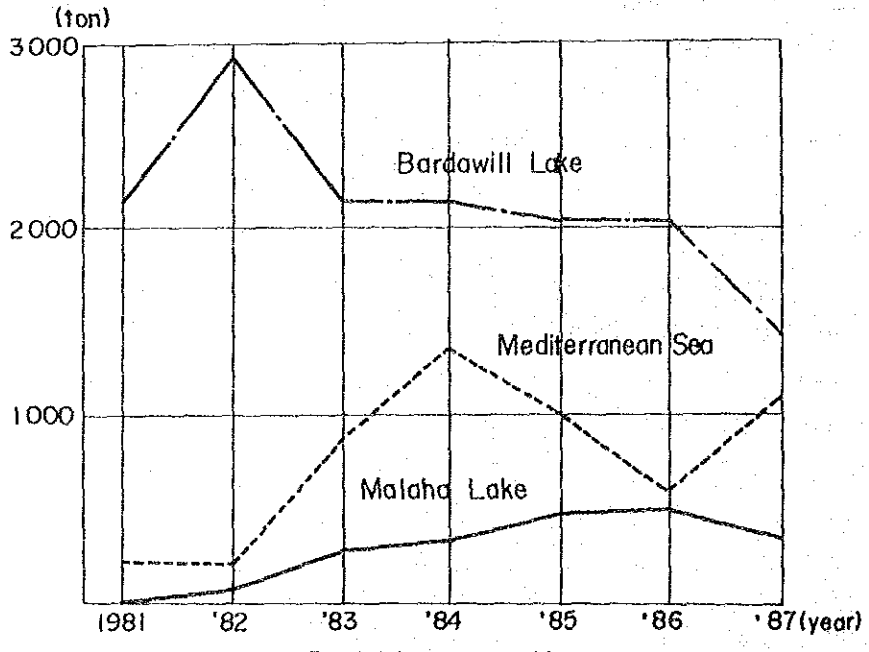
2.6. Fisheries

Inland fishery is performed in the Bardawil and Malaha Lakes, and marine fishery is conducted in the coastal areas of the Mediterranean Sea (Figure 2.6-1).

The Bardawil Lake and the Malaha Lake are hypersaline shallow water bodies and maintain fishery productivity by an exchange of seawater between the lakes and the Mediterranean Sea through man-made openings. Therefore, management of the lakes including the maintenance of the openings is indispensable to continue fishery production. Some of the catch from the Bardawil Lake has been exported to European markets. Producing fish for foreign markets characterizes the fishery in the lake.

Marine fishery is conducted by fishermen of El Arish on a small scale. The fishing grounds are limited in the coastal areas to a depth of 50 m because of the old and undeveloped fishing boats and equipment.

Figure 2.6-1. Fishery Production in the Study Area



Source : Bardawil Lake Management Office, Tulul Port Said Governorate.
El Arish Branch Office, GAFRD.

2.6.1. Fishery in the Bardawil Lake

1) Fishery Resources

There are important fishery resources in the lake such as seabream, mullet, and seabass. The exchange of seawater through the openings brings fish fry into the lake where they grow and migrate back to the open sea after maturing a sufficient size for reproduction (Figure 2.6-2). Approximately 2,800 fishermen around the lake and from El Arish are engaged in fishing in the lake with about 940 small-scale wooden boats (Table 2.6-1). Annual catch in recent years is approximately 1,500 - 2,000 tons, according to the official statistics. In addition, there are some quantities consumed by the fishermen and their families as well as those landed illegally, which do not appear on the official statistics. Accordingly, the total catch would be estimated about 2,000 - 3,000 tons annually (Figure 2.6-3).

Main species in the lake are gilthead seabream (SPARUS AURATUS), gray mullet (MUGIL CEPHALUS, MUGIL CAPITO and MUGIL AURATUS), seabass (DICENTRARCUS LABRAX and DICENTRARCUS PUNCTATUS), common sole (SOLEA VULGARIS) and croaker (ARGYROSOMUS REGIUS). The assortment catch for these fish are 55 to 70 percent (seabream), 20 to 30 percent (mullet) and 15 to 25 percent (other fish).

The fishing methods practiced in the lake are gill net fishing, veranda net fishing and purse seine net fishing. Approximately 80 percent of the licensed boats in the lake are operated by these methods of fishing. The boats used in the gill net fishing are about 6 m long and driven by outboard engines of 6 to 20 HP with two fishermen. There are about 30 boats engaged in purse seine net fishing. These boats are 10 to 13 m long and driven by inboard engines of 100 to 150 HP with 10 to 12 crew members on board. GAFRD are attempting to convert these large-scale fishing boats to the fishing grounds in the Mediterranean Sea for fear of depletion of the fishery resources in the lake due to their large fishing capacity.

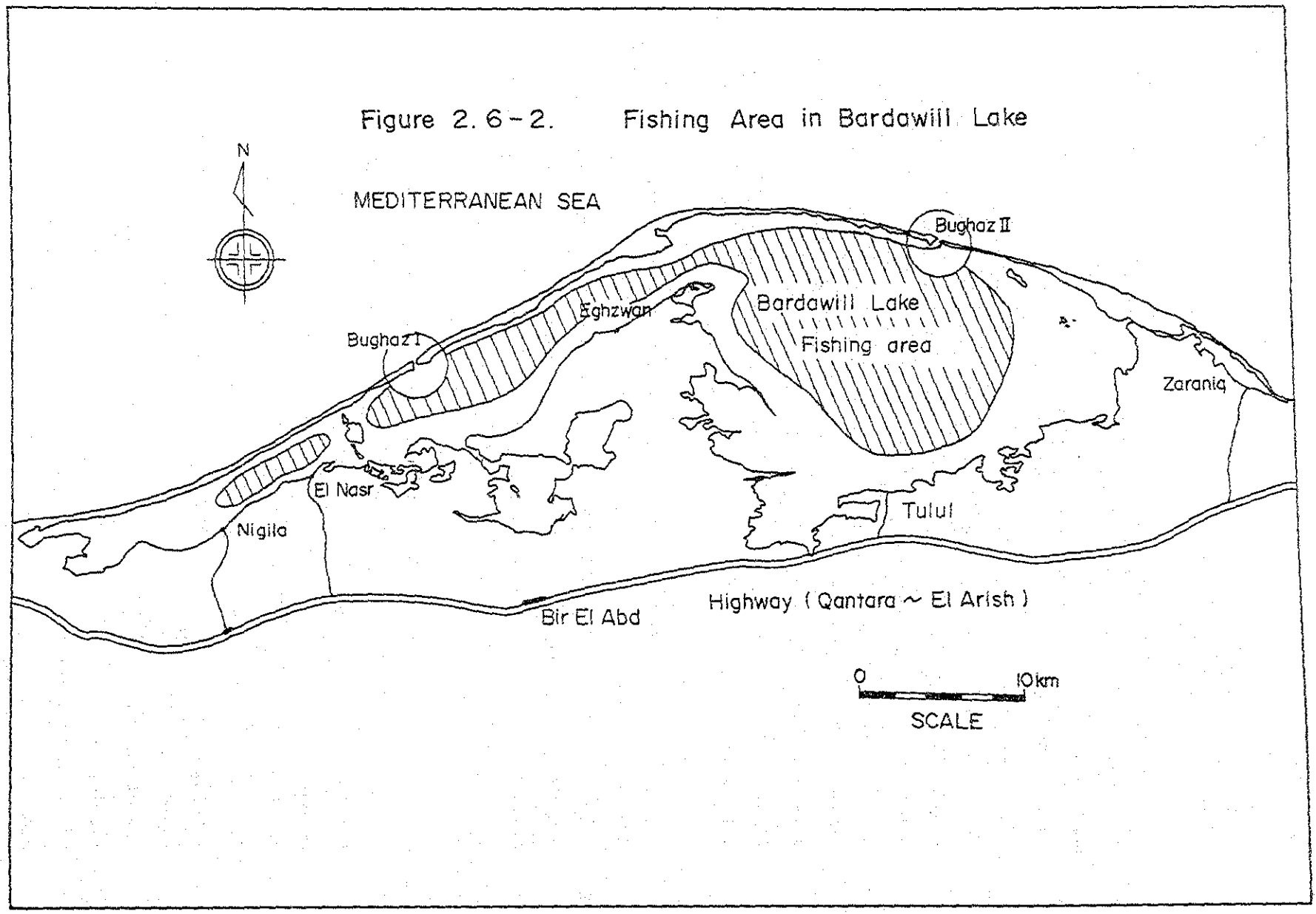
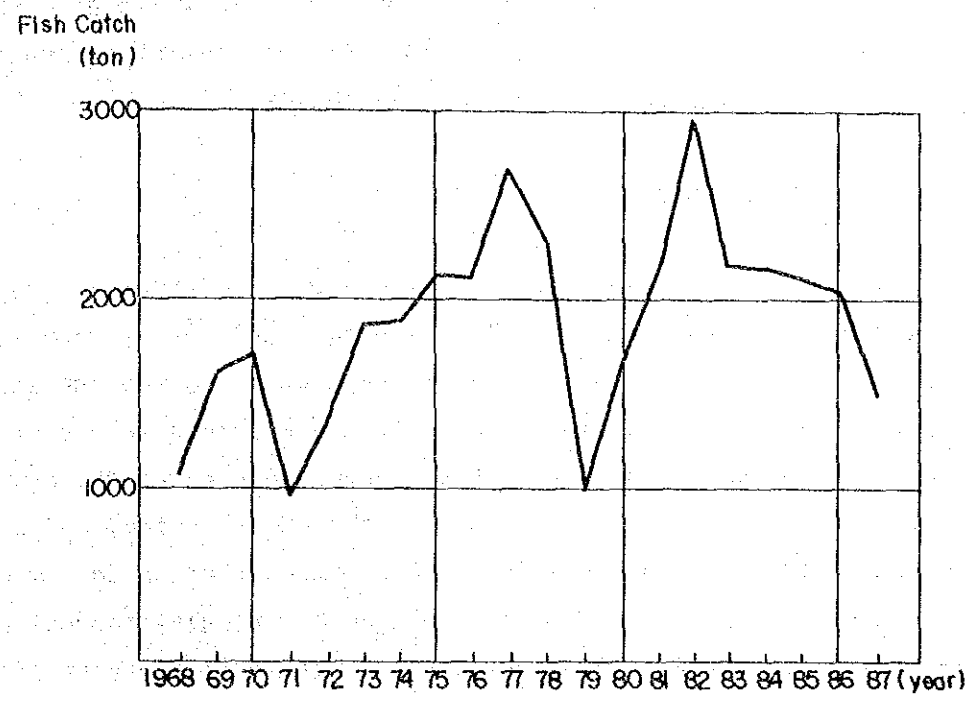


Figure 2.6-2. Fishing Area in Bardawill Lake
N
MEDITERRANEAN SEA
Bughaz II
Bughaz I
Eghzwan
Bardawill Lake
Fishing area
Zaraniq
El Nasr
Nigila
Tulul
Bir El Abd
Highway (Qantara ~ El Arish)
0
10km
SCALE

Figure 2.6-3. Fish Production in the Bardawil Lake



Source: GAFRD, Cairo, Bardawil Lake Management Office Tulul,

Table 2.6-1. Number of Fishermen and Fishing Boats Working in Bardawil Lake

Year	No. of Fishermen	No. of Fishing Boats
1985	-	863 boats
1986	-	931 "
1987	2,811 persons	939 "

(Source: GAFRD, Bardawil Lake Management Office in Tulul)

Based on the policy for preservation of the fishery resources in the lake, fishing is allowed only from early April to the end of December. The rest of the year is closed for fishing. Also the lake area within 2 km from the openings as well as within 500 m from the shoreline are prohibited areas for fishing.

2) Management of the Lake and Fishery

Fishery in the lake is under the control of GAFRD and its field office, Bardawil Lake Management Office has been established at Tulul. It is carrying out various management works for the lake and fishery activities. The maintenance of two openings is one of the important jobs of the office. It conducts dredging at the openings with its own dredger, (a 15-ton boat with 480 HP engine, and a dredging capacity of approximately 100 cu.m/hour at up to 6 m deep) every summer. In addition to the continuous dredging conducted by the office, large-scale dredging work is necessary every several years, which consumes a large amount of budget. The most recent large-scale dredging work was conducted for six months and spent 7 million LE in 1986.

3) Fish Landing Ports and Marketing

Landing ports are currently opened at El Zaraniq, Tulul, Eghzwan, El Nasr, and Nigila. The catches are landed, sorted, weighed and sold to local wholesalers and exporters at the landing ports mentioned above. The landing port at Tulul is the largest and handles about 80 percent of the total catch from the lake.

The landing ports have still poor facilities, i.e., two fish handling halls and an old cold storage at Tulul. Therefore, the fish landing and handling work is difficult and complicated. The fishes are handled under unsanitary conditions.

In order to improve this situation, adequate landing port facilities should be built. GAFRD has drawn up a plan to improve the landing ports in Eghzwan and Tulul. The plan is proceeding up to the implementation phase with the financial cooperation of EC. The following facilities are planned to be constructed or provided.

Tulul: (Fish landing facilities) (Research station)

- Ice plant
- Landing jetties
- Fish sorting shelters with drainage system
- Workshop for boats repair
- Fuel oil tank
- Vehicles and other equipment

- Aquaculture center

Eghzwan: (Fish landing facilities) (Research station)

- Ice plant
- Landing jetties
- Fish sorting shelters with drainage system
- Small workshop
- Water tank
- Vehicles and other equipment

- Aquaculture center

The fish catches are to be sold through the fishery cooperatives to local wholesalers and exporters. However, a large part of the catches are sold through individual fish agents. There are about 30 fish agents, who provide fishermen with facilities such as their transportation, fishing materials and cash loans on the basis a verbal contract. They handle all the catches of the contracted fishermen with commissions at certain rates (7 to 15%) on the sales amount of the fish. Their effect on the fishery and its marketing are significant.

Most fish for local markets is consumed in El Arish which has the largest demand in North Sinai. Large size fresh gilthead seabream, seabass and common sole are selected for export at the landing ports and airfreighted in iced packages to Italy and Greece. Approximately 300 to 500 tons of fish are exported annually, which amounts to about 70 percent of the total export of fishery products from the country. It characterizes fishery in the lake.

2.6.2. Fishery in Malaha Lake

1) Lake Management and Fishery

The Port Said branch of the Egyptian Company for Fishing and Fishing Equipment conducts the lake management including maintenance of the openings and fishing in the lake. The maintenance of the openings is indispensable for fishery production in the lake, therefore, the company continuously conducts dredging operations in the openings. Besides, the company is also carrying out excavation work to connect the two lakes (the north lake and the south lake) for improvement of water exchange and circulation in the lakes.

The fishing period is from August to December. Fishing operations are halted from December to the end of July in order to restock the lake. In early June, net fences are set crossing the openings. The net fences are made so as to enable fish to enter the lakes but block the fish going out from the lake. The fishing company employs fishermen mainly from Port Said and Damietta only during the fishing season. The number of the fishermen is 128 in total. The fishing company gradually reduces the number of fishermen according to the catches. The fishing boats

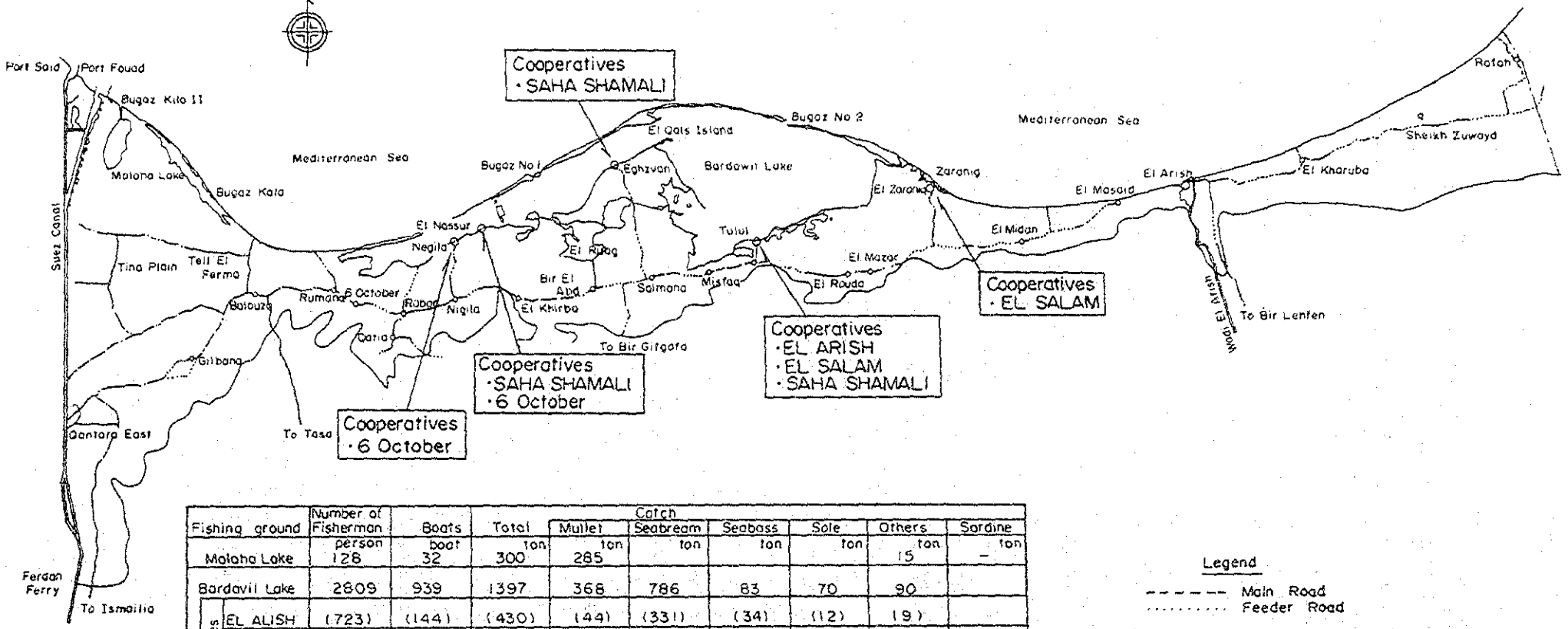
are about 6 m long, wooden and of the flat-bottom type. The fishing company provides every team consisting of 8 fishermen with two fishing boats. The fishing equipment used are mainly veranda-nets. The quantity of catch is 300 to 400 tons annually, most of which is gray mullet.

2) Marketing

All the fish catches are purchased at a contracted price (0.3 LE/kg in 1987) regardless of fish species and size by the fishing company at the landing points. The company transports all the fish to Port Said and sells them to the Fish Marketing Cooperatives of the Port Said Governorate at 0.4 to 3.0 LE/kg depending upon fish species and size. The Fish Marketing Cooperatives distributes them to the retailers cooperatives after adding the transportation fee (about 5 PT/kg). All the fish are consumed in Port Said.

Finally, the present conditions of fishery in the Bardawil Lake and the Malaha Lake are summarized as shown in Figure 2.6-4.

Figure 2.6-4. Present Condition of Fishery



Fishing ground		Number of Fisherman	Boats	Catch Total	Mullet	Seabream	Seabass	Sole	Others	Sardine
		person	boat	ton	ton	ton	ton	ton	ton	ton
Malaha Lake		128	32	300	285				15	–
Bardavil Lake		2809	939	1397	368	786	83	70	90	
Cooperatives	EL ALISH	(723)	(144)	(430)	(44)	(331)	(34)	(12)	(9)	
	EL SALAM	(350)	(140)	(186)	(73)	(87)	(11)	(5)	(10)	
	SAHA SHAMALI	(1200)	(480)	(543)	(82)	(322)	(36)	(49)	(54)	
	6 October	(536)	(175)	(238)	(169)	(46)	(2)	(4)	(17)	
Mediterranean		490	81	1036	Other 109					927

2.7. Agro-industry and Marketing

Agricultural products from North Sinai are virtually confined to fruits, vegetables in the crop subsector, and goats and sheep in the livestock subsector. Perishable products are mostly consumed in the area, or freshly marketed outside the governorate. But date palm fruit is exceptional, being dried by the harvesters themselves, or by merchants who sell the processed products packed in bags.

Around one third of the total production of perishables is recorded as exports from the governorate, and a half is marketed within the Governorate. Marketing activities are largely carried out by middlemen and transporters from Cairo, Suez and Ismailia, who visit the farmers' fields to collect their produce. In the Governorate, there is a wholesale market in El Arish, annual sales of which are estimated at 5,000 tons and retailers are also found in El Arish, Rafah, Sheikh Zuwayid and Bir El Abd.

Two major marketing routes are identified in the Study Area for agricultural produce. One represents marketing by farmers themselves in El Arish, Suez, Ismailia and Cairo. This type of marketing is only carried out by a few capable farmers who can afford to use their own vehicles or hired ones to transport their produce to the consumers. Transportation in this case is costly i.e. 5 LE/100 km/ton, particularly for hired ones..

The other route is adopted by common smallholders. They usually trade at the farmgate with middlemen or merchants who offer short-term credits to farmers for their input purchase. These traders frequently visit farms, especially during harvesting seasons to collect products from them. They often offer the same prices as the ordinary level even though attractive levels are prevailing in the urban markets. They may also restrain farmers from free trading with other merchants by fastening them with precropping loans.

