Distr.
GENERAL
E/ESCWA/AGR/87/16
29 December 1987
ORIGINAL: ENGLISH

UNITED NATIONS

ECONOMIC AND SOCIAL COUNCIL

ECONOMIC AND SOCIAL COMMISSION FOR WESTERN ASIA

Joint ESCWA/FAO Agriculture Division

IDENTIFICATION OF REGIONAL FOOD SECURITY PROJECTS: A CASE STUDY FOR IRAQ

December 1987

E/ESCWA/AGR/87/16

87-1389

SUMMARY AND CONCLUSIONS

The state of food security in the ESCWA region has been steadily falling over the last 20 years. At the present time, the self-sufficiency ratio in the region stands at about 50 per cent. Considerable amounts of food are being imported causing significant financial problems to a good number of countries in the region. A number of factors have combined to make it extremely difficult for future efforts to achieve a reasonable level of self-reliance in food production. Chief among them is the differential distribution of agricultural and financial resources among the countries of the region. Therefore, bringing about complementarities of those resources at a much greater scale than has hitherto been achieved, and within a framework of equal sharing of costs, benefits and risks is the main substance of any solution to this problem.

Iraq, being foremost among the countries of the region with respect to the availability of agricultural resources that are mostly under-utilized and partly unutilized, has recently completed or nearly completed a large number of irrigation and land reclamation projects, which are over and above the requirements of land distribution to small farmers. It encourages private investment in large-scale agricultural production projects, including investment from other Arab countries, and provides considerable incentives in the form of exemptions from duties and taxes, in addition to lease of agricultural land, fully provided with water and infra-structures, at reasonable rates.

The present study was carried out with the main objective of assessing the financial viability of investment in large-scale food (and agricultural) production projects in Iraq with a view to attracting Arab investment to regional food security projects that could be established in Iraq. The project selected for the study, Al-Nai State Farm, represents the central irrigated area in Iraq.

The project concept is to utilize the existing developed resources of Al-Nai State Farm to operate a fully integrated crop livestock production system, and to market its products in Iraq and/or other Arab countries.

The farm is located about 90 km to the north-east of Baghdad on the western side of Baghdad-Kirkuk road, on a plain parallel to the river Tigris. The farm has a gross area of 42,000 donums. It is equipped with a well designed irrigation system comprising three pump stations, a set of main, secondary and tertial canals and a set of 57 main structures. Except for the secondary canals serving 5,000 donums (the first stage of the project) all the main and secondary canals are lined. The land in this first stage (5,000 donums) is not finely levelled. The drainage network of the farm includes the open collector drain and branch and outfall drains. Therefore, the secondary canals serving the 5,000 donums of the first stage needs to be lined, the land sould be levelled and field drains should be established upon starting the new project. The farm is also equipped with a good number of administrative and functional buildings as well as homes for employees and labourers. Buildings include a cotton ginnery.

The new project integrates crop and livestock production. It will utilize a net area of 22,000 donums in winter to produce potatoes, barley and green fodder (85 per cent cropping intensity). During summer only 2,000 donums will be planted in corn and cotton (34 per cent intensity). In all the total cropping intensity will reach 120 per cent. The project will produce for sale 56,000 tons of potatoes and 250 tons of cotton, annually.

The project's livestock enterpirse comprises a dairy herd of 7,200 head fresian, out of which 2,400 will be milking cows. The project will operate a 5 ton per hour feed mill to produce the required concentrates for the dairy herd. The livestock enterprise is expected to produce annually 11.2 thousand tons of milk, 441 thousand fattened calves, 711 heifer and 98,000 culled cow.

The project will also operate a 1,000 bee hive honey production enterprise to produce 40 tons of honey per year.

The total investment cost of the project is estimated at ID 41 million, of which ID 25 million will be in equity and ID 16 million in long term loans. The annual gross returns are estimated at ID 19 million.

The project proved to be financially highly viable with an internal rate of return 26.4 per cent, benefit-cost ratio 1.53 and three years pay-back period. It proved to be highly profitable and liquid enough to finance its annual operations without need to resorting to short-term loans. The net profit to sales ratio reaches 0.71, the net profit to equity ratio reaches 0.54, sales to fixed assets ratio reaches 0.71 and sales to equity ratio reaches 0.76. The loan equity ratio does not exceed 36:64 in any year.

The project is sensitive to decreases in benefits, i.e., the internal rate of return is elastic with respect to decreases in benefits with the elasticity varying between -1.18 to -2.17. Yet the project is not very sensitive to increases in the cost of fixed assets or the operating cost. The project will still be viable (with IRR more than 15 per cent) even if the cost of fixed assets or the operating cost is doubled. The internal rate of return is inelastic with respect to increase in the cost of fixed assets, with elasticity ranging between -0.45 and -0.67. The same is true with respect to increases in the operating cost, with elasticity ranging between -0.34 and 0.52.

CONTENTS

CONTENTS

CONTENTS

IDENTIFICATION OF REGIONAL FOOD SECURITY PROJECTS: A CASE STUDY FOR IRAQ

1. INTRODUCTION

1.1 Objectives

The ESCWA region, as is well known, has undergone profound socio-economic changes in the past fifteen years mostly as a (direct or indirect) result of the great wealth brought about by oil revennues. A direct consequence has been the much greater dependence on foreign sources to satisfy the rapidly accelerating demand for food. This dependence has now reached the very high level of 50 per cent of food consumption, one of the highest in the World.

Country differences and seasonal fluctuations, not withstanding the food security situation in the region, is a cause for alarm. This is mainly due to the differential distribution of agricultural and financial resources among the countries of the region. There is reasonable abundance of the former in few countries, part of which is either unutilized or grossly under-utilized, and even greater abundance of the latter in the major oil exporting countries of the region. Clearly much of the solution lies in bringing about complementarities of these resources at a much greater scale than has hitherto been achieved, and within a framework of equal sharing in costs, benefits and risks.

Investment in large-scale, modern agricultural production schemes, capable of utilizing the state of technology and management systems, in areas where resource quantity and availability is secured seem to present attractive opportunities. Iraq is foremost among the countries of the region in this respect. Resource-wise, Iraq has completed, or nearly completed, a large number of irrigation and land reclamation projects which are over and above the requirements of land distribution to small holders. It has invested heavily in physical infra-structures to serve the farming communities. Policy wise, the country encourages private investment in large-scale agricultural production projects, including investment from other Arab countries, and provides considerable incentives in the form of exemptions from duties and taxes, in addition to lease of agricultural land fully provided with water and infra-structure at reasonable rates.

The present study, therefore, was undertaken to assess the feasibility of one type of such investment, which is a representative of the central irrigated area in this country. It is hoped that the project, which this study has shown that it is financially highly feasible, will attract Arab capital, and perhaps more important, will raise interest and call attention to the best investment opportunities now available in this country.

1.2 The Case Study

To fulfill the objectives of the present study, one of the state farms available for private investment was selected; namely Al-Nai State Farm. The area where the farm is now located was under irrigated agriculture during the Abbasyid Reign. The source of irrigation water was the old Nahrawan canal. However, after the demise of the irrigation system in Iraq (during the Mangols invasion) the area was left to rain-fed agriculture. More recently, part of the land was again placed under irrigation through pumping water from the river Tigris for the use of he local inhabitants of the area. In 1971, part of the land was transformed into a state farm with an area of about 42,000 donums (10,250 ha.).

Al-Nai State Farm is located about 90 km to the north-east of Baghdad on the western side of Baghdad-Kirkuk road, on a plain parallel to the river Tigris (Figures 1 and 2). The farm is now under the jurisdiction of Al-Khalis province in Dyala Governorate. It is about 35 km from the province centre. The elevation of the farm land is about 46-56 m above sea level with an inclination toward the north-west.

Due to the mountain ranges to the north and east, the area of the farm is part of the very dry steppe region in Iraq with an average annual precipitation of about 185 mm. Most of the precipitation falls during the winter-spring season between November and May.

Temperature ranges between an average maximum of 44°C and an average minimum of 16°C.

Radiation averages are about 600 cal/cm^2/day for the summer months and 250/cm^2/day for the winter months.

Wind speed at 10 m above ground surface level is about 3.5 m/sec. during March through September. This value falls down to 2 m/sec. during December and January. These figures indicate greater evapo-transpiration potentials during the summer months.

Figure 1. Location of Al-Nai State Farm

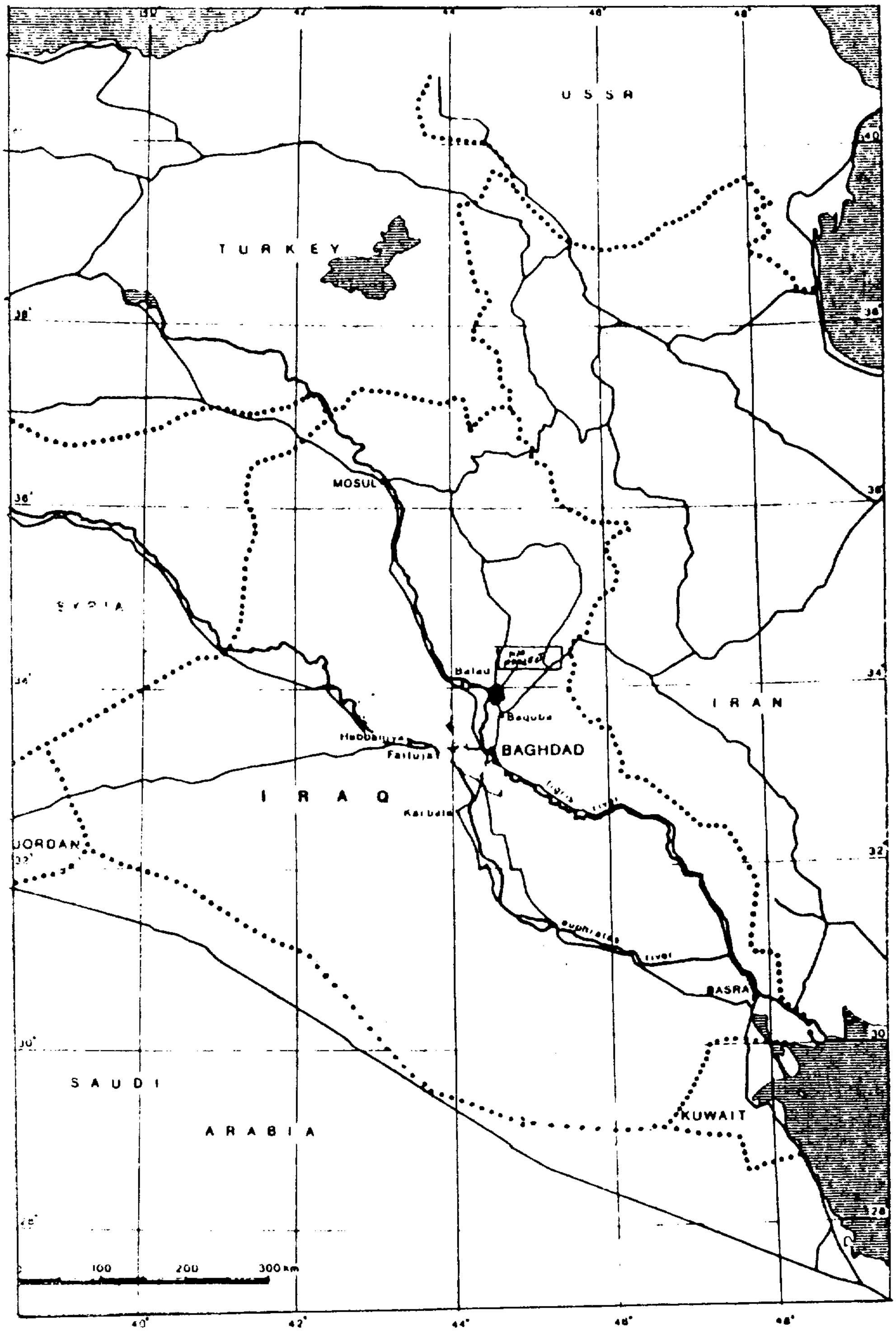
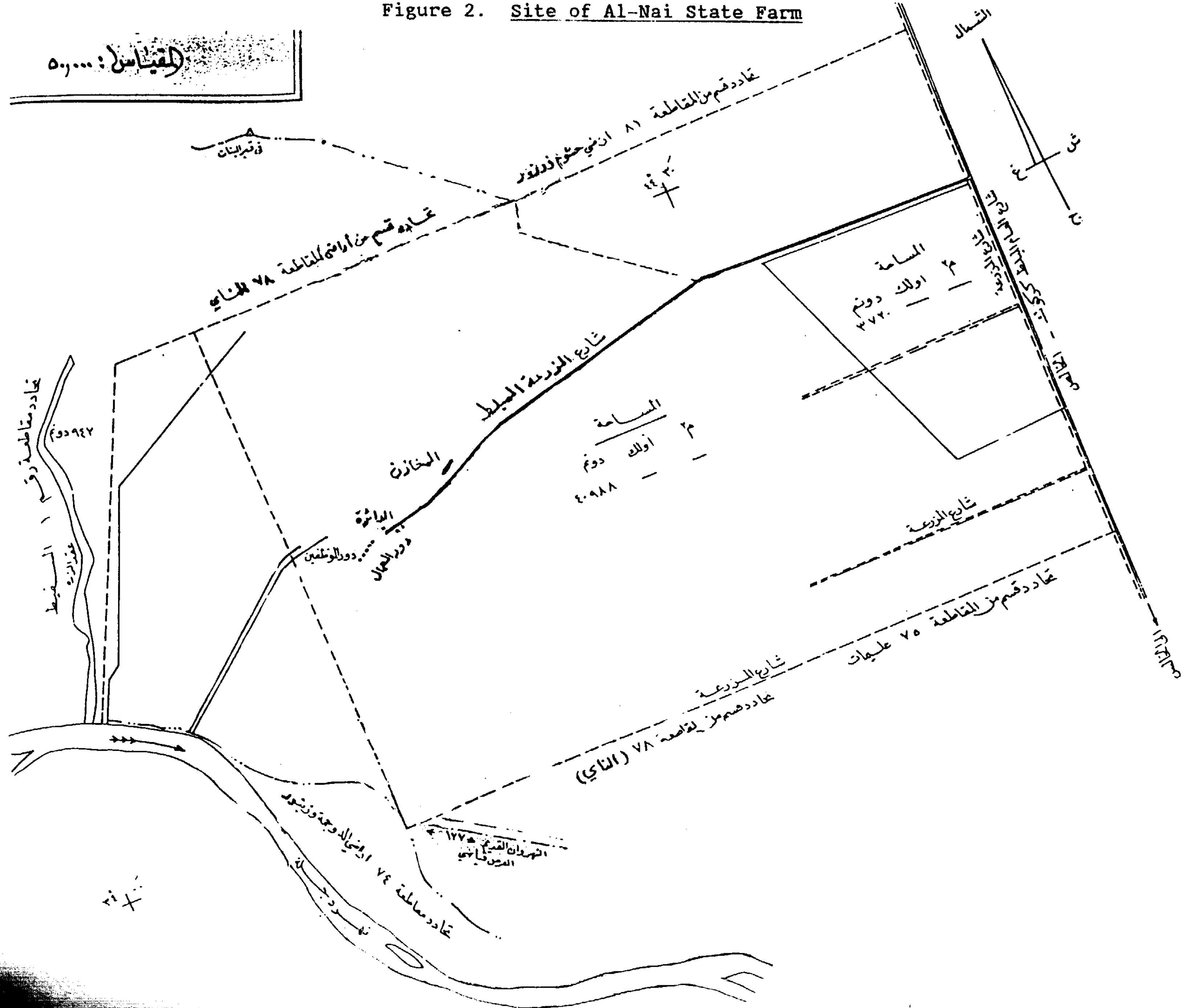


Figure 2. Site of Al-Nai State Farm



2. AL-NAI FARM EDAPHIC FACTORS

2.1 Topology

Al-Nai state farm is situated about 15 m above the water level of the river Tigris. The land is somewhat leveled except for some eroded locations along the river bank where the topography is not unifrom and has steep inclination towards the eastern side of the river.

2.2 Soil

The soil of Al-Nai state farm is part of the alluvial plain of central and southern Iraq. The soil has no clear profile development. However, stratification is a prevailing characteristic of the soil owing to water sedimentation. The soil exceeds several meters in depth through-out the farm area and is classified as follows:

(a) River-bank soils: They constitute about 10-15 per cent of the total farm area. ECe of this type ranges between 1 and 12 mmhos/cm (dS m^{-1}). These soils are coarse to medium textured, calcareous (20-30 per cent lime) with a range of gypsum content from 0.05 to 1.0 per cent. The pH ranges between 7.3 and 8.2.

(b) River-basin soils: These soils constitute 55-60 per cent of the total area of the farm. Generally, most of these soils are moderately saline. Their lime, gypsum contents and pH are similar to those of the river bank soils.

(c) Depression soils: These soils constitute about 5-7 per cent of the farm's area, and they are generally characterized by fine texture and cracked surfaces. Lime content is between 24 and 27 per cent. Most of the soils of these areas are highly saline.

(d) Eroded soils: These soils cover about 14 per cent of the total area of the farm. They are mostly water eroded induced by severe grazing, low vegetative cover and steep inclination. These soils are not suitable for traditional agricultural cropping at the present time.

2.3 Salinity

Table No.1 shows that about 68 per cent of the soils of the farm are considered saline and saline-alkali. Therefore, salinity problems must be taken into consideration in selecting crops to be cultivated, using management techniques and designing crop rotations.

2.4 Hydrological Conditions

Although no field drains exist in the farm at the present time, water table depth is about 13-15 m below soil surface. This is due to the fact that most of the area in the project is not under intensive cultivation.

Salinity of the water table ranges between 6 and 20 mmhos/cm. Sodium adsorption ratio (SAD) varies between 8.4 and 14.7. This calls for certain precautions and measures to prevent resalinization when the area is placed under cultivation.

(a) Soil permeability: About 60 per cent of the farm land is moderately permeable below water table. Its value ranges between 0.5 and 1.5 m/day.

(b) Infiltration rate: Soils of the farm differ in their infiltration rate due to differences in texture and structure of the soil layers. Generally, infiltration rate ranges from very fast (5-10 cm/hr) for river banks soils, to moderate (0.75-2.0 cm/hr) for river basin soils, to very slow (less than 0.75 cm/hr)for depressions soils.

(c) Irrigation: Source of irrigation water for the farm is river Tigris. Average annual EC of the water at the main pumping station is about 0.5 mmhos/cm. This water is classified as grade No.2 according to the American System of water classification.

Table 1. Classes of soils prevailing in Al-Nai state farm according to salinity

Salinity Class	ECe mmhos/cm	Percentage
Non-saline soils	0–4	13.0
Slightly saline soils	4–8	2.6
Moderately saline soils	8–15	13.8
Non-saline to moderately saline soils	0–15	8.0
Slightly saline to moderately saline soils	4–15	20.0
Moderately to highly saline soils	>8	11.8
Saline-Alkali soils	>4 and ESP >15	16.0
Eroded soils		14.0

Source: Al-Nai State Farm Project, Feasibility Study Report, Project Tesco, Mesaber, Budapest, Hungary, 1972.

3. PRESENT STATE OF AL-NAI FARM

3.1 Present Land Utilization

During the period 1973-1986, the project was run as a state farm. Table 2 presents the crop production data for the last three years, 1983-1984 to 1985-1986. During the last year 1985-1986 about 8,252 donums (2,063 ha) were under cultivation for winter crops. Main crops were small grains (barley and wheat). Of this area, 2,430 donums (608 ha) were allocated for "Numar" barley variety. This variety is generally more salt tolerant. The average yield was 249.7 kg/donum. The other variety of barley was "weah". This variety is an industrial (brewing) variety. Its average yield was 152.5 kg/donum. "Maxipak" wheat variety occupied 2,540 donums (635 ha) with an average yield of 136.7 kg/donum. "Abu-Ghraib" variety of wheat was planted on 300 donums (75 ha). It gave an average yield of 204.7 kg/donum. On the other hand, 482 donums (120 ha) were planted with mixtures of wheat and barley varieties.

