3.3 POTENTIAL AREAS FOR DEVELOPMENT

3.3.1 General Principles of Regional Development Planning

As was mentioned earlier, the Project Area extends about 300 km from north to south and 120 km from east to west, and remains to this day largely uninhabited. The objectives of this comprehensive regional development plan is permanently to settle the Area with a population appropriate to its resource base and thereby to add to the small inhabited area of Egypt and establish closer integration with the neighboring Sudan.

As pointed out in Chapter II, the Project Area has exploitable resources for the development of agriculture, fishery, mining and manufacturing and tourism. There are two different ways to plan and implement the development of the Area's potentials and to create therein a viable regional economy and stable society. The first method is to divide a given region into several smaller areas by their respective sectoral resource endowments and then to incorporate separately envisaged sectoral development paths and related community building for these areas into a coherent regional development plan. The second method is to map the entire regional resource endowments and then to divide the region into smaller areas identifiable by noting agglomerations or clusterings of these development potentials. Regional development is planned to achieve closer linkages among respective sectoral development projects and programs within and among the identified areas.

The largely uninhabited Project Area has practically no basic infrastructure except in Aswan City and its immediate vicinity. Therefore, any kind of development projects and programs for productive sectors and for community settlement necessarily entail massive investment in basic infrastructural facilities such as transportation and communication, power, housing, etc. Consequently, the second method is more desirable for the Project Area, because it aims to provide basic infrastructure in areas where expected agglomerations of economic and social activities will enable more efficient utilization of such facilities and ensure better direct and indirect resource development effects.

In other words, the Study Team will identify in the Project Area several development centers, where resource endowments warrant better foreward and backward linkages and common utilization of infrastructure, and thereby justify the settlement of a sizable population. It goes without saying that these centers should be provided with basic public services facilities for the residents in the centers and in the outlying areas. Sectoral development planning which is stressed in the first method is also important, but it is desirable first to determine the priority of development by assessing expected agglomerations of various sectoral activities in respective localities and then to proceed to the formulation of sectoral development plans.

The first step in identifying development centers is to find potential areas for development, where there are clusterings of exploitable resources to sustain a sizable population. These areas in addition must be strategically located vis-a-vis the expected transportation network, or in other words, have greater possibilities of integration with other potential areas of development. A development center or a central city will be established in each potential development area to provide administrative and other basic needs services to the area population as well as to facilitate closer linkages between development efforts in various productive sectors. A development center will have a service area with a radius of about 30 - 40 km, and, consequently neighboring development centers should be so located to keep the same distance between them.

3.3.2 Distribution of Development Potentials by Sector

(1) Agricultural Development Potentials

As already indicated in Section 2.1 in Chapter II, there are two kinds of potential development areas: upland agricultural areas and foreshore agricultural areas. The upland agricultural areas are located between altitudes of 183 m (i.e., the high water level of High Dam Lake in a flood year) and 210 m (i.e., the economically justifiable maximum head for pumping water from the lake) and have topographical and soil conditions adequate for agricultural production. Eighteen areas have been identified, with a total net area of 134,000 feddans (for details, see 2.1 of Chapter II and 4.1 of Chapter IV).

Foreshore agricultural areas are located between 175 and 185 m in altitude, which is above the range of annual fluctuations of the lake water level in a medium flow year. Sites must be flat with gentle sloping to reduce capital costs and have a contiguous area of 20 km^2 (approx. 4,760 feddans) or over to enable the settlement of a community with a population of approximately 2,000 or over. A total of fifteen sites have been identified on the maps of scale 1:25,000, including some areas less than 20 km^2 but contiguous to the identified upland agricultural areas. The total net arable area is approximately 16,000 feddans (for details, see 2.1 of Chapter II and 4.1 of Chapter IV).

(2) Fishery Development Potentials

The primary production (i.e., phyto-plankton) of High Dam Lake is substantial. The echo-sounder probe indicated wide distribution of kalb-samak in as yet largely unexploited off-shore areas of the lake and in some of the major khors surveyed. Although the percentage of Tilapia nilotica in the total tilapia hauls has reportedly been declining relative to Tilapia galilaea, the improvement of the storage method at fishing camps and in carrier boats is expected to enable tilapia fishing in the southern half of the lake where the distance from Aswan currently makes it nearly impossible. Therefore, the lakeshore will be shortly dotted with small villages of fishermen who also practice subsistence-oriented agriculture mainly in the foreshore area. The High Dam Lake Development Authority has a plan to construct permanent structures possibly at ten locations to give better shelters for fishermen and eventually have them develop into full-fledged communities.

Two experiments of fish culture have recently been started: one near the West Harbor and the other in the end of Khor Ramla. Artificial rearing of tilapia seedlings to be released to the lake will be started in the near future and more advanced types of aquaculture will be introduced in a more distant future. However, the appropriate sites for such undertakings are yet pending on further investigation.

In addition, the expected increase of fishing efforts and the improved transportation of hauls will call for the upgrading of harbor facilities, first at Aswan and later possibly at Abu Simbel. The headquarters of fishery management and studies will be also needed somewhere near the High Dam.

(3) Mining

The mineral resources available in the Project Area are largely non-metallic, such as clay, kaolin, quartz, barite, orthoclase, silica sand, limestone, talc, granite, marble, sandstone, phosphorite, etc., and distributed on the western and eastern shores of the lake. Metallic minerals are limited to iron, gold, copper and chromite, all deposited on the east bank of the Nile or the eastern shore of the lake. A few of the non-metallic minerals are already under exploitation or about to be exploited, while mining of iron and gold ores are currently discontinued.

Major development possibilities are as follows:

(i) Aswan area: Mining of granite, sandstone, clay, quartz and feldspar and reopening of an iron mine
(ii) Kurkur area: Mining of clay and limestone
(iii) Kalabsha area: Mining of kaolin and clay
(iv) El Allaqi/Abu Swayel area: Mining of marble and possibly copper, chromite and gold
(v) Abu Simbel: Mining of sandstone

(4) Manufacturing

In contrast to agriculture, fishery and mining which have to be developed close to the sites of respective resource endowments, the development of manufacturing has a far wider range of alternatives for its location. Manufacturing industries could be developed near places where primary products which they utilize as raw materials are produced or mined. It could be established in places where there is good access to manpower to employ, consumers to sell its finished products to, and/or better forward or backward linkage with other related manufacturing industries and with other sectoral activities. In addition, it will be necessary to take into account the requirements inherent in certain types of manufacturing industries such as scale merits of operation, capital and labor intensiveness and so forth. The identification and location of prospective industries will have to be made by examining their relative advantages in the terms indicated above. It is expected that Aswan

City, with its sizable agglomerations of population and industries, will play an integral role in the manufacturing development in the Project Area.

(5) Tourism

The tourism resources in the Project Area are classified into the following categories: (a) historical ruins at Abu Simbel, Aswan City and on the lakeshore; (b) scenic points mainly around the first cataract of the Nile; (c) modern constructions like the Aswan High Dam; and (d) cultural assets of Nubians.

The major constraint for tourism development in the Project Area is that the potential demand exceeds the available capacity of accommodation. Because tourist arrivals are projected to increase further in the future, hotel rooms and related tourist facilities will be substantially increased chiefly at Aswan and Abu Simbel.

(6) Water Resources

The greatest water resource available in the Project Area is High Dam Lake, which, however, is the primary source of water for the entire country of Egypt. As already mentioned in 1.1.2 of Chapter I, Egypt's share of Nile water is currently almost all utilized downstream for irrigation and other various purposes. The scale of future development in the Project Area depends, consequently, on the possibility of increasing the annual yield of the Nile and of improving the efficiency of water management in the existing irrigation systems downstream, and furthermore, on the establishment of the national water allocation system which is consistent with socio-economic priorities of regional development. The Water Master Plan currently under preparation by the Academy of Scientific Research and Technology, the Ministry of Irrigation and other related government agencies is expected to take into consideration the water requirements envisaged in this regional development plan for the Project Area.

(7) Transportation

The transportation network in the Project Area is extremely limited except in Aswan City and its immediate vicinity, reflecting its relative economic backwardness. Major inter-regional and intra-regional transportation links which currently exist are as follows.

(i) Air-routes which connect Aswan to Abu Simbel and to Cairo via Luxor
(ii) Railway which connects Aswan to major population centers further north
(iii) Nile waterway between Aswan and Cairo
(iv) National Highway Route 2 to connect Aswan to Cairo
(v) Paved roads with a total extension of 170 km which connect from the city center to the airport via Sahara City, from the city to the iron mine, from the airport to Kurkur and from Abu Simbel to Tushka, with the rest being unpaved community streets and camel paths in the desert

(vi) Lake surface transportation between Aswan and Wadi Halfa across the Sudan border

The future transportation development will and must play a crucial role in the Project Area, by providing good access to, and linkage among areas endowed with exploitable resources and thereby serving to activate various economic and social activities.

3.3.3 Potential Areas of Development

For rough perimeter demarcation of potential areas of development, it is important to take into consideration their respective centers which will effectively provide various public services and function as central nodes for economic as well as social activities in the areas. As shown in Figure 3-3-1, the distance between the existing urban centers from Aswan City as far as Esna at the southern end of Qena Governorate ranges from a little over 40 to 55 km. In other words, these urban centers service their respective outlying areas with a radius of 30 - 40 km.

Figure 3-3-1

Distance Between Existing Urban Centers Outside the Project Area

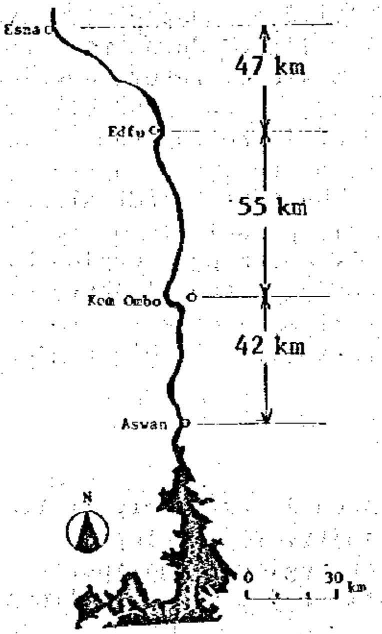
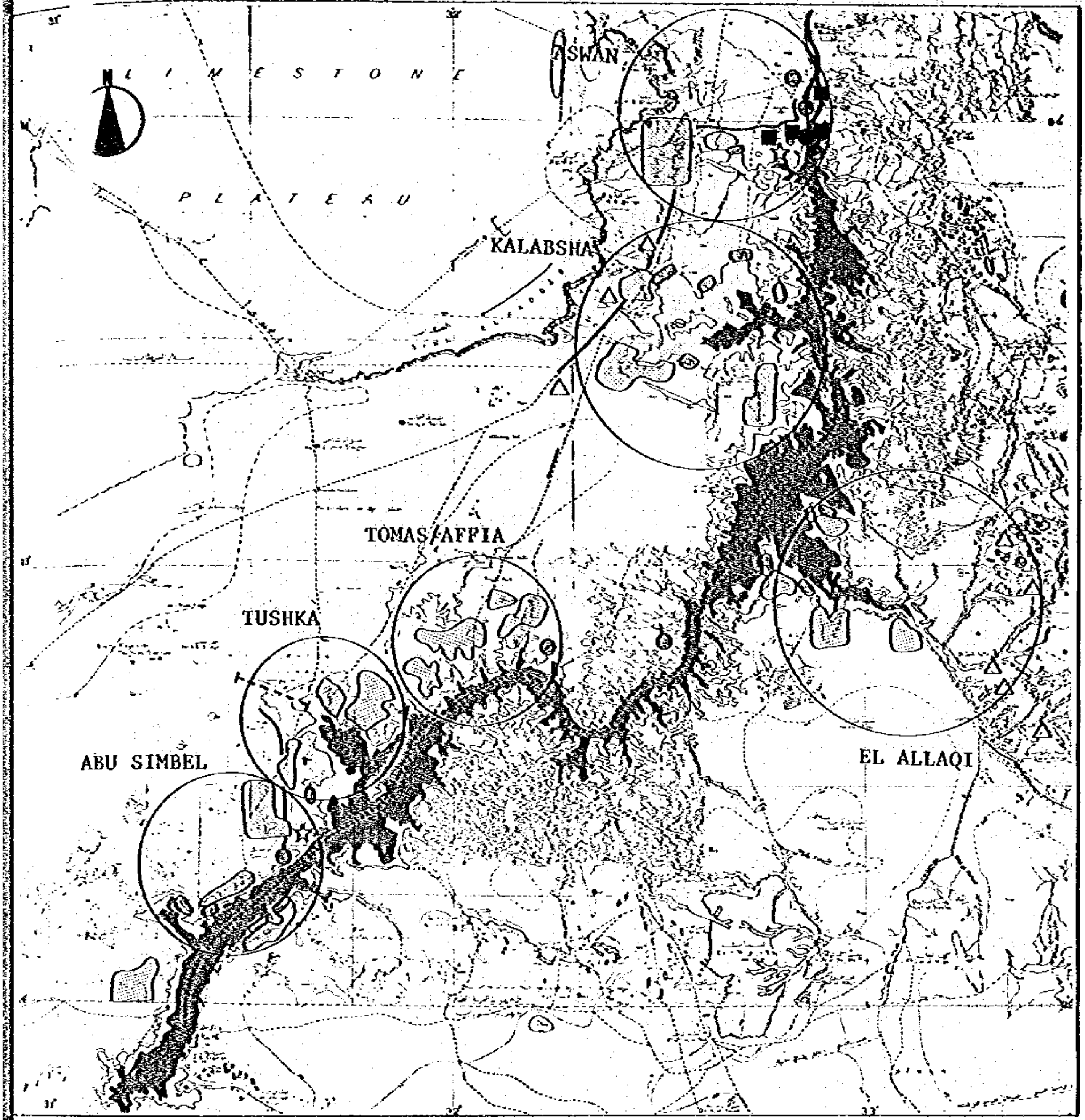


Figure 3-3-2 shows the distribution of the foregoing resource endowments in the Project Area. Agricultural development potentials are found more or less clustered in the areas from Kurkur to Kalabsha, around El Allaqi, and in the southern part of the lake shore, especially on the western shore from Abu Simbel to Tushka and Tomas/Affia. Abu Simbel and Aswan have non-agricultural development potentials; tourism for the former and industrial, tourism and other secondary and tertiary sector potentials for the latter. El Allaqi and Kalabsha have mining potentials in addition. Six potential areas of development can be demarcated in the Project Area, by noting the clustering of resources.



INTEGRATED REGIONAL DEVELOPMENT PLAN OF THE HIGH DAM LAKE AREA

Figure 3-3-2

Potential Areas for Development

▨	Upland Foreshore } Agricultural areas
●	Fishery port
△	Mines
O	Tourism development sites
■	Industrial development sites
═ ┈	Paved roads Navigation route
- - -	Tushka Spillway
☆	Airports

CHAPTER IV

SECTORAL DEVELOPMENT PLANNING

CHAPTER IV

SECTORAL DEVELOPMENT PLANNING

4.1 AGRICULTURE

Agricultural development in the High Dam Lake area is constrained mainly by the difficulty of water conveyance from the lake for want of underground water sources. The prospective development will comprise two types of agriculture, namely, upland agriculture and foreshore agriculture. The former is developed on lands higher than the maximum flood water level of the lake and will be provided with permanent water conveyance facilities for perennial irrigation. The latter will be developed on the zone below 183 m and above 175 m in altitude and provided with supplementary irrigation by portable water conveyance equipment.

Foreshore agriculture can be practiced relatively easily due to its cheaper costs and simple facilities, and in fact has been recently started by Nubians. Irrigated upland agriculture is technically possible, but due to difficulties of topographical, soil and hydrological conditions around the lake, its development will be very costly, and its economic feasibility seems to be far from encouraging.

4.1.1 Farming System and Expected Income

(1) Basic Concepts for Development Planning

In view of the evident soil and climatic limitations, agricultural development for the High Dam Lake area need be based on a production program which is attractive to prospective settlers, securing a stable standard of living for them. In other words, the farming system to be envisaged for the Project Area must be so identified as to offer economic incentives larger than what the settlers can, or do, obtain in the place of their origin.

As was discussed in Section 3.2 of Chapter III, the agricultural labor productivity per worker in the Project Area is projected to reach approximately £E 2,000 in 1997, or an annual income of about £E 1,800 per worker, which is on a par with the expected national productivity in the agricultural sector. Considering the less favorable conditions for development in the High Dam Lake area, the farming system will have to be so designed as to aim at a slightly higher annual income. In order to achieve this target, agriculture for the Project Area must meet a number of requirements as shown below.

Based on the profitability of crops shown in Section 2.1 of Chapter II, a cropping pattern appropriate for the Project Area is identified separately for upland and foreshore agriculture, as shown in Figures 4-1-1 and 4-1-2 and Table 4-1-1. As seen from the table, the cropping intensity is set at 180%, which is substantially higher than the current practice in the northern part of Aswan Governorate. The higher intensity is selected mainly because (i) maximum possible land utilization is necessary to ensure higher agricultural income and (ii) the practice of fallow need be avoided to have the soils mature and become fertile as quickly as possible.