In the area between El Arish and Rafah, activities such as oil extraction in the outskirts of El Arish, and a slaughterhouse together with a milk processing in the suburbs of Rafah, are taking place under the management of the North Sinai Governorate Public Enterprise Commission.

Recently, two olive-oil extraction plants were established in the outskirts of El Arish. They have been installed hydraulic presses made in Italy and their processing capacity is 15 tons and 25 tons per day, respectively. Limited material supply coupled with restricted electricity led to the underworked nature of these plants. They are now dealing with 1,000 tons of raw material per annum to be produced into 180 tons of crude olive oil. They are used for farmers to extract oil from fruit under a processing fee payment system. These factories receive 100 LE from the entrusted material suppliers as a processing fee.

In the field of livestock processing, a branch factory of a private dairy firm in Ismailia was established in Rafah. Raw milk supply to this factory has been mainly supported by sources outside the governorate. A large amount of raw milk has been collected in the Nile Delta region and transported by tank lorries, covering a distance of some 400 km. The factory is equipped with the lines for city milk (UHT milk), yoghurt and cottage cheese, but only 20 to 30 percent of its capacity is now in operation (daily capacity can deal with 2 tons of raw material). It currently processes cottage cheese only, leaving other lines idle. Under these conditions it was recently handed over to the town council for new management.

In addition, there is a slaughterhouse in the outskirts of El Arish, belonging to the aforementioned governorate livestock farm. It annually slaughters about 300 heads of buffaloes with liveweights ranging from 300 to 600 kg, along with some culled cows derived from little reared herds by the farmers. However, the Bedouins slaughter their own livestock by themselves.

As regards fishery products, marketing is mentioned in the previous Sections 2.6.1 and 2.6.2.

2.8. Infrastructure and Social Services

2.8.1. Water Supply and Sewerage

There are two sources of water, one is groundwater and the other is water from the Nile which needs to be conveyed by pipeline. The area between El Arish and Rafah depends entirely on groundwater. Desalination units for groundwater are found at El Arish and El Masaid.

A potable water station with a 400 litres/sec capacity functions at El Qantara West. Crossing the Suez Canal by siphon, two pipelines are provided along the highway up to Tulul and El Arish along the highway. One pipeline is about 80 km to Bir El Abd with 300 mm diameter with an extension to Tulul of about 21 km with 200 mm diameter. This provides water for the settlements along the highway in the west of Tulul. Another pipeline of 700 mm diameter provides water to El Arish at a distance of 165 km, serving some settlements along the route to El Arish. The supply capacity of these two pipelines are 4,000 cu.m/day and 20,000 cu.m/day, respectively. There is also a water lorry service for remote areas located away from the pipeline.

The average daily water consumption are estimated as follows;

100 - 120 litres per capita per day in urban communities
30 - 40 litres per capita per day in rural communities

The pipeline from the Port Said Canal to El Arish through El Qantara West, and water distribution lines at El Qantara East (new community), Bir El Abd, El Masaid, etc., have been constructed during the First Five-Year Plan period. Also three water desalination units have been installed at El Masaid during the same period. In the Second Five-Year Plan period, additional water pipelines and water desalination units are proposed.

Meanwhile, most of the existing settlements in the Study Area lack public sewerage systems.

2.8.2. Electricity

Small-scale power plants are located in the major settlements in the Study Area. A high voltage line (22 kv) has been installed along the highway between El Qantara East and El Arish. The capacity of this line is considered insufficient to meet future demands, therefore, an increase in capacity to 66 kv is proposed. In the First Five-Year Plan period, phase one of the Sinai electrification scheme has been completed. As a result, the extension of electricity grids and the installation of transformer stations at Balouza, Rumana, Nigila, Bir El Abd, and Rafah has been realized.

2.8.3. Transportation and Communication

The road has an important transportation role in the Study Area. The railway between El Qantara East and Rafah at border functioned until 1967, but has since been removed.

1) Road Network

The most important road in the Study Area is the El Qantara East - El Arish - Rafah highway. This main regional road has been developed as a first class paved road. This two-lane rural highway can carry up to 15,000 equivalent passenger car units per day, and this capacity is in excess of current traffic volumes. The present average daily traffic on this road is extremely low, since it is estimated to be less than 2,000 passenger car equivalents per day. Another main road in North Sinai is the Ismailia - Bir Gifgafa - Bir Lehfen - El Arish road.

Some branch roads are paved and the others are not. These are mostly connecting roads or extensions to the coast. Major branch

roads are those from El Qantara East towards Ismailia, from Balouza to El Tasa, and from Bir El Abd to Bir Gifgafa.

Ferries cross the Suez Canal are working at Ismailia, Ferdan, and El Qantara in the Study Area. According to a recent traffic survey (1983) carried out by Pacer Consultants, an annual increase in passenger flows of 12 percent, and freight flows of 22 percent was indicated. The study also showed that more than 70 percent of total passengers and freight flow to and from the Sinai cross the Suez Canal via the El Qantara Ferry.

The mode of passenger travel was as follows;

Private cars	24%
Intercity taxis	31%
Public buses	13%
Other buses	32%

In the First Five-Year Plan period, the El Qantara East- Bir El Abd road (83 km), El Qantara East - El Shatt road (125 km) and about 113 km of internal roads in El Masaid, Bir El Abd (new community), El Qantara East (new community) and others have been built and paved. In the Second Five-Year Plan period, road construction of 206 km is proposed in the Sinai and a new road connecting Balouza to Port Fouad directly (50 km) is currently under construction.

2) Air Transport

A domestic civil airport is located in the south of El Arish. The airport has one main runway and one secondary runway. Both runways have taxiways and aprons, the airport facilities can serve medium-size aircraft including B 737, DC 9 and ABC 1-11. The airport now hosts two domestic round trips weekly from El Arish to Cairo during summer by the Air Sinai Airline (1988). Annual passenger traffic is estimated to be approximately 5,000 (1985/86).

3) Harbour

A harbour with pier has been completed to the east of El Arish during the First Five-Year Plan period. This is the only harbour in North Sinai and serves mainly fishing vessels. It can handle up to 7,000 ton class ships. The harbour has the following objectives:

- To serve as a base for coastal fishery
- To act as a refuge for fishing vessels
- To handle cargo directly to North Sinai
- To encourage industries, tourism, and new communities in the area.

4) Telecommunication

As for telecommunications, a micro-wave transmitter is used by mainly governmental offices. Telecommunication facilities for inhabitants such as telephone and telex have also been improved. North Sinai Governorate has 11,900 lines, and there are about 7.4 telephone lines available per hundred capita (1987).

2.8.4. Education and Medical Services

The existing educational services are insufficient. In major settlements, only primary schools and a few preparatory and secondary schools exist. Health services are limited and deficient in the Study Area. The Area depends on the main health services of a public hospital at El Arish City and some health units in the large villages such as Rafah, Sheikh Zuwayid and Bir El Abd. Police and fire stations are in the Markaz centers and can treat various emergency cases. Service facilities such as restaurants, cafeterias and cinemas are mostly in the El Arish - Rafah area.

The present conditions of infrastructure and social services are shown in APPENDIX-F.

2.9. Tourism

2.9.1. Natural Features of the Area

A study of the Mediterranean coastal area in the North Sinai Governorate shows that the Study Area has great potential as a summer recreation and resort place in terms of climate, landscape, coastal and offshore characteristics. Since the coastal area between El Arish and Rafah has more than 100 mm rainfall per annum and a high level of ground water, date palms, olives, eucalyptus and other trees can grow. Moderate slopes of sand, continuous palm-shaded white sandy beaches and landscapes make a fascinating environment for recreation and an ideal resort area for tourism development.

Bardawil Lake is separated from the Mediterranean Sea and is surrounded by untouched sand hills, dunes and flat land. Even though the area has only bushes, the nature and environment of this area has good potential for recreation and tourist resort development. El Ruag and Maharet El Marqab are bays within the lake. An expansive and calm water surface of the lake presents a good environment for water sports.

El Zaraniq lagoon, on the eastern edge of Bardawil Lake and the associated wetlands on the periphery, is a world-famous bird sanctuary. Various kinds of migratory birds travelling between Asia/Europe and Africa stopover in the area.

The area from the western part of Bardawil Lake to Port Said city is another stretch of sandy beaches on the Mediterranean Sea coast. The hinterland of this area is quite flat. Beaches are wide and many shells are scattered everywhere on the shore.

2.9.2. Tourism Resources

1) Natural Resources

From a tourism development point of view, natural resources of the Study Area are listed in addition to the favourable climatic condition as follows;

- wide flat beaches at Balouza-Rumana coast
- palm-shaded beach on the El Arish-Rafah coast
- attractive landscape of Bardawil lagoon and sand hills/dunes
- bird sanctuary of El Zaraniq lagoon
- large and calm water surface in the creek of Bardawil Lake
- inland palm trees

2) Historical Resources

Various sites of historical interest are found in the Study Area. These sites will be potential resources for tourism development. The following is a list of the major historical attractions in the Area (Figure 2.9-1).

- Horus Road (Ancient commercial and military road)
- Mahamal Road (Holy family's road)
- Farma City (Ancient Persian city)
- Citadels
  Kattiah, Kasar Gheit, Um Mahamudiya, Kathib El Maghara, Lafahin, Thalow, Tina.

Even though the Area has a long historic legacy, few intensive research has been carried out to establish their true value.

3) Tourism Facilities

Major areas of tourism in North Sinai are concentrated in the El Arish-Rafah area up to now. Therefore, the existing facilities for tourists are located in this area, particularly in El Arish.

The total number of hotel rooms is 1,050 as of 1988. Three tourist village, S.A.M.A., Ziral El Nekhel, El Gandul are planned or currently being developed in the El Arish area. A total of 2,000 units of accommodation will be completed by 1991 (APPENDIX- G).

4) Problems

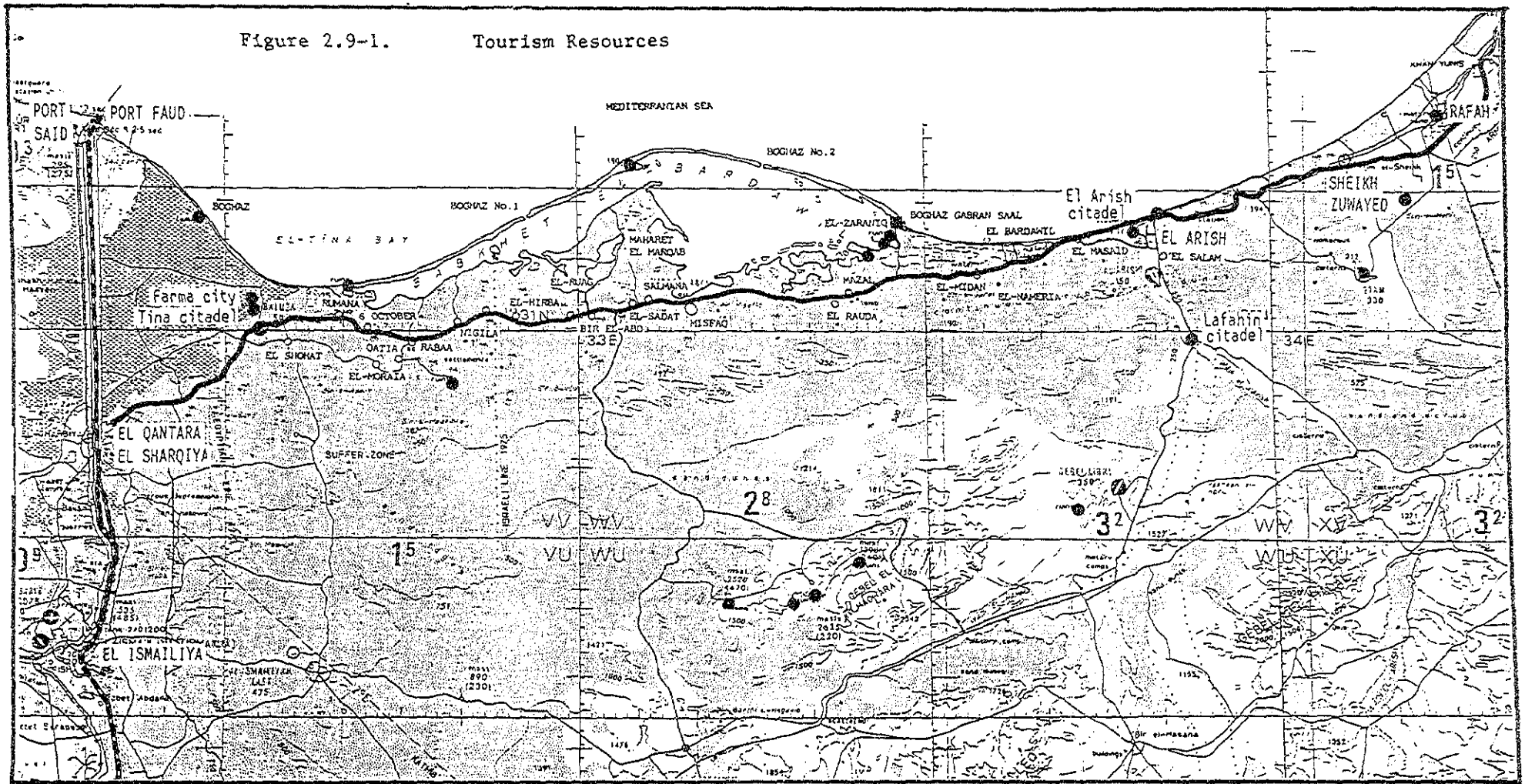
Even though the Study Area has attractive sandy beaches, pollution from tar-lumps and occurrence of jelly fish are big problems for coastal tourist resorts. Tar-lumps in bilge water dumped from tankers and other vessels are contaminating the whole coast from Port Said to Rafah. The size of lumps varies from bean size to larger than full hand size.

2.9.3. Opinion Survey for Vacation

An opinion survey was executed in order to obtain people's opinion for their vacations. The results of the survey can influence the selection of tourist facilities or the preparation of a tourism master plan. Details of questionnaire and the analysis are given in APPENDIX-G. The followings are major indications from the respondent's answers.

- Around 45 percent of respondents visited Alexandria at last vacation.
- 84 percent of respondents spent their vacation for mainly resting and 12 percent for visiting friends.
- Alexandria is the most popular resort for respondents planning their next vacation.
- Respondent's desire to visit North West, North Sinai, South Sinai and Red Sea is similar level.
- Most favourite accommodation for respondents is apartment houses, followed by bungalows.
- Generally speaking, respondents are fond of passive and quiet activities such as resting, picnicking, hiking, etc.
- Active sport activities at vacation time are not yet popular among respondents.

Figure 2.9-1. Tourism Resources



TOURISM RESOURCES

LEGEND

- Historical Resources
- Natural Resources
- Horus Road(Ancient Commercial and War Road)
- Mahamal Road(Holy family's Road)
- Suez Canal
- Major Cities and Towns

N

SCALE

KM 0 10 20 30 40 50

2.10. Farmer's Organization and Supporting Services

2.10.1. Farmer's Organization

At present, there are 31 cooperatives in the North Sinai Governorate and 4,336 farms are members of these cooperatives.

Type of Cooperatives	Total Number	Members
Development bank type	17	1,882
Desert type	17	2,368
Others	2	86
Total	31	4,336

Cooperatives have been established in each village and members of cooperatives can be supplied input materials and credit for agricultural production through the cooperatives. Credit service is available for crop production, livestock, machineries, and irrigation facilities etc.

2.10.2. Agricultural Extension Services

Extension services for agriculture in the North Sinai Governorate have been carried out under the control of the Agricultural Office in the Governorate. Figure 2.10-1 shows the organizational chart of the Extension Office at Bir El Abd. At present about 460 extension workers are distributed in the Governorate and work for extension by using pamphlets and advice. However, the numbers of vehicles and motorcycles are not enough for the adequate services.

2.10.3. Agricultural Credit Services

1) Crediting Organization

The executing agency for agricultural credit services is PBDAC (Principal Bank for Development and Agricultural Credit).

Organization of the PBDAC is shown in Figure 2.10-2. There are 4,307 branches of village bank distributed as terminal units throughout the country.

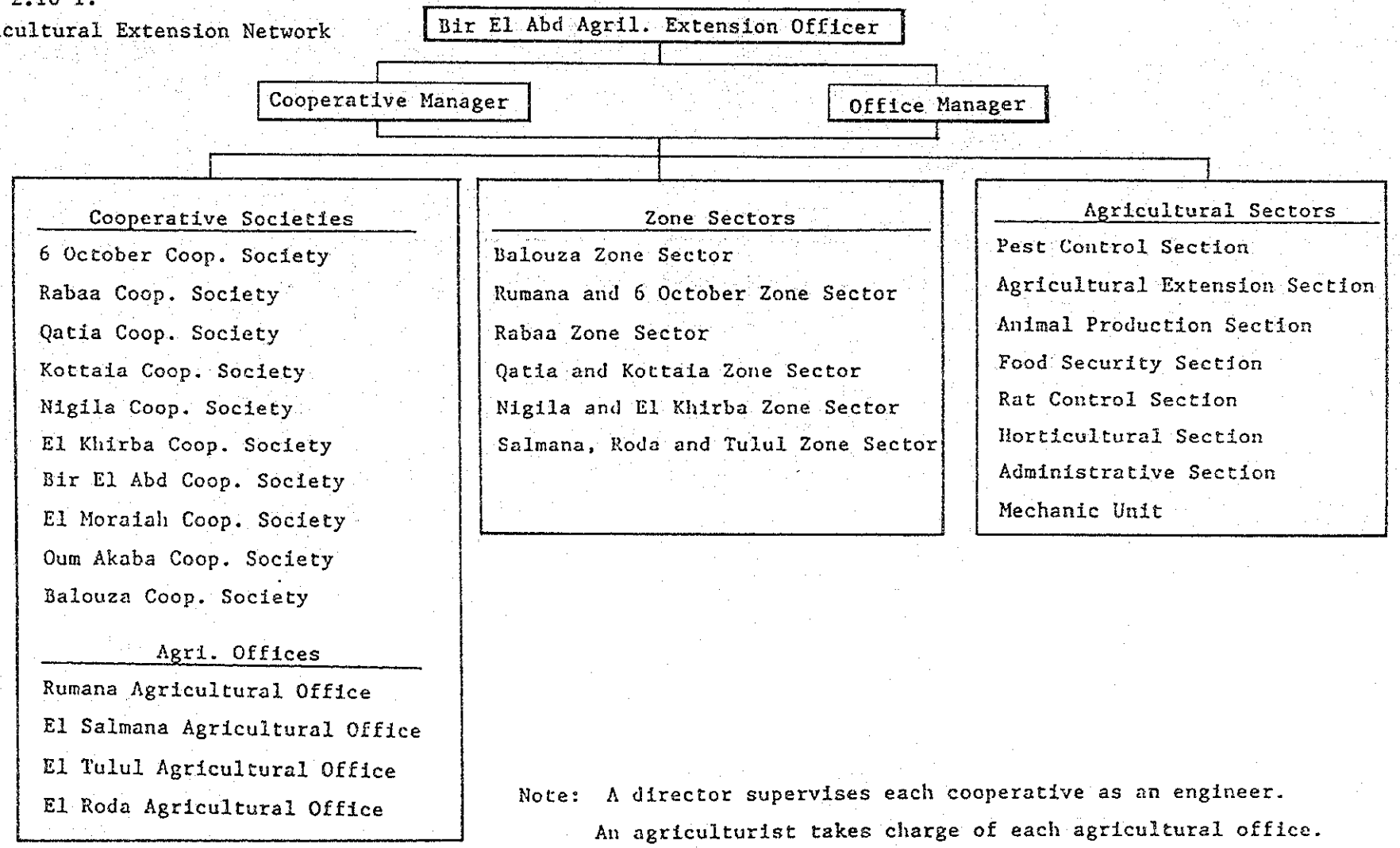
2) Types of Credit

Following three types of credits are available;

Credit	Objectives	Repayment Period
Short Term	Livestock, poultry	below 12 months
Medium Term	Livestock shed and facilities Agro-industry facilities Agricultural machineries Irrigation facilities	1 - 5 years
Long Term	Land reclamation Horticulture	5 - 15 years
Seasonal	Production loan for summer and winter fruits (in cash and in kind)	After harvesting

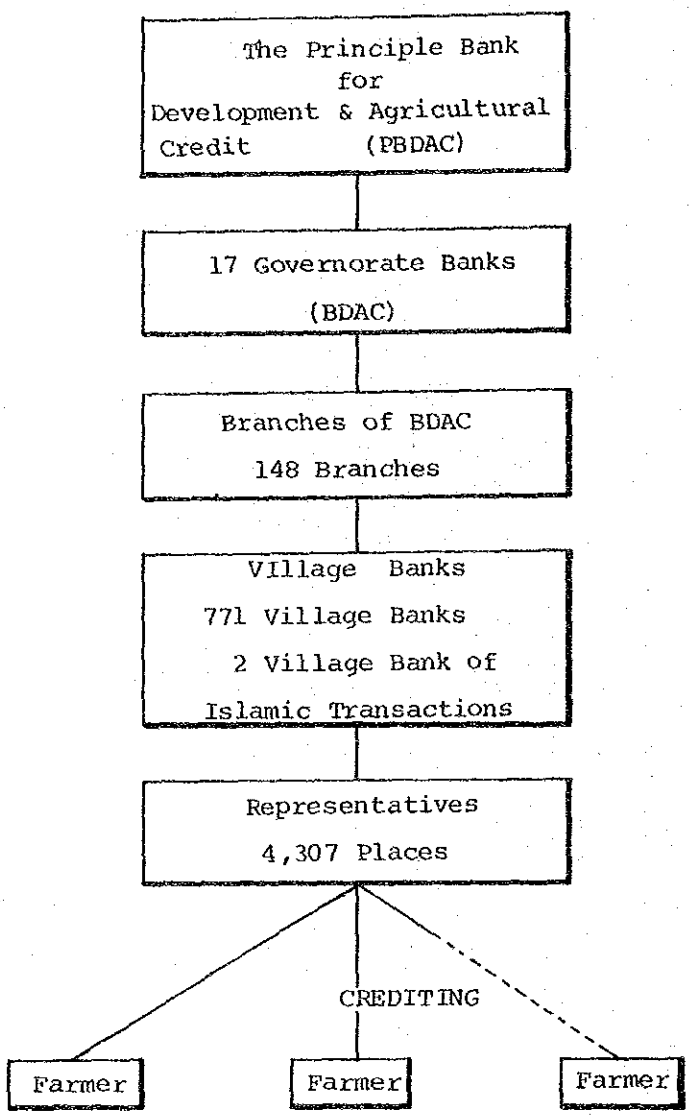
Source: Village Bank of NSG

Figure 2.10-1.
Agricultural Extension Network



Note: A director supervises each cooperative as an engineer.
An agriculturist takes charge of each agricultural office.

