocky, sticky, Few shell fragments. Few veins of gypsum and salt crystals.
100 - 150	:	Clay, hard, compacted white spots of calcium carbonate and concretions.

Profile No. A 5

Soil unit	:	a 2
Topography	:	Undulating, some scattered hummocks.
Vegetation	:	Scattered shrubs and bushes.
Date of record	:	17.6.1980

Profile Description

0 - 20	:	Very dark brown (10 YR 3/3 moist) clay, friable, subangular blocky structure. Fine to medium cracks. Moderate effervescence.
20 - 50	:	Friable clay, subangular blocky, sticky. Few shell fragments.
50 - 100	:	Clay, slightly hard, sticky, Some shell fragments and gypsum veins. Moderate-reaction to dilute HCl.
100 - 150	:	Clay, slightly hard with common concretions of calcium carbonate and gypsum veins. Strong reaction to dilute HCl.

Profile No. A 6

Soil unit	:	a 2
Topography	:	Undulating, some scattered dunes (1 m)
Vegetation	:	Dense shrubs and bushes.
Date of record	:	17.6.1980

Profile Description

0 - 50	:	Dark brown clay (10 YR 3/3 moist), friable, subangular blocky structure. Fine to medium cracks. Mixed sand and stratification is observed. Few shell fragments. Moderate reaction to dilute HCl.
100 - 150	:	Ditto, but less fragments with depth. Some gypsum veins and salt crystals specially in 100 - 150 cm. Moderate effervescence.

Profile No. A 7

Soil unit	:	c
Topography	:	Undulating. Scattered dunes ½ - 1 m.
Vegetation	:	Dense shrubs and bushes.
Date of record	:	17.6.1980.

Profile Description

0 - 50	:	Dark brown silty clay loam (10 YR 3/3 moist), friable, granular structure. Weak reaction to dilute HCl.
50 - 100	:	Clay, friable, subangular blocky structure. Some salt crystals. Moderate effervescence.
100 - 150	:	Clay, friable, subangular blocky sand stratified. Veins of gypsum and soft $CaCO_3$ Strong reaction to dilute HCl.

Profile No. A 8

Soil Unit	:	a 2
Topography	:	Undulating
Vegetation	:	Low grass and scattered shrubs.
Date of record	:	17.6.1980.

Profile Description

0 - 50	:	Dark brown clay (10 YR 3/3 m), friable, subangular blocky structure, sticky and plastic. Wide deep cracks. Fine roots. Moderate reaction to dilute HCl.
50 - 100	:	Friable clay, subangular blocky, few soft concretions of calcium carbonate.
100 - 150	:	Ditto, with white spots of calcium carbonate. Strong reaction to dilute HCl.

Profile No. A 9

Soil unit	:	a 2
Topography	:	Nearly level
Vegetation	:	Bush cleared for rainfed cultivation
Date of record	:	17.6.1980

Profile Description

0 - 50	:	Clay, dark brown (10 YR 3/3 m), friable, subangular blocky structure, sticky. Moderate effervescence.
50 - 100	:	Loam, friable, granular to subangular, some salt crystals.
100 - 150	:	Sandy loam, structureless, some salt crystals. Strong reaction.

Profile No. B 1

Soil unit	:	a 2
Topography	:	Gently undulating to level
Vegetation	:	Overgrazed - rainfed corn.
Date of record	:	18. 6. 1980

Profile Description

0 - 50	:	Dark brown clay (10 YR 3/3 moist), subangular blocky structure, sticky, plastic. Medium cracks. Common fine roots. Moderate reaction t dilute HCl.
50 - 100	:	Ditto, but with poor structure and stratified layers. Few shell fragments.
100 - 150	:	Clay, hard, subangular blocky, sticky, fine cracks. Moderate reaction to dilute HCl.

Profile No. B 2

Soil unit	:	a 1
Topography	:	Gently undulating to flat.
Vegetation	:	Overgrazed.
Date of record	:	18.6.1980.

Profile Description

0 - 50	:	Dark brown clay loam (10 YR 3/3 moist), slightly hard, subangular blocky structure, sticky and plastic. Deep wide cracks. Moderate reaction to dilute acid.
50 - 150	:	Ditto, but with few shell fragments. Moderate effervescence.

Profile No. B 3

Soil unit	:	bl
Topography	:	Undulating
Vegetation	:	Overgrazed - some scattered plots of rainfed corn.
Date of record	:	18.6.1980

Profile Description

0 - 50	:	Dark brown clay loam (10 YR 3/3 moist), granular to subangular blocky structure. Deep cracks. Common fine roots. Medium reaction to dilute HCl.
50 - 150	:	Clay loam, subangular blocky, sticky and plastic. Fine cracks and no roots. Rich in lime.Strong, reaction to dilute HCl.

Profile No. B 4

Soil Unit	:	b 2
Topography	:	Nearly level
Vegetation	:	Scattered areas of rainfed maize.
Date of record	:	18.6.1980

Profile Description

0 - 50	:	Clay loam, dark brown (10 YR 3/3 moist), granular to subangular blocky, sticky. Medium cracks. Common fine roots. Moderate reaction to dilute HCl.
50 - 100	:	Clay, subangular blocky structure, sticky and plastic. Fine cracks. Moderate effervescence.
100 - 150	:	Clay, slightly hard, subangular blocky, sticky and plastic. Spots of calcium carbonate and veins of gypsum. Moderate effervescence.

Profile No. B 5

Soil Unit	:	a 2
Topography	:	Nearly flat. Low lying area.
Vegetation	:	Dense grasses and shrubs.
Date of record	:	18.6.1980.

Profile Description

0 - 50	:	Dark brown (10 YR 3/3 moist), hard, subangular blocky structure, sticky and plastic. Wide and deep cracks. Strong effervescence.
50 - 100	:	Ditto.
100 - 150	:	Ditto, but with some veins of gypsum, white spots of calcium carbonate and some salt crystals.

Profile No. B 6

Soil Unit	: b 2
Topography	: Undulating - low lying area
Vegetation	: Dense shrubs and bushes. Some trees.
Date of record	: 18.6.1980

Profile Description

Shells and shell fragments on the surface.

0 - 50	: Clay loam, dark brown (7.5 YR 4/2 moist), subangular, bleeky structure, sticky. Deep wide cracks. Common fine and medium roots. Strong reaction to HCl.
50 - 100	: Clay loam, slightly hard, sticky and plastic, subangular blocky. Strong reaction to dilute HCl.
100 - 150	: Clay loam, hard, subangular bleeky, sticky, and plastic. Few crystals of salt. Soft concretions of $CaCO_3$. Strong effervescence.

Profile No. B 7

Soil Unit	:	a 2
Topography	:	Undulating - low lying area
Vegetation	:	Dense shrubs and bushes.
Date of record	:	18.6.1980

Profile Description

0 - 50	:	Clay, very dark gray (10 YR 3/1 moist) subangular blocky, sticky, plastic. Deep and wide cracks. Plenty of fine roots. Moderate reaction to dilute HCL.
50 - 100	:	Clay loam to clay, stratified irregularly. Spots of calcium carbonate.
100 - 150	:	Mixed texture, clay loam to silty clay, sticky. Fine pores. Spots of $Caca_3$ and gypsum veins and crystals. Strong reaction to dilute HCl.

Profile No. B 8

Soil Unit	:	a 2
Topography	:	Gently undulating.
Vegetation	:	Dense shrubs and bushes. High trees.
Date of record	:	18.6.1980.

Profile Description

0 - 50	:	Clay loam, very dark gray (10 YR 3/1 moist) subangular blocky structure, sticky plastic. Deep wide cracks. Commons fine and medium roots. Moderate reaction to acid.
50 - 100	:	Hard, clay, blocky, sticky and plastic. Fine cracks. Spots of calcium carbonate. Moderate effervescence.
100 - 150	:	Clay, hard to very hard, blocky, sticky. Spots of $CaCO_3$. Moderate reaction to dilute HCl.

Profile No. B 9

Soil unit	:	a 1
Topography	:	Nearly level.
Vegetation	:	Dense shrubs and bushes.
Date of record	:	18.6.1980.

Profile Description

0 - 100	:	Clay loam, slightly hard, dark brown (7.5 YR 4/2 moist) granular to subangular blocky with depth, sticky and plastic. Common fine roots, and deep wide cracks. Moderate reaction to dilute HCl.
100 - 150	:	Mixed stratified layers, clay loam, sticky, poor structure. Spots of calcium carbonate. Moderate effervescence.

Profile No. C 1

Soil Unit	:	al
Topography	:	Level
Vegetation	:	Rainfed maize cultivation
Date of record	:	24.6.1980 - Heavy rainfall three days before.

Profile Description.

0 - 50	:	Silty clay loam ; dark brown (10 YR 3/3 moist), friable, subangular blocky structure, sticky and plastic, Deep and wide cracks. Common fine roots.Moderate reaction to dilute HCl.
50 - 100	:	Clay loam, friable, subangular blocky, sticky, fine and medium pores. Brown mottles 5 mm in diameter. Moderate effervescence.
100 - 150	:	Clay, slightly hard, subangular blocky structure. Common fine and medium pores. Soft concretions of calcium carbonate. Common brown mottles. Moderate effervescence.

Profile No. C 2

Soil unit	:	bl
Topography	:	Level
Vegetation	:	Low grasses and scattered shrubs.
Date of record	:	24.6.1980

Profile Description

0 - 50	:	Clay loam to clay ; dark brown (7.5 YR 3/3 moist), friable, plastic, subangular blocky. Deep wide cracks. Moderate reaction to HCl.
50 - 100	:	Soft clay, friable, subangular blocky, Common fine and medium pores. Some shell fragments and soft concretions calcium carbonate.
100 - 150	:	Clay, slightly hard, friable. Common fine and medium pores. Brown mottles and few crystals of salts. Moderate efferves-cence.

Profiles No. C3, C4, C 5

Soil Unit	:	a 2
Topography	:	Nearly flat
Vegetation	:	Low grasses overgrazed.
Date of record	:	24.6.1980

Profile Description

0 - 50	:	Silty clay ; dark yellowish brown (10 YR 4/5 moist), friable, subangular blocky structure. Deep cracks to 50 cm. Moderate reaction to dilute HCl.
50 - 100	:	Silty clay , friable, subangular blocky, sticky and plastic. Common fine cracks. Common fine and medium pores. Moderate effervescence.
100 - 150	:	Clay, slightly hard, subangular blocky, sticky, veins and soft concretions of calcium carbonate, and gypsum crystals. Strong effervescence.

Profile No. C6, C7

Soil unit	:	bl
Topography	:	Level to gently undulating.
Vegetation	:	Low grasses and scattered shrubs.
Date of record	:	26.6.1980.

Profile Description

0 - 50	:	Clay loam, dark grayish brown (7.5 YR 4/2 moist), friable, granular to subangular blocky structure. Medium cracks. Moderate reaction to dilute HCl.
50 - 100	:	Ditto but with finer cracks.
100 - 150	:	Clay loam and different stratification after 120 cm. Soft concretions of $CaCO_3$. Moderate effervescence.

Profile No. C 8

Soil unit	:	al
Topography	:	Undulating
Vegetation	:	Dense shrubs and bushes
Date of record	:	26.6.1980

Profile Description

0 - 50	:	Clay loam, dark brown (10 YR 3/3 moist), granular to subangular blocky structure, friable, deep wide cracks and holes. Moderate reaction to dilute HCl.
50 - 100	:	Ditto
100 - 150	:	Clay loam to clay, slightly hard, subangular, sticky. White spots of calcium carbonate. Common fine and medium pores. Moderate effervescence.

Profile No. C9, C10

Soil unit	:	a 2
Topography	:	Nearly level
Vegetation	:	Low grasses and bushes ; scattered plots of rainfed maize cultivation.
Date of record	:	26.6.1980

Profile Description

0 - 50	:	Clay to silty clay, dark brown (10 YR 3/3 moist), friable, subangular blocky structure. Common fine roots. Moderate reaction to dilute HCl.
100 - 150	:	Soft clay, friable, subangular blocky. Common fine and medium pores. Fine cracks. Moderate effervescence.