Table 2. Crop production for the period 1983-1986 at Al-Nai State Farm

Year	Crop	Total Area donums	Total Yield tons	Yield kg/donum
1983/1984	Barely	6,595	2,449	371
	Wheat	4,538	891	196
	Watermelon	200	X	X
	Clover	1,000	X	X
	Corn	150	X	X
	Okra	100	X	X
	Cotton	106	X	X
	Onion	70	X	X
1984/1985	Barely	8,822	1,524	173
	Wheat	5,778	262	45
	Cotton	1,000	108	108
	Watermelon	200	790	395
	Muskmelon	40	18	455
	Onion	60		
	Corn	700	78	111
1985/1986	Barely	4,570	933	204.2
	Wheat	2,840	409	144
	Mixed wheat and brley	842	X	X

Source: Records of Al-Nai State Farm.
X Data not available.

3.2 Machinery, Equipments and Buildings

(a) Machinery, equipments and implements: The numbers and operational conditions and types of machinery, equipments and implements presently available at Al-Nai state farm is presented in table 3, while the numbers and costs of different types of buildings are presented in table 4.

Table 3. Type and number of machinery, equipments and implements present at Al-Nai State Farm during July, 1986

Type	Number		
	Operating	Non-operating	Total
Fiat tractor	18	4	22
Cotton picker	3	4	7
Combine, J.D.	5	2	7
Combine, Larva	2	1	3
Fork-lift		1	1
Shovel		1	1
Station Wagon, Land Cruise	3		3
Minibus, Coaster	1		1
Pickup, Toyota	7	1	8
Tanker		1	1
Trucks	3	3	6
Ditcher, Pocklain	1	1	2
Ditcher, Lehbrer	1	1	2
Ditcher, International		1	1
Grader	2	1	3

Source: Records of Al-Nai State Farm.

Table 4. Type, number and cost of buildings at at Al-Nai State Farm(*)

Type of Buildings	Number of buildings	Total Cost ID
Staff houses	10 units	65,000
Houses (labour)	40	63,400
Staff houses	45	34,500
Houses (labour)	24	144,000
Houses (labour)	20	12,000
Office (central)	2	28,000
Seed storage building	2	47,000
Garage and accessories	1	74,000
Electricity plant	2	44,000
Fueling station	1	27,500
Central market	1	8,300
Shade for vegetable cleaning	1	5,300
Workshop building	1	15,750
Electricity network	2	32,470
Pesticides storage building	1	15,000
Drinking water plant	1	12,000
Ginne and seed storage	1	804,650
Machinery house	1	5,400
Office, etc.	1	7,860
Fences	1	5,600
Guard room	1	800
Fire extenguisher room	1	1,770
Spare parts store	1	23,900
Total		1,478,200

Source: Records of Al-Nai State Farm.

(*) The cost of buildings represents the initial cost paid by the Iraqi Government at the time each building was constructed.

3.3 The irrigation system

The continuous delivery method was used in designing Al-Nai irrigation system. According to this method, water is supplied continuously in quantities depending on the area to be irrigated and the type of crops to be planted. The irrigation network was implemented at three stages (table 5 and figure 3). The first stage serves a gross area of 5,000 donums. The second stage serves 20,000 donums and was implemented at two phases; the first phase serves 6,000 donums and the second serves 14,000 donums. The third stage serves 16,000 donums. Therefore, the system is designed to irrigate a gross area of 41,000 donums.

Table 5. Stages of execution of the irrigation system in Al-Nai Project

Stage	Gross area (donum)	Canals serving the stage
First	5,000	C-1-3
Second		
A	6,000	SC-1
B	14,000	MC, MC-1, SC2
Third	16,000	MC-2
Total	41,000	

The irrigation network comprises the following:

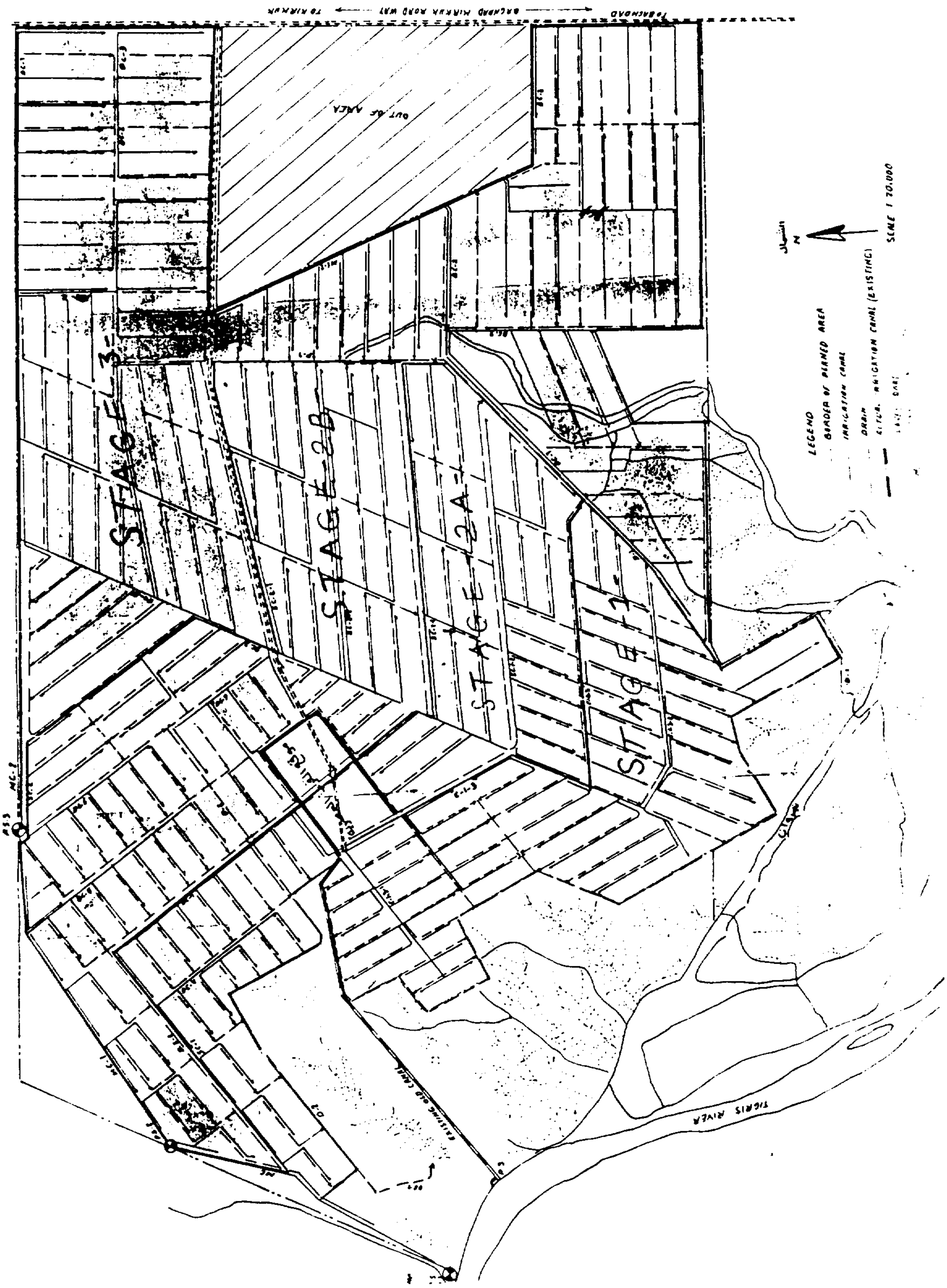
(a) The main pumping station, situated at Tigris river shore, is designed to lift the water about 19 meters to irrigate the whole project with the following data:

- Four pumps, each having a discharge of 3 m^3/second, with one serving as a stand-by;
- The mximum static head is 20.36 m; and
- The area to be irrigated is 41,000 donums.

(b) The second pumping station, is located at 3.69 km of the main canal and irrigates the second and third stages, with the following data:

- Three pumps, each with a discharge of 3 m^3/second, with one serving as a stand-by;
- The mximum static head is 3.15 m; and
- The area to be irrigated is 30,000 donums.

Figure 3. Stages of Al-Nai Project Implementation



(c) The third pumping station, located at 4.33 km of the MC-1 canal, is used to irrigate the third stage of the project. It has the following data:

- Three pumps, each with a discharge of 4.4 m^3/second, with one serving as a stand-by;

- The mximum static head is 3.25 m; and

- The area to be irrigated is 16,000 donums.

(d) A set of main, secondary and tertial canals as follows(*) (Figure 3)

- The main canal which is designed for a maximum discharge of 9 m^3/second. It is divided into three parts; MC which extends between the main and the second pumping station, MC1 which extends between the second and third pumping stations and MC-2 which starts from the third pumping station to the end of the project area.

- The branch canals SC-1 and SC-2 designed for maximum discharge of 2-7 m^3/second.

- Fifteen tertiary canals. Except for the secondary canals serving the first stage of the project, all the main and secondary canals are lined with concrete. The final leveling of the first phase was also not completed.

(e) A set of 57 main structures (table 6) comprising the following:

- 2 cross regulators;
- 20 road crossings;
- 5 drain crossings;
- 2 diversion structures; and
- 11 drop structures.

Table 6. Irrigation structures in Al-Nai state farm

Stage	Cross regulation	Road crossings	Drain crossings	Escapes	Division structures	Drop structures
First	-	4	1	3	2	-
Second						
A	2	5	1	3	-	-
B	-	5	-	6	-	8
Third	-	6	3	5	-	3
Total	2	20	5	17	2	11

(*) For general layout and design formation on the network, see Appendix 1

The irrigation system suffers from sedimentation in the inlet canal (the canal conveying the water from River Tigris to the main pumping station). This high rate of sedimentation limits the amount of water in the inlet canal to the extent that only one - out of the three pumps that are supposed to work simultaneously - can be operated. Sedimentation increased during flood season when up to seven feet of sediments can accumulate in front of the main pumping station. The pumped water carries large amounts of sediments. These have accumulated in some canals and large amounts of seeds and water plants have grown on them.

3.4 The Drainage System

The drainage network in Al-Nai State Farm consists of the following components:

- open collector drain;
- branch drains; and
- outfall drains.

The general layout and location of the drainage disposal network is suitable for the local topographical conditions.

(a) Open collector drains

The project design adopts a value of q = 15 l/sec/km^2. The design discharge had been checked and the cross sections designed for the collection drains were found appropriate.

(b) Branch and outfall drains

Again, after checking the design discharge of branch and outfall drains, the design of their cross sections were found appropriate. It follows that the drains will convey the expected discharges during operations. It should be noted, however, that in many cases the outfall is unsatisfactory for the junior drains (collector drains) due to the shallow ground slopes. In this case back watering and silting of the drains might occur and careful maintenance is a necessity.

3.5 Employment Status for the 1985-1986 Cropping Season

Table 7 presents the staff and other personnel employed by Al-Nai State Farm during he cropping season of 1985-1986.

Table 7. Number of labour, agricultural staff and other technical officers employed during the 1985-1986 cropping season

Type	Number	Type	Number
Pump station:		Clerk	7
Operator		Typist	1
Maintenance	10	Gas station clerk	1
Electrician	1	Sanior Agr. Engineer	1
Welding man	2	Agriculture Engineer	1
Workshop man	2	Assistant Agr.Engineer	8
Machinist	1	Assistant Elec. Engineer	2
Service labour	8	Assistant Civil Engineer	1
	2	Mechnical Engineer	1
Drivers:			
Vehicle	11	Assistant Mechanical Engineer	1
Tractor	33	Agriculture Fieldman	5
Bulldoze	1	Senior Agr. Extenstion	2
Grader	1	Surveyor	1
Ditcher	1	Unskilled labour	18
Intendent	1	Watchmen	3
Assistant Intendent	2	Temporary labourers	50

Source: Records of Al-Nai State Farm.

4. THE PROJECT

4.1 The Project Concept

The purpose of the project is to utilize the existing developed resources of Al-Nai State Farm to operate a fully integrated crop livestock production system, and to market its products in Iraq and/or neighbouring Arab countries. The project has five distinct and identifiable parts, the success of the project being dependent on the success of each of the individual componenets. The first of these deals with crop production, where both cash and forage crops will be produced. The second component deals with livestock production; where dairy and feedlot fattening activities will be undertaken. Subsidiary activities of the second component include operating a feed mill to produce the required feed concentrates for the livestock production. The third component deals with the operation and maintenance of the irrigation and drainage systems. A small component dealing with the operation of a relatively small enterprise of honey production constitutes the fourth component of the project. It is believed that this component is one of the most profitable agricultural enterprises, and it is believed that this component constitutes one of the best potentials of the project. The fifth and last component of the project is the marketing component. Since the project is envisaged to operate as a regional project, in the sense that it might be regionally financed for the benefit of the region, the marketing component assumes great importance.

The project will be run as a private sector project, where the investor(s) may be from the private sector in Iraq or any other Arab country, or an Arab Organization. The project can be run as a joint venture. In this case the Iraqi Government may be one of the partners.

The Iraqi Government will lease the land for a period up to 90 years. The rent depends on whether the investor(s) pay(s) for the cost of irrigation network, buildings and other infrastructure or whether he pays only for the benefit of their use on an annual basis. In the first case the rent will be nominal while in the second case the rent will be determined among other things, on the basis of the investment involved. The study assumes that the first alternative applies. It also assumes that the investor has the right to keep whatever he needs from the machinery, equipments and implements of the farm. In this case an agreement need to be reached with the Iraqi Government regarding their purchase price or annual rent. On the other hand, he might not keep any of them. The study assumes that the second alternative applies.

4.2 Improving the Irrigation System

As mentioned in section 3.3, the irrigation system in Al-Nai State Farm suffers from lack of maintenance and sedimentation problems. At the same time the secondary canals serving the 5,000 donums of the first stage are not lined, and the land in this area is not levelled. Therefore, these problems have to be solved to enable the optimum utilization of Al-Nai resources.

4.2.1 The main pump station

The delivery (inlet) canal serving the main pump station and its connection with River Tigris should be cleared form accumulated sediments. Therefore, the continuous services of a small dredger is required. Yet this is a temporary solution. The problem arised from the fact that while the location of the main pumping station was chosen to minimize the expected sedimentation, at the time of completing the station, a new pumping station was installed upstream the river, about 200 meters away. This new situation created problems both with respect to the quality and quantity of water available during summer. Therefore, a thorough study needs to be undertaken to look for a final solution for the accumulation of sediments. It is important also that the stand-by pump be operated from time to time to lift the sediments off the inlet canal and clear its bed.

4.2.2 The irrigation canals for the second and third stages

Canals should be inspected daily during the irrigation period, specially in the unlined canals, to keep water level according to design. A small red point showing the designed water level should be marked on each structure to help control over flows and prevent resulting damages. The designed data to be applied to different structures are shown in Appendix 1. The cropping pattern mentioned in table 9 should be strictly followed. It is also imperative that syphon pipes are used to convey the water to the fields to have better control on water and save on labour.

4.2.3 The irrigation system for the first stage

Out of the gross area of Al-Nia State Farm (41,000 donums) the first phase, covering 5,000 donums was not levelled. In addition, the secondary canals serving this area were not lined. Therefore, two options could be used for irrigating this area; the option used for the other stages of the project, i.e., gravity irrigation method, and any other method, the most relevant of which might be sprinkler irrigation. If the first method is applied, land needs to be graded and finely levelled.

Sprinkler irrigation increases the efficiency of irrigation by about 10 per cent. This is due to the fact that while farm conveyance losses can almost be neglected, the application losses are quite high. Evaporation losses from spraying might reach 20 per cent and even more if the weather (wind, temperature and humidity) and spray characteristics (radius of spray and size of drops) are not favourable. Yet, it should be noted that not all of the application losses are actual losses since they partly cover the leaching requirements.

Wind data relevant to the site of the project1/ show that wind speed is too high for sprinkler irrigation for about one fifth of the year, mostly during summer where the other weather factors (temperature and humidity) are at a disadvantage2/. Therefore, the use of wind breaks is a pre-requisite for the use of sprinkler irrigation. These wind breaks, however, cause a

1/ See Appendix 2.
2/ See Appendix 3.

loss of 10-15 per cent of the land that still has to be irrigated. This high loss is attributed to the fact that the predominent wind direction changes from N-W or S-E in winter to N-W in summer and is more evenly distributed over various directions in spring. This means that more wind breaks will be required.

In view of the different pros and cons and the high investment costs, sprinkler irrigation will only be economically feasible for intensively cultivated crops. The use of sprinkler irrigation has to be preceded by thorough investigation to establish its technical and economic feasibility. Therefore, in the present study, it is assumed that the same irrigation system will apply to stage 1. The cost of lining its secondary canals and the cost of leveling its area (5,000 donums) are estimated and added to the investment cost.

4.2.4 Maintenance of irrigation canals and structures

Regular inspection and maintenance of the irrigation system is required to ensure their proper functioning. Canals should be kept in good condition by removing weeds, deposited sediments and material washed from the sides during rainfall. The control of rodents has also to be given special attention.

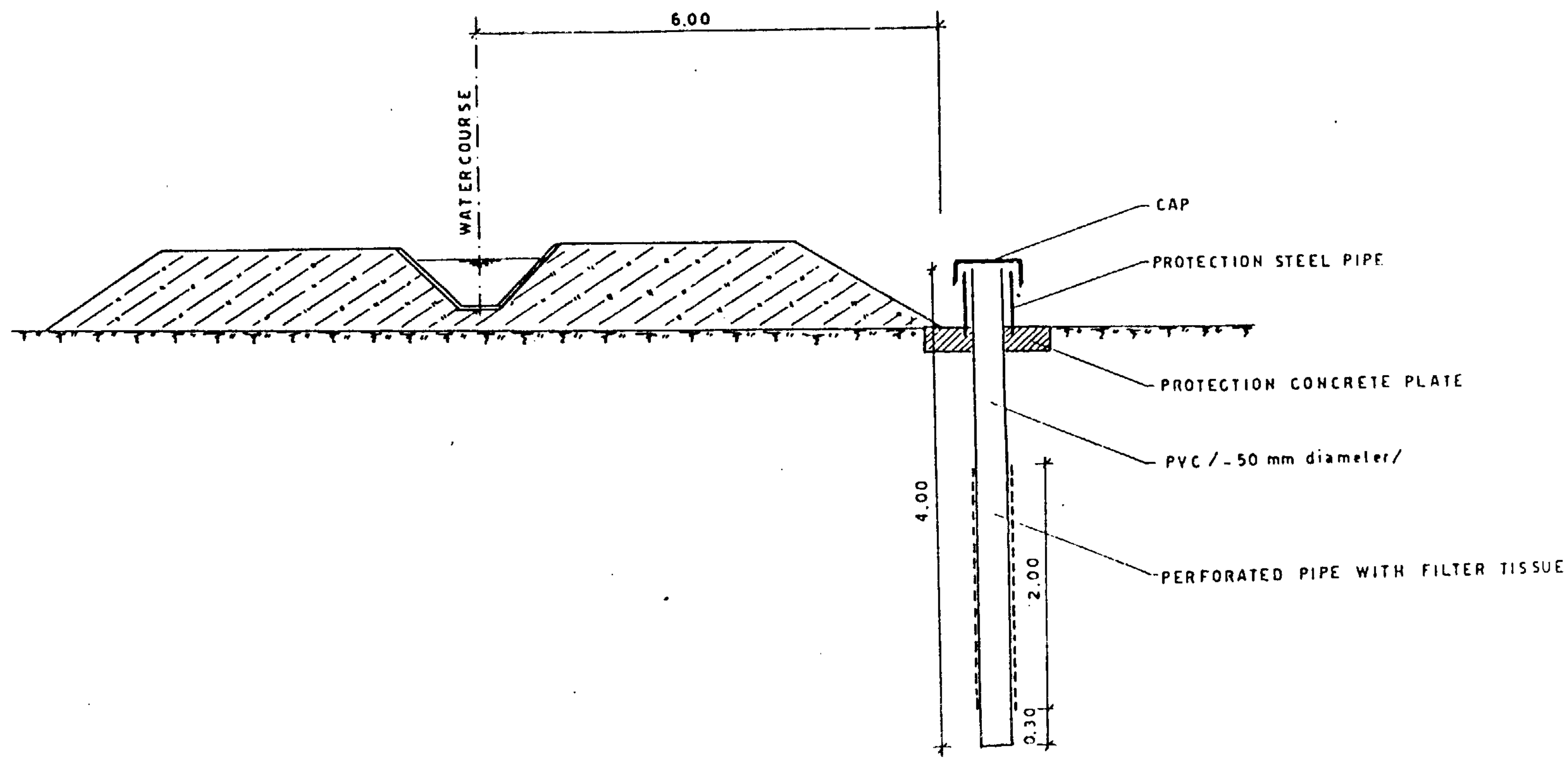
Weed growth in irrigation canals is not a major problem as it is in drainage canals. The flow velocities, the turbidity of the water and the intermittent canal operation are such that growth of weeds on a large scale is prevented. Only minor canals, such as distributaries, are likely to show some growth of weeds. Weeds growing on side slopes are not harmful. They might even have the advantage of preventing the washing out of fine particles during rain. Hydrolic excavators or cutters attached to tractors should be used to remove excessive weed grwoth in irrigation canals.