Table 4-1-1 Proposed Cropping Patterns

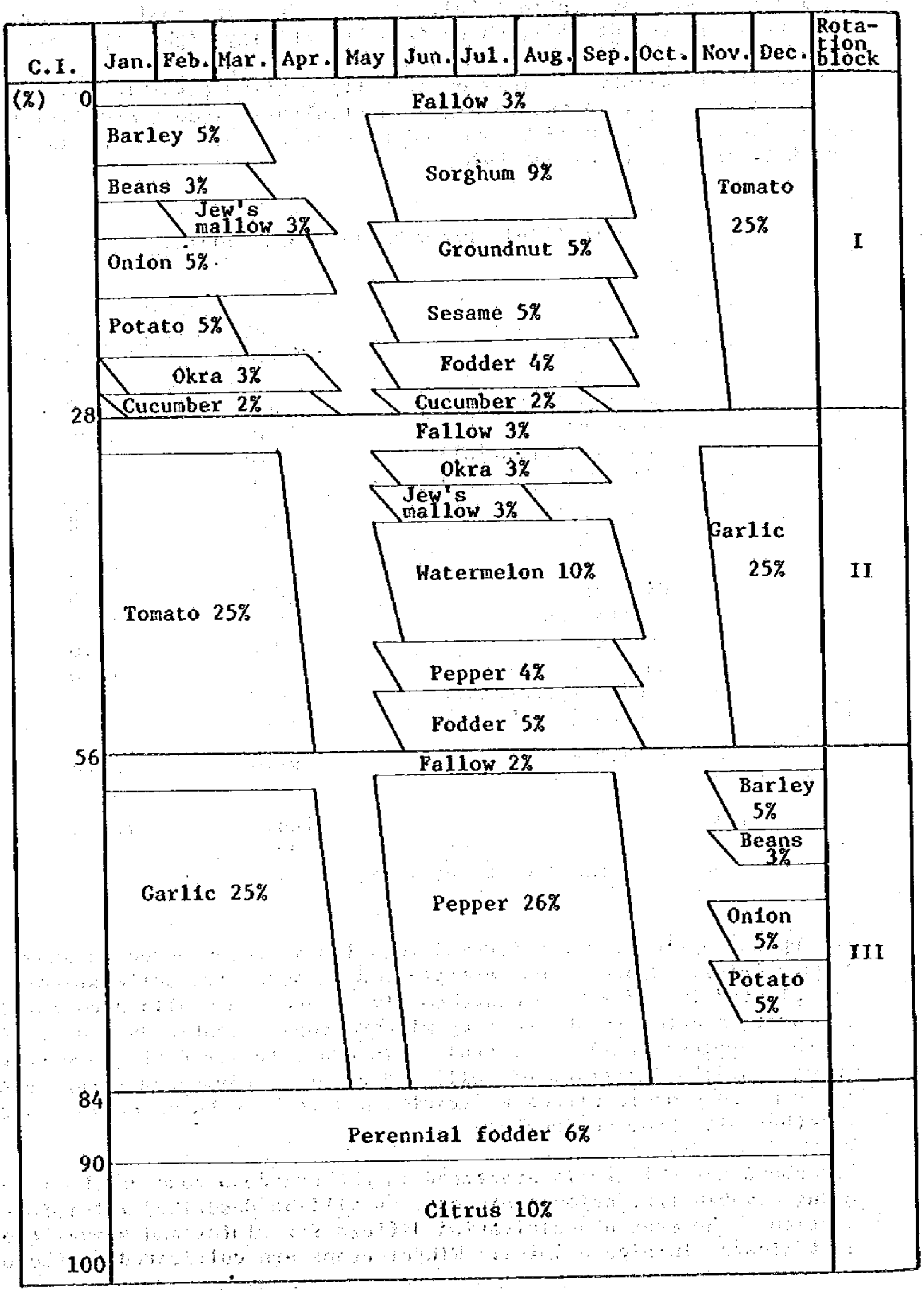
Season	Crops	Distribution (%)	
		Upland	Foreshore
Winter	Cereals & Beans	8.0	20.0
	Vegetables	68.0	70.0
	Fodder (perennial)	6.0	-
	Citrus (")	10.0	-
	Sub-total	92.0	90.0
Summer	Sorghum	9.0	22.5
	Oil Seeds	10.0	10.0
	Vegetables	18.0	17.5
	Spices	30.0	30.0
	Annual Fodder	9.0	10.0
	Fodder (perennial)	6.0	-
	Citrus (")	10.0	-
	Sub-total	92.0	90.0
Total		184.0	180.0

Source: The JICA Study Team.

For upland agriculture, triennial rotation is recommended as shown in Figure 4-1-1. Winter crops are planted in November, while summer crops are planted in mid-May in order to give a one-month allowance for land preparation after the harvest of winter crops. Continuous cultivation of the eggplant family is refrained in order to avoid its adverse consequences like infection of soils and crops. Leguminous forage crops are included to promote nitrogen fixation and to be used as green manure together with crop residuals.

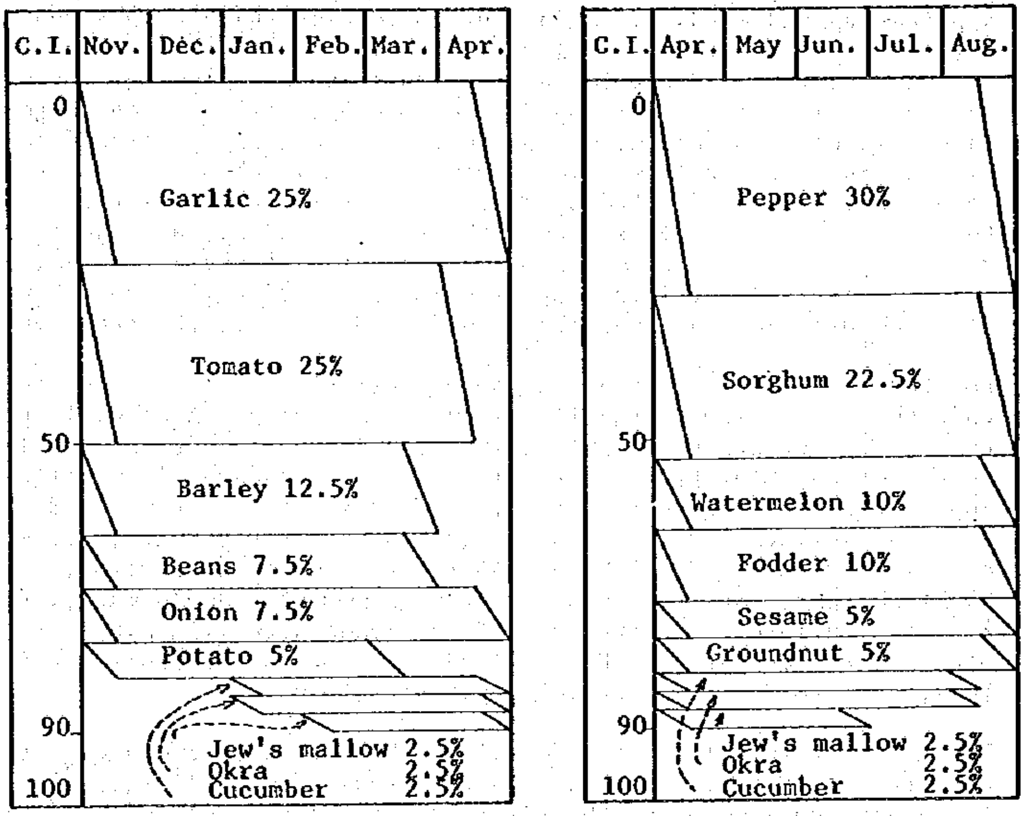
Foreshore agriculture is practiced in the drawdown zone of the lakeshore using movable irrigation equipment, as will be described later in this section. The area of cultivation differs for winter and summer crops, as indicated in Figure 4-1-2. Winter crops are cultivated on the upper

Figure 4-1-1 Proposed Cropping Pattern for Upland Agriculture (triennial rotation)



C.I. = Cropping Intensity in %.

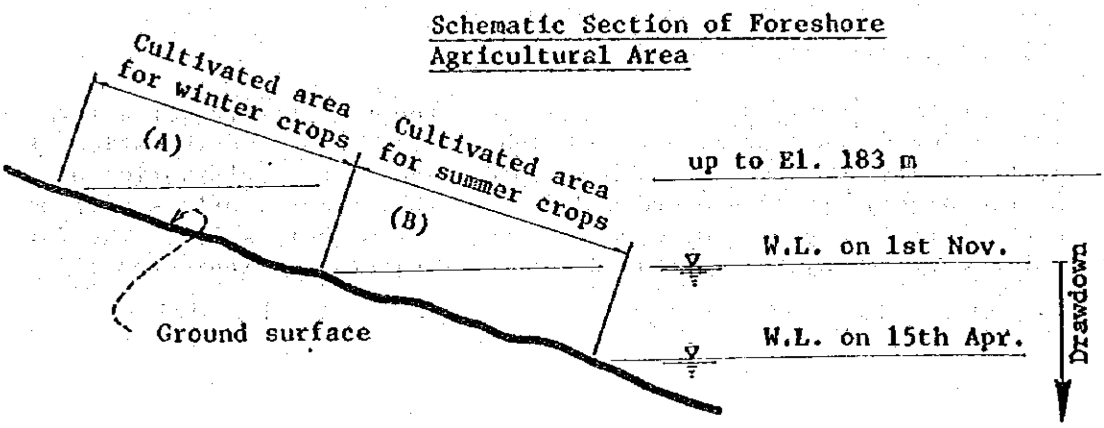
Figure 4-1-2 Cropping Pattern for Foreshore Agriculture


Cropping Pattern for Winter Cropping Area (A)

Cropping Pattern for Summer Cropping Area (B)

C.I. = Cropping Intensity in %.

Schematic Section of Foreshore Agricultural Area



part of the drawdown zone, while summer crops are planted closer to the shoreline. However, their cropping periods do not overlap each other, in order to supply water to the two areas by a single irrigation equipment. Considering the fluctuation of the water level, winter crops are planted in the beginning of November and summer crops in the beginning of May.

The farming in the Project Area will be semi-mechanized in the sense that it is similar to the current practice in Egypt where tractors are mainly used for land preparation, sowing of cereals and part of fertilizer application and weeding. A farm of 10 feddans which emphasizes the intensive cultivation of various vegetables cannot expect high returns on mechanization. Excepting soil preparation and plowing, mechanization is less efficient in that the damage to crops will be much larger than manual weeding, planting, harvesting, etc., and is not significantly time-saving for the intensive cultivation of vegetables. The speed of mechanical plowing (including time needed for transporting tractors to the fields) is said to be about 2 hours per feddan, as opposed to the manual speed of 16 - 20 man/hours. The speed of manual sowing, planting, weeding and fertilizer application per feddan is around 3 man/hours, 24 man/hours, 40 - 50 man/hours and 20 -30 man/hours, respectively.

For fertilizer application and use of certified seeds, it is also assumed that the future level of utilization in the Project Area will approximate the current practices in the Governorate as recommended by the local branch of the Ministry of Agriculture. The standard of fertilizer application per feddan in the Governorate is, for instance, 130 kg of ammonium sulfate and 100 kg of superphosphate for sorghum, 250 kg of ammonium sulfate and 100 kg of superphosphate for watermelon, 50 kg and 25 kg for okra, and 100 kg of ammonium sulfate for Jew's mallow (mulukia). Ammonium sulfate (31% nitrogen) and superphosphate (15% P_2O_5) are locally manufactured at the Kima Factory and sold for low subsidized prices of £E 4.5 and £E 2.0, respectively, per bag of 50 kg.

Taking all things into consideration, the yields of crops expected in the Project Area will be 30% less than the current levels achieved in Aswan Governorate during the first 10 years after settlement, chiefly due to the immature soils therein. Judging from the information on the newly reclaimed lands in the Governorate and the New Valley, the yields of crops will gradually rise after the initial 10 years in parallel with the expected improvement in farming practices and irrigation management among the settled farmers, and reach the average yields of the Governorate during 1968 - 1977, as shown on Table 4-1-2.

(3) Farm Model and Expected Income

It must be emphasized that the selected cropping pattern for a farm of 10 feddans is not the kind from which one can expect maximization of profits. If some 100,000 farmers specialize in the cultivation of one or two highly profitable crops and flood the markets, prices will no doubt fall to depress the expected income from their sales. The foregoing cropping system envisaged for the Project Area indicates a

Table 4-1-2 Unit Yield for Major Crops

(Unit: ton/feddan)

Crops		1st 10 Years	After 10 Years
Winter Crops	Barley	1.0	1.2
	Tomato	5.0	5.6
	Garlic	4.3	6.1
	Onion (green)	5.5	7.7
	Broad Beans	0.5	0.8
	Okra	1.1	1.5
	Jew's Mallow	1.3	1.8
	Cucumber	2.0	2.9
	Potatos	4.2	6.0
	Lucern	12.0	17.0
Summer Crops	Sorghum	0.8	1.0
	Watermelon	4.2	6.0
	Sesame	2.2 (ardab)	3.2 (ardab)
	Okra	2.7	3.8
	Pepper (red)	3.4	4.8
	Jew's Mallow	2.5	3.5
	Groundnuts (seed)	5.0 (ardab)	7.0 (ardab)
	Cucumber	3.2	4.5
	Cowpea	6.0	8.5
Orchard	Mango	1.4	2.0
	Orange	2.1	3.0
	Lemon	2.5	3.5
	Dates	2.1	3.0

typical or average farm with balanced market prospects for various cash crops which it produces.

Some apriori assumptions on the prospective farming activities are made in consideration of the requirements mentioned already in the beginning of this section as follows.

(i) Cash crops which have larger market prospects and/or fetch higher prices are given top priority in the use of available farmland.

(ii) The production of coarse grains as foodstuffs for home consumption aims at the current self-sufficiency level of 50% in the Governorate. This is deemed necessary because prospective rural communities will be widely scattered in the lakeshore.

(iii) The production of animal protein chiefly focuses on poultry raising, because large ruminants like cattle require a large quantity of fodder and thus lowers the productivity of limited farmland available to individual farmers. It is assumed that the Project Area is 100% self-sufficient in poultry meat and eggs and consequently part of the farmland is planted to coarse grains to be 100% self-sufficient in feedstuffs for poultry.

(iv) For large ruminants, self-sufficiency in milk and beef is set at 25% during the initial 10 years and gradually raised afterwards to 50% by the end of the century. This calls for cultivation of fodder on the farmland, assuming 100% self-sufficiency in the supply of fodder.

(v) Permanent crops are mainly fruit-bearing trees and their planted area will be gradually expanded to 10% of the farmland.

As already mentioned in the preceding paragraphs, the farming practices in the Project Area are assumed generally to conform to the current practices recommended by the Department of Agriculture in Aswan Governorate. In other words, the total production cost per feddan for each crop is expected to be equal to the figures cited in Table 2-1-13 (Section 2.1 of Chapter II) and remain constant. Likewise, the farmgate prices (1977-78) of crops shown in the same table are held constant throughout the plan period. With regard to okra and Jew's mallow, farmgate prices are estimated with special reference to the monthly fluctuations of Cairo wholesale prices. Supposing that the crop yields stay 30% less than the Governorate averages during the initial 10 years and reach the same levels afterwards, and given the cropping pattern as already indicated, the net income per farm of 10 feddans is estimated to be £E 2,126 in 1987, £E 2,332 in 1992 and £E 3,738 in 1997, as shown on Table 4-1-3. Supposing that 1.7 members of each household engages in farming on the average, the net income per worker will be around £E 2,200 at the end of the present century.

During initial years, permanent crops like mango and citrus will play an economically minor role as they take 4 or 5 years to start bearing fruits. The major sources of income will then be tomato, garlic and pepper. After the initial 10 years, the sources of income will diversify to give more stability to the farmers, as indicated in the table. If land reclamation and irrigation development are to begin in 1982, the farmers' net income per feddan of farmland will be £E 213 in 1987, and increase to £E 233 and £E 374 in 1992 and 1997, respectively. In addition, one out of every 2 to 3 farming households will keep a head of dairy cattle, and assuming the lactation of 1 ton per year per head of cattle, will have an additional annual income of about £E 50. Likewise, 10 layers per household will yield an annual income of about £E 100 from the sales of eggs.

