6.2.3 Agricultural Extension Plan

As a primary stage towards the agriculture development of the Nejd, the pilot farm is obliged to diffuse the agricultural technology and knowledge to the farmers of the existing farms and to the new comers who will be engaged in agriculture in the future.

The results obtained from these extension activities will be fed back to the pilot farm and will be analyzed by carrying out the consecutive activities at the pilot farm.

Government engineers, agriculture officers, innovative farmers and agriculture students will do this extension work, in addition to their training. Pilot farm staff will also be engaged in the extension work along with these people mentioned above.

(1) Contents of the agriculture extension work

The main extension works are as follows:

1. Guidance of appropriate farming techniques
2. Publicizing technical informations
3. Investigating and collecting informations

These are explained in detail in TABLE 6.2.1.

1) Guidance work

The pilot farm staff guide farmers to the appropriate farming technology.
This activity can be carried out by means of periodical circulations, exhibitions, practical guidance, lectures and so on.

2) Publicity work

Publicity work includes publishing technical informations and periodicals, producing agriculture films, making photograph panels, opening exhibition and so on.

Publicity work will be carried out by the pilot farm staff in co-operation with the government officers and innovative farmers.

3) Investigation and information collection work

This work includes investigating the various agriculture problems in the Nejd. Besides the statistical data and other relevant documents and informations will be collected.

The informations collected will be useful for guidance and publicity work. The agriculture problems which were investigated will be analyzed and tested in the pilot farm and suitable solutions should be found out.

Although the works were divided into 3 types mentioned above, they can not be executed independently. The works are related to each other and hence they should be carried out systematically.

(2) Execution of agriculture extension work

Pilot farm staff will be responsible for carrying out this agriculture extension work. They should plan properly in accordance with government engineers, agriculture officers and innovative farmers. They can utilize the help of agricultural students in collecting various informations at the field level. The students can also gain actual field informations and knowledge by interviewing the farmers.

TABLE 6.2.1 Contents of Agriculture Extension Works

Content	Work items	Description of activity
GUIDANCE	Circulation Guidance	Periodical circulation in the region and direct guidance at the farm
	Exhibition Guidance	Exhibition and guidance at the demonstration field to the innovative farmers
	Practical Guidance	Practical guidance of cultivation, machinery operation etc. at the pilot farm
	Transmission Guidance	By group meeting of farmers and giving lectures & making discussions
	Observation Guidance	Guiding by visiting advanced farms, test farms, co-operative market etc.
PUBLICITY	Publication of technical informations	Publication of periodicals regarding technical informations
	Preparing of technical manuals	Preparing of technical manuals for each subject
	Producing films	Producing of films explaining the appropriate agriculture techniques
	Preparing of panels & drawings	Photographic panels and drawings will be prepared and used as lecture-aid.
	Opening of exhibition	Opening exhibition of machinery, equipments, etc. & explaining new techniques.
INVESTIGATION AND INFORMATION COLLECTION	Investigation of present problems	Investigating the agriculture problems, diagnosis of soil, problems caused by insects, pests etc.
	Arrangement and analysis of data	Collecting, arranging and analyzing various statistical data like agriculture production, population, manpower, machineries, production cost etc. and find the actual conditions.
	Information collection	Collecting relating documents and guidance books

6.2.4 Groundwater, Meteorology and Soil Observation Plan

(1) Observation plan of groundwater

Continuous observation of groundwater level is necessary to evaluate the hydrogeological features and properties of the Nejd. Therefore after the establishment of pilot farm, the groundwater level at the two observation wells of the pilot farm and the other observation wells around it should be measured continuously and systematically.

The observation work will be supported technically by PAWR.

(2) Observation plan of meteorological data

During the study, a meteorological observation station was established at the pilot farm site. It is very much necessary that the observation facilities of the station should be expanded and improved so as to measure all the relevant meteorological data.

Continuous observation of these data is necessary since these data can be used in planning the future agriculture development.

(3) Observation plan of soil condition

Soil monitoring in existing farms will be executed as a part of observation activities. Problems will be grasped by monitoring the soil conditions at each farm. Counter plans for the problems will be studied at the pilot farm. These results will be useful for proceeding agriculture development project in the Nejd and the other areas.

6.2.5 Coordination of Organizations Responsible for the Pilot Farm

The establishment of pilot farm is the first step of agriculture development in the Nejd. The results of its activities will be diffused and will be reflected in the future development projects in the Nejd. The role of the pilot farm will increase and will be more important for the phased progress of the agriculture development.

Therefore, the management of the pilot farm should be considered as a part of regional agriculture development.

A committee called "Project Appraisal and Advisory Committee" will be established to coordinate the different organizations responsible for the pilot farm development.

Staffing pattern of this pilot farm team is shown in Section 6.5.1.

6.3 Project Formulation

6.3.1 Location and Scale of the Project

(1) Location of the project site

The location of the pilot farm has been decided inside of Dauka area which is the most promising area for agriculture development among the five study areas.

The area was selected based on the results of hydrogeological investigation, electric prospecting, soil investigation and socioeconomic condition.

It is located at 150 km north of Salalah, along Muscat-Salalah National Highway and 1.2 km west of the Highway.

The recently developed farms like Hailat Al-Rakah, Dauka, Shasr and Quitbeet are located around the site.

It lies on a wadi plain and is approximately at 280 meters above the sea level. There is a little vegetation of acasia and gramineous weed.

Alluvial desert soil along wadi is dominant in the area with 'class S2', land suitability classification. The area extends about 432 ha in a band in east-west direction.

The location of the site is shown in FIG.6.3.1.

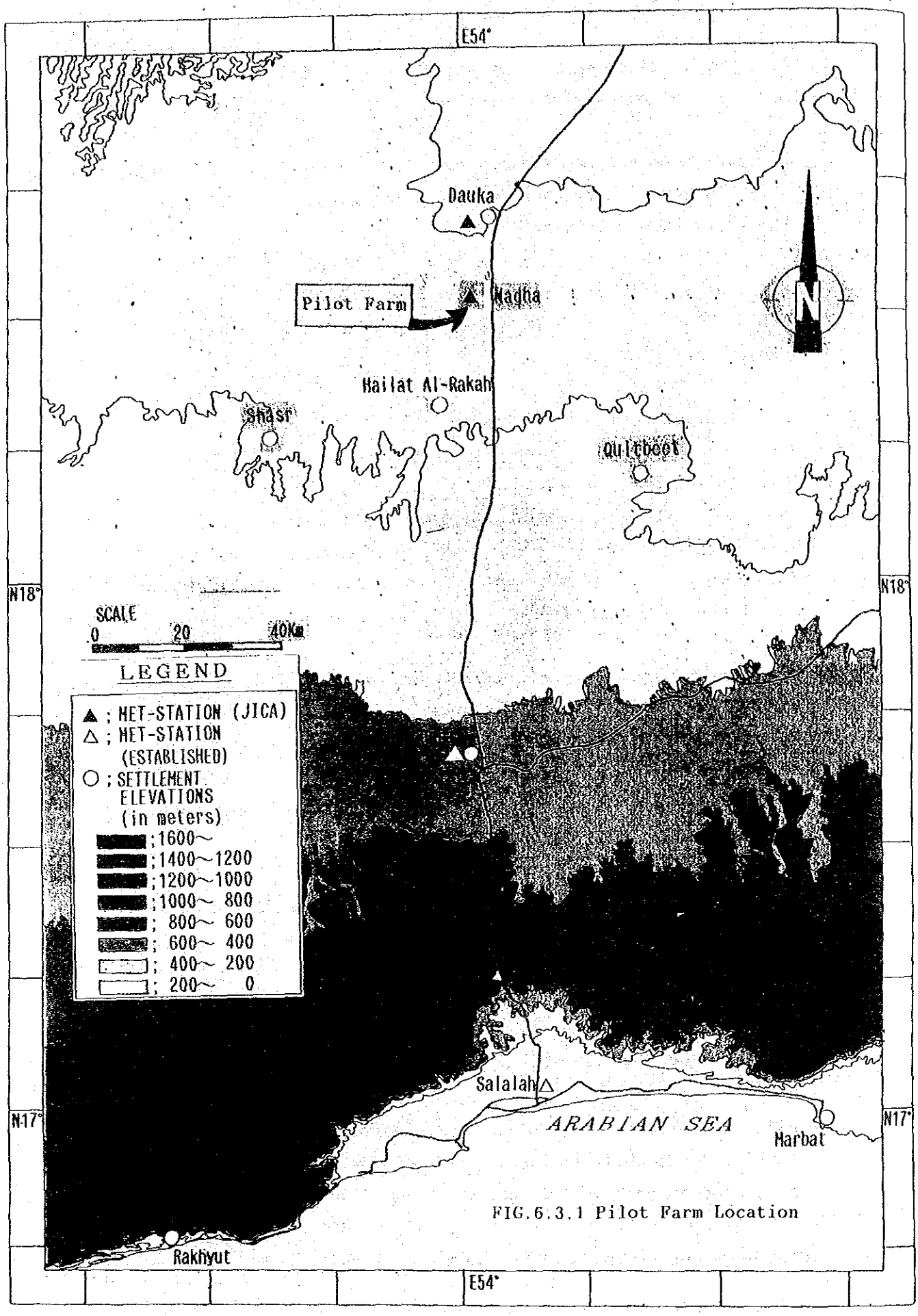


FIG.6.3.1 Pilot Farm Location

(2) Scale of the project

The farm size of the project was decided as 50 ha, considering the pumping rate of two test-wells to be operated at the pilot farm.

Based on the crop water requirement, the water consumption of a 50 ha farm is estimated to be a maximum of 7.08 m^3/min and an average of 5.48 m^3/min with 18 hours of pumping operation. The maximum pump capacity of one production well is 3.54 m^3/min.

The inside casing diameter of the test well, which was drilled during this study, was designed large enough for the installation of a suitable submersible pump.

However, from the study it is understood that the groundwater is of fossil water type, and hence long-term pumpage will gradually decrease the water level. The continuous monitoring of groundwater level is indispensable to clarify the relationship between pumping rate and change of groundwater level.

Three types of farm will be operated at the pilot farm, and the following allotment will be made in order to achieve the target.

Experimental farm	5 ha x 1 ea. =	5 ha
Small scale verification farm	6 ha x 1 ea. =	6 ha
	9 ha x 1 ea. =	9 ha
Large scale verification farm	30 ha x 1 ea. =	30 ha
Total		50 ha

Three different sizes of verification farms are included in order to analyze the optimum farm size suitable for the area.
Normally the size of the farms which is supposed to be owned/cultivated by local farmers is 6 - 9 ha. Hence two small scale verification farms of 6 and 9 ha were selected.
The size of the farms which is supposed to be managed by government or private organizations is about 30 ha. Hence a large scale verification farm of 30 ha is selected for demonstration and verification.

1) Experimental farm

The main purpose of the experimental farm is to experiment and analyze the suitable crops and appropriate technology for the Nejd. For this purpose 5 ha is allotted.

The subjects of this farm is discussed in Section 6.2.1.

2) Small scale verification farm

The purposes of small scale verification farm are as follows:

- To apply the results of experimental farm.
- To study appropriate cultivation techniques
- To study the effective water control and water management practices
- To study the agricultural inputs necessary for farming
- To investigate effective farm management such as operational and maintenance cost
- To demonstrate and training the cultivation technology for local farmers.

Participation of local farmers will be considered in actual operation and semi-residential training in spite that its operation and supervision will be done by the pilot farm staff.

To establish these purposes, two farms (approximately 6 ha and 9 ha area) are provided in the pilot farm.

3) Large scale verification farm

The purposes of large scale verification farm are as follows:

- To study appropriate cultivation techniques
- To study the effective water control and water management practices
- To study the agricultural inputs necessary for farming

- To investigate effective farm management such as operational and maintenance cost
- To demonstrate and training the cultivation technology

A farm of 30 ha is provided for the purposes presented above.

6.3.2 Irrigation Plan

(1) Crop water requirement

The crop evapotranspiration (ETo) is determined based on the observed meteorological data, using Blaney-Criddle, Radiation and Penman methods.

