year can be estimated on the basis of the above-estimated potential number of livestock the target year and is depicted in Table 2.2.6 to 2.2.10.

In these tables, a self-sufficiency rate of 100 percent is feasible for chicken, eggs and fresh milk, and a 48 percent self-sufficiency rate for red meat is viable.

All the results of the computation mentioned above are integrated and shown in Table 2.2.11.

2.3 Trends and Prospects for Integrated Self-Sufficiency Rates of Edible Agricultural Products

In studying the trends and prospects for the self-sufficiency rates, as described before, attention must be paid to the population increase in the country projected at 3.5 percent per annum. This means that a higher growth rate is required every year for agricultural production in order to improve the self-sufficiency rate.

The present self-sufficiency rates for each major agricultural product have been discussed previously and are shown in Table 2.2.11.

Furthermore, the trend and prospects for the integrated self-sufficiency rates of edible agricultural products are shown in Table 2.3.1. This table represents and predicts the following rates:

- 43.6% in the base year, 1988,
- 44.0% as the average rate during the 7 years from 1982 to 1988,
- 50.4% in 1995, or the middle-year, and
- 54.7% in 2000, the target year.

The projected figures are analyzed on the basis of the definitions

Table 2.2.11 Prospects for Supply of Agricultural Products in Oman

NO.	ITEMS	IMPORT OR EXPORT(-) AMOUNT PROSPECTS (TON)			PRODUCTION AMOUT PROSPECTS (TON)			CULTIVATION AREA PROSPECTS (ha)		
		1988	1995	2000	1988	1995	2000	1988	1995	2000
1	CEREALS	191,021	263,435	312,757	744	1,020	1,320	468	500	550
	RICE	108,848	139,815	166,049	0	0	0	0	0	0
	WHEAT	94,425	123,621	146,708	744	1,020	1,320	468	500	550
	OTHERS	-12,252	0	0	0	0	0	0	0	0
2	VEGETABLES	75,690	89,835	108,762	133,909	172,950	204,005	7,585	7,384	7,488
	TOMATO	9,253	1,779	1,870	26,901	33,792	35,537	1,212	1,028	888
	ONION	7,864	9,561	12,520	7,700	9,561	12,520	560	587	696
	GARLIC	302	-0	0	1,200	1,581	1,725	150	136	123
	W.+S.MELON	2,667	3,664	4,455	32,000	42,130	51,228	1,875	1,965	2,049
	CABBAGE	3,442	4,250	5,038	17,900	24,083	28,551	770	795	816
	CUCUMBER	577	652	760	10,000	12,394	14,433	670	591	577
	OTHERS TOTAL	51,586	69,930	84,119	38,208	49,409	60,012	—	—	—
	OKRA	0	39	47	700	745	900	53	40	41
	EGGPLANT	2,096	566	683	8,000	10,748	12,981	420	401	406
	CARROTS	620	371	448	6,000	7,048	8,512	252	256	284
	RADISH	3,930	1,061	1,281	15,000	20,153	24,339	630	642	658
	SQUASH	786	212	256	3,000	4,031	4,868	189	189	195
	CAULIFLOWER	0	112	135	2,000	2,129	2,572	220	168	171
	OTHERS	44,154	67,569	81,268	3,508	4,555	5,840	584	584	584
3	TUBERS	11,116	0	-0	5,900	19,382	22,754	308	715	795
	POTATO	10,023	0	-0	3,500	13,702	15,610	140	489	520
	OTHERS	1,093	0	-0	2,400	5,679	7,144	168	226	275
4	BEANS,NUTS	2,279	1,285	1,526	0	0	0	0	0	0
	SOYBEAN	1,049	208	247	0	0	0	0	0	0
	GROUNDNUTS	30	16	19	0	0	0	0	0	0
	OTHERS	1,200	1,061	1,260	0	0	0	0	0	0
5	FRUITS	11,948	-3,540	-2,154	167,442	248,768	286,500	35,087	35,825	35,977
	DATES	-4,805	-11,899	-12,128	100,000	126,651	145,020	24,170	24,170	24,170
	LIME,LEMON	-17,841	-10,000	-10,000	26,000	27,907	31,268	2,400	1,716	1,690
	OTHER CITRUS	11,373	912	1,071	-	17,324	20,348	—	1,237	1,272
	BANANA	2,606	-1,500	-3,000	22,100	29,977	35,162	1,625	1,719	1,758
	COCONUTS	313	-7,483	-9,314	5,500	13,640	15,700	328	628	628
	GRAPE	4,766	339	398	200	6,433	7,556	100	370	398
	PAPAYA	-0	0	0	2,000	2,642	3,202	273	163	169
	OTHERS TOTAL	15,535	26,091	30,819	11,642	24,194	28,245	6,191	5,822	5,893
	MANGO	3,046	3,231	3,795	7,600	10,231	12,017	3,780	3,935	4,006
	OTHERS	12,489	22,861	27,025	4,042	13,964	16,228	2,411	1,887	1,887
6	SUGAR	38,322	40,439	48,026	0	0	0	—	—	—
7	OIL	20,541	32,340	42,406	0	0	0	—	—	—
8	SAUCE,SPICES	3,136	3,733	4,264	5,553	7,934	9,777	—	—	—
	CHILI PEPPER	294	418	515	5,553	7,934	9,777	610	601	611
	SPICE	1,861	1,651	1,773	0	0	0	—	—	—
	SAUCE	981	1,664	1,977	0	0	0	—	—	—
9	BEVERAGES	8,971	49,690	59,485	0	0	0	—	—	—
	COFFEE	3,925	5,102	6,690	0	0	0	—	—	—
	TEA,MATE	1,521	1,394	1,497	0	0	0	—	—	—
	COCOA	8	9	10	0	0	0	—	—	—
	OTHERS	3,518	43,184	51,287	0	0	0	—	—	—
10	OTHER FOODS	9,516	9,006	10,696	0	0	0	—	—	—
11	FISH	—	—	—	—	—	—	—	—	—
12	ANIMAL PRODUCTS	147,422	182,217	199,239	51,717	95,004	130,387	—	—	—
	MILK	90,166	139,838	167,849	41,638	44,562	51,151	—	—	—
	BUTTER	5,481	5,477	5,757	0	0	0	—	—	—
	CHEESE	2,152	2,821	3,350	0	0	0	—	—	—
	MUTTON	13,029	17,835	15,686	3,799	7,391	14,275	—	—	—
	BEEF	3,307	3,989	6,597	2,750	4,957	5,134	—	—	—
	CHICKEN	24,863	9,607	0	1,580	27,294	43,827	—	—	—
	EGG	8,424	2,650	0	1,950	10,800	16,000	—	—	—
13	TOBACCO	—	—	—	—	—	—	409	409	409
14	FEED CROPS	—	—	—	—	—	—	10,174	12,007	14,412
	TOTAL	—	—	—				54,641	57,441	60,241

explanatory notes:
1) * includes "leguminous vegetables"
2) # includes citrus other than lime and lemon

Source: Estimate by the JICA study team.

Table 2.2.11 (Continued)