Special attention should be paid to lined canals. Apart form maintenance of the lining itself (repair of cracks and other damages), the sedimentation has to be removed. Drag-lines cannot be used in this case since they will damage the linings. Special suction equipments that can be operated either from the embankment or from the water by small suction dredges should be utilized.

4.3 Improving and maintenance the Drainage System

The main function of the drainage system is to control the ground water table. At the present time water table is deep (more than 10 meters). Yet it should be checked by a network of observation wells equipped with piezometers to a depth of 10 meters and a density of one piezometer for every 2-3 irrigation plots. In order to obtain more detailed information on ground water fluctuations a pilot section can be set up with additional shallow wells, 4 metres deep at a density of two wells per irrigation plot, to be located along a given watercourse. These can have small diameters (not more than 0.5 cm) and of a simple construction and can be installed in auger holes (figure 4).

Figure 4. Disposition of observation well close to the watercourse



The readings of the water table in the observation wells are to be taken not less than once a month. The annual processing of the records of the water table can produce the following information:

- contour maps for the water table after a rain storm and during peak irrigation;
- direction of ground water flow; and
- zones of in-seapage and out-seapage.

With this information at hand the design and adequacy of field drains can be assessed, as well as the increased seapage losses from irrigation canals, if any.

Open drains have to be kept free of weeds and fine soil particles, wahsed in from the side slopes during rainfall. Both weeds and soil particles will obstruct the flow of water. Without proper maintenance the drainage system will soon become blocked and will not function adquately. To limit the machine reach required, maintenance for main and collector and branch drains will generally be carried out from both sides, while collector drains can be maintained from one side only. For both cases a horizontal machine reach up to 10 m is necessary. The maximum digging depth has been limited to 5 m by introducing a berm of drains that are deeper than this limit.

For collector drains, hydraulic excavators would be the appropriate machine. They tend to be more powerful with longer arms and are often replacing draglines. Moreover, hydraulic excavators have a more positive control over the bucket, and can be fitted with all kinds of attachements such as weed-cutting buckets. As job mobility is not important for drain maintenance, crawler-mounted equipment is most suitable, as it does not need the use of stabilizers. For deeper drains, however, draglines are still the most suitable equipment.

To prevent the soil from being washed back into the drain, it should not be deposited on the berm, but on top of the soil banks adjacent to the drains. The top of these soil banks have to be levelled afterwards by a buldozer.

Mechanical removal of weeds could best be done with hydraulic excavators equipped with special buckets.

4.4 Crop Production

4.4.1 Land classes and recommended crops

Table 8 presents different calsses of lands and their percentage areas to the total area of Al-Nai farm. It shows that the cultivable area amounts to 33.3 thousand donums or about 80 per cent of the gross area of the farm.. Good arable land constitute about 18 per cent of the gross area while fair arable land and limited arable land constitutes about 36 and 26 per cent respectively. The table also shows the recommended crops for each land class.

Table 8. Land classes of Al-Nai state farm and their percentages of total area

Land class	Area (donum)	Percentage of total area	Recommended crops
Good arable land	7,392	17.6	Potatoes, corn
Fair arable land	14,880	35.7	Small grains, alfalfa, clover
Limited arable land	11,020	26.4	Cotton, barley, mixed pasture
Non-arable land	8,440	20.3	
Total	41,732	100.0	

4.4.2 Water availability and the cropped area

As mentioned earlier, the main pumping station has 4 pumping units each with a discharge of 3 m^3/second. Pumping station 2 has 3 pumping units whereas pumping station 3 has 2 pumping units each with the same capacity. Since all water must be pumped through station 1 (main pumping station) and assuming one stand-by pump. The total amount of water available for irrigation is 9 m^3/second. Therefore, the total irrigable area for winter and summer seasons are as follows:

(a) Winter season:

Available water = 9 m^3/sec. x 3,600 sec./hr x 18 hr/working day
= 583,200 m^3/day

Assuming that irrigation is carried out every 8 days, the total available water = 583,200 x 8 = 4,665,600 m^3/8 days

Assume that the depth of each irrigation is 6 cm = 6/100 m

Therefore, theoretically the area that can be irrigated
= 4,665,600 x 6/100 = 77,760,000 m^2 = 31,104 donums (7,776 ha)

Assuming an overall efficiency of distribution = 70 per cent

Therefore, actual area that can be irrigated = 31,104 x 70/100
= 21,773 donums (5,443 ha).

This gives a winter cropping intensity of 86 per cent.

(b) Summer season:

Available water = 583,200 m^3/day
Assuming irrigation every 5 days
Total available water = 2,916,000 m^3/5 days
Assuming the depth of each irrigation = 8 cm = 8/100 m
Therefore, theoretically, the area that can be irrigated
= 13,580 donums (3,645 ha).

Assume an overall distribution efficiency of 60 per cent
Therefore, actual area that can be irrigated
= 8,748 donums (2,187 ha).

This gives a summer season cropping intensity of 34 per cent
Therefore, the total cropping intensity = 86 + 34 = 120 per cent.

4.4.3 Cropping pattern

According to the above calculations, a cropping pattern is suggested in table 9 for a 6 years period that can be repeated if it can be managed efficently. The cropping pattern could be ammended if the needs arise.

Table 9. Suggested 6 year crop rotation

Year	Season	Area in crops in donums						
		7000	7000	7000	500	500	500	500
1	W	Barley	Alfalfa	Potatoes	Clover	Clover	Clover	Clover
	S	-	Alfalfa	-	Cotton	Corn	Corn	Corn
2	W	Potatoes	Alfalfa	Barely	Clover	Clover	Clover	Clover
	S	-	Alfalfa	-	Corn	Cotton	Corn	Corn
3	W	Alfalfa	Barley	Potatoes	Clover	Clover	Clover	Clover
	S	Alfalfa	-	-	Corn	Corn	Cotton	Corn
4	W	Alfalfa	Potatoes	Barley	Clover	Clover	Clover	Clover
	S	Alfalfa	-	-	Corn	Corn	Corn	Cotton
5	W	Potatoes	Barley	Alfalfa	Clover	Clover	Clover	Clover
	S	-	-	Alfalfa	Cotton	Corn	Corn	Corn
6	W	Barley	Potatoes	Alfalfa	Clover	Clover	Clover	Clover
	S	-	-	Alfalfa	Corn	Cotton	Corn	Corn

4.4.4 Estimated crop output

According to the suggested cropping pattern, only one perenial crop (alfalfa) will be planted in 7,000 donums, and 16,000 donums will be planted in winter; 7,000 donums in barley, 7,000 donums in potatoes and 2,000 donums in clover. During summer only 2,000 donums will be planted, 1,500 donums in corn and 500 donums in cotton. Table 10 estimates the output expected from these six crops.

Table 10. Estimated annual output of different crops

Crop	Area in donums	Yield (ton)	Total production (ton)
Barley, grains		0.6	4,200
Barley, fodder	7,000	1.0	7,000
Potatoes	7,000	8.0	56,000
Alfalfa	7,000	9.0	63,000
Clover	2,000	4.0	8,000
Corn	1,500	1.0	1,500
Cotton	500	0.5	250

4.5 Livestock Production

4.5.1 The breed

The two breeds, fresian and holestein, proved to have the ability to acclamatize to temperte climate and maintain their high producing ability, particularly in Iraq, provided that good husbandry practices and well balanced rations are adopted. Therefore, fresian is chosen to build up the herd. In-heifers will be imported during the period September - March, when the weather is most favourable.

4.5.2 Green fodder prodcution

The success of dairy production enterprises depends to a great extent on the ability to provide the right ration. One of the most important feed for dairy animals is roughage. Therefore, the size of the herd to be established depends on the amounts of feed produced under the adopted cropping pattern. Green fodder produced on the farm includes:

- Alfalfa: Alfalfa is one of the most nutritious high yielding forage crops. It can be fed as green fodder, silage or hay. Alfalfa is a perennial crop. It gives 6-8 cuts in the first year. However, the number of cuts increases to 9 in following years. It produces on the average about 9,000 tons of green fodders per donum. Therefore, the expected amount of Alfalfa is 63,000 tons per year or 15,000 tons of hay according to the recommended cropping pattern.

- Clover (Berseem): Berseem is one of the important green fodders in Iraq and gives high yield in the middle and southern parts of Iraq. It is highly nutritious and a good soil fertility preservative crop. It gives 2-4 cuts per season or about 4-5 tons of green fodder that could also be used as silage. According to the recommended cropping pattern the expected annual output of clover is 8,000 tons of green fodder or 2,000 tons of hay.

- Barley: Barley could be grown for grain and/or green fodder. It is a winter crop. In Iraq it gives 1-1.5 tons of green fodder, in addition to the grains. The expected output of barley fodder, according to the recommended cropping pattern is 7,000 tons per year.

4.5.3 Size of the herd

The amount of green fodder produced on the farm, 78,000 tons, can support 7,200 head of livestock, out of which 2,400 will be milking cows. These will be kept in three stations, each with a capacity of 2,400 head, of which 800 are milking cows. The stations will be located near-by the forage fields to minimize the cost of feed transport.

After completion of the buildings and infrastructure, 2,400 in heifer of age 23-27 months will be imported to reach the project between September and March. The herd will reach its complete size (7,200 head with 2,400 milking cow) in the sixth year (Appendix 4). The average milk output per cow is estimated at 4,000 kg/year for the first milking period of 305 days. For the second and thrid milking periods, milk output per cow increases to 4,400 kg and 4,800 kg respectively. Cows are culled at the age of seven to eight years.

4.5.4 Milk output

Table 11 estimates the total milk output at 9.3 thousand tons for the first year of milk production. The milk output will increase gradually to stabilize at about 11.2 thousand tons as of the sixth year of milk production.

Table 11. Estimated milk output in tons

Production year	Number of cows in milking periods			Total milk
	First	Second	Third and above	
1	2,328	-	-	9,312
2	-	2,097	-	9,227
3	300	-	1,887	10,258
4	360	270	1,698	10,778
5	306	324	1,770	11,146
6	241	275	1,884	11,217
7 and on	240	217	1,943	11,241

Source: Appendix 4, assuming 4, 4.4 and 4.8 tons of milk per cow in the first, second and third and on milking periods.

4.5.5 Livestock output

Table 12 shows the output of fattened calves, heifers for breeding and culled cows over the years. It shows that, as of the seventh year of livestock enterprise, the project will produce annually 192 culled cows, 981 fattened valves and 711 heifers. The average weight of the culled cow is 500 kg, while it is 450 kg for the fattened calf.

Table 12. Number of livestock heads produced for sale

	Culled cows		Fattened calves		
Year	Number	Weight (kg)	Number	Weight (kg)	Heifers
1	24	12,000	-	-	-
2	171	85,500	996	444,200	360
3	177	88,500	864	388,800	426
4	189	94,500	891	400,950	537
5	195	97,500	945	425,250	657
6	195	97,500	981	441,450	699
7 and on	195	97,500	981	4441,450	711

Source: Computed from Appendix 4.

4.5.6 Livestock by-products

The dairy cow produces on the average 5.5 tons of manure per year. Counting the number of cows and heifers in the project, the manure output is estimated at 11,770 tons for the first year and is expected to increase gradually to stablilize at about 19,900 tons per year as of the sixth year (table 13).

Table 13. Estimated manure output in tons

Year	Number of cows and heifers	Total manure
1	2,140	11,770
2	2,941	16,175
3	3,178	17,479
4	3,386	18,623
5	3,584	19,712
6 and on	3,618	19,899

Source: Appendix 4, assuming 5.5 tons per head.

4.5.7 Buildings, machinery and equipments

The herd will be kept in open sheds. Therefore, the required buildings include:

- Information and guard room (78 m^2);
- Administration building (250 m^2);
- Veterinary clinic (875 m^2);
- Spare parts shop (60 m^2);
- 6 sheds for hay storage (936 m^2 x 6);
- 12 milking cows sheds, each of a capacity of 200 milking cow (1,625m^2 x 12);
- 3 milking parlors (1,625 m^2 x 3);
- 3 dry cows sheds, each of a capacity of 200 cows (1,625 m^2 x 3);
- 6 Fattening sheds, each of a capacity of 200 calves (1,625 m^2 x 6);
- 3 calving and young calves sheds, each comprises of two parts, the first is divided into 60 small closed pens (1.5 m^2); and the second is divided into pens of 20 calves capacity. These sheds should be air cooled;
- 6 heifer sheds each with a capacity of 200 heifers (1,625 m^2);
- 3 sheds, each of an area of 1,625 m^2 to be used for raising replacement heifers. They can also be used, if needed, for raising heifers to be sold and/or for calves fattening;
- One incinirator to burn infected animals (50 m^2); and
- One 5 ton/hour feed plant with storage facilities.

Except for the calving sheds, all the sheds will be open. They will be built of iron structure on concrete base, and covered with isolated aluminum sheets. The sheds will be equipped with water, electricity and sewage network. Mobile structure of steal bars will be fixed to allow keeping animals is and taking them out of the sheds. Feeders will be on the floor along the mid passage.

Each of the three milking parlors will consist of four units and each unit will be of a capacity 8 x 2 (herrign bone type), with milk storage capacity of 6.4 tons. It will also be equipped with 4 silos for concentrates of a capacity 20 m^3 each. Therefore, in all, it will be possible to milk 192 cows at a time.

4.5.8 Drinking water

Drinking water requirements for the livestock amount to 164 m^3 as shown in table 14.

Table 14. Drinking water requirements for the livestock

Type of animal	Number	Water requirements Liter/animal/day	Water requirements Liter/day
Cows	884	120	106,080
Heifers and calves	766	60	45,960
Young calves	750	15	11,250
Total	2,400		163,290

4.6 Livestock Feed

A feed mill of 5 tons per hour capacity will be established to enable the production of the cncentrates required for the dairy herd. The feed mill comprices the following:

(a) Reception area; where all feed ingredients are received and temporarily stored;

(b) Grinding facility; where all coarse ingredients are ground to the required degree;

(c) Weighing facility; where all ingredients are weighed before being mixed into a given homogenous feed;

(d) Mixing facility; where different ingredients are mixed to produce different types of feed;

(e) Packing facility; where produced feed is packed into sacks of standardized weight; and

(f) Storing facility; where the feed is stored until it is used.

It is assumed that the feed mill will be operated one eight hours shift per day for 300 days per year to produce 12,000 tons of concentrates, which are required to keep up the dairy herd and the fattening of the male calves. The estimated cost of the feed mill with all its facilities and building is estimated at ID 75,000.

4.7 Honey Production

Honey production is one of the most profitable agricultural activities. It is assumed that the project will include 1,000 bee hive that will produce about 40 tons of honey per year (1000 x 40 kg). The total cost of establishing the bee production activity is estimated at ID 157,500; ID 75,000 for the bee hives (ID 75 x 1,000), ID 7,500 for the sheds and ID 75,000 for the initial bee population (ID 75 x 1,000).

4.8 Machinery and Implements

4.8.1 Farm machinery requirements

The number of farm machinery required is determined by many factors mainly the annual usage in hours per year, the time available for each operation according to the kind of crop under Iraqi conditions, the effective width of the implement which depends directly on the horse power of the machine used and efficiency. Other factors affecting the number required are the combination of the tractor and implements, the time consumed to complete the opertion and the capacity of each combination.

The speed of operation differs according to its type. Nevertheless, the average speed was considered as the base for the calculations. The daily usage of farm machinery is estimated at 18 hours. The available time for preparing the land which is between the harvesting time of a crop and planting time of the successive crop is calculated form the crop rotation as shwon in appendix 5.

For calculating the number of tractors needed to prepare the land for planting, the area is converted to plowing units according to the standard conversion. The effective width or loading capacity is taken as a normal for a tractor rating 70-80 H.P. The efficiency is estimated between 70-80 per cent. The following equation[1/] is applied to calculate the field capacity (implement productivity) in donum (250 m^2) per available time.

0.4 x Width (m.) x speed (km/hr) x efficiency percentage x daily hours (18) x time available (day).

Dividing the area as defined in plowing units by the field capacity gives the number of tractors needed for preparing and planting each years crops in the rotation, and dividing the actual area by the field capacity gives the number of plows needed. The peak number is taken, which is 20 tractors and 12 plows. The details of thes calculation are presented in appendix 6.

The same equation is applied to get the number of different kind of implements needed.

4.8.2 <u>Forage crops machinery required</u>

The following assumptions are used in the estimation of tractors and forage implements needed for the recommended rotation:

(a) Alfalfa gives 6 cuts during the first year and 9 custs during the second year. The average production is one ton per cut per donum. The first cut starts after 60 days from planting time and the consecutive cuts are at 45 days intervals during the first year and 30 days interval during the second year.

(b) Clover gives 5 cuts if it is used as forage crop only or 3 cuts if it is left afterwards for making seeds. The average production is 3 tons per cut per donum and the first cut starts after 60 days from planting time.

(c) Corn, if is used as forage crop, should be cut after three months from planting time and finished during 15 days. Corn as forage gives 6 tons per donum.

(d) Barley gives two cuts with 1.5 ton per cut per donum and left for seeding. The first cut starts after 60 days from planting while the second is performed after 45 days from the first cut.

(e) About 75 per cent of the forage production is fed to animals and the rest, 25 per cent, is bailed.

(f) The average distance between the sheds and forage fields is about 7 km.

1/ Donnel, Hunt (1979): Farm Power and Machinery Management ISUP, Ames, Iowas, USA and American Association of Agricultural Engineers (1963): Agricultural Engineers Yearbook, St Joseph, Michigon, USA.

(g) The time needed for loading, transporting, unloading and coming back to load again is 1.5 hours.

(h) The capacity of the wagon is 3 tons, and the feeding wagon takes half-an-hour to distribute the hay in the troughs.

Table 15. Farm machinery and implements

Item and description	Number required	Price (ID)	Total price (ID)
Tractor rating 70-80 H.P. (wheeled)	55	4,500	274,500
Three-furrow mold-board plow	14	750	10,500
Disc Harrow	4	900	3,600
Set of boarder and ditcher	3	1,950	5,850
Three-row ridging bodies	3	450	1,360
Weeder ridger (cultivator)	6	1,125	6,750
Seed drill (3-4 m.)	7	5,250	36,750
Row crop planter (4-row)	2	1,500	3,000
Cotton picker attached to row crop tractor	1	15,000	15,000
Potato planter (4-row)	6	1,800	10,800
Potato harvestor (2-row)	15	750	11,250
Combine harvestor (4 m.)	4	13,750	75,000
Corn harvestor attachment (2-row) as forage	4	4,500	18,000
Sprayer (5-7 m.)	5	1,125	5,625
Mower/conditioner	3	1,125	3,375
Square baler	4	3,000	12,000
Pick up elevator for bales or bale thrower attached to a baler	4	1,125	4,500
Forrage havestor (chopper)	6	1,500	9,000
Wagon	15	1,950	29,250
Feeding Wagon	6	2,250	13,500
Tractor equiped with fron fork loader and rear slurry scraper	2	6,750	13,500
Manure spreader (4-5 ton)	3	2,250	6,750
Fertilizer distributor (spinner)	3	750	2,250
Sub soiler attached to a heavy tractor	2	15,600	31,200
Multi purpose elevator	3	1,125	3,375
Land leveller	3	1,125	3,375
Truch for transportation (12 ton)	2	30,000	60,000
Total			631,050
20 per cent spare part			126,210
Grand Total			757,260

Applying the above assumption on the recommended cropping pattern shows that the peak of machine application is from December to March. The first cut starts from 15 December to 15 January where 12,000 donums would need to be cut. To calculate the number of machinery required, the number of donums to be cut each day should be known. This is got by dividing the crop area by 30. Thus, the quantity of hay to be transported daily as feeding staff is 437 tons. The area to be cut and bailed is 100 donums/day and as hay is 300 donsum/day.