Figure 2.10-2 Farmers Credit



CHAPTER 3. STRATEGY OF DEVELOPMENT PLAN

3.1. General

3.1.1. Background

With the end of the Middle East War, the Government of Egypt devoted itself to reconstruction and development of the Sinai Peninsula by establishing the Sinai Development Authority (SDA). Development of the Sinai Peninsula is given the highest priority in the Second Five-Year Plan.

Potential for agricultural development in the northern part of the Sinai Peninsula is considered high with vast land and a mild climatic conditions, however, the region remains undeveloped due to the limited water resources. Accordingly, former president Sadat gave his orders on July 1980 to commence the construction of the El Salam Canal to introduce irrigation water from the River Nile to the northern part of the Peninsula. The earth works of El Salam Canal have been completed to the point just west of the Suez Canal.

In the event of sufficient water being supplied to the North Sinai by expanding the El Salam Canal through a siphon under the Suez Canal, the integrated rural development based on agricultural and fisheries will be promoted in the Study Area rapidly. The Study Area, moreover, has two large hypersaline lakes, that is, the Bardawil Lake which is the only lake having non-contaminated water in Egypt and the Malaha Lake, and has a long coastline on the Mediterranean Sea. These waters are recognized to be suitable for fishery and tourism development.

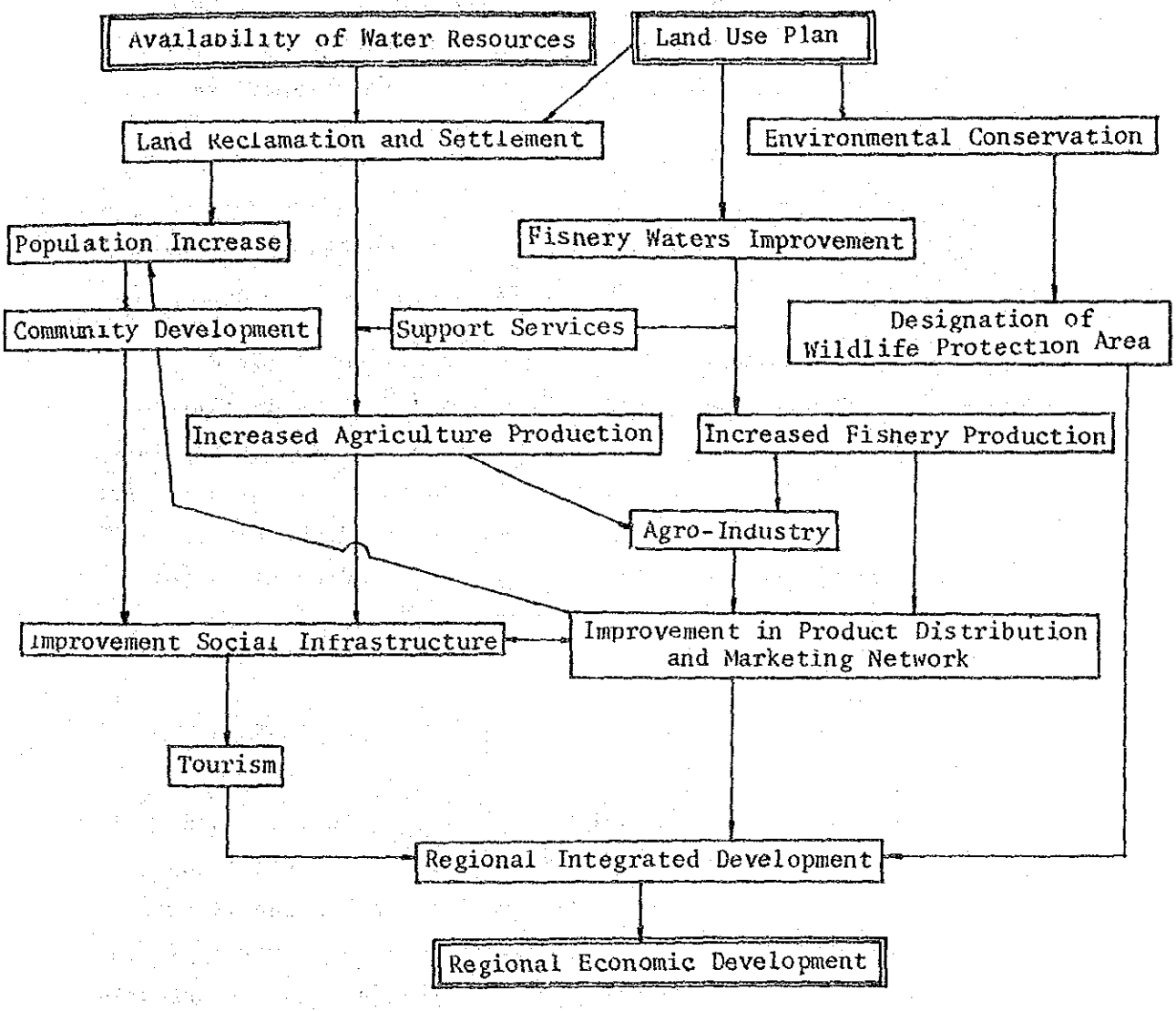
3.1.2. Stage Development

The Master Plan covers a vast area of about 3,200 sq.km extending about 190 km along the Mediterranean Sea coast from the Suez Canal to Rafah. And the plan includes a wide range of development components. Accordingly, the development plan will be implemented by stages.

The major constraint which has left the area behind until now is the lack of water resources. The proposed plans will be realized in a staged development process after the Nile water becomes available as shown in Figure 3.1-1.

In particular, agricultural development and its related projects (land settlement, new-community development, agro-industry, and supporting services) involve a large area, so that the implementation should proceed step by step in parallel with the El Salam Canal extension. Implementation of fishery, tourism and other development components will follow them. In other words, the plan will be implemented firstly to increase the regional productivity and secondly to improve the regional infrastructure which will subsequently offer the amenities of the inhabitants.

Figure 3.1-1. Stage Development Plan



3.1.3. Specific Characteristics of Area

From the aspects of natural and socio-economical conditions, the Study Area can be largely divided into two divisions by El Arish, that is, Western Division and Eastern Division. Furthermore, the Western Division can be subdivided into Tina Plain, Southwest of Bardawil Lake and East of Bardawil Lake, and the Eastern Division into Wadi El Arish Basin and Sheikh Zuwayid/Rafah area. The development plans are formulated taking into account the specific characteristics and development potential for the respective area (refer to Figure 2.1-1).

1) Western Division
(Tina Plain, Southwest of Bardawil Lake and East of Bardawil Lake)

This area is characterized by low rainfall and limited groundwater resources, therefore, the cultivated land is limited. The population density is low. However, with flat and stable land, provision of irrigation facilities will substantially raise the farm production. There is also potential for fishery development including aquaculture and tourism in the water bodies along the coast.

2) Eastern Division
(Wadi El Arish Basin and Sheikh Zuwayid/Rafah Area)

This area is characterized by high rainfall in Egypt and intensive agriculture is practised depending upon rainfall and groundwater. Fishermen in the North Sinai reside in the vicinity of the El Arish port, while fishing areas are located primarily in the Bardawil Lake. El Arish is well-known and the favorite resort site in Egypt where development plans are underway.

3.2. Development Potential

As the results of reviewing existing data and field survey, the Study Area located in the North Sinai region is comparatively well endowed with natural and human resources in the Sinai Peninsula. When the Nile water becomes available, the potential of the integrated rural development based on the agricultural and fishery development is considered high.

3.2.1. Land Resources

REGWA (entrusted by GARPAD) carried out a reconnaissance and a semi-detailed soil survey, the result of which forms the basic data in the Land Master Plan (1985) of GARPAD on suitability for land reclamation at the national level.

The LMP estimates the area suitable for land reclamation with irrigation by the El Salam Canal in North Sinai to be 210,000 feddan and with irrigation by groundwater to be 5,200 feddan (Table 3.2-1).

Table 3.2-1. Comparison of Development Area with Existing Plans

(Unit: feddan)

Dames & Moore	Area*1	Land Master Plan*2	Area*1
El Tina Plain	20,000	Tina Plain (SN.1)	102,500
Qantara-Balouza	16,000	North Bitter Lake (SN-2)*3	28,000
Rumana-El Mazar	20,000	Bardawil 1 (SN-3)	60,000
		Bardawil 2 (SN-7)	15,000
		West of El Arish (SN-8)	6,100
Sub-Total	56,000		211,600
Lower El Arish	17,000	El Arish	5,200
El Arish-Rafah Strip	15,000		
Total	88,000		216,800

Note: *1 ... Gross area
*2 ... Land Master Plan does not include the area of El Arish
*3 ... Total area of SN-2 is 56,000 feddan. Southern half (East Bitter Lake) is excluded from this table.

In the M/P Study, land suitability for irrigated agriculture was classified in accordance with "Land Classification for Irrigation" by the U.S. Bureau of Reclamation. This classification standard is also used in the LMP by GARPAD but the M/P Study Team made a slight modification according to the results of the field survey.

The potential of land resources for agricultural development in the Study Area is considered high, however, there are some restrictions such as mobile sand dunes from a topography aspect, and low-lying Sabkha from a drainage aspect. According to the results of the land classification, there is no land classified as Class-1 in the Study Area. Even land with good potential for agricultural development has problems such as poor drainage, submergence, and salinity in the flat clayey lowland, on the other hand, of erosion and poor retention for water and nutrients in sandy terrain.

Consequently, it is estimated that land reclamation could be carried out in the area classified as Classes-2 and -3 and in a part of Class-4. As for Class-6 land which is unsuitable for cultivation, land use other than agricultural should be considered.

According to the LMP, all of the Tina Plain was classified as an arable area. In the northern part of the Tina Plain, however, drainage by pumps will be necessary due to its low elevation and considerable cost will be necessary for salt leaching. Therefore, those areas are classified as Class-6 in this M/P Study and excluded from the land reclamation. Fishery development is proposed in this area.

On the other hand, land reclamation will be conducted as far as possible in the flat areas of sandy terrain taking into consideration the popularity of drip irrigation method in the Study Area.

Classes-2 and -3 land is distributed in Wadi El Arish basin and Sheikh Zuwayid/Rafah Area where at present fruit and vegetables are harvested with rainfall and groundwater irrigation.

At present a part of Sabkha is used as a salt pan. Most of Sabkha will be used as a sink for agricultural drainage. Mobile sand dunes will be enclosed by vegetation to prevent encroachment on farmland, villages, and social infrastructure. Regarding the sand dune fixation, the programmes are implemented by DRI at Sheikh Zuwayid, however, the programmes are still initial trial stage.

As the result of the land classification, the arable land in the Western Division that will be reclaimed owing to the El Salam Canal extension is 254,700 feddan in total (horizontal expansion) and those in the Eastern Division where existing farmlands are distributed is about 60,000 feddan (vertical expansion).

3.2.2. Water Resources

The Water Master Plan on water resources and use has been prepared on a nationwide basis, while the feasibility study of the El Salam Canal Project has been conducted by MPWWR, and North Sinai Water Resources Study Report by RIWR/MPWWR.

Per capita share of farmland has gradually decreased in Egypt due to the high rate of population increase. Because more than half of the total labour force has been engaged in agriculture sector, this implies a direct effect on the living standards as well as agricultural production being insufficient to national demand. Agricultural import at present, therefore, accounts for about 25% of total import, which has worsened the balance of payments. One of the most effective means of agricultural development, which is essential to provide a good standard of living and to improve the

national economy, is horizontal agricultural expansion, and the Second Five-Year Plan has proposed horizontal expansion of about 600,000 feddan.

The available and possible water resources and usage of Egypt will be as shown in Tables 3.2-2 and 3.2-3.

The total horizontal agricultural expansion planned to the Year 2000 is 1.26 million feddan and its center lies on the areas around the Suez Canal. The reasons for inclusion of the area east of the Suez Canal including the Study Area into a center of the horizontal expansion are as follows;

- Horizontal expansion of absorbing a large population is necessary for promotion of settlement programme in North Sinai which contributes to the dispersion of population.
- The future urbanization plan was proposed in the Suez Canal area due to its unique location in the world. In order to proceed the implementation of the plan, agricultural development is necessary on both sides of the Suez Canal.

The fact mentioned above confirms the necessity of horizontal agricultural expansion of the Study Area in North Sinai. However, there is no substantial water resources in the Study Area, and this area can make use of only groundwater of 136,000 cu.m/day, most of which has already been developed. This implies importance of diverting the Nile water for large-scale agricultural expansion in North Sinai. The total possible extra water resources in the Year 2000 is estimated at 10.7 billion cu.m, and of these 20% is re-use of drainage water. The re-use of drainage water is essential for further large-scale agricultural expansion.

The irrigation water for the M/P land reclamation area will be obtained the Nile water from the Damietta barrage, mixing with drainage water from El Sirw drain by gravity and drainage water from

Bahr Hadous drain by pumping. This project is considered to have a high priority for its implementation judging from the necessity of horizontal agricultural expansion in North Sinai and an importance of re-use of drainage water in Egypt.

Table 3.2-2. Water Resources in Egypt

(unit: BCM, billion cu.m)

Item	Year 1987/88 (BCM)	Year 2000 (BCM)
- Nile water	52.8	55.5
- Re-use of drain water	4.6	7.0
- Groundwater	2.6	4.9
- Saving by improving the existing irrigation systems	-	1.0
- Storage of river flow released to maintain navigation and to prevent encroachment	-	2.3
Total	60.0	70.7

Table 3.2-3. Water Use in Egypt

Item	Year 1987/88 (BCM)	Year 2000 (BCM)
- Irrigation	46.2	53.7
- Municipal and industrial usage	7.4	10.0
- Water to be released to maintain navigation and to prevent encroachment	2.7	0.6
- Non beneficial evaporation, etc.	2.0	2.7
Total	58.3	67.0

Source: MPWWR

3.3. Development Strategy

3.3.1. Comprehensive Regional Development Strategy

The Master Plan has been prepared after a review of the existing programmes and policies of various agencies, though none of them has officially been approved by the central government.

There are two comprehensive development plans prepared for the Sinai Peninsula: (1) Sinai Development Study, Phase I by Dames and Moore, and (2) Sinai Development Plan by DRTPC/Cairo University.

1) Sinai Development Study (SDS), Phase-I (1985)

SDS (Phase I) proposed the following development plans for the Sinai Peninsula as a whole by the target year of 2000.

- Regional integration with the rest of the country
- *Optimum* resource development
- Permanent resettlement of the whole Sinai Peninsula
- Development of labour force and incentives
- Strengthening of economic activities
- Dispersed resettlement system
- Improvement in communication and transportation
- Environmental improvement

This study placed emphasis on strengthening various economic sectors, agricultural development, processing, marketing, supporting services as well as on fishery and tourism development. And the development plan for the northern area proposed the following:

- Stable water supply as principal development priority
- Resettlement in the North Sinai together with development of agriculture, processing industry, and communication network in the area between El Qantara and Rafah.
- Designation of El Arish as the urban development center, and of Bir El Abd, El Mazar, Nigila and Rabaa as the marketing development centers.

- Integrated development of the Bardawil Lake area including fishery, commerce, industry, agriculture and tourism.

Subsequently, the following three urgent programmes are proposed:

- Water supply
- Master plan study for village center
- Establishment of agencies for industry and tourism promotion

2) Sinai Development Plan (1982)

Meanwhile, DRTPC/Cairo University Plan proposed a pyramid-type village hierarchy whose economic foundation differed depending on its natural resource potential. Proposed plan included agriculture and processing industry in the northwest area between the Suez Canal and Rumana, on the other hand, agriculture in the northeast area between El Arish and Rafah. The development center was El Arish followed by Rafah, Sheikh Zuwayid and Bir El Abd. Construction of a road connecting El Qantara and El Arish was proposed, in addition to connecting tunnels beneath the Suez Canal at El Qantara and Ismailia.

The development period was divided into three phases, i.e., the first phase for improvement of the existing services and development of farmland, industry, tourism, infrastructure and transportation network; the second phase for primarily large-scale construction projects; and the third phase for further improvement in the provision of services.

These plans implied the necessity of the following measures.

- Optimum use of existing water resources
- Survey/investigation of appropriate irrigation methods by soil types
- Feasibility study of the pipeline project making use of the water resources of the River Nile

- Fixation of sand dunes and prevention of expansion of the sand dune area through forestation

- Promotion of livestock and fishery

Land reclamation in the Tina Plain and fishery development in the Bardawil and Malaha Lakes were also proposed, with El Qantara being the center of agro-processing, commerce and administration.

3) Second Five-Year Plan

The Second Five-Year Plan (1987/88 - 1991/92) is under way. The following is a summary of the basic principles underlying the Five-Year Plan with respect to integrated rural development.

The capacity of the Egyptian economy is to be strengthened through;

(1) Raising domestic production and productivity, leading to a reduction of imports and expansion of exports.

(2) Strengthening the physical and social infrastructure which will lead to a rise in the living standards of the people and an improvement in attitudes and behaviour in the field of development.

(3) Achieving a population-location balance through relocation from the narrow valley into more spacious areas where agricultural and other industrial communities can be established.

These principles are designed to transform the present urban-oriented society and economy in Egypt into a more balanced economy, nationwide. This is to be aimed at, not only during the present Five-Year Plan period, but continuously for the future.

4) Present Master Plan Study

This M/P Study will be made in accordance with the principles of the Five-Year Plan. After technical investigation for M/P formulation, the feasibility study on the priority subprojects and early implementation are major concern. In this M/P, the area is

focused on the coastal area of Mediterranean Sea; furthermore, a continuous series of land reclamation and settlement from El Qantara to El Arish in the Western Division where the population is scarce is aimed rather than the partial development surrounding growth pole along the highway.

3.3.2. Agricultural Development Strategy

With respect to agricultural development, SDS (Phase I) proposed the programmes confined to the area with a large population between El Arish and Rafah. Major proposals are as follows:

- Re-development of the El Arish-Rafah area
- Increased production of vegetables in the villages
- Stable water supply through wells and farmland development
- Organization of livestock and pasture cooperatives
- Creation of dairy farming (Rafah area)
- Promotion of fishery

For this area (Eastern Division), in addition, CICCAS (entrusted by GARPAD) studied on the agricultural potential. The CICCAS report delineates the agricultural development plans incorporating livestock, rural industry in the east of El Arish where arable land is abundant.

The following were the major agricultural development policies;

- Improvement and expansion in rainfed fruit-farming
- Improvement and expansion in irrigated fruit-farming
- Increased production of castor beans, flowers, and medical plants for vegetable oil production
- Five-Year programme for sand dunes fixation with vegetation

- Appropriate water use, fertilization, pest/disease control and mechanization as key factors for agricultural development
- Development and improvement of livestock and poultry

On the other hand, the agricultural development particularly concerned with land reclamation and settlement was studied in the Pre-Feasibility report for reclamation, cultivation and reconstruction of lands in North Sinai by REGWA (entrusted by GARPAD). Identifying the potential of land reclamation, fishery, and rural industry in the El Qantara and El Arish areas, the REGWA's report proposed a settlement plan for 120 villages with 2,000 to 2,500 residents and 2,500 feddan of land in each village, assuming a total population of 270,000 to 300,000.

Moreover, the Tina Plain located at the west end of the Study Area was surveyed through the feasibility study on agricultural development by PPU/GARPAD.

In the present study, it has been recognized that the climatic conditions except low rainfall in the Study Area are suitable for agricultural production. Therefore, in the event of irrigation water being supplied, the potential for agricultural development will become greater and land reclamation in the Area will bring about enough capacity for increasing employment opportunities. Due to the arid conditions, excluding Sheikh Zuwayid/Rafah which has annual rainfall of about 300 mm, irrigated agriculture should form the basis of development. Existing water resources are groundwater and unstable surface water at upstream of the Wadi El Arish. Therefore, introduction of irrigation water from the River Nile by extending the El Salam Canal is indispensable for the integrated regional development based on a stable agricultural infrastructure.