NO.	ITEMS	SELF-SUFFICIENCY RATE PROSPECTS (%)			YIELDS PER HECTAR PROSPECTS (TON/ha)			DEMANDS FOR DOMESTIC CONSUMPTION (TON)		
		1988	1995	2000	1988	1995	2000	1988	1995	2000
1	CEREALS	—	—	—	—	—	—	191,765	264,455	314,077
	RICE	0.0	0.0	0.0	—	—	—	108,848	139,815	166,049
	WHEAT	0.8	0.8	0.9	1.5	2.0	2.4	95,169	124,641	148,028
	OTHERS	0.0	0.0	0.0	—	—	—	-12,252	0	0
2	VEGETABLES	—	—	—	—	—	—	209,599	262,785	312,767
	TOMATO	74.4	95.0	95.0	22.2	32.9	40.0	36,154	35,570	37,407
	ONION	49.5	50.0	50.0	13.7	16.3	18.0	15,564	19,122	25,040
	GARLIC	79.9	100.0	100.0	8.0	11.6	14.0	1,502	1,581	1,725
	W.+S.MELON	92.3	92.0	92.0	16.1	21.4	25.0	34,667	45,794	55,683
	CABBAGE	83.9	85.0	85.0	23.2	30.3	35.0	21,342	28,333	33,589
	CUCUMBER	94.5	95.0	95.0	14.9	21.0	25.0	10,577	13,047	15,192
	OTHERS TOTAL	—	—	—	—	—	—	89,794	119,338	144,131
	OKRA	100.0	95.0	95.0	13.2	18.5	22.0	700	784	947
	EGGPLANT	79.2	95.0	95.0	19.0	26.8	32.0	10,096	11,314	13,664
	CARROTS	90.6	95.0	95.0	23.8	27.5	30.0	6,620	7,419	8,960
	RADISH	79.2	95.0	95.0	23.0	31.4	37.0	18,930	21,213	25,620
	SQUASH	79.2	95.0	95.0	15.8	21.3	25.0	3,786	4,243	5,124
	CAULIFLOWER	100.0	95.0	95.0	9.1	12.6	15.0	2,000	2,241	2,707
	OTHERS	7.4	6.3	6.7	—	—	—	47,662	72,124	87,108
3	TUBERS	—	—	—	—	—	—	17,016	19,382	22,754
	POTATO	25.9	100.0	100.0	25.0	28.0	30.0	13,523	13,702	15,610
	OTHERS	68.7	100.0	100.0	—	—	—	3,493	5,679	7,144
4	BEANS,NUTS	0	0	0	—	—	—	2,279	1,285	1,526
	SOYBEAN	0	0	0	—	—	—	1,049	208	247
	GROUNDNUTS	0	0	0	—	—	—	30	16	19
	OTHERS	0	0	0	—	—	—	1,200	1,061	1,260
5	FRUITS	—	—	—	—	—	—	179,390	245,227	284,346
	DATES	105.0	110.4	109.1	4.1	5.2	6.0	95,195	114,751	132,892
	LIME,LEMON	318.7	155.8	147.0	12.9	16.3	18.5	8,159	17,907	21,268
	OTHER CITRUS	0.0	95.0	95.0	11.0	14.0	16.0	11,373	18,235	21,419
	BANANA	89.5	105.3	109.3	13.6	17.4	20.0	24,706	28,477	32,162
	COCONUTS	94.6	221.5	245.8	16.8	21.7	25.0	5,813	6,157	6,386
	GRAPE	4.0	95.0	95.0	15.0	17.4	19.0	4,966	6,771	7,953
	PAPAYA	100.0	100.0	100.0	12.0	16.2	19.0	2,000	2,642	3,202
	OTHERS TOTAL	—	—	—	—	—	—	27,177	50,286	59,064
	MANGO	71.4	76.0	76.0	2.0	2.6	3.0	10,646	13,461	15,811
	OTHERS	24.5	37.9	37.5	—	—	—	16,531	36,824	43,253
6	SUGAR	0.0	0.0	0.0	—	—	—	38,322	40,439	48,026
7	OIL	0.0	0.0	0.0	—	—	—	20,541	32,340	42,406
8	SAUCE,SPICES	—	—	—	—	—	—	8,689	11,667	14,041
	CHILLI PEPPER	95.0	95.0	95.0	9.0	13.2	16.0	5,847	8,352	10,292
	SPICE	0.0	0.0	0.0	—	—	—	1,861	1,651	1,773
	SAUCE	0.0	0.0	0.0	—	—	—	981	1,664	1,977
9	BEVERAGES	0.0	0.0	0.0	—	—	—	8,971	49,690	59,485
	COFFEE	0.0	0.0	0.0	—	—	—	3,925	5,102	6,690
	TEA,MATE	0.0	0.0	0.0	—	—	—	1,521	1,394	1,497
	COCOA	0.0	0.0	0.0	—	—	—	8	9	10
	OTHERS	0.0	0.0	0.0	—	—	—	3,518	43,184	51,287
10	OTHER FOODS	0.0	0.0	0.0	—	—	—	9,516	9,006	10,696
11	FISH	—	—	—	—	—	—	82,770	127,905	151,905
12	ANIMAL PRODUCTS	—	—	—	—	—	—	199,139	277,221	329,626
	MILK	31.6	24.2	23.4	—	—	—	131,804	184,400	219,000
	BUTTER	0.0	0.0	0.0	—	—	—	5,481	5,477	5,757
	CHEESE	0.0	0.0	0.0	—	—	—	2,152	2,821	3,350
	MUTTON	22.6	29.3	47.6	—	—	—	16,828	25,226	29,961
	BEEF	45.4	55.4	43.8	—	—	—	6,057	8,946	11,731
	CHICKEN	6.0	74.0	100.0	—	—	—	26,443	36,901	43,827
	EGG	18.8	80.3	100.0	—	—	—	10,374	13,450	16,000
13	TOBACCO	—	—	—	—	—	—	—	—	—
14	FEED CROPS	—	—	—	—	—	—	—	—	—
	TOTAL									

Table 2.3.1 Trends and Prospects for Integrated Self-Sufficiency Rates of Edible Agricultural Products of OMAN

(1,000 R.O., %)

ITEM \ YEAR	1982	1983	1984	1985	1986	1987	1988	1995	2000
import value (1)	101,978	109,834	123,863	126,674	131,579	128,513	148,472	138,542	154,560
export value (2)	6,254	8,115	9,574	11,453	11,026	12,882	15,963	4,347	4,896
net import value (3)=(1)-(2)	95,724	101,719	114,289	115,221	120,553	115,631	132,509	134,195	149,664
crop products value (4)	30,428	32,436	34,444	37,307	39,779	42,536	46,155	67,209	78,253
animal products value (5)	41,707	47,410	52,186	54,167	56,411	55,566	56,321	69,075	102,532
total products value (6)=(4)+(5)	72,135	79,846	86,630	91,474	96,190	98,102	102,476	136,284	180,785
self-sufficiency rate (%) (7)=(6)*100/((3)+(6))	43.0	44.0	43.1	44.3	44.4	45.9	43.6	50.4	54.7

explanatory notes:

1) Methods of estimating the figures of this table are explained in section 2.4.(5).
2) Figures of (1) and (2) from 1982 - 1988 are derived from the Foreign Trade Statistics (1986 and 1988, Royal Oman Police). Edible agricultural products were selected and the values of those were summed up by the JICA team. The values of non-edible plant and animal products were excluded from these figures.
3) Figures of (4) and (5) from 1982 - 1988 were estimated by the JICA team, from Table 2.1.4.
4) Figures of prospects for 1995 and 2000 were estimated by the JICA team, from Table 2.1.7.

and assumptions described in the following Addendum.

2.4 Basis of the Definitions and Assumptions for "Prospects for Demand and Production for Agricultural Products"

(1) Calculation of the annual per capita supply of each product and future demands.

(a) The following data were employed for the calculation:

(i) Domestic production data prepared by MAF

(ii) Foreign trade statistics, 1986 and 1988 issued by the Royal Oman Police

(b) The quantity supplied for domestic consumption was calculated using the following formula:

Supplies for domestic consumption =

Domestic production + imports - exports

The change in stock usually considered in such a calculation is disregarded due to it being relatively small and the difficulty in estimating it for each product.

(c) Since the quantity supplied for domestic consumption includes various wastage during transportation from production sites to consumers, these wastages were excluded from the estimated gross food quantity according to the following procedures:

(i) Present wastage

Wastage for locally produced vegetables and fruits was estimated according to the assumption made by Kirloskar Consultants (Jan., 1989).

Wastage for locally produced agricultural products, other than vegetables and fruit, as well as for imported agricultural products, were estimated using the recent ratios of wastage employed in the Japanese "Food Balance Sheet."

(ii) Future

To reduce such losses in the future, structural improvement of the distribution system is required. The recent ratio of wastage in the Japanese "Food Balance Sheet" was adopted in order to estimate future losses in the target year. The estimate of losses in 1995, the middle year, is based on the assumption that the improvements may be made at a 60% progress rate until the target year.

(d) Since the gross food value includes residue wasted in the normal diet, residue quantities were estimated and excluded from the gross food value in order to obtain the net quantity of food consumed by the people. We used the net ratio proposed in the Japanese "Food Balance Sheet."

(2) Unit Agricultural Yield Employed in the Estimate of Future Production

The present unit yield employed in the estimate was obtained from the Department of Agriculture and Statistics (MAF). Unit yields for each product proposed in volume 3, section 4.2 under future technological improvement were employed for the unit yield in the target year. The unit yield in 1995 was estimated by averaging the present yield value and that in the target year.

(3) Calculation of per capita calorie, protein and fat supply

The amount of protein and fat contents in 100 grams of each food was determined by referring to the "Food Composition Tables for the Near East" by the FAO and the "Japanese Standard Component Table of Food , 4th Edition" by the Science and Technology Agency, Japan. The daily per capita supply of calories, protein and fat was obtained by multiplying

identical contents by the daily per capita net food supply.

(4) The PFC balance in Oman and major countries

The PFC balance, or the proportion of calories supplied by protein, fat and carbohydrates, was estimated on the basis of the respective calories of protein and fat obtained by multiplying daily per capita supplies of protein and fat by the Atwater energy conversion factor.

(5) Calculation of self-sufficiency rate of agricultural products

(a) Self-sufficiency rate for major agricultural products

The self-sufficiency rate for each product was estimated by the following formula:

$$\frac{\text{Domestic production volume}}{\text{Volume supplied for domestic consumption}} \times 100$$

(i) The change in stock, usually considered in the estimate, was disregarded due to it being relatively small and the difficulty in estimating it for each product. The following was thus obtained:

Volume supplied for domestic consumption =
Domestic production volume
+ import volume
- export volume

(ii) Both domestic production volume and volume supplied for domestic consumption include wastage during distribution. However, the equation above was used in order to reflect the present situation in production and distribution in the country, as well as to compare the present situation with future improved production and distribution structures.

(b) Integrated self-sufficiency rate of edible agricultural products

The self-sufficiency rate of edible agricultural products, excluding seafood was estimated by the following formula:

$$\frac{\text{Value of domestic agricultural products}}{\text{Value of edible agricultural products supplied for domestic consumption}} \times 100$$

The following concepts were adopted to estimate the rate:

(i) Since the production value of livestock products includes the value allocated to feed, it was excluded from both the domestic production value and the value allocated to domestic consumption.

(ii) The change in stock, usually considered in the estimate of the amount allocated to domestic consumption, was disregarded due to it being relatively small and the difficulty in estimating it for each product. The following was thus obtained:

Value supplied for domestic consumption =

Domestic production value
+ import value
- export value

(iii) Both the domestic production amount and the amount allocated to domestic consumption include losses suffered during distribution. However, the above was used in order to reflect the present situation of production and distribution in the country, as well as to compare the present situation with the future improved production and distribution structures.

(iv) The future price of agricultural products was projected as follows:

a) Agricultural products excluding livestock products

i) *Domestic agricultural products*

The farmgate price in 1989, submitted by the Department of Agricultural Statistics (MAF), was adopted.

ii) Imported agricultural products

The price of domestic products was used to price imported agricultural products. In contrast, the average unit price of each imported agricultural product in 1988, which was calculated from the Foreign Trade Statistics, 1988, issued by the Royal Oman Police, was applied to the following:

- the domestic products for which a unit price could not be obtained from MAF

- wheat because the price of imported wheat differs significantly from the price of locally produced wheat.

b) Livestock products

Based on several reports regarding animal product prices, the unit prices of livestock products were assumed.