Crop water requirement (ETcrop) is calculated by multiplying crop evapotranspiration (ETo) by crop coefficient (kc). Different crops/cropping pattern will be experimented at the pilot farm and hence the kc value will vary according to the type of crop. As shown in Appendix, kc value ranges from 0.4 - 1.1. Considering a full crop growing season with all stages, an average kc value of 0.85 is assumed and the crop water requirement is calculated. (Refer to Appendix)

TABLE 6.3.1 shows the monthly crop water requirement.

TABLE 6.3.1 Monthly Crop Water Requirement

Unit: mm/day

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL AVE.
5.4	6.7	8.2	8.9	9.5	10.5	9.7	9.5	8.6	7.6	6.0	5.3	8.0

(2) Irrigation method

Irrigation methods such as centre pivot sprinkler system (in large scale verification farm) and rain gun and side wheel sprinkler systems (in small scale verification farm and experimental farm) will be introduced. Drip irrigation system will be adopted for experimental farm and built in a part of it.

(3) Irrigation efficiency

1) Field application efficiency

The field application efficiency varies according to the type of irrigation method. The study will adopt a medium field application efficiency coefficient of 0.8 so that several irrigation methods can be applied, although this study will adopt an economic irrigation method.

2) Conveyance efficiency

The pipeline system will be used in irrigation water-conveyance from the water source to the field in order to minimize water-conveyance loss. The water-conveyance efficiency in this case will be adopted as 0.9.

3) Irrigation efficiency

The irrigation efficiency at the pilot-farm will be 0.72 by multiplying the values 1) and 2) mentioned above.

$$\begin{aligned} \text{Irrigation efficiency} &= \text{Field application efficiency} \\ &\quad \times \text{Conveyance efficiency} \\ &= 0.8 \times 0.9 \\ &= 0.72 \end{aligned}$$

(4) Net water requirement (N.W.R.)

Net water requirement is computed from crop water requirement and irrigation efficiency and is shown in TABLE 6.3.2.

TABLE 6.3.2 Net Water Requirement

Unit : mm/day

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Max
E T c r o p (mm/day)	5.4	6.7	8.2	8.9	9.5	10.5	9.7	9.5	8.6	7.6	6.0	5.3	10.5
Irrigation Efficiency	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	—
N . W . R (mm/day)	7.5	9.3	11.4	12.4	13.2	14.6	13.5	13.2	11.9	10.6	8.3	7.4	14.6
N . W . R (mm/Month)	232.5	260.4	353.4	372.0	409.2	438.0	418.5	409.2	357.0	328.6	249.0	229.4	438.0
N.W.R per 50ha (cu/m/day)	3.750	4.650	5.700	6.200	6.600	7.300	6.750	6.600	5.950	5.300	4.150	3.700	7.300

(5) Effective rainfall

For the recent 6 years the average precipitation at Thumrait, the only available meteorological station in the Nejd, was as low as 32 mm. Hence the effective rainfall can be assumed as zero and not taken into consideration in the study.

(6) Leaching water requirement

Crusting is anticipated in the soil surface at the initial stage of irrigation because soils in the area contains high amount of $CaCO_3$ (14 - 43%). Minimum plowing and frequent irrigation are effective to control the crusting formation.

Besides, leaching is required to control the salinity of the soil. The salinity of water of this project is about 1,500 μS/cm. In case of sprinkler and drip irrigation, the water requirement for leaching under this condition is 6 - 10% of crop water requirement.

The leaching water requirement in this case can be covered within the water loss in the farm field. In case that more leaching water is required than the water loss there, the leaching should be planned in other seasons except summer since the irrigation water demand is greater in summer.

(7) Water requirement for the wind break trees

The total number of wind break trees estimated for the pilot farm is 11,682. The daily water requirement of one wind break tree is 30 litres per day as quoted from the report of anti-desertification study in U.A.E. So, the total water requirement for the wind break tree reaches to 350.5 cubic meter per day.

(8) Pumping water requirement

Pumping water requirement is estimated as follows.

TABLE 6.3.3 Total Water Requirement of 50 ha Farm

Unit: Cu.m/day

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
N.W.R	3750	4650	5700	6200	6600	7300	6750	6600	5950	5300	4150	3700
Wind breaks	351	351	351	351	351	351	351	351	351	351	351	351
Total	4101	5001	6051	6551	6951	7651	7101	6951	6301	5651	4501	4051

Total: 2.16 MCM/yr.

The maximum net water requirement is 14.6 mm/day in June and the minimum is 7.4 mm/day in December.
Using these values the daily water requirements for the 50 ha farm is 7,651 cu.m/day as the maximum and 4,051 cu.m/day as the minimum. Total annual requirement is 2.16 Million Cu.m.

Consequently, the pump water requirement for the two pumping cases is summarized as follows:

TABLE 6.3.4 Pumping Water Requirement

Pumping Time	MAX	MIN	MEAN
18 hrs	7.08 cu.m/min (118.07 lit/sec)	3.75 cu.m/min (62.52 lit/sec)	5.48 cu.m/min (91.32 lit/sec)
24 hrs	5.31 cu.m/min (88.55 lit/sec)	2.81 cu.m/min (46.89 lit/sec)	4.11 cu.m/min (68.49 lit/sec)

The maximum requirement is 118.07 lit/sec and the pump capacity required for one production well in case of 18 hrs of pump operation is 59.04 lit/sec.

6.3.3 Irrigation Facilities Plan

Irrigation facilities proposed for the pilot farm are summarized as follows:

(1) Water supply facilities

1) Production well

The two test wells which were drilled for the groundwater study will be used as production wells which will serve as the water source for the pilot farm. Submersible pump-type is suitable for these wells.

The profile of the production well is shown in the following table:

TABLE 6.3.5 Production Well Profile

Items	Values	Remarks
Drilling depth	350 m	
Drilling diameter	216 - 610 mm	
Casing diameter	245 - 340 mm	
Depth of main aquifer	GL-280 to - 310 mm	
Water production	MAX. 7.08 m^3/min	18 hrs opera. per day
Depth of pump installation	GL-50.0 m	
Pump capacity	3.54 m^3/min/set	18 hrs opera. per day

2) Depth of submersible pump installation

As a result of pumping test of the drilled wells in this study, the drawdown of water level was 5 - 8 m under the condition of Q = 50 - 60 lit/sec with 72 hours of pump operation.

It is anticipated that the drawdown of water level will be 4 - 7 m under the condition of the same pumping rate with 18 hours pump operation. However, the recovery of water level will decrease gradually as the total pumped water increases.

Actual drawdown of water level will be confirmed through long term pumping test (for instance continuous pumping test for one month) and monitoring of groundwater level in parallel with the management of the pilot farm. The depth of submergible pump installation is designed as GL-50 m considering the safety limit of the drawdown of the groundwater level in the long term run.

3) Pump housing

Pump housing is required to prevent the well head and the control panel against sand and strong sunshine. Also the valves are placed inside the pump housing. The dimension of the housing is 4.0 m x 4.0 m.

(2) Water Distribution Facilities

1) Farm Pond

Farm pond is designed to absorb the time-difference between pump operation hours and field irrigation hours by storing the pumped water for some period of time. Assuming 12 hours for field irrigation work, the farm pond capacity reaches to 2,585 cu.m (= 3.59 cu.m/min x 2 sets x 6 hrs x 60 min). One farm pond is connected with the two production wells and supplies irrigation water to the field through pipe line network. The dimension of the pond is 35.0m L x 35.0m B x 2.5m H, which is made of concrete bricks lined with cement mortar on its surface.

2) Pump station

Pumped water will be stored in the farm pond and will be distributed to the irrigation facility in each farm by distribution pumps. Five pumps will be installed including one spare pump, considering the farm arrangement as shown below.

	Irrigation Area	Irrigation Method	Water Pressure Requirement	Pump Capacity (Max)	Pump Head
1.	30.0 ha	Center pivot	5.5 kg/cm^2	4.0 m^3/min	60 m
2.	5.0 ha	Drip & raingun	5.5 kg/cm^2	0.7 m^3/min	60 m
3.	6.0 ha	Side wheel sprinkler	5.5 kg/cm^2	0.8 m^3/min	60 m
4.	9.0 ha	Raingun	5.5 kg/cm^2	1.2 m^3/min	60 m
5.	Spare	-	5.5 kg/cm^2	4.0 m^3/min	60 m

A pump station for these pumps and the control panel will be built with a crane in it. Its dimension will be 120 m^2 = 15 m x 8 m.

3) Water distribution pipeline

Pipeline system will be used for water conveyance so as to minimize the water conveyance loss. The system of the pipeline is semi-closed and reticulate for ensuring water conveyance with several valve control facilities. The material of pipe will be of steel.

Hydrants will be installed at each farm plot to facilitate irrigation to each plot separately.

(3) Drainage facility

According to the result of the soil survey in the pilot farm site, impermeable layer and groundwater were not found within 5 meters of depth. Both the top soil and the irrigation water quality were found rather good.

Irrigation method shall be selected to supply the minimum water requirement for the crop. Hence the salinity problem will not occur in the near future. Consequently particular drainage facility will not be planned, except for open-channel drainage along the roads. If necessary, subsurface drainage pipe network will be recommended in the future.

However, drainage pipes will be installed in a 1 ha plot for experimental farm.

(4) On-farm irrigation facilities

1) Centre pivot sprinkler irrigation system

One centre pivot sprinkler irrigation system will be installed for the large-scale verification farm of 30 ha area.

2) Side-wheel sprinkler system

One side-wheel sprinkler irrigation system will be installed for the small scale verification farm of 6 ha area.

3) Rain gun irrigation system

One rain gun irrigation system will be installed to irrigate small-scale verification farm of 9 ha area and the experimental farm of 4 ha area.

4) Drip irrigation system

A drip irrigation system will be installed for an area of 1 ha in the experimental farm.

6.3.4 Appurtenant Facilities Plan

The following appurtenant facilities are planned for the smooth management of the pilot farm.

(1) Road

Roads in the pilot farm are classified as trunk roads, branch roads and cultivation passway depending on their specific functions.

1) Trunk road

The main function of the trunk road is to connect the farm with the highway and it is the main road in the farm.

The effective width is six meters paved with gravel and the total width is ten meters. The total length is estimated as 5.1 km.

2) Branch road

The main function of the branch road is to connect the trunk road with cultivation passway and paved with gravel with an effective width of four meters and a total width of seven meters. The total length is estimated as 3.3 km.

3) Cultivation passway

Cultivation passway will be prepared at the side of the farm plot for the smooth operation of field work. Its total width including the windbreak trees is 7 m. The total length is estimated as 2.3 km.

(2) Windbreak facilities plan

According to the meteorological data of the Thumrait station, the local average wind velocity is estimated to be 6 m/sec, prevailing in the southerly with a occurrance probability of more than 80%. In this regard, the gust velocity is expected to reach 12 m/sec which may cause damage to crops and facilities. Windbreaks will not only protect adjacent land and crops from strong wind, but also decrease evapotranspiration and control temperature and humidity. Two kinds of windbreak facilities will be made, i.e. windbreak trees for long

term use and windbreak fence for short term use. The latter will be in use till the growing up of the windbreak trees.

1) Windbreak trees

The height of the matured tree is supposed to be 5 meters and the efficient protection distance from the row of trees is 50 meters, since the windbreak is said to be effective for a distance of 10 to 15 times of the tree height.

The windbreak trees are to be planted along the roads and the cultivation passways. The tree belt is lined from east to west and consists of 3 tree lines for one belt; the width of the belt is 4 m and the planting space along the line is 2.5 m.

The following five species were selected for windbreak trees as discussed in Appendix.

1. Casuarina sp.
2. Prosopis sp.
3. Tamarisk sp.
4. Acacia sp.
5. Conocarpus sp.

2) Windbreak fence

Windbreak fence of 5 m height is to be built as a short term countermeasure. Until the growing up of the trees, the fence will protect the farm and the trees against the wind. Also it will work as barriers against grazing animals approaching from outside.

Windbreak fence will consist of steel poles and a net of 50.2% screening efficiency.

(3) Power facility

Generators will be installed for supplying electricity to the pumps, office and accommodations. The capacity is estimated as follows:

1. Office and Accommodation	50 KVA
2. Pumps and Others	450 KVA
Total	500 KVA

Five numbers of 100 KVA generator will be used.

The generators and control panels will be kept in a generator house of 100 sq. meters area.