Table 4-1-3 Expected Farm Income (10 feddans)

	1987					1992					1997				
	Yields (ton/ feddan)	Cultivated Area (feddan)	Costs (£E)	Gross Income (£E)	Net Income (£E)	Yields (ton/ feddan)	Cultivated Area (feddan)	Costs (£E)	Gross Income (£E)	Net Income (£E)	Yields (ton/ feddan)	Cultivated Area (feddan)	Costs (£E)	Gross Income (£E)	Net Income (£E)
Winter Crop															
Barley	1.0	0.6	46	57	11	1.0	0.5	38	48	10	1.2	0.6	56	81	25
Straw			0	60	60				50	50				60	60
Beans	0.5	0.2	16	28	12	0.5	0.3	24	42	18	0.8	0.3	27	67	40
Tomato	3.9	2.5	310	878	568	3.9	2.5	310	878	568	5.6	3.0	402	1,512	1,110
Garlic	4.3	2.5	388	860	472	4.3	2.5	388	860	472	6.1	1.7	280	330	550
Okra	1.1	0.3	36	66	30	1.1	0.3	36	66	30	1.5	0.2	26	60	34
Jew's Mallow	1.3	0.3	36	68	32	1.3	0.5	36	68	32	1.8	0.2	26	63	37
Onion	5.5	0.5	60	110	50	5.5	0.5	60	110	50	7.7	0.7	91	216	125
Potato	4.2	0.5	128	172	44	4.2	0.5	128	172	44	6.0	0.7	165	294	129
Vegetable	2.0	0.2	20	46	26	2.0	0.2	20	46	26	2.9	0.2	22	67	45
Summer Crop															
Sorghum	0.8	0.8	42	66	24	0.8	0.9	47	75	28	1.1	0.9	47	107	60
Straw			-	80	80			-	90	90				90	90
Groundnut	ardab														
	" 5.5	0.5	30	68	38	5.5	0.5	30	68	38	7.0	0.7	49	132	83
Sesame	2.2	0.5	27	44	17	0.2	0.5	27	44	17	3.2	0.7	44	90	46
Pepper	3.4	3.0	420	897	477	3.4	3.0	420	897	477	4.8	2.0	300	844	544
Okra	2.7	0.3	36	57	21	2.7	0.3	36	57	21	3.8	0.2	26	53	27
Jew's Mallow	2.5	0.3	36	47	11	2.5	0.3	36	47	11	3.5	0.2	26	42	16
Watermelon	4.2	1.0	170	252	82	4.2	1.0	170	252	82	6.0	1.3	234	468	234
Vegetables	3.2	0.2	20	37	17	3.2	0.2	20	37	17	4.5	0.2	22	52	30
Cowpea	6.0	0.9	18	65	47	6.0	0.8	16	58	42	8.5	1.4	35	143	108
Perennial															
Mango	-	0.25	10	-	-10	1.4	0.25	18	56	38	2.0	0.25	20	80	60
Orange	-	0.25	10	-	-10	2.1	0.25	18	58	40	3.0	0.25	20	82	62
Lemon	-	0.25	10	-	-10	2.5	0.25	18	46	28	3.5	0.25	20	61	41
Dates	-	0.25	10	-	-10	2.1	0.25	18	65	47	3.0	0.25	20	94	74
Lucern	12.0	0.5	25	72	47	12.0	0.6	30	86	56	17	0.7	35	143	108
Total					2,126					2,332					3,738
per feddan					213					233					374

Source: The JICA Study Team.

(4) Other Farming Possibilities

A settler in one of the upland agricultural areas will be provided with a farm of 10 feddans to secure a higher income as already discussed in the preceding paragraphs. With respect to foreshore agriculture, the farm size is expected to be much smaller, because the total net arable land available at each identified site is small at around 1,600 feddans, and there is a certain size requirement for scattered rural communities to provide them with basic needs services. Moreover, prospective settlers in the foreshore areas will, on the whole, engage in lake fisheries as another major source of income. The average household farm size will be around 4 - 5 feddans. The development requirements for foreshore agriculture do not particularly differ from upland agriculture. Mono-cultural specialization will have to be avoided and diversification of cash cropping, mostly vegetables and fruits as indicated for upland agriculture, must be emphasized to ensure remunerative and stable farming. A probable major difference, which is a matter of degree, is that the self-sufficiency in coarse grains as foodstuffs for home consumption must be increased due to the smaller size and more scattered location of settlement communities. In this respect, the net income per feddan of farmland is likely to be smaller than is the case with upland agriculture. It is expected that the cash income from fishing will compensate the lower household income from farming.

Another farming possibility is the development of large-scale, plantation-type agriculture. However, as long as available data is concerned, the potential agricultural areas found in the High Dam Lake area are not large enough for such a development, except in the Kurkur area. As already indicated in Section 2.1 of Chapter II, moreover, the financial IRR of 5 - 6% is unlikely, under the normal circumstances, to attract private or commercial capital. Considering the long-term national objective to absorb as many population as possible in the un-developed or under-developed regions of the country, it is definitely more desirable to settle a larger number of small-holders than a few large commercial estates.

As already implicit in the selected farm model in the foregoing paragraphs, the relative importance of livestock is assumed to be low in the Project Area. The major reason lies in the lesser profitability of such an undertaking. An annual gross income per head of dairy cattle is estimated to be around £E 200, assuming the lactation of 1 ton per year, while feedstuffs annually cost £E 150 per head. In addition, a heifer costs about £E 300. Even considering the sales of calves and the salvage value of milch cows, dairy farming is not particularly profitable. Cattle raising will have to be practiced mostly for home consumption and to the extent that crop residuals and wastes can be put to better use. It is also better to raise poultry mostly for home, and partly local, consumption, because large-scale intensive farming of broilers and layers are far more efficient and there is already a plan to start such an undertaking near Aswan City.

If we suppose the future increase of beef and poultry consumption in the Governorate, possibilities of starting large-scale intensive farming of beef cattle and poultry should be examined. Assuming that the annual demand for beef in Aswan Governorate increases to 3,250 tons by the end of this century (per capita consumption of 13 kg), and that the Project Area will supply 50% of the demand, or 1,625 tons. Assuming a body weight of 400 kg per head, this means a slaughtering of 6,770 heads. Assuming further a fatality rate of 3% and 450 days of feeding for 90-day old calves, a total of about 7,100 heads must be reared in the Project Area. If the beef cattle of this number is made subject to centralized intensive rearing, the total net income would amount to £E 38,400 as shown below and the undertaking is not very profitable.

Sales	6,770 heads x 240 kg x £E 0.75	= £E 1,218,600
Purchase Cost	7,100 calves x £E 50.00	= £E 355,000
Feedstuff Cost	6,100 animal units x 10 tons x £E 12.00	= £E 732,000
Labor Cost	60 employees x £E 720	= £E 43,200
Other Costs (including depreciation)		= £E 50,000
Net Income		= £E 38,400

The profitability of beef cattle is impaired by the high cost of feedstuff. On the other hand, only 4.4 kg of feed is needed to produce 1 kg of broiler meat and, therefore, a reasonable level of income can be expected of chicken raising, even allowing for electricity and other costs and depreciation, as shown below.

Sales	1,000,000 chickens x 1 kg x £E 1.00	= £E 1,000,000
Feedstuff Cost	1,000,000 chickens x 4.4 kg x £E 0.10	= £E 440,000
Purchase Cost	1,200,000 chicks x £E 0.10	= £E 120,000
Labor Cost	50 employees x £E 720	= £E 36,000
Other Costs (including depreciation)		= £E 200,000
Net Income		= £E 204,000

(5) Expected Agricultural Production

On the basis of the foregoing assumptions and estimates, the total agricultural production in the Project Area is calculated by crop in Table 4-1-4. As seen from the table, most of the crops produced in the Area excluding grains and beans will be in excess of the estimated consumption in Aswan Governorate as shown in Table 4-1-5, and consequently shipped to large consuming centers like Cairo in the north or exported.

Table 4-1-4 Expected Agricultural Production in the Project Area

	1987		1992		1997	
	Planted Area (feds.)	Production (tons)	Planted Area (feds.)	Production (tons)	Planted Area (feds.)	Production (tons)
Winter:						
Barley	2,700	2,700	5,400	5,400	9,500	11,400
Beans	800	400	2,400	1,200	4,400	2,500
Tomato	11,000	43,000	24,500	95,900	44,500	192,200
Garlic	11,000	47,500	24,500	105,900	24,500	125,700
Okra	1,300	5,000	2,900	11,100	2,900	12,300
Jew's Mallow	1,300	5,000	2,900	11,100	2,900	13,100
Onion	2,200	12,000	4,900	26,700	10,000	59,800
Potato	2,200	9,000	4,900	20,600	10,000	46,000
Vegetables	900	1,800	2,000	4,000	2,000	5,800
Summer:						
Sorghum	3,500	2,800	9,200	7,360	13,000	14,300
Cowpea	4,000	24,000	8,000	48,000	20,300	172,550
Groundnut	2,200	8,200	4,900	18,300	10,000	40,800
Sesame	2,200	600	4,900	1,300	10,000	3,000
Pepper	13,300	45,000	29,600	100,400	29,600	119,000
Okra	1,300	5,000	2,900	11,100	2,900	12,300
Jew's Mallow	1,300	5,000	2,900	11,100	2,900	13,100
Watermelon	4,400	18,500	9,800	41,200	19,800	91,900
Vegetables	900	1,800	2,000	4,000	2,000	5,800
Perennial:						
Orange	1,250	2,300	2,500	5,100	3,750	9,000
Mango	1,250	1,500	2,500	3,300	3,750	6,000
Date	1,250	2,300	2,500	5,100	3,750	9,000
Lemon	1,250	2,700	2,500	6,000	3,750	10,200
Lucern	2,000	24,000	6,000	72,000	10,000	170,000

Source: The JICA Study Team.

Table 4-1-5 Expected Consumption of Food Crops in Aswan Governorate

	Total Consumption in Aswan Governorate (tons)			Expected Per-capita Consumption (kg)		
	1987	1992	1997	1987	1992	1997
Wheat	152,000	191,100	238,000	177	182	186
Rice	12,900	22,000	32,000	15	21	25
Coarse Grains						
Foodstuff	58,500	71,400	87,000	68	68	68
Feedstuff	30,300	48,500	73,200	-	-	-
Beans	8,600	15,800	25,600	10	15	20
Groundnut	4,300	6,300	7,700	5	6	6
Tomato	26,600	50,400	80,600	31	48	63
Potato	18,000	23,100	29,400	21	22	23
Onion	7,700	10,500	12,800	9	10	10
Sesame	1,300	1,600	1,900	1.5	1.5	1.5
Garlic	1,700	3,200	3,800	2	3	3
Okra	1,300	1,600	2,600	1.5	2	2
Jew's Mallow	1,300	1,600	2,600	1.5	2	2
Pepper	1,700	3,200	3,800	2	3	3
Watermelon	17,200	26,300	38,400	20	25	30
Mango	2,600	4,200	6,400	3	4	4
Orange	8,600	11,600	17,900	10	11	14
Lemon	2,600	4,200	6,400	3	4	5
Date	8,600	12,600	17,900	10	12	14

Source: The JICA Study Team.

4.1.2 Land Reclamation and Irrigation

(1) Upland Agricultural Areas

(a) Irrigation Method

Successful irrigation in the area around High Dam Lake can be achieved through careful selection and design of the irrigation systems and skilled water management. Physical conditions such as soil, topography and climate and the uncertain availability of Nile water indicate many difficulties for profitable agricultural development in the area, and irrigation is likely to be expensive. Hence, the efficiency of water use will be essential in the selection of appropriate irrigation methods.

Surface Irrigation

In general, there are two types of surface irrigation methods: (i) one type where a required depth of water is ponded on the land and allowed to soak in and (ii) the other where water flows over the land at a controlled rate so that the required amount of water infiltrates into the soil. The former are flood basin irrigation methods and simple for farmers to learn how to operate. The major methods of the second type are furrow and border strip irrigation.

The flood basin method is currently the most common form of perennial irrigation in Egypt. This method can be used on most soil types, but accurate land levelling will be very important in order to have uniform water distribution. In addition, it is necessary to adjust the basin size to suit the capacity of a given irrigation system so that the entire basin can be flooded quickly and uniformly.

The technical suitability of furrow irrigation will depend on the gradient and soil conditions. Especially on sandy soils, it is necessary to have a flow rate as large as possible to ensure even distribution of water along the length of furrows. On the other hand, the flow rate must be controlled according to the slope of furrows to prevent erosion. When the gradient is large, the furrow length must be shortened, perhaps to as short as 50 m.

Border strip irrigation requires accurate cross-levelling of the strips and a fairly large flow of water to achieve uniform distribution of water. On the unstable soils which are common in the High Dam lake area, it would be impossible to keep even flow of water and this will result in severe erosion. Hence, border strip irrigation is not recommendable for the Project Area.

The surface irrigation methods technically applicable to the Project Area are, therefore, the basin and furrow methods. However, these methods need close supervision of the operation and hence require more labor in order to keep water losses as small as possible. In general, the surface irrigation methods are not recommendable for large scale development in the Project Area, because the soils are very sandy and land levelling will be expensive due to the undulating topography in the western shore.

Sprinkler Irrigation

The sprinkler irrigation method is suitable for areas with irregular topography and shallow unstable soils, since it requires virtually no land levelling. In addition, especially on sandy soils, it is possible to achieve higher irrigation efficiency than surface methods, and this is particularly important in areas where water is scarce or expensive. In general, the sprinkling efficiency varies from 70% under hot arid climate to 85% under cool humid climate.

The velocity of wind is the major limitation on the use of sprinklers. High wind distorts the distribution pattern of the sprinklers and reduces the uniformity of application. Under hot and dry conditions, wind also increases evaporation losses from the spray. Satisfactory uniformity under windy weather can be achieved by closer sprinkler spacing than would otherwise be required, and narrower spacing is generally recommended for a wind speed exceeding about 4 km/hour. The velocity greater than 8 km/hour is a serious hazard for sprinkler operation. The available climatic data shows that the monthly mean wind velocity around High Dam Lake varies between 4.6 and 9.0 km/hour, and over 8 km/hour in April and May. However, by the provision of windbreaks, the effect of wind can be reduced.

Sprinkler irrigation systems have been introduced in the pilot farms in Kurkur, Kalabsha and Tushka (El-Salam) areas. The portable sprinkler system is employed in the above farms and the sprinkler spacing is kept at 18 m. However, this interval seems to be too large, considering the prevailing wind velocity. The intervals of 12 m x 12 m might be recommendable. The systems have been well operated by workers in the above farms. Therefore, the sprinkler irrigation method can be operated by farmers, if adequate guidance is provided. For the High Dam Lake area, the semi-portable sprinkler irrigation method will be more desirable in view of its lower investment cost and labor requirement.

Drip Irrigation

In this methods, water is slowly dripped to the soils through mechanical devices. Very high application efficiency of water can be expected of this method, provided that the supply of water is exactly matched with the water requirement of each crop, which is a highly delicate maneuver. When properly operated, this method has many advantages, such as water saving, better crop response, labor saving, and saving on agricultural chemicals due to less needs of weed and disease control. It is also possible to use saline water of up to 4 mmhos.

In spite of these advantages, there are many limitations and problems. The greatest maintenance problem is blockage of the system. Water must be carefully filtered before let into the system. Clogging often occurs due to the precipitation of salts contained in water. The drippers must be constantly checked, which is a tedious and time consuming procedure. The durability of drip irrigation equipment is shorter than the other systems, unless it receives very careful treatment. Other limitations are high costs (more than £E 1,000/feddan for vegetables) and high skills required for installation and operation. For the High Dam Lake area, drip irrigation is not recommendable for these reasons.

Recommendable Irrigation Method

The recommendable irrigation method for the upland area in the Project Area will be sprinkler irrigation. The basin and furrow irrigation methods should be applied only in areas, if any, where the gradient is gentle, soils are relatively deep and infiltration rates of soils are not very high. Sprinkler irrigation can be applied for all arable land areas identified around the lake.

The use of water by the various types of irrigation methods are calculated in Table 4-1-6. As is shown in the table, sprinkler irrigation can save water as much as 30% compared with surface irrigation. Considering the limited availability of Nile water, semi-portable sprinkler irrigation should be the standard method to be introduced in the identified areas around the lake. The recommendable spacing will be 12 m x 12 m by using intermediate pressure sprinklers.

Table 4-1-6 Water Use by Irrigation Method

Irrigation Method	Type of Field Canal	Irrigation Efficiency 1/ (1) Application	(2) 2/ Field Canal	(3)=(1)x(2) Project	Water Use 1/(3)(ratio)
Basin	Lined Canal	0.65	0.80	0.52	1.93(130)
Furrow	Lined Canal	0.60	0.80	0.49	2.04(137)
Sprinkler	Pipe (closed)	0.70	0.95	0.67	1.49(100)

Notes: 1/ FAO, Irrigation and Drainage Paper No. 24, 1977. Conveyance efficiency of the main pipeline from the intake to the site are assumed to be zero.

2/ Blocks are larger than 50 feddans.

(b) Irrigation Requirement

Irrigation requirement is defined as the depth of water required for meeting evapotranspiration (crop water requirements) minus contribution by effective precipitaion, groundwater and stored soil water plus leaching requirement and water losses.

Since direct measurement data is not available for the Project Area, crop water requirements are estimated on the basis of meteorological parameters. Around the High Dam Lake area, there are two meteorological stations, i.e., Aswan and Wadi Halfa in the Sudan. The meteorological records at these stations are on the whole similar as shown in Table 1-1-1 of Chapter I. Therefore, the values of meteorological parameters at the Aswan station are used to compute values of crop water requirements for the entire High Dam Lake area.

Crop water requirements (ETcrop) are estimated by the reference crop evapotranspiration (ETo) and crop coefficient (Kc), or ETcrop = Kc·ETo. Several methods are applicable for the estimation of ETo, using meteorological parameters. Among them, the modified Penman method would give the best results with minimum possible error, as mentioned in the FAO/UNDP study report1/ on crop water requirements for the New Valley area. In general, the weather conditions in the New Valley (Kharga) and Aswan are more or less similar except wind conditions (wind velocity at Kharga is about twice as high as at Aswan).

At Kharga, crop water requirements were measured by FAO in 1976 on the basis of lysimeter and pan-evaporation data (Class-A pan and Colorado

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1/ FAO/UNDP, Groundwater Pilot Scheme, New Valley, Technical Report I, 1976.

pan) obtained from the Kharga Water Requirement Station and printed in the aforementioned report. The report compared and analyzed (i) estimated values by two modified Penman methods (Doorenbos-Pruitt and Rijtema), (ii) evaporation data obtained from Class-A pan and Colorado pan, and (iii) direct measurement data on lysimeter. The value of ETo was then recommended as the average of the above three values. Because these recommended ETo values are very close to the averages of values respectively estimated by Rijtema's and Doorenbos-Pruitt's equations, ETo for the High Dam Lake area can be estimated on the basis of these two equations, using the meteorological data measured at Aswan, as shown in Table 4-1-7.