Profiles No. D1, D2

Soil Unit	:	b 2
Topography	:	Nearly flat
Vegetation	:	Low grasses and scattered shrubs; grazed. Rainfed maize cultivation.
Date of record	:	26.6.1980.

Profile Description

0 - 50	:	Soft clay, dark brown (7.5 YR 3/2 moist), friable, subangular blocky, plastic, fine and medium roots. Medium and deep wide cracks. Medium reaction to dilute HCl.
50 - 100	:	Clay, friable, subangular blocky, sticky and plastic. Fine and medium pores. Moderate effervescence.
100 - 150	:	Clay, slightly hard, subangular blocky, White spots of $CaCO_3$. Fine veins and crystals of gypsum. Strong reaction to dilute HCl.

Profile No. D 3

Soil unit	:	b 1
Topography	:	Very gently undulating to level.
Vegetation	:	Few scattered shrubs and low grasses.
Date of record	:	26.6.1980.

Profile Description

0 - 50	:	Clay loam, dark brown (7.5 YR 4/2) ; friable, subangular blocky structure. Deep wide cracks common fine cracks. Moderate reaction to dilute HCl.
50 - 100	:	Clay loam, friable, subangular blocky, sticky plastic. Common fine and medium pores. Moderate effervescence.
100 - 150	:	Clay loam, slightly hard, subangular blocky. Few soft white spots of $CaCO_3$. Moderate reaction to dilute HCl.

Profile No.D 4

Soil unit	:	a 1
Topography	:	Gently undulating
Vegetation	:	Low grasses and shrubs.
Date of record	:	26. 6. 1980.

Profile Description.

0 - 50	:	Dark brown (10 YR 3/3 moist) clay loam, friable, sticky, plastic, subangular blocky structure. Deep cracks. Common fine roots.
50 - 100	:	Clay loam, slightly hard, subangular blocky. Common fine and medium pores. Moderate reaction to dilute HCl.
100 - 150	:	Clay , hard, subangular blocky, mixed structures and stratifications. Soft and hard fine concretions of $CaCO_3$. Strong effervescence.

Profile No. D5, D 6

Soil unit	:	a 2
Topography	:	Undulating and scattered hummocks (30 cm)
Vegetation	:	Dense grasses and bushes.
Date of record	:	26.6.1980

Profile Description

0 - 50	:	Dark brown clay loam (10 YR 3/3 moist), subangular blocky. Medium deep cracks. Common fine and medium roots. Moderate reaction to dilute HCl.
50 - 100	:	Clay, friable, subangular blocky structure; plastic and sticky. Moderate reaction to dilute HCl.
100 - 150	:	Clay, hard, subangular blocky, sticky. Common fine and medium pores. Soft calcium carbonate concretions and fine gypsum crystals. Strong reaction to dilute HCl.

Profile No. D 7

Soil unit	:	a 1
Topography	:	Undulating
Vegetation	:	Dense shrubs and bushes.
Date of record	:	26.6.1980

Profile Description

0 - 50	:	Clay loam to silty clay, dark brown (10 YR 3/3 m.) , friable, subangular blocky structure. Common deep wide cracks. Moderate reaction to HCl.
50 - 100	:	Clay loam, slightly hard, subangular blocky, sticky and plastic. Moderate effervescence.
100 - 150	:	Clay loam, slightly hard, subangular blocky, common fine and medium pores. Few gypsum veins and crystals. Soft and fine hard concretions of $CaCO_3$. Strong reaction to dilute HCl.

Profile No. D 8

Soil unit	:	a 2
Topography	:	Undulating
Vegetation	:	Dense shrubs and bushes.
Date of record	:	26.6.1980

Profile Description

0 - 50	:	Dark grayish brown (10 YR 4/2 m.) clay loam, granular to subangular blocky structure, friable, sticky and plastic. Common fine and medium roots. Moderate reaction to dilute HCl.
50 - 150	:	Clay, slightly hard, friable when moist, sticky and plastic, subangular blocky. Common fine and medium pores. Moderate reaction to dilute HCl.

Profile No. D 9

Soil unit	:	a 1
Topography	:	Gently undulating to level.
Vegetation	:	Dense bushes and shrubs. Scattered trees.
Date of record	:	26.6.1980.

Profile Description

0 - 50	:	Clay loam, dark brown (10 YR 3/3 moist), friable, subangular blocky structure, sticky and plastic. Common fine roots. Moderate reaction to dilute HCl.
50 - 100	:	Clay loam, slightly hard, subangular blocky, sticky and plastic. Fine and medium roots. White spots of calcium carbonate. Few fine Crystals of gypsum. Strong effervescence.
100 - 150	:	Clay loam, slightly hard, subangular blocky, sticky. Common spots of $CaCO_3$ and gypsum crystals. Strong reaction to dilute HCl.

Profile No. E 1

Soil unit	:	a 1
Topography	:	Level
Vegetation	:	Rainfed maize cultivation
Date of record	:	27.6.1980.

Profile Description

0 - 50	:	Clay loam, dark brown (10 YR 3/3 moist), granular structure, sticky and plastic. Common fine roots. Deep wide cracks. common fine and medium pores. Moderate reaction to dilute HCl.
50 - 150	:	Clay loam, slightly hard, friable when moist, subangular blocky structure. Common fine and medium pores. Moderate reaction to dilute HCl.

Profiles No. E2, E3, E4, E 5

Soil Unit	:	b 1
Topography	:	Gently undulating to level.
Vegetation	:	Low grasses and shrubs ; graized
Date of record	:	27.6.1980

Profile Description

0 - 50	:	Clay loam ; dark brown (7.5 YR 3/3 moist) subangular blocky structure. Deep cracks to 50 cm. Common fine roots. Common fine and medium pores. Moderate reaction to dilute HCl.
50 - 100	:	Clay loam, slightly hard, sticky and plastic, subangular blocky structure. Fine cracks. Common fine and medium pores. Moderate reaction to dilute HCl.
100 - 150	:	Clay loam, hard friable when moist, sticky and plastic, subangular blocky structure. Common fine and medium pores. Hard concertions (3 mm diameter) of calcium carbonate and few crystals of gypsum. Moderate reaction to dilute HCl.

Profile No. E 6

Soil unit	:	a 2
Topography	:	Undulating
Vegetation	:	Dense shrubs and low grasses
Date of record	:	27.6.1980

Profile Description

0 - 50	:	Soft clay ; dark brown (10 YR 3/3 moist), friable, subangular blocky, sticky and plastic. Medium deep cracks. Common fine roots. Moderate effervescence.
50 - 150	:	Slightly hard, clay, subangular blocky, sticky and plastic. Fine and medium pores. White spots of calcium carbonate after 100 cm., and few crystals of gypsum. Moderate reaction to dilute HCl.

Profile No. E 7

Soil unit	:	a 1
Topography	:	Undulating
Vegetation	:	Dense grasses and bushes. Scattered trees.
Date of record	:	27.6.1980

Profile Description

0 - 50	:	Dark yellowish brown clay loam (10 YR 3/4 moist), granular to subangular blocky structure, sticky. Deep cracks. Common fine and medium roots. Moderate reaction to dilute HCl.
50 - 100	:	Clay loam, slightly hard, subangular blocky, sticky and plastic. Fine and medium cracks. Moderate effervescence.
100 - 150	:	Clay loam to clay with depth, subangular, sticky and plastic. Fine and medium pores. Strong reaction to dilute HCl.

Chemical Soil Samples Analyses

Profile No.	Depth (cm.)	S.P. %	PH	EC	Paste Extract Meg/L.					
					Ca	Mg	Na	K	HCO_3	Cl
A1	0 - 50	40	7.8	0.7	5.0	0.0	1.1	0.1	2.0	4.0
	50-100	46	7.9	0.9	7.5	2.0	1.8	0.1	2.5	5.0
A2	0 - 50	33	7.7	0.75	5.0	0.0	0.5	0.3	3.0	4.0
	50-100	43	7.6	1.0	7.5	2.5	0.5	0.3	5.0	4.5
A3	0 - 50	40	7.5	0.8	7.5	0.0	0.9	0.2	4.2	3
	50-100	40	7.6	2.8	17.5	7.5	2.6	0.3	5.3	6
	100-150	43	7.7	7.3	25	17.5	15.6	0.4	35	5
A4	0 - 50	33	7.6	1.5	80	8.5	7.8	0.3	5	4.5
	50-100	33	7.6	4.2	16	25	10.4	0.5	6	5.5
	100-150	40	7.5	4.5	12.5	27.5	11.7	0.6	6	5.5
A5	0 - 20	33	7.7	1.0	5	2	4.4	0.3	4	6
	20 - 50	40	7.7	0.75	5.2	0	14.3	0.2	4	4
	50-100	43	7.6	4.3	17.5	7.5	10.6	0.5	6.6	21
	100-150	40	7.6	6.6	27.5	0	43.4	0.6	4	48
A6	0 - 50	43	7.8	0.7	4	3	0.8	0.12	3.2	3.5
	50-100	40	7.7	0.8	6	0	1.9	0.15	3	4
	100-150	46	7.8	0.8	4	3.2	0.6	0.18	3.5	4.5
A7	0 - 50	40	7.8	0.7	3.5	1.2	1.6	0.14	3.5	4
	50-100	43	7.9	1.6	5.0	12.5	2	0.13	5	6.5
	100-150	46	7.6	1.8	2.3	7.1	6	0.15	7	19.5
A8	0 - 50	43	7.7	0.65	2.5	2.5	1.3	0.2	2.5	3
	50-100	46	7.5	1.6	5.0	3.5	6.0	1.4	5	10
	100-150	50	7.8	4.8	17.5	5.0	30.4	0.3	5	30
A9	0 - 50	33	7.8	1.0	5	3.5	0.9	0.4	4	5
	50-100	33	8	1.0	7	2.5	1.3	0.3	4.5	5.8
	100-150	33	7.6	4.5	27.5	10	10.2	0.8	6	36.4

Representative Soil Samples Analyses

Profile No.	Depth cm.	% Clay	% Silt	% Sand	$CaCO_3$ %	Hydro Cond. cm/hr	Ex. Na. meg./ 100 g.	Phor-phours P.P.m.	Nitrogen p.p.m.	Organic Matter %
A1	0 - 50	53	26	21	24	0.5	0.68	0.05	17	0.8
	50-100	51	25	24	23.8	0.12	1.0	0.05	17	-
A2	0 - 50	17	32	51	12.9	2.7	0.41	0.05	20	0.5
	50-100	17	37	51	13.4	2.7	0.44	0.05	11	-
A3	0 - 50	51	16	32	23.3	2.48	0.73	0.05	21	0.5
	50-100	49	16	35	21.8	1.65	0.8	0.1	14.3	-
	100-150	54	15	31	20.5	0.95	2.97	Traces	14	-
A4	0 - 50	43	14	43	17	1.96	0.33	0.05	16	0.6
	50-100	46	13	41	16.8	0.98	0.2	0.05	21	-
	100-150	43	14	43	18	1.43	0.1	1.0	19	-
A5	0 - 20	41	16	43	16	1.45	0.37	0.05	21	0.7
	20 - 50	43	13	46	15.1	1.93	0.1	0.05	21	-
	50 - 100	45	14	41	18.5	1.11	1.4	Traces	9.8	-
	100 - 150	45	18	37	18.4	1.46	0.5	0.05	9.8	-
A6	0 - 50	51	14	35	24	2.58	0.69	0.09	14	0.2
	50-100	47	12	41	19.5	1.57	1.0	0.08	9.8	-
	100-150	49	14	37	21.8	1.15	1.5	0.05	9.8	-
A7	0 - 50	47	16	37	19.4	1.46	0.6	0.01	9.8	0.08
	50-100	47	16	37	19.4	1.5	1.2	Traces	9.8	-
	100-150	49	18	33	20	0.76	1.7	Traces	9.8	-
A8	0 - 50	53	14	33	13.4	2.86	0.9	0.05	9.8	0.05
	50-100	55	6	29	22.3	1.15	1.9	0.05	10.0	-
	100-150	55	8	27	21.8	4.64	0.2	0.05	7	
A9	0 - 50	29	2	59	16.5	5	0.4	0.05	18.2	0.05
	50-100	18	14	57	17.3	6.58	0.5	Traces	21	-
	100-150	39	6	16	16	1.69	0.3	Traces	9.8	-