The average unit prices of butter and cheese were estimated on the basis of the Foreign Trade Statistics, 1988, issued by the Royal Oman Police because all of them are imported.

(6) Cross-check of utilized data

When the JICA team estimated these prospects for demand and production of agricultural products, it compared and cross-checked the data of cropping area from the Department of Agricultural Statistics, which form the basis of the estimation, with the data obtained through LANDSAT image analysis. The LANDSAT data utilized in analysis were selected from MSS data obtained when cloud-cover was less than 30%. The images are composed of 12 scenes as shown in Table 2.4.1. The locations

Table 2.4.1 LANDSAT Data Analysis

Timing	Former Term		Latter Term	
Path/Row*	Date y./m./d.	Sensor**	Date y./m./d.	Sensor**
159/043	1984/01/09	MSS	1986/01/06	MSS
159/044	1984/01/09	MSS	1986/01/22	MSS
158/044	1985/01/28	MSS	1987/01/18	TM
157/044	1985/02/06	MSS	1987/01/27	TM
159/048	1984/01/09	MSS	1986/02/07	MSS
160/048	1984/05/15	MSS	1986/01/13	MSS

Explanatory notes:
1) * indicates the "path" and "row" number of the Landsat data
2) **MSS means "Multi Spectrum Scanner"
TM means "Thematic Mapper"

Table 2.4.2 Vegetation Area Computed from LANDSAT Data

	Former Term			Latter Term		
	Area (ha)			Area (ha)		
Path/Row*	Total	Dense	Coarse	Total	Dense	Coarse
159/043	14,852	5,690	9,162	16,973	6,655	10,318
159/044	2,749	1,719	1,030	4,796	2,451	2,345
158/044	36,624	14,736	21,888	43,453	19,393	24,060
157/044	2,139	1,400	739	2,753	1,728	1,025
159/048and 160/048	2,346	595	1,751	2,943	1,220	1,723
Total	58,710	24,140	34,570	70,918	31,447	39,471

Explanatory note:
* indicates the "path" and "row" number of the Landsat data

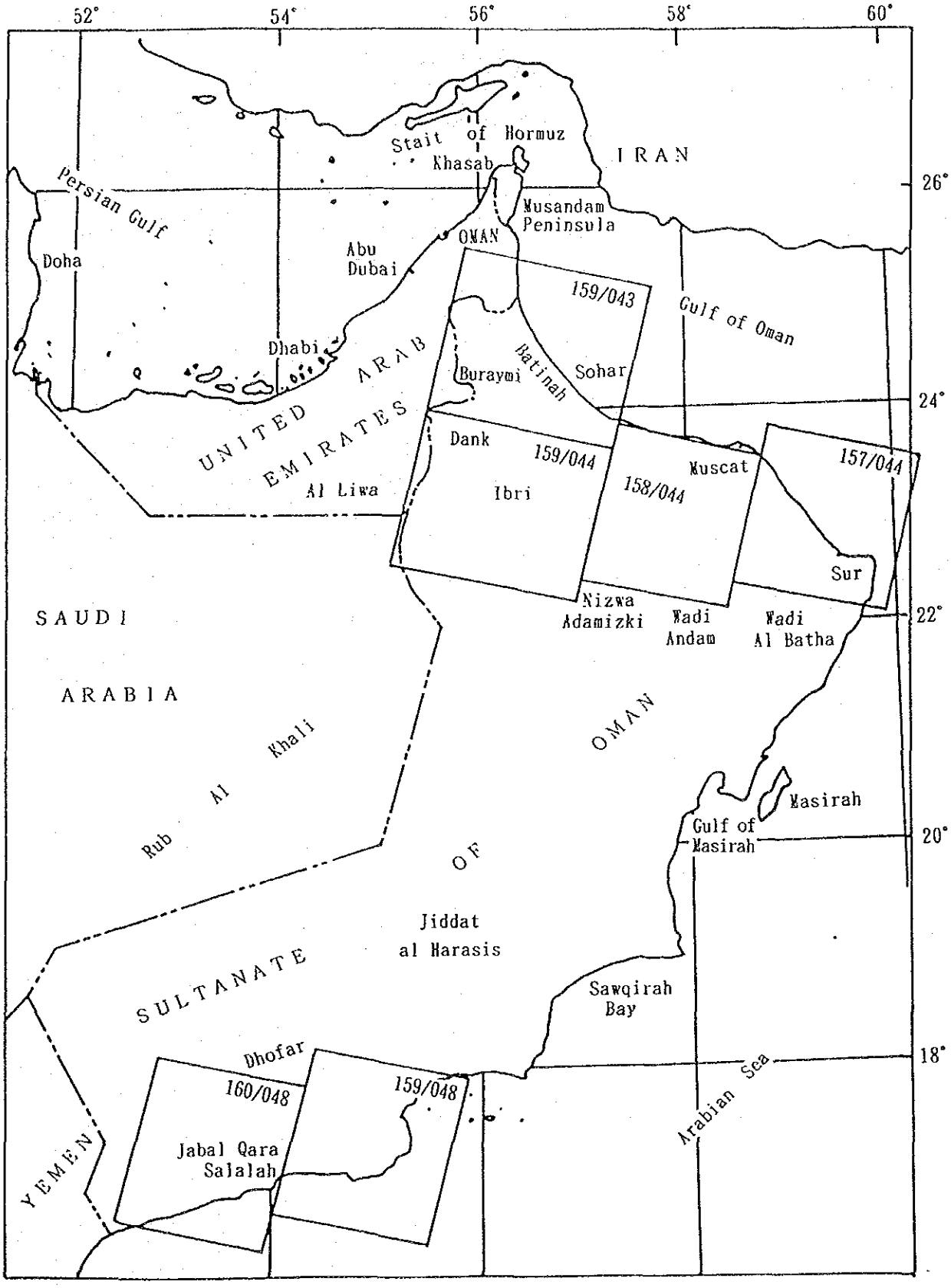


Figure 2.4.1 Location of LANDSAT Image

of analysis, depicted in Figure 2.4.1, were selected to include all the principal agricultural production areas, north and south. It should be noted that the team could not use the data obtained on the same date due to the limits of shooting periods and the degree of cloudiness.

In the image analysis, the vegetation in the scenes was scrutinized and classified as either "dense" and "sparse" and then the area covered with vegetation was computed. Table 2.4.2 shows the results of the analysis.

Generally, the dense part was classified as the area where date palms, feed crops and other fruit trees cover the ground surface densely, though there were some cases classified as sparse because these plants were in the initial stages of breeding, or planted at wide intervals, even if the crop is normally classified as dense. Similarly, vegetables which were generally classified as sparse were sometimes mixed with bushes growing naturally along the coast. Consequently, it was difficult to classify and quantify the vegetation area precisely due to the limits of the image-unit's precision scale, covering 80m x 80m, if LANDSAT MSS data were utilized.

The analysis mentioned above clarified the following observations:

(1) The cropping area in 1984/85 data was within the range of 58,710 ha and 24,140 ha.

(2) The cropping area in 1986/87 data was within the range of 70,918 ha and 31,447 ha.

(3) The increasing trend of cropping area can be seen between 1984/85 and 1986/87 data.

CHAPTER 3

DESCRIPTION OF PROJECT/PROGRAM IN 10-YEAR MASTER PLAN FOR AGRICULTURAL DEVELOPMENT

CHAPTER 3 DESCRIPTION OF PROJECT/PROGRAM IN 10-YEAR MASTER PLAN FOR AGRICULTURAL DEVELOPMENT

3.1 Irrigation and Dam

[NW-1] Improvement of Irrigation System and Centrally-Controlled Water-Distribution System

Objective:

The aims and goals of the project are to identify and promote irrigation technologies and water-saving rules in order to achieve water conservation, eliminate water wastage, and to optimize the agricultural revenue from each cubic meter of irrigation water.

Description:

(1) Present State of Irrigation

Thousands of aflaj and wells were dug or drilled in the past and are pumped for irrigation. Even if the drilling of new wells is restricted, the access to groundwater is not controlled as farmers pump freely from existing wells and the discharges are only limited by the aquifer characteristics.

Consequently, in many places water extraction is today higher than the renewable water resources. Groundwater levels in the aquifers are being lowered. This leads to the drying up of wells and aflaj in the Interior Region during the dry years and to sea-and deep-salt groundwater encroachment in the coastal areas and salinization of soils and pumped water.

(2) The Present Actions of MAF in the Improvement of the Mobilization and Use of Water Resources

MAF has embarked on an ambitious program of construction of recharge dams which aims to recover for agriculture the volumes of water which

were previously lost to the desert or the sea during floods. This is an important first step in water-resource mobilization.

The next step is to optimize the revenue to be expected from the use of groundwater, which is a national wealth. This can be done by:

- *proposing cropping patterns and irrigation practices which are* well-adapted to the soil and water quality, and

- controlling both the farmers' pumping rates and the water allocation to the farms.

In order to determine the parameters of this optimization, MAF has a pilot project study underway in Southern Batinah. The Barka-Rumais area was selected for this study due to the heavy pumpings there which are causing a rapid deterioration of the agricultural soils and groundwater quality. The pilot project will:

- identify the present agricultural conditions and drawbacks,

- analyze the soil and water conditions,

- design new irrigation systems,

- prepare agricultural policy rules.

This will be done in close cooperation between the MAF/FAO team, the selected consultant, and MWR.

(3) The 10-year Agricultural Master Plan - 22 Project Areas

MAF has identified 22 areas in the Sultanate where new systems of controlled irrigation are to be studied and implemented.

The projects are based on the principle that the present free access to water resources should be modified in such a way that the delivery of water to the farms is scientifically determined by a central

organization on the basis of maximum revenue and water-resource conservation both at the farm and national level.