Applying the same method mentioned earlier, the numbers of different kind of forage implements are obtained. Table 15 gives the number, prices and total cost of the machinery and implements required according to the recommended rotation.

4.9 Labour Requirements

4.9.1 Labour requirements for irrigation

Labour requirements for operation and maintenance of the irrigation and drainage systems are presented in table 16. This table shows the ultimate requirements at the final stage of development of the farm. Separate from the maintenance group, a special servicing group has been introduced, responsible for the maintenance and repair of the mechanical equipments and vehicles.

Table 16. Labour requirements for irrigation

Function	Number	Function	Number	Function	Number
Main office		Supervisor	1	Surveyor	1
Chief engineer	1	Gatesman	5	Rodman	3
Asst. engineer	3	Driver	1	Driver	4
Accountant	2	Maintenance		Servicing	
Senior clerk	4	Engineer	1	Engineer	1
Junior clerk	4	Supervisor	2	Foreman	1
Driver	2	Operator	9	Mechanic	3
Operation		Skilled labour	2	Unskilled labour	6
Engineer	1	Unskilled labour		Driver	11
Total number of personnel					70

4.9.2 Labour requirements for crop production

Labour requirements for crop production are presented in table 17. These do not include field irrigation labourers or farm machinery operators.

Table 17. Labour requirements for crop production

Function	Number
Chief Agricultural Engineer	1
Agricultural Engineer (crop production)	4
Agricultural Engineer (soils)	2
Agricultural Engineer (pest control)	3
Agricultural supervisor	18
Account	1
Clerk and typist	2
Store keeper	2
Field labourer	250
Total	283

4.9.3 Labour requirements for livestock production

Table 18 presents the labour requirements for operating the livestock enterprise, including the operation of the feed mill and the honey production enterprise.

4.9.4 Labour requirements for operating farm machinery

Labour required for operating farm machinery includes one mechanical engineer, 65 tractor, truck and combine harvester drivers, 2 mechanics, and 8 mechanic assistants.

Table 18. Labour requirements for livestock and honey production

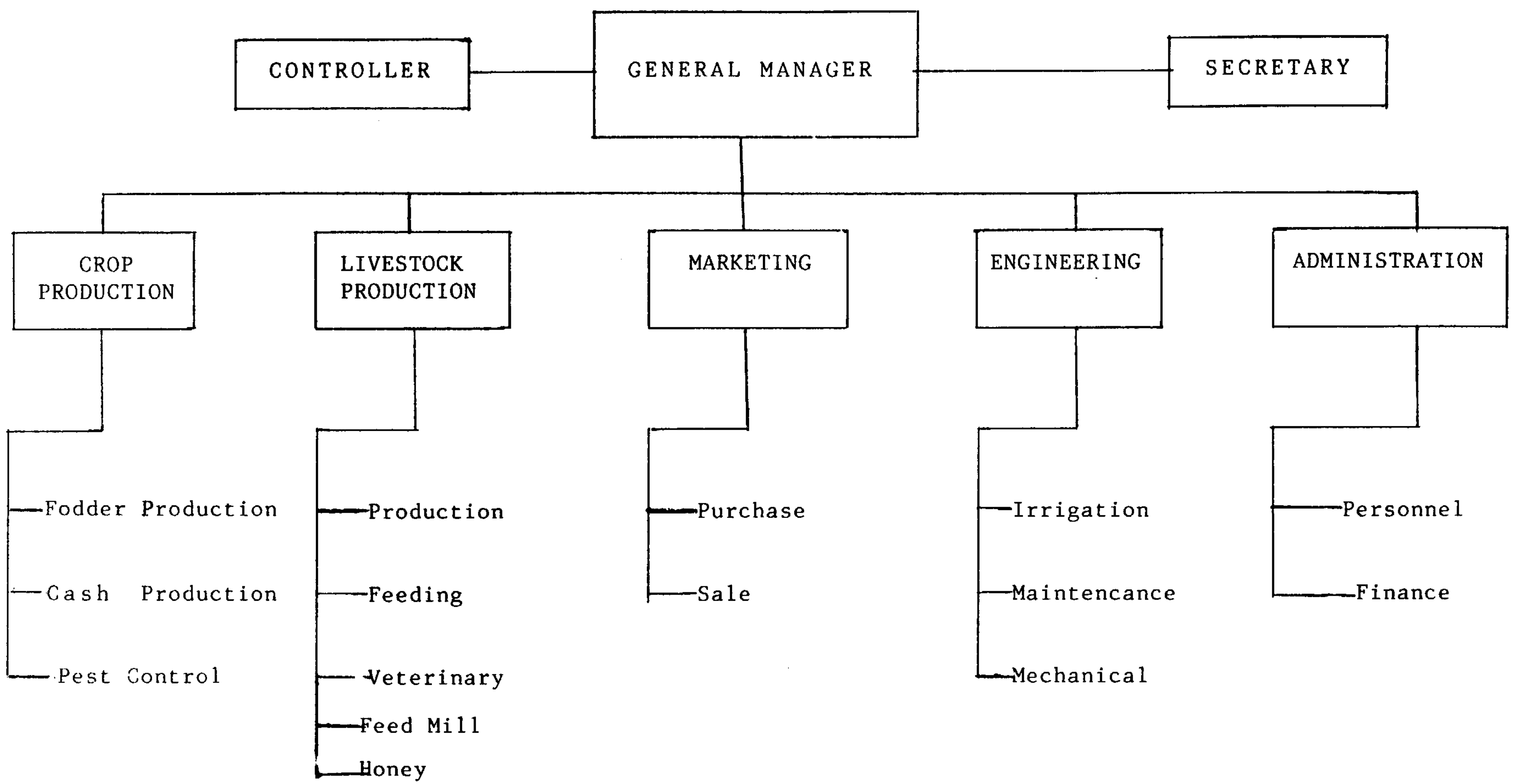
Function	Number
Director of livestock	1
Agricultural Engineer	9
Veterinary	3
Medical assistant	3
Agricultural supervisor	12
Technical labourers	5
Accountant	2
Clerk and typist	2
Store keeper	2
Drivers	5
Husbandry labourers	60
Bee labourers	20
Labourers (unskilled)	20
Guard	4
Total	148

4.10 Organization and Staffing

The organization of the project is designed to achieve efficiency and effectivieness. While the full responsibility falls upon the General Manager, he is supposed to do the work through his aides. He is assisted by five directors heading each of the main five activities of the project (figure 5). There are:

- Crop production manager; who will be assisted by fodder, cash crops and pest control supervisor;
- Livestock manager; who will be assisted by feeding, production veterinary, feed mill and honey production supervisiors;
- Marketing manager; who will be assisted by purchase and sale supervisors;
- Engineering manager; who will be assisted by irrigation, maintenance and mechnical and electrical supervisors; and
- Administration manager; who will be assisted by personnel and finance supervisors.

Figure 5. <u>Organization Chart for Al-Nai Project</u>



In staffing this organizational structure it should be noted that no one is appointed without detailed job specification to ensure that he is needed and to facilitate the periodic evaluation of his performance in an operational manner. It is only through efficient and effective management that the project can be a profit generating enterprise.

Table 19 summarizes the information regarding the labour requirements for different activities and adds the additional overhead staff requirements, along with their salaries.

Table 19. Labour requirements and cost for Al-Nai Project
(in Iraqi Dinars)

Function	Number	Monthly Salary	Annual Salary(*)	Total Annual Salary
General manager	1	800	7,800	7,800
Division manager	5	600	6,500	32,500
Section supervisor	13	450	5,850	76,050
Agricultural engineer	13	400	5,200	67,600
Mechnical engineer	2	400	5,200	10,400
Veterinaries	2	400	5,200	10,400
Assistant agricultural engineer	30	350	4,550	136,500
Assistant engineer	3	350	4,550	13,650
Senior clerk	5	300	3,900	19,500
Clerk	8	300	3,900	31,200
Accountent	5	300	3,900	19,500
Technician	10	300	3,900	39,000
Medical assistant	3	300	3,900	11,700
Irrigation technician	21	300	3,900	81,900
Store keeper	6	300	3,900	23,400
Agricultural driver	65	300	3,900	253,500
Driver	23	250	3,250	74,750
Skilled labourer	72	200	2,600	187,200
Unskilled labourer	280	150	1,950	546,000
Guards	5	150	1,950	9,750
Total	551	-	-	1,652,300

(*) 13 Months salary to cover for insurance and post service benefits.

5. PROJECT COSTS AND REVENUES

5.1 Cost of Fixed Assets

5.1.1 Irrigation and drainage

Table 20 presents the initial cost of the already existing irrigation system and the additional cost of improving the irrigation network for the first stage and of establishing field drains and related structures. the total cost of the irrigation and drainage system amounts to about ID 14,2 millions.

Table 20. Cost of irrigation and drainage systems

Number	Item	Iraqi dinar
1	Construction of pumping stations (1,2 and 3) and water purification plant at each pumping house and building of 6 houses at each pumping station	1,787,000
2	Electricity supply for the pumping station	177,116
3	Secondary canal formation and land levelling with drainage system up to the collectors	5,646,073
4	Main canal formation and lining of the second stage canals	1,316,398
5	Formation of Mc-2 and lining of the third stage canals	1,510,026
6	Construction of main irrigation structures for the third stage	361,312
7	Improving the irrigation for the first stage	450,000
8	Construction of field drain system (Proposed)	2,352,185
9	Construction of field drain outlet structures	580,000
	Total	14,180,110

Source: Al-Nai State Farm records and our estimates.

5.1.2 Farm machinery

Table 15 above gives the machinery requirements for plant production along with its unit prices and total cost. It estimates their total cost at ID 757.260.

5.1.3 Livestock and honey enterprises

Table 21 gives the total cost of establishing livestock and honey enterprises. It estimates the cost of buildings, machinery and equipments necessary for the livestock enterprise at ID 7.8 millions, the cost of bee hives and sheds at ID 157,500 and the cost of imported heifers at ID 1.8 millions. Therefore, the total costs of establishing the livestock and honey production enterprises at about ID 9.8 millions.

5.1.4 Buildings and infra-structure

Table 4 above shows that the initial cost of the building and infra-structure existing in Al-Nai State Farm amounts to about ID 1.5 million.

5.1.5 Total cost of fixed assets

Table 22 summarizes the total cost of the project's assets. In estimating these costs the cost of all investments already existing at Al-Nai State Farm was calculated at 1.5 times their initial cost. Therefore, the total cost of the project's assets is estimated at about ID 32.5 million. Table 23 distributes these costs according to expected year of expenditure and adds physical contingency at 5 per cent and price contingency at 15 per cent, 25 and 35 per cent for the first, second and third years respectively. Therefore the total cost has increased to ID 40 millions distributed among four years; ID 18.4 millions for the initial year, ID 9.6 million for the first year, ID 3.8 million for the second year and ID 4.1 million for the third year.

Table 21. Cost of fixed assets for livestock and bee enterprises

Item	Area m^2	Cost m^2 ID	Total cost ID
Information and guard romm	78	120	11,700
Administration building	250	150	46,875
Veterinary clinic	875	95	103,910
Stores	60	75	5,625
Hay stores	5,616	40	280,800
Silage pits	1,260	25	39,375
Milking cows sheds	19,500	85	2,071,875
Nilking parlor	4,875	95	578,900
Dry cows shed	4,875	85	517,970
Fattening sheds	9,750	85	1,035,940
Calving sheds	4,875	95	598,900
Heifer sheds	9,750	85	1,035,940
Breeding sheds	4,875	85	517,970
Incinerator			32,500
Water tank			25,000
Milking parlor equipment			495,000
Generator			62,500
Boiler			6,250
Electrical work			62,500
Watering equipments			93,750
Sewage network			125,000
Fire equipments			12,500
Feed mill and ancillaries			75,000
Bee hives			75,000
Bee hives sheds			7,500
Bee population			75,000
Subtotal			7,973,280
Imported heifers			1,800,000
Total			9,773,280

Table 22. Total cost of fixed assets

Item	Iraqi dinars
Irrigation and drainage	19,578,080
Farm machinery	757,260
Livestock and honey production	9,773,280
Buildings and infra-structure	2,217,300
Other assets	210,450
Total	32,536,370

Source: Computed farm Table 4, 15, 20, and 21.

Table 23. Distribution of cost of fixed assets by years of expenditure

Number	Item	Iraqi dinar
0	Payment to Iraqi Government against existing assests	18,414,190
1	Improving irrigation system	450,000
1	Farm machinery	757,260
1	Livestock and honey production	6,825,780
1	Physical and price contingencies(*)	1,606,610
1	Sub-total (total for year 1)	9,639,650
2	Assets for livestock and honey production and others	2,947,500
2	Physical and price contingencies(*)	884,250
2	Sub-total (total for year 2)	3,831,750
3	Completion of drainage system	2,931,190
3	Physical and price contingencies(*)	1,172,480
3	Sub-total (total for year 3)	4,103,670
	Total	35,988,700

Source: Table 22.

(*) Physical contingency at 5 per cent and price contingencies at 15, 25 and 35 per cent for the first, second and third years, respectively.

5.2 Operating Cost

5.2.1 Cost of labour

Table 19 above gives the annual cost of labour at about ID 1.7 million. It will be noted that the salaries and wages paid to staff members and labourers are much above the average salaries and wages paid by the Government or even the private sector. This reflects the fact that the project will have to attract the best available in the market including Iraqis working abroad.

5.2.2 Cost of pre-requisites for crop production

Table 24 estimates the annual cost of pre requisites for crop production at about ID 1.2 millions; of which ID 551.150 for seeds, ID 487,800 for fertilizers and ID 162,200 for pesticides.

5.2.3 Cost of pre-requisities for livestock production

Table 25 estimates the annual cost of feed ingredients necessary to supplement the grain and fodder produced at the farm at about ID 514 thousands. Adding the cost of veterinary medicaments and the sugar needed to supplement the honey production enterprise raises the cost of annual ingredients to about ID 541 thousands.

5.2.4 Total operating cost

Table 26 shows that total operating costs amount to about ID 4.7 millions. The main components of this figure are salaries, wages and other benefits (35.4 per cent); cost of pre-requisites for crop production 25.7 per cent; maintenance cost (23.9 per cent) and cost of pre-requisits for livestock production (11.6 per cent). Adding depreciation allowances raises the operating costs to about ID 5.6 million. Thus the depreciation allowances constitute about 17 per cent of the total operating cost.

Table 24. Annual cost of pre-requisites for crop production
(Iraqi Dinars)

Item	Ammount (ton)	Unit cost	Total cost
Barley seeds	210	140	29,400
Alfalfa seeds	35	1,000	35,000
Potatoes seeds	4,200	350	1,470,000
Corn seeds	15	350	5,250
Cotton seeds	5	300	1,500
Clover seeds	10	1,000	10,000
Fertilizers (NPK)	3,252	150	487,800
Pesticides			162,200
Total			1,201,150

Source: Computed from table 9 and own estimates.

Table 25. Annual cost of materials for livestock production
(Iraqi Dinars)

Item	Ammount (ton)	Unit cost	Total cost
Feed ingredients	2,630	170	447,100
Milk substitute	149	450	67,050
Veterinary medicaments	149	450	22,900
Sugar for bees	10	400	4,000
Total			546,050

Source: Computed from Appendices 4, and own estimates.

5.3 Project Revenues

Table 27 shows that the gross revenues of the project are estimated at about ID 19 million of which about ID 14.2 million or 75 per cent are gross revenues from crop production, about ID 4.6 million or 24 per cent are revenues from livestock production, and only one per cent are revenues from honey production.

Table 26. Total operating cost

Item		Iraqi dinars	Percentage	Percentage
Pre-requisites crop production		1,201,150	25.7	21.4
Pre-requisites for livestock production		541,050	11.6	9.7
Salaries and wages & benefits		1,652,300	35.4	29.5
Fuel		64,750	1.4	1.1
Power		50,000	1.1	0.9
Maintenance		1,114,150	23.9	20.9
Building and infra-structure1/	346,960			
Farm machinery2/	35,860			
Other machinery3/	91,700			
Irrigation1/	625,600			
Other fixed assets1/	14,030			

Table 26. (Continued)

Item		Iraqi dinars	Percentage	Percentage
Miscellaneous		45,000	0.9	0.8
Total before depreciation		4,668,400	100	
Depreciation[4/]		935,654		16.7
Existing assets	368,248			
Farm machinery	75,726			
Livestock building	227,576			
Improving irrigation	9,000			
Livestock equipments	196,500			
Drainage system[1/]	58,654			
Total including depreciation	5,604,054			100.0

Source: Computed from tables 19, 24 and 25 and Appendices 7 and 8.

1/ At 5 per cent;
2/ See Appendix 7;
3/ At 10 per cent;
4/ Appendix 8.

Table 27. Poject revenues

Item	Amount (ton)	Price	Gross revenue (ID)
Potatoes	56,000	250	14,000,000
Cotton	250	1,000	250,000
Milk	11,241	250	2,810,250
Breeding heifers[(*)]	710	750	532,500
Fattened calves[(*)]	981	900	882,900
Culled cows[(*)]	195	1,000	195,000
Honey	40	5,000	200,000
Manure	19,899	10	198,990
Total			19,069,040

Source: Calculated from table 10, 11, 12 and 13.

(*) head.

6. PROJECT FINANCE AND FINANCIAL VIABILITY

6.1 Total Investment Cost

Chapter 5 estimated the total cost of fixed assets and the annual operating cost for the project. These figures along with the other cost estimates such as the start-up costs can be utilized to estimate the project finance requirements. Table 28 estimates the total investment necessary for the implementation of the project, if the project is completely financed by equity capital, at about ID 37.2 million. Yet, this amount should be increased if credit finance is to be utilized.

Table 28. Calculation of investment cost
(Iraqi Dinars)

Year	Expenditure	Revenue	Net Returns Annual	Net Returns Cummulative
0	20,882,350	0	(20,882,350)	(20,882,350)
1	13,508,400	0	(13,508,400)	(34,390,750)
2	8,500,150	5,731,630	(2,768,520)	(37,159,270)
3	8,772,070	13,754,430	4,982,360	(32,172,910)
4	4,668,400	17,118,820	12,450,420	(19,726,490)
5	4,668,400	18,387,480	13,719,080	(6,007,410)
6	4,668,400	18,725,960	14,057,560	8,050,150

Source: Computed from tables 23, 26 and 27. It is assumed that only 50 per cent of the revenues of any given year could be utilized to finance the operations of the same year.

6.2 Financial Plan

For the project to be financially viable, its internal rate of return should be higher than the rate of interest on commercial loans. Therefore, the higher the loan equity ratio used in the financial package of the project, the more profitable the project will be. But since increasing the loan-equity ratio will also increase the risk. It is, therefore, required to reach a balance between the higher profitability and the increasing risk of a high loan-equity ratio. Considering these factors along with the conditions of investment in agriculture in Iraq it is believed that a 40-60 loan-equity ratio would be the optimum ratio, According to the calculations of table 29 the total finance required for implementing the project amounts to ID 41 million; of which ID 25 million will be in equity and ID 16 million will be in loans. Table 29 also shows that about 84 per cent of the equity (ID 20.9 million) will be spent during the initial year (year 0) and the rest (ID 4.1

million) will be spent during the first year. On the other hand it shows that 62.5 per cent of the loan will be spent during the first year of project implementation and the balance ID 6 million will be spent during the second year. the two loans are of medium term, they will be repaired in 5 years installments with a grace period of one year. Since the Agricultural Bank in Iraq gets very low interest rate on its loans to farmers, it has been assumed that the rate of interest on these two loans will be 6 per cent.

Table 29. Investment cost (equity and loan), loan and loan servicing
(ID 1,000)

Year	Total Expenditure	Interest Payments	Loan Repayment	Revenue	Capital	Loan	Balance
0	20,882	-	-	-	20,890	-	8
1	13,508	600	-	-	4,110	10,000	2
2	8,500	840	2,000	5,731	-	6,000	391
3	8,772	648	3,200	13,754	-	-	1,134
4	4,668	456	3,200	17,119			8,795
5	4,668	264	3,200	18,387	-	-	10,255
6	4,788	72	3,200	18,726	-	-	10,656
7	4,668	-	1,200	18,952			13,084

Source: Computed from table 28 given the assumption of 6.2.