On the other hand, values of kc are estimated by the procedure proposed by Doorenbos and Pruitt[1/] on the basis of the recommended cropping pattern in this study. Then, the crop water requirements are calculated as shown in Table 4-1-8. According to the table, the highest daily value is 9.8 mm for Jew's mallow which occurs in July.

Based on the cropping schedule already mentioned, the total irrigation requirement is estimated. According to the meteorological and underground conditions around High Dam Lake, any form of moisture contribution such as precipitation, groundwater and stored soil water is unlikely. Therefore, irrigation requirement (IR) can be estimated by the following formula.

$$IR = \frac{ETcrop}{(1 - LR)} \times \frac{1}{E_p}$$

where: LR = leaching requirement
E_p = project efficiency

The irrigation method recommendable in the upland agricultural area is sprinkler irrigation as already discussed. The project efficiency (Ep) of sprinkler irrigation is estimated to be 67%, assuming that the field application efficiency (Ea) and the conveyance efficiency (Ec) are 70% and 95%, respectively. On the other hand, leaching requirement is estimated to be 0.04 as will be mentioned later. The calculated irrigation requirement for the whole Project Area is shown below in accordance with the progress of development as will be described later in this section.

	up to 1987	up to 1992	up to 1997
Aggregate Upland Area Reclaimed (fds)	32,000	82,800	134,000
Irrigation Requirement (m^3/fd)	9,860	9,905	9,665
Annual Irrigation Requirement (million m^3)	316	820	1,295

[1/] FAO, Irrigation and Drainage Paper 24, 1977.

Table 4-1-7 Estimation of Potential Evapotranspiration

Month	Mean Temp. (°C)	Relative Humidity (%)	Wind Velocity (km/day)	Sky Cover (oktas)	Daily ETo (mm/day) (I)1/ (mm)	(II)2/ (mm)	Mean3/ (mm)	Monthly Eto (mm)
Jan.	16.8	36	125	1.3	2.6	3.8	3.5	108.5
Feb.	18.6	31	161	1.1	3.7	5.6	4.5	126.0
Mar.	22.4	24	188	1.1	5.3	8.0	6.5	201.5
Apr.	27.2	20	195	1.0	6.5	10.0	8.5	255.0
May	31.9	18	216	1.0	8.0	11.9	10.0	310.0
June	33.6	19	175	0.3	7.4	11.3	9.5	285.0
July	34.0	21	139	0.4	6.8	9.7	8.5	263.5
Aug.	34.2	23	154	0.5	6.6	10.0	8.5	263.5
Sep.	32.0	26	154	0.4	5.9	9.2	7.5	225.0
Oct.	29.6	29	161	0.7	4.9	7.9	6.5	201.5
Nov.	24.0	36	111	1.0	3.0	5.4	4.0	120.0
Dec.	19.8	41	139	1.3	2.8	4.1	3.5	108.5
Total for year (mm)								2,468.0

Notes: 1/ Calculated by the modified Penman method as suggested by Doorenbos and Pruitt (FAO, Irrigation and Drainage Paper No.24, 1977)

2/ Recommended value by the Rijtema equation (FAO, Research on Crop Water Use, Salt Affected Soils and Drainage in the Arab Republic of Egypt, 1975)

3/ Mean value of (I) and (II) rounded to the nearest 0.5 mm because the value cannot claim an accuracy greater than this.

Table 4-1-8 Crop Water Requirements

(Unit: mm/month)

Crop	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
(A) Winter Crops													
- Barley	127	131	55								56	110	479
- Broadbean	124	70									55	104	353
- Tomato	127	153	190	12							52	83	617
- Garlic	114	135	200	105							55	95	704
- Jew's Mallow		75	233	199									507
- Onion	114	135	200	105							55	95	704
- Potato	114	113	9								53	91	380
- Okra	31	82	206	174									493
- Cucumber	34	96	197	111									438
(B) Summer Crops													
- Sorghum					28	167	280	270	80				825
- Groundnut					28	136	255	270	83				772
- Sesame					75	205	293	294	102				962
- Okra					28	131	235	274	41				709
- Jew's Mallow					46	288	304	55					693
- Watermelon					28	134	239	268	93				762
- Pepper					160	285	264	264	165				1,138
- Pasture					44	248	264	264	158				978
- Cucumber					30	155	245	229	10				669
(C) Perennial Crops													
- Citrus	82	95	161	204	248	243	224	224	192	171	96	86	2,026
- Alfalfa	104	119	192	242	295	271	250	251	214	191	115	103	2,347
(D) Windbreaks	43	51	81	102	124	128	119	118	102	90	48	44	1,050

For the reclaimed area of 134,000 feddans, 1.29 milliard m^3 of water will be required for irrigation, which is equivalent to about 70% of the additional Egyptian share of water from the Jongley Project. The daily peak irrigation requirement for the whole area is 49 m^3 per feddan in July. This value will be used as a base for planning water conveyance facilities.

(c) Leaching Requirement and Drainage

Since there is no rainfall, the agricultural development around the lake fully depends on irrigation. The quality of water in the lake is good (soluble salt concentration is between 120 and 180 ppm, and SAR is less than 6.5). However, soils around the lake contain a considerable percentage of salts as mentioned in Section 2.1 of Chapter II. Hence, leaching should be practiced before sowing in order to reduce salt contents in the soils. In addition, periodical leaching will be required to maintain the salt balance in the soils below the tolerance limits of crops during the growing period.

Leaching Requirement

According to the detailed soil surveys by REGWA, the salinity levels are summarized for the four areas as shown below. EC values of more than 4 mmhos/cm will affect the yields of many crops, and more than 8 mmhos/cm will severely affect them save the salinity-tolerant crops. Judging by the REGWA figures below, it is necessary to ameliorate the salinity of the soils in all areas except Quastal/Adendan by leaching.

Area	Electric Conductivity		Salt Percentage (%)
	Range	Average (mmhos/cm)	
Kurkur	4.2 - 67.5	15.6	1.0
Kalabsha	4.0 - 32.0	7.7	0.5
Tushka	2.3 - 17.0	6.0	0.4
Quastal/ Adendan	0.7 - 2.1	1.7	0.1

Accurate estimation of the amount of water necessary for leaching is not an easy task, because leaching requirements vary by soil salinity, water quality, soil conditions and so on. However, a standard amount of leaching water can be estimated by using Volobuev's equation (1969) as shown below.

Area	Soil Salinity (%)	Leaching Water	
		(m^3/ha)	(m^3/fd.)
Kurkur	1.0	9,500	4,000
Kalabsha	0.5	6,640	2,800
Tushka	0.4	5,720	2,400

On the other hand, in any form of irrigation, a certain amount of salts are accumulated in the soils in proportion to the salinity level of water. Leaching requirement (LR) for seasonal irrigation is estimated to be 0.04 by the proposed formula by FAO[1/], assuming that the current average yields in the Governorate be obtained for main crops, especially vegetables, selected for the Project Area. Then, the amount of water (WR) needed to satisfy both ETcrop and LR is estimated as follows:

$$WR = ETcrop\ /\ (1-LR) = 1.04\ ETcrop$$

Drainage Planning

Systematic field investigation on the permeability of soils and underlying rocks as required for drainage planning has not been carried out in the Project Area. However, soils in the Area around the lake reportedly have high drainability. According to the Desert Institute, Cairo, the cemented materials lying under the soils are generally permeable sandstone (the order of 10^{-3} cm/sec or more) with sufficient drainability down to a fair depth. If so, drainage systems would not be needed in the Project Area, except for Kurkur, because there is no groundwater table below the soils. Leaching water will soak deep into extremely dry sandstone and may stay there. If an impermeable layer exists near the ground surface, say 1.5 m deep, leaching water or excess water applied would form a groundwater table and soluble salts would be transported upward and concentrate in the root zone by the capillary water movement. In such cases, a drainage system will be indispensable in order to remove the excess water. Therefore, the permeability and thickness of underlying rocks will have to be studied before implementation. In this report, drainage is not considered necessary, based on the information from the Desert Institute. The Kurkur area however will definitely require an effective drainage system.

(d) Water Conveyance Facilities

The prospective irrigated agriculture in the Project Area must depend on High Dam Lake as the only source of water. However, topographical and hydrological conditions indicate difficulties in constructing water conveyance facilities, especially pump stations. The major problems are: (i) large and unpredictable fluctuations of the water level in the lake and (ii) generally flat topographic formation on the

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[1/] $LR = \frac{ECw}{5ECe-ECw} \cdot \frac{1}{Le}$

where: ECw = electrical conductivity of the irrigation water, mmhos/cm
ECe = electrical conductivity of the soil saturation extract for a given crop, mmhos/cm
Le = leaching efficiency

It is assumed as ECw = 0.25, ECe = 2 and Le = 0.6.
See FAO, Irrigation and Drainage Paper No. 24, 1977, Table 36.

western shore of the lake, with a gradient ranging from 0.2 to 5%, and consequently, the wide movement of the shoreline in accordance with the fluctuation of the water level.

The long-term average level of water is estimated to be around 170 m in altitude as mentioned in Section 1.1 of Chapter I. The low water level in a drought year is tentatively estimated to be about 166 m with 10% probability, which is assumed to be the design low water level for pumping stations on the lake. Since the high water level is around 182 m in a flood, the maximum range of fluctuation reaches 16 m. In parallel with this fluctuation, the shoreline of the lake will move horizontally for a distance ranging from 0.3 to 9 km.

Pumps are assumed to be operated 16 hours per day at the time of peak water requirement (July), as commonly practiced in Egypt. Since the peak irrigation requirement is estimated to be 49 m^3/day per feddan, the required capacity for pumps is calculated to be 0.85 lit/sec per faddan.

Pump stations could be either fixed or floating types, the latter being traditionally employed on the Nile. The fixed type should probably use vertical-shaft mixed-flow pumps, judging from the practices in Syria at Lake Assad which was created by the Euphrates Dam and has similar hydrological conditions, with the design range of water level fluctuation at 15 m. But its construction costs are expected to be much higher in the High Dam Lake area than the traditionally used floating type. A fixed pump station, the second of its kind at Lake Assad, is now under detailed engineering to irrigate an area of about 43,000 feddans, and the construction costs of this station is equivalent to approximately £E 800 per feddan. However, in view of the pumping requirement per feddan in the High Dam Lake area being 1.47 times larger than at this station (0.58 lit/sec per feddan), the probable costs of construction would come to about £E 1,180 per feddan, with other conditions held constant. If the size of an irrigable area is sizably smaller, as is generally the case with the identified upland sites for irrigation development in the High Dam Lake area, the construction costs per feddan would become higher, because the main civil works including coffering cannot be reduced as much as the reduction of the total capacity of the pump station. Moreover, the flat topographic formation in the western shore of High Dam Lake is less suited to the fixed-type station employed at Lake Assad.

The floating-type pump station can be installed at much lower costs, including the costs of additoinal facilities necessary to bolster its limited head and capacity. Pumps are installed on a float and the discharge pipe of the pump is connected by a detachable flexible pipe to a fixed pipe or a stand constructed on the lakeshore, as generally seen at the existing stations downstream of Aswan. The largest floating pump station in Aswan Governorate is currently operated at Kattara and has the pumping capacity of 1.6 m^3/sec (engine output 600 HP). This capacity seems to be the maximum from the viewpoint of safe operation and maintenance and can irrigate an area of approximately 2,000 feddans. The identified upland agricultural sites can be served by one or more pump stations, depending on the size of their respective irrigable areas. The floating pump stations must be sited near the shore with a steep gradient and if there is no suitable site, the appropriate slope must be secured artificially. In order to accommodate for the limited head of the pumping station and lessen the hydraulic pressure required for the flexible pipe, an outlet pondage must be constructed just above the high water level in a flood year, i.e., 183 m and above, and a booster pump station must be installed at the pondage.

A carrier pipeline is recommendable to convey water from the booster pump station to the fields. Open channels are considered unsuitable, because they would require many booster pumps and concrete lining due to the very low gradient of the terrains and the sandy texture of the soils in the Project Area. Either steel or asbestos cement pipes could be used for the carrier pipeline, but if the required diameter of the pipes is more than 600 mm, steel pipes are recommendable. The costs of the carrier pipeline would be very high, where long distance has to be covered.

(2) Foreshore Agriculture

Possibility of agriculture on the foreshore which is affected by the annual fluctuation of the water level was first proposed as drawdown agriculture by the FAO report of 1974[1]. The idea is to cultivate the foreshore during the time when the shoreline gradually recedes, i.e., from the beginning of November until the end of July in the following year. In the FAO report, the drawdown agriculture is classified into two types; i.e., one with supplementary irrigation and the other without irrigation and fully dependent on subsoil moisture. Judging from the results from a few trials carried out at Abu Simbel and elsewhere, foreshore agriculture without irrigation seems too risky and unpredictable, due to the low water holding capacity of the sandy soils and the groundwater table falling rapidly following the drop of the water level. The availability of subsoil moisture or underground water is largely determined by topographic and soil conditions and the Study Team cannot entirely deny the possible existence of some localities where crop production is practicable without irrigation or with only supplementary irrigation. Nonetheless the Team considers it safer for the sake of attracting settlers to assume irrigation for foreshore agriculture in order to meet the peak water requirements of crops.

The irrigation method is furrow irrigation, using a portable pump and pipes with a small staired inlet channel (see Figure 4-1-3). Both winter and summer crops are cultivable. Winter crops are planted on the area immediately above the shoreline in the beginning of November as shown in Figure 4-1-3, and follwing the fall of the water level during the subsequent growing period of 4.5 months, the portable pump will be moved to the receded shoreline and the pipe is extended in order to supply water continuously to the fields. Summer crops will be sown in the beginning of March. The cultivated area will be between

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[1] FAO/UNDP and Lake Nasser Development Center, Aswan, Technical Report 4, 1974.

the boundary of the winter cropping area and the shoreline on the 1st of March as shown in Figure 4-1-3. The irrigation system is operated by the same procedure as indicated above. After winter irrigation, the irrigation system is moved for summer irrigation. In order to pump up water easily, a small inlet channel 1.5 m deep will be dug following the fall of the lake water level.

The area tentatively identified as suitable for this type of irrigated agriculture lies between the altitudes of 183 m and 175 m, which is above the annual fluctuation range of the water level in a medium flow year. The actual seasonal elevation of the water level naturally varies from year to year, and the actual site will lie somewhere below the high water level of a flood year (which precludes the construction of costly permanent structures for sprinkler irrigation) and above the water level which occurs in the beginning of March (to allow subsequently the growing period of 4 - 5 months). Therefore, no indication of the absolute altitudes is given in Figure 4-1-3. The range of 183 m and 175 m is tentatively given in order to estimate the arable area suitable for small scale development, which has been already started experimentally in a few places by some Nubians, partly encouraged by government supports. The foreshore area will be suitable for those who practice both agriculture and fishing for livelihood, as indeed a number of Nubians and fishermen interviewed by the Study Team expressed such wishes in the event of their settling in the lake area. The foreshore agricultural development is easier to implement because of its low capital costs and small scale of operation and should precede the more capital intensive upland agriculture in view of the presence of willing parties. It must be emphasized that the government agencies should undertake in advance more systematic studies on soil and topography and subsequently involve more in supervising settlers to ensure the success of this type of agriculture.

(3) Preliminary Cost Estimate

The investment costs for land reclamation are preliminarily estimated on the basis of the information collected mainly from the Ministry of Land Reclamation and the High Dam Lake Development Authority. Table 4-1-9 summarizes the basic construction costs for feddan as applied to the Project Area (excluding the water conveyance facilities) and is largely based on the actual local cost standards in Aswan in early 1979. The average development costs for both upland and foreshore agriculture, excluding water conveyance facilities, are summarized as follows.

	Work Item	Average Costs per Feddan	
		Upland Agri.1/ (£E/fd)	Foreshore Agri. (£E/fd)
1.	Land Preparation	50	150
2.	Irrigation Systems	700	100
3.	Roads	50	50
4.	Windbreaks	30	-
5.	Agricultural Machinery	100	100
6.	Buildings	320	770
7.	Studies	20	10
8.	Physical Contingency (10%)	130	120
	Total	1,400	1,300

1/ Excluding the Kurkur area.

In addition to the above, the costs of water conveyance facilities, i.e., pumping stations and carrier pipelines, are estimated using the unit construction costs shown in Table 4-1-10. The costs of these facilities would vary widely in the Project Area and depend upon the size of an irrigable area, on the one hand, and the location of the area (distance from the shoreline and altitude of the irrigation area), on the other.

Costs of the water conveyance facilities for upland agriculture vis-a-vis the area size and the distance from the shoreline are estimated and summarized in Figure 4-1-4, assuming that the slope from the irrigation area toward the lake is 0.2% on the average. As shown in the figure, costs for the water conveyance facilities per feddan sharply rise with increases in distance from the shoreline. If the distance is more than 25 km, the development of irrigated agriculture will be economically impractical in the High Dam Lake area.