(4) Buildings

The following buildings will be built in the pilot farm,

Office building	100 sq.m.
Training building	100 sq.m.
Research building	100 sq.m.
Laboratory building	50 sq.m.
Warehouse	100 sq.m.
Garage	120 sq.m.
Dormitory and staff quarter	850 sq.m.

(5) Agro-meteorological observation station

An agro-meteorological observation station with one automatic observing system and class-A pan type evaporator will be set up in the previous observation compound (NJD-3 observation well compound, installed in this project). The following meteorological properties will be observed.

- Atmospheric temperature
- Rainfall
- Humidity
- Solar radiation (flux, duration)
- Wind (velocity, direction)
- Ground temperature
- Evaporation

All the data except the evaporation data will be stored automatically into a data-disc.

FIG. 6. 3. 2

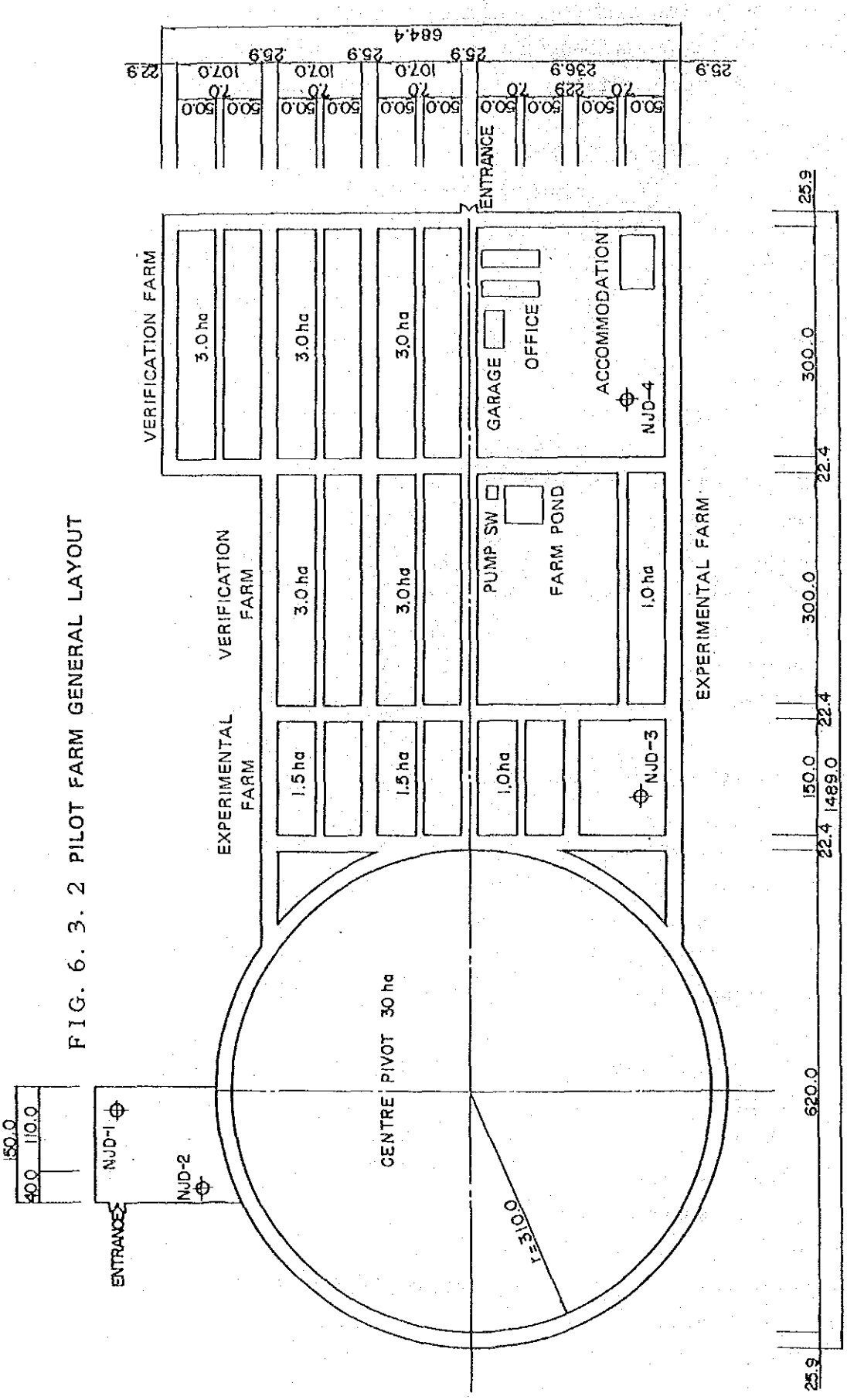


FIG. 6. 3. 2 PILOT FARM GENERAL LAYOUT

(6) Farm machinery plan

The following farm machines are planned for the pilot farm.

Riding Tractor (80 ps)	2 ea.
Disc Plow (14" x 3)	1 ea.
Disc Harrow (15" x 24)	1 ea.
Tooth Harrow (30 x 4 pcs)	1 ea.
Manure Spreader (2.3 ton)	1 ea.
Front Loader	1 ea.
Broad Caster (660 l)	1 ea.
Packer Seeder (2.4 m)	1 ea.
Rotary Mower (2.0 m)	1 ea.
Tedder (4 Rotor)	1 ea.
Rake (Sylinder Type)	1 es.
Tight Baler (40 x 40 x 50 cm)	1 ea.
Cubing Machine (120 ps)	1 ea.
Truck (2 Ton)	2 ea.

6.4 Pilot Farm Execution and Management Plan

6.4.1 Project Execution Agency

It is advisable that the design, construction plan, construction work and operational maintenance after construction of the pilot farm should be done by one organization and the DGAFS(MAF) is recommended for this purpose. Groundwater monitoring will be technically supported by PAWR.

6.4.2 Project Construction Plan

(1) Mode of construction

The construction works in principle should be carried out on contract basis. Among others, contractors for construction should be selected through competitive tender to carry out the works on contract basis.

(2) Construction period

One year is anticipated to complete all the construction works including detailed design and construction works.

(3) Consultant services

The participation of engineering consultants having rich experience and knowledge on necessary technical fields is required for smooth progress of the construction works and for the technical transfer of knowledge to the Omani engineers in the field.

The consultants should be in charge of the following works.

a) Detailed design
b) Preparation for tender
c) Supervision of construction works
d) Operation and maintenance of the facilities after the construction

6.4.3 Project Cost of the Pilot Farm

Project cost includes construction cost, machinery and material cost, general management cost, consulting service cost, and physical contingency.

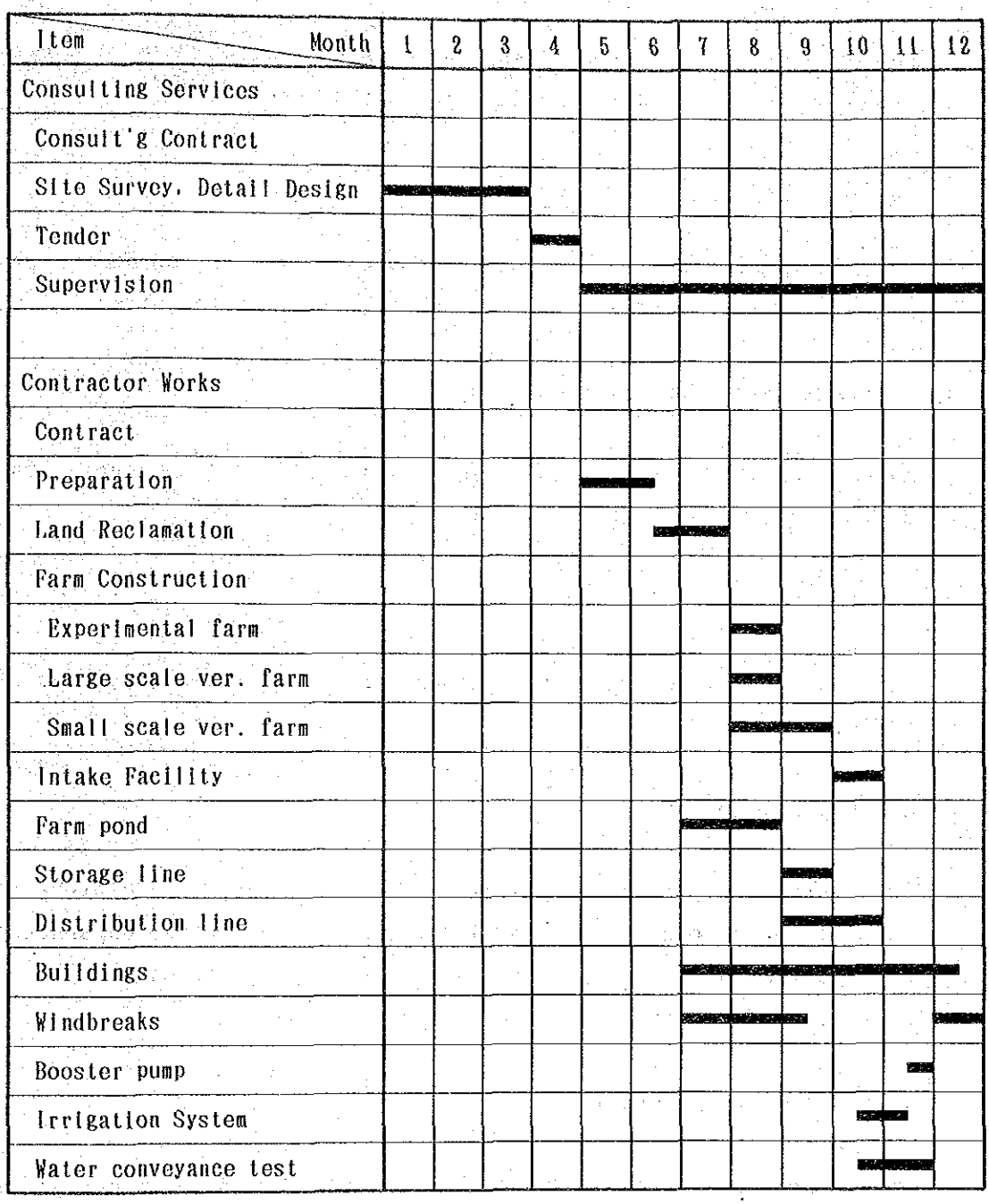
(1) Conditions for project cost estimation.

Project cost is estimated based on the conditions mentioned below.

1) Basic price

Basic prices, for example material price, machinery price, labour cost, etc. are quoted from the market prices in January 1989.

FIG.6.4.1 Pilot Farm Construction Schedule



2) Unit price

Unit prices of construction work is estimated by the sum-up system.

Labour and material prices used for this estimation are determined based on the data collected in Salalah and Muscat.

3) Indirect cost

The indirect cost for construction work is composed of overhead, sales benefit and so on. It is decided as 25% of the direct cost.

4) Exchange rate of foreign currency

Assumed as 1US$ = R.O. 0.384. Those are the actual exchange rates of foreign currency in January 1989.

5) Construction facilities cost

This is estimated as the purchase and installation cost for site office and residences.

6) Administration cost

Administration cost consists of salaries, administration miscellaneous cost, fuel and light expenses and other expenses for the staffs who are in charge of the project execution and management during the construction period.

7) Consulting service cost

This is the consultation charge for the detail design and supervision of the project.

8) Physical contingency

Construction cost unforeseenable at the point of the study or subject to increase; 10% of the civil construction cost is allowed.

(2) Project cost estimation for the pilot farm

As shown in TABLE A-6.4.1, the total project cost of the pilot farm is estimated as R.O.1,698,500 ($4,423,200). The cost of construction and equipments is estimated as R.O.1,342,991 ($3,497,400). The cost of project facilities, administration, consulting service and contingency is estimated as R.O.355,509 ($925,800).

1) Cost of construction and equipments

The breakdown is as follows:
Cost of construction R.O.1,193,951 ($3,109,250)
Cost of equipments R.O.149,040($388,150)

The break down of the equipments cost is as follows:

Farm machineries	R.O. 96,410
Meteorological equipments	R.O. 4,080
Vehicle	R.O. 36,050
Office equipments	R.O. 12,500
Total	R.O.149,040

2) Project cost of the pilot farm

The total project cost including the construction cost, machineries & equipments cost, project facilities cost and so on is shown in the following table.