6.3 Financial Viability

A number of criteria have been utilized to examine the financial viability of the project; the financial internal rate of return (FIRR), the benefit cost ration (BCR), the pay-back period (PBP) and the net present value. The analysis assumes that the project will last for 30 years. It does not take into consideration the residual value of the project, i.e., the value of the assets that could be sold by the end of the project life-time.

6.3.1 Internal rate of return

The financial rate of return is defined as the rate of discount that would equalize the discounted flow of financial returns of the project to the discounted flow of its financial costs for the entire life of the project. That is:

$$\sum_{t=0}^{n} \frac{Rt}{(1+r)^t} = \sum_{t=0}^{n} \frac{Ct}{(1+r)^t}$$

Where;

R_t = gross returns for the year t;
C_t = total cost for the year t;
r = the financial rate of return; and
n = the project's life-time in years.

The financial rate of return was calculated at 26.4 per cent. It means that every dinar invested in the project gives a rate of return which es equal to a compound interest rate of 26.4 per cent. Therefore, the project is highly viable.

6.3.2 Benefit-cost ratio

The benefit-cost ratio is defined as the ratio of the discounted flows of the project's returns and costs. The rate of discount used depends on the real rate of interest, and must reflect the opportunity cost of capital. If investment is financed by long-term loans the actual rate of interest should be used. Otherwise, the Central Bank rate or long-term loans would be used. The benefit-cost ratio is therefore calculated according to the following formulae;

$$B/C = \sum_{t=o}^{n} \frac{Rt}{(1 + i)^t} \div \sum_{t=o}^{n} \frac{Ct}{(1 + i)^t}$$

Where;

B/C = the benefit cost ratio;
R_t = gross returns for the year t;
C_t = total cost for the year t;
i = the normal rate of return on investment; and
n = the project's life-time in years.

Estimating the normal rate of return on invested capital at 15 per cent, the benefit-cost ratio calculated for the project is 1.53. Which means that the discounted flow of the project's benefits is more than one-and-half times as much as the discounted flow of its costs, both discounted at the rate of 15 per cent. This again reflects the high viability of the project.

6.3.3 Pay-back period

The pay-back period is defined as the number of years during which the project can accumulate enough net returns to cover its total investment. This period is usually calculated according to the following formula:

$$I = \sum_{t=1}^{P} (N+D)_t$$

Where;

I = total project's investment;
N = net profit after taxes for a normal year;
D = depreciation of invested capital for a normal year;
N+D = net monetary income for a normal year; and
P = Pay-back period in years.

Utilizing this formula, the pay-back period is two years taking (I) to mean the equity capital and three years if (I) refers to the total investment; i.e., equity and loans.

Yet the initial pay-back period, i.e., the number of years counting from the year of project initiation, during which the project can accumulate enough net retruns to cover its total investment is calculated at 7 years if total investment is taken to mean the equity capital and 8 years if it is taken to mean equity and loan.

Again the pay-back period reflects the high financial viability of the project.

6.3.4 Net present value

The net present value of the project is defined as the discounted net flows of the project during its whole life. The discount rate to be used is the same used in calculating the benefit-cost ratio. The project is considered financially viable if its net present value is greater than or equal to zero, the higher the net present value of the project is, the hgiher will be its viability. Utilizing 15 per cent as the discount rate, the net present value of the project is calculated at ID 29.9 million, which again reflects the high financial viability of the project.

If the net present value of the project is divided by the present value of the total inflows of the project (investment + operating costs) the co-efficient of investment is obtained. This co-efficient is equal to 0.53, which means that for every dinar invested a net income of 0.53 dinars will be obtained, again reflecting the high project's financial viability.

7. FINANCIAL ANALYSIS

7.1 Liquidity Analysis

The analysis of the investment profitability; i.e., analysing the financial viability of the projects. is carried out on the basis of the whole project life. Therefore, the good results obtained for the whole project life might be compatible with significant financial deficit for a given number of years, specially when loan repayment are due. Actually the financial flows used in the profitability analysis does not include items affecting the project's monetary balance. It only inlcudes those items related to the flows of the reserouces used in the project. Therefore, in the liquidity analysis other currency situations related to the financial operations should be consideed. These include loan servicing, insurance payments along with other currency flows that are not essentially related to the investment under consideration such as sale of excess land, or purchasing bonds. Including all these factors enables judging:

- Whether the equity and long-term loans are adequate;
- Whether the currency deficit if it exists, is not serious and can be met by short term loans;
- Whether the terms of the long-term loans are convenient; and
- Whether the profits are realized in the manner envisaged.

The liquidity analysis is carried out by analysing the projected statement of funds flow (table 30). Table 30 shows this statement for the first 11 years of the project life. It is noted that the net change in working capital is always positive and increases from year to year until it becomes more than ID 1.5 million in the third year, about ID 8.8 million in the fourth year, and then it stabilizes at about ID 14.3 million as of the eighth year. Yet it is noted that the net change in working capital is low at the initial year and first year of implementation; ID 8,000 and ID 2,000 respectively. But it is clear that, if it is needed, the project can easily accomodate for a short-term loan for whatever amount needed. Therefore, it can be concluded that the project is not expected to face any liquidity problem during its whole life-time.

7.2 Analysis of Capital Structure

The long-term financing of the project should be sufficient to cover the projects fixed and operating costs. Sources of finance are equity and long-term loans. Relying on short-term loans in capital financing puts heavy burdens on the currency budget, while the inflows of the project might not be sufficient in the short-term to meet the requirements of short-term servicing. Therefore, it is important when judging the viability of the project to look into the structure of the capital, taking into consideration the pros and cons of high and low loan-equity ratio. In forming the project's capital the loan-equity ratio was chosen to be 40:60. This was found to be the optimum ratio for this type of investment in Iraq. Yet table 30 shows that the annual loan-equity ratio is always lower than that. This ratio is expected to be 28:72 for year one and is expected to increase to 36:44 for year two. Yet, it is expected to decrease gradually after that till it vanishes as of year seven.

7.3 Profitability Analysis

All the criteria utilized in chapter 6 proves that the project is highly profitable, considering the 30 years of the project life as a whole. Yet it is also important to analyze the profitability of the project during the individual years of the project life-time. To achieve this objective the projected income statement has been prepared for the first eleven years of the project life (table 31), and a number of ratios have been calculated.

7.3.1 Net profit to sales ratio

Selling is the only income earning activity in the project. It is therefore very important to know how much of the value of the sales are kept as net profit after all expenses has been paid out. This is obtained by calculating the net income to sales ratio. table 31 shows that this ratio ranges between 0.48 and 0.54 between the second and sixth year of project implementation after, that it increases to 0.64 and then stabilizes at 0.71 as of the eighth year. Comparing this ratio to the same ratio for other agricultural projects proves that this project is highly profitable.

Table 30. **Projected statement of funds flow for the first eleven years of the project**

Year	0	1	2	3	4	5	6	7	8	9	10
Sales	-	-	5,731	13,754	17,119	18,388	18,726	18,952	18,952	18,952	18,952
Equity	20,890	4,110	-	-	-	-	-	-	-	-	-
Loans	-	10,000	6,000	-	-	-	-	-	-	-	-
Total inflows	20,890	14,110	11,731	13,754	17,119	18,388	18,726	18,952	18,952	18,952	18,952
Investment	18,414	9,640	3,832	4,104	-	-	120	-	-	-	-
Operating cost	2,468	3,868	4,668	4,668	4,668	4,668	4,668	4,668	4,668	4,668	4,668
Taxes	-	-	-	-	-	-	-	-	-	-	-
Financial obligations	-	600	2,840	3,848	3,656	3,464	3,272	1,200	-	-	-
Loan repayment	-	-	2,000	3,200	3,200	3,200	3,200	1,200	-	-	-
Interest	-	600	840	648	456	264	72	-	-	-	-
Distributed profit	-	-	-	-	-	-	-	-	-	-	-
Total out flows	20,882	14,108	11,340	12,620	8,324	8,132	8,059	5,868	4,668	4,668	4,668
Chang in W.C											
Beyining	-	8	10	401	1,535	10,330	20,586	31,253	44,337	58,621	72,905
Net change	8	2	391	1,134	8,795	10,256	10,667	31,084	14,284	14,284	14,284
Ending	8	10	401	1,535	10,330	20,586	31,253	44,337	58,621	72,905	87,189
Loan-equity ratio	0	28:72	36:44	30:70	23:77	15:85	5:95	0	0	0	0

Table 31. **Projected income statement as at the end of each of the first eleven years of the project**

Year	0	1	2	3	4	5	6	7	8	9	10
Sales											
Crops	-	-	5,731	11,787	13,182	14,250	14,250	14,250	14,250	14,250	14,250
Milk	-	-	-	1,164	2,318	2,436	2,630	2,740	2,796	2,810	2,810
Other livest.	-	-	-	744	1,461	1,502	1,646	1,762	1,804	1,808	1,808
Honey	-	-	-	59	158	200	200	200	200	200	200
Total	-	-	5,731	13,754	17,119	18,388	18,726	18,952	19,050	19,068	19,068
Cost of Produ.											
Oper.cost	2,468	3,869	4,668	4,668	4,668	4,668	4,668	4,668	4,668	4,668	4,668
Depreciation	368	681	877	935	935	935	935	935	935	935	935
Total	2,836	4,550	5,545	5,603	5,603	5,603	5,603	5,603	5,603	5,603	5,603
Inventory	-	-	5,731	2,291	1,073	195	143	83	69	-	-
Total cost of sales	2,836	4,550	(186)	3,312	4,530	5,408	5,460	5,520	5,534	5,603	5,603
Operating profit	(2,836)	(4,550)	5,917	10,442	12,589	12,980	13,265	13,432	13,516	13,465	13,465
Other expenditure											
Loan	-	-	2,000	3,200	3,200	3,200	3,200	1,200	-	-	-
Interest	-	600	840	648	456	264	72	-	-	-	-
Total	-	600	2,840	3,848	3,656	3,464	3,272	1,200	-	-	-
Net profit before taxes	(2,836)	(5,150)	3,077	6,594	8,933	9,516	9,994	12,232	13,516	13,465	13,465
Taxes	-	-	-	-	-	-	-	-	-	-	-

Continued

Table 31 (Continued)

Year	0	1	2	3	4	5	6	7	8	9	10
Net profit after tax											
Net profit / Sales			0.54	0.48	0.52	0.52	0.53	0.64	0.71	0.71	0.71
Net profit / Equity			0.12	0.26	0.36	0.38	0.40	0.49	0.54	0.54	0.54
Net profit / Fixed assets			0.10	0.20	0.27	0.30	0.33	0.41	0.47	0.49	0.50
Sales / Fixed assets			0.19	0.42	0.53	0.62	0.62	0.64	0.67	0.69	0.71
Sales / Equity			0.23	0.55	0.68	0.74	0.75	0.76	0.76	0.76	0.76

7.3.2 Net profit to equity ratio

This ratio measures the profitability of the capital owned by the shareholders. Table 31 shows that at the end of the second year of implementation the ratio is only 0.12 meaning that every dinar of equity capital gives 0.12 dinar in net profit. The ratio steadily increases until it reaches 0.54 as of the end of the eighth year. Thus each dinar of equity cpital yields 0.54 dinar, a matter that reflects the high profitability of the project.

7.3.3 Net profit to fixed assets ratio

This ratio measures the profitability of the fixed assets. Table 31 shows that the ratio is only 0.1 at the end of the second year of implementation and that it increases steadily reaching 0.5 at the end of the tenth year, again reflecting the high profitability of the project.

7.3.4 Sales to equity ratio

The sales to equity ratio is an indicator of the capital-output ratio. It gives the rate of gross returns to the owned capital. Table 31 shows that this ratio is 0.23 at the end of the second year, and that it rapidly increases until it reaches more than 0.75 as of the end of the seventh year. It indicates that at the begining years of the project life, the project sales can cover its equity in less than three years, and as the project matures, its sales can cover its equity in less than two years. Again this indicates the high profitability of the project.

7.3.5 Sales to fixed assets ratio

The sales to fixed assets ratio is another indicator of the capital output ratio. It gives the rate of gross returns to the fixed assets. Table 31 shows that this ratio is 0.19 at the end of the second year of implementation, and that it increases at a high rate, reaching 0.71 at the end of the tenth year. Again, the project accumulated gross returns at the beginning require less than three years to cover the cost of its fixed assets, and as the project matures, it requires less than two years.

7.4 Shareholders Entitlements

Table 32 gives the projected balance sheet for the first eleven years of the project. It shows that the shareholders entitlements at the end of the initial year is about ID 18.1 million, that is, 86 per cent of the equity. Shareholders entitlements increase at a high rate reaching ID 52 million, that is 208 per cent of the equity at the end of the fifth year of implementation. At the end of the tenth year these entitlements reach almost ID 114 million, i.e., 456 per cent of the equity.

Table 32. **Projected balance sheet as at the end of the year**

Year	0	1	2	3	4	5	6	7	8	9	10
Assets											
Current											
Cash	8	10	401	1,535	10,330	20,586	31,253	44,337	58,621	72,905	87,189
Inventories	-	-	5,731	2,291	1,073	195	143	83	69	-	-
Total	8	10	6,132	3,826	11,303	20,781	31,396	44,420	58,690	72,905	87,189
Fixed											
Investment	18,414	28,054	31,886	35,990	35,990	35,990	35,990	35,990	35,990	35,990	35,990
Replacement	-	-	-	-	-	-	120	120	120	120	120
Acc. Dep.	368	1,049	1,926	2,861	3,796	4,731	5,666	6,601	7,563	8,471	9,406
Total	18,046	27,005	29,960	33,129	32,194	31,259	30,444	29,509	28,547	27,639	26,704
Total asset	18,054	27,015	36,092	36,955	43,497	52,040	61,840	73,929	87,237	100,544	113,893
Liabilities											
Debt	-	10,000	14,000	10,800	7,600	4,400	1,200	-	-	-	-
Equity	20,890	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
Indistri-bution	(2,836)	(7,986)	(2,908)	1,155	10,897	22,640	36,840	48,929	62,237	75,544	88,893
Shareholders entitlement	18,054	27,014	36,092	36,955	43,497	52,040	61,840	73,929	87,237	100,544	113,893
Sh. H. E											
Equity	0.86	1.08	1.44	1.48	1.74	2.08	2.47	2.96	3.49	4.02	4.56
Debt											
Equity	-	0.4	0.56	0.43	0.3	0.18	0.05	-	-	-	-

8. SENSITIVITY ANALYSIS

The judgement about the project viability is very much dependent on the projects assumptions and estimates. It is therefore important to estimate the sensitivity of the profitability criteria utilized to the changes in the assumptions and/or estimates. Irrespective of the fact that the estimates of the cost of fixed assets include elements of contingency; both physical and price; the sensitivity analysis is still needed. This analysis was carried out with respect to changes in the cost of fixed assets, the operating costs and benefits of the project.

8.1 Sensitivity of the Internal Rate of Return and Benefit-Cost Ratio to Changes in Cost of Fixed Assets

Table 33 shows that the project is still viable even if the cost of fixed assets is doubled. In this case IRR decreases from 26.4 to 15.24 and the B-C ratio decreases from 1.53 to 1.01. The value of IRR obtained for the project when doubling the cost of fixed assets is still above the 15 per cent assumed as the alternative cost of investment in Iraq. On the other hand, the B-C ratio obtained under these condition is low (1.01). Yet, the reason is that the rate of discount used in calculating the B-C ratio is 15 per cent. If this rate is reduced to 10 per cent the B-C ratio would increase to 1.33. These results show that the project's viability is not very sensitive to the increase in the cost of fixed assets. This is also asserted by calculating the elasticity of IRR and B-C ratio with respect to the cost of fixed assets. Table 33 shows that both IRR and B-C ratios are inelastic to changes in the cost of fixed assets. The IRR elasticity ranges between -0.667 and -0.451 and the elasticity of B-C ratio ranges between -0.523 and -0.342. Figure 6 shows that the two elasticities decrease as the percentage increase in the cost of fixed assets goes from 10 per cent to 100 per cent.

8.2 Sensitivity of the Internal Rate of Return and Benefit-Cost Ratio to Changes in Operating Costs

Table 34 shows that the behaviour of the project's viability with respect to increases in operating costs is more or less similar to that with respect to changes in the cost of fixed assets. That is, the project is still viable even if the operating cost is doubled. Again, IRR obtained for the project when doubling the operating cost is 15.56 which is above the 15 per cent assumed as the alternative cost of investment in Iraq. On the other hand, the B-C ratio obtained under same condition is low (1.02). Again, this low B-C ratio is attributed to the fact that the rate of discount used in calculating the ratio is 15 per cent. If the rate is reduced to 10 per cent, the B-C ratio would increase to 1.21. These results indicate that the project's viability is not very sensitive to the increase in operating cost. The elasticity of IRR and B-C ratio to the change in operating cost assertain this conclusion. Table 34 shows that both IRR and B-C ratio are inelastic to changes in operating cost. The IRR elasticity ranges between -0.439 and -0.626, and the elasticity of B-C ratio ranges between -0.275 and -0.523. Figure 7 shows that while the elasticity of IRR increases, the elasticity of B-C ratio decreases as the percentage increase in operating cost goes from 10 per cent to 100 per cent.

Figure 6. <u>**Elasticity of Internal Rate of Return and Benefit-cost Ratio to Cost of Fixed Assets**</u>

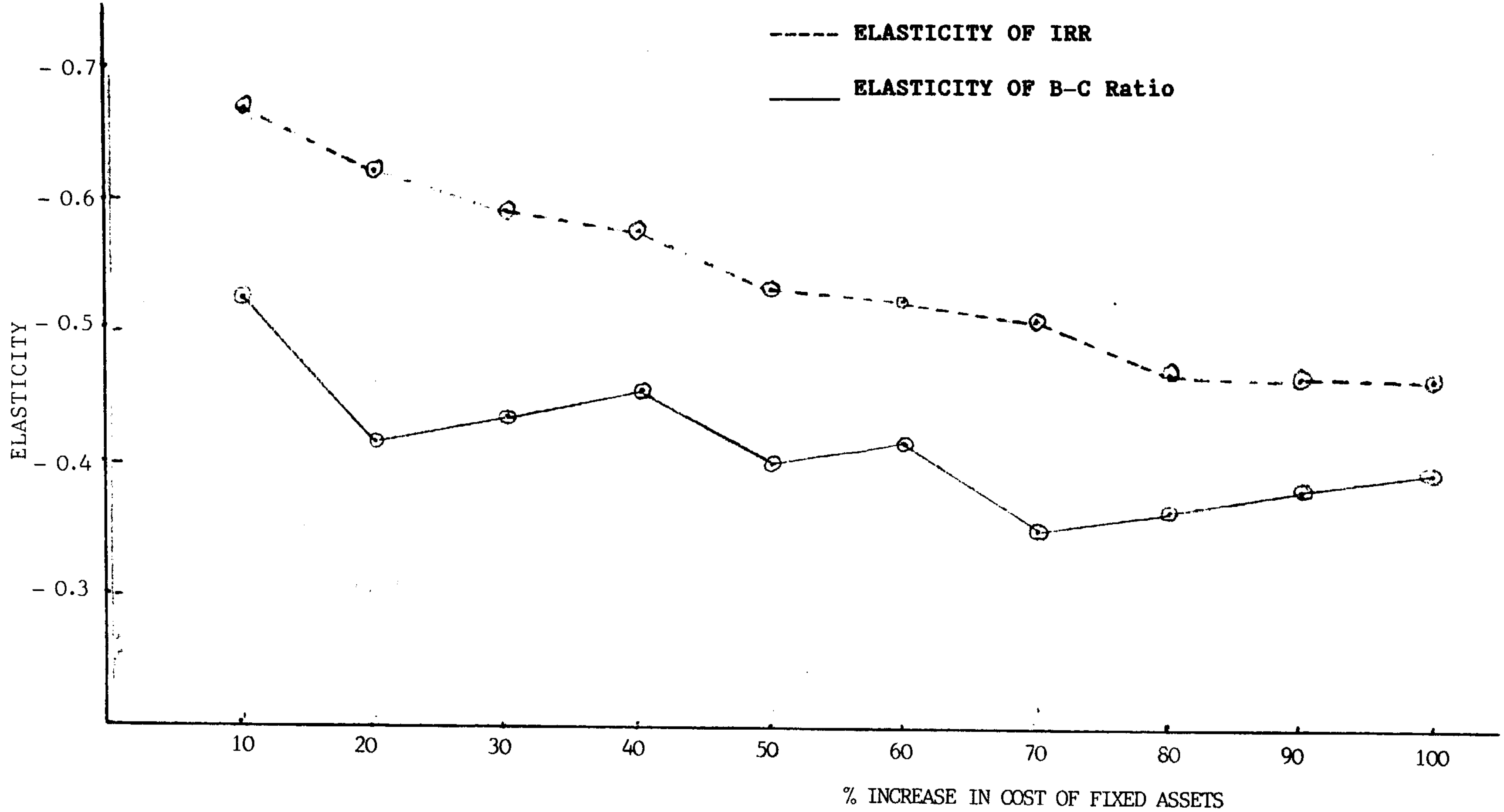


Figure 7. Elasticity of Internal Rate of Return and Benefit-cost Ratio to Operating cost