1) El Salam Canal Extension

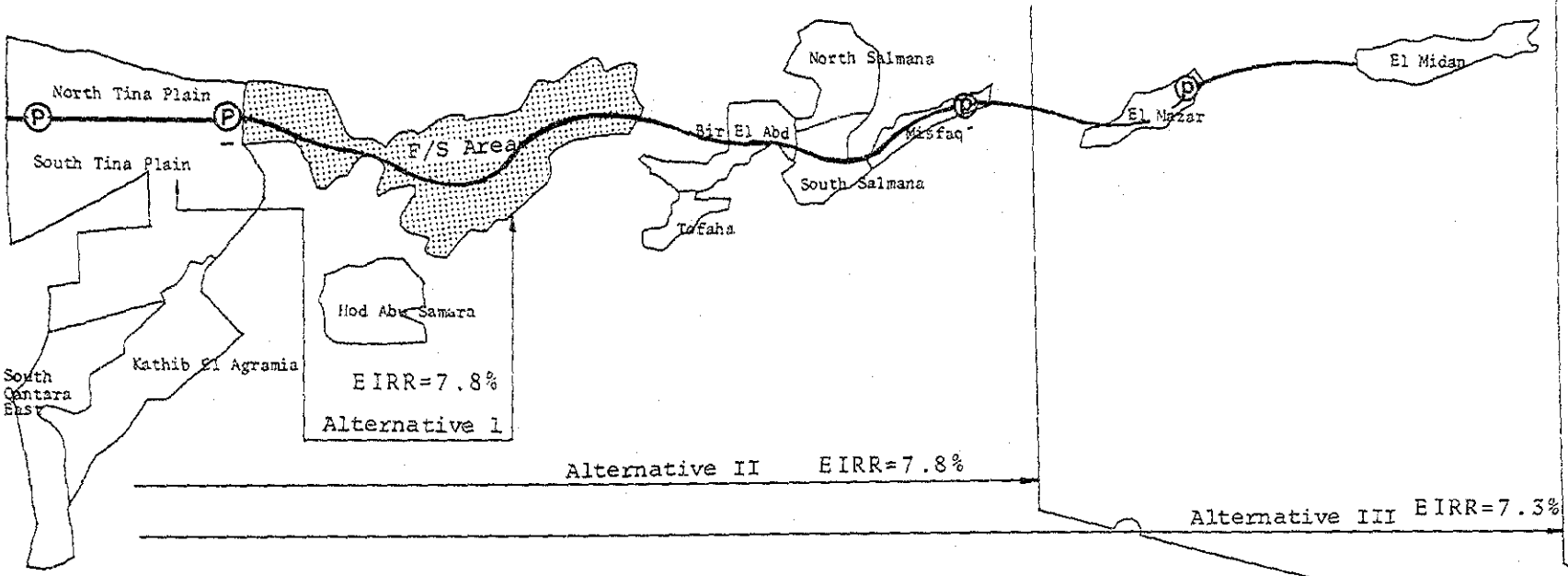
To determine how far the El Salam Canal should be extended, comparative economic evaluation was made for three alternatives, as shown in Figure 3.3-1.

The results indicate that agricultural development in the North Sinai area would be more profitable taking large area in order to reduce construction costs per feddan necessary for siphon, main/lateral canals and pump stations, etc. Namely, Alternative II up to Misfaq is the most profitable from the viewpoint of cost and benefit (refer to APPENDIX-H).

For comparison purpose, EIRR was accounted based on the project cost and benefit estimated for the Rabaa/Qatia Area temporarily. And the results of EIRR might be lower than the actual. Therefore, feasibility study for each subproject should be done in order to estimate EIRR in more detail.

The continuous series of development without vacant area is desired, therefore, the extension up to El Midan (Alternative III) will be adopted in the Long-term Plan. In other words, the Canal will be extended up to Misfaq area by the Medium-term Plan (target year 2002) and for further eastern portion, the Canal extension will be reconsidered after reviewing the progress and result of the development by that time. Consequently, a series of continuous area between Suez Canal and El Arish will be reclaimed in addition to the Eastern Area where existing farmlands are distributed and now used for cropping.

Figure 3.3-1 Comparative Evaluation of El Salam Canal



Items \ Area Name	North Tina Plain	South Tina Plain	South Qantara East	Kathib El Agramia	Hod Abu Samara	F/S Area	Bir El Abd	Tofaha	North Salmana	South Salmana	Misfaq	El Mazar	El Midan
Gross Area (feddan)	22,300	60,000	22,900	25,200	14,000	53,400	10,000	4,100	12,000	9,100	5,000	6,700	10,000
Net Area (feddan)	16,700	50,600	18,300	20,200	11,200	41,600	8,000	3,300	9,600	7,300	4,000	5,000	8,000
Proposed Cropping Pattern (CP)	CP-2	CP-1 CP-2 CP-3 CP-4	CP-1 CP-3	CP-4	CP-4	CP-1 CP-2 CP-3 CP-4 CP-5	CP-4	CP-1	CP-1	CP-1	CP-5	CP-1 CP-4	CP-1 CP-4
Gross Production Value (1,000LE)	54,267	166,916	96,575	18,778	10,411	-	7,437	8,313	24,187	18,392	23,360	9,100	14,432
Production Cost (1,000LE)	16,746	73,076	48,377	12,868	7,134	-	5,096	3,856	11,223	8,535	10,607	4,674	7,437
Net Production Value (1,000LE)	37,521	93,840	48,198	5,910	3,277	54,071	2,341	4,457	12,964	9,857	12,753	4,426	6,995

Alternative I

Alternative II

Alternative III

2) Land Use and Settlement Planning

The land use plan was drawn up based on the land classification map as follows:

Firstly, nonarable Class-6 land (mobile sand dune and Sabkha) was excluded from the land reclamation area. Meanwhile, existing roads, villages and towns, ruins and military areas were to be left as they were or expanded in the future.

Secondary, arable land (Class-2 to Class-4 land) was proposed to be reclaimed as shown in Figure 3.3-2 and Table 3.3-1. Accordingly, 254,700 feddan (gross) of land was determined to be reclaimed for farmland (203,800 feddan, net) and the reclaimed farmland will be allocated to settlers in different categories as below:

Category	Farm Size (feddan/household)	Ratio in Total Area (%)
Smallholders	5	50 - 65
Graduates	10	10 - 15
Investors	80/unit	25 - 35

As for the distribution ratio for each category, land conditions and balance of farm labour requirement should be considered. It is recommended to promote the settlement of smallholders including the Bedouin who are willing to settle.

Based on the above-mentioned premise, the land settlement plan in the M/P Area was prepared as shown in Figure 3.3-2 and Table 3.3-2. As the results, 50 percent of reclaimable land is distributed for smallholders, 15 percent for graduates and 35 percent for investors, respectively.

Sand flat where partly settled Bedouin farmers cultivate crops under drip irrigation, were determined to be allocated to smallholders including Bedouin. Sandy terrain with gentle

undulation (sand undulating) was to be allocated to graduates or investors. A somewhat steeper portion of sand undulating was to be allocated to the investors who will grow fruit trees. Clay flats were planned for allocation to smallholders migrating from the Delta region.

Exploring the groundwater, farmland with drip irrigation system have been expanded by Bedouin settlers. But the groundwater quality is saline; therefore, the existing farmlands will also be included in the on-farm development plan when Nile water becomes available through the El Salam Canal extension. The current land ownership will be assured or compensated after the project implementation.

The total number of farming families is estimated at 27,600 households. On their farmland, fruits, vegetables, oil crops and fodder crops will be cropped under sprinkler and drip irrigation systems (surface irrigation in the Tina Plain). Livestock production mainly of sheep, goats and beef cattle will be practised.

Oil-extracting and slaughtering/cut meat processing plants will be established for agro-industrial development in investors complex which includes the following facilities:

- Farm machinery shed
- Slaughterhouse with cut meat plant
- Oil extraction and refinery plant
- Fruits and vegetables marketing center

For settlers, new-communities (settlement villages) will be planned to be distributed with a maximum distance between house and farm of between 2.5 and 3.0 km. Livestock rearing facilities will be set up adjoining the settlement village.

One of the factors which can determine the project's success is the settlement plan. It is anticipated that many people who belong

Figure 3.3-2. Land Reelamation and Settlement Plan

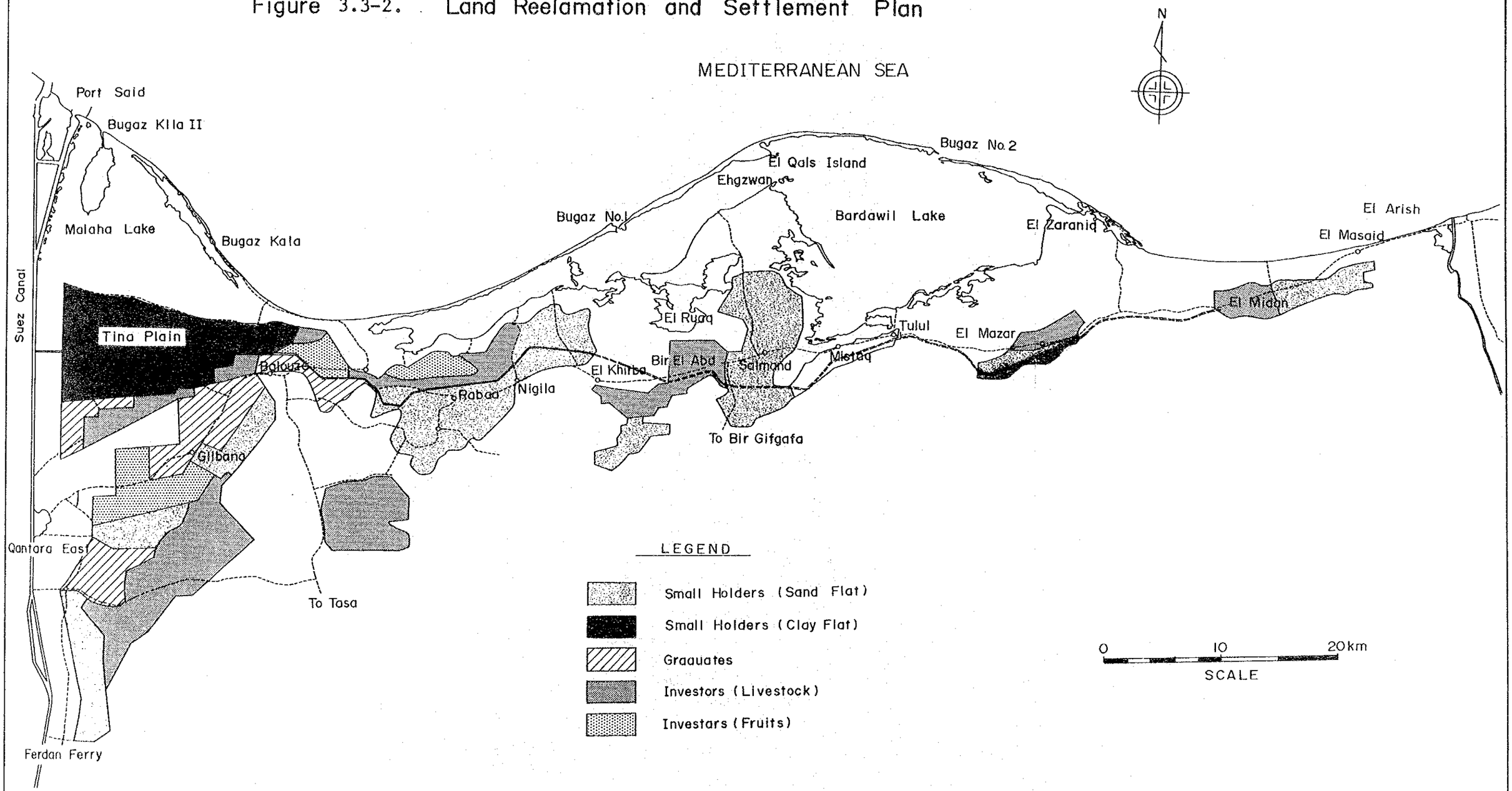


Table 3.3-1. Land Reclamation Plan

Sub-Area	Area (feddan)		
	gross	net */	net/gross
North Tina Plain	22,300	16,700	0.75
South Tina Plain	60,000	50,600	0.84
South Qantara-East	22,900	18,300	0.80
Kathib El Agramia	25,200	20,200	0.80
(Sub-total)	(130,400)	(105,800)	
Rabaa/Qatia	53,400	41,600	0.78
Hod Abu Samara	14,000	11,200	0.80
(Sub-total)	(67,400)	(52,800)	
Bir El Abd	10,000	8,000	0.80
Tofaha	4,100	3,300	0.80
North Salmana	12,000	9,600	0.80
South Salmana	9,100	7,300	0.80
Misfaq	5,000	4,000	0.80
(Sub-total)	(40,200)	(32,200)	
El Mazar	6,700	5,000	0.75
El Midan	10,000	8,000	0.80
(Sub-total)	(16,700)	(13,000)	
Total	254,700	203,800	0.80

*/ net cultivable area

Table 3.3-2. Land Settlement Plan

(Unit: feddan)

Settlement Category	Farm Size	Area (gross)	%
Small Holders			
Sand flat	5	82,200	
Clay flat	5	38,000	
(Sub-total)		(120,200)	50.0
Graduates	10	36,000	15.0
Investors			
Livestock	80	67,000	
Fruits	80	17,100	
(Sub-total)		(84,100)	35.0
Total Cultivated Land */		240,300	100.0
Non-cultivated Land		14,400	
Total		254,700	

*/ including the area of on-farm facilities

to various categories including the Bedouin, will come to settle from many different locations. Therefore, the main premises for the settlement are as follows:

- To act in harmony with each other
- To realize highly productive agriculture
- To achieve self-supporting agricultural management

In order to establish a rural communities with favourable cooperation among residents and also to promote productive agriculture, it is recommended to form settlements with farmers who belong to the same category or whose places of origin are the same. The settlers will be organized for the efficient use of irrigation and for marketing of agricultural products.

3) Farm Management Planning

It is imperative to establish stabilized productivity by improving soil-water-holding capacity and nutrient retention capacity. This can be realized by coupling crop production with a livestock sector. Firstly, crops should be diversified including fodder crops to prevent continuous monocropping hazards and to increase vegetative coverage on the reclaimed land, protecting them from wind erosion. Secondly, livestock by-products should be effectively utilized to supply manure to farmland and crop by-products to livestock feeding.

The crop selection was made among: 1) food crops, 2) fodder crops, 3) oil crops, 4) vegetables and fruits for foreign exports. As regards livestock, local beef cattle and flocks of goats and sheep, under a collective feeding system, are proposed.

Finally, six farming type are proposed to be developed in the M/P Study area, based on the soils, topography and sizes of holdings.

The typical cropping pattern with rotation will be proposed for respective farm types as below:

Farm Type	Settlement	Characteristics		
CP-1	Smallholders	Sand flats	Oil crops Goats & sheep	Sprinkler irrigation
CP-2	"	Clay flats	Food crops; Fodder crop; Cattle	Surface basin irrigation
CP-3	Graduates	Sand undulating	Oil crops; Fruits; Cattle	Sprinkler and drip irrigation
CP-4	Investors	"	Livestock	Sprinkler irrigation
CP-5	"	"	Fruits	Drip irrigation
CP-6	Existing farmers	Sand flats	Vegetables, Fruits	Sprinkler and drip irrigation

Clay flat (Tina Plain) is suitable for food crops and fodder crops including rice, as it needs periodical leaching of salts by flood irrigation. Typical patterns of farming found in the Nile Delta are adaptable to this plain.

Flat sandy terrains, on the other hand, are suitable for cash crops farming, especially oil processing crops coupled with livestock production. Undulating sand terrains have complicated topography, therefore, it can be oriented to farming developed as fruits or vegetable gardens for graduate settlers, also as commercial farms of livestock or fruits orchards for investors. Wind erosion should be prevented by windbreaks.

In the Eastern Division, the existing farms will be improved their productivities through rational use of groundwater for irrigation.

3.3.3. Fishery Development Strategy

With respect to fishery, Bardawil Lagoon Development Programme is being implemented by GAFRD. Fishery production in Egypt lags behind consumption, while the demand for fishery products has a tendency to increase, resulting in a dependence on imports. North Sinai area has a potential for inland fishery development in the Bardawil and Malaha Lakes and aquaculture is possible in the north Tina Plain.

In the Bardawil Lake, fishery will be developed through the improvement of openings (Bughaz I and II) to maintain the salinity and to migrate fish fry by an exchange of seawater. Production of the lake is limited, because the high salinity inhibits normal growth of common fishes and the nutrients is not supplied. As reported by the previous studies, the fish catch is declining, indicating that the lake has already been over-exploited.

Under these conditions, the following measures can be considered:

(1) To secure seawater exchange and circulation, which is an indispensable for fishery production in the lake. Existing openings Bughaz I and II should be protected from siltation so as to maintain the lake's fishing grounds.

(2) To raise the primary production by introducing drainage water into the lake, which will dilute the salinity and supply nutrients.

(3) To strengthen the fishery regulations and management so as to preserve and exploit the resources under appropriate fishing activities.

Priority should be given to the preservation of the natural environment, because the Bardawil Lake is the country's sole lake without pollution. Therefore, it is desirable not to lead drained water into the lake in order to preserve its clean ecosystem.

Accordingly, the measure in item(2) should be taken on a limited basis. For the fishery development, the following plans will be studied:

- Improvement of the lake openings (Bughaz I and II)
- Reconstruction of the western part of the lake
- Fish landing port improvement
- Nigila fishery center

The Malaha Lake is a hypersaline shallow water body as the Bardawil Lake. The fishery production is maintained by keeping the salinity below the critical level by water exchange and fish fry migration from the sea through the openings. Therefore, the evelopment plan should be made through (i) to preserve fishing ground by efficient water exchange and circulation, (ii) to dilute salinity and supply nutrients by directing drainage water, and (iii) to introduce aquaculture techniques.

3.3.4. Agro-Industry and Marketing Development Strategy

The Sinai Peninsula has not been developed for industrial development owing to its remoteness and scarce supply of raw materials. However, once agricultural and fishery development comes into operation, this sector will play a major role.

Since this sector requires water and electricity supplies as well as an efficient transport system, the processing plants will be established at locations along the highway or near the production area of raw materials. The site for fisheries processing will be found at the principal landing port.

The processing plants with a combination of oil extraction and refining facility and those with slaughterhouse with a cut meat processing facility will be established. And the ice plant for fish preservation with cold storage will be established at fish landing.

Marketing activity for agricultural products is not organized, therefore, no warehouse and cold storage for marketing use are observed. This method of handling often causes a fair percentage damages or loss from withering. The following facilities are required to storing, processing and marketing of agricultural, livestock and fishery products.

(1) Marketing Centers for Perishable Products

Especially facilities for vegetables and fruits destined for exports are required. Vegetable and fruits have large volumes, accordingly, it is necessary to market them efficiently.

(2) Cold Storage and Marketing Facilities for Fishery Product

Fishery ports and related facilities are planned at Tulul and Nigila by the cooperation of EC. The project will be promoted to keep the quality of fishery product and to diminish the loss during the marketing.

3.3.5. New-Community Development Strategy

Population of the Study Area will increase in future owing to the various development plans. In particular, the agricultural development will affect the population increase drastically. Such a rapid increase will require new-communities for settlers. Therefore, settlement villages have to be constructed in the reclaimed area to cope with this increasing population.

Currently, in the existing communities alongside the highway, such infrastructure as water supply, electricity and telecommunication has been established compared to other areas.

El Qantara East (new-community) will be the marketing point between the North Sinai region and the Delta region having an important role to the agricultural development of Tina Plain. Bir El Abd is a center of Markaz of which area shares nearly half of the

North Sinai region. A new-community is currently under construction. It is also a diverging point for the Maghara coal mine road as well as the center of a regional economic zone.

Function of such existing communities as El Arish, Rafah, Sheikh Zuwayid, El Qantara East, Bir El Abd should be expanded to make them centers for commercial and marketing system.

The study of PPU/GARPAD states that existing communities, if they are to continue self-sustaining economic bases through traditional activities, will find it impossible to provide a labour sources, service, nor to be easily linked with the new-community plan. However, in view of regional development, at least the social service networks should be linked intentionally between the existing communities and the proposed new-communities. In other words, the principal existing communities will act as service centers for the settlement villages in the area.