The 22 selected areas are mainly located in areas using traditional irrigation systems. The aims, goals and means of the project are the following:

- to evaluate the potential interest among farmers and land owners and their ability to manage modern farms;

- to have in each agricultural zone in the country a sizable, modern, irrigated perimeter to demonstrate the interest and the benefit to be expected from modern technologies;

- to experiment with various irrigation systems corresponding to cropping patterns well-adapted to the soils and water quantities and qualities;

- to promote crops with the highest market potentials;

- consequently to design the irrigation systems including well fields, conveyance systems and farm distribution networks with reference to the existing land ownership; and

- to propose project-management procedures including crop pattern, water allocation and eventually, if so decided, metering and billing of the consumed water.

For each of the 22 projects, the water-resource conservation and the revenue of the farmers will be analyzed and optimized considering the possibility of application of the procedures to irrigated land in other places.

It is worth mentioning that even if the 22 projects are located mainly in pumped-well-irrigated areas, the aflaj-irrigated palm groves will also be considered in order to propose new systems of water allocation adapted to modern irrigation to optimize the use of water during the

dry and wet years without any losses to the present owners of water rights.

The project sites to be expected in each region under this Master Plan are as follows.

Batinah ; Eight projects. One project in eight Wilayats. Total 4,000 ha.

Sharqiya ; Four projects in areas like Al-Kamil, Al-Wasil, Al-Ghabbi and Wadi Al Batha. Total 350 ha.

Dakhliya ; Five projects in areas like Tanuf, Firq, Wadi Qurayat and Manah. Total 950 ha.

Dhahira ; Four projects in areas like Al Buraimi, Suwaidai Al Maa, Dubaishy and Buzayli. Total 700 ha.

Al Janubiya ; One project in the Salalah Plain. 500 ha.

(4) Cost-Sharing Method of the Program

The construction cost of the project is thoroughly financed by MAF under this Plan. Detailed cost-sharing methods for operation and maintenance and percentages of the cost to be shared between the consumer (through water billing) and the Ministry should be considered in a study under the next 5-year plan, paying attention to farmers' income in the project area. The water-billing system will require institutional and legislative establishment. This should be considered in connection with the formulation of appropriate organizations which will decide irrigation rotation in accordance with the cropping patterns to be introduced, operate the irrigation system, provide necessary maintenance, and finally collect water charges from farmers. Some scenarios regarding the establishment of the organizations to be considered in the study are as follows.

(i) Officers of MAF fully control the irrigation system.

(ii) Private companies assume responsibility.
(iii)A farmers' organization is in charge.
(iv) Combination of the above.

Each case has advantages and disadvantages. In case(i) an agricultural policy and water-use policy of MAF will be easily directed at farmers. Experienced irrigation engineers and technicians will be able to control the irrigation network well. 75 irrigation engineers and technicians will be required for operation and maintenance. In addition, 44 accountants and officers (2 persons/project) will be necessary to introduce the water-billing system. These costs must be financed by MAF or by the farmers.

In case(ii), it might be a solution to encourage the participation of private sectors in the agricultural sector. However the total cost of case(ii) may be higher than that of case(i) because they must earn profits.

The success of case(iii) is dependent on the quality of farmers. Their agricultural management is generally poor at present. However, this method will nurture their self-reliance and turn their attention to agricultural management. Furthermore, this is the least expensive option.

An example of case(iv) is a combination of case(i) and case(iii). The government officers will control the whole system at the initial stage and transfer their roles to the farmers' organization in due course. Taking into account the present situation of Omani agriculture the most realistic approach is case(iv).

Timing :

Timing of these projects is shown in Table 3.1.1.

Table 3.1.1 Schedule of Improvement of Irrigation System and Centrally-Controlled Water-Distribution System Project

NO	PROJECT	REGION	QTY. (ha)	SCHEDULE 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
1	Saham	Batinah	500	---------- **********
2	Sohar	Batinah	500	---------- **********
3	Shinas	Batinah	500	---------- **********
4	Al-Khabourah	Batinah	500	---------- **********
5	A' Suweiq	Batinah	500	---------- **********
6	Al-Ma' awil	Batinah	500	---------- **********
7	Al-Masna' ah	Batinah	500	---------- **********
8	Barka	Batinah	500	---------- **********
9	Al-Kamil(1)	Sharqiya	100	---------- **********
10	Al-Kamil(2)	Sharqiya	50	******
11	Al-Wasil & Al Ghabbi	Sharqiya	100	---------- **********
12	Al Batha	Sharqiya	100	---------- **********
13	Tanuf	Dakhliya	100	---------- **********
14	Firq	Dakhliya	200	---------- **********
15	Mannah(1)	Dakhliya	100	---------- **********
16	Mannah(2)	Dakhliya	50	---------- ******
17	Wadi-Qurayat	Dakhliya	500	---------- **********
18	Al Buraimi	Dhahira	300	---------- **********
19	Al Maa	Dhahira	100	---------- **********
20	Dubaishy	Dhahira	200	---------- **********
21	Buzayli	Dhahira	100	---------- **********
22	Salalah	Janubiya	500	---------- **********

Note; '------ Study, ****** Construction

Budget :

The total budget of the projects is R.O. 60,990,000. The annual budget of each project is shown in Table 3.1.2.

Table 3.1.2 Annual Budget of Improvement of Irrigation System and Centrally-Controlled Water-Distribution System Project

Study Phase (1000 RO)

NO	PROJECT	REGION	TOTAL BUDGET	ANNUAL BUDGET										1991 - 1995	1996 - 2000
				1991	1992	1993	1994	1995	1996	1997	1998	1999	2000		
1	Saham	Batinah	120	60	60									120	
2	Sohar	Batinah	120		60	60								120	
3	Shinas	Batinah	120			60	60							120	
4	Al-Khabourah	Batinah	120			60	60							120	
5	A'Suweiq	Batinah	120				60	60						120	
6	Al-Ma'awil	Batinah	120	60	60									120	
7	Al-Masna'ah	Batinah	120				60	60						120	
8	Barka	Batinah	120	60	60									120	
9	Al-Kamil(1)	Sharqiya	120						60	60					120
10	Al-Kamil(2)	Sharqiya													
11	Al-Wasil & Al Ghabbi	Sharqiya	120	60	60									120	
12	Al Batha	Sharqiya	120			60	60							120	
13	Tanuf	Dakhliya	120	60	60									120	
14	Firq	Dakhliya	120		60	60								120	
15	Mannah(1)	Dakhliya	120					60	60					60	60
16	Mannah(2)	Dakhliya	120							60	60				120
17	Wadi-Qurayat	Dakhliya	120						60	60					120
18	Al Buraimi	Dhahira	120					60	60					60	60
19	Al Maa	Dhahira	120	60	60									120	
20	Dubaishy	Dhahira	120		60	60								120	
21	Buzayli	Dhahira	20	20										20	
22	Salalah	Janubiya	120	60	60									120	
Total			2,420	440	600	360	300	240	240	180	60			1,940	480

Construction Phase

NO	PROJECT	REGION	TOTAL BUDGET	ANNUAL BUDGET										1991 - 1995	1996 - 2000
				1991	1992	1993	1994	1995	1996	1997	1998	1999	2000		
1	Saham	Batinah	4,500				1,500	1,500	1,500					3,000	1,500
2	Sohar	Batinah	4,500					1,500	1,500	1,500				1,500	3,000
3	Shinas	Batinah	4,500						1,500	1,500	1,500				4,500
4	Al-Khabourah	Batinah	4,500						1,500	1,500	1,500				4,500
5	A'Suweiq	Batinah	4,500						1,500	1,500	1,500				4,500
6	Al-Ma'awil	Batinah	4,500			1,500	1,500	1,500						4,500	
7	Al-Masna'ah	Batinah	4,500							1,500	1,500	1,500			4,500
8	Barka	Batinah	4,500			1,500	1,500	1,500						4,500	
9	Al-Kamil(1)	Sharqiya	900									450	450		900
10	Al-Kamil(2)	Sharqiya	300	300										300	
11	Al-Wasil & Al Ghabbi	Sharqiya	900			450	450							900	
12	Al Batha	Sharqiya	600					300	300					300	300
13	Tanuf	Dakhliya	900				450	450						900	
14	Firq	Dakhliya	1,800				900	900						1,800	
15	Mannah(1)	Dakhliya	900									450	450		900
16	Mannah(2)	Dakhliya	600									600			600
17	Wadi-Qurayat	Dakhliya	4,500								1,500	1,500	1,500		4,500
18	Al Buraimi	Dhahira	2,700								900	900	900		2,700
19	Al Maa	Dhahira	900				450	450						900	
20	Dubaishy	Dhahira	1,800						900	900					1,800
21	Buzayli	Dhahira	1,270		500	500	270							1,270	
22	Salalah	Janubiya	4,500			1,500	1,500	1,500						4,500	
Total			58,570	300	500	5,450	8,520	9,600	8,700	8,400	8,400	5,400	3,300	24,370	34,200

Grand Total (Study + Construction)	60,990	740	1,100	5,810	8,820	9,840	8,940	8,580	8,460	5,400	3,300	26,310	34,680

[NW-2] Subsidy for New Irrigation System Project for 30,000 ha

Objective:

The objective of the project is to improve the general state of the agricultural production infrastructure in Oman and to increase agricultural investment efficiency in the future by encouraging farmers to introduce new irrigation methods.

Description:

The project is a subsidy program for capital expenditure incurred by farmers when they introduce new methods such as sprinkler, bubbler and drip irrigation.

The prevailing irrigation method in Oman is flood irrigation. Only small areas have introduced water-saving irrigation methods, performance of which is as high as 20 to 40 percent more than the flood-irrigation method. However, it takes a long time for farmers to accustom themselves to such new facilities and for them to realize the water-saving effects, even though such effects will have the largest impact on farming.