Table 6.4.1 Project Cost of the Pilot Farm unit: R.O.

Item	Cost
1. Construction cost	1,193,951
2. Machineries & equipments cost	149,040
Sub Total	1,342,991
3. Project facilities cost	9,400
4. Administration cost	5,700
5. Consultation service cost	186,000
6. Physical contingency	154,409
Grand total	1,698,500

6.5 Operation and Maintenance Plan for Pilot Farm

6.5.1 Pilot Farm Team

The pilot farm office takes care of operation/maintenance of several facilities in the pilot farm. This team is composed of 20 staffs including experts of agronomy and irrigation, agricultural extension workers, operators and mechanics. Observation workers should be included for monitoring of groundwater/soil and maintenance of meteorological observation equipments. If the activity of the pilot farm goes well, the experts from outside should also be invited for training.

Item	Staff	No.	Work
1.	Team leader	1	Management of all the pilot farm activities
2.	Irrigation engineers	2	Guidance of irrigation, training and extension
3.	Agronomist	1	Guidance of agronomical practices, experimental cultivation, training and extension
4.	Extension workers	2	Extension of agriculture techniques to the other farms
5.	Observation workers	4	Observation of meteorology, soil and groundwater, maintenance of equipments
6.	Mechanics	2	Maintenance of vehicles and farm machineries
7.	Machinery operators	2	Operation of machineries
8.	Clerical staff	1	Administration, accounting
9.	Office worker	1	Assistance of administration
10.	Laborers	3	Field work
11.	Cook	1	Cooking
	Total	20	

6.5.2 Operation and Maintenance Cost

Total annual cost of operation and maintenance of facilities under this project is estimated as R.O.174,786 ($455,200)(TABLE A-6.5.1 & TABLE A-6.5.2). Its breakdown is shown below.

(1) Administration

Salaries	R.O.18,000
Vehicles maintenance cost	2,803
Office equipments maintenance cost	6,375
TOTAL	R.O.27,178

(2) Farm operation

1) Salaries (Farm staffs only)	R.O.75,120
2) Intake facility	601
3) Irrigation facility	7,533
4) Drainage facility	14
5) Road works	79
6) Wind breaks	2,035
7) Water supply (potable)	56
8) Buildings	219
9) Generator + Hut	50,372
10) Machinery	11,457
11) Meteorological equipments	122
TOTAL	R.O.147,608

6.5.3 Benefit of Pilot Farm

Not all the benefits which would be derived from setting up the pilot farm is quantitatively enumerated, as its nature is of non-profit experimental and educational purpose. However, the monetary benefit-cost of the pilot farm is detailed as shown below.

The total project cost amounts to about R.O.1.7 million (Jan. 1989 price), which is about 50% of an average annual development expenditure budget for the MAF.*

Annual M/O cost (excluding the depreciation cost) is about R.O.82 thousand and staff salary around R.O.93 thousand. On the other hand, annual revenue can be expected from the sale of Rhodes grass, which amounts to around R.O. 180 thousand.** So the revenue would almost cover the cost.

* The Third Five-Year Development Plan, P.66

** R.O.100/ton x 40 ton/ha x 50 ha x 90% = R.O.180,000

6.6 A Case Study of Agriculture Development in the Nejd

6.6.1 Background and Purpose of the Project Plan

In order to proceed the agriculture development in the Nejd systematically, the phased development which begins with the pilot farm construction must be practiced. In case of proceeding with the development project after the pilot farm construction, the appraisal of the project enlargement rate for farm development and limitation of the project scale is quite important.

In this section, a case study of the project developed from the guideline is discussed in order to understand the problems to be expected at the project execution stage as the second phase of the agriculture development plan.

Main items to be studied are as follows.

a) Rough estimation of the project cost
b) Appraisal of the project
c) Governmental subsidy for the project.

6.6.2 Presumptions of the Project Plan

According to the guideline for the agriculture development, the presumptions of the project plan are as follows:

(1) Target scale for the project

Based on the groundwater condition obtained by the groundwater survey, the target scale for the project is presumed as 500 ha.

(2) Phased development

Development area will be expanded step-by-step based on the evaluation of the groundwater.

(3) Crop selection

Rhodes grass will be cultivated.

(4) Project starting period

The project will be started after the confirmation of development potential by monitoring/management at the pilot farm for two years.

6.6.3 Construction Plan

(1) Selection of the development area

Based on the reasons mentioned in section 5.4.1 the following four areas were selected.

1) Nagha area (around pilot farm)

Located near the national highway and centre of the developed area.

2) Dauka area

Located near the national highway and with high-pressured groundwater.

3) Shasr area

Located near a branch road and with high-pressured groundwater next to Dauka area.

4) Wadi Mokhawrim area

Located near the branch road and with enough 'S2' soil area.

As shown in FIG.6.6.1, two areas, Nagha and Dauka, are selected from the four areas and the mean cost of project is estimated, since the project cost of each area is different. The reasons are as follows:

1) These areas are located near the national highway and construction of a new road is not required. Easy to collect and ship the farm products.

2) Easy to approach from existing settlements and existing farms

3) Nagha area locates the pilot farm in it. Hence the technical guidance can be carried out smoothly.

4) High pressured groundwater is available in Dauka area.

5) These areas has enough S2 soil area.

6) Although the other two areas are located near branch roads, their conditions are not favourable and large scale of improvement works are required for shipping of farm products such as vegetables, fruits etc.

(2) Procedure of construction

After the confirmation of the development potential by management/monitoring in the pilot farm for two years, the construction of new farms will start according to the project plan. The project plan presumes that the area of new farms is 50 ha and the development unit is expanded step-by-step first in Nagha area and then Dauka area. It presumes that the 50 ha farm is constructed in ten places consecutively and the development set a target of 500 ha in total.

(3) Facilities plan

The facilities, materials and machineries required for the 50 ha farm is listed in TABLE 6.6.1.

FIG. 6. 6. 1 Location of Farms for the Case Study

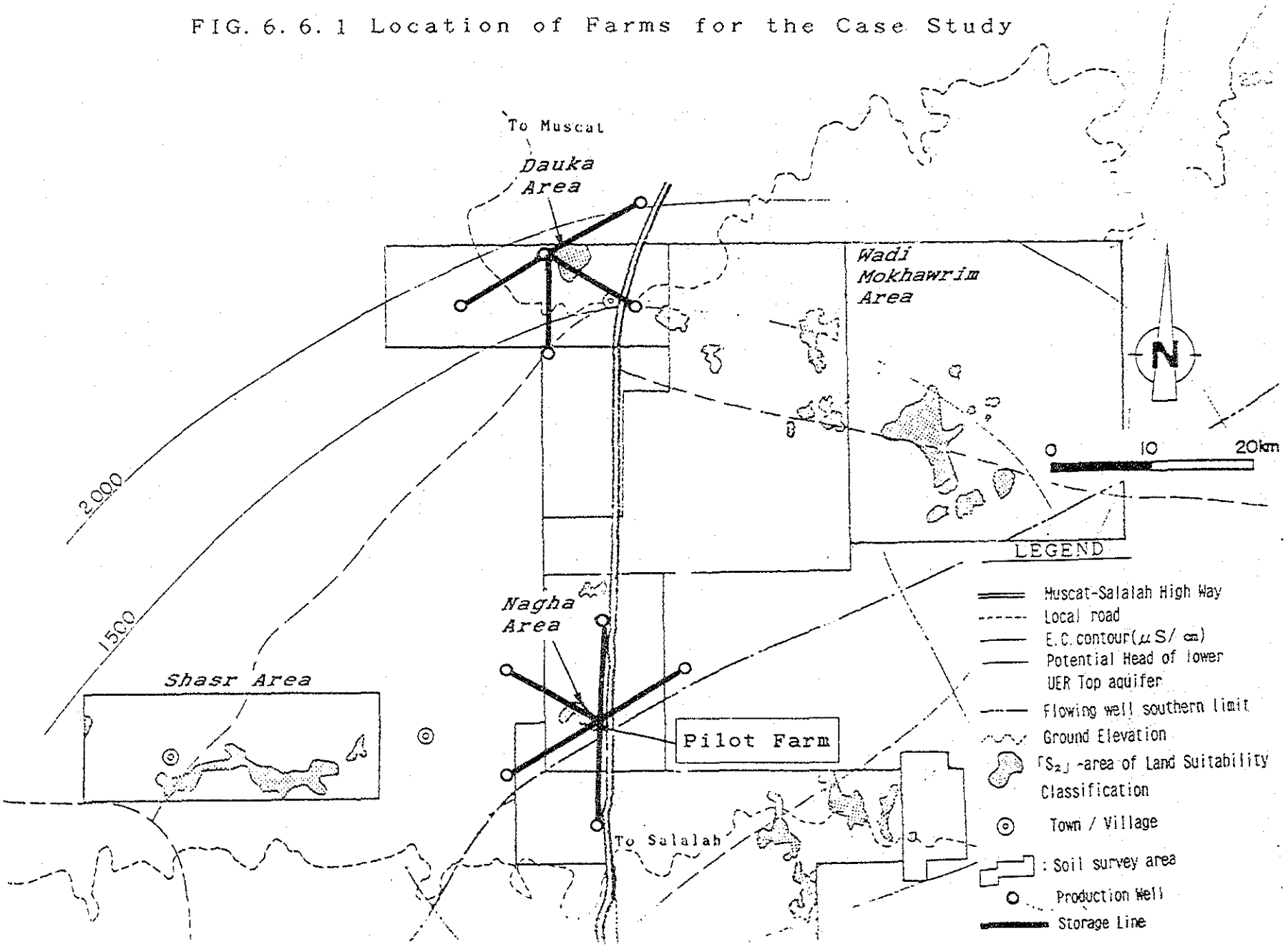


TABLE 6.6.1 Facilities for 50 ha Farm Agriculture Development Unit

Item	Details
1. Land reclamation	50 ha area should be the unit of development and it will be irrigated by a center pivot irrigation system.
2. Irrigation and distribution line	Same as the pilot farm plan
3. Windbreak trees	-- ditto --
4. Farm road	Construct 2,571 m of trunk roads and 406 m of cultivation pass way
5. Farm pond	One farm pond is designed per 50 ha farm area
6. Booster pump	Arrange two booster pumps of 65 KW
7. Irrigation facility	Introduce a centre pivot irrigation system for 50 ha area.
8. Production well	Wells are designed assuming their depths area 330 m in Nagha area and 430 m in Dauka area
9. Monitoring well	-- ditto --
10. Submersible pump	Submersible pump should be installed at Nagha area only. 45 KW
11. Storage line	Storage line is designed from production well to farm pond to deliver water
12. Power facility	Power facility is designed for both submersible pump and booster pump
13. Access road	Access road is designed to connect the national highway and development area
14. Operation and Maintenance Road	This road is designed for operation and maintenance of production well and distribution line
15. Farm machineries	Necessary farm machineries are introduced
16. Vehicles	Vehicles are provided for operation and maintenance of the farm
17. Residences and accomodations	Residences and accomodations for settlers are provided

Five sets of these items will be required both in Nagha area and Dauka area.

(4) Farm machinery plan

1) Machineries for land reclamation and seeding works

The machineries listed in Table 6.6.2 will be introduced for land reclamation and seeding works. One set of machineries are required for the first development stage. But machineries have to be replaced by new ones for the endurance term is supposed to be five years.

2) Machineries for management, harvest and transportation

The machineries listed in Table 6.6.2 will be introduced for management, harvest and transportation works. The machineries mentioned in the list are for 50 ha farm area.

4 wheels driving car and motorcycle will be introduced for the smooth running of farming works.