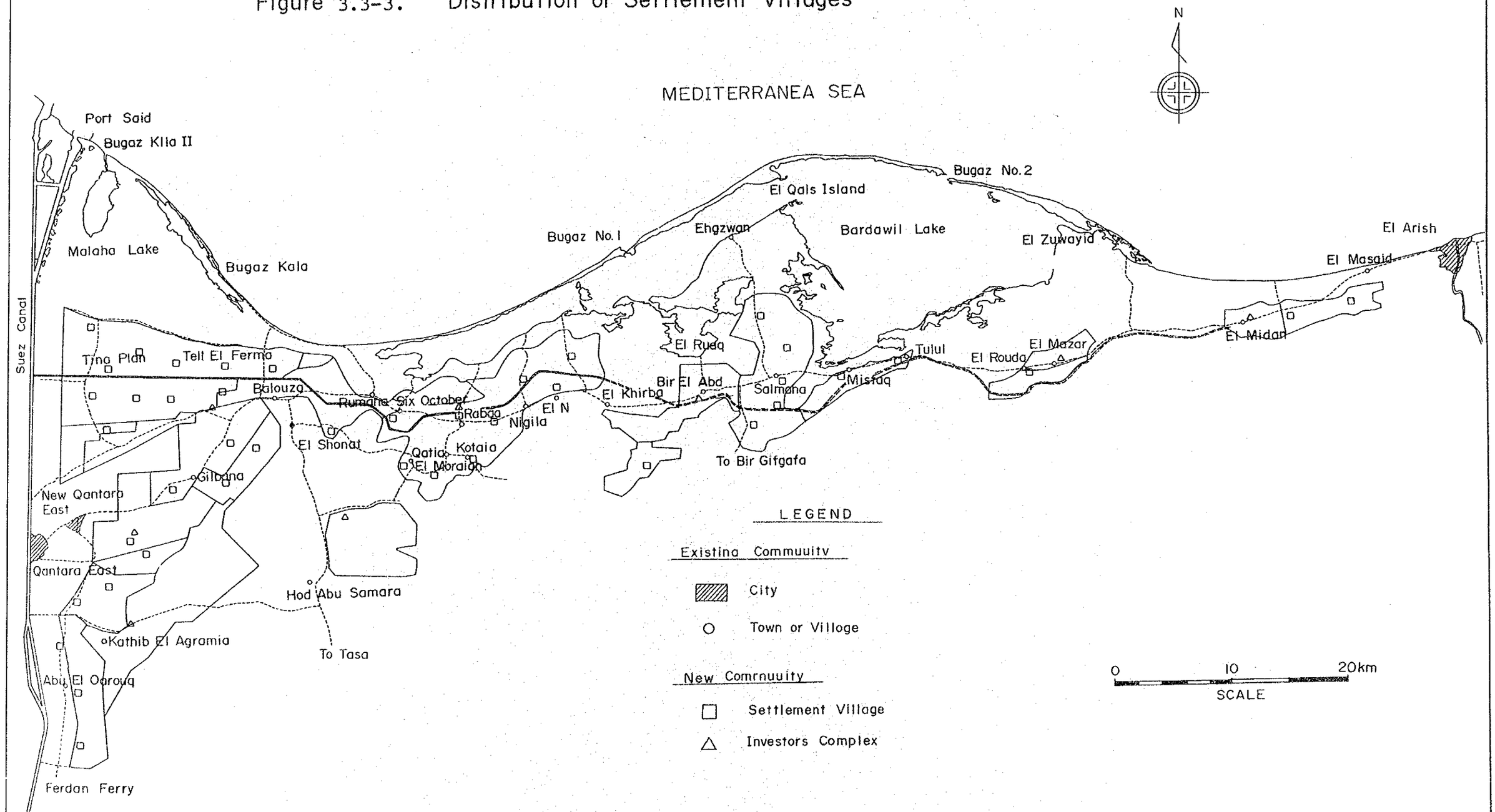
The number of households of settlement farmers is about 30,000 and the new-community development for providing them their housing is necessary. The settlement villages are distributed to make the distance from house to farm within 2.5 to 3.0 km; accordingly, the number of settlement villages is about 40 in total (Figure 3.3-3). In addition, a new-community for fishery households will be constructed near the Malaha Lake. For the new-communities, infrastructure such as house and potable water supply and social services as medical care and educational facilities are required.

Table 3.3-3. Number of Settlement Farmers

Settlement Category	No. of Families	Population
Small Holders		
Sand Flat	16,400	82,000
Clay Flat	7,600	38,000
(Sub-total)	(24,000)	(120,000)
Graduates	3,600	18,000
Total	27,600	138,000
Non-farming Families*/	4,900	24,500
Grand Total	32,500	162,500

Note: */ 15% of total families

Figure 3.3-3. Distribution of Settlement Villages



3.3.6. Tourism Development Strategy

The basic survey on tourism development was conducted by EGYPTEAM and the city development master plan for El Arish was prepared by MOD. This survey concluded that coastal areas of the Mediterranean Sea had a potential for tourism development owing to the favourable climatic conditions and landscape.

The present study also confirmed that the coastline from Balouza to Rumana and from El Masaid to Rafah, and El Ruag Bay in the Bardawil Lake and Port Fouad in the Meditterranean Sea coast are especially suited for tourism development. The area can be developed as a recreation area for local people and tourists from other areas of Egypt after constructing road systems and lodging and recreational facilities.

The El Zaraniq lagoon at the eastern end of Bardawil Lake is world famous for migratory birds. In parts of the Tina Plain, ruins of the Greek and Roman era are distributed, however, excavation or preservation measures are still underway.

The tourism development closely relates to the development of other sectors. In the regional development context, the growth of urban and rural areas may greatly encourage the tourism development. There may be several difficulties for the Study Area in attaining rapid development due to lack of infrastructure and social services compared to the existing resort areas. The tourism development should go simultaneously with the development of infrastructure and social services of the region. Finally, the development has an important role for increasing the amenities of rural life in the new communities.

CHAPTER 4. THE SECTOR DEVELOPMENT PLAN

4.1. Crop and Livestock Production Plan

4.1.1. Farming Type

Six farming types are proposed to be developed in the M/P area, based on the soils, topography and various sizes of holdings adopted. Their conditions and features are shown in Table 4.1-1.

4.1.2. Selection of Crop and Animal Species

It is imperative to make selections which are viable and likely to maximize the utilization of available human resources with efficient techniques in the field of horticulture, in combination with water resources from El Salam Canal. What is to be produced must be of value added and largely exportable, consistent with the prospect of future trends in the supply - demand situations for both domestic and foreign markets. The existing horticultural zone in North Sinai is favourably situated to serve as a supplier of fresh and/or processed foodstuffs to the Greater Cairo metropolis and also internationally, towards the Middle or Near East and Europe during the off-season. In order to harness such favorable locational conditions, it is essential to introduce industrial crops of a value added type. Flat and expansive desert areas provide an ideal base for the large-scale, low-cost production of industrial crops. The expected function of employment creation can be derived not only from local agro-industrial activities, but also to some extent from farm activities. This can be achieved through the combined system of fodder and oil crops with meat production. Labour demand arises from collective animal husbandry with fodder, agro-industrial by-products, and crop residues.

Accordingly, the recommended crops for Sinai may consist of (1) field crops and fodder crops for the initial few years (to make the desert fertile), (2) industrial crops to supply local processing materials and (3) vegetables and fruits for foreign exports or for markets outside the governorate. Agricultural activities are

Table 4.1-1. Proposed Farming Types

Type of Farming	CP-1	CP-2	CP-3	CP-4	CP-5	CP-6
Locational Situation	Sand Flat	Clay Flat	Sand Undulating	Sand Undulating	Sand Undulating	Eastern Terrain
Project area (feddan)	61,000	31,300	39,900	65,900	5,700	59,500
Settlers	smallholder	smallholder	graduate	investor	investor	existing farmer
Holding size (feddan)	5	5	10	80	80	8
Type of farming	combined, oil crop with sheep/goats	combined, field crop with cattle	combined, crop, orchard with cattle	livestock, specialized	orchard, specialized	crop diversified summer fallow
Role of animal husbandry	Major role	auxiliary role	auxiliary role	specialized	not combined manure purchased	not combined manure purchased
Labour Supply / mechanization	labour intensive, suppliable to other types	mechanizing paddy only labour intensive	self supplied labour, no typical mechanization	hired labour, mechanized	hired labour, mechanized	self supplied labour

determined by various parameters such as suitable crops or varieties for soil and climatic conditions as well as their yield or quality levels. Their ability to follow relevant farming practices to ensure them. Emphasis should be put on versatile crops with long shelf life, available for processing and less damaging to soil fertility.

In the initial stages of reclamation, highly salt-tolerant crops and varieties are preferable, and land-maturing stage fodder crops should be incorporated into a rotation systems as evenly as possible so that they can restore soil fertility during the longer span of the project period. These crops are particularly important for procuring green fodder during the winter when shortages often become acute.

To ensure feed security, various factors such as crop selection in terms of low-temperature adaptability, soil adaptability (e.g. alfalfa for sandy areas and berseem for loamy areas), well-balanced nutritional composition (combination of gramineae, legumineae and amaranthaceae) should receive careful consideration.

As regards livestock species and varieties, a host of elements should be taken into account, i.e., feeding experience, current technical levels, usage and processing of products, mortality risk, type and amounts of available fodder or grains, etc. Basically, herds of local beef cattle and flocks of goats and sheep, under a system of collective feeding is coupled with vegetable oil system, and cattle meat production coupled with field crops. Further individual, rearing systems should be coupled with crops production, enclosed feeding of sheep and goats by feeding fodder, marketed crop residues and oil cakes.

Poultry, rabbit-rearing, and dairy farming were studied, but it was found that profitable management could not be realized under the prevailing conditions observed in the Study Area. Besides, heavy investment and technical experience are essential to make these sectors commercially viable.

4.1.3. Cropping Patterns

The representative cropping pattern for each farming type is proposed as follows (Figure 4.1-1):

1) Cropping Pattern CP-1

This pattern is applied on sandy flat areas, where immediate cropping is available after the completion of land consolidation work. Twenty percent of the area under this pattern is planted with olive trees (for oil production), where a rotation is introduced covering fodder crops, oil crops, and vegetables. The sandy soils under this pattern have low water holding capacity and poor nutrient retention capacity. These constraints can be improved by heavy application of manure or crop residues. This is why livestock is emphasized in this pattern to which fodder crops are heavily devoted. For example, successive cuttings of alfalfa for two years, can be incorporated with fodder beet as a winter crop and sordan and napiergrass as summer forages so that seasonal fluctuations in feeds supply can be minimized. As a whole, the importance of the roles fodder crops play in the protection of farmlands from wind erosion as well as in the supply of soil organic matter is fully realized in the cropping patterns.

Vegetables are grown principally during nily and winter season. In addition, vegetables share of the total cropping was limited to less than 15 percent with a great diversity of species to avoid over production.

As regards oil seeds, high-yield oil bearing species which produce oil cakes with high nutritional value were chosen. Olive oil is harvested in the fifth year after planting, but during the growing period prior to the first harvesting other short season crops can be intercropped. Goats and sheep constitute the livestock sector because they are suitable for smallholders.

2) Cropping Pattern CP-2

This pattern is applied on saline clay flat land. After leaching, salt-tolerant amshoot (Echinochiloa crassicarum) is sown as a fodder crop followed by paddy. Rice is used as a regular rotation crop because periodical leaching under submerged conditions with paddy rice every three year is desirable to facilitate desalinization.

Vegetables are grown as nily and spring crops. Frenchbeans and tomatoes are planned as export crops. An equal share was given to cereals and fodder crops. Maize, alfalfa, and other salt-susceptible crops are excluded. Beef cattle constitutes the livestock species. Mechanization is only applied to paddy cropping.

3) Cropping Pattern CP-3

Because this pattern is applied on fairly undulating sandy terrain, 40 percent of the arable area is devoted to orchards. The rest is cropped in a way such that fodder crops and others (field crops, oil seeds, and vegetables) have roughly equal shares. Beef cattle constitute the livestock sector. This pattern, with a holding size roughly twice that of CP-1. It should be managed by family labour and through minimum initial investment. To meet this requirement, the share of vegetable cropping was set at under 15 percent. Plastic tunnels are used for some species of winter vegetables. Groundnut is planned only for confectionery usage but no oil varieties are introduced due to low returns for processing materials. As for orchard trees, species which have not been planted widely in existing orchards, i.e., apples, oranges, grapes and figs, are adopted to avert possible competition or oversupply.

4) Cropping Pattern CP-4

This is applied to undulating sandy terrain but comparatively flat sand deposits, devoted to feed crop production through which investors keep a large size herds of beef cattle or goats and sheep.

Less than 20 percent of cropping share is given to early summer oil crop (sunflower). For the same reason, fodder maize is to be introduced as a nily crop, so that its growing season would fall in late summer to mid autumn.

As major fodder crops, alfalfa is to be grown perennially for three consecutive years, fodder beet and feed barley are cropped for winter crops, with sordan (a gramineae species genetically closer to sorghum) and fodder maize as summer fodders.

In this pattern either beef cattle or sheep/goats are employed on a commercial basis, i.e. in large herds or flocks, depending on the profitability (though the latter require more labour). Hired labour and mechanization are essential for the investors to manage their farms under this pattern, and livestock rearing also requires hired labour according to the herd size being kept. Investors can employ smallholders to meet their labour requirements.

5) Cropping Pattern CP-5

This is applied to areas which are highly undulating sand and subject to wind erosion, reclaimed with limited cutting or filling into orchard plots. The reclaimed land is irrigated with drip pipes. Consequently, the area under such conditions can only be developed as orchards.

Fruit species were selected in order to avoid competing with existing fruit producing areas in and around the governorate. A larger planting share, namely 40 percent, was allotted to apples because of their relatively limited planting throughout Egypt and within the North Sinai Governorate. This is followed by grapes and figs each of which have 20 percent of the orchard area. Various minor fruit species, such as oranges and guavas are planted in the orchard area.

Planting density is initially set at 250 seedlings per feddan for maximizing yields at an early stage of maturity, but thinning should be practised as soon as they develop to form a broad canopy, eventually leaving only two thirds of the original population at the matured stage.

Labour supply from smallholders is fully utilized to manage orchards, but the selected species will provide broadly dispersed peaks of harvesting ranging from June to November. Harvesting quantities are then evenly distributed during the proposed harvesting season, so that hired labour may be economized. Harvested fruits are sent to a fruit grading and packing center for fresh marketing. Processed fruit such as juice, canned fruits, and dry fruits still have a low level of domestic consumption, and only a few percent of fruits are marketed in a processed form.

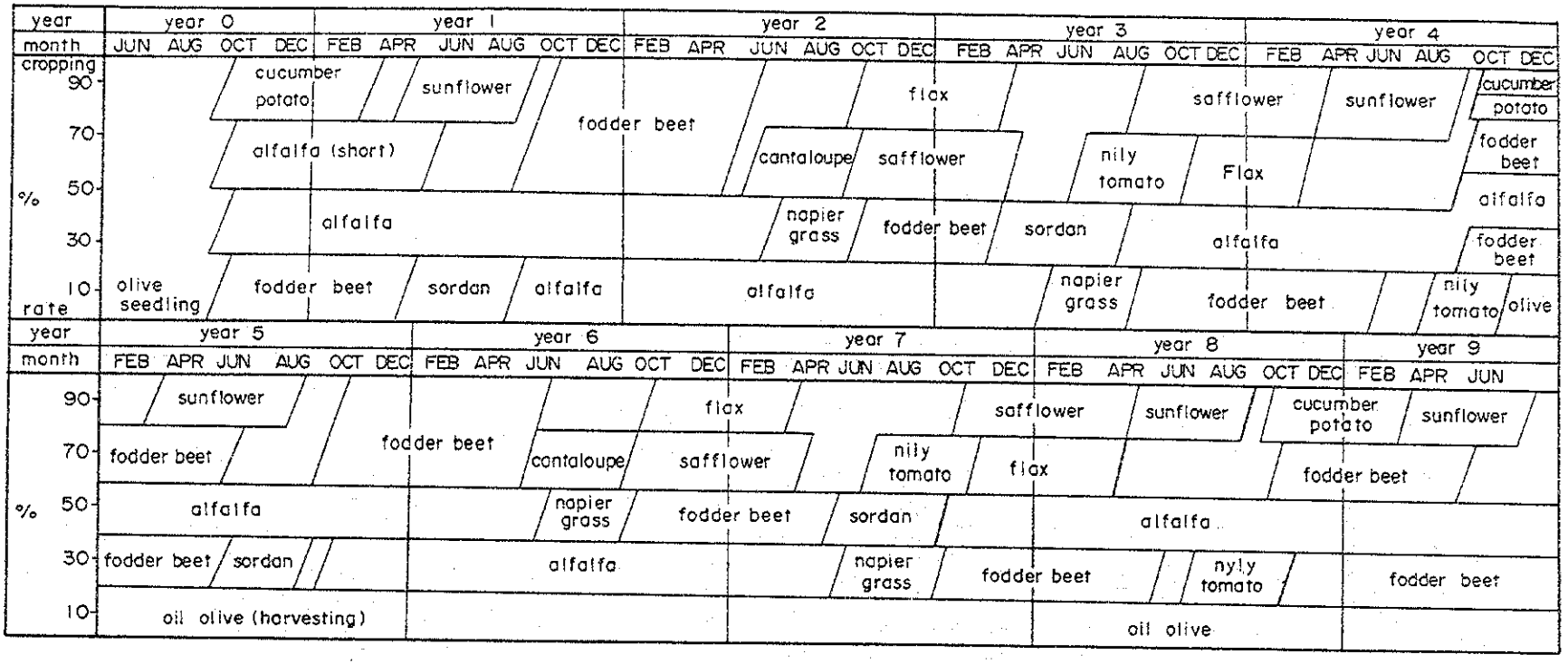
6) Cropping Pattern CP-6

This pattern is only applicable to the existing farms in the Eastern Division, located in El Arish and farther to the east. The agriculture is specialized in orchards and the horticultural sector. A part of orchards are still at an immature stage, representing 80 percent of the total acreage, and consists of such species as peaches, almonds, olive (as a food), figs and dates. Solanaceae and cucurbitaceae as summer crops are projected to decline, even though they are currently prevalent during the summer, leaving more concentration on winter crops.

For the rational use of groundwater, this pattern gives complete fallow for summer season, and introducing only winter crops. In this pattern, continuous single cropping should be avoided through a crop rotation using different families of vegetables, that is, solanaceae, cucurbitaceae and malvaceae. The organic matter necessary for field plots should be supplied from nearby poultry farms or from the western Study Area where surplus manure is anticipated.

Figure 4.1-1 Proposed Cropping Pattern

CP-1 : Smallholders (Sand Flat)



CP-2 : Smallholders (Clay Flat)

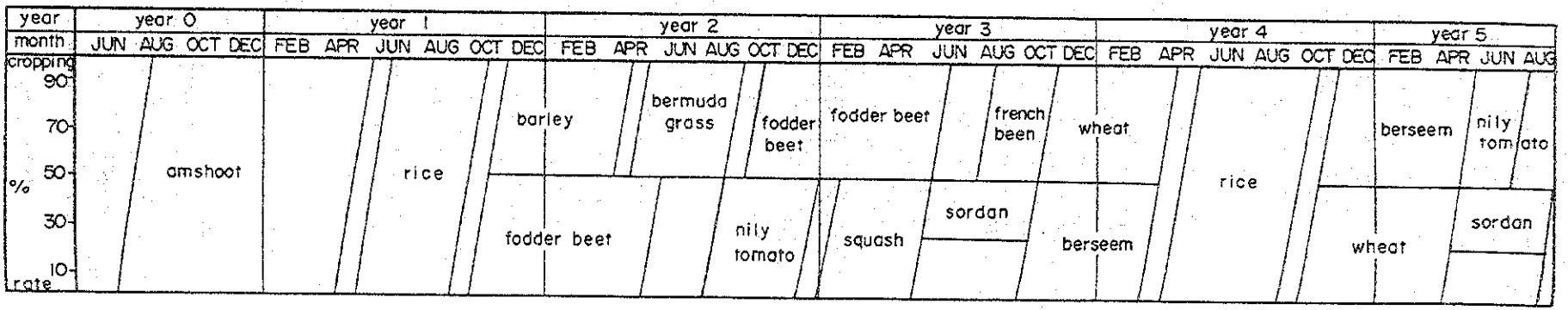
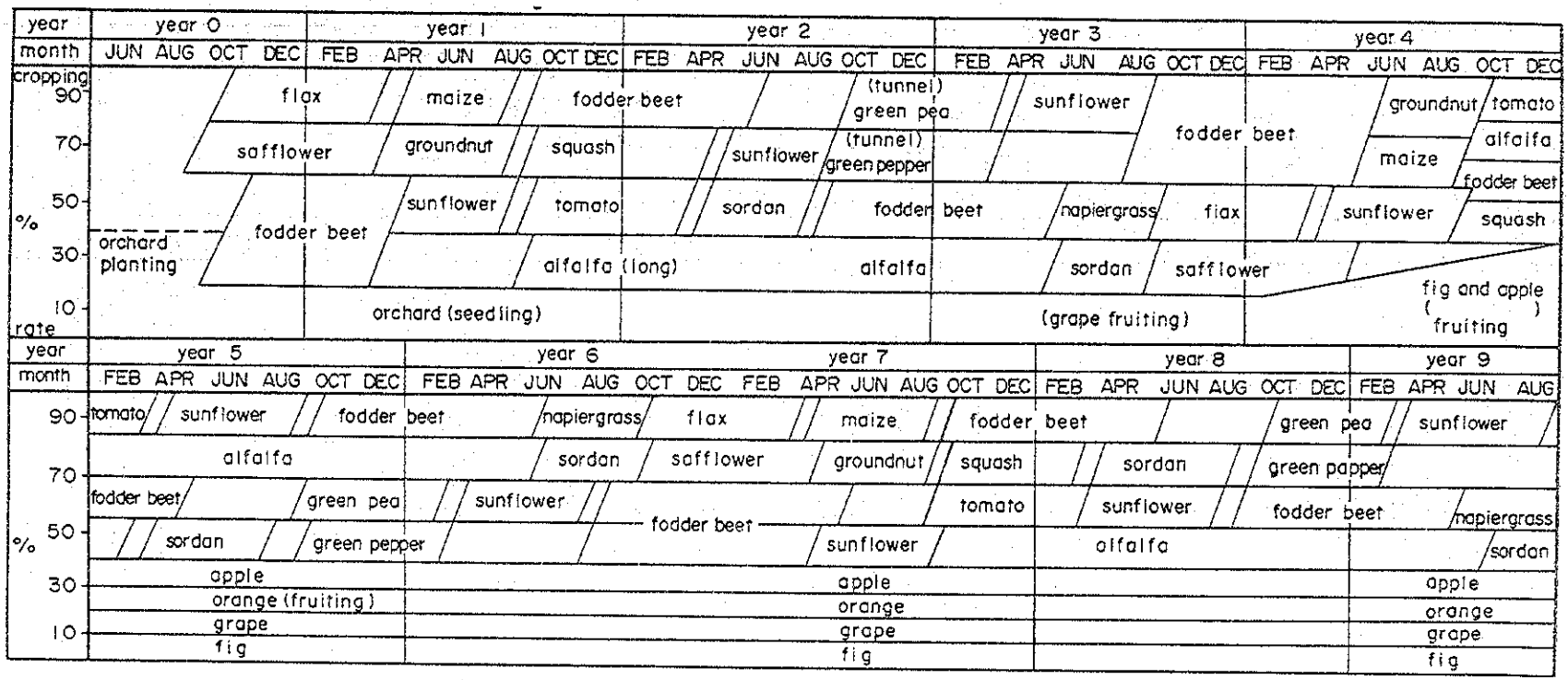