Chemical Soil Samples Analyses

Profile No.	Depth (cm.)	S.P. %	PH	E.C.	Paste Extract Meg/L.					
					Ca	Mg	Na	K	HCO_3	Cl
B1	0 - 50	50	7.9	1.1	7	2.5	2.6	0.12	4.0	4.5
	50-100	43	7.9	0.8	5	2.0	1.8	0.09	4.3	4.2
	100-150	46	8.0	0.8	5	2.5	1.8	0.09	4.5	4.3
B2	0 - 50	50	7.9	4.4	27.5	15.5	2.8	0.4	5.4	28.0
	50-100	46	7.8	5.1	28.5	17.0	6.3	0.5	6.6	31.0
	100-150	46	7.8	6.6	25.0	17.5	30.4	0.7	5.0	30.0
B3	0 - 50	40	7.9	0.8	7.5	0.0	1.5	0.2	4.5	4.0
	50-100	43	7.5	6.3	27.5	20.5	18.7	0.7	6.0	20.0
	100-150	40	7.7	15.0	35.0	3.5	156.5	0.2	5.0	105.0
B4	0 - 50	43	8.0	1.7	15.0	12.5	3.9	0.2	6	6
	50-100	46	7.9	7.7	25.0	25.0	134.4	0.4	6	33.5
	100-150	50	7.9	14.0	23.0	40.0	162.6	0.5	6	122.6
B5	0 - 50	43	7.8	17.0	9	6.5	3.6	0.3	6	9
	50-100	46	7.7	9.8	21.5	31.0	15.6	0.5	5	8.5
	100-150	50	7.9	18.0	32.5	47.5	19.5	1.1	5.4	5.4
B6	0 - 50	37	7.7	1.2	8	3.5	1.8	0.3	4	5
	50-100	39	7.8	4.9	27.5	12.5	15.5	0.2	6	14
	100-150	40	7.8	4.4	27.5	11	7.8	0.3	5	10
B7	0 - 50	33	7.8	1	8	2.5	1.2	0.4	5	4.5
	50-100	39	8	0.9	5	2.5	1.2	0.4	4	5
	100-150	41	7.8	4.5	32.5	2.5	13.3	1.8	8	18.4
B8	0 - 50	37	7.9	3.1	32.5	7.5	2.9	0.2	5	6.6
	50-100	40	7.7	13.7	30	15	156.5	0.2	6	25.5
	100-150	43	7.8	11	30	25	104.3	0.3	7	50
B9	0 - 50	43	8	1.1	10	2.5	2.4	0.2	6	4.5
	50-100	47	7.7	1.6	7	4.5	6.2	0.2	6	7
	100-150	47	7.9	3.4	12	8	13.1	0.2	4	20

Chemical Soil Samples Analyses

Profile No.	Depth (cm.)	S.P. %	PH	E.C.	Paste Extract Meg/L.					
					Ca	Mg	Na	K	HCO_3	Cl
C1	0 - 50	42	8	0.9	6.5	2.5	1.1	0.2	5	4.5
	50-100	46	7.8	5.7	20	17.5	10.1	0.6	4.4	5.5
	100-150	43	7.9	5.8	25	17.5	9.6	0.2	5	4.5
C2	0 - 50	43	7.9	0.9	2.8	7.5	1.3	0.3	4	5
	50-100	47	7.7	0.85	3.5	5	2.2	0.17	6	9.4
	100-150	45	7.9	4.1	20.0	7.5	7.1	0.3	6	4.1
C3	0 - 50	36	7.9	1.8	5	10	4.2	0.4	6	14.1
	50-100	37	7.8	2.9	7.5	7.5	10.4	0.3	7	16
	100-150	38	7.7	8.7	27.5	22.5	50.4	-	6	79
C4	0 - 50	46	7.8	2.5	10	7.5	6	0.2	6	5
	50-100	50	7.7	0.12	10	7.5	-	0.2	8.4	6
	100-150	48	7.8	12.0	27	27.5	156.6	0.4	6	95
C5	0 - 50	35	7.5	8.9	25	17.5	5.8	0.46	6	80
	50-100	46	7.7	15	37.5	35	169.8	0.7	7	95
	100-150	50	7.5	20	32.5	57.5	156.5	1.1	7	78
C6	0 - 50	36	7.8	1.2	5	2.5	4	0.2	5	6
	50-100	41	7.7	3.2	15	10	5.2	0.1	5	10
	100-150	43	7.8	8.9	17.5	12.5	78	0.1	6	45.5
C7	0 - 50	45	7.6	1	2.5	5	3.3	0.2	4	3.5
	50-100	45	7.5	1.5	7.5	4	5.5	0.2	6	5.5
	100-150	48	7.4	5.7	28.5	18.5	26.1	0.4	5	17
C8	0 - 50	37	7.5	1	7	2.5	3.6	0.3	5	6.5
	50-100	36	7.5	4.4	15	11.5	12.7	0.4	4.8	20.5
	100-150	38	7.4	8.5	28.5	22.5	39.1	0.3	5	17
C9	0 - 50	42	7.4	0.65	3.5	2.5	2.5	0.15	4	4
	50-100	43	7.5	1.4	7.5	5	5	0.16	5	3.5
	100-150	42	7.5	4.0	25	15	15	0.26	5	4.5

Chemical Soil Samples Analyses

Profile No.	Depth (Cm.)	S.P. %	PH	E.C.	Paste Extract Meg/L. Ca	Mg	Na	K	HCO_3	Cl
D1	0-50	47	7.9	1.3	2.8	5	7.5	0.11	7	5
	50-100	52	7.8	5.2	20	15	9.1	0.3	5	35.5
	100-150	48	7.9	14	27.5	17.5	130	0.4	6	49.8
D2	0-50	43	7.6	0.85	7.5	0	3.1	0.2	5	3.8
	50-100	44	7.5	1.5	7.5	0	6.7	0.2	6	4.5
	100-150	44	7.7	1.3	7.5	1.5	6.6	0.2	5	6.5
D3	0-50	36	7.7	7	30	30	20	0.03	5	27.5
	50-100	35	7.6	8	20.5	25	45	0.4	7	36.5
	100-150	36	7.9	13	27.5	22	104.5	0.6	6.8	38.5
D4	0-50	47	7.8	1.1	27.5	27	52.1	0.3	2	6.2
	50 - 100	50	7.5	5.9	7.5	15	26.1	0.4	6	4.6
	100 - 150	50	7.5	1	7.5	0	3.1	0.2	4	5.7
D5	0 - 50	47	7.7	4.5	30	7.5	14	0.55	4	6
	50 - 100	50	7.8	5.7	25	12.5	20.5	0.76	6	12
	100 - 150	50	8	11	27.5	25	80	0.4	4	72.5
D6	0 - 50	45	7.8	1.9	12.5	0.0	5.8	0.19	5	2
	50 - 100	43	8	0.9	6	1.0	4.17	0.2	6	4
	100 - 150	47	7.5	0.65	25.5	22.5	26.1	0.3	5	8.5
D7	0 - 50	38	7.9	1.2	7.5	0	3.5	0.12	5	6
	50 - 100	50	7.7	8.4	25	15	52.2	0.18	6	26
	100 - 150	50	7.8	16.5	25	21	0.8	0.14	5	16.8
D8	0 - 50	33	8	1.3	7.5	12.5	2	0.6	6	3.5
	50 - 100	33	7.8	3.5	15	17.5	4.1	2.6	4	13.5
	100 - 150	35	7.8	7.2	25	17.5	45.3	0.2	6	4.5
D9	0 - 50	44	7.4	4.4	7.5	15.	26.1	0.16	6	26
	50 - 100	47	7.7	9.5	25	47.5	40	0.43	4	66
	100 - 150	48	8	2.7	10	11	8	0.43	6	20

Chemical Soil Samples Analyses

Profile No.	Depth (Cm.)	S.P. %	PH	E.C.	Paste Extract Meg/1					
					Ca	Mg	Na	K	HCO_3	Cl
E1	0 - 50	45	7.9	0.75	5	2.5	1.2	0.13	5	3.5
	50 - 100	47	7.8	0.7	5	0	2.3	0.2	4	2.5
	100 - 150	43	8	0.75	2.5	2.5	2.6	0.1	5	2
E2	0 - 50	43	7.8	2.1	10	10	4.3	0.4	5	7.5
	50 - 100	46	7.9	2.7	12.5	3	10.9	0.2	5	17
	100 - 150	46	7.9	8.5	27.5	20	52.2	0.5	5	27
E4	0 - 50	50	7.8	1.3	7.5	5	2.1	0.3	-	-
	50 - 100	48	7.7	7.4	22.5	24.5	26.1	4	10	11
	100 - 150	46	7.8	10	28	30	65.2	0.4	5	35.5
E5	0 - 50	42	7.7	6.6	25	20	18	1.3	5	14
	50 - 100	44	7.8	5.3	20	20	16.5	0.27	5	6
	100 - 150	43	8	1.2	6	5	2.1	0.2	4	3
E6	0 - 50	46	8	0.9	17	10	1.6	0.2	4	25
	50 - 100	50	7.8	2.7	10	12.5	4.4	0.27	5	3
	100 - 150	47	7.8	-	-	-	-	-	-	-
E7	0 - 50	40	8	1	12.5	2.5	2.6	0.1	3	2.5
	50 - 100	40	8.1	1.7	21.5	2.5	4.3	0.1	5	5
	100 - 150	40	8.1	1.7	7.5	2.5	8	0.1	4	13.5

Chemical Soil Samples Analyses

Profile No.	Depth (cm.)	S.P. %	PH	E.C	Past Extract Meg/L					
					Ca	Mg	Na	K	HCO_3	Cl
F1	0 - 50	45	7.8	0.8	10	3	2.9	0.14	2	3
	50-100	47	8	1.2	5	1.5	4.4	0.12	5	3
	100-150	47	7.9	6.2	25	10	32	0.29	4	8
F2	0 - 50	43	8	1.4	7.5	2	6.2	0.23	6	4.8
	50-100	47	8.1	3.2	10	17	5.2	0.23	6	11
	100-150	50	7.7	15	7.5	32	127.1	0.69	6	57.8
F3	0 - 50	47	7.9	1.6	10	2.5	2.6	0.13	6	6
	50-100	45	7.9	5.6	30	12.5	15.6	0.21	4	6
	100-150	43	7.9	7.7	25	27.5	32	0.36	6	9.5
F4	0 - 50	45	7.7	4.2	22.5	20	1.9	0.41	4	3
	50-100	48	7.8	5	37.5	22.5	4.3	0.36	6	2.5
	100-150	46	8	5.8	27.5	22.5	11.2	0.38	5	3.5
F5	0 - 50	63	7.8	4.1	22.5	20	3.1	0.36	3	3.5
	50-100	47	7.8	4.4	25	15	3	0.37	5	2
	100-150	50	7.9	4.1	22.5	12.5	3.7	0.38	4	3
F6	0 - 50	46	7.9	4.1	22.5	12.5	3.7	0.38	4	3
	50-100	43	7.6	4.5	27.5	15	3.7	0.3	5	3
	100-150	45	7.8	5.2	30	20	5.2	0.29	4	2.5
F7	0 - 50	43	7.5	1	7.5	2.5	1.4	0.07	5	2
	50-100	45	7.6	1.3	10	2.5	0.8	0.03	6	3
	100-150	43	7.5	7.2	25	15	39.1	0.77	4	1.5
F8	0 - 50	50	7.3	2.5	10	12	5.6	0.14	9	5
	50-100	50	7.5	2	12.5	15	8.9	0.13	7	4
	100-150	43	7.6	3.8	10	7.5	78.3	0.32	6	6.5
F9	0 - 50	46	7.7	0.85	4	3	3.4	0.07	6	2.5
	50-100	43	7.8	0.85	5	2.5	2.3	0.11	5	3
	100-150	42	7.7	5.9	22.5	15	26	0.25	5	9