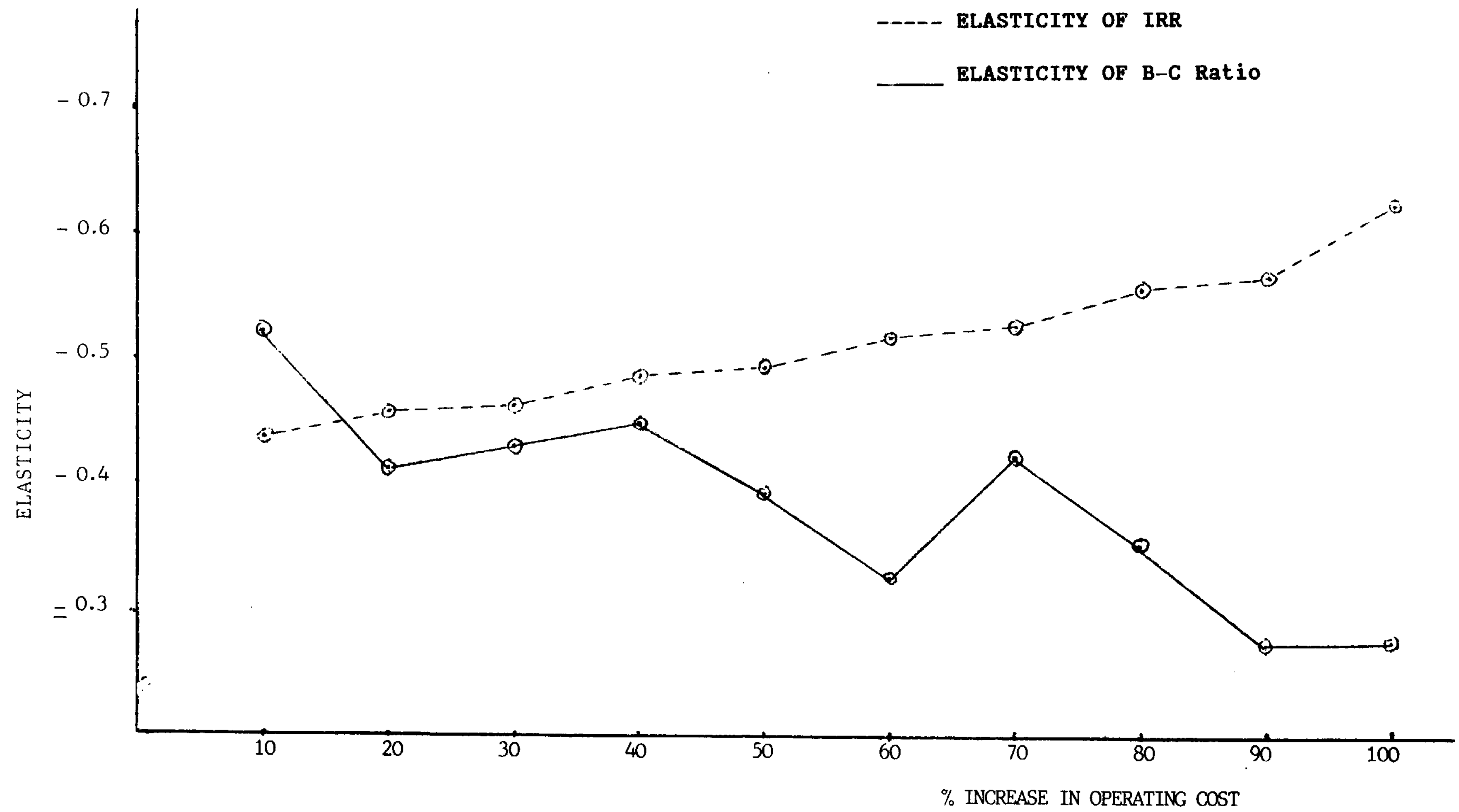


Table 33. Sensitivity of internal rate of return and benefit-cost ratio to changes in the cost of fixed assets

Percentage increase in fixed cost	IRR	Elasticity of IRR	B-C Ratio	Elasticity of B-C Ratio
0	26.40		1.53	
		-0.667		-0.523
10	24.64		1.45	
		-0.617		-0.414
20	23.12		1.39	
		-0.588		-0.432
30	21.76		1.33	
		-0.570		-0.451
40	20.52		1.27	
		-0.526		-0.394
50	19.44		1.22	
		-0.514		-0.410
60	18.44		1.17	
		-0.499		-0.342
70	17.52		1.13	
		-0.457		-0.354
80	16.72		1.09	
		-0.454		-0.369
90	15.96		1.05	
		-0.451		-0.381
100	15.24		1.01	

Table 34. Sensitivity of internal rate of return and benefit-cost ratio to changes in operating cost

Percentage increase in operation costs	IRR	Elasticity of IRR	B-C Ratio	Elasticity of B-C Ratio
0	26.40		1.53	
		-0.439		-0.523
10	25.24		1.45	
		-0.459		-0.414
20	24.08		1.39	
		-0.465		-0.432
30	22.96		1.33	
		-0.488		-0.451
40	21.84		1.27	
		-0.494		-0.394
50	20.76		1.22	
		-0.520		-0.328
60	19.63		1.18	
		-0.528		-0.424
70	18.64		1.13	
		-0.558		-0.354
80	17.60		1.09	
		-0.568		-0.275
90	16.60		1.06	
		-0.626		-0.377
100	15.56		1.02	

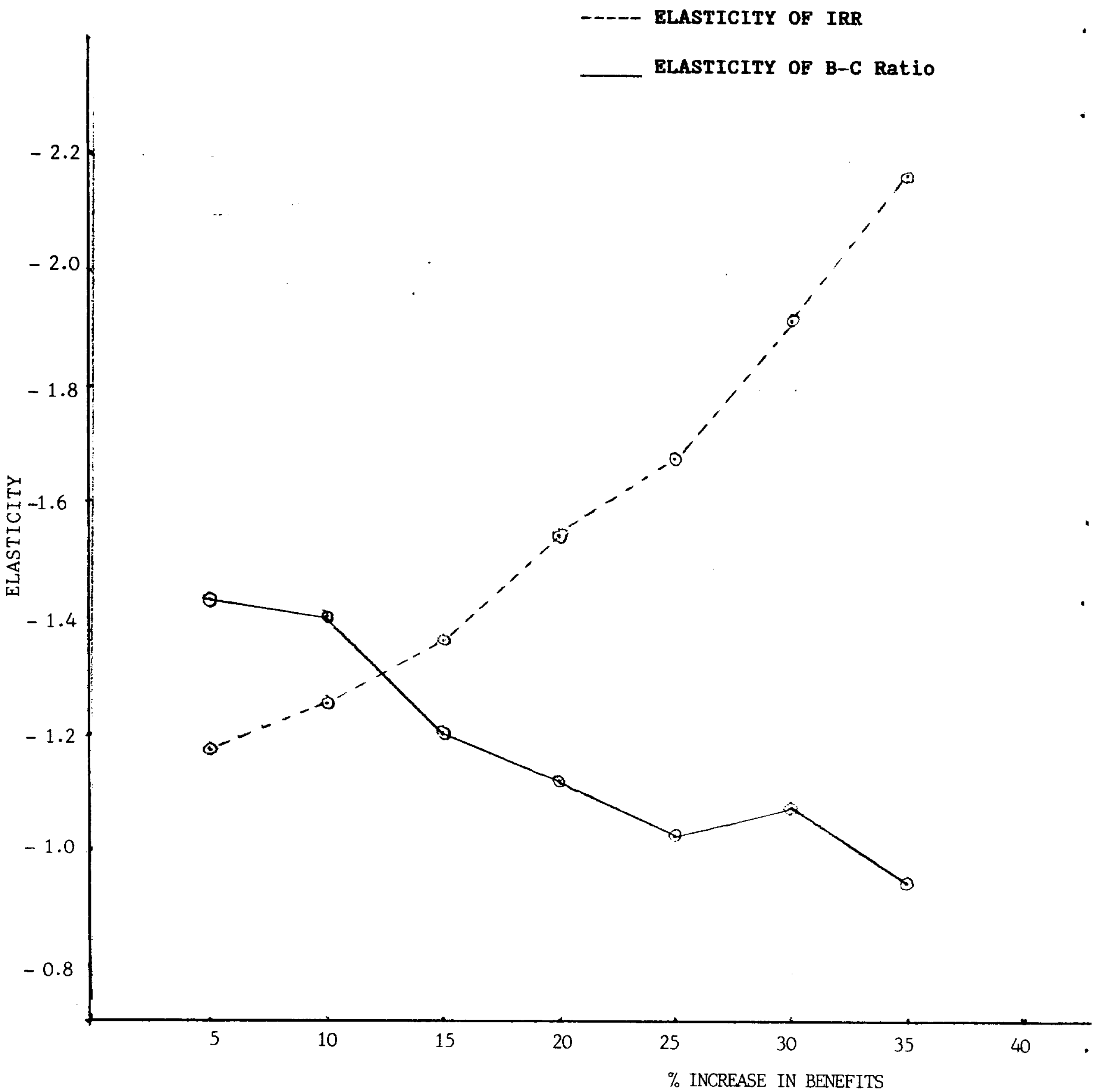
8.3 Sensitivity of the Internal Rate of Return and the Benefit-cost Ratio to Changes in Benefits

To the contrary of the effect of the cost of fixed assets and the operating cost, the project's viability is very sensitive to changes in benefits. The IRR calculated for the project drops from 26.4 to 14.76 -slightly less than the 15 per cent assumed for the alternative cost of investment- when the benefits of the project is decreased by 35 per cent. The B-C ratio drops from 1.53 to 1 under same conditions (table 35). The project's sensitivity to changes in its benefits is assertained by the estimates obtained for the elasticities of IRR and B-C ratio with respect to benefits. Both the two elasticities are higher than -1. The IRR elasticity ranges between -1.18 and -2.17, while the B-C ratio elasticity ranges between -0.95 and -1.44. Yet the behaviour of the two elasticities differ; while the elasticity of IRR increases as benefits decrease, the elasticity if B-C ratio decreases (figure 8).

Table 35. Sensitivity of the internal rate of return and the benefit-cost ratio to to the project's benefits

Percentage decrease in benefits	IRR	Elasticity of IRR	B-C Ratio	Elasticity of B-C Ratio
0	26.40		1.53	
		-1.182		-1.438
5	24.84		1.42	
		-1.256		-1.408
10	23.28		1.32	
		-1.374		-1.212
15	21.68		1.24	
		-1.550		-1.129
20	20.00		1.17	
		-0.680		-1.026
25	18.32		1.11	
		-1.921		-1.081
30	16.56		1.05	
		-2.174		-0.952
35	14.76		1.00	

Figure 8. Elasticity of Internal Rate of Return and Benefit-cost Ratio to Benefits



Appendix 1

Table 1. Design Data for Secondary Canals of Stage 1.

Name of Canal	Length km From	Length km To	Disharge m^3/sec	Area surved (donum)	Bed slop cm/km	Bed width (m)	Depth of water (m)	Remarks
C-1-3	0+00	2+300	0.860	2,600	15	1.20	1.00	1- There is a road crossing at km 2+300
	2+300	3+360	0.710		20	1.00	0.87	2- There is a drain crossing at km 0+800 3- There are 5 water courses
C-1-3-1	0+00	0+100	0.207	620	30	0.60	0.50	1- There is a road crossing at km 0+100
	0+100	1+115	0.186		30	0.60	0.48	2- There is a scope at km 1+115 3- There are 6 water courses
C-1-3-2	0+00	0+650	0.375	1,125	30	0.80	0.62	1- There is a diversion structure at km 0+000
	0+650	1+850	0.312		30	0.80	0.57	2- Ditto at km 0+650
	1+850	2+550	0.146		40	0.80	0.41	3- There is a road crossing at km 1+850 4- The is escope at km 2+550 5- There are 7 water courses
C-1-3-3	0+00	1+250	0.252	820	30	0.75	0.57	1- There is a road crossing at km 1+250
	1+250	2+500	0.166		40	0.60	0.43	2- A scape structure at km 2+500 3- There are 5 water courses

Appendix 1

Table 2. Design Data for Secondary Canals, Stage 2-A

Name of Canal	Length km From	Length km To	Disharge m^3/sec	Area irrigated (donum)	Bed slop cm/km	Bed width (m)	Depth of water (m)	Remarks
SC-1	0+00	2+600	2.70	6,000	10	1.80	1.35	1- There are 15 tertiary water courses
	2+600	4+600	0.383		10	1.60	1.35	2- There is one road culvest at km 6+800
	4+600	6+150	2.255		10	1.40	1.35	3- There is one drain crossing at km 5+500
	6+150	8+220	1.000		10	1.40	0.90	
SC-1-1	0+00	1+250	0.370	1,100	12	1.00	0.60	1- There are 5 tertiary canals
	1+250	2+250	0.240		12	0.70	0.60	2- There is one road crossing at km 2+250
	2+250	4+200	0.140		12	0.50	0.45	3- There is one re escape structure at km 3+200
SC-1-2	0+00	0+950	0.555	1,700	15	0.90	0.70	1- There are 13 tertiary canals
	0+950	2+250	0.391		15	0.90	0.63	2- There are 3 road crossing at km 0+950 and 3+000
	2+250	2+950	0.283		15	0.60	0.58	3- There is one escape at km 3+900
	2+950	3+930	0.120		15	0.60	0.50	
T-0	0+00	0+900	0.11	350	15	1.30	0.90	
DC-4	0+00	0+050	0.147	450	20	0.60	0.40	1- There are 5 tertiary canals
								2- There is one escape at km 1+800
	0+050	1+820	0.110		20	0.50	0.30	3- There is crossing regulator at km 0+033 and another at km 0+60

Appendix 1

Table 3. Design Data for Main and Secondary Canals, Stage 2-B

Name of Canal	Length km From	Length km To	Disharge m^3/sec	Area irrigated (donum)	Bed slop cm/km	Bed width (m)	Depth of water (m)	Remarks
MC-1	0+00	4+330	6	29,600	7	3.00	1.90	1- There are 5 tertiares 2- There are 2 secondary canals
DC-7	0+00	0+750	0.220	660	30	1.00	0.45	1- There are 5 tertiary canals 2- There are 2 drops at km 0+600 and 0+750
	0+750	1+040	0.132		30	0.80	0.40	3- There is one escape at km 1+000
DC-8	0+00	0+760	0.900	2,800	30	1.10	0.70	1- There are 13 tertiary canals
	0+760	1+600	0.696		30	1.10	0.60	2- There are 2 road crossing at km 0+760 and 3+000
	1+600	3+000	0.215		20	0.60	0.45	3- There is one drop at km 1+615
	3+000	4+450	0.072		40	0.30	0.30	4- There is one escape at km 2+920
SC-2	0+000	0+050	1.773	6,300	19	1.90	0.95	1- There are 9 tertiary canals
	0+050	1+230	1.553		17	1.60	0.95	2- There is one road crossing at km 4+770
	1+230	2+910	1.437		17	1.40	0.95	
	2+910	4+440	1.330		17	1.20	0.95	
	4+440	4+770	1.220		17	1.10	0.95	
SC-2-1	0+00	1+315	0.295	900	15	0.85	0.50	1- Thre is one road crossing at km 1+315
	1+315	2+430	0.165		20	0.50	0.40	2- There is one escape at km 2+400 3- There are 3 canals taking water from this canal
SC-2-2	0+00	1+000	0.652	1,900	40	0.80	0.60	1- There are 9 tertiary canals
	1+000	2+092	0.307		40	0.60	0.45	2- There is one fall structure at km 1+012
	2+092	4+080	0.172		20	0.60	0.40	3- There is one escape at km 4+050 4- There is one road crossing at km 2+090
DC-5	0+00	0+670	0.252	820	40	0.70	0.40	1- There are 8 tertiary canals
	0+670	1+300	0.189		38	0.70	0.35	2- There are 3 drop structures at km 0+360, 0+670 and 1+300
	1+300	1+900	0.126		33	0.70	0.30	3- There is one escape at 2+450
	1+900	2+490	0.063		15	0.50	0.30	
DC-6	0+00	0+340	0.220	670	30	0.70	0.40	1- There are 6 tertiary canals
	0+340	1+230	0.157		20	0.60	0.40	2- There are 2 drop structures at km 0+340 and 0+900
	1+230	1+820	0.063		15	0.50	0.30	3- There is one escape at km 1+800

Appendix 1

Table 4. Design Data for Main and Secondary Canals, of stage 3

Name of Canal	Length km From	Length km To	Disharge m^3/sec	Area irrigated (donum)	Bed slop cm/km	Bed width (m)	Depth of water (m)	Remarks
MC-2	0+00	3+260	3.945		7	2.50	1.60	1- There are 15 tertiary canals
	3+260	6+380	3.045		7	1.650	1.60	2- There are 6 secondary canals
	6+380	7+810	2.010		10	1.60	1.21	3- There are 2 drop structures at km 6+380 and 7+810
	7+810	9+920	1.731	1,6000	10	1.60	1.13	
	9+920	10+910	1.621		10	1.40	1.13	4- There is one drain crossing at km 8+800
	10+910	11+960	1.480		10	1.20	1.13	
	11+960	12+660	0.924		10	1.00	0.95	5- There are 2 road crossings at km 8+860 and 11+960
BC-1	0+00	0+620	0.794		16	1.20	0.75	1- There are 11 tertiary canals
	0+620	1+765	0.668		16	1.10	0.75	2- There are 2 road crossing at km 1+765 and 3+365
				2,400				
	1+765	2+365	0.542	2,400	16	0.80	0.70	3- There is one escape at km 3+450
	2+365	3+510	0.319		11	0.80	0.60	4- There is one drain crossing at km 3+510
BC-2	0+00	1+550	0.373		30	1.00	0.60	1- There are 7 tertiary canals
				1,200				2- There is one drain crossing at km 1+500
	1+550	2+630	0.216		30	0.80	0.45	3- There is 1 road crossing at km 1+500
								4- There are 2 escapes at 2+600 and 3+250
								5- There is one drop at km 2+630
DC-1	0+00	3+725	0.144	430	30	0.70	0.47	1- There are 4 tertiary canals
								2- There are 2 escapes at km 2+600 and 3+350
								3- There is 1 road crossing at km 2+950

Appendix 1

Table 5. Design Data for Tertiaries of secondary Canal: SC-1, Stage 2-A

Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level	Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level
DC-1	0+200	56.04	54.60	T8	5+800	55.48	54.15
DC-2	1+000	56.96	55.00	T9	6+100	55.45	54.20
DC-3	1+850	55.88	55.15	T10	6+150	55.45	55.05
DC-4	2+600	55.80	55.42	Road culvert	6+800	--	--
T1	3+400	55.72	55.55	T11	8+000	54.82	54.65
T2	3+700	55.69	55.20				
T3	4+000	55.66	54.70				
T4	4+300	55.63	54.35				
T5	4+600	55.60	54.05				
T6	4+900	55.57	54.00				
T7	5+450	55.51	54.10				
Drain crossing	5+500	--	--				

Appendix 1

Table 6. Design Data for Tertiaries of secondary Canal: SC-1-2, Stage 2-A

Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level	Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level
T1	0+350	54.45	54.15	T10	2+600	53.79	53.00
T2	0+150	54.48	54.30	T11	2+900	53.73	53.35
T3	0+750	54.40	54.10	Road crossing	3+000		
T4	0+450	54.43	53.35	Escape	3+900		
Road crossing	0+950			T12	3+930	52.95	
T5	1+100	54.17	54.05	T12-1	3+930	52.95	
T6	1+400	54.13	53.90				
T7	1+700	54.08	53.55				
T8	2+000	54.04	53.40				
Road crossing	2+150	--	--				
T9	2+300	53.84	53.15				