Figure 4.1-1 Proposed Cropping Pattern

CP-3 : Graduate (Sand Undulationg)



CP-4 : Investors (Livestock)

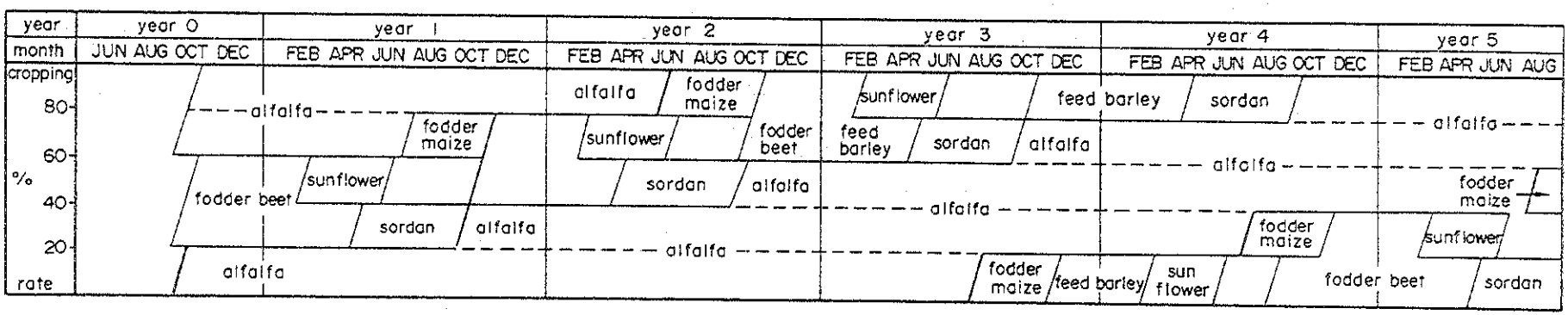


Figure 4.1-1 Proposed Cropping Pattern

CP-5 : Investors (Fruits)

year	year 0	year 1	year 2	year 3	year 4	year 5
month	JUN AUG OCT DEC	FEB APR JUN AUG OCT DEC	FEB APR JUN AUG OCT DEC	FEB APR JUN AUG OCT DEC	FEB APR JUN AUG OCT DEC	FEB APR JUN AUG
cropping 90 70 % 50 30 10 rate		apple (40%)		apple	⇒ fruiting	(40%)
		grape (20%)		grape ⇒ fruiting		(20%)
		fig (20%)		fig ⇒ fruiting		(20%)
		orange (10%)		orange		(10%) fruiting
		guava (10%)		guava	⇒ fruiting	(10%)

CP-6 : Existing Farms (Eastern Division)

Month	1st year						2nd year						3rd year						4th year					
Year	Feb	Apr	Jun	Aug	Oct	Dec	Feb	Apr	Jun	Aug	Oct	Dec	Feb	Apr	Jun	Aug	Oct	Dec	Feb	Apr	Jun	Aug	Oct	Dec
80%	(Ochra)				Tomato						Squash						Eggplant						Ochra	
0%	Fruits (Peach, Almond, Olive, Fig)						Fruits (Peach, Almond, Olive, Fig)						Fruits (D.O.)						Fruits (D.O.)					

4.1.4. Target Yields and Production

Crop yields will increase as time elapses after reclamation. Generally speaking, loamy soils have slower pace in yield development but can attain higher levels than sandy soils. Reasonable yield levels are expected on the basis of comparable levels in the Nile Delta for the Tina Plain and those in Ismailia for sand sheets. They are also estimated from experiences in the existing reclaimed areas.

It is important to stress that quality and timing of harvesting will be more vital factors for farmers to market their vegetables or fruits in the future. Crop yield targets are listed in Table 4.1-2. One target is to increase production by increasing cropping intensity to 200 percent (i.e. two crops a year), resulting in greater water-use efficiency, minimizing barren land, with plant coverage over soil surface to prevent upward salt movement. Total net cultivation area and the estimated production by farm types are shown in Tables 4.1-3 and 4.1-4, respectively.

4.1.5. Basic Techniques for Crop Production

Choking of dripping emitters, hazardous salt accumulation, manifestation of alkaline hazard, nematodes, particularly schists will encounter some basic problems as reclaimed farmlands. With regard to salinization, no effective countermeasure has been developed other than periodic leaching, changing plant hills, or surface mulch to restrict soil evaporation. Alkalinity problems can be mitigated through application of gypsum. Schist nematodes may be prevented by crop rotation and chemical control, etc.

In planting orchard trees, organic application in deep pits before planting will foster the development of a canopy. This organic manure will raise the water and nutrient retentive capacity of sandy soils, and will serve as a means of improving the productivity of sandy soils along with slow-acting fertilizer and splitting applications.

Table 4.1-2. Target Crop Yield

(unit : ton / feddan)

Crop	Clay Flat Crop	Clay Flat Straw	Sand Flat Crop	Sand Flat Straw	Sand Undulating Crop	Sand Undulating Straw	East Area Crop	East Area Straw
Cereals								
Rice	2.0	2.0	-	-	-	-	-	-
Wheat	1.3	1.4	-	-	-	-	-	-
Maize	-	-	-	-	1.5	1.5	-	-
Groundnut	-	-	-	-	0.8	0.6	-	-
Oil								
Flax	-	-	0.5	2.3	0.5	2.3	-	-
Safflower	-	-	0.5	-	0.5	-	-	-
Sunflower	-	-	0.9	-	0.9	-	-	-
Fodder								
Amshoot	20.0	-	-	-	-	-	-	-
Alfalfa	-	-	30.0	-	32.0	-	-	-
Berseem	28.0	-	-	-	-	-	-	-
Feed Barley	-	-	-	-	1.0	1.5	-	-
Fodderbeet	35.0	-	32.0	-	32.0	-	-	-
Fodder Maize	-	-	-	-	25.0	-	-	-
Napiergrass	30.0	-	27.0	-	27.0	-	-	-
Sordan	35.0	-	32.0	-	32.0	-	-	-
Vegetable								
Tomato	8.0	-	7.0	-	7.0	-	8.0	-
Green Peppet	-	-	-	-	5.0	-	-	-
Cucumber	-	-	5.0	-	-	-	-	-
Squash	8.0	-	-	-	7.0	-	8.0	-
Cantalope	-	-	6.0	-	-	-	6.0	-
Okra	-	-	-	-	-	-	10.0	-
Green Beans	5.0	1.0	-	-	-	-	-	-
Potato	-	-	6.0	-	-	-	-	-
Green Peas	-	-	-	-	4.0	-	-	-
Fruits								
Apple	-	-	-	-	2.0	-	-	-
Peach	-	-	-	-	-	-	3.0	-
Grape	-	-	-	-	6.0	-	5.0	-
Guava	-	-	-	-	7.0	-	7.0	-
Olive	-	-	3.0	-	-	-	4.0	-
Orange	-	-	-	-	8.0	-	8.0	-
Fig	-	-	-	-	5.0	-	5.0	-

Notes : 1 Except cantaloupe and okra, vegetable yields indicate those for nily or winter crop.
2 Olive yield gives oil olive species for "undulating"

Table 4.1-3. Total Net cultivation Area

(unit : 1000 / feddan, net)

Cropping Pattern	C. P-1	C. P-2	C. P-3	C. P-4	C. P-5	C. P-6	Total
North Tina Plain	-	16.7	-	-	-	-	16.7
South Tina Plain	7.0	12.8	16.1	14.7	-	-	50.6
South Qantara East	3.1	-	15.2	-	-	-	18.3
Kathib El Agramia	-	-	-	20.2	-	-	20.2
Rabaa / Qatia	23.5	1.8	4.6	6.0	5.7	-	41.6
Hod Abu Samara	-	-	-	11.2	-	-	11.2
Bir El Abd	-	-	-	8.0	-	-	8.0
Tofaha	3.3	-	-	-	-	-	3.3
North Salmana	9.6	-	-	-	-	-	9.6
South Salmana	7.3	-	-	-	-	-	7.3
Misfaq	-	-	4.0	-	-	-	4.0
El Mazar	2.8	-	-	2.2	-	-	5.0
El Midan	4.4	-	-	3.6	-	-	8.0
Sub-total (canal irrigated)	61.0	31.3	39.9	65.9	5.7	0	203.8
Wadi El Arish	-	-	-	-	-	5.1	5.1
Sheikh Zuwayed / Rafah	-	-	-	-	-	54.4	54.4
Sub-total (ground water irrigated)	-	-	-	-	-	59.5	59.5
Total	61.0	31.3	39.9	65.9	5.7	59.5	263.3

Table 4.1-4. Estimated Agricultural Production by Cropping Pattern

stabilized stage (unit : 1000.feddan, 1000 ton)

Cropping Pattern	C. P-1		C. P-2		C. P-3		C. P-4		C. P-5		C. P-6		Total	
	A	P	A	P	A	P	A	P	A	P	A	P	A	P
Area under pattern (net)	61.0		31.3		39.9		65.9		5.7		59.5		263.3	
rice	-	-	11	21	-	-	-	-	-	-	-	-	11	21
wheat	-	-	8	11	-	-	-	-	-	-	-	-	8	11
miaze	-	-	-	-	2	3	-	-	-	-	-	-	2	3
groundnut	-	-	-	-	2	2	-	-	-	-	-	-	2	2
sunflower	6	5	-	-	6	6	13	12	-	-	-	-	25	23
safflower	6	5	-	-	2	1	-	-	-	-	-	-	8	4
flax (grain)	6	3	-	-	2	1	-	-	-	-	-	-	8	4
flax (stalk)	-	14	-	-	-	4	-	-	-	-	-	-	-	18
tomato	6	42	5	40	2	14	-	-	-	-	3	24	16	120
cucumber	2	8	-	-	-	-	-	-	-	-	-	-	2	8
cantaloup	3	18	-	-	-	-	-	-	-	-	-	-	3	18
squash	-	-	5	40	2	14	-	-	-	-	3	24	10	78
potato	2	10	-	-	-	-	-	-	-	-	-	-	2	10
green pepper	-	-	-	-	2	10	-	-	-	-	-	-	2	10
green pea	-	-	-	-	2	8	-	-	-	-	-	-	2	8
french bean	-	-	5	25	-	-	-	-	-	-	-	-	5	25
okra	-	-	-	-	-	-	-	-	-	-	3	24	3	24
eggplant	-	-	-	-	-	-	-	-	-	-	3	27	3	27
berseem	-	-	8	224	-	-	-	-	-	-	-	-	8	224
alfalfa	24	728	-	-	6	178	40	1201	-	-	-	-	70	2107
fodder beet	18	583	8	286	8	253	13	427	-	-	-	-	37	1549
sordan	6	194	5	174	4	127	13	427	-	-	-	-	28	922
napiergrass	6	164	3	75	2	53	-	-	-	-	-	-	11	292
fodder maize	-	-	-	-	-	-	13	334	-	-	-	-	13	334
feed barley	-	-	-	-	-	-	13	13	-	-	-	-	13	13
apple	-	-	-	-	4	8	-	-	2	5	-	-	6	13
orange	-	-	-	-	4	32	-	-	1	5	-	-	5	37
grape	-	-	-	-	4	24	-	-	1	7	-	-	5	31
fig	-	-	-	-	4	20	-	-	1	6	2	12	7	38
guava	-	-	-	-	-	-	-	-	1	4	-	-	1	4
peach	-	-	-	-	-	-	-	-	-	-	10	30	10	30
almond	-	-	-	-	-	-	-	-	-	-	29	23	29	23
oil olive	12	36	-	-	-	-	-	-	-	-	7	28	19	64

Note : A ; area, P; production

4.1.6. Agricultural Labour and Mechanization

Generally, smallholders manage their farms on the basis of a family labour system. However, large-scale management by investor requires hired labour along with a substantial degree of mechanization for harvesting and other practices. It is important to economize on the numbers of machines and vehicles to be introduced by maximizing the performance per machine through such devices as dispersed harvesting periods and other operational peaks in machinery use.

In this plan, the range of mechanization is confined to investors' farms and smallholder's paddy practice. The labour intensive system is applied to the other farming practices to make full use of family labour resources.

4.1.7. Livestock Species

Feeding systems and feedable sizes of herds and livestock species are determined on the basis of the available amount of green fodders, oil cakes and meals, stalk and straw, and other residues from field crops and byproducts from processing. From the feed conversion ration (F.C.R), beef cattle can make the best advantage, followed by sheep and goats. However, medium- or small-sized livestock (sheep and goats) can easily be reared and also have low mortality. Apart from commercial large-scale feeding systems, medium- or small-sized livestock should be the mainstay of animal husbandry to be reared by smallholders.

With regards to beef cattle, indigenous Baladi varieties are to be adopted initially to avoid risk and to alleviate the burden of the initial investment. However, these should be switched to hybrid with foreign varieties with the highest F.C.R. during the first replacement period (within five years) when the workers become accustomed to rearing beef cattle.

As to sheep and goats, it is recommended to begin with local varieties in the North Sinai such as Duseeni or Rafmanii for sheep and Anglo-Nubian or Shami for goats.

4.1.8. Livestock Rearing System

Beef cattle can be managed either through backyard fattening by small-scale farmers with self-supplied fodders and crop residues, or through large-scale, collective feeding by graduates, or investors. From economic and managerial aspects, it is the best way to keep livestock in enclosed feedlots without the need for establishing housing facilities. Shade preparation and water supply, however, will be necessary (Figure 4.1-2).

Sheep and goats, although their F.C.R. is low, are adaptable to small herd rearing by the settled Bedouin. Moreover, these species are able to utilize olive oil cakes which presents difficulties in feeding other species.

Above all, livestock as a whole plays a vital role in supplying organic matter to sandy soils. The enclosed feedlot system, as recommended above, facilitates the collection of manure as compared with pasturing or tether grazing systems, but its greatest advantage lies in its low rearing cost.

4.1.9. Feed Balance

It is essential to restrict the amount of concentrates as far as possible due to recent remarkable rises in feed prices. In feeding beef cattle, especially in case of investors and graduates, a supplemental purchased feed supply is needed within a range equivalent to less than 30 percent of total digestible nutrients.

The most economical way of supply will be available in the purchase of rice straw from the Delta region, because it is a cheap and abundant supply. Alfalfa hay can be used for yearling beef cattle instead of costly concentrates.

Sources of self-supplied feeds consist of olive oil cakes or meal as concentrate feeds, forage crops within rotation crops, and rice straw or bean stalks. Feeding loss is estimated at 15 percent of the available feed sources. Expected annual trends in yield and production, quantities of feed crops and available nutrient components are shown in APPENDIX-D. It is assumed that the daily gain will reach 0.7 kg per day with F.C.R. of 2.5 in the finishing stage of fattening beef cattle.

Self-supplied feeds, especially fodders are freshly fed by hand or mower cutting or converted into naturally dried hay in preparation for off-season feeding (silage is an alternative, but it becomes too expensive as it needs polyethylene bags).

4.1.10. Carrying Capacity and Livestock Economy

Carrying capacity varies considerably with the rate of employing fodder crops in cropping patterns, under the programmed feeding system during the stabilized phase. In case of exclusive livestock management by investors, calculations provide the level as 1.4 head/feddan for beef cattle, and 26.8 head/feddan for adult goats/sheep. Additionally, the index for dairy cows which produce 15 kg of raw milk per day amounts to 0.5 head/feddan, which is economically infeasible at current milk price levels.

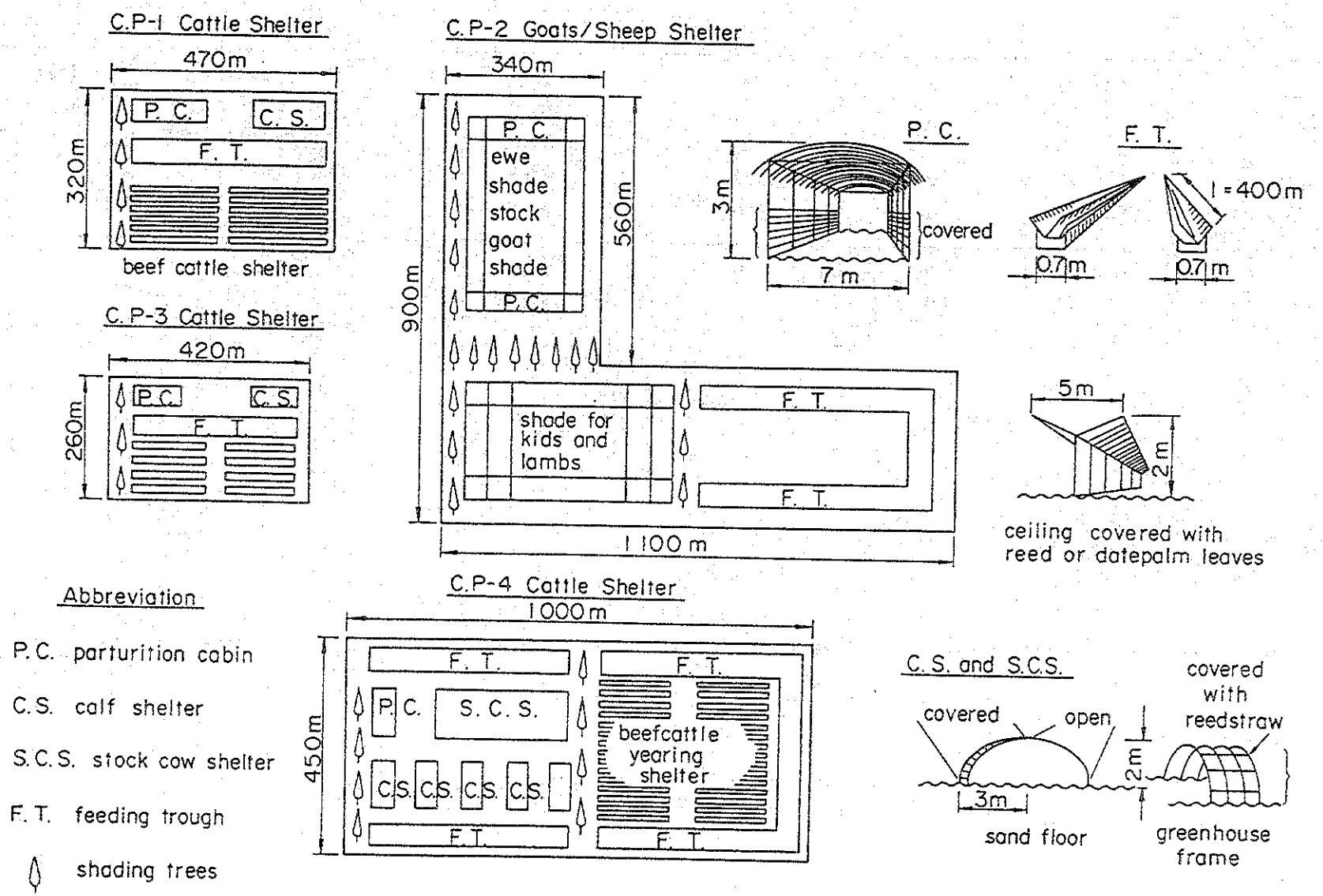
Generally speaking, the expected rate of margin from the livestock sector only reaches up to 20 - 30 percent. The possibility of raising this rate up to a level of 50 percent or higher, depends entirely on the extent of saving in the costs of facilities and purchased feeds.

Beef cattle and mixed flocks of goats and sheep are typical livestock species which can be relatively easy to tend, if herds are kept in an open feedlot with the provision of water supply and suitable shade established in a public place not far from villages and also close to fodder production area. Individual farmers are allotted small areas within public feedlot yards to establish individually an enclosed feeding place with barbed wire and reed screens as well as shade with date palm leaves or plastic sheets, etc. Feeding and watering troughs are also provided.