Chemical Soil Samples Analyses

Profile No.	Depth (cm.)	S.P. %	PH	E.C.	Paste Extract Meg/L.					
					Ca	Mg	Na	K	HCO_3	Cl
F10	0 - 50	40	7.6	0.8	5	2	1.8	0.18	6	2
	50-100	30	7.7	0.65	10	17	0.3	0.16	5	2.5
	100-150	36	7.7	0.9	5	5	0.8	0.16	5	2
G1	0 - 50	33	7.6	1.5	7.5	7	3.8	0.16	4	4.5
	50-100	32	7.5	7.4	35	12.5	52.2	0.26	4	27.5
	100-150	36	7.5	12	25	37.5	78.3	0.38	5	75.5
G2	0 - 50	45	7.4	1.7	5	8	4.6	0.23	4	5
	50-100	46	7.6	5.0	15	25	12.8	0.29	5	3.5
	100-150	50	7.7	8.5	22.5	15	52.2	0.5	6	20.5
G3	0 - 50	48	7.8	28	42.5	130	208.7	0.4	6	35.5
	50-100	50	7.8	31	31	55	247.8	0.4	5	56.4
	100-150	46	7.7	8.3	10	27.5	64.3	0.24	6	30
G4	0 - 50	43	7.4	4.8	27.5	22.5	3.1	0.2	5	2
	50-100	40	7.7	12	32.5	27.5	91.3	0.14	5	50
	100-150	46	7.5	6.5	42.5	25	104.3	0.12	5	30.5
G5	0 - 50	46	7.5	1.5	7.5	2.5	2.1	0.23	4	5
	50-100	50	7.9	5.3	12.5	15	5.2	0.51	5	3.4
	100-150	46	7.9	6.9	22.5	12.5	52.2	0.76	4	5.5
G6	0 - 50	43	7.3	4.5	27.5	17.5	3.1	0.03	10	2
	50-100	43	7.5	7.2	22.5	30	35	0.27	4	3
	100-150	53	7.7	14	20	37.5	130.4	0.36	6	11
G7	0 - 50	40	7.6	2	10	5.5	4.9	0.06	5	4
	50-100	43	7.4	2.5	12.5	11.5	3.1	0.35	5	3
G8	0 - 50	40	7.7	2.1	10	4.5	8.3	0.6	11	10
	50-100	50	7.8	9	12.5	15	39.1	0.4	10	21
	100-150	47	7.9	15	20	12.5	130.4	0.5	8	42

Chemical Soil Samples Analyses

Profile No.	Depth (cm.)	S.P. %	PH	EC	Paste Extract Meg/L.					
					Ca	Mg	Na	K	ACO_3	Cl
G9	0 - 50	43	7.4	4.7	32.5	27.5	2.9	0.25	5	3
	50-100	47	7.7	4.6	21.5	22	11.7	0.29	6	17
	100-150	47	7.8	8.5	25	17.5	56.2	0.28	6	27
G10	0 - 50	50	7.5	1.3	6	7	1.4	0.16	5	3
	50-100	50	7.6	1.2	8	2.5	1.8	0.14	5	3.5
	100-150	43	7.7	2.3	12	6	4.2	0.16	6	3.5
G11	0 - 50	45	7.9	0.9	5	8.5	1.6	0.23	6	3
	50-100	47	7.8	1.3	8	2.5	3.5	0.11	6	2.5
	100-150	48	7.7	2.0	10	6	5.5	0.11	7	2
G12	0 - 50	45	7.6	2	12	5	3.9	0.63	5	2.5
	50-100	33	7.7	4	15	10	5.2	1.36	4	3.5
	100-150	50	7.7	7.3	22.5	15	52.1	0.24	6	20
H1	0 - 50	40	7.6	1.5	6	4	3.8	0.4	6	5
	50-100	42	7.6	1.0	10	12.5	2	0.5	6	3.5
	100-150	45	7.5	1.3	5	15	1.6	0.5	5	3
H2	0 - 50	46	7.5	1.6	10	5.5	2.2	0.2	4	7.5
	50-100	43	7.7	1.2	5	2.5	4.1	0.2	5	5.5
	100-150	45	7.6	2.5	12.5	7.5	6.8	0.3	5	4.5
H3	0 - 50	43	7.6	1.6	5	5	6.5	0.23	3	9
	50-100	46	7.6	1.9	10	5	3.3	0.03	5	9
	100-150	43	7.5	5.5	25	15	15.7	0.36	5	15
H4	0 - 50	47	7.7	0.9	6.5	2.5	1.6	0.2	4	3
	50-100	50	7.7	1.6	10	5	2.9	0.1	4	2.5
	100-150	43	7.9	1.1	2.5	6	4	0.1	5	3.5

<u>Chemical Soil Samples Analyses</u>

Profile No.	Depth (Cm.)	S.P. %	PH	EC	Paste Extract Meg/L.					
					Ca	Mg	Na	K	HCO_3	Cl
H 5	0 - 50	46	7.8	1.5	5	10	1	0.2	6	5
	50 - 100	46	7.6	4	20	17.5	5.3	0.2	3	8.5
	100 - 150	50	7.6	4.1	18	12.5	12.8	0.1	5	6.5
H 6	0 - 50	47	7.7	2.6	12.5	15	1.3	0.1	5	2.5
	50 - 100	50	7.7	3.8	21	17.5	2.9	0.1	3	6.5
	100 - 150	47	7.5	5.5	30	12.5	2.8	0.3	5	4
H 7	0 - 50	50	7.7	4.1	27.5	15	1.3	0.3	6	5
	50 - 100	43	7.7	3.8	12.5	25	1.8	0.1	4	2.5
	100 - 150	43	7.7	1.0	2.5	5	3.	0.1	5	2
H 8	0 - 50	50	7.7	1.2	10	2.5	1	0.2	4	1.5
	50 - 100	50	7.5	1.8	10	7.5	1.2	0.1	5	4
	100 - 150	50	7.6	4.4	25	15	3.5	0.3	4	2
H 9	0 - 50	50	7.7	2.5	20	12.5	1.6	0.03	5	2
	50 - 100	45	7.6	1.6	10	5	2.3	0.21	4	2.5
	100 - 150	45	7.6	3.2	12.5	17.5	5	0.21	7	4.5

Site No. 1

Location : 1 km south of Lib-Soma near the autostrad to Merca.

Topography : Undulating to level.

Natural cover : Scattered shrubs of Acacia sp. and low grass

Parent materials : Shabelle alluvium. Flood plain meander formation.

Drainage : Well drained

Depth, cm.	Description
0 - 30	Grayish yellow brown to dull yellow brown (10 YR 5/3 D, 4/2) clay, loose mulch with deep wide cracks with gelgia formation. Hard granular to subangular blocky with depth, sticky and plastic, common fine roots and pores. Medium reaction with dilute HCl.
50 - 90	Grayish yellow brown (10 YR 4/2) clay, hard subangular blocky dry, friable moist, sticky and plastic wet. Common fine pores and medium roots, common crabonate concretions with some gypsum crystals, strong reaction to HCl. Some slickensides on ped surface could be noticed.
9 0 - 120	Dark brown to dull yellowish brown (10 YR 3/3, 4/3) hard clay of subangular blocky to blocky with common slickensides, common fine pores and few very fine roots. Medium reaction to HCL. Yellowish brown mottles are observed with few carbonate concretions.

Site No. 2

Location	:	1 km south of Lib-Soma and about 3.5 km west of the autostrad to Merca.
Topography*	:	Low terrace or relatively high table land of levelled surface. With few mounds.
Natural cover	:	Scattered acacia shrubes.
Present use	:	Bare
Parent material	:	Stratified Shabelle alluvium of flood plain meander formation (complex).
Drainage	:	Well drained

Depth cm.	Description
0 - 30	Dull yellowish brown to greyish yellow brown (10 YR 5/3 D, 4/2 M) soft clay to clay loam of granular structure ; sticky and plastic fine to medium cracks to more than 60 cm. Common fine pores and roots. Structure develops to sub-angular blocky with depth. Medium reaction to HCl.
30 - 60	Dull yellowish brown to grayish yellow brown silty clay loam, hard, friable, sticky and plastic, subangular blocky. Fine cracks, fine roots and pores, medium reaction to HCl.
60 - 120	Dull yellowish brown to grayish brown silty clay loam, hard friable, sticky, and plastic, sub-angular blocky. Fine cracks, fine roots and pores medium reaction to HCl.

* Some scattered medium size mounds were observed. The site represents a relatively higher land from relative to the surroundings which drop to a lower swampy area to the north-west.

Site No. 3

Location : About 5.5 km west of the asphalt road and 1 km south of Lib-Soma project.

Topography : Apreaching a depression or law and forming a swamp with relative dense vegetation and shallow water depth at this season (October 1978).

Natural cover : Scattered shrubs which get dense in the swamp.

Parent material : Stratified Shabelle alluvium in the flood plain meander.

Drainage : Well to moderate depending on the depth, thickness and permeability of the different layers.

Depth, cm.	Description
0 - 30	Grayish yellow brown (10 YR 4/2 M) clay loam, hard dry, friable moist, sticky and plastic, calcareous, cracks are fine to medium to about 50 cm.
30 - 60	Dark brown (10 YR 3/3 M) clay, friable, sticky and very plastic, calcareous with cracks of medium size, carbonate accumulation starts at 40 cm. Better subangular blocky structure which is more compacted than above.
60 - 90	Ditto but with better structure
90 - 120	Stratified layer of dull yellowish arrange (10 YR 6/4) sandy loam to loamy texture of calcareous material.
120 +	Dark brown (10 YR 3/3) clayey layer again.

Site NO. 4

Location	:	1 km west of asphalt road and about 1 km north of dusty road (km 50 - Barrire) or between Feda- Mousa and km 50 - Barrire.
Topography	:	Fairly level .
Natural cover	:	Scattered shrubs and low grass. Rainfed sorghum.
Parent material	:	Shabelle alluvium.
Drainage	:	Deep well drained.

Depth , cm.	: Description
0 - 30	Dull yellowish brown to grayish yellow brown (10 YR 5/3 D, 4/2 M) clay. Deep wide cracks more than 50 cm, very hard, friable, very sticky and very plastic, calcareous.
30 - 50	Similar, with hard prismatic structure.
	Similar to site. No. 1.

Site No. 5

Location	:	3 km west of asphalt road at Feda Mousa vicinity.
Topography	:	Undulating to level.
Natural cover	:	Scattered low shrubs, some rainfed level land.
Parent material	:	Shabelle alluvium - brown coloured areas
Drainage	:	Deep, well-drained mostly dominant.

Depth, cm	Description
0 - 50	Grayish yellow brown (10 YR 4/2 D, 5/3 M), to dull yellowish brown, clay loam, deeply, cracked with common medium andfine roots and pores. Calcareous with subangular blocky structure, hard, friable, sticky and plastic.
50 - 100	Brownish black (10 YR 3/2 M), clay, very hard angular blocky, friable, very sticky and very plastic, loose roots with common medium and fine pores.

Site No. 6

Location	:	About 4 km west of asphalt road at km 50 on the dusty road to Berrire at a location about 2 km south of the dusty road.
Topography	:	Level.
Parent material	:	Shabelle alluvium.
Natural cover	:	Medium dense and size scattered shrubs of mainly acacia sp. Some trees could be observed.
Drainage	:	Deep and well.