Appendix 1

Table 7. Design Data for Tertiaries of secondary Canal: SC-1-1, Stage 2-A

Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level
T1	0+020	54.65	54.30
T2	1+250	54.50	54.10
T3	2+250	54.38	53.70
Road crossing	2+250	--	
Escape	3+200	--	
T4	4+200	53.70	

Appendix 1

Table 8. Design Data for Tertiaries of secondary Canal: DC-4, Stage 2-A

Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level
T1	0+050	55.41	55.20
Cross regulator	0+060		
T2	0+330	54.80	54.60
Cross regulator	0+330		
T3	0+650	54.24	54.10
T4	1+550	54.06	53.80
Escape	1+800		
T5	1+820	53.95	

Appendix 1

Table 9. Design Data for Tertiaries of secondary Canal: SC-2-2, Stage 2-B

Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level	Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level
T1	0+030	56.55	56.45	D2	2+100	55.13	54.90
T2	0+050	56.53	56.45	Escape	4+050	--	--
T3	0+300	56.44	55.79	D1	4+080	54.75	54.55
T4	0+550	56.38	56.27				
T5	0+600	56.34	55.80				
T6	0+850	56.24	55.76				
D3	0+900	56.20	56.02				
Fall structure	1+012	--					
Road crossing	2+092	--					

Appendix 1

Table 10. Design Data for Tertiaries of secondary Canal: SC-2-1, Stage 2-B

Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level
SC-2-1-1	1+315	56.22	55.70
SC-2-1-2	2+400	56.45	55.88
Escape	2+400	--	
SC-2-1-3	2+430	56.00	55.81

Appendix 1

Table 11. Design Data for Tertiaries of secondary Canal: SC-2, Stage 2-B

Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level
DC-6	0+040	57.49	57.25
T1	0+500	57.42	56.90
T2	0+900	57.36	56.50
T3	1+230	57.29	56.40
T4	2+910	57.01	56.40
T5	3+800	56.86	56.75
T6	4+100	56.80	56.70
T7	4+440	56.74	56.30
DC-7	4+700	56.69	56.45
Road crossing	4+770	--	

Appendix 1

Table 12. Design Data for Tertiaries of secondary Canal: MC-1, Stage 3

Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level
T1	0+700	57.95	57.10
T2	1+500	57.90	57.70
T3	2+300	57.84	57.75
T4	2+950	57.79	57.68
DC-5	3+050	57.79	57.55
T5	3+050	57.79	57.65
Sc-2	4+000	57.72	57.50

Appendix 1

Table 13. Design Data for Tertiaries of secondary Canal: DC-8, Stage 3

Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level	Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level
T1	0+000	58.99	58.75	T10	1+550	58.43	57.65
T2	0+060	58.98	57.90	Drop structure	1+615		
T3	0+600	58.91	58.45	Escappe	2+920		
T4	0+760	58.77	57.70	DC-8-2	3+000	57.70	57.30
T5	0+650	58.89	58.45	Road crossing	3+000		
Road crossing	0+760			DC-8-3	4+450	56.97	56.81
T6	1+150	58.57	57.70				
T7	0+970	58.73	58.15				
T8	1+500	58.47	57.40				
T9	1+300	58.63	57.80				
DC-8-1	1+550	58.43	57.93				

Appendix 1

Table 14. Design Data for Tertiaries of secondary Canal: DC-7, Stage 3

Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level
T1	0+040	56.43	56.00
Drop structure	0+060		
T2	0+450	56.12	55.55
T3	0+740	56.03	55.70
Drop structure	0+750		
Escape structure	1+000		
T4	1+040	55.14	54.85
T5	1+040	55.14	54.85

Appendix 1

Table 15. Design Data for Tertiaries of secondary Canal: DC-6, Stage 3

Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level
T1	0+015	57.25	56.70
T2	0+340	57.15	56.10
Drop structure	0+340		
T3	0+600	56.04	55.65
T4	0+900	55.92	55.25
Drop sturcture	0+900		
T6	1+500	55.17	54.85
Escape structure	1+800		
T7	1+820	55.13	54.65

Appendix 1

Table 16. Design Data for Tertiaries of secondary Canal: DC-5, Stage 3

Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level
T1	0+360	57.41	57.05
Drop structure	0+360		
T2	0+670	56.59	56.30
Drop structure	0+670		
T3	1+000	55.77	55.55
T4	1+300	55.70	55.40
Drop structure	1+300		
T5	1+550	55.06	54.90
T6	1+900	55.00	54.60
T7	2+200	54.95	54.60
Escape structure	2+450		
T8	2+490	54.91	54.45

Appendix 1

Table 17. Design Data for Tertiaries of secondary Canal: MC-2, Stage 3

Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level	Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level
DC-8	3+260	59.77	59.00	T8	10+200	55.51	54.80
BC-1	6+380	59.55	59.30	T9	10+600	55.48	54.75
T1	6+380	5.9.55		T10	10+910	55.45	54.55
Fall structure	6+380			T11	11+200	55.41	54.50
T2	7+200	57.62	57.45	T12	11+600	55.38	54.40
DC-2	7+500	57.59	57.00	T13	11+960	55.34	54.10
T3	7+750	57.55	57.15	Road crossing	11+960		
T4	7+750	57.55	57.00	Escape structure	12+300		
Fall structure	7+810			T14	12+660	55.10	54.05
Drain crossing	8+800			BC-4	12+660	55.10	54.85
Road crossing	8+860			BC-3	12+660	55.10	55.00
T5	8+900	55.65	55.55				
T6	9+600	55.58	55.30				
T7	9+920	55.54	54.95				

Appendix 1

Table 18. Design Data for Tertiaries of secondary Canal: DC-1, Stage 3

Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level
T1	2+150	52.50	52.20
Escape structure	2+600		
T2	2+950	52.26	52.00
Road crossing	2+950		
Escape crossing	3+350		
T3	3+725	51.93	51.50
T4	3+725	51.93	51.75

Appendix 1

Table 19. Design Data for Tertiaries of secondary Canal: BC-2, Stage 3

Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level
Drain crossing	1+500		
DC-1	1+500	53.54	53.15
T1	1+500	53.54	53.40
Road crossing	1+500		
T2	2+300	53.31	53.00
Escape structure	2+600		
T3	2+630	53.06	52.65
Drop structure	2+630		
T4	2+950	52.16	52.05
Escape structure	3+250		
T5	3+275	52.06	51.70

Appendix 1

Table 20. Design Data for Tertiaries of secondary Canal: BC-1, Stage 3

Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level	Name of tertiary or structure	Chainage KM	Up stream water level	Down stream water level
T1	0+020	59.30	57.65	Drain crossing	3+510		
T2	0+620	59.20	57.85	DC-2	3+510	58.59	57.95
T3	1+250	59.11	57.55	DC-3	3+510	58.59	58.45
T4	1+765	59.02	57.60	T7	3+510	58.59	57.70
Road crossing	1+765						
T5	2+050	58.92	58.20				
T6	2+350	58.87	58.50				
DC-1	2+350	58.87	58.75				
Road crossing	2+365						
Escape structure	3+450						

Appendix 2

Table 1. Monthly mean wind speeds at Baghdad Airport as percentages of occurance within specified ranges (observation period 1945-1975)

Local time	0.00 hrs.			3.00 hrs.			6.00 hrs.			9.00 hrs.			12.00 hrs.			15.00 hrs.			18.00 hrs.			21.00 hrs.			Mean		
wind speed m/sec.	calm	1-5	>5	calm	1-5	>5	calm	1-5	>5	calm	1-5	>5	calm	1-5	>5	calm	1-5	>5	calm	1-5	>5	calm	1-5	>5	calm	1-5	>5
January	21	68	11	15	72	13	6	66	28	3	59	28	15	74	12	22	65	11	26	61	13	24	65	11	17	66	16
Febraury	18	69	13	13	68	20	5	59	36	3	44	37	12	73	16	18	71	11	22	64	16	19	66	13	14	62	20
March	15	71	14	8	69	23	2	58	40	2	60	38	5	73	23	17	68	14	19	64	17	15	69	15	11	67	23
April	16	71	14	7	72	21	2	62	36	2	63	36	5	69	26	20	66	14	19	66	15	19	65	16	11	67	22
May	16	74	9	6	73	21	2	59	39	2	59	38	5	66	29	19	69	12	17	67	16	16	56	15	11	65	22
June	12	73	14	4	59	37	2	48	51	1	44	55	5	54	41	22	68	10	20	65	15	14	68	18	10	60	30
July	10	69	21	2	47	50	2	38	60	1	37	61	5	58	37	19	67	13	20	61	19	13	64	20	9	55	35
August	13	74	14	4	57	39	2	52	47	2	42	56	9	63	29	22	70	9	23	63	14	13	68	15	11	61	28
September	20	67	9	9	69	22	4	61	33	3	53	43	19	68	12	28	66	7	28	62	10	17	69	13	16	64	19
October	21	72	7	13	74	13	5	71	24	4	66	28	28	66	6	28	65	7	29	63	8	19	71	9	19	68	13
November	25	69	7	18	81	7	6	71	22	6	75	19	26	67	7	28	65	8	31	61	7	26	67	6	21	69	10
December	23	69	8	16	75	9	6	68	26	4	73	24	22	70	9	25	67	8	29	62	9	25	68	8	19	69	13
Mean	18	69	12	10	68	23	4	59	37	3	56	39	13	67	21	22	67	10	24	63	13	18	66	13	14	64	21

Appendix 2

Table 2. Monthly mean wind directions at Baghdad Airport as percentages of occurance (observation period 1961-1970)

Month	N	N-E	E	S-E	S	S-W	W	N-W	Calm
January	5.7	3.0	6.1	19.0	4.2	5.5	10.0	23.7	23.1
Febraury	9.3	4.3	6.2	19.7	5.0	3.2	7.9	24.5	20.0
March	11.5	5.1	5.0	16.7	4.9	3.3	10.7	28.2	14.6
April	13.2	7.1	7.1	15.3	6.0	3.4	9.3	23.8	14.8
May	17.7	5.9	5.0	9.3	4.7	3.2	10.5	32.7	11.0
June	16.0	2.1	0.70	1.6	0.8	1.8	15.9	50.0	11.2
July	9.4	1.0	0.20	1.2	1.4	2.2	19.7	56.1	8.8
August	12.5	1.9	1.2	0.80	1.4	1.9	19.0	49.7	11.7
September	17.4	3.1	1.2	2.0	0.5	3.1	11.3	41.3	19.2
October	17.1	6.7	5.5	7.4	1.5	2.9	9.4	29.0	20.6
November	8.8	4.1	5.4	10.5	2.4	1.8	7.4	32.8	26.8
December	5.8	2.5	4.6	16.5	4.3	3.2	9.0	29.2	24.9
Year	12.0	3.9	4.0	10.0	3.2	3.0	11.7	35.1	17.2

Appendix 3

Table 1. Actual 40 years daily normal maximum and minimum temperature in Centigrades, at Baghdad, period 1938-1977

First quarter of the year

Days	January		February		March	
	Max.	Min.	Max.	Min.	Max.	Min.
1.	17.0	4.6	16.9	4.5	19.2	5.9
2.	16.7	5.3	16.4	4.3	19.7	6.7
3.	16.7	4.3	16.1	4.9	20.8	7.6
4.	15.8	4.1	16.6	4.5	21.3	8.2
5.	15.0	4.5	17.2	4.7	21.3	9.2
6.	15.3	4.0	17.0	4.7	20.7	8.9
7.	15.6	4.4	17.9	5.5	21.3	8.3
8.	15.6	4.4	18.0	5.8	20.9	7.8
9.	15.5	4.5	16.8	5.3	21.7	7.5
1o.	15.4	3.9	17.2	4.9	22.7	9.1
11.	15.1	3.4	17.3	4.5	21.7	9.5
12.	15.3	3.1	18.0	4.6	21.6	9.7
13.	15.2	3.8	19.1	6.3	21.3	8.9
14.	15.7	4.0	19.6	5.7	21.4	7.8
15.	15.7	3.9	19.7	6.4	22.2	8.8
16.	16.2	3.8	19.7	6.6	22.4	8.9
17.	16.4	4.3	19.5	7.0	22.1	8.8
18.	16.4	4.1	19.0	6.7	22.7	9.0
19.	16.0	4.6	20.0	6.4	22.9	9.7
2o.	16.5	4.0	20.1	6.7	23.0	9.6
21.	16.3	4.4	20.0	7.1	23.7	10.0
22.	16.8	4.2	19.9	7.5	23.6	11.3
23.	16.8	3.6	19.8	7.0	23.2	10.6
24.	16.3	3.6	20.1	7.1	22.7	10.2
25.	16.7	4.4	19.5	6.8	23.6	9.9
26.	16.0	4.0	19.6	7.2	24.1	10.5
27.	15.7	3.8	19.3	7.9	23.5	10.6
28.	17.0	4.5	19.0	6.6	24.0	10.3
29.	17.1	4.7	20.0	8.3	24.1	11.1
30.	17.2	4.7			24.3	11.3
31.	16.1	9.2			25.0	10.4
Mean:	16.1	4.2	18.6	6.1	22.3	9.2

Appendix 3

Table 1. (Continued)

Second quarter of the year

Days	April		May		June	
	Max.	Min.	Max.	Min.	Max.	Min.
1.	25.4	10.9	32.4	17.7	39.2	22.2
2.	26.4	11.4	32.7	17.3	39.4	22.9
3.	26.6	12.2	32.6	17.9	40.0	23.9
4.	26.4	12.6	33.0	17.5	40.5	23.4
5.	26.5	12.6	32.9	18.0	40.0	23.1
6.	26.5	13.1	33.4	18.6	39.8	23.2
7.	27.0	13.9	32.3	18.7	40.5	22.6
8.	27.5	14.3	32.6	17.5	39.8	23.0
9.	27.3	14.0	32.5	17.2	39.6	23.1
10.	27.4	13.5	33.4	17.3	39.9	22.7
11.	27.0	13.3	34.4	18.3	40.3	23.4
12.	27.2	13.9	34.6	19.7	40.8	23.7
13.	27.8	13.3	34.8	19.1	40.9	23.0
14.	28.0	13.5	35.4	19.6	40.7	23.0
15.	28.3	13.3	36.0	20.3	40.8	23.5
16.	28.8	14.4	35.7	19.8	41.0	23.1
17.	29.6	15.6	36.0	20.0	41.2	23.7
18.	29.1	15.3	36.1	20.1	41.3	23.5
19.	29.2	15.2	37.2	20.3	41.1	24.1
20.	29.2	15.4	37.4	20.8	41.1	23.4
21.	30.0	15.3	37.4	21.0	41.4	23.3
22.	30.1	15.3	38.0	21.3	41.7	23.9
23.	30.8	15.9	38.5	22.3	41.5	24.2
24.	31.8	16.3	38.8	22.0	41.6	23.7
25.	32.1	16.8	38.2	21.5	42.1	24.3
26.	32.2	17.7	38.4	21.4	42.0	23.8
27.	32.3	17.3	37.7	21.4	42.3	23.9
28.	32.9	17.5	38.2	21.7	42.4	24.3
29.	31.8	17.3	38.5	22.0	42.1	24.8
30.	32.4	17.0	38.8	21.9	42.2	24.6
31.			38.9	22.0		
Mean:	28.9	14.6	35.7	19.8	40.9	23.5

Appendix 3

Table 1. (Continued)

Third quarter of the year

Days	July		August		September	
	Max.	Min.	Max.	Min.	Max.	Min.
1.	42.8	24.2	43.2	25.6	42.2	23.2
2.	42.8	25.1	43.5	24.8	42.0	23.4
3.	42.6	25.4	43.7	25.5	41.6	23.2
4.	42.4	25.6	43.8	25.5	41.6	23.1
5.	42.3	24.1	43.6	25.6	41.6	23.5
6.	42.4	24.6	43.7	26.1	41.5	22.7
7.	42.2	24.5	43.5	25.4	41.8	22.5
8.	42.6	24 [illegible]	43.8	24.8	41.3	22.2
9.	42.8	24.[illegible]	43.7	25.0	40.9	22.5
1o.	42.6	25.2	43.7	25.0	40.5	22.3
11.	42.8	24.6	43.8	25.1	40.3	21.0
12.	42.8	25.5	43.6	25.0	40.4	21.3
13.	43.1	24.9	43.7	24.8	40.5	22.1
14.	43.0	25.0	43.8	24.5	40.1	22.2
15.	43.5	24.9	43.6	25.3	40.2	21.7
16.	43.5	25.9	44.1	24.7	39.7	21.0
17.	43.9	25.2	44.1	25.1	39.1	20.4
18.	44.2	25.5	44.1	24.9	39.1	20.1
19.	44.4	25.3	43.9	25.1	38.7	19.7
20.	44.3	25.4	43.4	25.0	39.2	20.0
21.	44.3	25.7	43.8	24.3	39.1	19.9
22.	44.2	25.9	43.8	24.7	39.0	19.8
23.	44.1	26.0	43.3	24.3	38.9	19.4
24.	44.1	25.8	43.1	24.1	38.4	19.6
25.	44.2	26.1	42.8	24.3	38.3	19.3
26.	44.3	26.1	42.6	24.0	37.7	19.6
27.	44.1	26.1	42.4	23.1	37.7	18.8
28.	44.3	26.3	42.8	23.1	37.4	19.0
29.	44.2	25.9	43.0	23.6	37.2	18.6
3o.	44.5	25.2	43.1	24.2	37.0	19.3
31.	44.3	25.7	42.5	24.6		
Mean:	43.5	25.3	43.5	24.7	39.7	21.0

Appendix 3

Table 1. (Continued)

Fourth quarter of the year

Days	October		November		December	
	Max.	Min.	Max.	Min.	Max.	Min.
1.	36.9	18.5	29.6	12.7	19.7	6.6
2.	36.6	18.1	29.5	13.6	19.7	5.7
3.	36.1	18.0	28.5	13.9	19.5	5.7
4.	36.1	17.7	28.7	13.0	19.0	5.9
5.	35.9	17.6	29.0	13.4	19.0	6.7
6.	35.7	17.3	28.0	14.6	19.4	6.2
7.	34.8	17.0	26.9	13.8	19.4	7.2
8.	35.1	17.1	26.7	12.5	19.2	6.6
9.	35.2	16.8	26.3	12.5	19.1	6.3
1o.	35.0	17.0	26.6	12.0	18.4	5.9
11.	34.3	17.2	25.9	12.0	18.1	5.7
12.	34.5	16.7	25.0	11.4	17.6	4.9
13.	34.0	16.8	25.4	10.7	18.1	4.6
14.	33.7	16.3	25.3	10.3	17.5	5.9
15.	33.6	16.6	24.3	10.2	17.9	4.7
16.	33.2	16.9	24.8	9.8	17.8	5.0
17.	33.6	16.5	24.0	10.3	17.7	5.2
18.	33.2	16.6	23.8	10.3	17.3	5.1
19.	33.2	16.8	23.2	9.5	17.4	5.3
2o.	33.4	16.2	22.5	9.2	16.9	5.3
21.	32.8	16.6	22.1	8.3	17.0	4.8
22.	31.4	16.3	21.9	8.2	16.5	4.9
23.	30.2	15.2	21.7	7.2	16.0	4.3
24.	30.8	14.4	21.5	7.3	16.0	4.3
25.	30.4	14.4	21.2	7.3	15.8	4.2
26.	30.3	14.3	21.3	8.0	16.3	4.0
27.	30.8	14.3	20.4	7.2	16.5	4.0
28.	30.8	14.4	19.9	6.6	16.6	4.5
29.	30.0	13.2	20.2	7.3	16.2	5.0
3o.	29.7	13.3	20.2	6.7	16.3	5.5
31.	29.8	13.4			16.3	5.1
Mean:	33.3	16.2	24.5	10.3	17.7	5.1

Appendix 3

Table 2

a- Monthly and annual means of rainfall /mm/ for the required area

	Jan.	Febr.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	year
Baghdad	21.2	25.6	23.8	22.0	8.6	0.1	0.0	0.0	0.3	3.4	16.8	23.8	147.6

b- mean monthly evaporation in /mm/ for 1965-1969 at Baghdad

	Jan.	Febr.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Baghdad	2.3	3.5	5.3	7.3	11.1	14.3	16.7	14.6	10.1	6.5	3.4	2.9

c- Mean relative humidity for the meteorological station of Baghdad

	Jan.	Febr.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Baghdad	72	62	53	45	32	23	23	24	28	37	57	72