TABLE 6.6.2(1) List of Farm Machineries

	Work item	Machinery	Specifications	No.
Land reclamation and seeding works	Compost spreading	Manure spreader	2.3 t	1
	front loader			1
	Plowing	Bottom plow	14" x 3	1
	Harrowing	Disk harrow	20" x 24	1
	Reclamation	Tooth harrow	30" x 4	1
	Fertilization	Broad caster	660 l	1
	Seeding	Packer seeder	2.4 m	1
	Land rolling	Packer seeder	2.4 m	
	Traction	Riding tractor	60 p.s.	1
	Total			8

TABLE 6.6.2(2) List of Farm Machineries

	Work item	Machinery	Specifications	No.
Management, harvest and transportation works	Additional fertilization	Broadcaster	660 l	2
	Reaping	Rotary mower	2.0 m	2
	Turning over	Tedder	4 rotor	2
	Grass gathering	Rake	cylinder type	2
	Packing	Tight baler	40 x 40 x 50 cm	2
	Loading	Front loader	-	2
		Truck	4 ton	2
	Traction	Riding tractor	60 p.s.	2
	Total			16
Operation and maintenance work		Car	4 WD	1
		Motorcycle		1

6.6.4 Project Cost of the Case Study

Project cost consists of construction cost, machinery and material cost, facility cost, general management cost, consulting service cost, and physical contingency. The cost is estimated for a 50 ha farm and the total project cost for 500 ha farm area is estimated as 10 times of the 50 ha farm.(Refer TABLE A-6.6.11)

(1) Conditions for project cost estimation

The conditions for the project cost estimation is same as those for the pilot farm mentioned in section 6.4.3(1).

(2) Project cost of the case study

1) Construction cost

The total construction cost is R.O.1,296,500 ($3,376,300).

2) Machinery cost

The total machinery cost is R.O.84,534 ($220,100). Its breakdown is shown below.

Machineries for land reclamation and seeding works	R.O. 4,084 ($ 10,600)
Management, harvest and transportation works	R.O.73,100 ($190,400)
Sub total	R.O.77,184 ($201,000)
Vehicles	R.O. 7,350 ($ 19,100)
Total	R.O.84,534 ($220,100)

3) Project cost

The project cost for 50 ha farm is shown in Table 6.6.3. The mean values of the 10 farms of the Nagha and Dauka area are shown in this table. The total project cost for 500 ha farm area is estimated as 10 times of the 50 ha farm.

TABLE 6.6.3 Project Cost of the Case Study

Item	Mean value of 50 ha unit farm
1. Construction cost	R.O.1,296,500
2. Machinery cost	R.O. 84,500
Sub-total	R.O.1,381,000
3. Project facilities cost	R.O. 7,400
4. Administration cost	R.O. 5,700
5. Consultation service cost	R.O. 110,700
6. Physical contingency	R.O. 150,500
Total	R.O.1,655,300

6.6.5 Operation and Maintenance Cost

(1) Operation and maintenance cost

Operation and maintenance cost includes depreciation, repair cost and fuel consumption cost.
The mean annual operation/maintenance cost of 50 ha unit farm is R.O.128,500 ($334,600) although it is slighly different for each farm with respect to water resource conditions of the area.(Refer TABLE A-6.6.12 & A-6.6.13)

The following three costs are the main items of operation/maintenance cost.

O/M cost of intake facilities	28%
O/M cost of farm facilities & housing	48%
O/M cost of farm machineries	23%
O/M cost of connection roads, vehicles	1%

1) Operation/maintenance cost of intake facilities

The intake facilities means the facilities from production well to the end of storage line. Submersible pump is planned to be installed in Nagha area only since the pressurized condition of groundwater is less in Nagha area than Dauka area.
The water cost is calculated from this operation/maintenance cost by dividing the total water intake.

The water cost is approximately R.O.0.021/m^3 ($0.055/$m^3$)

2) Operation/maintenance cost of farm facilities

Farm facilities includes the distribution facilities, irrigation facilities, farm road and windbreak facilities. The cost is same for Nagha area and Dauka area.
The annual operation and maintenance cost for 50 ha unit farm is approximately R.O.59,100 ($153,900).

3) Operation/maintenance cost of farm machineries

Annual operation/maintenance cost for land reclamation and seeding works and management/harvest/transportation works for a 50 ha farm is estimated as approximately R.O.30,000 ($78,100).

(2) Renewal cost for machineries

Since the endurance duration for farm machineries are 5 years, the renewal cost is required for each 5 years. Its breakdown per 50 ha farm is shown as follows.

Machineries for land reclamation and seeding works
= R.O.20,420 ($53,000)

Machineries for management, harvest and transportaion
= R.O.73,100 ($190,000)

CHAPTER – 7

PROJECT APPRAISAL ON THE NEJD AGRICULTURAL DEVELOPMENT

CHAPTER 7 PROJECT APPRAISAL ON THE NEJD AGRICULTURAL DEVELOPMENT

7.1 National Policy for Agriculture-Livestock and its Related Sectors.

This section and the next section provide the background of national agricultural and regional policies, on which these guidelines have been given.

Towards the post-oil era, a long term strategy has been formulated at national policy level.

The strategy directs that the natural resource basis for national income shall be diversified more than ever, in which the development of water resources have been given a top priority, and the capital formation shall mainly be built upon the income generating projects in the economic environment of free market system with the rule of fair competition. At the same time, fairness shall be observed in the socio-political environment, i.e., in the aspects of geographical distribution of investment and of keeping up the integrity of rural communities which should be in balance with the properly conserved physical environment.

Meanwhile, the performance standard of Omani human resources should be kept raising with appropriate education system.

The plan seeks after the ideal national goal, so some policies of balancing nature are destined to reconcile with the basic principles. In the agriculture-livestock sector, these long term targets are translated more realistically into the three important short term goals in the Third Five-Year Development Plan (1986-1990). They are:

1. Vertical expansion for improvement of productivity.
2. Continuation of providing the farmers with subsidy.*
3. Development of means for marketing of agricultural produce and domestic animals.

The ministry of Agriculture and Fishery, which is the ministry concerned and Oman Bank for Agriculture and Fisheries (OBAF) is entrusted for a part of operations concerning the goals one and two, and Public Authority for Marketing Agriculture Produce (PAMAP), under the Ministry of Commerce and Industry, has made a move to engage itself in the operations regarding the goal three; still the lion's share goes to the private sector's hand which controls most of the business.

* Subsidy distorts price mechanism in the international free market system. But self-sufficiency in food has still been taken for granted. Most of the countries, except a few notable major wheat producers, have been trying to evade the GATT. The price of rice in Japan, for example, is about eight times as much as the world market price; Saudi-Arabia will reduce its subsidy for wheat production from SR 2,000 per ton to SR 1,500 this year, which is about four times as much as the world market price. A high rate of subsidy is prevalent in GCC states also.

Subsidy in the agriculture-livestock sector has been granted in different forms on the capital investment, recurrent inputs and marketing cost.

Policy on subsidy needs a delicate handling, as it is a compromise between the long term and short term resource management goals. If we expect it to contribute the sector in establishing itself to be a competent producer, then it should at least demand an average agriculturist a slightly better and efficient farm management practice than the prevailing one.

7.2 Regional Policy of the Southern Region

There are a ministry and a committee at different levels of the administrational setup, which solely handle the affairs of the Southern Region.

The Ministry of State and Wali of Dhofar is established to see to it that the long term national policy is observed in the southern Region.

17.8 percent of the government capital formation was made during the first five-year development plan and 9.6 percent was made during the second. The third development plan envisages that ten percent will be allotted to the southern region.

A Ministerial Committee named "The Planning Committee for Development and Environment of Southern Region" (PCDESR) was established by the royal decree No. 48/84 (then amended by Decree 27/86). It consists of seven ministers, an under secretary and a representative from the council for conservation of environment and prevention of pollution, and is chaired by the minister of state and wali of Dhofar. It is responsible for co-ordination in all the aspects of development in the southern region and thus has been making a ceaseless effort to elaborate the optimum measures that bridge the gap between development and conservation of environment. The decree itself defined its terms of reference. They include the land use studies and the preparation of development plans.

At the moment, a regional development plan and a sub-regional land use plan are prepared by the committee.

In the agriculture-livestock sector, the urgent policies which have special relevancy to the affairs of Southern Region have been drawn within the frame work of the third five-year development plan.
They are as follows:

(1) Agricultural sub-sector:

a. Introduction of some judicial means to stop parcelling the small holdings by inheritance.
b. Improvement of farming method.
c. Inducing nomadic people to lead life of sedentary agriculturist.
d. Establishment of experimental agricultural farm in the Nejd.
e. Establishment of large scale (upto 1,000 hectares) agricultural farm in the Nejd.
f. Development of integrated crop and processing industries.

(2) Livestock sub-sector:

a. Subsidy for purchasing cattle feed and hybrid cattle.
b. Marketing of cattle.
c. Culling of overpopulated cattle.

Petroleum Development, Oman (PDO), being a major crude oil producer in the southern region, has a say in the future policy of the region.

The Dhofar Cattle Feed Company, the operation of which covers the fields of cattle management, hay and concentrated feed production, has been contributing for the implementation of regional agriculture-livestock policies such as cattle purchase scheme and satisfying the demand of hay and other feed from the pastoralists.

7.3 The Nejd Sub-Region and Its Potential Role in The Southern Region

This section deals with an observation and an argument for the necessity of forming an economic network within the southern region in order to get the most of its economic potential. The guidelines given in the chapter five are to be in the direction of consolidating the agricultural production basis in the Nejd, following the example of the PDO farm in Rahab.

7.3.1 Physical Limitation of Resources Utilization in the Nejd

Among the potential groundwater resources in the Nejd, the most suitable one for the irrigation purpose is available from the aquifer zone in the Lower Umm er-Rhaduma formation, which is found at about three hundred metres deep from the surface in the Hanfeet area, where we have proposed to set up an agricultural pilot farm. The aquifer is confined; water almost fossilized, yet there are some indications that it finds probable seepage at the low lying marsh, Umm AL-Samim, some 700 kilometres north-east down the groundwater basin.

The scale of groundwater basin and the degree of interference between the wells dictate us to determine the size of the farm and the density of its distribution. The indicative minimum figure so far is one 50 ha farm per 1,000 km^2 in the study area.

In the beginning, as the water has considerable artesian head, we shall be able to make use of a part of the groundwater cheap by means of artesian wells in certain parts of the Nejd. But by using it, the water table will go down accordingly, if the water is fossilized or the volume of re-charge is less than that of the draw down.

The lower the water level goes down, the higher the cost of pumping it becomes. Finally there shall be a point below which the cost reaches prohibitively expensive for the agricultural use. Water is not crude oil, so the point is far shallower than the case with crude oil. It is at the depth of somewhere around 100 meter at the present level of technology.

There is a 4.5 percent possibility of selecting a patch of land in the study area which covers 418 thousand hectares with the soil quality above the S2 class*, in which the soil is either highly (0.01%) or moderately suitable for agriculture use.

* according to the FAO classification method.

Meteorological data indicates that the area is of typical harsh desert environment: longer duration of strong sun shine associated with strong wind in a dry atmosphere with wide diurnal range in temperature and subsequently in relative humidity.

And the above mentioned physical constraints deem to narrow the range of choice of the plants which can be cultivated in commercial scale. Plants should have tolerance to the desert environment in general. They are to be of salinity-resistant, though leaching is an essential technique to minimize its damage; sturdiness is another quality if it is a tree. According to the report of PDO Farm, the pioneer agricultural farm in Nejd, the possible major crops in the Nejd fall into the plants mentioned below:

a. arbor crops: Besides traditional date palm orchard, some trees like prosopis, casuarina and tamarix for wind-breakers or shade providing hedges.

b. forage crops: Rhodes grass.

c. vegetable crops: creeping varieties of Cucubitaceae and Solanaceae, and Cruciferae.

The farm has started producing Rhodes grass in semi-commercial scale. It has at least a competitive edge over the northern producers in the market not only in the Nejd but also in the Salalah plain.

The production unit of the Nejd pilot farm will grow Rhodes grass in its first round of trial, as the grass has its market in the southern region itself at the moment. The date palm and some vegetables, of course, can find market easily in the southern region. (It may take some time for the agriculture in the Nejd to fit into the regional integration of agriculture-livestock sector.)

A relative isolation from the world with vegetation does not guarantee the pest free farm at all. Even a sward of seemingly pest-resistant Rhodes grass is intruded by some competing grass which growers are too happy to call weed; insect pests like grasshoppers, locusts, catapillars and shoot flies will soon come. Then rodents like mice and hare, and sedentary birds like sand partridges, wagtails and grouses, which attracts the predators like ladybirds and lacewings, then foxes, the birds of prey, thus completes the food chain. And you have occasional visits of some flocks of migratory birds like storks and cranes in winter.