Therefore it is important to provide farmers with incentives for the promotion of new irrigation schemes in the form of subsidies.

In connection with this project, extension officers will give intensive guidance to farmers in close co-operation with researchers. Also, some kind of input subsidy should be given to selected farmers participating in this project to encourage them to practice highly productive farming with integrated modern techniques.

With respect to aflaj, it may be difficult to introduce these new facilities unless the existing water-distribution system is improved. Accordingly, the introduction of new irrigation facilities is proposed for areas where the major water sources are wells, such as the Batinah coast, the Salalah Plain and some areas in other regions.

The target area to be developed in such a manner over 10 years is 30,000 ha.

Responsibility:

Either a coordination committee formed from the D.G. of Agricultural Research, the D.G. of Irrigation and Dam and the D.G. of Agriculture and Livestock, or a new entity set up specifically to execute the project should be established in order to achieve smooth implementation and follow-up. The new irrigation section would be established in the D.G of Agriculture and Livestock for execution and supervision of this project. The staff requirement is shown in Table 3.1.3.

Source of Finance:

A portion of the modern irrigation facilities cost -- an average of 50% -- will be subsidized by the government and the remaining investment cost would be financed by OBAF. Self-financing by farmers and/or finance from commercial banks are possible for the remaining investment cost.

Subsidy Ratio:

The subsidy ratio of the project is the same as the present subsidy ratio applied to the modern irrigation project in Batinah, which is financed by H.M. Sultan Qaboos. It is as follows;

Class	Size of farm (acre)	Ratio %
1	5 - 10	75
2	10 - 50	50
3	50 - 100	30

In addition to the above, the following subsidy conditions should be

established.

(i) Farmers to receive subsidy must install a flow meter.

(ii) Farmers must report monthly water consumption, with kinds of crops and cultivation area to an agricultural extension center or extension officer.

Timing:

The project will be implemented throughout the 10-year period of the Master Plan.

Budget:

The total budget of the project is R.O. 37,500,000. Staff requirements and capital expenditure needed for the establishment of the Irrigation Systems Section, which are recurrent budget, are shown in Table 3.1.3.

Table 3.1.3 Staff Requirements and Capital Expenditure for Establishment of the Irrigation Section

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1. STAFF			
(1)DIRECTOR OF THE SECTION	1 NOS.	5,832	5,832
(2)IRRIGATION ENGINEER	2 NOS.	7,284	14,568
	3 NOS.	6,552	19,656
(3)SURVEY ENGINEER	1 NOS.	6,552	6,552
(4)IRRIGATION SYSTEM MAINTENANCE TECHNICIAN	2 NOS.	2,820	5,640
(5)OTHER SUPPORTING STAFF	1 NOS.	3,360	3,360
TOTAL	10 NOS.		55,608
2. CAPITAL EXPENDITURE	1 SET	40,000	40,000
GRAND TOTAL			95,608

[NW-3] Legal Framework for Agricultural Water Use

Objective:

The objective of the study is to establish an appropriate nationwide legal framework for agricultural water use which will be imposed on farmers. Optimizing agricultural water use is an important factor determining agricultural production and securing socio-economic, environmental profitability to be returned to the people.

Description:

Agriculture consumes more than 90% of total water requirements in Oman. Legislation of laws and/or regulations which restrict the agricultural water use would be unavoidable in the preparation of a legal framework by the government in order to conserve scarce water resources. The National Water Resources Master Plan is being undertaken by MWR, of which one main objective is to formulate such a legal framework. MAF is conducting a study entitled "New Organization of Irrigation in View of the Conservation of Water Resources and Optimization of Their Use in Barka-Rumais." Some sort of measures to control use of water in the area through laws, regulations etc. will be considered in the study.

MAF is in the best position to instruct farmers on effective agricultural water use. MAF extension officers are fully in charge of providing farmers with necessary and appropriate advice regarding agricultural techniques such as water management, cultivation methods, etc. It is essential for these officers to confirm actual water consumption, water quality, soil condition and kinds of crops cultivated in each farm in order to recommend to farmers the proper agricultural farming techniques.

To maintain consistency with the legal framework to be formulated by MWR, and taking into consideration results of the study by MAF, the action program to be taken by MAF will be worked out under this study. The following items are to be given careful attention.

(i) Establishment of institutional and organizational responsibilities for collection of data regarding agricultural water consumption on farms in each region under MAF, and the processing of this data with other relevant agricultural farming data for feedback to the farmers.

(ii) Determination of water requirements of major crops based on research. The D.G. of Agricultural Research will be in charge of this important research subject.

(iii)Assessment of irrigation efficiency based on results of (i) and (ii).

(iv) Establishment of necessary legal framework in cooperation with MWR.

Timing:

1991-1992	;	The study on formulation of an overall action program.
1995	;	Review of the action program.
1999-2000	;	Review of the program.

Budget:

1992-1993	;	R.O. 90,000
1995	;	R.O. 80,000
1999-2000	;	R.O. 80,000
Total		R.O. 250,000

[NW-4] Recharge Dams

Objective:

The objective of the projects is to increase agricultural production and stabilize farmers' income by improving the agricultural production infrastructure by constructing recharge dams on the main wadis to retain flood flows that would otherwise be lost to the sea or the desert.

Description:

A recharge dam is a retention dam to retain flood flows and recharge the stored waters to the aquifers via the wadi channels. MAF had already completed 6 recharge dams as of 1989 and records of observations of wells established around the constructed recharge dams have been kept continuously. The recharge dams program consists of four projects as follows.

(i) NW-4-1 Groundwater-Recharge Scheme
(ii) NW-4-2 Maintenance and Improvement of Existing and Newly Constructed Dams
(iii) NW-4-3 Study on a Recharged Water Effective Use Pilot Project
(iv) NW-4-4 Identification of New Groundwater Recharge Schemes

The Groundwater-Recharge Scheme comprises the study and construction of recharge dams. As preparatory work, 53 recharge dam projects have been selected on the basis of results of preliminary and feasibility studies conducted by MAF. Taking into account economic factors such as internal rate of return and water cost of these projects, and a well balanced regional allocation of the projects, 42 promising recharge dam projects have been further selected from the above for the 10-year Master Plan as shown in Table 3.1.4. (Recharge dams selected in alternatives 1 and 2 are tabulated in Table 3.1.5 -3.1.6). Total construction cost of such projects is estimated to be R.O. 65,200 thousand. The F/S and D/D studies for implementation of those projects will cost R.O. 6,520 thousand.

The operation and maintenance cost of existing recharge dams and newly constructed dams will be included in the program of the Maintenance and Improvement of Existing and Newly Constructed Dams. The cost is estimated at R.O. 25,000/dam/year shown in Table 3.1.10.

Irrigation projects which utilize the recharged water must be implemented in parallel with the construction of recharge dams in order to improve investment efficiency. The objective of the study on the Effective Use of Recharged Water is to work out an appropriate irrigation plan, paying strict attention to water balance in and around the project area. This project will be in the form of a case study, to evaluate the effectiveness of the selected recharge dams as well. The data accumulated by observing and monitoring wells around the recharge dams will be useful for this study.

The reconnaissance studies conducted by MAF on the identification of recharge dam sites have not covered the entire country. The necessary reconnaissance investigations for new schemes will be conducted in the first 5-year period and the F/S and D/D studies on those schemes will be carried out in the second 5-year period.

Timing:

The implementation schedule of the Groundwater-Recharge Scheme is shown in Table 3.1.7.(The implementation schedule of the recharge dam projects selected in alternatives 1 and 2 is tabulated in Table 3.1.8 - 3.1.9). The Maintenance and Improvement of Existing and Newly Constructed Dams program, the study on a Recharged Water Effective Use Pilot Project and the Identification of New Groundwater-Recharge Schemes will be implemented throughout the period of the 10-year Master Plan.

Budget:

Total budget of the projects is as follows.

	NAME OF PROJECT	COST(R.O.)
NW-4-1	Groundwater-Recharge Scheme	71,720,000
	Study Phase	6,520,000
	Construction Phase	65,200,000
NW-4-2	Maintenance and Improvement of Existing and Newly Constructed Dams	8,413,000
NW-4-3	Recharged Water Effective Use Pilot Project	500,000
NW-4-4	Identification of New Groundwater-Recharge Schemes	6,000,000
	Total	86,633,000