4.1.3 Development Program and Projects

(1) Development Program

The identified agricultural development areas around High Dam Lake can be grouped into two zones, i.e., the northeast and southwest zones. The former comprises the Kurkur, Kalabsha, Dakka and El Allaqi areas and the latter the areas from Tomas/Affia down to the Sudan border. In the northeast zone, implementation of agricultural development will be commenced from the large-scale Kurkur project (30,000 feddans in gross terms) which is nearest to Aswan City and already an on-going project. On the other hand, in the southwest zone, the Quastal/Adendan area will be first developed, in which the feasibility study on selected areas is now being carried out by an Egyptian company and scheduled to be completed by the end of 1979. The reasons why priority is given to the two projects are as follows:

(i) The project site is near the existing town, i.e., Aswan or Abu Simbel,

Figure 4-1-3 Schematic Plan of Foreshore Agriculture

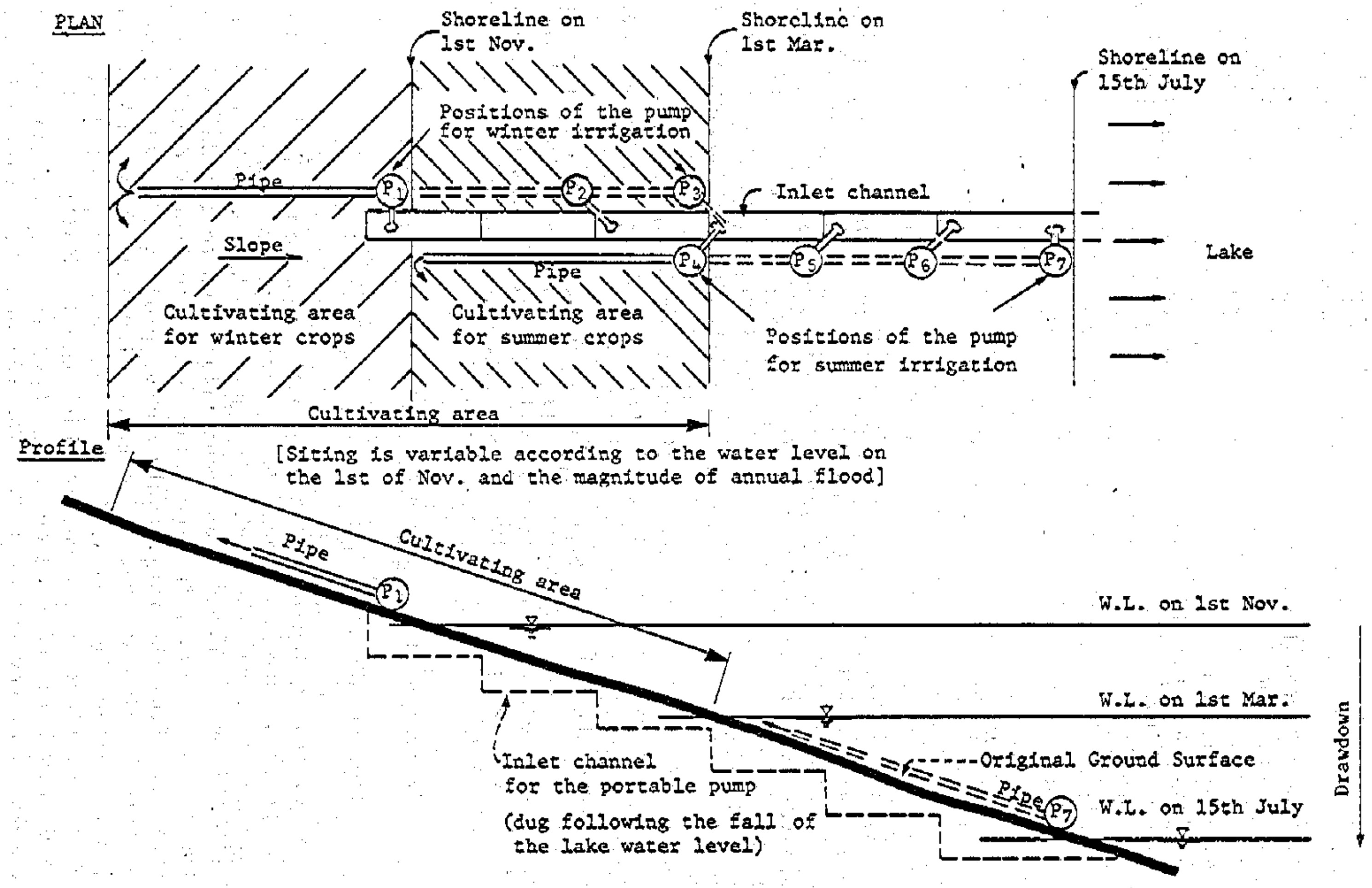


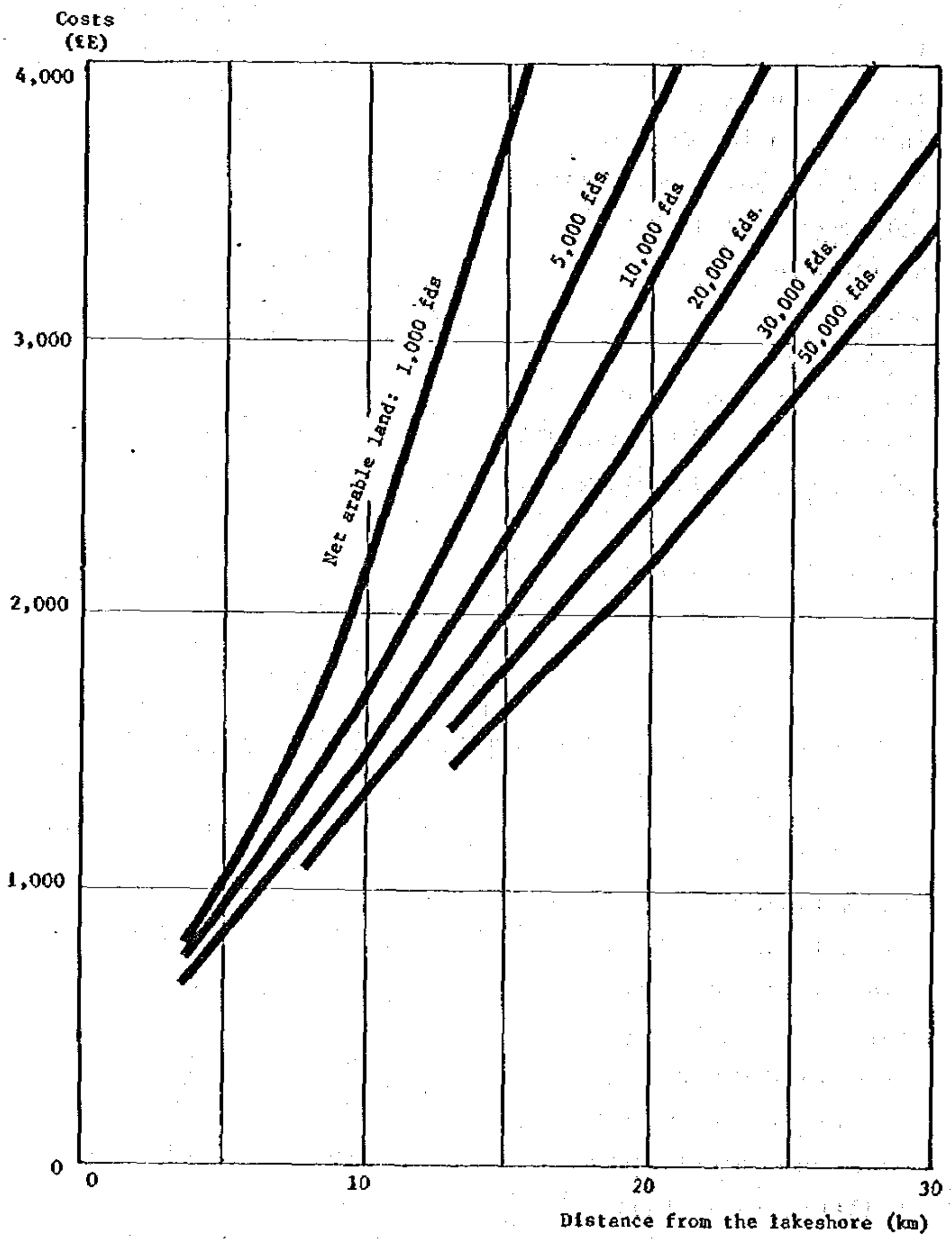
Table 4-1-9 Agricultural Development Cost per Feddan

Work Item	Cost (£E/feddan)
1.- Land Smoothing	50
2.- Main Irrigation Canals	200
3.- Sprinkler Systems (including pumps)	600
4 - Collector Drains	50 - 200
5 - Tile Drains	200 - 500
6 - Roads	50
7 - Windbreaks	30
8 - Agricultural Machinery	100
9 - Houses (£E 3,000 per family)	300
10 - Storage Facilities, Workshops and Others	20
11 - Studies	20
12 - Physical Contingency	10%

Table 4-1-10 Unit Construction Cost for Land Reclamation

Description	Unit	Unit Cost (£E)
1 - Excavation, Common	m^3	2
2 - Excavation, Soft Rock	"	12
3 - Excavation, Sound Rock	"	20
4 - Earth Filling & Compaction	"	3
5 - Reinforced Concrete	"	150
6 - Unreinforced Concrete	"	80
7 - Structural Steel Works	ton	1,000
8 - Drilling for Testing	m	30
9 - Transportation, (6 - ton trucks)	ton.km	0.1

Figure 4-1-4 Costs of Water Conveyance Facilities



(ii) The soil conditions, especially the depth of the soils, are better than in the other areas,

(iii) Undesirable undulation of the land is relatively less than in the other areas, and

(iv) Field investigations, both on soil and topography, are most progressed among the identified areas around the lake.

The implementation of the two projects will play an important role in agricultural development in the entire Project Area and serve as a sort of pilot projects to prove the technical and economic feasibility of large-scale and small-holder agricultural development.

Following the implementation of the two projects, the Kalabsha and Abu Simbel/Tushka areas will be developed based on the detailed investigation, planning and detailed design which are to be carried out during the time when the Kurkur and the Quastal/Adendan projects are being implemented. Basically, the agricultural areas should be developed gradually from the areas near the major development centers, i.e., Aswan and Abu Simbel, to the outlying areas in parallel with the provision of roads and other transportation facilities.

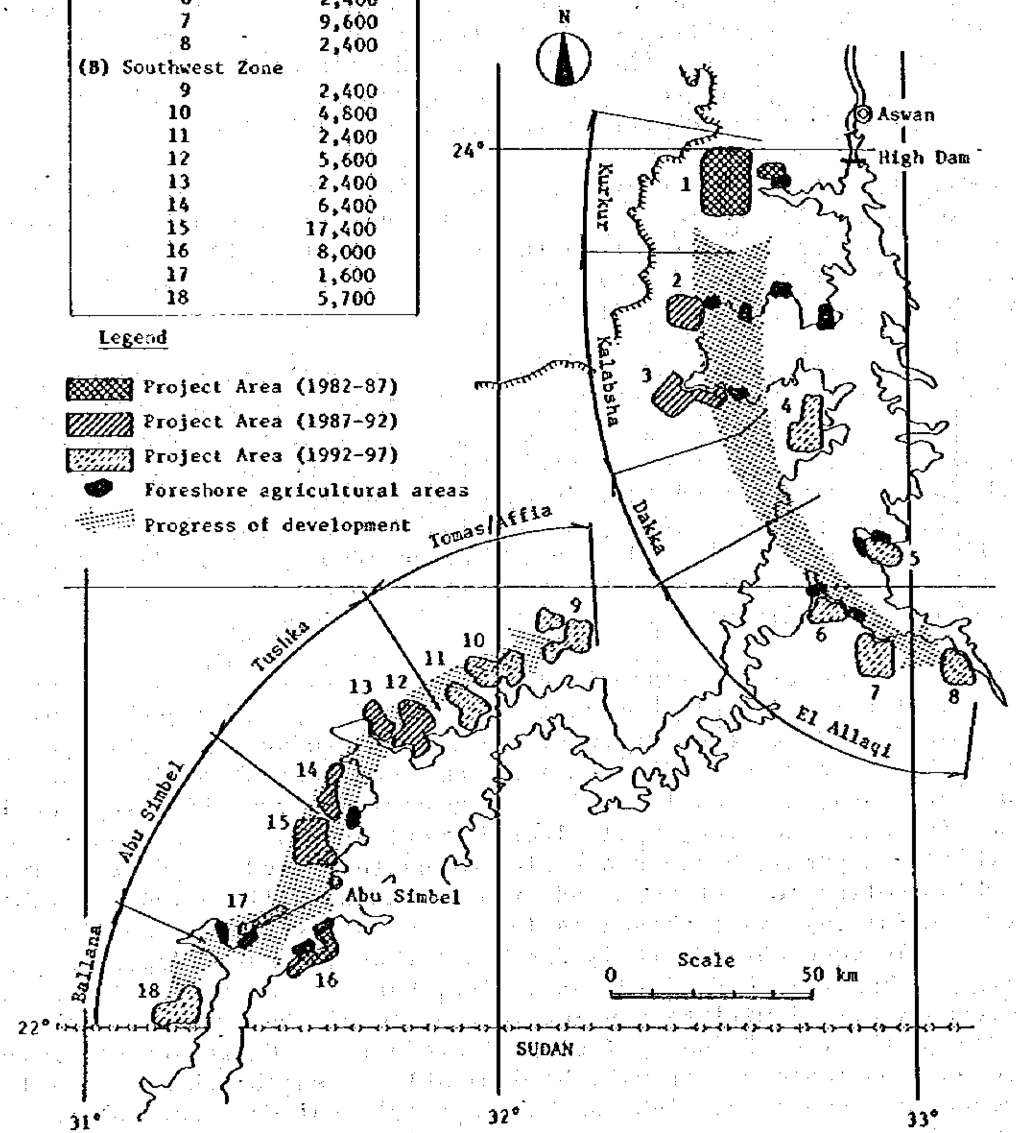
In the case of foreshore agricultural areas, development should be started preceding the development of upland areas,because this type of agriculture can be implemented relatively easily. In addition, success of foreshore agriculture will encourage other farmers to settle nearby.

The development of the Dakka, El Allaqi, Tomas/Affia and Ballana areas will come later, because the location is very far from the development centers, accessibility is very poor and information on development possibilities is yet insufficient. The recommended development schedule of each upland area is as shown in Figure 4-1-5 and Table 4-1-11. The progress of implementation will be approximately 10,000 feddans per annum. In order to ensure successful agricultural development around the High Dam Lake area, field investigations and experiments on crops are indispensable.

In both the foreshore and upland agricultural areas, it is essential to establish agricultural cooperatives which will perform such services as technical guidance and information service, products marketing, inputs procurement, common facilities and equipment, mutual or institutional guarantee systems, and financing. Especially for the development in the High Dam Lake area, agricultural cooperatives must emphasize marketing aspects, because a series of systematized shipment activities, such as collection, storage and transportation will be indispensable for the farming system based on intensive cultivation of easily perishable vegetables. It is fortunate that the marketing of a perishable merchandise, i.e., freshwater fish, has been operating in Aswan Governorate, and will be a valuable example of the system suitable for direct marketing of the agricultural products to Cairo and other major consumption centers. It will be desirable to establish an overall cooperative (an Aswan High Dam Lake Agricultural Cooperative) as an umbrella organization for local cooperatives in the prospective development areas. This cooperative can organize the marketing of vegetables

Figure 4-1-5 Location of Project Areas and Development Schedule

Site No.	Net Irrigation Area
	(feddans)
(A) Northeast Zone	
1	24,000
2	5,000
3	14,000
4	18,300
5	1,600
6	2,400
7	9,600
8	2,400
(B) Southwest Zone	
9	2,400
10	4,800
11	2,400
12	5,600
13	2,400
14	6,400
15	17,400
16	8,000
17	1,600
18	5,700



Legend

▦ Project Area (1982-87)

▨ Project Area (1987-92)

░ Project Area (1992-97)

● Foreshore agricultural areas

⋯ Progress of development

vis-a-vis the urban markets in the northern part of Egypt, and if possible, export markets.

(2) Supporting Projects

(a) Surveys and Studies

Currently available data and information on topography, soil, underlying rocks and so on are insufficient to formulate a definit plan for agricultural development. According to the Ministry of Development and New Communities, detailed topographic mapping, additional soil surveys (reconnaissance level) and construction of new farms in the selected areas will be carried out in the near future. In addition to the above, many field investigations and experiments are indispensable in order to formulate a realistic development plan, as follows:

(i) Rearrangement of soil maps and land capability classification maps prepared by REGWA, using new detailed topographic maps,

(ii) Soil surveys over potential arable areas, excluding the area already covered by detailed soil surveys by REGWA,

(iii) Topographic mapping for selected areas in Dakka, El Allaqi, Tomas/Affia, Tushka and Ballana based on field reconnaissance,

(iv) Permeability tests on undisturbed soil samples from representative soil profiles,

(v) Permeability tests of Nubian sandstone (upper layer) to study drainage requirement, and

(vi) Site selection suitable for foreshore agriculture, including soil surveys.

These investigations should be carried out prior to the definite planning, detailed design and implementation at each area as indicated in Table 4-1-11.

(b) Agricultural Experimental Station

At Abu Simbel, the experimental farm has been operated since 1972. During 1972-73, a systematic research program was conducted by FAO and the results were submitted in 1974. However, no systematic research program has been continued since then. In addition, the meteorological station has been closed. The size of this farm and facilities are inadequate but the possibility of expansion is limited, because the farm is surrounded by small rocky hills. Therefore, a new experimental station of appropriate size should be established elsewhere.

In order to proceed with agricultural development successfully around the lake, an experimental station (100 feddans) should be established in the northeast zone (Kalabsha). The station will function as a center not only for research but also for extension services. The station should comprise three sections of (i) soil and water, (ii) crop research and (iii) plant pathology and entomology. The major research subjects for each section will be as follows.