As long as pumped groundwater physically and economically can maintain this micro-cosmos, the Nejd will remain as an agro-producer. It may sustain the livelihood of the people of the Bedu for many generations to come. At the site, the minimum prospect for future life of artesian well (upto the height of water table being 100 metres deep) is approximately 400 years for 500 ha of development area. For the extra needs of the resource beyond the Nejd, the groundwater is always kept on standby, as far as the surplus of the resource and the energy to draw it up are available.

7.3.2 Peculiarity of Agricultural Usage in the Nejd

The Nejd is a desert, and the life style of the Bedu, inhabitants of the Nejd is of nomadic tradition. So there have been few traces of sedentary agriculture there.

Eight years ago, you found nothing but a few date palm trees at Shasr, the well known oasis for centuries. With new road connection, the four wheel vehicles have replaced the camels. Then came a Baluchi who knew agriculture as well as animal husbandry. At present, with subsidies for rehabilitation of the water point and its channels, and input by the government, an area is developed in the four hectare date orchard with vegetable gardens. Further, an extension farm using the same well source and a farm irrigated by a newly dug shallow well are well under way.

Agricultural farm development at Hailat Al-Rakah is a fine example of entrepreneurship expressed by the Bedu people. Their interest, though, does not lie in cultivating the land, but in keeping or managing the farm land. They dug a shallow well at their own risk. Then along with material input, they bought technique, as they have no way of knowing it. When they keep camel, they need not buy technique, because they are in verse with it. Their life is used to revolve around the camel physically; it still does and will do, though it may become more symbolic.

Thus one of the peculiarity of the agriculture in the Nejd is that there had been no sedentary agriculture at all before the 80th; people, in private and public sectors, have just started grouping their way towards establishing agricultural methods suitable for the natural environment as well as the market situation.

The use of the water points as well as the grazing fields has been controlled by the traditional inter-tribal agreements within the Bedu. But the groundwater reserves have recently become a state property under the royal decree No. 82/88.

With it, the government is in a very favourable position to conceive a masterplan for the Nejd agricultural development, which complies with its long-term national policy goal. It would be able to provide the local people with the agricultural produces which will rely on the best water-use.

7.3.3 Possibility of New Intra-Regional Division of Production in Agriculture-Livestock Sector

In the past, when Dhofar was more isolated, engaging with long-distance trade of a seafaring tradition and the scale of economy was much smaller than now, and while among clans, between the old settlers and the new comers fought one another for the hegemony on the one hand, people living in the sub-regions, Jerbeeb, Jebals and Nejd of Dhofar, on the other hand, established a finely tuned exchange economy system among themselves, understanding well about the differences of environment around their settlements, production bases, and the ways of life. Internal trade relationship had grown to such an extent that the people of Jebals would buy dried sardines on credit from people in Jerbeeb during the pre-monsoon period and would repay it in kind, with ghee. It would take years to coax a vegetarian cattle and camel into nibbling a piece of it, to begin with, *then generations to breed a strain which takes a liking for it.*

Now, thanks to the more means of stable communications with the outer world than before, and to the luck they can enjoy from the relics of ancient organisms, people in the region, propagating, can afford to enjoy the material affluence. So the traditional economic equilibrium based on the principles of self-sufficiency within the region became out of date, and much of the system are disrupted.

When we are to prepare for the post-oil era, it is essential to evaluate the resource potentials, natural as well as human, (population growth and subsequent land-use change); to reallocate the use of resources to be optimum; to re-establish the networks of economy, production and trade, within the region.

At present, limited Jerbeeb is suffering by rapid urbanization, so balance of land-use demarcation among different economic sectors should be established. Steep Jebal is over-crowded by people, then subsequently by cattle, so outlets besides the Jerbeeb to be created for people of younger generation to work and cattle population shall be adjusted to the capacity of pasture. And the vast Nejd with the Bedu less itinerant than before and settling high above the fossilized inorganic liquid; hence they should be given some guide lines not to let them drown in a dream of the liquid.

(As to water resources, they are given the highest priority among the resources to be developed. And plans have been set up to make use of the semi-fossilized groundwater resources in the Nejd as a part of resource management policy for the Southern Region, it would be worthwhile, at the same time, to review the water-use in the Jerbeeb and to give precedence to the plans to increase the precipitation in the Jebal.)

When the value of the unit gross sale of Rhodes grass is almost as high as that of the most expensive rice in the world, it is only natural that people grow the grass in the Jerbeeb plain.

On the other hand, the Jerbeeb has been famous for its coconut, banana, and papaya. With its most favourable climatic condition in the coast of Arabian Peninsula, it has a big advantage over the neighbouring GCC countries as well as the northern region of Oman itself in production of certain types of fruits and vegetables as the high value added produces. Yet the region imports vegetables from Batinah and Dubai. Even fodder and dry sardines are imported from Batinah.

Only after the norms of communities of the Jeballis and the Bedu regarding the cattle can camel start changing, i.e. more esteem in quality of the cattle and camel than in quantity, new intra-regional division of production in agriculture-livestock sector would take shape in the region.

The Jerbeeb would have a scope of expanding its GCC market for already established agro-produces, and of stopping the inflow of some of other agro-produces by growing them. It could concentrate on planning marketing strategies for its most advantageous agro-produces. "Arabia Felix" might be a brand name for a new variety of banana with excellent taste and flavour produced here. The phrase has connotation of its heritage with frankincense production.

With change in demand, change in crop items would take place gradually, i.e. from forage crop, which covers about 44 percent of the total cultivated area of 3,000 hectares into orchard and vegetable cultivation, which covers about 32 percent and 13 percent respectively in 1987.

The Nejd may have an opportunity to make its debut as an agricultural exporter to the other sub-regions at this moment; in the initial stage of production, though, the produces, mostly Rhodes grass, would only have market in the Nejd itself, substituting the ones coming from outside the Nejd: it might also hold a favourable position in the Jerbeeb market against the one from the north. But it would require fairly hard efforts in reducing the cost to compete with the Jerbeeb producers in their own market of Jerbeeb and the Jebal. Until Long term confined groundwater use under certain conditions is scientifically proved, and method of efficient agriculture is established, agriculture in the Nejd will remain as a minor supplier to the local market.

The people of Jebal would have pedigree bulls and would transform themselves into excellent producers of healthy yearlings of cattle for the dairy and beef producers in the Jerbeeb, after the equilibrium of mountain meadow and number of breeding cattle is established ecologically.

For a Jeballi, to say a farewell to a departing cow which has been prinstakingly cared by his family members is a painful experience, and to reduce the number of cattle as a whole is surely a discouragement to the clans living there, but it would be far better than lamenting it too late that how green were their valleys.

The contemporary Jeballis have a responsibility to hand over the valleys and the hills, which they have inherited from their ancestors, to their offsprings without losing their value. The well maintained landscape itself is a resource. People will come to appreciate it.

The pre-desert, the zone between the Jebal and the Nejd, is the home of frankincense tree, Boswellia sacra and is grown wild. If a better management method is found to take care of the trees with the co-operation of two sub-regions, it may be worthwhile to impliment it. Sales may increase with the advancement of perestroika policy in the USSR, as the rites of the Orthodox church require it. It would not be irrelevant to mention here in passing that, if honey is made from pollen of these trees, it would create a unique brand. Apiary products in the Jebal itself have attracted a number of connoiseurs.

7.4 Significance of the Pilot Farm

Establishment of the pilot farm corresponds to the first step of the phase-wise development which is described in the guideline of Chapter 5.

Not all the benefits which would be derived from setting up the pilot farm is quantitatively enumerated, as its nature is of non-profit educational purpose.

On the possibility of running a commercial agricultural farm in the Nejd, the PDO farm in Rahab has shed light very much, and it has already set up a forage production unit of commercial scale.

The PDO recommends the step-wise approach to the expansion of the irrigated farm, mainly not on the basis of water resources, but from the point of view of the financial viability, as it is an initiative driven by the major oil producer of Oman to induce the private sector into the Nejd by establishing a secured environment for investment there.

As the dynamics of the groundwater could only be studied by using the water, the pilot farm shall be trying to find out the agronomically best way of using it. Once water resource is confirmed, the raison d'etre of the farm lies in cultivating the new minds among the people in the Nejd to be able to discover the desert once again from the standpoint of the settlers.

7.5 Appraisal of the Nejd Agriculture Development Plan

7.5.1 Introduction

This section deals with an appraisal of "a case study of agricultural development" as the second phase of the phased agricultural development prospect described in Chapter 6. At the initial stage of the study, the section was planned to be devoted to the analysis of the pilot farm, but in the light of the publication of draft final report of regional development plan for the southern region in March 1989 by the PCDESR, we think that it is more appropriate to expand our area of discussion towards the longer time span of the future prospect. The case study, by nature, only sketch a broad outline of the prospect, so does its appraisal, ie, more to be indicative than to be in detail.

Completion of the second phase of the Nejd agriculture development scheme, according to the case study, will see the two units of farms: The one would be adjacent to the pilot farm, and the other near Dauka where abandoned flowing well is located at the moment. Both units would consist of five fifty hectare sub-units. Groundwater would be collected from the appropriate numbers of wells duly kept away from one another. Each unit has its own settlement where some of the basic social needs like a school and a mosque are to be provided. (All the pros and cons of the concentrated and scattered farm are discussed in Chapter 5. Social values are beyond enumeration in terms of money.*)

* The cost of laying storage line with their maintenance roads for water of irrigation and drinking amounts to 64 percent of the total construction cost for water supply and road. (see Table A-7.5.5)

Presumptions for the financial appraisal is given in section 7.5.2. As it is quite obvious that the development itself is not really economically viable, economic appraisal is not carried out, nor the sensitivity analysis of the financial appraisal, as the latter relies on many indefinite factors. Financial appraisal of a case study of agriculture development and the subsidy policy to the development scheme which is described in chapter 6 are discussed in section 7.5.2. The social appraisal of the project is dealt in 7.5.3.

7.5.2 Financial Appraisal

(1) Financial Internal Rate of Return (FIRR)

1) Presumptions for appraisal

a) Project life

It is set to 30 years, as the useful life of the most of the assets are 30 yeras.

b) Price

Prices are as of Jan. 1989.

c) Farm Land

The value of the farm land is estimated as zero, since it is national property and has no value without irrigation facilities.

d) Crops

Rhodes grass is the most favourable crop at the moment. With water, it can even grow in the virgin soil of the Nejd. It is a seller's market in the southern region, because of a peculiar cattle raising practice which prevails there. Its price is exorbitant. Grasses are transported all the way from the north. The following table shows the unit income comparison between the Rhodes grass and wheat.

TABLE 7.5.1 Prices of Rhodes Grass and Wheat

	Unit price R.O./ton	Yield ton/ha	Unit income R.O./ha
Rhodes grass	100	40	4,000
Wheat	70	5	350

source: Draft Final Report of Regional Development Plan for the Southern Region (PCDESR)

Even if the government sets the domestic price of wheat at five times the international market price for import substitution, the unit income per hectare will be R.O.1750.* At present, if a private capital is invited to invest in the Nejd agriculture development scheme, every entrepreneur will no doubt grow the Rhodes grass.

* US$182/ton x 5ton/ha x R.O.384/US$ x 5 = R.O.1750
commodity price forecast by World Bank, January 1988

Price prospect of the Rhodes grass depends on usage of animal husbandry of the south and the livestock market situation in the Southern Region, where beef is mostly imported. According to the Draft Final Report of Regional Development Plan for the Southern Region, it is proposed that the government will restructure the livestock sector in the Southern Region. Yet it does not see any drastic decrease of fodder production for some time, and the Nejd will be allocated for fodder production, because if foresees Jerbeeb's change in land use pattern. So in this scenario, Rhodes grass shall be grown on the project area throughout the project life with sowing the seeds every five years.

e) Unit Price of Rhodes grass

Two unit prices of R.O.100/ton and R.O.70/ton are set for the Rhodes grass and the unit production rate is set at 40 tons.

In the report of Regional Development Plan for the Southern Region (March, 1989), R.O.100/ton is set as the model price of Rhodes grass, for the development plan in the Nejd. Besides, during our field survey until Feb. 1989 the market price of Rhodes grass had been R.O.100/ton. Hence the upper limit of Rhodes grass was set as R.O.100/ton.