Table 3.1.4 42 Recharge Dam Projects for the 10-Year Master Plan

No.	Scheme Name	Wadi	Region	Budget (R.O.)	Addit. Water (MCM)	New Land (ha)	Total Benefit (R.O.)	Water Cost (R.O./cu.m)	I R R (%)	Remarks
1	Bu Baqarah	Al Qawr	Batinah	1,000,000	1.00	36.84	196,000	0.690	24.40	
2	Shinas	Hatta	Batinah	3,300,000	4.00	147.37	728,000	0.548	28.25	F/S is on-going
3	Shinas	Fayd	Batinah		0.30	11.05	54,600	3.007	2.51	
4	Husayfin	Zabin	Batinah	1,500,000	1.90	70.00	345,800	0.783	20.11	
5	Al Asra	Fizh	Batinah	1,500,000	1.50	55.26	294,000	0.967	17.55	
6	Saham-Sohar	Ahin	Batinah	2,800,000	5.00	184.21	910,000	0.270	52.53	F/S is on-going
7	Saham-Sohar	Sakhin	Batinah	2,000,000	0.50	18.42	91,000	2.964	2.64	F/S is on-going. Project site will be changed.
8	Saham-Sohar	Sarami	Batinah	1,900,000	1.30	47.89	236,600	0.841	18.75	F/S is on-going
9	Saham-Sohar	Shafan	Batinah	1,300,000	1.10	40.53	200,200	1.135	13.70	F/S is on-going
10	Al Khaburah	Bani Umar	Batinah	1,200,000	1.60	58.95	291,200	0.585	26.57	F/S is on-going
11	Al Khaburah	Hawasinah	Batinah	1,600,000	1.20	44.21	218,400	0.872	23.33	F/S is on-going
12	Al Khaburah	Halhal	Batinah	1,700,000	0.50	18.42	91,000	2.584	3.93	F/S is on-going
13	Al Khaburah	Mabrah	Batinah	1,500,000	0.30	11.05	54,600	5.437	-2.55	F/S is on-going. Project site will be changed.
14	Al Bu Rashid	Hajir	Batinah	1,800,000	1.80	66.32	352,800	0.973	17.44	
15	As Suwayq	Bani Ghafir	Batinah	3,000,000	3.80	140.00	691,600	0.632	24.70	
16	Al Musana'a	Far	Batinah	2,000,000	4.00	147.37	728,000	0.520	29.64	
17	Rustaq	Far	Batinah	1,300,000	2.13	56.05	244,950	0.329	29.81	D/D is on-going
18	Barka-Rumais	Bani Kharus	Batinah	3,100,000	1.20	75.45	337,480	2.679	8.04	F/S is completed
19	Barka-Rumais	Rukkhah	Batinah	3,300,000	1.40	88.02	391,810	1.289	18.83	F/S is completed
20	Barka-Rumais	Tawu	Batinah		0.50	31.44	153,537	2.422	10.55	F/S is completed
21	Yanqul	Dank	Dhahirah	600,000	0.59	21.74	49,994	0.541	11.06	P/S is completed
22	Arid	Al Arid	Dhahirah	400,000	0.36	13.26	30,505	0.540	10.23	P/S is completed
23	Dariz	Kabir	Dhahirah	1,200,000	1.07	39.42	90,663	0.650	8.31	P/S is completed
24	Maqabil	Hijir	Dhahirah	1,000,000	0.56	20.63	47,452	0.590	9.99	
25	Maqabil	Hijir	Dhahirah		0.62	22.84	52,537	0.923	5.48	
26	N-W Interior	One main wadi	Dhahirah	1,000,000						P/S will be done
27	Buraimi	One main wadi	Dhahirah	2,000,000						P/S is on-going
28	Jabal Akhdar	6 main wadis	Dakhliya	1,800,000						F/S is on-going
29	Jabal Akhdar	64 sites	Dakhliya	3,200,000						F/S,D/D is on-going
30	Jabrin	Bahla	Dakhliya	1,000,000	0.82	21.87	50,430	0.891	1.59	
31	Al Ghafat	Seyfam	Dakhliya	700,000	0.63	16.80	38,745	0.942	1.99	P/S is completed
32	Birkat Al Mawz	Muaydin	Dakhliya	2,000,000	0.86	22.93	52,890	1.054	1.48	
33	Izki	Halfayn	Dakhliya	1,500,000	0.38	10.13	23,370	1.071	0.58	P/S is completed
34	Suq Qadim	Halfayn	Dakhliya		0.88	23.47	54,120	0.997	1.59	P/S is completed
35	Sudayrah	Samad	Sharqiya	2,000,000	1.47	56.38	94,262	1.327	0.48	P/S is completed
36	Al Ghulaji	Al Batha	Sharqiya	2,000,000	2.73	104.70	175,057	0.641	7.54	
37	Az Zahir	Al Batha	Sharqiya	1,000,000	2.00	76.70	128,247	0.475	11.23	
38	Masirah	One main wadi	Sharqiya	1,000,000						R/S is on-going
39	Quryat	Mijlas	Muscat	1,000,000	1.50	55.26	273,000	0.369	40.21	
40	Dayqa	Dayqa	Muscat	3,000,000						
41	Darbat	Darbat	Al Janubiya	1,000,000						R/S is on-going
42	Musandam	One wadi	Musandam	2,000,000						P/S is on-going
Total				65,200,000						

Note: JICA team estimated budget, based on the results of preliminary and feasibility studies conducted by the government. Water cost and IRR include both values adopted from government sources, and values calculated by the JICA team on the basis of its own survey.

Table 3.1.5 Recharge Dam Projects for the 10-Year Master Plan
(Alternative 1)

No.	Scheme Name	Wadi	Region	Budget (R.O.)	Addit. Water (MCM)	New Land (ha)	Total Benefit (R.O.)	Water Cost (R.O./cu.m)	I R R (%)	Remarks
1	Bu Baqarah	Al Qawr	Batinah	1,000,000	1.00	36.84	196,000	0.690	24.40	
2	Shinas	Hatta	Batinah	3,300,000	4.00	147.37	728,000	0.548	28.25	F/S is on-going
3	Shinas	Fayd	Batinah		0.30	11.05	54,600	3.007	2.51	
4	Saham-Sohar	Ahin	Batinah	2,800,000	5.00	184.21	910,000	0.270	52.53	F/S is on-going
5	Saham-Sohar	Sakhin	Batinah	2,000,000	0.50	18.42	91,000	2.964	2.64	F/S is on-going. Project site will be changed.
6	Saham-Sohar	Sarami	Batinah	1,900,000	1.30	47.89	236,600	0.841	18.75	F/S is on-going
7	Saham-Sohar	Shafan	Batinah	1,300,000	1.10	40.53	200,200	1.135	13.70	F/S is on-going
8	Al Khaburah	Bani Umar	Batinah	1,200,000	1.60	58.95	291,200	0.585	26.57	F/S is on-going
9	Al Khaburah	Hawasinah	Batinah	1,600,000	1.20	44.21	218,400	0.672	23.33	F/S is on-going
10	Al Khaburah	Halhal	Batinah	1,700,000	0.50	18.42	91,000	2.584	3.93	F/S is on-going
11	Al Khaburah	Mabrah	Batinah	1,500,000	0.30	11.05	54,600	5.437	-2.55	F/S is on-going. Project site will be changed.
12	As Suwayq	Bani Ghafir	Batinah	3,000,000	3.80	140.00	691,600	0.632	24.70	
13	Al Musana'a	Far	Batinah	2,000,000	4.00	147.37	728,000	0.520	29.64	
14	Rustaq	Far	Batinah	1,300,000	2.13	56.05	244,950	0.329	29.61	D/D is on-going
15	Barka-Rumais	Bani Kharus	Batinah	3,100,000	1.20	75.45	337,480	2.679	8.04	F/S is completed
16	Barka-Rumais	Rubkhah	Batinah	3,300,000	1.40	88.02	391,810	1.289	18.83	F/S is completed
17	Barka-Rumais	Taww	Batinah		0.50	31.44	153,537	2.422	10.55	F/S is completed
18	Yanqul	Dank	Dhahirah	600,000	0.59	21.74	49,994	0.541	11.06	P/S is completed
19	Arid	Al Arid	Dhahirah	400,000	0.36	13.26	30,505	0.540	10.23	P/S is completed
20	Dariz	Kabir	Dhahirah	1,200,000	1.07	39.42	90,668	0.650	8.31	P/S is completed
21	Maqabil	Hijir	Dhahirah	1,000,000	0.56	20.63	47,452	0.590	9.99	
22	Maqabil	Hijir	Dhahirah		0.62	22.84	52,537	0.923	5.48	
23	Buraimi	One main wadi	Dhahirah	2,000,000						P/S is on-going
24	Jabal Akhdar	6 main wadis	Dakhliya	1,800,000						F/S is on-going
25	Jabal Akhdar	64 sites	Dakhliya	3,200,000						F/S.D/D is on-going
26	Jabrin	Bahla	Dakhliya	1,000,000	0.82	21.87	50,430	0.891	1.59	
27	Al Ghafat	Sayfam	Dakhliya	700,000	0.63	16.80	38,745	0.942	1.99	P/S is completed
28	Birkat Al Mawz	Muaydin	Dakhliya	2,000,000	0.86	22.93	52,890	1.094	1.48	
29	Izki	Halfayn	Dakhliya	1,500,000	0.38	10.13	23,370	1.071	0.58	P/S is completed
30	Suq Qadim	Halfayn	Dakhliya		0.88	23.47	54,120	0.997	1.59	P/S is completed
31	Sudayrah	Samad	Sharqiya	2,000,000	1.47	56.38	94,262	1.327	0.48	P/S is completed
32	Al Ghulaji	Al Batha	Sharqiya	2,000,000	2.73	104.70	175,057	0.641	7.54	
33	Az Zahir	Al Batha	Sharqiya	1,000,000	2.00	76.78	128,247	0.475	11.23	
34	Masirah	One main wadi	Sharqiya	1,000,000						R/S is on-going
35	Quryat	Mijles	Muscat	1,000,000	1.50	55.26	273,000	0.369	40.21	
36	Dayqa	Dayqa	Muscat	3,000,000						
37	Darbat	Darbat	Al Janubiya	1,000,000						R/S is on-going
38	Musandam	One wadi	Musandam	2,000,000						P/S is on-going
Total				59,400,000						

Note: JICA team estimated budget, based on the results of preliminary and feasibility studies conducted by the government. Water cost and IRR include both values adopted from government sources, and values calculated by the JICA team on the basis of its own survey.