Appendix 3

Table 3. Mean number of days per month of cases of clear and cloudy skies means taken for last decades of years Baghdad/Central Station

October		November		December		January		February		March		April		May	
Clear	Cloudy	Clear	Cloudy	Clear	Cloudy	Clear	Cloudy	Clear	Cloudy	Clear	Cloudy	Clear	Cloudy	Clear	Cloudy
14.9	0.9	10.8	3.0	11.5	2.4	6.8	3.8	6.7	2.5	8.2	2.7	6.0	2.5	13.2	2.8

Appendix 3

Table 4. Monthly total sunshine hours at Baghdad taken from 20 years period data 1958-1977

Latitude: 33^{o} 20′′ N.   Longitude: 44^{o} 24′ E. Height above mean sea level: 34.1 meters

YEARS	JAN.	FEBR.	MARCH.	APR.	MAY	JUNE	JULY	AUG.	SEP.	OCT.	NOV.	DEC.
1958.	163.1	267.0	274.1	293.9	299.4	365.0	371.0	377.2	329.5	308.8	200.6	190.6
1959.	224.8	206,7	250.7	269.6	316.8	326.8	270.5	337.4	325.5	392.1	251.4	218.4
1960.	240.4	242.4	241.4	205,3	291.5	311.3	297.8	345.8	314.6	315.5	226.0	229.0
1961.	178.4	206.8	263.5	261.4	281.3	283.0	302.9	335.6	313.2	294.6	196.6	199.0
1962.	189.2	186.7	250.0	281.7	359.8	384.6	394.4	352.4	324.8	280.2	233.6	158.4
1963.	174.3	182.7	266.1	200.5	261.8	381.6	402.6	378.4	316.0	238.2	240.8	185.0
1964.	217.1	184.6	176.9	245.1	292.6	331.7	327.3	336.3	310.3	301.0	205.0	173.6
1965.	147.7	215.1	228.2	259.6	324.2	360.9	393.6	359.5	305.3	226.7	220.3	104,5
1966.	196.4	184.6	245.6	267.3	303.3	384.3	351.8	358.5	315.3	263.0	216.6	202.5
1967.	226.8	161.7	262.3	278.4	268.9	365.3	364.8	355.4	307.2	206.2	140.1	178.2
Total:	1958.2	2038.3	2458.8	2562.8	2999.6	3474.5	3476.7	3536.5	3161.7	2825.3	2131.0	1939.2
Mean:	195.8	203.8	245.9	256.3	300.0	347.5	347.7	353.7	316.2	282.5	213.1	193.9

Appendix 4. Herd Build up

	Number of milking cows				Heifers and dry cows				Female calves					Male calves			Female calvings			Male calvings		
Year	Year start	Cull	Morta-lity	Year end	Year start	Cull	Morta-lity	Year end	Year start	Cull	Replace-ment	Sell	Year end	Year start	Morta-lity	Sell	Year start	Morta-lity	Sell	Year start	Morta-lity	Year end
1					2,400	24	48	2,328									1,140	114	1,026	1,140	114	1,026
2	2,328	186	45	2,097					1,026	30	309	360	327	1,026	30	996	990	99	891	990	99	891
3	2,097	168	42	1,887	309	3	6	300	1,218	36	366	426	390	891	27	864	1,020	102	918	1,020	102	918
4	2,187	174	42	1,971	366	3	6	357	1,308	39	312	537	420	918	27	891	1,083	108	975	1,083	108	975
5	2,328	186	45	2,097	312	3	6	303	1,395	42	249	657	447	975	30	945	1,122	111	1,011	1,122	111	1,011
6	2,400	186	48	2,160	249	3	6	240	1,458	45	249	699	465	1,011	30	981	1,125	114	1,011	1,125	114	1,011
7	2,400	186	48	2,160	249	3	6	240	1,476	45	249	711	471	1,011	30	981	1,125	114	1,011	1,125	114	1,011

(1) Animals are culled at the rate of 8 per cent of milking cows and 1 per cent of heifers and dry cows annually.

(2) Martalities are estimated at 2 per cent for milking cows, heifers and dry cows, while they are estimated at 3 per cent for calves and 10 per cent among calvings.

(3) Replacement of milking cows by heifers are calculated at 30 per cent for the second year, 35 per cent for the third year, 25 per cent for the fourth year and 18 per cent as of the fifth year.

(4) Heifer sales are calculated at the rate of 35 per cent for the second and third year, 41 per cent for the fourth year and 48 per cent as of the fifth year.

(5) Birth rate is considered 95 per cent, for the first year and 85 per cent after needs.

Appendix 5. Time available for planting and harvesting of the same crop and time availability of the succesive crops

Year	Crop and operation	A 7000	B 7000	C 1500	D 2000	E 500	F 7000
1st	Crop	Small grain	Alfalfa	Corn	Clover	Cotton	Potatoes
	Planting	15.10-10.11 25d(*)	1.10-30.10 30d	1.3-20.3 20d	1.10-30.10 30d	10.3-1.4 20d	15.2-15.3 30d
	Harvesting	1.5 - 1.6 30d		11.7-20.7 20d	15.2 -30.2 15d	1.9-1.10 30d	10.6-30.6 20d
	Time	8m., 15d. (255d.)		2m., 20d. (80d.)	15 days	15 days	3m., 15d. (105d.)
2st	Crop	Potatoes	Alfalfa	Clover	1500 500 Corn + Cotton	Colver	small grain
	Planting	15.2 -15. 3 30d		1.10-30.10 30d	1.3 -20.3 20d	15.10-30.10 15d	15.10-10.11 25d
	Harvesting	10.6 -30.6 20d	Turning off during May	15.2 -30.2 15d	1.7 -20.7 1.10	15.2 -30.2 15d	1.5 - 1.6 30d
	Time	4m., 15d. (135d.)	8m., 15d. (255d.)	15 days	15 days	15 days	5m., (150d.)
3rd	Crop	Small grain	Potatoes	Corn	Clover	Cotton	Alfalfa
	Planting	15.10-10.11 25d	15.2 -15.3 30d	1.3-20.3 20d	1.10-30.10 30d	10.3-1.4 20d	1.10-30.10 30d
	Harvesting	1.5 - 1.6 30d	10.6 -30.6 20d	1.7-20.7 20d	15.2 -30.2 15d	1.9-1.10 30d	
	Time	8m., 15d. (255d.)	4m., 15d. (135d.)	2m., 20d. (80d.)	15 days	15 days	
4th	Crop	Potatoes	Small grain	Clover	1500 500 Corn + Cotton	Clover	Alfalfa
	Planting	15.2 -15. 3 30d	15.10-10.11 25d.	1.10-30.10 30d	1.3 -20.3 20d	15.10-30.10 15d	
	Harvesting	10.6 -30.6 20d	1.5 - 1.6 30d.	15.2 -30.2 15d	1.7 -20.7 1.10	15.2 -30.2 15d	Turning off during May
	Time	3m., (90 days)	30m., (90 days.)	4m., (120 days)	15 days	15 days	4m., 15d. (135d.)
5th	Crop	Alfalfas	Potatoes	Corn	Clover	Cotton	Small grain
	Planting	1.10 -30.10 30d	15.2 -15.3 30d.	15.7 -30.7 15d	1.10-30.10 30d.	10.3 - 1.4 20d	15.10-10.11 25d.
	Harvesting	Turning off during May	10.6 -30.6 20d.	15.11-30.11 15d	15.2 -30.2 15d.	1.9 - 1.10 30d	1.5 - 1.6 30d.

(*) d. = day
(*) m. = month.

Appendix 6. Details of estimating the number of tractor and plowing required for land preparation

Year	Item or notes	7000	7000	1500	2000	500	7000	No. of Tractors and plows needed
1st	Crop	Small grain	Alfalfa	Corn	Clover	Cotton	Potatoes	
	Time available	90 days		120 days	15 days	15 days	135 days	
	Plowing units	1.55		1.70	1.55	1.70	2.70	
	Area as units	7000x1.55 = 10850		1500x1.70 = 2550	2000x1.55 = 3100	500x1.70 = 850	7000x2.70 = 18900	
	Donum per time	29.952x90 = 2696		29.952x120 = 3594	29.952x15 = 449	29.952x15 = 449	29.952x135 = 4044	
	No. of tractors	10850÷2696 = 4.02		2550÷3594 = 0.71	3100÷449 = 6.90	850÷449 = 1.89	18900÷4044 = 4.67	Total 18.19*
	No. of Plows	7000÷2696 = 2.60		1500÷3594 = 0.42	2000÷449 = 4.45	500÷449 = 1.11	7000÷4044 = 1.73	10.31
2nd	Crop	Potatoes	Alfalfa	Clover	1500 500 Corn + Cotton	Colver	small grain	
	Time available	255 days		80 days	15 days	15 days	105 days	
	Plowing units	2.70		1.55	1.70	1.55	1.55	
	Area as units	7000x2.70 = 18900		1500x1.55 = 2325	2000x1.70 = 3400	500x1.55 = 775	7000x1.55 = 10850	
	Donum per time	29.952x255 = 7638		29.952x80 = 2396	29.952x15 = 449	29.952x15 = 449	29.952x105 = 3145	
	No. of tractors	18900÷7638 = 2.47		2325÷2396 = 0.97	3400÷449 = 7.57	775÷449 = 1.73	10850÷3145 = 3.45	Total 16.19*
	No. of Plows	7000÷7638 = 0.91		1500÷2396 = 0.63	2000÷449 = 4.45	500÷449 = 1.11	7000÷3145 = 2.23	9.33
3rd	Crop	Small grain	Potatoes	Corn	Clover	Cotton	Alfalfa	
	Time available	135 days	255 days	15 days	15 days	15 days		
	Plowing units	1.55	2.70	1.70	1.55	1.70		
	Area as units	7000x1.55 = 10850	7000x2.70 = 18900	1500x1.70 = 2550	2000x1.55 = 3100	500x1.70 = 850		
	Donum per time	29.952x135 = 4044	29.952x255 = 7638	29.952x15 = 449	29.95x15 = 449	29.952x15 = 449		
	No. of tractors	10850÷4044 = 2.68	18900÷7638 = 2.47	2550÷449 = 5.68	3100÷449 = 6.90	850÷449 = 1.89		Total 19.62
	No. of Plows	7000÷4044 = 1.73	7000÷7638 = 0.91	1500÷449 = 3.34	2000÷449 = 4.45	500÷449 = 1.11		11.45
4th	Crop	Potatoes	Small grain	Clover	Corn + Cotton	Clover	Alfalfa	
	Time available	255 days	135 days	80 days	15 days	15 days		
	Plowing units	2.70	1.55	1.55	1.70	1.55		
	Area as units	7000x2.70 = 18900	7000x1.55 = 10850	1500x1.55 = 2325	2000x1.70 = 3400	500x1.55 = 775		
	Donum per time	29.952x255 = 7638	29.952x135 = 4044	29.952x80 = 2396	29.952x15 = 449	29.952x15 = 449		
	No. of tractors	18900÷7638 = 2.47	10850÷4044 = 2.68	2225÷2396 = 0.93	3400÷449 = 7.57	775÷449 = 1.73		Total 15.38
	No. of Plows	7000÷7638 = 0.91	7000÷4044 = 1.73	1500÷2396 = 0.63	2000÷449 = 4.45	500÷449 = 1.11		8.83

(*) The optimum number of tractors needed is 20 tractors which is adequate for the 3rd year, where as the excess of the number over the remaining years will be as stand by.

The optimum number of plows needed is 12 plows. These plows are enough even for plowing alfalfa area because during preparation of alfalfa area, the number of plows needed for other crops is less than this number.

Appendix 7. Annual cost of using Farm Machinery

Sr. No.	Items and Description	Price per Unit I.D.	Depreciation Life Yr.*	Depreciation ID.	Interest on Capital = Price/2 x 0.05 I.D.	Housing= 0.01 of initial cost I.D.	Insurance (Third Party) and Tax I.D.	Repair and Maintenance Yearly % of initial	Repair and Maintenance I.D.	Fuel Consumption **	Labour based on I.D.120 Monthly I.D.	Total Cost per Unit	No. of Machs. Req.	Total Annual Cost
1	Wheel tractor 70-80 H.P.	4500	10	450.00	112.50	45.0	112.50	10.0	450.00	1050	1440	3660.00	55	201300.00
2	Mold-board Plow	750	15	50.00	18.75			12.0	90.00			158.75	14	2222.50
3	Disc Harrow	900	15	60.00	22.50			11.0	99.00			181.50	4	726.00
4	Ridger/dicher set	1950	15	130.00	48.75			7.5	146.25			325.00	3	975.00
5	Three-row ridger	450	15	30.00	11.25			12.0	54.00			95.25	3	285.75
6	Cultivator	1125	12	39.75	28.15			9.5	106.90			174.80	6	1048.80
7	Seed drill	5250	20	262.50	131.25	52.5		5.0	218.75			665.00	7	4655.00
8	Row crop planter	1500	15	100.00	37.50	15.0		5.6	84.00			236.50	2	473.00
9	Cotton picker with tractor	15000	10	1500.00	375.00	150.0		6.5	975.00			3000.00	1	3000.00
10	Potato planter	1800	12	150.00	45.00	18.0		5.6	100.80			313.80	6	1882.80
11	Potato harvestor	750	12	62.50	18.75	7.5		6.5	48.75			137.50	15	2062.50
12	Combine harvestor	18750	10	1875.00	468.75	187.5		5.4	1012.50	500		4043.75	4	16175.00
13	Corn harvestor	4500	10	450.00	112.50	45.0		6.5	292.50			900.00	4	3600.00
14	Sprayer	1125	12	93.75	28.15			5.6	63.00			184.90	5	924.50
15	Mower/conditioner	1125	10	112.50	28.50			10.0	112.50			253.50	3	760.50
16	Square baler	3000	10	300.00	75.00			7.8	234.00			609.00	4	2436.00
17	Pick-up elevator	1125	12	93.75	28.15			5.6	63.00			184.90	4	739.60
18	Chopper	1500	10	150.00	31.25			5.8	87.00			268.25	6	1609.50
19	Wagon	1950	15	130.00	48.75			6.0	117.00			295.75	15	4436.25
20	Feeding wagon	2250	15	150.00	56.25			6.0	135.00			341.25	6	2047.50
21	Tractor + lodder + scraper	6750	10	675.00	168.75		112.50	10.0	675.00		1440	3071.25	2	6142.50
22	Manure spreader	2250	12	187.50	56.25	22.5		6.5	146.25			412.50	3	1237.50
23	Fer. distributor (Spinner)	750	15	50.00	18.75			5.0	37.50			106.25	3	318.75
24	Sub soiler	15600	10	1560.00	390.00			10.0	1560.00	1500	1440	6450.00	2	12900.00
25	Multi purpose elevator	1125	12	93.75	28.15			7.5	84.50			206.40	3	619.20
26	Land leveller	1125	15	75.00	28.15			12.0	135.00			238.15	3	714.45
27	Truck	30000	10	3000.00	750.00		750.00	10.0	3000.00	1000	1440	9940.00	2	19880.00
TOTAL														**293,352.60**

* Based on Agricultural Engineers Yearbook, 1963.

** Furel consumption = 0.25 liter per hr. per each draw-bar horse power; the draw-bar horse power = 75 per cent of the maximum, so the tractors rated 75 H.P. produces 56 draw-bar horse power. The price of diesel fuel is 50 fils/liter. The average usage of tractors is 1500 hr./yr.

Appendix 8. Depreciation of Fixed Assets

		0	1	2	3	4 and one
50	Existing assets1/	368,248	368,248	368,248	368,248	368,248
50	Improving irrigation1/		9,000	9,000	9,000	9,000
10	Farm machinery2/		75,926	75,926	75,926	75,926
30	Livest buildings3/		227,526	227,526	227,526	227,526
15	Assets for livest4/			196,500	196,500	196,500
50	Drainage system1/				58,654	58,654
	Total	368,284	680,500	877,000	935,654	935,654

1/ At 2 per cent
2/ At 10 per cent
3/ At 3.3 per cent
4/ At 6.7 per cent.

Appendix 9. Expected revenues from the project

Year	Item	Production Unit	Production Amount	Value (ID)
2	Potatoes	ton	42,000	10,500,000
	Cotton	ton	188	187,000
	Barley	ton	1,575	267,750
	Alfalfa	ton	23,265	738,500
	Corn	ton	562	196,870
	Clover	ton	6,000	72,000
	Total			11,462,620
3	Potatoes	ton	47,600	11,900,000
	Cotton	ton	212	212,500
	Heifers	head	360	270,000
	Calves	head	996	896,400
	Culled cows	head	171	171,000
	Milk	ton	9,312	2,328,000
	Honey	ton	24	117,700
	Manure	ton	15,000	150,000
	Total			16,045,600
4	Potatoes	ton	56,000	14,000,000
	Cotton	ton	250	250,000
	Heifers	head	426	319,500
	Calves	head	864	777,600
	Culled cows	head	177	177,000
	Milk	ton	9,227	2,306,750
	Honey	ton	40	200,000
	Manure	ton	16,118	161,180
	Total			18,192,030
5	Potatoes	ton	56,000	14,000,000
	Cotton	ton	250	250,000
	Heifers	head	573	402,750
	Calves	head	891	801,900
	Culled cows	head	189	189,000
	Milk	ton	10,258	2,564,500
	Honey	ton	40	200,000
	Manure	ton	17,479	174,790
	Total			18,582,940
6	Potatoes	ton	56,000	14,000,000
	Cotton	ton	250	250,000
	Heifers	head	657	492,750
	Calves	head	945	850,500
	Culled cows	head	195	195,000
	Milk	ton	10,778	2,694,500
	Honey	ton	40	200,000
	Manure	ton	18,623	186,230
	Total			18,868,980

continued /...

Appendix 9. (Continued)

Year	Item	Production		Value (ID)
		Unit	Amount	
7	Potatoes	ton	56,000	14,000,000
	Cotton	ton	250	250,000
	Heifers	head	699	524,250
	Calves	head	981	882,900
	Culled cows	head	195	195,000
	Milk	ton	11,146	2,786,500
	Honey	ton	40	200,000
	Manure		19,712	197,120
	Total			19,035,770
8	Potatoes	ton	56,000	14,000,000
	Cotton	ton	250	250,000
	Heifers	head	710	532,500
	Calves	head	981	882,900
	Culled cows	head	195	195,000
	Milk	ton	11,217	2,804,250
	Honey	ton	40	200,000
	Manure	ton	19,899	
	Total			19,063,640
9	Potatoes	ton	56,000	14,000,000
	Cotton	ton	250	250,000
	Heifers	head	710	532,500
	Calves	head	981	982,900
	Culled cows	head	195	195,000
	Milk	ton	11,241	2,810,250
	Honey	ton	40	200,000
	Manure	ton	19,899	198,990
	Total			19,069,640

Appendix 10. Feed requirements for livestock enterprise

A. Concentrates

Animal	Number (head)	Daily requirements(Kg)	Number of days	Toral (ton) requirements
Milking cows	2,400	5	365	4,380
Dry cows	250	3	365	274
Heifers	1,452	2.5	365	1,325
Small calves	2,136	2	295	1,260
Fattened calves	996	3	365	1,091
Total	-	-	-	8,330

B. Green Fodder

Animal	Number (head)	Daily requirements(Kg)	Number of days	Total (ton) requirements
Milking cows	2,400	45	365	39,420
Dry cows	250	45	365	4,106
Heifers	1,452	35	365	18,549
Small calves	2,136	25	295	15,753
Fattened calves	996	30	365	10.906
Total	-	-	-	88,933

Appendix 11. Loan utilization and servicing

Table 1. The first loan

Year	Loan	Interest	Repayment
1	10,000,000	600,000	-
2	-	480,000	2,000,000
3	-	360,000	2,000,000
4	-	240,000	2,000,000
5	-	120,000	2,000,000
6	-	-	2,000,000

Table 2. The second loan

Year	Loan	Interest	Repayment
2	5,000,000	360,000	-
3	-	288,000	1,200,000
4	-	216,000	1,200,000
5	-	144,000	1,200,000
6	-	72,000	1,200,000
7	-	-	1,200,000