As regards breeding and stock supply, home mating for goats/sheep flocks and a rental bull-mating service are planned until A.I. techniques are economically introduced and disseminated.

Finally, total livestock herds kept in the F/S Area and the meat production by farming types are estimated as shown in Table 4.1-5.

Figure 4.1-2. Livestock Rearing Facilities



Abbreviation

P.C. parturition cabin

C.S. calf shelter

S.C.S. stock cow shelter

F.T. feeding trough

shading trees

Table 4.1-5. Projected Livestock Herds and Estimated Products

(unit : 1000 heads, tons)

Cropping Pattern		C. P-1	C. P-2	C. P-3	C. P-4	Total
Beef Cattle						
	calf	0	12.4	15.8	70.9	99.1
	yearling	0	12.4	7.7	60.0	69.1
	stock cow	18.7	15.8	83.4	0	100.9
Goats						
	kid	291	0	0	0	291
	she-goats	146	0	0	0	146
Sheep						
	lamb	49	0	0	0	49
	ewe	24	0	0	0	24
Beef	(carcass basis)	0	2,737	2,732	13,398	18,867
Goat-meat	(carcass basis)	7,679	0	0	0	7,679
Mutton	(carcass basis)	1,348	0	0	0	1,348
Cattle hide	(1000 sheet)	0	12	12	64	88
Goat/sheep hide	(1000 sheet)	753	0	0	0	753

4.2. Irrigation and Drainage Plan

4.2.1. Irrigation Water Requirements

1) Crop Water Requirements

Water requirement for crops is calculated based on proposed cropping patterns and their monthly water requirement. Crop water requirements can be computed by the following formula:

$$ET\ (crop) = Ko \quad ETo$$

Where, ET (crop): crop water requirement (mm)
Ko : crop coefficient

In Egypt, crop coefficients established by GARPAD on the basis of values presented in FAO's Irrigation and Drainage paper No.24 are used widely for the estimation of the crop water requirement. These values, which are presented in APPENDIX-C, are applied for the M/P study.

ETo: reference crop evapotranspiration (mm)

The mean climatic characteristics in the M/P land reclamation area for calculation of the crop water requirements is estimated by the climatic data of Port Said, El Arish, and Ismailia and by the weighting factors obtained by the Thiessen method. ETo is calculated by the three methods, the Blaney-Cridle, the modified Penman and the radiation method. Difference among the ETo values calculated by the three methods is negligibly small. The ETo value by the modified Penman method, which offers the highest result, is adopted for this planning.

ETo by Modified Penman Method
(mm)

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.
ETo	92	103	171	200	239	253

Month	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
ETo	259	233	199	153	108	88	2,098

Reference

The values of ETo planned in the irrigation projects that water is supplied through the El Salam Canal are as follows;

North Hussinia: 2,184 mm/annum
South Hussinia: 2,009 "
Tina Plain : 1,971 "

Computed crop water requirement for different crops is presented in Table 4.2-1.

2) Irrigation Efficiency

The selected irrigation efficiency for method of irrigation is as follows;

Method of Irrigation	Field Application Efficiency Ba	Field Ditch Efficiency Bb	Conveyance Efficiency Bc	Project Efficiency Ep = Ba.Bb.Bc
Surface Irrigation	0.70	0.95	0.90	0.60
Sprinkler	0.75	0.95	0.90	0.64
Drip/Mini-Sprinkler	0.85	0.95	0.90	0.73

Table 4.2-1 Monthly Crop Water Requirements

(Unit : mm)

CROPS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
1. BARLEY	82.8	113.3	34.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.6	44.0	295.9
2. BERSEEM	69.0	77.3	128.2	150.0	179.2	0.0	0.0	0.0	0.0	0.0	54.0	66.0	723.7
3. FLAX	87.4	103.0	34.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.0	61.6	340.2
4. PEAS - GREEN	96.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	61.2	64.8	79.2	301.8
5. POTATO	73.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.9	86.4	92.4	298.3
6. FODDER BEET	82.8	108.2	179.6	180.0	0.0	0.0	0.0	0.0	0.0	0.0	43.2	52.8	646.5
7. WHEAT	64.4	92.7	179.6	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.2	411.8
8. SQUASH	82.8	51.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.0	66.0	254.3
9. SQUASH	46.0	77.3	153.9	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	377.1
10. CUCUMBER	82.8	72.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.0	66.0	274.9
11. SAFFLOWER	87.4	108.2	34.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	43.2	61.6	334.5
12. TOMATO	87.4	103.0	136.8	60.0	0.0	0.0	0.0	0.0	0.0	0.0	54.0	61.6	502.8
13. TOMATO	0.0	0.0	0.0	0.0	0.0	126.5	181.3	221.3	199.0	122.4	32.4	0.0	882.9
14. TOMATO	0.0	0.0	0.0	0.0	119.5	177.1	246.0	233.0	159.2	45.9	0.0	0.0	980.7
15. FRENCH BEAN	0.0	0.0	0.0	0.0	119.5	202.4	246.0	233.0	19.9	0.0	0.0	0.0	820.8
16. GROUNDNUT	0.0	0.0	0.0	0.0	71.7	151.8	207.2	221.3	159.2	30.6	0.0	0.0	841.8
17. MAIZE - FODDER	0.0	0.0	0.0	0.0	71.7	202.4	194.2	163.1	159.2	0.0	0.0	0.0	790.6
18. PEPPER	82.8	92.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	76.5	86.4	83.6	422.0
19. RICE	0.0	0.0	0.0	0.0	215.1	278.3	284.9	267.9	228.8	15.3	0.0	0.0	1290.4
20. SUNFLOWER	0.0	0.0	0.0	0.0	0.0	101.2	181.3	244.7	39.8	0.0	0.0	0.0	566.9
21. SUNFLOWER	0.0	41.2	119.7	210.0	47.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	418.7
22. CANTALOUPE	0.0	0.0	0.0	0.0	95.6	189.7	246.0	151.4	0.0	0.0	0.0	0.0	682.8
23. NAPIER GRASS	0.0	0.0	0.0	0.0	95.6	202.4	259.0	139.8	159.2	0.0	0.0	0.0	856.0
24. SORDAN	0.0	0.0	0.0	0.0	71.7	202.4	259.0	139.8	159.2	0.0	0.0	0.0	832.1
25. ALFALFA	78.2	97.8	171.0	200.0	227.0	240.3	152.8	137.5	117.4	90.3	102.6	83.6	1698.6
26. ALFALFA	78.2	97.8	171.0	200.0	0.0	0.0	0.0	0.0	0.0	90.3	102.6	83.6	823.5
27. APPLE	0.0	0.0	95.8	120.0	153.0	172.0	176.1	149.1	127.4	91.8	56.2	0.0	1141.3
28. FIG	0.0	0.0	68.4	112.0	153.0	182.2	176.1	158.4	119.4	85.7	43.2	0.0	1098.4
29. GRAPE	0.0	0.0	54.7	96.0	124.3	141.7	145.0	121.2	87.6	55.1	30.2	0.0	855.8
30. GUAVA	55.2	61.8	95.8	112.0	124.3	131.6	134.7	121.2	103.5	85.7	60.5	49.3	1135.4
31. OLIVE	44.2	49.4	82.1	96.0	114.7	121.4	124.3	111.8	95.5	73.4	51.8	42.2	1007.0
32. ORANGE	55.2	61.8	109.4	128.0	133.8	131.6	134.7	121.2	103.5	85.7	60.5	49.3	1174.6

3) Net Field Irrigation Requirement and Peak Project Irrigation Supply per Feddan

The five types of cropping patterns are planned for land reclamation area, taking into account soils, topography and land settlement types in the M/P land reclamation area. The net field irrigation requirement and the peak project irrigation supply per feddan for each cropping pattern are as follows:

Cropping Pattern	Net Field Irri. Requirement (cu.m/fedd/annum)	Project[1/] Irr. Supply (cu.m/fedd/annum)	Peak Project[2/] Irri. Supply (lit/sec/fedd)	
			Mar.	Jul.
CP - 1 (small holder, sand flat)	5,095	8,190	0.421	0.421
CP - 2 (small holder, clay flat)	6,188	10,830	0.634	0.634
CP - 3 (graduates)	4,548	7,100	0.383	0.383
CP - 4 (investors, livestock)	6,052	9,930	0.526	0.391
CP - 5 (investors, fruit)	4,529	6,510	0.373	0.364

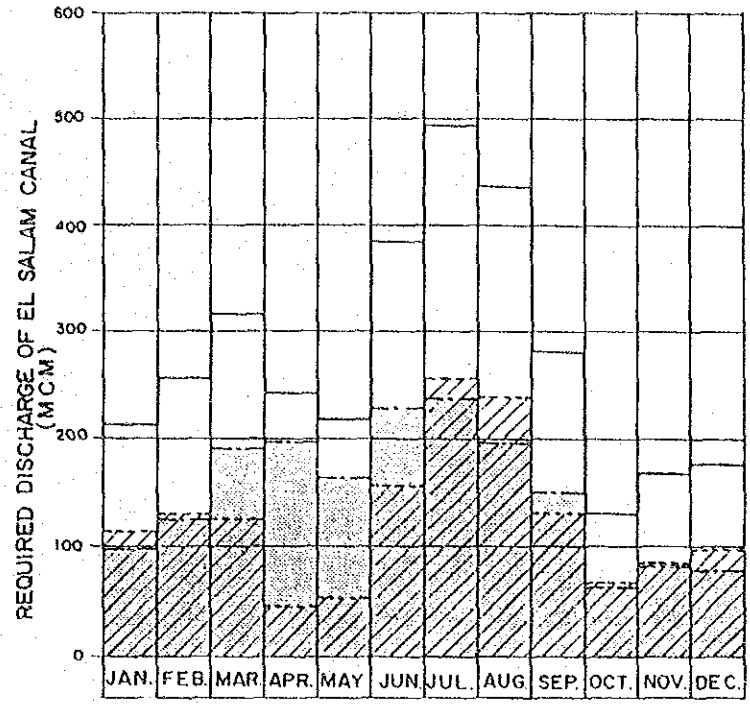
1/ ... Project Irrigation Supply = Field Irrigation Requirement/ EP x 1.05
1.05 : Rate of increase for irrigation of windbreak

2/ ... The peak project irrigation supply for the M/P land reclamation area occurs in July.

4) Project Irrigation Supply

The gross and net cultivable areas in the M/P land reclamation area are 254,700 feddan and 203,800 feddan, respectively. The total project irrigation supply is 1,813.1 MCM/annum and the peak project supply is 237.5 MCM/month in July (refer to Figure 4.2-1 and Table 4.2-2). The project irrigation supply per net cultivable area of one feddan is 8,900 cu.m/annum, and the peak project irrigation supply of 37.6 cu.m/day/net feddan.

Figure 4.2-1 Project Irrigation Supply



LEGEND :

: WESTERN AREA OF SUEZ CANAL

: M/P LAND RECLAMATION AREA

: WHOLE AREA

Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total (Mean)
Western Area of Suez Canal : 185,000 gross feddan													
MCM	114.7	130.5	125.6	45.5	52.8	156.5	255.8	238.6	131.0	67.7	85.5	97.5	1,501.7
cu.m/sec	42.8	53.9	46.9	17.6	19.7	60.4	95.5	89.1	50.5	25.3	33.0	36.4	(47.6)
M/P Land Reclamation Area (North Sinai) : 254,700 gross feddan													
MCM	98.0	124.7	191.0	197.1	164.2	228.4	237.5	196.4	150.6	63.1	82.9	79.2	1,813.1
cu.m/sec	36.6	51.5	71.3	76.1	61.3	88.1	88.7	73.3	58.1	23.5	32.0	29.6	(57.5)
Whole Area : 439,7000 gross feddan													
MCM	212.7	255.2	316.6	242.6	217.0	384.9	493.3	435.0	281.6	130.8	168.4	176.7	3,314.8
cu.m/sec	79.4	105.4	118.2	93.7	81.0	148.5	184.2	162.4	108.6	48.8	65.0	66.0	(105.1)

Table 4.2-2. Project Irrigation Supply

Cropping Pattern	Net Cultivable Area (feddan)	Project Irrigation Supply (MCM/annum)	Peak Project Irrigation Supply (MCM)
CP - 1	61,000	499.5	68.9
CP - 2	31,300	338.9	53.1
CP - 3	39,900	283.3	41.0
CP - 4	65,900	654.3	68.9
CP - 5	5,700	37.1	5.6
Total	203,800	1,813.1	237.5 = 88.7 cu.m/sec

The breakdown of the peak project irrigation supply for each proposed land reclamation areas is shown in Table 4.2-3.

Reclamation in the Tina Plain will require initial leaching and provision of drainage system with small drain spacing to reduce the salinity of the soils. The water requirements for initial leaching planned in North and South Hussinia Projects are as follows;

North Hussinia: 1,200 mm
South Hussinia: 2,350 mm

Initial leaching will be applied during the period excluding the summer season when the evapotranspiration is high, so that it has no effect on the design canal capacity.

Permanent leaching is required for salinity control in the soils after reclamation. When irrigation water of a salinity of 810 ppm is supplied through the El Salam Canal, the water requirement for permanent leaching is estimated to be as follows;

Surface irrigation : 10 - 20 percent of crop water requirement
Drip or Sprinkler irrigation: 5 - 10 percent of crop water requirement

Table 4.2-3 Peak Project Irrigation Supply

Cropping Pattern	Small-holder (sandy)	Small-holder (clay)	Gradu-ate	Inves-tor (live-stock)	Inves-tor (fruit)	TOTAL
Peak Project Irrigation Supply- JUL (lit/sec/feddan)	CP-1 0.421	CP-2 0.634	CP-3 0.383	CP-4 0.391	CP-5 0.364	
(1) South Tina Plain (1)		9,000 (5.71)				9,000 1/ (5.71) 2/
(2) North Tina Plain		16,700 (10.59)				16,700 (10.59)
(3) South Tina Plain (2)	7,000 (2.95)	3,800 (2.41)	16,100 (6.17)	14,700 (5.75)		41,600 (17.28)
(4) South Qantara East	3,100 (1.31)		15,200 (5.82)			18,300 (7.13)
(5) Kathib El Agramia				20,200 (7.90)		20,200 (7.90)
(6) F/S Area	23,500 (9.89)	1,800 (1.14)	4,600 (1.76)	6,000 (2.35)	5,700 (2.07)	41,600 (17.21)
(7) Nod Abu Samara				11,200 (4.38)		11,200 (4.38)
(8) Bir El Abd				8,000 (3.13)		8,000 (3.13)
(9) Tofaha	3,300 (1.39)					3,300 (1.39)
(10) South Salmana	7,300 (3.07)					7,300 (3.07)
(11) North Salmana	9,600 (4.04)					9,600 (4.04)
(12) Misfaq			4,000 (1.53)			4,000 (1.53)
(13) El Mazar	2,800 (1.18)			2,200 (0.8		5,000 (2.04)
(14) El Midan	4,400 (1.85)			3,600 (1.41)		8,000 (3.26)
TOTAL	61,000	31,300	39,900	65,900	5,700	203,800 (88.66)

Note: 1/ Net Cultivable Area in feddan.
2/ Peak Project Irrigation Supply in m³/sec.

5) Sources of Irrigation Water

The required amount of irrigation water to be supplied through the El Salam Canal is as follows;

Area	Gross Cultivable Area (feddan)	Required Amount of Irrigation Water (MCM/annum)
Western Area of Suez Canal	185,000	1,501.7
M/P Land Reclamation Area	254,700	1,813.1
Total	439,700	3,314.8

As shown above, the required amount of irrigation water is 3,314.8 MCM/annum, which will be available from the following water sources (refer to Figure 4.2-2 and APPENDIX-C).

Sources of Irrigation Water Supply
(Upper limit of salinity of irrigation water: 800 ppm)

Year	Nile River (MCM)	El Sirw Drain (MCM)	Hadous Drain (MCM)
Salinity of Nile Water : 250 ppm			
1986	1,830.5 (55.2%)	545.1 (16.4%)	939.2 (28.4%)
1987	1,771.6 (53.4%)	543.9 (16.4%)	999.3 (30.2%)
Salinity of Nile water : 370 ppm			
1986	2,001.0 (60.4%)	545.1 (16.4%)	768.7 (23.2%)
1987	1,927.1 (58.1%)	543.9 (16.4%)	843.8 (25.5%)

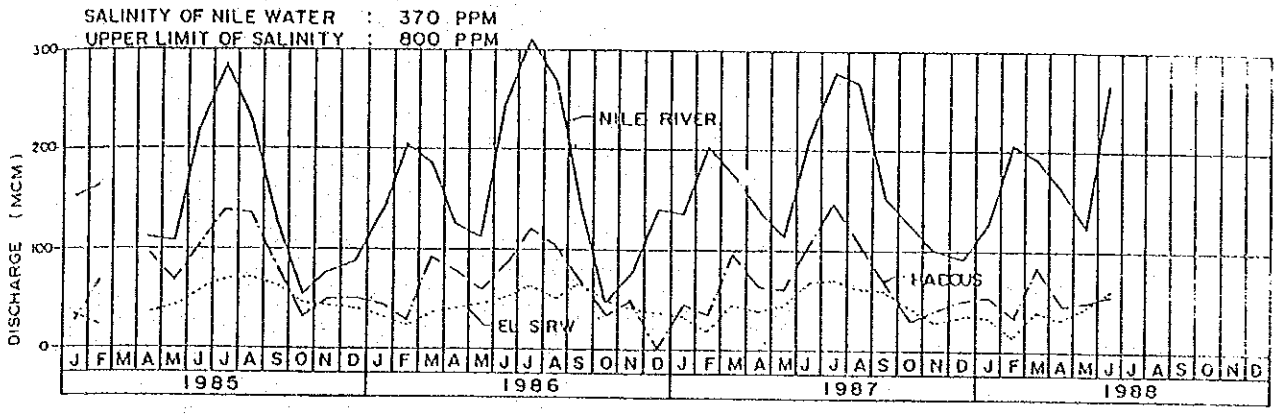
6) Required Canal Capacities

The required capacities of the El Salam Canal are shown in Figure 4.2-3.

4.2.2. On-farm Irrigation Systems

Reclamation work in the Study Area will be classified into two categories, one is the polder reclamation in the Tina Plain comprised of clay soils and another is the desert reclamation in the elevated area comprised of sandy soils.

Figure 4.2-2. Required Amount of Water from Nile River, Hadous Drain and El Sirw Drain



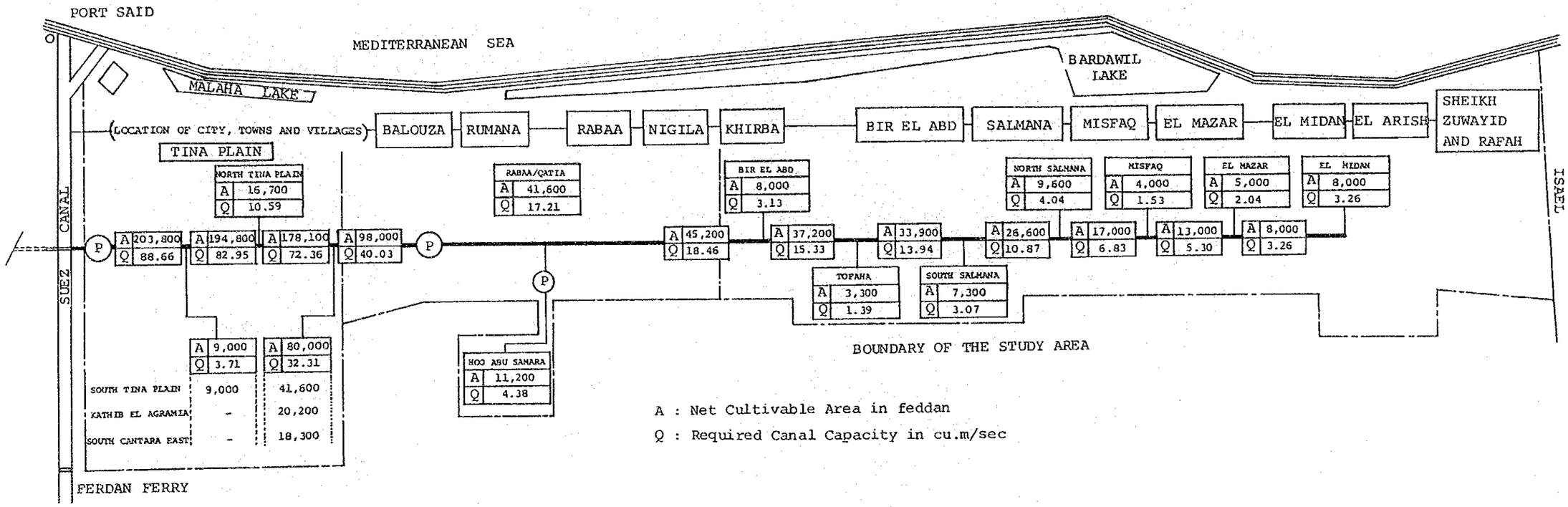
SALINITY OF NILE WATER : 250 PPM

YEAR / UPPER LIMIT OF SALINITY (PPM)		1986		1987	
		800	1,000	800	1,000
EL SIRW :	MCM	545.1	545.1	543.9	543.9
	(%)	16.4	16.4	16.4	16.4
HADOUS :	MCM	939.2	1,360.3	999.3	1,371.7
	(%)	28.4	41.1	30.2	41.4
NILE RIVER:	MCM	1,830.5	1,409.4	1,771.6	1,399.2
	(%)	55.2	42.5	53.4	42.2

SALINITY OF NILE WATER : 370 PPM

YEAR / UPPER LIMIT OF SALINITY (PPM)		1986		1987	
		800	1,000	800	1,000
EL SIRW :	MCM	545.1	545.1	543.9	543.9
	(%)	16.4	16.4	16.4	16.4
HADOUS :	MCM	768.7	1,279.5	843.8	1,305.9
	(%)	23.2	38.6	25.5	39.4
NILE RIVER:	MCM	2,001.0	1,490.2	1,927.1	1,465.0
	(%)	60.4	45.0	58.1	44.2

Figure 4.2-3 Schematic Illustration of El Salam Canal



A : Net Cultivable Area in feddan

Q : Required Canal Capacity in cu.m/sec

1) Polder Reclamation Area

The Tina Plain is a part of the delta formed by the River Nile. It has an altitude of less than one meter and is classified into clay flats in the land-use plan. The Tina Plain is covered with saline, loamy to clayey textured soils of which top layers have a low hydraulic conductivity of 0.2 to 0.3 m/day, so that a surface irrigation system has to be applied for this area.