However, the unit price of Rhodes grass is variable depending on monsoon, marketing demand, quality of Rhodes grass etc. And, it is impossible to estimate the future unit price of Rhodes grass at this stage. Hence financial appraisal was carried out considering the lower limit of Rhodes grass as R.O.70/ton.

Financial internal rate of return for the two unit prices of Rhodes grass of R.O.100/ton and R.O.70/ton is discussed below.

2) Financial Internal Rate of Return (FIRR):
(See TABLE A-7.5.3, A-7.5.6)

Financial internal rate of return (FIRR) of the project is estimated for the three cases of the governmental subsidy and for the two unit prices of Rhodes grass; R.O.100/ton, R.O.70/ton.

TABLE 7.5.2 FIRR for Different Cases of Government Subsidy

CASE	Governmental Subsidy	FIRR (%)	
		100 R.O./ton	70 R.O./ton
1.	Without any subsidy	+1.1	-6.7
2.	Construction of observation well, storage line and connecting road	+6.9	-5.8
3.	Construction of production well, observation well, storage line and connecting road	+11.6	-1.9

FIRR of the project for all the three cases of Governmental subsidy is positive for the unit price of Rhodes grass of R.O.100/ton but is negative for the unit price of R.O.70/ton.

Hence these results show that the project will be advantageous only if the unit price of Rhodes grass will be equal to or above R.O.100/ton. As has been discussed already, a high cost is necessary for the agriculture development project in the Nejd in order to install pipe line and roads. Hence a very high cost is indispensable for the project. Naturally, this high cost project will be economical only if the unit price of the Rhodes grass is equal to or above R.O.100/ton.

In the above three cases, the financial appraisal of the CASE 3 for the unit price of Rhodes grass of R.O.100/ton with FIRR as 11.6% is as follows:

The FIRR of the part of the project, i.e, cost of initial investment and running of the ten fifty-hectare farms against the benefit derived from the production of Rhodes grass on them, is estimated at 11.6 percent, and the Net Present value at 10 percent is estimated as R.O.478,050.

(2) Debt Service Schedule, Financial Statements and Government Expenditure

To foresee financial condition of 50-hectare size farm, financial statement is prepared under the conditions including governmental subsidy as follows:

1) Presumptions

a) Period of observation

It is set to twenty years, as the amortization period of the long term loan provided by the OBAF is twenty years.

b) Terms and Conditions of the Long Term Loan*

Term : 20 years

Grace period : 5 years

Interest rate: 0 percent

* Conditions set by the OBAF

c) Unit of Farm to be observed

An estimate is carried out for the fifty hectare sub-unit farm. It is easier to understand its financial account than that of the total farms. If one wants to know the total account of the whole project, multiply it by ten.

d) Amount of Investment

It is equivalent to the amount of loan, ie, the short term loan whose term is less than a year at the first year of the project is not counted, and is equal to the average of investment to ten sub-unit farms.

e) Water Cost (see Table A-7.5.5)

It is equivalent to an average annual depreciation and maintenance/operation cost of the production wells with their pumps.

f) Remuneration for growers

Average expected remuneration for growers (individual small farmers and big corporate entrepreneurs) is included in the account. The unit remuneration is set at R.0.720 per hectare per year.

g) The government expenditure (see Table A-7.5.5)

1. Interest

The government is supposed to bear the interest rate of 1.5% per annum for the long term loan to the project provided by the OBAF.

This interest rate is more or less equivalent to the international lending institutions' rate for long term loan to agricultural sector.

2. Monitoring Well with Observation Equipment
   It is supposed to bear the cost of installation of the facilities and its maintenance and operation. The latter cost may be borne by the PAWR, as the operation may appropriately fall within its jurisdiction.

3. Storage line with Maintenance Roads
   Construction costs and O/M cost are supposed to be borne by the government. The latter may be maintained by the MAF.

4. Connecting Roads
   Construction costs and O/M cost are supposed to be borne by the government. The latter may be borne by either the MOC or the Wali of Dhofar.

2) Debt Service Schedule and Financial Statements: (see Table A-7.5.4)

The financial statements tell us that, with generous doses of government subsidies, which is set to cover the interest cost of investment to the farm facilities, to bear the investment and operation/maintenance cost to the rest of the facilities except to installing the production wells with its pumps which is to be charged to the farm operators, the annual sale of Rhodes grass with the unit price of R.O.100/ton will not only cover the direct production cost including water cost, the O/M cost, depreciation cost and repayment of the long term loan but also be able to allow the farmers to retain the remuneration of R.O.720 per year per hectare. With the level of remuneration mentioned above, the periodical replacement cost of machinery can be paid without raising any extra short term loan.

7.5.3 Social Appraisal of the Project

(1) Social Aspect

People who live in the settlements around the project site is people of the Bait Kathiri.

They are experienced travelers. The leaders are used to innovation. Some of them operate transporting, the modern version of camel transport, trading, and contracting business in Salalah. They see the advent of agriculture in the area a chance of doing business. Some of them already started operating the agriculture farms at Hailat Al-Rakah. They irrigate it with water from shallow well and hire expatriate farm hands.

The first thing we should not do is to give them an illusion that available ground water is in abundance and eternal. It is quite natural that they are overjoyed at the sight of gushing water only to believe that it lasts beyond his lifespan. Prudence is a virtue of science.

Running an agricultural firm in a desert environment requires an all-round farmer, to begin with. He has to have a practical knowledge about plants, agronomy, soil, meteorology, machinery, accounting and what not. In an emergency, at the time of cyclon assault, or at the time of usual, yet un-expected machinery breakdown, he has to use his own judgement quick and right to sustain the plant life for some time till some helping hands come after some days from the town in the coastal plain.

It always involves of course a certain amount of difficulties to start agriculture where there has been little tradition in agriculture. In order to overcome it, the guidelines propose to run a pilot farm in the initial stage of the development scheme. Two years of practical training there will surely make trainees able farmers in the second stage, so they envisage.

The southern region is a rather isolated area. If the produces go beyond the regional boundary, instantly the huge amount of transport cost to cover at least the 1,000 km distance will be incurred. Only such produces as banana which have only the oversea competiters can manage to clear the barrier. If the South Yemen opens its market, market strategy will change dramatically along with the change in the types of agro-produces in the Southern Region.

However sparse they may be, people have been living in the frontier desert of the Nejd. It is important for the government to provide them with infrastructures not only for living but also for production and transport, because they give the local people self-esteem. But beyond the level of purely financial appraisal, ranking of the project in the priority schedule would be left contrusted to the perspective of the policy makers.

(2) Project Impacts

In addition to the project benefit that can be quantified and valued in monetary terms, every project entails cost and benefit that are intangible and do not lend themselves to valuation. Because these cost and benefit are a factor for project selection, it is important that these are identified. Probable impacts are as follows:

1) Agriculture development in the Nejd facilitate the development of southern region as a whole

Salalah plain is the central part of the southern region with a major farming area. In this plain, a little room is left for the additional large scale agriculture development, since there has been a rapid utilization of land and water resources caused by the rapid increase of population accompanying with the urbanization.

In this regard, the agriculture development in the Nejd which has a development potential, becomes important for the development of the southern region.

2) Development of basic industries creates new employment opportunities in the area

Agriculture development project creates new employment opportunities for the local people in the area. The new employment will be helpful for nomads to settle at one location.

3) Pilot farm project contributes for the development of human resources through its training and extension program.

The local people have no background of agriculture. The training activity at the Pilot Farm can develop their mind to improve the desert agriculture. This development will create a new valuable resource, "farmer", for the desert area.

4) The project will supply fodder grass for the livestock in the nearby Jabal

There is a high demand of grass for the cattle grazing in the Jabal area next to the Nejd. At present most of these demand is supplied from Salalah and North. Hence if Rhodes grass is cultivated in the Nejd, there will be a stable supply of grass to the Jabal.

5) The project will facilitate to improve the social infrastructure of the area

In the agriculture development project different infrastructure facilities like water supply, road, electricity etc. will be provided, and this will be helpful to improve the living conditions of the people of the Nejd.

ANNEX

Members of Advisory Committee

Name	Assignment	Remarks
Mr. MOMIKURA Yoshimasa	Chairman	Ministry of Agriculture, Forestry and Fisheries
Mr. SUGAWARA Toshio	Member (Geology/Groundwater)	Ministry of Agriculture, Forestry and Fisheries
Mr. TACHIBANA Takashi	Member (Irrigation/Drainage)	Ministry of Agriculture, Forestry and Fisheries
Mr. BAN Yoshiyuki	Member (Farming Program)	Ministry of Agriculture, Forestry and Fisheries

Members of the Study Team

Name	Assignment
Mr. TANAKA Makoto	Team Leader
Mr. SAKAMOTO Takao	Irrigation/Drainage Facility Plan
Mr. USHIKI Hisao	Hydrology/Meteorology Geology
Mr. MIYOSHI Fukujiro	Groundwater (Electrical prospecting)
Mr. OSHIKA Yuusuke	Groundwater (Boring)
Mr. SUZUKI Shinji	Agronomy
Mr. KUSAKA Hayata	Soil Survey
Mr. SUZUKI Seishiro	Survey/Facility/Cost-estimate
Mr. ONODA Fumiaki	Agro-economy/Project Evaluation

TECHNICAL PERMANENT COMMITTEE

Mr. Abdulla bin Hamdan Al Wahaibi
Chairman of Technical Permanent Committee
Director General of Irrigation Affairs, M.A.F.

H.H. Barghash bin Ghalib Al Said
Deputy Chairman of Technical Permanent Committee &
Director General of Water Resources Research, C.C.E.W.R.

Mr. Assad Alla bin Ahmed Taqi
Soil Scientist, Department of Agricultural Research

Dr. Muhammed Ramazan
Soil Expert, Department of Agricultural Research, Rumais, M.A.F.

Mr. Rifat Aboul Magd
Hydrologist, Irrigation Affairs, M.A.F.

Mr. Bernard Blasco
Hydrogeologist, Irrigation Affairs, M.A.F.

Mr. W. Donald Davison Jr.
Head of Special Studies, C.C.E.W.R.

Mr. G.C. Tibbits
Director of Regional Offices Department, C.C.E.W.R.

Mr. Nasir bin Mohmed Al Ghilani
Geologist, Water Resources Department, M.E.W.R.

Mr. Suleiman bin Shambaih Al Bulushi
Director of Gas Affairs, M.P.M.

Dr. Rowan Mactaggart
Technical Coordinator, P.C.D.E.S.R.

THE RECORD OF DISCUSSION
ON
THE PROPOSED PROJECT OF AGRICULTURE DEVELOPMENT
IN
NEJD AREA, SOUTERN REGION, SULTANATE OF OMAN

The Japanese Preliminary Survey Team (hereinafter referred to as "The Team")organized by Japan International Co-operation Agency (hereinafter referred to as "JICA") and headed by Mr. Kanezo TAKEUCHI, visited the Sultanate of Oman from 28 November to 9 December 1986 for the purpose of working out the scope of work for the proposed project of Agriculture Development in Nejd Area, Southern Region, Sultanate of Oman.

During its study in the Sultanate of Oman, the Team exchanged views and had a series of discussions with the representatives of the Ministry of Agriculture and Fisheries (hereinafter referred to as "MAF"), and other concerned Authorities of the Sultanate of Oman, such as the Council for Conservation of Environment and Water Resources(C.C.E.W.R.) and the Ministry of Environment and Water Resources (M.E.W.R.).

As a result of discussions, the Team and the MAF agreed on the scope of work attached hereto.

IBRAHIM BIN HAMAD BIN SULEIMAN AL-HARTHY
Under Secretary
Ministry of Agriculture and Fisheries

Kanezo TAKEUCHI
Leader,
Japanese Preliminary
Study Team,
The Japan International
Co-operation Agency

MINUTES OF THE MEETING
HELD WITH JICA TEAM CONCERNING THE PROPOSED PROJECT
OF AGRICULTURE DEVELOPMENT IN NEJD AREA, SOUTHERN REGION,
SULTANATE OF OMAN

In response to the request of the Government of the Sultanate of Oman, a Japanese Preliminary Survey Team organized by the Japan International Co-operation Agency, visited the Sultanate of Oman from 28 November 1986 to 9 December 1986 for the purpose of working out the scope of work for the Proposed Project of Agriculture Development in Nejd Area, Southern Region, Sultanate of Oman.