Depth, cm.	Descrpition
0 - 30	Grayish yellow brown (10 YR 4/2 D, 4/2 M) to brownish black clayey material, loose surface mulch, hard subsurface, friable, sticky and plastic calcareous material with subangular blocky structure. Deeply and wide cracked. Medium andfine roots are common.
30 - 60	Ditto.
60 - 100	Brownish black (10 YR 3/2 M) clay with silckensides clear in this layer of very sticky and plastic consistance. Similar to site No. 5.

Site No. 7

Location	: At about 7 km west of asphalt road at about 3 km south of the dusty road to Barrire.
Topography	: Level.
Parent material	: Shabelle alluvium
Natural cover	: Dense shrubs and trees of medium size with low grass (overgrazed).
Drainage	: Deep and well.

Depth, cm.	Description
0 - 50	Grayish yellow brown (10 YR 4/2 D), clay, hard, deeply cracked, loose granular surface on well-developed subangular blocky calcareous, porous with common medium roots. Coarse (tree) roots at 50 cm.
50 +	Difficult to dig because of dryness and roots. This site is very similar to site No. 6.

Site No. 8

Location : At about 9.5 km west of the asphalt road just north of the dusty road to Barrire from km 50.

Topography : Level.

Parent material : Recent Shabelle alluvium.

Natural cover : Shrubs, Irrigated corn at present.

Drainage : Imperfect at 80 - 90 cm.

Depth, cm.	Description
0 - 30	Brown to grayish brown (7.5 YR 4/4, 4/5 M) clay, granular to platy crust, hard dry, friable moist and plastic very sticky wet. Calcareous, medium cracks to 80 cm.
30 - 60	Brownish black (7.5 YR 3/2 M), clay, compacted subangular blocky, friable, very sticky, very plastic, calcareous medium cracks and pores with common fine roots.
85 - 120	Brownish black (7.5 YR 3/2 [illegible] or 10 3/1) gleyed clay, very compacted moist.

The corn growth on this site is weak or medium relative to the western fields of better drainage conditions and perhaps of better irrigation control.

Site No. 9

Location : 1 km south of lib-Soma on Afgoi-Audegli dusty road at about 1.5 km to the east inside the project site.

Topography : Undulating.

Parent materials: Stratified Shabelli alluvium.

Natural cover : Grass and scattered shrubs of light, medium or sometimes dense low acacia.

Drainage : Very deep, well drainage.

Depth , cm	Description
0 - 10	Dark brown (10 YR 3/4 M) sandy loam, loose wet mulch, cracked even after the first rain of this season (26/10/1978), dense medium and fine roots.
10 - 30	Dull yellowish brown (10 YR 4/5 M) clay loam granular, hard, friable, sticky and plastic, calcareous. Dense roots.
30 - 60	Dull yellowish brown (10 YR 4/3 M) clay of subangular blocky, permeable, cracked, calcareous.
60 - 90	Dull yellowish brown (10 YR 4/3 M) clay similar to the above layer except that slickensides are more apparent.
90 - 120	Brownish black (7,5 YR 3/2 M) clay loam, subangular blocky breaks to granular, calcareous, friable sticky and plastic.

Site No. 10

Location : 5.5 km south of Lib-Soma on Afgoi-Audegli dusty road at about 2.5 km east of the road inside the project site, near road from Bladi Amine.

Topography : Undulating to level ; complex of natural level and flood plain meander formations.

Parent material : Shabelle alluvium.

Natural cover : Mainly grass with few scattered shrubs.

Drainage : Well and deep

Depth, cm	Description
0 - 30	Brownish black (7.5 YR 3/2 M) clay loose platey surface becomes granular at subsurface, hard friable, sticky, plastic, calcareous, deep, crackes of medium and fine sizes, common fine and medium roots and pores.
30 - 60	Ditto, clay, subangular-blocky to blocky, compacted, cracked with fine pores and roots.
60 - 90	Ditto, but slickensides are more clear with shiny ped faces of blocky structure.
90 - 120	Ditto with dark or black mottles may be of MnO. Similar to site No. 8.

Site No. 11

Location	: 7 km south of Lib-Soma on Afgoi-Audegli (near Barrire) dusty road, at about 3.5 km east of the road inside the project site.
Topography	: Undulating to level.
Parent material	: Shabelle alluvium .
Vegetation	: Dense shrubs with many medium size acacia trees.
Drainage	: Well, deep.

Depth, cm.	Description
0 - 10	Brownish black (10 YR 3/2) loose crust of clay loam.
10 - 30	Ditto granular clay loam calcareous, cracked, many roots of fine size.
30 - 60	Brownish black (7.5 YR 3/2) clay, subangular blocky, friable, sticky, plastic, calcareous, many fine roots and pores.
60 - 90	Ditto except that it is more compacted with better structure (blocky), and slickansides are clear.
90 - 120	Ditto except big tree roots are present.

ANNEX 3

IRRIGATION AND INFRASTRUCTURE COSTS

The costing of the irrigation works and the infrastructure is based on the following assumptions :-

a) The project will provide all the foreign exchange needed according to the schedule.

b) All the project imported items will be custom - tax-free according to the current rules.

The current local prices were provided by the official government agencies mainly Somalia Construction Agency, WAGAD" and DONT in June 1980. These current local prices were then adjusted according to the above assumptions.

The costing of the different items of irrigation and drainage, works, houses, buildings, services infrastructure and roads have been based on outline design and estimated quantities of the main items.

The supply item of the plants, machines materials and equipment are the estimated cost of July 1980.

The cost of all machines, plants and equipments includes the initial spare parts needed for the first two years of operations.

Capital Cost Estimate of Irrigation Works

Description	Unit	Rate So. Sh.	Quantity	Sub-total '000' So. Sh.	Total So. Sh.
1. Topographic Survey	Ha	60.0	13000	780000	780000
2. Pump Station					
a- Civil work	Sum			2000	
b- Mechanical Plant	Sum			9000	11000
3. Canalization					
(a) Earthwork					
Main Canal					
Selected compacted fill	M^3	35.0	108000	3780	
Banks	M^3	18.0	192000	3456	
Excavation in cut	M^3	20.0	499200	9984	
Minor canals					
Excavation in cut	M^3	20.0	456000	9120	
Laterals					
Excavation in cut (by disc)	M^3	6.0	470000	2820	
Drains					
Excavation in cut	M^3	20.0	350000	7000	361600

Capital Cost ... (Contd.)

Description	Unit	Rate So.Sh.	Quantity	Sub total '000 ' So. Sh.	Total So. Sh.
(b) **Structure**					
Main canal	See the details			5000	
Minor Canals	" " "			6200	
Laterals	" " "			780	
Drains	" " "			2250	14230.0
Sub-Total					62170.0
Engineering 8%					4974.0
Total					67144.0

Details of Canalization Structure Costing

		So. Sh.
1. **Main Canal**		
1-1	Heavy Traffic Bridge or Syphone at K-3 on Afgoi-Barrire Road	1 000 000
1-2	R.S.G. Regulators 4 No. X 1000000	4 000 000
		5 000 000
2. **Minor Canals** :		
2-1	Movable weirs 17 No. X 200 000	3 400 000
2-2	Night Storage Weirs 30 No. X 80 000	2 400 000
2-3	Pipe bridges 10 X 40 000	400 000
		6 200 000
3. **Laterals** :		
	Field outlet pipes (F.O.B.) 278 X 2800	780 000
4. **Drains** :		
4-1	Fall structures 3 X 300 000	900 000
4-2	Crossing (Pipe bridge) 20 No. X 40 000	800 000
4-3	Drain Junction	550 000
		2 250 000

<u>Irrigation Work Capital Layout</u> 000 So. Sh.

Year	Pre-Construction						Construction Period						Total
Item	0		1		2		3		4		5		
	L	F	L	F	L	F	L	F	L	F	L	F	
1. Topographic Survey	180	600											780
2. Pump Station	-	-	500	9000	500	1000							11000
3. Earth Works	-	-	1500	20000	1200	5000	2000	-	1900	2000	2440	120	36160
4. Structure	-	-	2500	4000	1500	-	600	2500	600	900	1203	427	14230
5. Engineering	250	1000	100	750	150	750	100	500	150	500	224	500	4974
Total	430	1600	4600	33750	3350	6750	2700	3000	2650	3400	3867	1047	67144
Gross Year Total	2030		38350		10100		5700		6050		4914		67144

Capital Cost of Infrastructure

Item	No. Of Unit	Area of Unit M2	Cost Per M2 So. Sh.	Cost per unit So. Sh.	Total Cost of item So. Sh.	Total So. Sh.
Housing						
Senior house A	9	132	2200	290,400	2,613,600	
Medium house B	21	113	2200	248,600	5,220,600	
Junior house C	314		Sum	15,000	4,710,000	
Bachelor quarter	1	304	2200	668,800	668,800	
Rest House	1	304	2200	668,800	668,800	
Labourer house D	502		Sum	4,000	2,008,000	15,850,300
Offices						
H. Q. Office	1	500	2000	1,200,000	1,000,000	
Field Office	5	60	2000	120,000	600,000	1,600,000
Stores						
Input Stores	40	144	900	129,600	5,184,000	
Products Stores	20	288	900	259,200	5,184,000	
Products Sheds	8	432	700	302,400	2,419,200	
Spare parts Stores	2	120	900	108,000	216,000	
General Stores	2	120	900	108,000	216,000	13,219,200
Roads						
Main roads	30	km	200000		6,000,000	
Side roads	80	km	100000		8,000,000	14,000,000
Water Supply						
H. Q.	2	Sum		750,000	1,500,000	
Pump Site	1	Sum		500	500,000	2,000,000

Capital Cost ... (Contd.)

I t e m	No. of Units	Area of Unit M^2	Cost per M2 So. Sh.	Cost per Unit So. Sh.	Cost per item So. Sh.	Total Cost So. Sh.
Social Buildings						
Schools	1			20,000	20,000	
Dispensary	1	64	2000	128,000	128,000	
Club	1	100	2000	200,000	200,000	
Mosque	1	80	1000	80,000	80,000	428,000
Electricity						
Hq.		Sum			3,000,000	
Pumps Site		Sum			1,000,000	4,000,000
Workshops						
Pump site workshop	1	150	700	105,000	105,000	
Tractor Workshop	1	1600	700	1,120,000	1,120,000	
Vehicle Workshop	1	200	700	140,000	140,000	
Tractor Sheds	4	800	400	320,000	1,280,000	2,645,000
Telecommunications	S u m				600,000	600,000
						54,342,500

Local and Foreign Components of Infrastructure

in So. Sh.

Item	Local	Foreign	Total
Housing	7,925,150	7,925,150	15,850,300
Offices	800,000	800,000	1,600,000
Stores	3,304,850	9,914,350	13,219,200
Roads	9,800,000	4,200,000	14,000,000
Social buildings	300,000	128,000	428,000
Water supply	600,000	1,400,000	2,000,000
Electricity	1,200,000	2,800,000	4,000,000
Workshop Buildings	661,250	1,983,750	2,645,000
Telecommunications	60,000	540,000	600,000
Total	24,651,250	29,691,250	54,342,500

Infrastructure Capital Cost Layout

'000' So. Sh.

Item	Year 1		2		3		4		5		Total	
	F	L	F	L	F	L	F	L	F	L	F	L
Housing	3962	1000	-	2170	3170	1980	-	1980	793.15	795.15		
Offices	400	100	-	200	320	200	514.25	200	80	100		
Stores	8000	1000	200	1000	1000	-	-	1000	200	304.75		
Roads	2200	5000	2000	4800	-	-	-	-	-	-		
Social Buildings	-	-	-	-	-	-	-	-	128	300		
Water Supply	800	200	200	200	400	200	-	-	-	-		
Electricity	1600	400	400	400	800	400	-	-	-	-		
Workshop buildings	1000	300	100	100	800	100	-	100	83.75	61.25		
Telecommunications	-	-	-	-	540	60	-	-	-	-		
Total	17922	8000	2900	8870	7030	2940	514.25	3280	1284.9	1561.15	29691.15	24651.15
Yearly totals	25962		11770		9970		3794.25		2846.25		54342.30	

Capital Cost of Workshop Equipment and Machines

So. Sh.