The greater part of the polder reclamation area will be allocated to smallholders who have experience in traditional basin irrigation.

2) Desert Reclamation Area

The desert reclamation areas are covered with sandy soils and are classified into flat sandy terrain or undulating sandy terrain in the land-use plan. These areas have good a drainage but low water holding capacity. Application of a surface irrigation system for these areas will not be suitable because a low irrigation efficiency is anticipated.

The drip irrigation system, which is widely used in Egypt, is applied for irrigation of orchards. Mini sprinkler irrigation systems will require relatively higher annual costs, but they have the following advantages over a drip irrigation system.

- Less clogging
- Easy control of the moist area around the trees

Mini-sprinkler irrigation systems have not yet been introduced in Egypt. The installation of mini-sprinklers on an experimental scale for orchard and field crops is recommended for an economic and technical evaluation of the system. A comparison of on-farm irrigation systems to be applied for various land settlement types

in the desert reclamation areas is shown in Table 4.2-4. The recommended on-farm irrigation systems for the farmlands, excluding orchards, are as follows;

- Smallholder

  In selecting the on-farm irrigation systems including booster pumps for smallholders, the provision of maximum freedom in operating and maintaining these systems should be considered, as far as possible. Large-scale systems such as side roll, rain gun, center pivot and linear move, which require a high degree of cooperation among many smallholders, are not suitable as on-farm irrigation systems for smallholders. Both systems of hand-moved sprinkler and solid set sprinkler will provide the necessary flexibility for smallholders. However, hand-moved sprinklers are recommended because the initial costs of solid set sprinklers are too high.

- Graduates and Investors

  On-farm irrigation systems for the farms of graduates and investors where labour is relatively scarce should be the system of labour saving type. As shown in Table 4.2-4, the most suitable system is the side-roll sprinkler. A center pivot system requires larger farm size and land consolidation, and mechanical troubles is often caused, therefore, this irrigation system cannot be recommended for North Sinai area. However, the land utilization ratio is low because corners of rectangular farms are left unirrigated. As sufficient irrigation water is available for the M/P land reclamation area, a side roll sprinkler system in which a high land utilization ratio can be expected should be applied in principle.

Table 4.2-4. Comparison of On-farm Irrigation System

Irrigation System	Smallholders	Graduates	Investors
Hand-moved sprinkler	-	L	L
Solid set sprinkler	C	C	C
Side roll Sprinkler	F	-	-
Rain gun	F, E	E	E
Center pivot	F, Le	F, Le	Le
Linear move	F, M, T	M, T	M, T
For Orchard;			
Drip	-	-	-
Mini-sprinkler	M	M	M

Constraints:
- L: labour
- C: initial costs
- F: farm size (cooperative use)
- E: energy requirement
- Le: land utilization
- M: operating and maintenance skill of system
- T: topographical conditions

4.2.3. Drainage Plan

The design of the drainage system will be affected by many factors such as irrigation methods, groundwater levels, soil permeability, and so forth. The factors in the polder reclamation area differ significantly from those in the desert reclamation area. Therefore, the drainage systems of the M/P land reclamation area can be better by discussing both areas separately. As the data required for calculation of drain spacing by means of Hooghoudt's equation or other equation are not available, outline of the necessary drainage systems is assumed, based on those planned in similar projects.

1) Drainage of Polder Reclamation Area

The polder reclamation area in the Tina Plain comprising saline and clay soils requires initial leaching operations. In this area, drainage pumps will be installed to drain excess water into the sea because of an altitude of less than one meter. An open field drainage system with drain spacing of about 25 m will be applied during the reclamation stage. Required drainage rate will be 5 - 6 mm/day.

After completion of the reclamation stage, the open field drainage system will be replaced by a buried pipe drain with low ratio of land loss. The drainage rate is estimated at 0.11 lit/sec/feddan (2.3 mm/day) equivalent to about 20 percent of the peak value of gross field irrigation requirement. Spacing between the buried pipe drains will be 50 m.

2) Drainage of Desert Reclamation Area

The drainage rate in the desert reclamation area is estimated to be 0.04 lit/sec/feddan (0.8 mm/day) equivalent to about 10 percent of the peak project irrigation supply.

In land which is considerably above sea level, natural drainage will be expected to be equal to the deep seepage loss. Therefore, an open drainage canal system is required only for collection of operational waste from the irrigation canal system.

In the lowland, it is anticipated that problems of waterlogging and salinity will be caused by an initiation of irrigation. The field drainage system, with drain spacing of 100 - 150 m is therefore applied for the low lands.

4.3. Water Conveyance Plan

The construction work on the El Salam Canal was started in 1981 by the Ministry of Public Works and Water Resources (MPWWR), including construction of pumping stations and other appurtenant structures. The El Salam Canal reached 300 m to the Suez Canal and its alignment meets at right angles to the Canal at a point of 27.3 km from Port Said.

The extension of the El Salam Canal into the North Sinai is aimed to provide irrigation water for the potential development area up to El Midan (Figure 4.3-1). The development gross area of 254,700 feddans will require a considerable time so that staged development is applied.

The basic concepts of the extension plan of the El Salam Canal into North Sinai are summarized below;

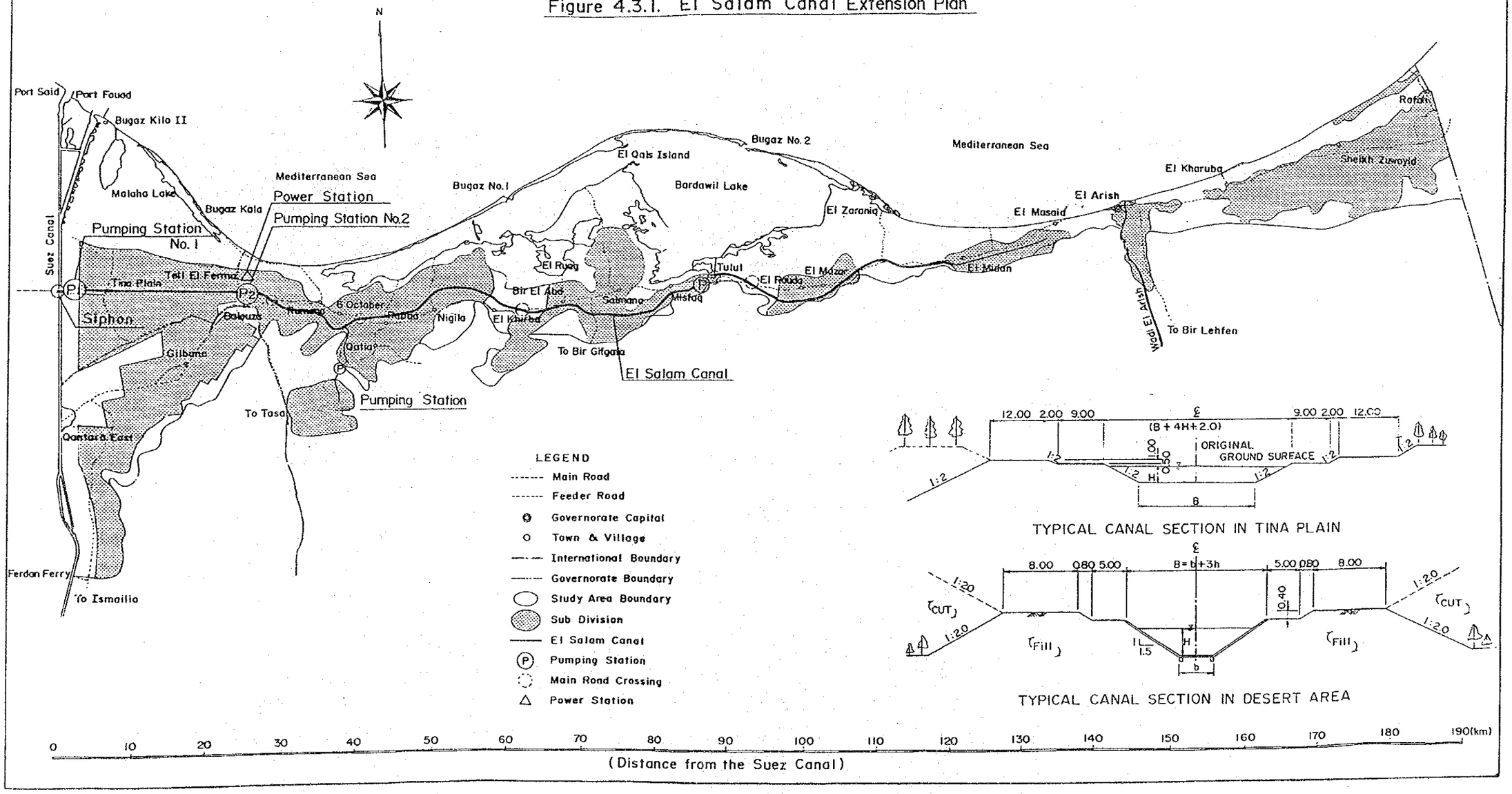
(1) The canal alignment in both Tina Plain and sandy areas has to be selected with consideration of the efficient construction work and canal maintenance, because these two areas are characterized by opposite geography and geological conditions.

(2) The canal in the sandy area must be strengthened against bank failure and seepage by lining for which type and materials must be carefully selected in consideration of the soil structure.

(3) The cost of pumping stations is studied not only in terms of the initial investment of construction and machines installed but also the economy of operation and maintenance.

(4) The structure and construction method of the siphon under the Suez Canal is designed by using available information from

Figure 4.3.1. El Salam Canal Extension Plan



both the geological survey carried out by the Ministry of Irrigation in 1980 and the future plan for canal extension proposed by the Suez Canal Authority.

4.3.1. Canal Alignment

The extended alignment of the El Salam Canal passes two distinct areas, namely the Tina Plain and a sandy area. These are characterized by quite different conditions in both aspects of geography and geology. The Tina Plain is flat. Its surface elevation varies from below sea level to an elevation of 2 m above sea level, and the major part is exposed to a high level of saline groundwater. On the other hand, the sandy area is characterized by complex geography of sand dunes.

The extended alignment of the El Salam Canal to the Study Area is determined on the basis of the field survey using maps scaled at 1:25,000 and the following technical considerations;

1) Tina Plain

- To pass the relatively high elevation area in order to exclude the area below sea level, expressed as a salt pan on the map.
- To shorten the Canal length in consideration of construction difficulties in the Tina Plain.
- To follow the direction of the El Salam Canal already constructed to the west bank of Suez Canal.
- To place the pumping station which lifts water 13 m from Tina Plain to the sandy area and to select its location on good foundations.

2) Sandy Area

- To employ gravity from the pumping station located at the beginning of the sandy area to the eastern end of the Study Area.

- To route the canal through the irrigable area considering the convenience of facility maintenance and water management performed by the people living in the Study Area.

- To plant trees for aforestation along the Canal in order to minimize the threat of mobile sand dunes as far as possible.

- To employ the pipeline or culvert box in the canal route passing the area excluded from the reclamation.

4.3.2. Annual Water Demand

The capacity of irrigation facilities was determined by estimating peak water demand, based on the cropping pattern in the development areas. The design capacity of the El Salam Canal was also estimated for supplying the peak water discharge of each subdivision.

The annual water demand for each part of the Study Area is different according to the cropping pattern. Total annual water demand for the entire area of 254,700 feddan was estimated to be 1,813 MCM. This is less than the amount of available water of 2,714 MCM. This was mentioned in detail in Section 4.2.1.

4.3.3. Canal Section

The canal section is separated into the Tina Plain and the desert area. In the Tina Plain it runs through a muddy area of heavy silty clay, while the sandy area consists of poorly graded sand which is difficult to be compacted.

The canal section designed for those areas should be free from seawater intrusion (in the Tina Plain) and from the seepage (in the sandy area) in addition to the consideration of embankment stability and construction work efficiency. For the design method of the canal section in the Tina Plain, the common policy adopted in the west area of the Suez Canal of which geographical conditions are similar to the Tina Plain was applied. The canal bank is supported by a counter weight placed outside of banks and the seawater intrusion into the canal is prevented by keeping the water surface at least 50 cm higher than the surrounding ground surface. To cross the Tina Plain, the necessary water head was estimated to be 3 m at the beginning of the canal which is gained by the pumping.

The embankment in the sandy area has a tendency of bank failures caused by reasons such as liquefaction of embankment materials with increasing pore pressure and sliding of the embanked soil after impounding. Remedial measures to prevent these problems have to be established with respect to the foundation soil used for the embankment. In addition to these problems, other difficulties in maintaining the canal effectively in the sandy area are listed below;

(1) Seepage loss of water and resulting salt accumulation on both sides of the canal
(2) Facility defects caused by the sand suspension in the canal water
(3) Increase in the cost of canal structures due to the widening of canal width and low design velocity
(4) Increase in canal maintenance costs

For the canal in the sandy area, consequently, a lining is necessary for this canal sections. Moreover, the afforestation on both sides of the canal should be carried out to protect the canal and maintenance road from sand accumulation. The trees to be planted in the sandy area should be durable, both to the salinity and drought. Tamarisk, Eucalyptus and Acacia trees are suitable for this area. Additional benefits of lumber supply and provision of shelter belt for the canal can also be expected.

In accordance with the class of canal magnitude, the plantation rows along the canal are as follows;

Canal	Plantation Rows for both banks
El Salam Canal	6 - 10 rows
Branch Canal	3 - 5 rows
Secondary Canal	3 rows

4.3.4. Siphon Under the Suez Canal

Two methods of the construction of siphon across the Suez Canal are studied; the shield driven tunnel and the immersed tunnel. For the study, the Suez Canal Authority issued a request note attached with the drawing of the designed section which enables two-way navigation.

It is listed as follows;

(1) To keep at least 5 m depth below the canal bottom of designed section to the upper edge of siphon.

(2) To start from the west of the railway and maintain at least 2 m depth below existing canal, railway and highway to the upper edge of siphon.

(3) To cross 1,050 m of designed canal section for two-way navigation.

(4) To prevent the El Salam Canal from the intruding seawater at the crossing the spoil bank (2 km wide) made by the Suez Canal Authority.

(5) To include the study of drilling method which makes it possible to cross the Suez Canal without temporary works of existing water canal, railway and highway on the west bank of Suez Canal.

Consequently, the shield driven tunnel is selected for construction method meeting the above-mentioned five conditions. On the other hand, the immersed tunnel is not applicable to the conditions of (1), (2) and (5).

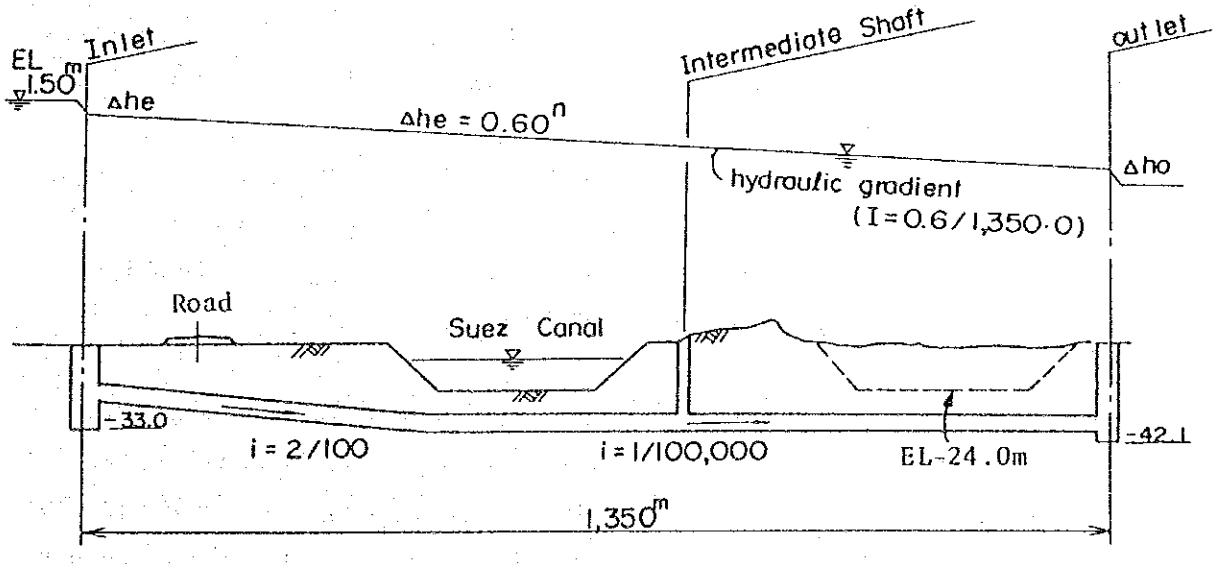
A siphon length becomes at least 1,350 m including 1,050 m of the planned width of the Suez Canal for two-way navigation, and 300 m of the canal ends.

The number of siphon lines will be determined, following the computation of peak demand discharge of the irrigable area, however, taking into consideration the operation and maintenance, the number of siphon should be at least two.

The peak discharge for the gross area of 254,700 feddans was estimated as 88.7 cu.m/s, which requires the number of lines of the siphon (n) in accordance with the siphon diameter as follows;

Diameter(m)	Number of Lines
D = 5.3	n = 2 (adopted)
D = 4.6	n = 3
D = 4.1	n = 4

Cost for siphons will be increased with its diameters. When the number of lines of the siphon increase, the construction period will be longer and the cost will also increase. Consequently it was clarified that 5.3 m diameter (n = 2) is the most economical in construction cost.



The geological survey for the proposed canal alignment was carried out at two sites on both banks of Suez Canal by the MPWWR (Ministry of Irrigation) in 1981, which revealed the suitable foundation geology for the siphon drilling work. A foundation, 30 m below sea level was a highly rigid sand layer having more than 100 of N's value, and any special measures for weak ground would be necessary. However, it requires the selection of a construction method to withstand high pressure as estimated at 3.5 kg/sq.cm of soil and water.

It will require about 45 months to complete the two lines of siphon. Shaft work will constitute the most critical part of the entire period.

As the construction method of shield driven tunnel requires a sufficient space to position the starting shaft and the excavated soil, the starting shaft is to be placed on the west bank of the Suez Canal. An intermediate shaft is needed to install at the mid-point of the siphon for convenience of the drilling work and future maintenance.

4.3.5. Pumping Stations

Main pumping stations along the El Salam Canal are proposed at four locations; two stations are in the Tina Plain, the third is to Hod Abu Samara and the fourth is located at Tulul.

In addition, substations are also proposed for the areas where gravity irrigation is impossible. These substations are individually planned in accordance with the staged development of the proposed reclamation areas in North Sinai.

Main pumping stations in the Tina Plain are the Tina pumping station located 2 km west of the siphon outlet to gain the water head of 3 m (maximum Q = 88.7 cu.m/s) for passing the Plain and the Balouza pumping station located 24 km east of the Suez Canal to have 13 m head for lifting the water (peak Q = 38.6 cu.m/s) from the Tina the Plain to the sandy area.

It is recommended that the pumps to be installed in the Tina Station should have vertical axial flow type with movable blades. It will be possible to be adopted for the wide range of discharge at a low water head. On the other hand, the pumps installed in the Balouza Station is recommended to have a vertical mixed flow type of which discharge is controlled by the number of operational pumping units.

The pump capacity and the number of pumps for each station should be determined in relation to the scheme of the stage development and the convenience of construction work.

4.3.6. Canal Related Structures

Appurtenant structures of the El Salam Canal are regulators and bridges to cross the highway. Regulators will be installed, with bifurcations and wasteways, which must function in accordance with the difference of water surfaces and discharge. Sluice gates equipped with wasteways on the bank of the canal will be set up as the regulator.

Spillage which will be caused by mistakes in operation shall be discharged into the Malaha Lake or the Bardawil Lake through bypass.

4.3.7. Control System

In order to carry out appropriate water management, monitoring facilities for current and water level shall be installed at each pump station and turnout. Operation and maintenance office shall be established near Balouza for concentrated control of these facilities. Information from each monitoring point will be transmitted to the O & M office by telephone line or wireless, and pumps and gates will be operated by remote control based on the simulation data by computer to realize ideal water management.