Table 4-1-11 Investment Schedule for Agricultural Sector

Site	Area (fds)	Project Cost (£E mil.)	'80'82	'87	'92	'97
I. Upland area						
(A) Northeast zone						
1. Kurkur	24,000	132.0	▯▯	▨		
2. Kalabsha	19,000	46.1		▯▯▯▯▯▯	▨	
3. Dakka	18,300	54.9			▯▯▯▯▯▯	▨
4. El Allaqi	16,000	40.5			▯▯▯▯▯	▨
(B) Southwest zone						
1. Abu Simbel	27,000	76.5	▯▯	1/ ▨	2/ ▨	3/ ▨
2. Tushka	14,400	38.5		▯▯▯▯▯▯	▨	
3. Tomas/Affia	9,600	27.8			▯▯▯▯▯▯	▨
4. Ballana	5,700	17.4			▯▯▯▯▯	▨
II. Foreshore area						
(A) Northeast zone						
1. Kurkur	800	1.6	▯	▨		
2. Kalabsha & Dakka	9,300	18.6	▯	▨		
3. El Allaqi	2,200	4.4		▯▯▯	▨	
(B) Southwest zone						
1. Abu Simbel	2,100	4.2	▯	▨		
2. Tushka	1,600	3.2	▯	▨		
Total area	150,000			44,200	54,600	51,200
Total cost		465.7		178.8	142.9	144.0

Notes: Broken bars indicate the period of study, planning and detailed design.

1/ Quastal/Adendan project (8,000 feddans).

2/ 17,400 feddans.

3/ Project area No.17 on Figure 4-1-5 (1,600 feddans).

(i) Soil and water research section
- Improvement of saline and alkaline soils,
- Experiment on crop water requirements and crop yields, and
- Selection of suitable irrigation methods, irrigation intensity and irrigation intervals for each soil type.

(ii) Crop research section
- Variety test for major crops,
- Establishment of appropriate cultivation methods, including fertilizer application, and
- Examination on new crops such as tropical fruits, essential and medicinal crops.

(iii) Plant pathology and entomology section
- Identification of diseases and insects of major crops and establishment of control measures.

In addition to the above, an agro-meteorological station should be annexed. The proposed organization and staffing is shown in Figure 4-1-6. The required construction costs are shown in Table 4-1-12.

Figure 4-1-6 Organization Chart of Agricultural Experimental Station (100 feddans)

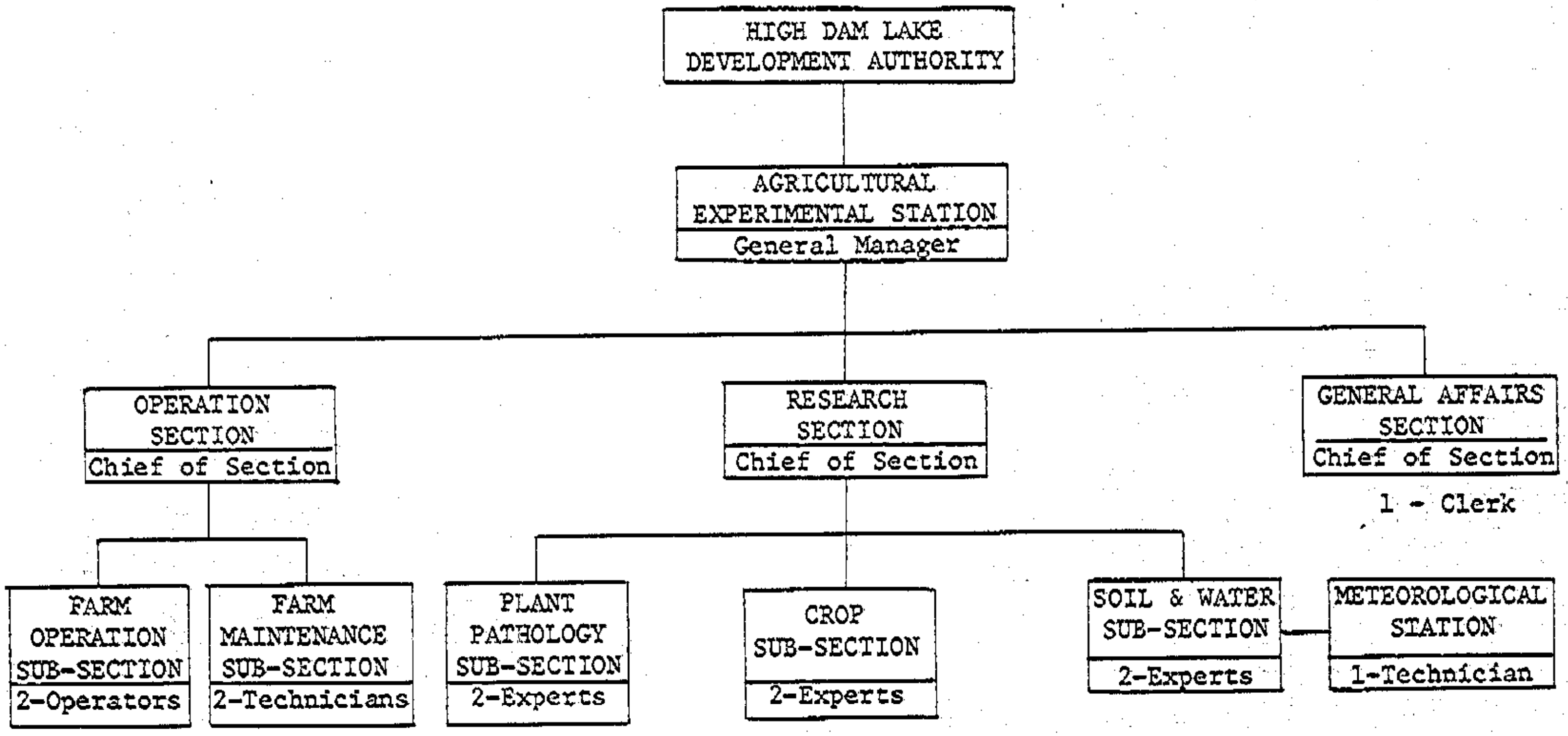


Table 4-1-12 Breakdown of Costs for Agricultural Experimental Station

Item	Quantity	Amount (£E)
I. Buildings		
1. Office and Laboratory	750 m^2	90,000
2. Garage	200 m^2	20,000
3. Warehouse	200 m^2 x 2	40,000
4. Staff Quarters	16 nos	120,000
5. Electric Supply	L.S.	25,000
6. Water Supply	L.S.	5,000
7. Miscellaneous	L.S.	30,000
Sub-total		330,000
II. Land Reclamation		
1. Water Conveyance Facilities		200,000
2. Land Reclamation (including Windbreaks)		20,000
3. Irrigation Facilities (Sprinkler System)		60,000
4. Access Road (5 km)		150,000
5. Miscellaneous (15%)		70,000
Sub-total		500,000
III. Farm Machinery and Vehicles		
1. Tractor w/attachment	2 sets	40,000
2. Trailer	2	5,000
3. Harvester	1	17,000
4. Power Sprayer and Duster	2	5,000
5. Truck	1	5,000
6. Jeep	1	8,000
7. Spareparts		20,000
Sub-total		100,000
IV. Laboratory Equipment	1 lot	50,000
V. Meteorological Station		20,000
Grand Total		1,000,000

4.2 FISHERY

4.2.1 General

The major survey objectives of the Study Team as requested by the HDLDA were:

(i) To survey the distribution of fishery resources in High Dam Lake, especially in the off-shore area (the main channel) which has been largely unexploited so far, and to identify suitable fishing methods therein;

(ii) To examine possibilities of increasing the fishery resources in the lake and to suggest appropriate measures thereof;

(iii) To examine the prevailing system of fish transportation and storage over the lake and indicate effective measures to remove its bottlenecks and to retain the freshness of hauled fish;

(iv) To make suggestions concerning the establishment of a fishery complex, especially with regard to port facilities, ice production, shipyards, etc.; and

(v) To recommend appropriate processing technologies and facilities.

As already presented in Section 2.2 of Chapter II, the Study Team conducted the echo-sounder probe, experimental fishing and a few experiments on storage methods as well as interviewed the Egyptian experts and some of the fishermen in Aswan concerning the past trends and the present characteristics of lake fisheries. Although the findings of the survey indicate a rough outline of what should be done in the future, however, the limited time available for the survey makes it difficult to finalize exact specifics of the recommended measures. For instance, accurate estimation of the total fishery stock in High Dam Lake requires far longer time and manpower input than was possible during this survey. The regular accumulation of basic data over several years at least is necessary to arrive at a reasonably correct figure. The same applies to the identification of appropriate types of fishing gear and suitable methods of fishing. At the same time, one always has to keep in mind that fishing activities must continue all that while and, consequently, will be likely to affect the stock base itself.

The basic understanding of the Study Team behind the recommendations which are to follow in this section is this; although the amount of primary production (phyto-plankton) in the lake appears substantial, introduction of more efficient fishing gears and methods, which will probably increase the annual fish hauls in a short while, is when attempted rashly, likely to lead to over-fishing and irrevocably to deplete the fishery stock in High Dam Lake. As the Egyptian fishery experts in Aswan are well aware of, the available basic data on the fishing activities and major fish species are yet very poor and consequently it is very difficult to detect early signs of detrimental development. In order to maximize the sustainable yields of tilapia, tiger fish and Nile perch from the long-term perspective, institution of an effective fishery control and management system must be assigned top priority with regard to High Dam Lake. This presupposes the regular accumulation of basic information and well-controlled experimentation on everything that pertains to lake fisheries. At the same time, the Study Team believes that the future fishery development must be planned to improve the livelihood and welfare of small-scale fishermen. The introduction of overly efficient fishing gears and methods must be carefully evaluated, because before long it will deprive these fishermen of one of the very few sources of cash income currently available in the rural areas of Egypt.

4.2.2 Analysis of Fish Catch and Population[1]

Analysis and prognosis of fish population require time-series data on fish catches and fishing efforts spent to realize them. However, statistics on fishing efforts in High Dam Lake are so far extremely limited. This section presents some tentative results of the population analysis, but it must be read with due caution, because the inadequate data base is prone to leave a wide margin of error.

(1) Aggregate Limited Annual Yield

Table 4-2-1 summarizes annual fishing yields and the number of fishing boats employed in High Dam Lake during the period of 1966-78. Both series show increasing trends over the past twelve years, but their rates of increase have been declining gradually. Based on these series of data represented as $C(t)$ and $B(t)$ respectively, the limited annual yield represented by the symbol C_∞ can be calculated by the logistic curve,

$$C(t) = C_\infty \ (1 + Ae^{-bt})^{-1} \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Then, $$C_\infty = (3.23 - 5.00) \times 10^4 \text{ (tons)}$$

The concept of limited annual yield (C_∞) should not be confused with that of maximum sustainable yield (MSY) used for fishery management. The former assumes that the current trends of fishing yields and efforts will continue in the future and does not take into consideration the reproductive structures of fish species concerned. In the fishing industry where resources can be optimally exploited by keeping the amount of annual fish hauls in appropriate proportion to the species' reproductive yields, the stage at which the actual fish haul reaches the value of the limited annual yield means that the existing level of exploitation is no longer sustainable in the future. In order to obtain the value of maximum sustainable yield, it is necessary to know the reproductive mechanisms of the exploitable species, various biological parameters as well as the detailed data on fishing efforts

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[1] This section is contributed by Dr. Nobuo Hirayama, Professor of Tokyo University of Fisheries.

Table 4-2-1 Trends of Annual Fishing Yields and Employed Boats (1966 - 1978)

(t)	C(t)		B(t)		Landings by Species (tons)									
Year	Landings (tons)	Increase (%)	Boats (nos.)	Increase (%)	Tilapia spp.	%	Lates niloticus	%	Bagrus spp.	%	Labeo niloticus	%	Others	%
1966	761.9	100.0	200	100.0	287.6	37.8	5.8	0.8	25.1	3.3	134.8	17.7	308.6	40.4
1967	1414.7	85.7	350	75.0	471.1	33.3	27.5	2.1	69.3	4.9	309.8	21.9	537.0	37.8
1968	2484.5	75.6	500	42.9	713.1	28.7	71.9	3.3	59.6	2.4	700.6	28.2	939.3	37.4
1969	4676.9	88.0	599	19.8	1978.3	42.3	289.3	6.7	112.2	2.4	954.0	20.4	1343.1	28.2
1970	5677.4	21.5	816	36.2	2384.5	40.0	451.4	9.7	176.0	3.1	817.5	14.4	1848.0	30.8
1971	6820.2	20.1	1039	27.3	3157.8	46.3	517.4	8.7	245.5	3.6	934.4	13.7	1965.1	27.7
1972	8343.8	22.3	1135	9.3	4146.9	49.7	451.3	6.6	258.7	3.1	826.0	9.9	2660.9	31.6
1973	10692.5	28.1	(1280)	12.8	7179.0	67.1	394.7	3.7	162.0	1.5	212.0	1.9	2744.8	25.8
1974	12256.7	14.6	(1460)	14.1	7244.0	59.1	490.0	4.0	127.0	1.0	83.0	0.7	4312.7	35.2
1975	14636.0	11.9	(1600)	9.6	9660.0	66.0	525.0	3.6	121.0	0.8	4.0	0.0	4326.0	29.6
1976	15697.0	7.3	(1760)	10.0	10519.0	67.0	446.0	2.8	75.0	0.5	-	-	4657.0	29.7
1977	18500.0	17.9	(1920)	9.1	1120.0	60.6	564.0	3.1	66.0	0.4	362.0	1.9	6304.0	34.0
1978	22575.0	22.0	(2080)	8.3										

Note: Parentheses indicate the estimated figures.

Source: High Dam Lake Authority.

covering an extensive period of time. In any case, the value of maximum sustainable yield must necessarily be lower than the limited annual yield. Based on the above calculation, it can be said that the aggregate maximum sustainable yield in High Dam Lake must be lower than the limited annual yield ranging from 32,300 to 50,000 tons.

(2) Changes of Fishing Efforts X(t) and Aggregate Catch per Unit Effort u(t)

In order to monitor changes in fish population and control fishery activities, it is essential to collect data on fishing efforts. The increase of fish catch does not necessarily mean the increase of fish population. The fish catch continues to increase with the augmentation of fishing efforts, but eventually a certain point is reached where additional fishing efforts expended do not yield any more increase in fish catch. This means that the optimum level of catch has been passed due to excessive fishing efforts, indicating overfishing.

It is possible to examine changes in fish population by means of annual catch per unit of fishing efforts represented as u(t). Supposing that $\bar{N}(t)$ represents the average fish abundance in the t-th year, its relationship with u(t) is shown as $\bar{N}(t) \infty u(t)$. Given the annual catch C(t) and fishing efforts X(t), it holds that,

$$u(t) = \frac{C(t)}{X(t)} \backsim \bar{N}(t) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

The annual fishing efforts X(t) can be obtained from,

$$X(t) = q\ g(t)\ B(t)\ T(t) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

where B(t) stands for the number of fishing boats, g(t) for the number of fishing gear per boat, T(t) for the annual number of operating days (or the annual number of haulings), and q for the catching efficiency of the fishing gear. It is reasonable to suppose that during the twelve years in question there have been substantial improvements in the fishing technologies employed in the lake (e.g. use of improved fishing gears and methods) and intensification of operations (e.g. increased numbers of boats, gears and days in operation). However, the statistical information on such factors are not available, precluding the accurate estimation of changes in fishing efforts. Supposing that the value of fishing efforts shown as q g(t) T(t) has approximately trebled in twelve years, it holds that,

$$X(t) = [1 + \frac{1}{6}(t-1966)]B(t)$$

B(t) can be obtained from Table 4-2-1 as,

$$B(t) = 160(t-1965)$$

Then,

$$X(t) = [1 + \frac{1}{6}(t-1966)] \times 160(t-1965) \quad \ldots\ldots\ldots \quad (4)$$

Table 4-2-2 Annual Catch per Boat and Estimated Annual Catch per Unit Effort

Year	Catch per Boat (CPB) and Catch per Unit Effort (CPUE)											
	Whole spp.		Tilapia spp.		Lates niloticus		Bagrus spp.		Labeo niloticus		Others	
	CPB	CPUE	CPB	CPUE	CPB	CPUE	CPB	CPUE	CPB	CPUE	CPB	CPUE
1966	3.81	3.81	1.39	1.39	0.03	0.03	0.13	0.13	0.67	0.67	1.54	1.54
1967	4.04	3.49	1.35	1.16	0.08	0.07	0.20	0.17	0.89	0.76	1.53	1.32
1968	4.97	3.74	1.43	1.08	0.14	0.11	0.12	0.09	1.40	1.05	1.88	1.41
1969	7.81	5.21	3.30	2.20	0.48	0.32	0.19	0.13	1.59	1.06	2.24	1.49
1970	6.96	4.19	2.92	1.76	0.55	0.33	0.22	0.13	1.00	0.60	2.27	1.37
1971	6.56	3.58	3.04	1.66	0.49	0.27	0.24	0.13	0.82	0.47	1.89	1.03
1972	7.35	3.68	3.65	1.83	0.40	0.20	0.23	0.12	0.73	0.37	2.34	1.17
1973	8.35	3.86	5.60	2.59	0.31	0.14	0.13	0.06	0.17	0.08	2.14	0.99
1974	8.39	3.60	4.96	2.13	0.34	0.15	0.09	0.04	0.06	0.03	2.95	1.27
1975	9.14	3.66	6.04	2.41	0.33	0.13	0.08	0.03	0.00	0.00	2.70	1.08
1976	8.92	3.75	5.98	2.25	0.25	0.09	0.04	0.02	-	-	2.65	0.99
1977	9.64	3.41	5.84	2.06	0.29	0.10	0.03	0.01	0.19	0.07	3.28	1.16
1978	10.85	3.61										

Note: The annual amount of fishing efforts X(t) is calculated by assuming that its value has approximately trebled in 12 years due to improved technologies and intensified fishing operations.