Type	2nd	3rd	4th	5th	
Workshop Tools	1,200,000	-	-	-	
Spare parts of the tools	150,000	-	-	-	
Generators	-	-	-	720,000	
Mobile Workshop	-	-	600,000	-	
Low loader	-	-	-	360,000	
Foreign Component	1,350,000	-	600,000	1,080,000	3,030,000
Local Component	27,000	-	12,000	22,000	61,000
Yearly Total	1,377,000	-	612,000	1,102,000	3,091,000

Capital Cost of Irrigation Maintenance Equipments

So. Sh.

Type	No.of Unit	2nd Year	3rd Year	4th Year	5th Year	6th Year	Life Times Years
Buldozer (D6)	3	-	-	-	-	1,800,000	15
Motor Grader	1	-	-	-	-	540,000	15
Dragline	2	-	-	-	960,000	-	15
Hydraulic Excavator	2	-	-	-	-	960,000	15
4X4 Wheel Station	1	102,000	-	-	-	-	7
4X4 Wheel Pickup	5	78,000	78,000	78,000	156,000	-	7
8 TonsLorry	3	-	292,000	146,000	-	-	7
8 Tons tipper	2	-	-	-	165,000	165,000	7
Mobile Crane	1	-	-	-	-	900,000	15
Mobile Workshop	1	-	-	-	-	420,000	10
Total Foreign		180,000	370,000	224,000	1,281,000	4,785,000	6,840,000
Local Component		4,000	7,000	5,000	26,000	95	137,000
Yearly Total		184,000	337,000	229,000	1,307,000	4,880,000	6,977,000

Details of Irrigation Work

Operation Cost

1. **Staff**

Category	No.	Total Annual Salary	Total So. Sh.
Chief Irrigation Engineer	1	24,000	24,000
Irrigation Engineer	1	18,000	18,000
Assistant Engineer	4	14,000	56,000
Senior Technicians	6	10,000	60,000
Skilled Labourer	18	8,000	144,000
Heavy machine operator	8	9,000	72,000
Clerk-Typist	2	8,000	16,000
Semi-Skilled Labourer	40	6,000	240,000
Vehicle Driver	11	8,000	88,000
Unskilled labourer	26	4,000	104,000
Watchman	10	4,000	40,000
			876,000

2. **Machines and Equipments**

Bulldozers (D6)	3 No. X 600,000	1,800,000
Motor Grader	1 No. X 540,000	540,000
Draglines	2 No. X 480,000	960,000
Hydraulic excavator	2 No. X 480,000	960,000
4x 4 Wheel Station Car	1 No. X 102000	102,000
4 X 4 Wheel Pickup car	5 No. X 78,000	390,000
8 Ton lorries	3 No. X 146,000	438,000
8 Ton earth tipper	2 No. X 165,000	330,000
Mobile workshop	1 No. X 420,000	420,000
Mobile 10 Ton Crane	1 No. X 900,000	900,000
		6,840,000
Additional charges 2%		137,000
Total		6,977,000

3. Annual Machines and Equipment Operation Cost :

A. **Fuel & Lubrication**

1. **Heavy Equipment** :

Total power = 8 X 175 = 1400 H.P.
Working hours/year = 250 X 8= 2000 hours

Total consumption = 180 gram/H/P./hour
Total consumption = 1400 X 2000 X 180 = 504 Tons
= 604,800 Litre
Cost = 604,800 X 2.3 = 1,391,040 S.Sh.

2. Vehicles

Total power = 700 H.P.
Working hours/year = 250 X 3 = 750 hour

Total consumption = 700 X 750 X 180 = 94,5 tons
= 113,400 Litre
Cost = 113400 X 2.3 = 260,820 So.Sh.

3. **Other machines**

Total power = 500 H.P.
Working hours/year = 1350 hours
Consumption = 500 X 1350 X 180 = 121.5 tons
= 145,800 Litre
Cost 145,800 X 2.3 = 335,340 So.Sh.

Total cost = 1391040 + 260820 + 335340 = 1987,200
Lubrication = 198,700

Total = 2,185,900 So.Sh.

B. Spare parts 8% of capital cost — 558,000

C. Other cost 5% — 137,000

Total machine and equipment operation
Cost 218500 + 558000 + 137000 — 2,880,000

4. <u>Pump Station Annual Operation Cost</u>

A. Fuel & Lubrication Power = 240 H.P/Unit
Working hours/year = 14000 Unit hour

Consumption = $240 \times 14000 \times \frac{180}{1000}$ = 605 tons
= 726000 litre

Cost = 726000 X 2.3 = 1670000 So.Sh.
Lubrication 10% — 167000

1837000
=========

B. Spare parts

7% of capital cost — 600000 So. Sh.

C. Other costs 5% — 121000

Total cost =
1,837,000 + 600,000 + 121,000 — 2,558,000 So. Sh.
=========

Workshop Machines and Tools :

	So. Sh.
Workshop tools	1,200,000
Spare parts Store	150,000
Generators	720,000
Mobile Workshop	600,000
Low Loader	360,000
Total	3,030,000
Charges 2%	61,000
Total	3,091,000

Build-up of Annual Pumps Operation Cost

So. Sh.

I t e m	3rd Year	4th Year	5th Year	6th Year on wards
Fuel	668,000	1,085,000	1,420,000	1,670,000
Lubrication	67,000	109,000	142,000	167,000
Spare parts	240,000	380,000	510,000	600,000
Total Foreign component	975,000	1,574,000	2,072,000	2,437,000
Local Component	50,000	75,000	100,000	121,000
Yearly Total Cost	1,025,000	1,649,000	2,172,000	2,558,000

Build-up of Annual Operation Cost of the Irrigation Maintenance Machines

Item	Year 2	Year 3	Year 4	Year 5	Year 6 on wards
Fuel & Lubrication	57,000	157,000	247,000	656,000	2,185,000
Spare parts	14,000	62,000	63,000	104,000	558,000
Total Foreign Component	71,000	219,000	310,000	760,000	2,743,000
Local Component	3,500	12,000	15,500	38,000	137,000
Yearly Total	74,500	231,000	325,500	798,000	2,880,000

Irrigation Staff build up cost

So. Sh.

Post	No.	Annual Salary So. Sh.	2nd Year	3rd Year	4th Year	5th Year	6th Year
Chief Irrigation Engineer	1	24000	24000	24000	24000	24000	24000
Irrigation Engineer	1	18000	-	-	-	18000	18000
Assistant Engineer	4	14000	14000	28000	42000	56000	56000
Senior Technician	6	10000	10000	30000	40000	50000	60000
Skilled Labourer	18	8000	-	24000	48000	72000	144000
Heavy Machine Operator	8	9000	-	-	-	36000	72000
Clerk Typist	2	8000	-	-	-	16000	16000
Semi Skilled Labourer	40	6000	-	96000	156000	204000	204000
Vehicle driver	11	8000	16000	24000	32000	56000	88000
Unskilled labourer	26	4000	16000	40000	60000	80000	104000
Watchman	10	4000	8000	16000	24000	32000	40000
Store Keeper	2	8000	-	-	-	8000	16000
Annual Total	129	-	88000	282000	426000	652000	878000

ANNEX 4

RICE MILLING EQUIPMENT

Recent Development of Rice Mill Units :-

The most essential of various functions of a rice mill are husking or dehusking, (removal of husk from rough rice), and whitening or milling, (removal of bran layer from the Kernel).

In rice growing countries, rice mills are classified into two different categories :-

A - Smaller Scale Rice Mills :-

Those mills are mostly a single or a battery of so-called hullers, and most of such small mills are not commercially operated but on custom basis. Generally the owners of those mills do not buy rough rice nor sell rice, but they only mill rice upon request by people who bring rough rice and take away white rice against some milling charge. Naturally they do not care much about milling recovery of rice and percentage of brokens or quality of finished product. In fact the modernization of huller mills have not been achieved, but it is widely known that those hullers are be worst kind of rice milling equipment which crush almost half of sound rough rice grains fed to the machines and lose the valuable rice.

The cause for the inefficiency of hullers lies in the following fact : Two different processes i.e. husking and whitening are performed all at once by hullers. In order to do husking, it is necessary to charge pressure to grains. On the other hand for the whitening of brown rice without making brokens, the pressure charged to grains must be kept to a minimum . As far as these two processes are performed in a single machine, breakage of kernals can not be avoided.

B - Larger Scale Rice Mills :

These mills, being commercially operated, are mostly composed of rough rice cleaners, disc huskers, compartment type rough rice separators, rice whitening machines (cone type), broken rice separating device and germand bran separators, and are comparatively better than the smaller scale ones. To improve milling recovery and lessen broken grain, in such larger scale rice mills, each of these two processes i.e. husking and whitening should be performed independently so that they can be done in the most proper way. Disc huskers and whitening machines (cone type) used in such mills are not efficient due tothe fact that much rough rice is always mixed with brown rice to be fed to the cone type whtener, and to avoid this, husking rate should be high enough so as to reduce the quantity of remaining rough rice in brown rice. To improve the husking rate of disc huskers, the clearance between discs should be narrow enough. However, the narrower the clearance, the more broken grains are produced or the less milling recovery.

The recent development in rice processing is to replace these disc huskers and whitening cones by rubber roll huskers and cylinderical whitening machines (abrasive type and friction type). The rubber roll type rough rice husker is the most suitable machine which fulfills the requirement mentioned before. This machine feeds rough rice in between two rubber rollers turning in opposite direction with a little clearance adjusted automatically. The peripheral speed of the two rolls is a little different which works to peel off the husk of rough rice gently and perfectly by elasticity of the rubber. Thus the rough rice can be husked without any breakage. The whitening is to remove bran from brown rice and process it into white rice. For this purpose there are two different types of whiteners, abrasive type and friction type.

Abrasive type machine incorporates abrasive roller made of carborundom with high hardness and surrounded with perforated steel cylinder. Peripheral speed of the roller is relatively higher and pressure charged to grain is less. Thus, this machine functions to scrape and cut off the surface of brown rice with sharp edges of the roller under lower pressure on the grain.

Friction type machine incorporates milling roller surrounded with perforated screen. Peripheral speed of the roller is relatively lower and pressure on the grain is greater. Thus this machine functions to peel off the bran layer by the friction caused between the grains. Most desirable result of whitening can be attained by adopting the proper combination of the two systems according to the characteristics of the grain to be whitened.

Bulk Storage of Rough Rice

The storage complex is usually located close to the milling section and has provision for cleaning, weighing and drying before storage. Mechanical conveying equipment suitably aligned and interlocked is used for handling rough rice. The storage units are built with provisions for aeration and temperature detection, inspection man-holes and ladders, beside feed inlets.

Two possible designs for storing 15.000 tons of bulk rough rice are :-

1. 21 steel silos with hopper bottom aligned in three rows.

2. Concrete bins.

In these systems, feeding as well as unloading will be done by mechanical equipment and as such there is minimum need for unskilled labour.

In the layout with 21 silos, each unit has a diameter of 10 meters and height above hopper level is 15 metres and holds 700 tons per silo. Steel structures are obviously lighter than concrete construction and may be preferred where soil bearing capacities are low. However, concrete bins and silos have the basic advantage of realisation with local materials.

Rough rice is unloaded in bulk into a receiving dump from where it is conveyed to the elevator by an inclined screw. It is then elevated and fed to a scalper/cleaner below which a weighing scale is installed. The cleaned and weighed quantity goes to the dryers through elevators of suitable heights and rated capacities. In between drying passes there is provision for tempering in small bins which are serviced by screw conveyors. The dried rough rice next goes to the tall elevator and the top conveyors aligned on top of the silos. Several rows of top conveyors are needed depending on the number of row built.