Table 3.1.6 Recharge Dam Projects for the 10-Year Master Plan
(Alternative 2)

No.	Scheme Name	Wadi	Region	Budget (R.O.)	Addit. Water (MCM)	New Land (ha)	Total Benefit (R.O.)	Water Cost (R.O./cu.m)	I R R (%)	Remarks
1	Bu Baqarah	Al Qawr	Batinah	1,000,000	1.00	36.84	196,000	0.690	24.40	
2	Shinas	Hatta	Batinah	3,300,000	4.00	147.37	728,000	0.548	28.25	F/S is on-going
3	Shinas	Fayd	Batinah		0.30	11.05	54,600	3.007	2.51	
4	Saham-Sohar	Ahin	Batinah	2,800,000	5.00	184.21	910,000	0.270	52.53	F/S is on-going
5	Saham-Sohar	Sakhin	Batinah	2,000,000	0.50	18.42	91,000	2.964	2.64	F/S is on-going. Project site will be changed.
6	Saham-Sohar	Serami	Batinah	1,900,000	1.30	47.89	236,600	0.841	18.75	F/S is on-going
7	Saham-Sohar	Shefan	Batinah	1,300,000	1.10	40.53	200,200	1.135	13.70	F/S is on-going
8	Al Khaburah	Bani Umar	Batinah	1,200,000	1.60	58.95	291,200	0.585	26.57	F/S is on-going
9	Al Khaburah	Hawasinah	Batinah	1,600,000	1.20	44.21	218,400	0.672	23.33	F/S is on-going
10	Al Khaburah	Halhal	Batinah	1,700,000	0.50	18.42	91,000	2.584	3.93	F/S is on-going
11	Al Khaburah	Mabrah	Batinah	1,500,000	0.30	11.05	54,600	5.437	-2.55	F/S is on-going. Project site will be changed.
12	Al Bu Rashid	Hajir	Batinah	1,800,000	1.80	66.32	352,800	0.973	17.44	
13	As Suwayq	Bani Ghafir	Batinah	3,000,000	3.80	140.00	691,600	0.632	24.70	
14	Al Musana'a	Far	Batinah	2,000,000	4.00	147.37	728,000	0.520	29.64	
15	Rustaq	Far	Batinah	1,300,000	2.13	56.05	244,950	0.329	29.61	D/D is on-going
16	Barka-Rumais	Bani Kharus	Batinah	3,100,000	1.20	75.45	337,480	2.679	8.04	F/S is completed
17	Barka-Rumais	Rukhkhah	Batinah	3,300,000	1.40	88.02	391,810	1.289	18.83	F/S is completed
18	Barka-Rumais	Tawy	Batinah		0.50	31.44	163,537	2.422	10.55	F/S is completed
19	Yanqul	Dank	Dhahirah	600,000	0.59	21.74	49,994	0.541	11.06	F/S is completed
20	Arid	Al Arid	Dhahirah	400,000	0.36	13.26	30,505	0.540	10.23	F/S is completed
21	Deriz	Kabir	Dhahirah	1,200,000	1.07	39.42	90,668	0.650	8.31	F/S is completed
22	Maqabil	Hijir	Dhahirah	1,000,000	0.56	20.63	47,452	0.590	9.99	
23	Maqabil	Hijir	Dhahirah		0.62	22.84	52,537	0.923	5.48	
24	Buraimi	One main wadi	Dhahirah	2,000,000						F/S is on-going
25	Jabal Akhdar	6 main wadis	Dakhliya	1,800,000						F/S is on-going
26	Jabal Akhdar	64 sites	Dakhliya	3,200,000						F/S,D/D is on-going
27	Jabrin	Bahla	Dakhliya	1,000,000	0.82	21.87	50,430	0.891	1.59	
28	Al Ghafat	Sayfam	Dakhliya	700,000	0.63	16.80	38,745	0.942	1.99	F/S is completed
29	Birkat Al Mawz	Muaydin	Dakhliya	2,000,000	0.86	22.93	52,890	1.094	1.48	
30	Izki	Halfayn	Dakhliya	1,500,000	0.38	10.13	23,370	1.071	0.58	F/S is completed
31	Suq Qadim	Halfayn	Dakhliya		0.88	23.47	54,120	0.997	1.59	F/S is completed
32	Sudayrah	Samad	Sharqiya	2,000,000	1.47	56.38	94,262	1.327	0.48	F/S is completed
33	Al Ghulaji	Al Bathe	Sharqiya	2,000,000	2.73	104.70	175,057	0.641	7.54	
34	Az Zahir	Al Batha	Sharqiya	1,000,000	2.00	76.70	128,247	0.475	11.23	
35	Masirah	One main wadi	Sharqiya	1,000,000						R/S is on-going
36	Quryat	Mijlas	Muscat	1,000,000	1.50	55.26	273,000	0.369	40.21	
37	Dayqa	Dayqa	Muscat	3,000,000						
38	Darbat	Darbat	Al Janubiya	1,000,000						R/S is on-going
39	Musandam	One wadi	Musandam	2,000,000						F/S is on-going
	Total			61,200,000						

Note: JICA team estimated budget, based on the results of preliminary and feasibility studies conducted by the government. Water cost and IRR include both values adopted from government sources, and values calculated by the JICA team on the basis of its own survey.

Table 3.1.7 Implementation Schedule of the Groundwater-Recharge Schemes

(Unit: 1000 R.O.)

No	Project	Wadi	Region	Budget	'91	'92	'93	'94	'95	'96	'97	'98	'99	2000
1	Bu Baqarah	Al Qawr	Batinah	1,000										1,000
2	Shinas	Hatta	Batinah	3,300	1,600	1,700								
3	Shinas	Fayd	Batinah											
4	Huseyfin	Zabin	Batinah	1,500							1,500			
5	Al Asra	Fizh	Batinah	1,500								1,500		
6	Saham/Sohar	Ahin	Batinah	2,800	1,300	1,500								
7	Saham/Sohar	Sakhin	Batinah	2,000					1,000	1,000				
8	Saham/Sohar	Sarami	Batinah	1,900	900	1,000								
9	Saham/Sohar	Shafan	Batinah	1,300	600	700								
10	Khaburah	Bani Umar	Batinah	1,200			1,200							
11	Khaburah	Hawasinah	Batinah	1,600			1,600							
12	Khaburah	Halhal	Batinah	1,700				1,700						
13	Khaburah	Mabrah	Batinah	1,500					1,500					
14	Al Bu Rashid	Hajir	Batinah	1,800									1,800	
15	As Suwayq	Bani Ghafir	Batinah	3,000					1,000	2,000				
16	Al Musana'a	Far	Batinah	2,000						1,000	1,000			
17	Rustaq	Far	Batinah	1,300			1,300							
18	Barka/Rumais	Bani Kharus	Batinah	3,100	1,900	1,200								
19	Barka/Rumais	Rubkhah	Batinah	3,300	1,900	1,400								
20	Barka/Rumais	Taww	Batinah											
21	Yanqul	Yanqul	Dhahirah	600					600					
22	Arid	Al Arid	Dhahirah	400					400					
23	Dariz	Kabir	Dhahirah	1,200			1,200							
24	Maqabil	Hijir	Dhahirah	1,000								1,000		
25	Maqabil	Hijir	Dhahirah											
26	N-W Interior	One main wadi	Dhahirah	1,000								1,000		
27	Buraimi	One main wadi	Dhahirah	2,000				2,000						
28	Jabal Akhdar	6 main wadis	Dakhliya	1,800			900	900						
29	Jabal Akhdar	64 sites	Dakhliya	3,200		800	1,200	1,200						
30	Jabrin	Bahla	Dakhliya	1,000							1,000			
31	Al Ghafat	Seyfam	Dakhliya	700				700						
32	Barkit Al Mosz	Muaydin	Dakhliya	2,000									1,000	1,000
33	Izki	Halfayn	Dakhliya	1,500			1,000	500						
34	Suq Qadim	Halfayn	Dakhliya											
35	Sudayrah	Samad	Sharqiya	2,000				800	1,200					
36	Al Ghulaiji	Al Batha	Sharqiya	2,000						2,000				
37	Az Zahir	Al Batha	Sharqiya	1,000						1,000				
38	Masirah	One wadi	Sharqiya	1,000					1,000					
39	Quryat	Mijilas	Muscat	1,000								1,000		
40	Dayqa	Dayqa	Muscat	3,000						600	2,400			
41	Darbat	Darbat	Al Janubiya	1,000					1,000					
42	Musandam	One wadi	Musandam	2,000				1,000	1,000					
		Total		65,200	8,200	8,300	8,400	8,800	8,700	7,600	5,900	4,500	2,800	2,000

Table 3.1.8 Implementation Schedule of the Groundwater- Recharge Schemes (Alternative 1)

(Unit: 1000 R.O.)

No	Project	Wadi	Region	Budget	'91	'92	'93	'94	'95	'96	'97	'98	'99	2000
1	Bu Baqerah	Al Qawr	Batinah	1,000										1,000
2	Shinas	Hatta	Batinah	3,300					1,600	1,700				
3	Shinas	Fayd	Batinah											
4	Saham/Sohar	Ahin	Batinah	2,800	1,300	1,500								
5	Saham/Sohar	Sakhin	Batinah	2,000									2,000	
6	Saham/Sohar	Sarami	Batinah	1,900	900	1,000								
7	Saham/Sohar	Shafan	Batinah	1,300	600	700								
8	Khaburah	Bani Umar	Batinah	1,200			1,200							
9	Khaburah	Hawasinah	Batinah	1,600			1,600							
10	Khaburah	Halhal	Batinah	1,700								1,700		
11	Khaburah	Mabrah	Batinah	1,500										1,500
12	As Suwayq	Bani Ghafir	Batinah	3,000								1,700	1,300	
13	Al Musana'a	Far	Batinah	2,000							2,000			
14	Rustaq	Far	Batinah	1,300							300	1,000		
15	Barka/Rumais	Bani Kharus	Batinah	3,100	1,900	1,200								
16	Barka/Rumais	Rubkhah	Batinah	3,300	1,900	1,400								
17	Barka/Rumais	Taww	Batinah											
18	Yanqul	Yanqul	Dhahirah	600						600				
19	Arid	Al Arid	Dhahirah	400						400				
20	Dariz	Kabir	Dhahirah	1,200			1,200							
21	Maqabil	Hijir	Dhahirah	1,000								1,000		
22	Maqabil	Hijir	Dhahirah											
23	Buraimi	One main wadi	Dhahirah	2,000				2,000						
24	Jabal Akhdar	6 main wadis	Dakhliya	1,800			900	900						
25	Jabal Akhdar	64 sites	Dakhliya	3,200		800	800	800	800					
26	Jabrin	Bahla	Dakhliya	1,000							1,000			
27	Al Ghafat	Sayfam	Dakhliya	700				700						
28	Barkit Al Moaz	Muaydin	Dakhliya	2,000									1,000	1,000
29	Izki	Halfayn	Dakhliya	1,500			1,000	500						
30	Suq Qadim	Halfayn	Dakhliya											
31	Sudayrah	Samad	Sharqiya	2,000				800	1,200					
32	Al Ghulaiji	Al Batha	Sharqiya	2,000						2,000				
33	Az Zahir	Al Batha	Sharqiya	1,000						1,000				
34	Masirah	One wadi	Sharqiya	1,000					1,000					
35	Quryat	Mijilas	Muscat	1,000									1,000	
36	Dayqa	Dayqa	Muscat	3,000						600	2,400			
37	Darbat	Darbat	Al Janubiya	1,000					1,000					
38	Musandam	One wadi	Musandam	2,000				1,000	1,000					
		Total		59,400	6,600	6,600	6,700	6,700	5,600	6,300	5,700	5,400	5,300	3,500

Table 3.1.9 Implementation Schedule of the Groundwater-Recharge Schemes (Alternative 2)

(Unit: 1000 R.O.)