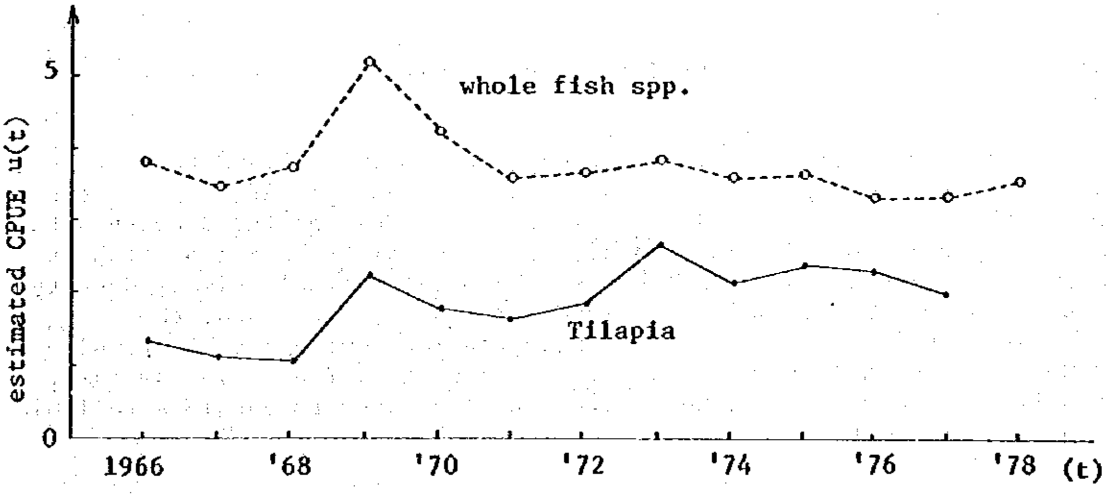
Source: JICA Study Team estimates.

Table 4-2-2 shows the annual values of catch per boat, C(t)/B(t), and catch per unit effort, C(t)/X(t). As can be seen from the table, the annual catch per unit effort (CPUE) has stayed more or less stable since the start of the 1970s (see also Figure 4-2-1). This can be taken to mean that the aggregate fish population in High Dam Lake has maintained the stable level during the period. It must be noted, however, that the stability of the aggregate population can mask population changes of respective species which are being exploited.

(3) Limited Annual Yield and CPUE of Tilapia

Tilapia spp. has continued to yield the largest annual haul since 1966 and is by far the most important species in High Dam Lake. The limited annual yield for tilapia is calculated, by applying the logistic curve already mentioned, to be 1.39 x 10^4 tons, which is larger by only 2,700 tons than the fish landings of 13,900 tons in 1977. This indicates that the fishing efforts have already reached a considerably high level relative to the population. Moreover, the estimated annual catch per unit effort (CPUE) has perceptibly begun to decline after peaking in 1973, as shown in Figure 4-2-1. It would have to be concluded from these estimates that the annual landings of Tilapia spp. need be lowered approximately to the level of 10,000 tons in 1975 and 1976. Otherwise, the artificial rearing and release of tilapia seedlings, as will be discussed in the later section, will have to be undertaken to maintain the level of yield approximate to those in 1977 and 1978. The latter attempt is especially promising in view of the reportedly high level of primary production in High Dam Lake, which seems to be reflected in the faster growth of the species compared with examples reported in other lakes (see Section 2.2.1 and Table 2-2-3 in Chapter II).

Figure 4-2-1 Estimated CPUE for Whole Species and Tilapia



Source: Table 4-2-2.

(4) Tentative Population Estimate from Echo-soundings

As already discussed in Section 2.2.2 of Chapter II, the off-shore distribution of fish is presented relatively in terms of the density per kilometer traversed by the survey boat, which is in this section represented by the symbol of di. It is judged through the experimental fishing conducted at selected places that the fish recorded singly by echo-soundings mostly consist of tiger fish and Nile perch. Given the beam angle of the ultrasonic wave of the echo-sounder at 33°, and the range of habitat for tiger fish and Nile perch from 7 - 17 m in depth, the mean breadth of coverage by the echo-sounder can be calculated as,

$$B = 2 \times (7 - 17) \tan \frac{33°}{2} \fallingdotseq 7.1 \times 10^{-3} (\text{km})$$

Then, the density of fish per square kilometer ρi is obtained from,

$$\rho i = \frac{di}{B} \text{ (no. of fish/km}^2\text{)}$$

Supposing that fish are distributed throughout the lake, the total number of fish N can be calculated as,

$$N = \frac{G}{n} \sum_{i=1}^{n} \rho i = \frac{G}{nB} \sum_{i=1}^{n} di = \frac{G}{B} \bar{d}$$

where G is the total area of the lake, n is the total kilometers traversed and $\bar{d}$ is the mean of di. Given the area of the lake at approximately 6,000 km^2, and taking the mean density per kilometer of 4.95 fish/km from the data taken in the winter from the main channel between Aswan and Abu Simbel (see Figure 2-2-5a),

$$N = \frac{6{,}000 \times 4.95}{7.1 \times 10^{-3}} = 4.18 \times 10^6$$

Supposing that the weight per fish is 0.5 - 0.6 kg, the number is converted to 2,100 - 2,500 tons.

Considering the current estimated production of about 3,500 tons of tiger fish and Nile perch combined per annum, the calculated population is remarkably small. This is mainly due to the use of the density data pertaining only to the main channel, where the distribution of fish is generally sparse compared with khors. When considerably higher density figures in such khors as El Ramla and Kalabsha are included, the calculation will yield a much larger population, which may be around 10,000 tons in the informed judgement of the Study Team. In any case, it will be necessary to conduct more echo-soundings to obtain a reliable population estimate.

4.2.3 Fishing Gear and Method

The local method of tilapia fishing by trammel nets is on the whole appropriate. However, it must be noted that this type of fishing net catches small, that is, immature fish which it is desirable to protect from the viewpoint of stock management. Therefore, it is recommendable to examine, through further experimental fishing, variations of total hauls and distribution of fish size by different mesh sizes of its inner net.

With regard to floating gill-nets used for *kalb-samak* fishing, the mesh size of 7 cm is preferable to the currently used 6 cm to protect younger fish. In this respect, it is necessary to study the scaled body length of mature fish and the selectivity of various mesh sizes by multi-filament nylon nets, before finalizing the appropriate mesh size. In addition, the current practice of fixing floating gill-nets close to one another should be discontinued. It must be also avoided to fix these nets in the narrow parts of the lake so as not to obstruct the surface traffic.

An Egyptian fishery expert expressed his opinion to the Study Team at the meeting arranged by the HDLDA that fyke nets and mid-water trawl nets are appropriate in High Dam Lake, in order to even out the fish hauls throughout the year and to improve the efficiency of fishing efforts. The Study Team is of the opinion that mid-water trawl nets must not be introduced into the lake, because they are too efficient to protect young fish and can easily lead to over-fishing. As already pointed out in 2.2.1 of Chapter II, tilapia hauls are largest during March and May when *Tilapia nilotica* spawn near the shoreline and the situation must be rectified to conserve the species' stock base. If at least the current level of annual production must be maintained, an evening-out of monthly output is one of the possible measures. However, necessary steps to be taken in such a case must be identified after careful study of the seasonal behavior pattern of *Tilapia nilotica* and examination of suitable fishing gear from the viewpoint of obtaining a maximum *sustainable* yield.

Mid-water trawl nets may enable the evening-out of the annual output, provided that the tilapia behave as required by this type of fishing gear off the spawning season, but this requires at least a strict control on the number of nets to be used in the lake in order not to deplete the stock base irrevocably. One should also keep in mind in this respect that the introduction of more efficient fishing gear is likely to threaten the livelihood of the fishermen currently operating in the lake, unless effective measures are instituted to increase the stock base itself. The Study Team is of the opinion that the testing of fishing gear should focus for the time being on various types of stationary nets, such as gill-nets, fyke nets, etc., to identify suitable types vis-a-vis the seasonal behaviors of *bolti*, especially *Tilapia nilotica*. The maintenance and perhaps increase of the annual output appears very likely by simply improving the storage method of fish hauls as indicated later in this section, because this will open up the southern half of the lake where tilapia are yet largely unexploited due to the difficulty of storage before and during transportation by carrier boats.

It was reported that lake fishermen have been planning to equip their rowing boats with outboard engines. Considering the already expected increase of fishing boats in the near future, which will certainly expand the annual output of fish in the lake, it is no doubt a delicate question whether or not to promote this trend, because the introduction of engines will also contribute to the intensification of fishing efforts and might lead more quickly to excessive fishing. The powered fishing boats, however, will be effective for improving the freshness of fish hauls and, above all, the welfare of fishermen, by facilitating easier traffic over the lake. In any case, it will be necessary to establish an effective fishery management system and thereby to check undesirable developments before they become too late to rectify and to increase the stock base by artificial rearing and release of seedlings.

4.2.4 Transportation, Storage and Processing

(1) Storage at Fishing Camps

It was already pointed out that under the current conditions, a substantial portion of hauled fish is spoiled at fishing camps before carrier boats come to collect them. Improved storage facilities of carrier boats, as will be described later in this section, are meaningless, unless this situation is remedied. It is therefore recommendable to install an adiabatic container in a fishing boat and at each camp. A fishing boat is estimated to haul about 50 kg of fish a day on the average. Supposing that ice alone is used for storage, the appropriate capacity of a container for the boat would be around 150 liters. Supposing that a fishing camp accommodates 7 fishing boats, the collected hauls per day would amount to around 350 kg. The approximate capacity of a container at the camp would then be 1 ton. In the case of the iced-water storage method, the holding capacity of the container would be approximately 170 liters for the boat and 1.2 tons for the camp. Moreover, the containers must be made water-tight.

The use of net cages for live fish is another possibility. However, the experiment showed that the dead fish spoiled quickly due to the high water temperature, and that small net cages were too constricting to keep the fish alive. It also indicated the need to remove weakened or damaged fish as well as already dead ones prior to and during storage. This means that net cages must be used in combination with heat-proof containers. The survival ratio at the first trial justifies further experimentation in order to identify appropriate sizes and locations of net cages in the fishing grounds.

(2) Storage and Transportation by Carrier Boats

The findings of the experiments conducted in the lake during the summer indicate the suitability and efficiency of iced-water storage. New carrier boats should be the type equipped with a water-tight adiabatic fish hold, and the existing ones should be remodelled likewise. The fish hold should be divided into preferably three partitions and use fiber-reinforced plastic for inner lining and thicker adiabatic interfacing than is currently used. Suppose that the size of a partition is 1.5 m in width, 2 m in length and 1 m in height and that 1 ton of fish are stored with 1 ton of ice and 0.5 ton of water under the atmospheric temperature of 40°C and the lake water temperature of 30°C. Given the adiabatic coefficient of 0.5 keal/°C.h.m^2, 0.56 ton of ice is estimated to melt till the temperature of iced water reaches 0°C, and the rest of ice will be enough to keep that temperature level for approximately six days. Preferably, a partition should be made larger than the size indicated above to allow for higher atmospheric and lake water temperatures and other possible circumstances which affect the effectiveness of the fish hold partition, and the required duration of storage.

The operation procedure is as follows. Supposing that each carrier boat collects for three days from eight camps, each servicing seven fishing boats, the carrier boat must carry approximately 20 tons of ice per outing (6.4 tons to be distributed to fishing boats and camps, 10 tons for its own fish hold, plus some allowance), on the assumption that the ratio of fish to ice and water be 1:1:0.5 in weight as found from the experiments. Then, the total fish hold capacity per carrier boat would be around 30 tons. The partitions are respectively packed with ice at the harbor and, at each camp visited, the stored ice is delivered to the fishing boats and camps. The partly-emptied partition is then used to store collected hauls by adding water from the lake.

It must be pointed out that the amount of water used for storage should be kept at the possible minimum to economize the consumption of ice, because the water temperature of the lake is generally high during the summer and the skin of tilapia is sufficiently hard to sustain dense storing. The appropriate ratio of fish to ice and water is 1:1:0.5, according to the experiments. Ice can be crushed at the West Harbor before loading on to the carrier boats or at respective fishing camps, but crushed pieces must be larger than currently used, roughly 10 - 20 cm instead of the present 2 - 3 cm, to improve the cooling efficiency of ice.

The suggestions presented above assumed the continuation of the existing collection system of fish hauls by cruising carrier boats. However, if fishing boats come to have better mobility due to outboard engines, fish hauls stored in iced-water on these boats can be directly transported to carrier boats moored near each camp. In such a case, the installation of storage containers at the camps would become unnecessary, provided that the fleet of carrier boats are effectively deployed over the lake.

Another important advantage of iced-water storage is that its introduction will enable increased tilapia hauls in the southern half of the lake where the species remain largely un-exploited due to the great distance carrier boats have to traverse. Because the migration of the tilapia is limited to a small area, the total output will increase without over-taxing the productivity of the northern fishing grounds.

Supply from the ice plant located in Aswan City is currently transported by regular types of lorries with cloth coverings. As a result, 25% in the summer and 10% in the winter of the loaded ice is lost during transportation. It is advisable to carry ice in the ice store lorry used for transporting landed fish to the Marketing Center of Aswan in order to reduce the loss, at least until the new ice plant near the harbor starts operation.

(3) Processing

As explained in 2.2.3 of Chapter II, similar types of activities like weighing and packing are currently carried out at the West Harbor and the Marketing Center of Aswan, with repeated loading and unloading before fish are shipped by railway. The entire operation from landing to final packing can be done at the West Harbor to send fish directly to the railway station.

With regard to the salting of kalb-samak, the current operation is by no means commendable from the viewpoint of hygienics. The rust of second-hand oil cans gets mixed, and fleas are left to swarm into the cans. Plastic cases with a net top will be suitable to avoid contamination by rust and dead fleas as well as to allow sufficient evaporation. The fish must be eviscerated including gills and thoroughly bled and washed in the water before being stuffed with salt and stored.

Drying is not currently practiced in the High Dam Lake Area but appears suitable in the climate of southern Egypt with high temperature, very low humidity and practically no rain throughout the year. The tilapia are fairly flat fish and can be either opened or filleted into two pieces and then dried under the sun. The spoilage at the camps can be greatly reduced by introducing this ancient and sure method of preserving fish.

4.2.5 Harbor and Related Fishery Facilities

In March of 1978, the Government of Egypt put to international tender the project of a joint company, called Misr Aswan Fishing and Fish Processing Company, to develop a Fisheries Complex near the High Dam. The tender was subsequently awarded to a Japanese company. The project includes improvement of harbor facilities and construction of an ice plant as well as installation of a complete fish processing plant including a fish meal mill. The location of the complex has been decided immediately behind the West Harbor in the middle of the small promontory. It must be emphasized, however, that the operation of a sizable processing plant (planned daily throughput of 100 tons of hauled fish and 300 days of yearly operation) must be preceded by the assessment of the lake fishery resource base and of the expected maximum sustainable yields by species.

The West Harbor is currently performing services other than handling fish hauls and related activities, one of the causes for occasional congestion. It has been recently decided that the harbor be developed as a specialized fishing port and the servicing of international passenger and cargo traffic and tourists be moved to the East Port near the railway station. Therefore, the following improvements are considered necessary for the harbor facilities. The present dirt wharf is apt to collapse and its poor footing obstructs the efficiency of various activities. Although it is sloped to adjust to the seasonal water level fluctuation of about 4 - 7 m, it will have to be reinforced with concrete. The number of appropriately-sized pontoons must be increased separately to service (i) landing of fish hauls, (ii) weighing, grading, cleaning, packing, etc. of landed fish, (iii) loading of ice, food, etc., (iv) loading and storage of fuels for boats, and to house, (v) port administration buildings and (vi) various workshops. Finally, the wharf and pontoons must be connected with a number of conveyors appropriate to respective activities. Some cranes and forklifts will be also needed to ensure the efficiency of the handling at the port.

4.2.6 Aquaculture and Fishery Management

(1) Aquaculture

The HDLDA has expressed its strong desire to start large-scale aquaculture to expand the productivity of High Dam Lake and requested the Study Team to specify the requirements for such an undertaking. Aquaculture, first of all, requires thorough investigation of hydrological, physical and other natural conditions of the lake to identify its suitable locations and appropriate methods. It is also necessary to examine the availability of seedlings, feedstuffs, fertilizers and technologies of operation and management, and the handling conveniences from harvesting to final shipping. The selection of appropriate species must be done vis-a-vis the environments of the selected aquacultural sites, the compatibility of combination when more than two species are cultured together, and above all, the preference of consumers and the expected size of market. The most important requirement is probably the availability of aquacultural specialists and technicians who are capable of devising, through trial and error, technologies best suited to the local conditions.

Aquaculture in Japan is entirely in the hand of private entrepreneurs, and consequently the profitability is the guiding principle. All of the cultured species are the kinds which fetch high or fairly high prices in the market. In the case of farming omnivorous fish with neither artificial feeding nor application of fertilizer, that is, the method of letting seedlings feed on naturally available organisms, the annual yield in Japan is around 100 - 200 kg per hectare of fish ponds. The annual output rises to 400 - 800 kg per hectare, when fertilizers are applied to nurture naturally available organisms for seedlings to feed on. In this case, approximately 6 - 8 tons of fertilizers, largely dried chicken droppings, are necessary per hectare of fish ponds. In the case of artificial feeding of formula feedstuffs, the annual yield per hectare reaches 2 - 5 tons in large fish ponds using a stagnant water system. Supposing that these methods of fish culture are adopted in High Dam Lake, their respective requirements to produce 10,000 tons of fish annually are calculated as follows.