A typical layout for 15.000 tons rough rice storage may comprise the following dimensions and capacity rating may be varied as found necessary :-

a) 21 silos each holding 700 tons, aligned in 3 rows. (Diameter = 9 m and height 19 m).

b) 4 elevators for feeding the cleaner, dryers and silos. Silo elevator 30 to 40 t/hr capacity - Dryer 30 to 40 t/hr capacity.

c) 3 rows of top conveyors (belt or screw) housed in a top gallery floor.

d) 3 rows of belt or screw conveyors below the silos.

e) Dryers, air heaters, blowers, cleaners and weighers, mobile separation equipment, control panel etc. to match the receiving rate and storage quantities.

f) Thermo couple assembly inside the silos.

g) Temperature readings at every 1½ m intervals vertically. At each level, temperature measurements at 3 points.

Utilization of Rice By-Products

As a result of the milling processes, there are by-products which have an economic value, these by-products can be used as follows :-

1. Broken rice which either remains mixed with rice or separated can be utilized for baby food, spirits, chicken feed or in starch and glucose industry.

2. Rice bran and germ can be utilized for animal feed or rice oil extraction.

3. Husks can be utilized as fuel, in brick industry, as an ingredient of animal feed (ground) and for the extraction of furfural and silica.

Rice Mill Equipment :-

A rice mill of 100 tons white rice and brokens daily capacity for local consumption shall require the following equipment :-

A. Preliminary Cleaning Section :

1. To remove large impurities, eliminate other impurities larger or smaller than rough rice grains and the suction of light materials.

2. The capacity of this section will be 25 tons/ha, in case of flat storage under sheds or elevator storage (silos).

3. Rough rice bin of 200 tons capacity.

B. Principal Cleaning Section :

1. To clean rough rice from foreign matter including weed seeds and empty grains.

2. The elimination of foreign matter which must be free of rough rice.

3. The capacity of this section will be 8 tons/hr of rough rice.

C. Hulling Section :

1. To hull rough rice.

2. To remove husk from brown rice with husk aspirators.

3. To separate brown rice from rough rice by separators.

4. The efficiency of machinery should :-

   - Ensure that husks are free from any rice particles, such as brokens and immature grains.

   - The share of such particles should not exceed 0.25% of the quantity of husk by weight.

   - Secure the purity of brown rice from any rough rice.

5. The capacity of this section will be 7 tons/hr.

D. Whitening Section :

1. To obtain well polished rice.

2. For the separation of bran and germs together.

3. For the separation of brokens.

4. The capacity of this section will be 5 tons/hr. of brown rice.

E. Grading Section :

1. To classify the output into :-

- Head rice practically free of brokens.
- Broken rice bigger than half kernel.
- Broken rice, half to quarter the Kernel.
- Fine brokens.

2. The capacity of this section shall be 5 tons/hr.

F. Packing :

For automatic packing of the finished products (white rice, brokens, germs and bran) in suitable bags according to local market needs.

G. Accessories :

All necessary equipment and accessories for horizontal and vertical transportation, connections, spouting, ducts and erection materials needed for the mill machinery.

H. Driving Power :

- All machines arranged for individual electric motor drive.

- Two diesel generating sets each of 300 K. W. suitable for the power required for driving the electric motors of the equipment. One shall be as a standby, and can be used for operating the two ice making plants during a period not more than four months per year.

I. Laboratory Equipment :

The mill should be equipped with different laboratory equipment to test and control the rough rice and finished products according to the required specifications of same.

J. Spare Parts :

Spare parts for at least two years of operation of the mill should be included in the tender and delivered with the machinery to ensure perfect and continuous running of the mill.

Tender Conditions :

Tender conditions and specifications for rice mill plant shall be on " turn-key" basis and must include :-

A. The quality of local rough rice indicating :-

- Foreign matter.
- Moisture content.

- Chalky and green grains.
- The shape of kernels.
- The weight of 1000 kernels (specific gravity).

B. The quality of the required finished product including:-

- The percentage of brokens.
- Percentage allowed of chalky, coloured and under-milled grains .
- To be practically free from foreign matter.

C. The detailed technical specifications of machinery and equipment including :-

- Steel structure building.
- The capacity of each section.
- The detailed equipment of each section.
- Detailed spare parts required.
- Laboratory equipment.

D. Erection of machinery and equipment of the plant including :-

- Time required for erection.
- Number of technicians needed for erection and start-up.
- The total cost of erection.
- Detailed tools required for erection and maintenance of the machinery.

ANNEX 5
MACHINERY COEFFICIENTS

a : Earth-moving Machines Needed :

Norms for Calculations :

1. Area to be reclaimed on the first and second year 2900 ha.
2. Working period per year :-

   a- For Gu season : December - January - February - March.

   b- For Der season : July - August - September.
3. Net working days per month 25 days.
4. Net working days per year 100 + 75 = 175 days.
5. Net working hours per day 6 hours.

Bush clearing :

Average bulldozer blade width 4 meters.
Average operating speed 3000 m/hr. (1st Speed)
Machine efficiency 25%.

b : Ripping :
Norms :

Width of ripper 2m.
Operating speed 6000 m/hr. (2nd year)
Machine efficiency 50%
Output per one machine 3.6 ha/day.

c : **Levelling** :

Equipment used, land plane 24' with 4 X 4 wheel tractor 150 HP.

Output of such equipment per hour $\frac{7.2 \times 6000}{100\,000} = 4.32$ ha/hr.

Output per day 4.3 X 6 = 25.8 ha/day

d : **Agricultural Machinery** :

Crop pattern :

Number of machinery required should be based on the crop pattern shown below :

Crop	3rd Tear		4th Year		5th Year		6th Year	
	Gu	Der	Gu	Der	Gu	Der	Gu	Der
Rice	1450	1800	2550	3050	3600	4150	5000	5000
Maize	-	-	900	-	1525	-	2075	-
Sesame	-	-	-	1275	-	1800	-	2500
Cowpea (green manure)	1450	1800	1650	1775	2075	2350	2925	2500
Total	2900	3600	5100	6100	7200	8300	10000	10000

Agricultural Operations time table :

Operation	Gu Season			Der Season		
	From	To	Period (days)	From	To	Period (days)
Ploughing	15 Feb.	31 Mar.	40	1 Sep.	30 Sep.	25
Harrowing	15 Feb.	31 Mar.	40	15 Aug.	30 Sep.	40
Levelling	20 Feb.	31 Mar.	35	20 Aug.	30 Sep.	35
Planting	20 Mar.	10 Apr.	20	20 Sep.	10 Oct.	20
Disc bedding	20 Mar.	10 Apr.	20	20 Sep.	10 Oct.	20
Ditching	20 Mar.	10 Apr.	20	20 Sep.	10 Oct.	20
Weeding	3 Cycles	July-Aug.	Each 20	2 Cycles	Dec.-Jan.	Each 20
Plant Protection	2 cycles	July-Aug.	Each 10	2 Cycles	Dec.-Jan.	Each 20
Harvesting	1 Sep.	30 Sep.	30	15 Feb.	31 Mar.	40
Baling	1 Sep.	30 Sep.	30	15 Feb.	31 Mar.	40
Transporting	1 Sep.	30 Sep.	30	15 Feb.	31 Mar.	40

Norms of Agricultural Machinery :

Tractor Power	Agric. Machine		Tractor Speed m/h	Machine output	
	Description	Width cm.		per hour ha.	per 6 hours (day) ha.
Wheel Tractor 90 HP	Disc, Plough, 5 discs	130	6500	0.72	4.3
	Offset disc harrow with transport wheels	275	6500	1.5	9
	Planter	350	6500	1.5	9
	Seeder	350	6500	1.5	9
	Disc bedder		8000	7	42
	Ditcher with adjustable wings		6500	7	42
	Sprayer	1200	6500	6	36
	Weeder	350	6500	1.5	9
Wheel tractor 150 HP	Land Plane	720	6500	4	24
Wheel tractor 65 HP	Trailers, 5 tons				15 tons
Combine harvester	For rice and Maize	400	4000	1.2	7

ANNEX 6

Costs and Prices

Table (1) Number and Capital Costs of earth-moving machinery

(000 So.Sh.)

Years	1			2			3			4			5	
Item	No.	L	F	No.	L	F	No	L	F	No	L	F	L	F
Buldozer D 6	7	42	4200	6	36	3600	5	30	3000	2	12	1200	-	-
Spare parts	-	6	630	-	5	540	-	4	1080	-	2	720	6	180
Land leveller	2	5	540	-	-	-	2	5	540	-	-	-	-	-
Spare parts	-	8	80	-	-	-	-	8	80	-	-	-	-	-

No. = Number of machines L = Local currency F = Foreign

Source : Annex 5 Machinery Coefficients

Table (2) : Numbers and Costs of Agricultural Machinery

	2nd Year			3rd Year			4th Year			5th Year			Notes
	Qty	Price Per Unit $	Total $	Qty	Price per Unit $	Total $	Qty	Price per Unit $	Total $	Qty	Price per Unit $	Total	
Wheel Tractor 150 HP (4X4)	9	26000	234000	3	26000	78000	3	26000	78000	3	26000	78000	15 spare parts
Wheel Tractor 90 HP (4X4)	73	18000	1314000	26	18000	468000	37	18000	666000	22	18000	396000	" " "
Wheel Tractor 60 HP (4X4)	8	14000	112000	12	14000	168000	24	14000	336000	32	14000	448000	" " "
Disc Plough (H.D)5 Discs	33	1300	42900	12	1300	15600	16	1300	20800	8	1300	10400	10% " "
Disc Harrow 24 Disc	10	2500	25000	3	2500	7500	5	2500	12500	3	2500	7500	" " "
Land Leveller	9	8000	72000	3	8000	24000	3	8000	24000	3	8000	24000	" " "
Seeder	20	4500	90000	7	4500	31500	9	4500	40500	6	4500	27000	" " "
Planter	-	-	-	5	4000	20000	3	4000	12000	4	4000	16000	" " "
Disc bedder	4	1000	4000	1	1000	1000	3	1000	3000	1	1000	1000	" " "
Ditcher	4	1000	4000	1	1000	1000	3	1000	3000	1	1000	1000	" " "
Weeder	16	2500	40000	8	2500	20000	9	2500	22500	9	2500	22500	" " "
Sprayer	10	6000	60000	2	6000	12000	5	6000	30000	4	6000	24000	" " "
Agricultural Trailer Stons	8	2000	16000	12	2000	24000	24	2000	48000	32	2000	64000	" " "
Combine harvester (Rice)	7	70000	490000	5	70000	350000	4	70000	350000	7	70000	490000	15% Spare
Combine harvester (Maize)	-	-	-	4	60000	240000	3	60000	180000	3	60000	180000	" "
Baler	2	5500	11000	2	5500	11000	2	5500	11000	2	5500	11000	10% Spare
(000 So.Sh.)			12920			9168			9483.9			11216.5	

Source : Annex (5) Machinery Coefficients.

Table (3) : Economic Prices World Prices At Farm Gate (So. Sh.)

	Maize		Rice		Sesame	
CIF Mogadishu S MT 1 US $	6.23	12	6.23	12	6.23	12
CIF Mogadishu So.Sh./M.T.	686	1680	2865	5172	4510	8688
Handling & porting charges So.Sh./MT	86	86	86	86	86	86
Mog Warehouse So.Sh. / MT	954	1766	2771	5258	-	-
- Transport to the project site So. Sh. /Ton	30	30	30	30	-	-
Farm gate price So. Sh./MT	924	1736	-	-	-	-
Farm Gate/ Quintal	92.4	173.6	274	523	421	838

Source : Calculated from :
Somalia - Agricultural Sector Review Volume III Annexes 4 -7, 1980 and ADC, INCH, 1980.