Several meetings were held between the Japanese Team and the Omani Team. The Japanese Team paid several visits to :

- The Technical Secretatiat of C.C.E.W.R.
- The Ministry of Petroleum and Minerals
- The Nejd Area, Southern Region

The meetings held in the Ministry of Agriculture and Fisheries were attended by :

From JICA :

1.	Mr. Kanezo TAKEUCHI	Head, Techn, Aff. Div, Agri. JICA	Leader/ Co-ordinator.
2.	Mr. kozo INADA	Staff Develop. Coop. Div. M.F.A.	Co-opr, Policy
3.	Dr. Toshio SUGAHARA	Hydrgeo.R.D.P.O. M.A.F.F.	Geology, Groundwater.
4.	Mr. Tomohiro NODA	D.D.Crop. Prod. M.A.F.F	Cul, Soil.
5.	mr. Katsuhiko SATO	Section Chief M.A.F.F.	Agr, Devel.

From M.A.F.

1.	Mr. Zakariya Bin Yahya Al Riyami	Act. Dir, W.R.D.	Leader
2.	Dr. Wafai T. Saleh	Legal Dept.	Co-ordinator
3.	Mr. Wazeir Hassan	Planning Unit	Agriculture Expert.
4.	Dr. Hassan Wahbi	D.G.Agri.	Irrigation expert.
5.	Dr. M. Ramdan	''	Soil expert
6.	Mr. Abdul Satar Kota	''	Agronomist
7.	Dr. Naim Abdel Rahman	D.G.W.R.I.	Irrigation expert
8.	Mr. Osman Mokhtar	''	Project Eng:
9.	Mr. Blasco	''	Hydrogeologist
10.	Mr. Rifat Abul Magd	''	Hydrologist

(Contd .. 2/-)

From the Ministry of Environment and Water Resources :

1. Ahmed Al Mostafa M.E.W.R. Hydrogeologist

As a result of discussions the participants concluded the following:-

1. The attached scope of work which can be summarized as follows :

   A. The objective of the project is to study the agriculture development in promissing areas of Dauka, Shisur, Wadi Makhavrim, Hanfit and Qitbeat.

   B. Propose plans for efficient utilization of soil and water for on farm water management.

   C. Formulation of a plan for a pilot farm, leading to adaptable farming system by appropriate utilization of groundwater.

2. MAF shall take all necessary steps to coordinate with appropriate ministries, bodies such as C.C.E.W.R. and M.E.W.R. for implementing the programme.

3. The Japanese and Omani delegations feel there is a great need for training of Omani counterparts during the course of the study.

   The Japanese Team will convey it to the concerned authorities in Japan.

Zakariya Bin Yahya Al Riyami
Acting Director,
Water Resources Department,
Leader of the Omani Team

K. Takeuchi

Kanezo TAKEUCHI
Leader of the Japanese
Preliminary Survey Team,
Japan International
Cooperation Agency

SCOPE OF WORK

FOR

THE STUDY

ON

THE AGRICULTURE DEVELOPMENT PROJECT

IN

THE NEJD REGION

THE SULTANATE OF OMAN

AGREED UPON

BETWEEN

JAPAN INTERNATIONAL COOPERATION AGENCY

AND

THE MINISTRY OF AGRICULTURE AND FISHERIES

Muscat, 8th December, 1986.

Zakariya Bin Yahya Al Riyami
Acting Director,
Water Resources Department,
Leader of the Omani Team

Kanezo TAKEUCHI
Leader of the Japanese
Preliminary Survey Team,
Japan International
Cooperation Agency

I INTRODUCTION

In response to the request of the Goverment of the Sultanate of Oman, the Goverment of Japan decided to conduct a study on the Agriculture Development Project in the Nejd Region (hereinafter referred to as "the study"), in accordance with the relevant laws and regulations in force in Japan.

Accordingly, Japan International Cooperation Agency, (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programmes of the Goverment of Japan, will undertake the study, in close cooperation with the authorities of the Sultanate of Oman.

The present document sets forth the scope of work for the study.

II. OBJECTIVE OF THE STUDY

The objective of the study are;

1 to study and evaluate groundwater, with a view to developing agriculture in the Nejd Region.

2 to formulate agriculture development plans.

III. OUTLINE OF THE STUDY

1. Study Area

The study covers the following five areas in Nejd Region: Wadi Mukhawrim, Dauka, shisur, Hanfit, Quitbeet.

2. Programmes of Implementation

The Study consists of two stages.

2-1 The Stage I: Survey on natural and socioeconomic conditions, and on groundwater for agriculture development

2-1-1 *The Phase I: Preliminary survey*

(1) to collect and review the relevant data and information in the Study area and its neighboring areas.

a) Topography

b) Meteorology and hydrology

c) Geology and Hydrogeology

d) Soil and land classification

e) Wells

f) Agriculture and Agroeconomy

g) Social Structure

h) Others

(2) Field investigation

(3) Setting-up of conditions for agriculture development

2-1-2 Phase II: Selection of one of the promising area in the study areas and survey for groundwater development therein.

(1) Selection of suitable test well drilling site

(2) Test well drilling survey

(3) Monitoring of groundwater (including existing wells)

(4) Hydrogeological analysis of survey results

2-2. Stage II: Formulation of agriculture development plans in the selected area

2-2-1 Phase I : Survey for formulating basic plans of agriculture development.

(1) Soil survey for irrigable area around the test well

(2) Study on the adaptable agriculture

(3) Formulation of basic plans of agriculture development

2-2-2 Phase II: To formulate a guideline for agriculture development.

(1) Formulation of a draft guideline for agriculture development

(2) Formulation of plans for a pilot farm, leading to adaptable farming system by appropriate utilization of ground-water .

IV. WORK SCHEDULE.

The tentative work schedule is shown in Annex 1.

V. REPORTS

JICA will prepare and submit the following reports in English to the Government of the Sultanate of Oman.

1. Stage I:

(1) Inception Report

Twenty (20) copies at the commencement of the field works in the Phase I.

(2) Progress Report

Twenty (20) copies at the end of the field works in the Phase I

2. Stage II

(1) Interim Report (I)

Twenty (20) copies at the commencement of the field works in the Phase I

(2) Interim Report (II)

Twenty (20) copies at the end of the field works in the Phase II

(3) Draft Final Report

Twenty (20) copies at the end of the Phase II.
The Government of the Sultanate of Oman provides JICA with its comments on the Draft Final Report through the Embassy of Japan within one (1) month after the receipt of the Draft Final Report.

(4) Final Report

Fifty (50) copies and twenty (20) copies of its summary within two (2) months after the receipt of the Government of the Sultanate of Oman's comments on the Draft Final Report.

VI. UNDERTAKING OF THE GOVERNMENT OF THE SULTANATE OF OMAN

1. To facilitate a smooth conduct of the Study, the Government of the Sultanate of Oman will take necessary measures:
   (1) to secure the safety of the Japanese study team,
   (2) to permit the members of the Japanese study team to enter, leave and sojourn in the Sultanate of Oman for the duration of their assignment therein, and exempt them from alien registration requirements and consular fees,
   (3) to exempt the members of the Japanese study team from taxes, duties, fees and any other charges on equipment, machinery and other materials brought into the Sultanate of Oman for the conduct of the Study,
   (4) to exempt the members of the Japanese study team from income tax and charges of any kind imposed on or in connection with any emoluments or allowances paid to the members of the Japanese study team for their services in connection with the implementation of the study,
   (5) to provide necessary facilities to the Japanese study team for the remittance as well as the utilization of funds introduced into the Sultanate of Oman from Japan in connection of the implementation of the Study,

(6) to secure permission for entry into private properties or restricted areas for the conduct of the study.

(7) to secure permission for the Japanese study team to take all data and documents including photographs related to the Study out of Oman to Japan.

2. The Government of the Sultanate of Oman shall bear claims, if any arises, against the members of the Japanese Study team resulting from, ocurring in the course of or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or wilful misconduct on the part of the members of the Japanese study team.

3. The Ministry of Agriculture and Fisheries (thereinafter referred to as "MAF") shall act as the counterpart agency to the Japanese Study team and also as the coordinating body in relation to other governmental and non-governmental organizations concerned for the smooth conduct of the Study.

4. MAF shall, at its expense, provide the Japanese study team with the following, in cooperation with other relevant organizations:

(1) Available data and information related to the Study,

(2) Additional survey related to the Study, when necessary, such as monitoring of groundwater after the test well drilling survey (including existing wells), and soil analysis,

(3) Counterpart personnel,

(4) Suitable office space with necessary office furniture in Muscat and Salalah,

(5) Two four wheel drive vehicles with drivers,

(6) Credentials or identification cards.

VII. UNDERTAKING OF JICA

For the implementation of the Study, JICA shall take the following measures:

1. to dispatch, at its own expense, the Study team to Oman,

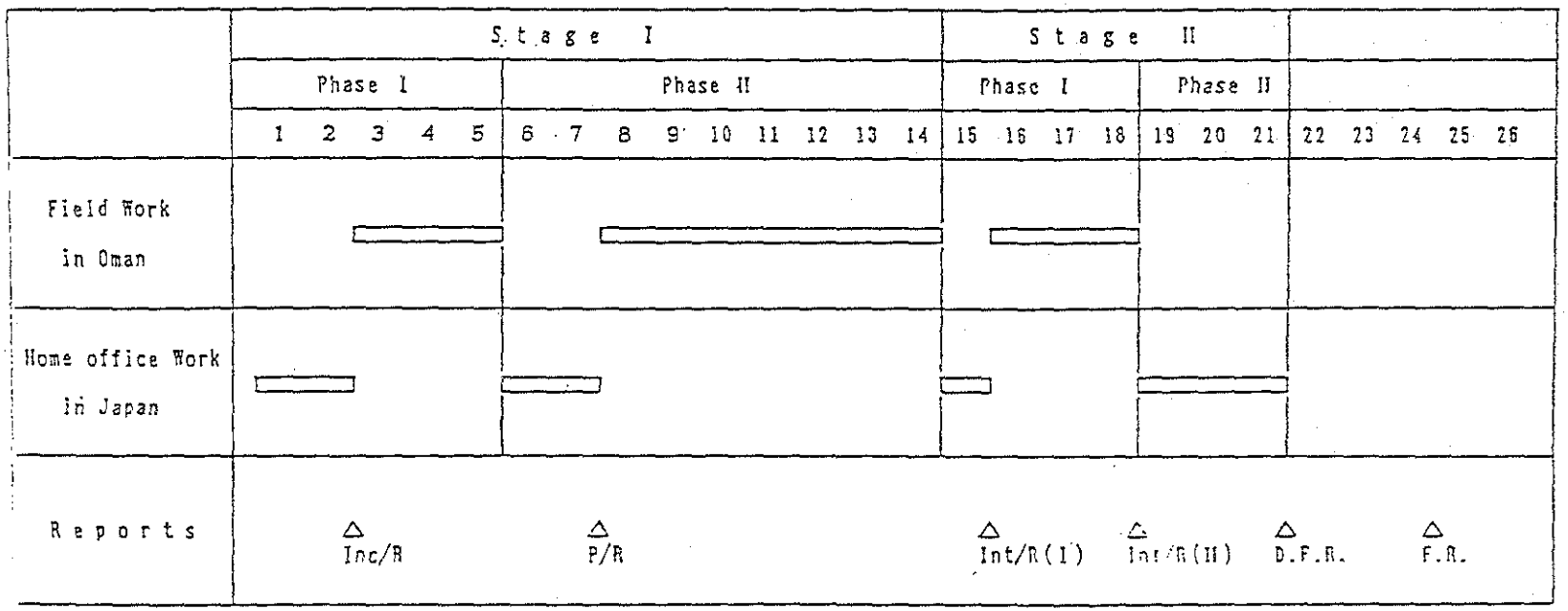
2. to pursue technology transfer to Omani counterparts in the course of the Study,

3. To carry out, at its own expense, the drilling of a test well and observation wells.

VIII. JICA and MAF shall consult with each other in respect of any matter that may arise from or in connection with the Study.

NNEX I

TENTATIVE WORK SCHEDULE



Inc/R : Inception Report
P/R : Progress Report
Int/R : Interim Report
D.F.R. : Draft Final Report
F.R. : Final Report