The first method of culture without supplementary feeding or fertilizer application could yield 200 kg per hectare per annum, considering the abundancy of phyto- and zoo-plankton and benthos in High Dam Lake. But the total area necessary to secure an annual output of 10,000 tons will amount to as large as 50,000 ha, or approximately one-tenth of the lake surface area. Supposing that the seedlings grow to 0.5 kg in , weight after one year with a survival ratio of 50%, it would be necessary to procure some 40 million seedlings annually.

The second method of fertilizer application would require, assuming an annual yield of 600 kg per hectare, 17,000 ha of fish ponds and some 100,000 tons of dried chicken droppings with some additives, in order to harvest 10,000 tons of fish a year.

The last method of artificial feeding would require only 2,900 ha of fish ponds, assuming an annual yield of 3.5 tons per hectare. But this would need some 17,000 tons of formula feeds. If one supposes that 60% of the feeds are fish meal, its annual supply must be around 10,000 tons. In other words, 60,000 tons of fresh fish must be processed annually into fish meal to obtain 10,000 tons of cultured fish. Strictly from the viewpoint of efficient resource utilization, the fish culture with artificial feeding itself defeats its very purpose, unless the open market mechanism operates to differentiate higher- and lower-priced fish.

The echo-sounder probe during January-February of 1979 recorded the extensive presence of a layer of phyto-plankton in depth ranging between 10 and 40 m. There appears to be few species feeding on these phyto-plankton organizms in the lake, and it may be possible to plant Chinese silver carps, Japanese crucean carps or some other phyto-plankton feeders in the lake. However, it must be emphasized that careful and comprehensive studies will have to precede such moves, because introduction of a new species might irretrievably damage the ecosystem.

It was mentioned in Section 2.2 of Chapter II that the HDLDA had already begun its experiments of fish culture at two locations and intended to expand the operation. The Study Team is impressed with the speed at which the HDLDA has put its plan into action in such a short period of time and expects that the attempt will continue in the future by learning from trial and error. The Team is by no means against any attempt at aquaculture in High Dam Lake, but recommends a cautious and realistic approach in such an undertaking. Of foremost importance is the assignment of priorities, given the current conditions of fisheries in the lake. It will always have to be kept in mind that the future development efforts should not overlook the livelihood of 7,000 lake fishermen and the urgent need of the systematic stock management in the lake.

(2) *Rearing and Release of Seedlings*

Rearing of seedlings and their release to a natural habitat is one of the effective measures of stock management and, at the same time, constitutes one of the elementary steps toward complete aquaculture. Judging from the results of existing surveys and the Team's experiments, the primary production in the lake appears substantially large as a habitat of phyto- and zoo-plankton species. Therefore, artificial rearing and release of seedlings on a large scale will be certain to increase the fishery resources of High Dam Lake.

The Study Team considers it relatively easy artificially to rear the seedlings of Tilapia nilotica, which have reportedly been declining in annual output in the last few years. To show an example from Japan, adult fish, which are put into an un-reinforced earth pond with a capacity of 4,000 m^2 at the ratio of one pair of a spawner and a milter per square meter when the water temperature reaches 20°C in the spring, will spawn in the pond and produce one million seedlings grown to the size of 5 - 100 g after a few months. It is reported that Tilapia nilotica do not migrate very far, and, consequently, when the seedlings are released into the lake, matured fish could be hauled from the areas they are released after a few years.

The Study Team considers it desirable to establish, at the earliest possible opportunity, a system for rearing and releasing tilapia seedlings similar to the method described above by using adult fish caught alive from the lake. In addition, a number of seedlings should be released with tags on to assess the effect of such an undertaking. The success will ensure the increase of the stock base of Tilapia nilotica in the lake and the accumulation of basic knowledge necessary for the future introduction of more advanced methods of fish culture.

(3) Fishery Management

The conservation of fishery resources in High Dam Lake requires estimation of the population size and the maximum sustainable yield for each of the species, implementation of effective fishery control, and protection of the ecosystem and environment of the lake. The estimation of the population and sustainable yield is very difficult in the short time that was available to the Study Team, and, even if tried, hastily estimated figures are deemed to leave a wide margin of error. The echo-sounder probe, release of tagged seedlings and sample estimation of the primary production (i.e. phyto-plankton) of the lake must be repeated regularly, partly to help effective fishery control.

The fishery control must be preceded by careful recording and analysis of the effects on the fish population and annual yields from the scale of fishing efforts (e.g., the number of fishing boats and gears actually operated, annual days of operation per boat, etc.) and the efficiency of fishing efforts (e.g., types of fishing gear employed, methods of fishing used, etc.) This will require collection over an extended period of time of the data on (i) the number and location of fishing camps, (ii) the number of fishing boats and fishermen per camp, (iii) the annual average days of operation per fishing boat, the average daily frequency of casting per boat and the length and mesh size by type of fishing nets used, (iv) the size of fish hauls by species, month and fishing ground, (v) the size distribution of hauled fish by species and month, (vi) the age, maturity and fucundity of hauled fish by species, (vii) biological characteristics of major species, such as growth and life history, etc. The accumulation of this data will greatly contribute to an early detection of over-fishing and thereby enable quick adoption of corrective measures.

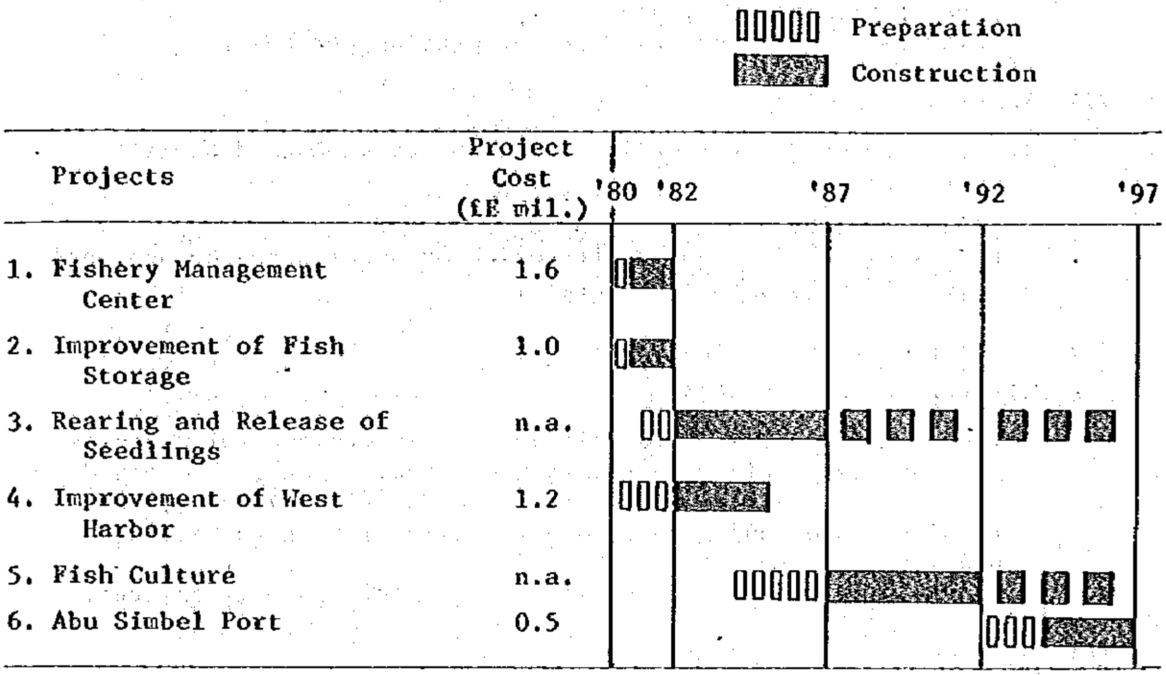
An appropriate fishery control and management system should be identified on the bases of various studies indicated above. It should consist of a combination of (i) restriction or prohibition on the type of fishing gear and the method of fishing, (ii) restriction on the size and the total number of fishing boats to be employed, (iii) restriction on the fishing season (or establishment of a closed fishing season), (iv) restriction on fishing grounds (or closing of a number of fishing grounds), (v) restriction on the size of fish to be caught, etc. Artificially protected rearing and release of seedlings as suggested in the preceding section is also an important measure for the fishery control and management.

4.2.7 Suggested Development Program

As stated in the foregoing paragraphs, the most urgent requirement for the development of lake fisheries is to institute an effective system of fishery management by establishing a Fishery Management Center. This will serve to secure maximum sustainable yields of species on a long-term basis. Equally urgent is the improvement of the storage method of fish hauls, which will eliminate the substantial wastage of fish catches in a short while and raise the annual production without intensification of fishing efforts. In the medium term, rearing and release of Tilapia nilotica should be started on the basis of information and experiments accumulated at the Fishery Management Center, and through the 1980s, appropriate fishery control measures should be established by the Center in parallel with this rearing and release of seedlings. In addition, port facilities at the West Harbor must be improved and expanded to prepare for the intensification of fishing efforts in the lake. In the long-term, aquaculture can be started by having appropriate coves closed by wire nets as has been already done at Khor Ramla. Coupled with effective fishery control and stock management, this will contribute to expanding the stock base of High Dam Lake, which could annually yield fish hauls in the order of some 80,000 tons, provided, it must be emphasized, that all the necessary studies and fishery management measures are carried through under the leadership of the Fishery Management Center. During the 1990s, port facilities which handle increased fish hauls will become necessary at Abu Simbel. The suggested implementation schedule is summarized in Table 4-2-3.

Excluding two port development projects which are dealt with in Section 4.5 of this chapter, some details of each project are given below.

Table 4-2-3 Investment Schedule for Fishery Sector



Projects	Project Cost (£E mil.)
1. Fishery Management Center	1.6
2. Improvement of Fish Storage	1.0
3. Rearing and Release of Seedlings	n.a.
4. Improvement of West Harbor	1.2
5. Fish Culture	n.a.
6. Abu Simbel Port	0.5

(i) Fishery Management Center

Description

The primary purpose of the proposed Fishery Management Center is not in basic research *per se*, but in the collection of information urgently needed for the maintenance, increase and effective utilization of fishery resources in High Dam Lake. The Center is to record and analyze the kinds of data indicated as necessary in Section 4.2.6, in order to identify and implement specific measures of fishery control and management. The activities of the Center, in other words, focus on applied research. This does not imply in any sense that the basic research is unnecessary in High Dam Lake. On the contrary, the basic research which has been carried out in the lake by other government agencies is expected to provide one of the important bases on which the Center orients its activities in the future.

The functions which the Center is to perform can be tentatively grouped into eight sections as shown below.

(1) Section of Fishery Operation Survey

The section collects information on:

- number and distribution of fishing camps,
- number of fishermen and fishing boats per camp,
- days of annual operation per boat at each camp,

- number of fishing nets and total length and mesh size by type of fishing nets, and
- daily fish hauls and frequency of casting per boat.

(2) Section of Landed Fish Survey

The section conducts a daily sample survey on landed hauls concerning:

- total hauls by species and by age,
- body length and weight distribution by species and by age, and
- composition by age and maturity.

(3) Section of Fishery Management

The section undertakes:

- identification and implementation of fishery control measures, such as restrictions on the type of fishing gear, the method of fishing, the size and total number of fishing boats, the fishing season and grounds and the size of fish to be caught, and
- supervision and enforcement of the fishery control measures.

(4) Section of Resource Analysis

Major activities of the section are:

- release of tagged fish and stock assessment (mainly tilapia), and
- echo-sounder probe and estimation of off-shore fish distribution (mainly tiger fish).

(5) Section of Seedlings Production and Fish Propagation

Major activities of the section are:

- rearing and release of Tilapia nilotica seedlings (some of the seedlings are tagged before release by the Department of Resource Analysis), and
- experimentation and development of suitable aquacultural technologies (crossing of species, selection of appropriate species to be introduced for culture, techniques to increase spawns, such as by the use of hormones and control of the water temperature, etc.)

(6) Section of Welfare and Training for Fishermen

The section undertakes activities such as:

- seminars and training courses to improve the fishing practices and the living accommodations among lake fishermen, and
- operation of a wireless emergency rescue system.

(7) Section of Ecological Research

The section undertakes studies on:

- spawning seasons and grounds, seasonal changes of maturity, maturing ages, characteristics of spawning, patterns of growth, distribution and mobility, feeding habits, etc.,
- varieties and seasonal distribution and availability of phto- and zoo-plankton species, benthos and other organisms, and
- introduction of new species.

(8) Section of Environmental Research

Major activities of the section are:

- measurement of the physical conditions (the contour of the lake bed, fluctuations of water level, movement of the current, turbidity and transparency of water, deposits on the lake bed, etc.),
- measurement of chemical properties of the lake water (water temperature, dissolved oxygen and nutrient salts, pH, etc.), and
- identification of measures for environmental protection.

Necessary Facilities and Investment

The necessary facilities and other requirements for the Center consist of the following items. Total investment cost required for the construction of main buildings and other ancillary facilities is tentatively estimated to be around £E 1.6 million.

Site: approximately 3 ha on a slightly elevated ground near the spillway, about 3 km to the northwest from the West Harbor.

Main Buildings (air-conditioned and three-storied): departmental offices (total floor space of 960 m^2, 120 m^2 each per department) and office spaces for the director, administration staff, a library, seminar and training classes, laboratories, corridors and rest rooms, etc. (total floor space of 1,100 m^2).

Total Cost £E 927,000

Furniture: conference tables, desks and chairs, cabinets and lockers, screens and projectors, typewriters, portable calculators, etc.

Total Cost £E 17,000

Field and Laboratory Equipment: measuring tools, a multi-purpose telescopic projector and regular-type telescopes, a set of water-quality testers, a set of lake deposits testers, a plankton-sampling kit, regular and polaroid cameras, batteries and battery chargers (for echo-sounders) and other miscellaneous laboratory equipment.

Total Cost £E 22,000

Survey Boats: one medium-size (10 tons) boat (there is already an offer from the Government of Norway and the boat is expected to arrive by the end of 1979) and three smaller boats with outboard engines.

Total Cost £E 65,000

Wireless Communication System: one set each at the headquarters, the larger survey boat and 10 major fishing camps.

Total Cost £E 80,000

Landing Facilities: a reinforced wharf for survey boats and a landing pad for helicopters.

Total Cost £E 204,000

Culture Ponds: 2 ha

Total Cost £E 65,000

Housing for Staff and Visitors: staff housing of 40 units and 2 guest houses.

Total Cost £E 220,000

(ii) Improvement of Storage

The project involves installation of water-tight adiabatic storage tanks in fishing boats and fishing camps and remodelling of storage tanks in carrier boats. Preliminary cost estimates are as follows.

0.1-ton tanks for 2,000 fishing boats	£E 360,000
1.5-ton tanks for 300 fishing camps	£E 540,000
Materials for remodelling 69 carrier boats	£E 100,000
Total investment Cost	£E 1 million

(iii) Rearing of Seedlings and Aquaculture

Details of these projects will have to be determined after various studies and experiments at the Fishery Management Center. As mentioned in the foregoing paragraphs, some 40 million seedlings will be necessary to obtain, for example, 10,000 tons of fish hauls. This would require a total area of 16 ha for rearing fish. Coves to be selected should have good accessibility from the Center. Rearing can be done by fishermen settled along the lake-shore on commission basis.

4.3 MINING AND MANUFACTURING

4.3.1 Development Strategy

Mining and manufacturing development strategy for the Project Area should be formulated so as to achieve the following objectives;

(i) The effective utilization of regional (Governorate) resources,

(ii) The identification and formation of linkages of this sector with other economic sectors and of sub-sectors,

(iii) Development maintaining good balance and concord with neighboring governorates in Upper Egypt,

(iv) The equalized regional distribution of Egyptian mining and manufacturing industries toward the minimization of regional disparities, and

(v) The satisfaction of regional/local demand.

Particular emphasis should be placed on Objective (iv) above. A majority of Egyptian mining and manufacturing activities are currently concentrated in Cairo and its vicinity and the delta area by reason of easy market access, availability of imported raw materials, ease of recruiting skilled laborers, engineers and managers, high level of infrastructural development, geographically close linkages between sub-sector activities, climate and so forth. Such concentration, however, has already resulted in an extreme density of factories and consequent environmental pollution in some districts, as exemplified by the Helwan area. Also, population concentration has been accelerating in the metropolitan region of Cairo and in the delta area as a result of this industrialization.. Whereas industrial decentralization will eventually become inevitable, effective population redistribution to the Project Area and other parts of Aswan Governorate, or to Region 8 as a whole, will certainly be impossible without industrial development along with agricultural land reclamation. For resettlement in the agricultural sector alone will not be able to absorb the rapidly increasing population, which is expected to reach the order of 60 - 70 million by the year 2000.

With said objectives in mind, the following three types of strategic industries are proposed;

A. Resource-based industries: those which exploit and process or utilize to the extent possible natural resources (fish, agricultural crops, minerals, electric power) available in the Project Area (or in Aswan Governorate, in some cases),

B. Supporting industries: those which support the development of other economic sectors (agriculture, construction, transportation) and the development of other mining and manufacturing sub-sectors within Aswan Governorate (and Region 8, in some cases), and