Table (4) : Economic and Financial Prices
So. Sh. / quintal 1980

	Economic IUS$= 6.23	Financial
Seeds		
Rice (Rough)	178	225
Maize	92.4	100
Sesame	421	300
Cowpea	300	300
Fertilizers		
Urea 46/N	183	231
TSP	188	257
Stam F/KG	30	40/Kg
Sevin/Kg	40	55/Kg
Labour		
Man	5	10
Woman	4	8
Child	2.5	5
Petrol Diesel	2.3/L	2.9/L

Prices including handling costs

Source : ADC, ONAT and Table (3) in Annex 6.

Table (5) : Costs of agricultural inputs and wages of casual labour force (000 So. Sh.)

	3		4		5		6		7	
	E	F	E	F	E	F	E	F	E	F
Seeds										
Rice	578.5	731.2	996.8	1260	1379.5	1743.7	1780	2250	1780	2250
Maize	-	-	24.9	27	42.3	45.8	57.5	62.3	69	75
Sesame	-	-	53.8	38.4	57.7	54	105.2	75	105.2	75
Cowpea	29.2	292	308	308	398	398	488	488	450	450
Total	870.5	1023.2	1383.5	1633.4	1895.5	2241.5	2430.7	2875.3	2404	2850
Urea										
Rice	189	1501	2049	2587	2836	3580	3660	4620	3660	4620
Maize	-	-	329	415	558	704	759	958	914	982
Sesame	-	-	232	293	329	416	457	577	457	577
Cowpea	148	187	155	196	201	254	247	311	228	286
Total	1337	1688	2765	3491	3924	4954	5123	6446	5259	6465
TSP										
Rice	611	835	1052	1439	1457	1991	1880	2570	1880	2570
Maize	-	-	169	231	285	390	389	532	469	641
Sesame	-	-	118	161	169	231	235	321	235	321
Cowpea	304	416	319	436	413	565	507	693	467	639
Total	915	1251	1658	2267	2324	3177	3011	4116	3057	4171
Sevin										
Rice	520	715	896	1232	1240	1705	1600	2200	1600	2200
Maize	-	-	144	198	244	335	352	456	400	549
Sesame	-	-	102	140	144	198	200	275	200	275
Total	520	715	1142	1570	1628	2238	2132	2931	2200	3024
Stam F										
Rice	975	1300	1680	2240	2325	3100	3000	4000	3000	4000
Labour Force										
Man	260	520	448	896	620	1240	800	1600	800	1600
Woman	546	1092	941	1882	1302	2604	1680	3360	1680	3360
Child	812	1625	1400	2800	1937	3875	2500	5000	2500	5000
Total	1618	3237	2789	5578	3859	7719	4980	9960	4980	9960

Table (5) Continued

	3		4		5		6		7	
	E	F	E	F	E	F	E	F	E	F
Maize										
Man	-	-	162	324	274	459	373	747	-	-
Woman	-	-	43	86	73	146	99	199	-	-
Child	-	-	-	-	-	-	-	-	-	-
Total	-	-	205	410	347	695	472	946	570	1140
Sesame										
Man	-	-	89	178	126	252	175	350	-	-
Woman	-	-	265	530	374	748	520	1040	-	-
Child	-	-	-	-	-	-	-	-	-	-
Total	-	-	354	708	500	1000	695	1390	695	1390
Cowpea										
Man	97	195	102	205	132	265	162	325	-	-
Woman	78	156	82	164	106	212	130	260	-	-
Child	-	-	-	-	-	-	-	-	-	-
Total	175	351	184	369	238	477	299	585	270	540
Total Labour Cost										
Rice	1618	3237	2789	5578	3859	7719	4980	9960	-	-
Maize	-	-	205	410	347	695	472	946	-	-
Sesame	-	-	354	708	500	1000	695	1390	-	-
Cowpea	175	351	184	369	238	477	292	585	-	-
G.Total Labour Cost	1793	3588	3532	7065	4944	9891	6349	1288	6515	13030

Source : Table 7.4 in the text and Annex (6)

Table (6-a) Earth-moving, fuel quantities and Costs

So. Sh. 2.9/L.

Operation	1st Year				2nd Year				3rd Year			
	Gu		Der		Gu		Der		Gu		Der	
	Litre	So.Sh,	Litre	So.Sh.	Litre	So.Sh	Litre	So.Sh	Litre	So.Sh	Litre	So.Sh
B/Clearing + Ripping	161000	466900	120750	350175	161000	466900	120750	350175	138000	400200	603750	1750875
Levelling			80500	23345						80500	23345	

Contd.

Operation	4th Year				5th Year			
	Gu		Der		Gu		Der	
	Litre	So.Sh.	Litre	So.Sh.	Litre	So.Sh.	Litre	So.Sh.
B/ Clearing + Ripping	207000	600300	603750	1750875	207000	600300	684250	1984325
Levelling		120750	350175			120750	350175	

140 - 180 HP 230 Litre / 8 h 2.
150 HP 210 " "

Source : Estimation of team of experts.

Table (6-b) : Fuel Costs So. Sh. L/2.3

Earthmoving Machinery (Economic Costs) (000 So. Sh.)

Operation	Year 1		Year 2		Year 3		Year 4		Year 5	
	Gu	Der	Gu	Der	Gu	Der	Gu	Der	Gu	Der
Clearing + Ripping	370.3	277.7	370.3	277.7	317.4	1388	476	1388	476.1	1573.7
Levelling	92.5		92.5		185		277.7		277.7	
Total/Year	740.5		740.5		1890.4		2141.7		2327.5	

Table (7) : Fuel quantities and costs of agricultural Machinery

(000 So. Sh.)   So. Sh. 2.3/ L.

Agric. Operations	3		4		5		6	
	Q	So. Sh.	Q	So.Sh.	Q	So.Sh.	Q	So.Sh.
1	188.1	432.7	260.6	599	355.6	817.8	445.6	1024
2	90	207	120	276	170	391	225	517
3	117.6	270.3	161.7	371.9	207.7	477.7	271.9	625.4
4	90	207	137.5	316.2	190	437	245	563
5	17.5	40.2	25	57.5	37.5	86.2	47.5	109
6	17.5	40.2	25	57.5	37.5	86.2	47.5	109
7	135	310.5	322.5	741.7	457.5	1052	607.5	1397
8	22.5	51.7	55	126.5	77.5	178	102.5	235
9	67.5	155.3	138	317.4	198	455	261	600
10	17.5	40.2	35	80.5	47.5	109	70	161
11	50.1	136.0	108.8	250	204	469	346.8	797
		1891.1		3194.2		4558.9		6137.4

TABLE (8) Quantities and Costs of Fuel for Agricultural Machinery So. Sh. 2.9/L

	3rd Year				4th Year				5th Year				6th Year			
	Gu		Der		Gu		Der		Gu		Der		Gu		Der	
	Litre	So.Sh	Litre	So.Sh	Litre	So.Sh	Litre	So.Sh	Litre	So.Sh.	Litre	So.Sh	Litre	So.Sh	Litre	So. Sh.
1 Ploughing	85000	246500	103125	299063	120000	348000	140625	407813	165000	478500	190625	552813	230000	667000	215625	625313
2 Harrowing	40000	116000	50000	145000	55000	159500	65000	188500	80000	232000	90000	261000	110000	319000	105000	304500
3 Levelling	51450	149205	66150	191835	73500	213150	88200	255780	95550	277095	110250	319725	139650	404985	132300	383670
4 Seeding	40000	116000	50000	145000	70000	203000	67500	195750	100000	290000	90000	261000	140000	406000	105000	304500
5 Disc bedding	7500	21750	10000	29000	12500	36250	12500	36250	17500	50750	20000	58000	25000	72500	22500	56250
6 Ditching	7500	21750	10000	29000	12500	362500	12500	36250	17500	50750	20000	58000	25000	72500	22500	56250
7 Weeding	60000	174000	75000	217500	142500	413250	180000	522000	210000	609000	247500	717750	29250	848250	315000	913500
8 Spraying	10000	29000	12500	36250	25000	72500	30000	87000	35000	101500	42500	123250	50000	145000	52500	152250
9 Harvesting	31500	91350	36000	104400	72000	20800	66000	191400	108000	313200	90000	261000	153000	443700	108000	313200
10 Baling	7500	21750	10000	29000	15000	43500	20000	58000	22500	65250	25000	72500	30000	87000	40000	116000
11 Transporting	22950	66555	27200	78880	51000	147900	57800	167620	112200	325380	91800	266220	193800	562020	153000	443700

60 hp 85 L/8 hours
90 hp 125 L/8 "
150 hp 210 L/8 "
105 hp 150 L/8 "

Cost / L So. Sh. 2.9
Calculation of fuel = No. of hp X 200 grams X 85 X 8 hours / day = - L / Day

Table (9) : Agricultural Permanent Staff and Salaries
(000 So. Sh.)

	1		2		3		4		5		6		7		Rates
	No.	W	No.	W	No.	W	No.	W	No.	W	No.	W	No.	W	(000 sosh per year
Project Manager, Administrative	1	36	1	36	1	36	1	36	1	36	1	36	1	36	36
Assistant Manager	-	-	-	-	1	30	1	30	1	30	1	30	1	30	30
Administrative Officer	-	-	1	18	1	18	1	18	1	18	1	18	1	18	18
Chief Plant Protection	-	-	-	-	1	24	1	24	1	24	1	24	1	24	24
Chief Agronomist	-	-	-	-	1	24	1	24	1	24	1	24	1	24	24
Procurement Officer	1	24	1	24	1	24	1	24	1	24	1	24	1	24	24
Accountant Secondary School	-	-	1	14	2	28	2	28	2	28	2	28	2	28	14
Clerk Typist	4	32	8	64	14	112	16	128	16	128	16	128	16	128	8
Chief Farm Manager	-	-	1	18	3	54	4	72	4	72	4	72	4	72	18
Farm Manager	-	-	-	-	2	28	4	64	8	112	8	112	8	112	14
Ass. Farm Manager	-	-	-	-	2	20	6	60	8	80	8	80	8	80	10
Irrigation Supervisor	-	-	-	-	2	20	6	60	8	80	8	80	8	80	10
Assistant Irrigation	-	-	-	-	2	20	6	60	8	80	0	80	8	80	10
Irrigation Workers	-	-	-	-	30	120	90	360	120	480	120	480	120	480	4
Farming Workers	-	-	-	-	30	120	90	360	120	480	120	480	120	480	4
Plant Protection	-	-	-	-	10	40	30	120	40	160	40	160	40	160	4
Store keeper	-	-	2	16	6	48	8	64	8	64	8	64	8	64	8
Drivers	1	8	6	48	10	80	12	96	12	96	13	104	13	104	8
Unskilled labourers	2	8	3	12	6	24	8	32	10	40	10	40	10	40	4
Total		108		250		870		1660		2056		2064		2064	

Source : Agriculture Section Chapt. (4)

Table (12) : Cars needed for the farm

(000 So. Sh.)

	(1)		(2)		(3)		(4)		(5)	
	No.	Cost	No.	Cost	No.	Cost	No.	Cost	No.	Cost
Land Rovers, Pick-up S 13000 and station S 17000	6	468	2	156	4	312	2	204		
Motorcycles	-	-	4	12	2	6	4	12	2	6

T E A M S O F E X P E R T S

TEAMS OF EXPERTS

FIRST TEAM (NOVEMBER, 1978) :

1. Agric. Engineer Mr. Ahmed Talaat Aziz - Head of the team Ex-chief, Rice Milling Organization, A. R. E.

2. Dr. Nabil Tawfeik Habashy - Economics Specialist Head, Land Economics Research Section, Agricultural Economics Research Institute , Agricultural Résearch Center, A. R. E.

3. Dr. Mohamed El-Fawal - Agronomy Specialist Professor of Agronomy, Faculty of Agriculture, University of Alexandria

4. Dr. Hatem El-Attar - Soils Specialist Associate Professor - Land Division Faculty of Agriculture University of Alexandria

SECOND TEAM (JUNE - JULY 1980):

1. Agric. Engineer Mr. Ahmed Talaat Aziz - Head of the Team, Ex-chief, Rice Milling Organization, A. R. E.