No	Project	Wadi	Region	Budget	'91	'92	'93	'94	'95	'96	'97	'98	'99	2000
1	Bu Baqarah	Al Qawr	Batinah	1,000										1,000
2	Shinas	Hatta	Batinah	3,300					3,300					
3	Shinas	Fayd	Batinah											
4	Saham/Sohar	Ahin	Batinah	2,800	1,300	1,500								
5	Saham/Sohar	Sakhin	Batinah	2,000					1,000	1,000				
6	Saham/Sohar	Serami	Batinah	1,900	900	1,000								
7	Saham/Sohar	Shafan	Batinah	1,300	600	700								
8	Khaburah	Bani Umar	Batinah	1,200			1,200							
9	Khaburah	Hawasinah	Batinah	1,600			1,600							
10	Khaburah	Halhal	Batinah	1,700								1,700		
11	Khaburah	Mabrah	Batinah	1,500									1,000	500
12	Al Bu Rashid	Hajir	Batinah	1,800							1,000	800		
13	As Suwayq	Bani Ghafir	Batinah	3,000							1,000	2,000		
14	Al Musana'a	Far	Batinah	2,000						1,000	1,000			
15	Rustaq	Far	Batinah	1,300				800	700					
16	Barka/Rumais	Bani Kharus	Batinah	3,100	1,900	1,200								
17	Barka/Rumais	Rukkhah	Batinah	3,300	1,900	1,400								
18	Barka/Rumais	Teww	Batinah											
19	Yanqul	Yanqul	Dhahirah	600				600						
20	Arid	Al Arid	Dhahirah	400				400						
21	Dariz	Kabir	Dhahirah	1,200			1,200							
22	Maqabil	Hijir	Dhahirah	1,000								1,000		
23	Maqabil	Hijir	Dhahirah											
24	Bureimi	One main wadi	Dhahirah	2,000				2,000						
25	Jabal Akhdar	6 main wadis	Dakhliya	1,800			900	900						
26	Jabal Akhdar	64 sites	Dakhliya	3,200		1,600	1,600							
27	Jabrin	Bahla	Dakhliya	1,000							1,000			
28	Al Ghafat	Sayfam	Dakhliya	700				700						
29	Barkit Al Moaz	Muaydin	Dakhliya	2,000									1,000	1,000
30	Izki	Halfayn	Dakhliya	1,500			1,000	500						
31	Suq Qadim	Halfayn	Dakhliya											
32	Sudayrah	Samad	Sharqiya	2,000				800	1,200					
33	Al Ghulaiji	Al Batha	Sharqiya	2,000						2,000				
34	Az Zahir	Al Batha	Sharqiya	1,000						1,000				
35	Masirah	One wadi	Sharqiya	1,000					1,000					
36	Quryat	Mijlas	Muscat	1,000									1,000	
37	Dayqa	Dayqa	Muscat	3,000						600	2,400			
38	Darbat	Darbat	Al Janubiya	1,000					1,000					
39	Musandam	One wadi	Musandam	2,000				1,000	1,000					
		Total		61,200	6,600	7,400	7,500	7,500	9,200	5,600	6,400	5,500	3,000	2,500

[NW-5] Sub-surface (Underground) dams

Objective:

The objective of the underground dams is to increase agricultural production and improve its economic profitability by restricting essential groundwater outflow to the sea and into the desert.

Description:

Every year, even if there is no rain, large quantities of essential groundwater flow out to the sea and into the desert. Artificially recharged groundwater might also be escaping.

A sub-surface dam (underground dam) is an effective method for retaining essential groundwater outflow. It can dam groundwater and store it behind a cut-off wall which extends down from near the ground surface to the basement, provided an appropriate underground valley, fenced by an impermeable basement stratum is identified.

On the other hand, low sub-surface dams could be considered along the coast if the impermeable basement is so deep that construction of high sub-surface dams is not economical. If they are used in combination with recharge dams, this will further increase their effect. Sub-surface dams, the bottoms of which, the cut-off walls, are sealed to the basement have already been constructed and made excellent use of in Japan.

The underground dams provide irrigation water necessary for improving agricultural productivity by restricting discharge and are, in some cases, expected to be more effective than recharge dams. However, the area for the construction of the underground dam is not only limited by geological conditions but also requires a longer period of investigation. Therefore, a pilot project with observation and monitoring system should be established in order to evaluate the technical and economical viability of construction.

By using available but as yet incomplete data and the results of a few site surveys, some expected locations have been initially identified as follows:

(i) Wadi Muaydin
About 1 km upstream from Birkat Al Mawz

(ii) Wadi Al Kabir
Tawi Qarn al Kabsh, about 8 km upstream from Dariz

(iii) Wadi Al Arid
About 2 km upstream from Al Arid

(iv) Wadi Bahla
About 2 km northeast of Jabrin

(v) Wadi Sahtan
Exit of Sahtan bowl

(vi) Wadi Mistral
Just downstream of Ghubrah

(vii) Wadi Abyad
About 3 km downstream of Awabi

(viii) Wadi Manzariyah
Manzariyah

(ix) Wadi Samad
About 5 km northwest from Lizq

(x) Wadi Andam
Rubkah

(xi) Zarub Gap
Buraimi

(xii) Batinah coast

(xiii) Salalah Plain

An outline of the studies is as follows.

(i) Reconnaissance study

(a) Site surveys and electric resistivity surveys at about twenty places.

(b) Computer analysis in order to assess roughly dam size at one representative location where geological data is available in the Batinah coast or the Salalah Plain.

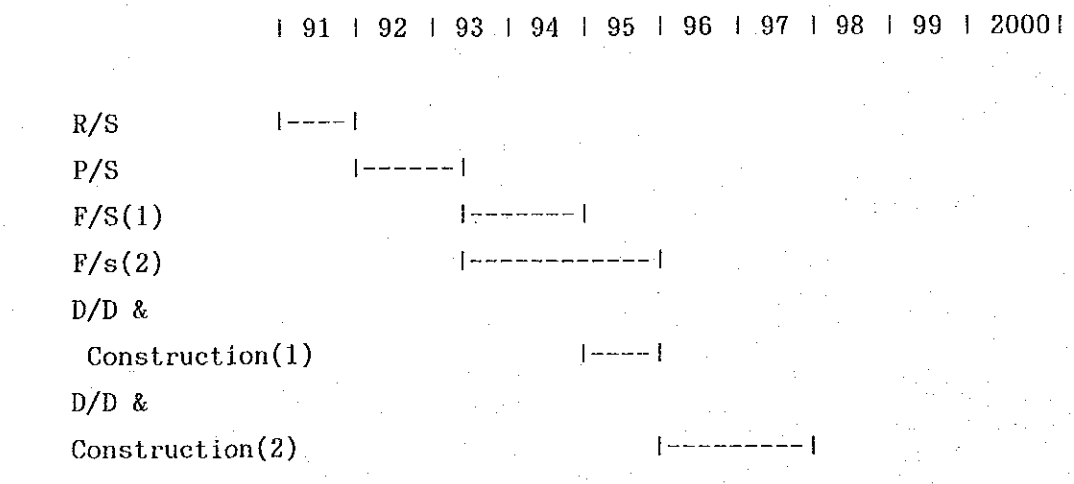
(ii) Preliminary study

Five borings and seismic surveys(3 km) on the Batinah coast, and four borings at three places in the other regions.

(iii)Feasibility study

Five drilling wells, thirty borings, seismic surveys(5 km), pumping tests, dam design and cost estimate etc.

Timing:



Budget:

The budget of the sub-surface dam is as follows.

NAME OF PROJECT	QUANTITY	COST(R.O.)
Reconnaissance study	1 Set	75,000
Preliminary study	1 Set	150,000
Feasibility study (1)	1 Set	100,000
Feasibility study (2)	1 Set	200,000
Construction (1)	1 Set	1,900,000
Construction (2)	1 Set	2,425,000
Observation & Monitoring	1 Set	150,000
Total		5,000,000

[NW-6] Aflaj

Objective:

The objective of the Aflaj program is to conserve the traditional agricultural society by maintaining aflaj which continuously provide the traditional agricultural society in rural areas with irrigation water and domestic water.

Description:

The program comprises the following three projects.

(i) NW-6-1 Repair and Maintenance of Aflaj

Aflaj are part of the indispensable infrastructure which maintains rural society in Oman, and must be maintained in good condition. Accordingly, the aflaj maintenance and rehabilitation program shall be continued following the Third Five-year Development Plan. Although the accurate total number of aflaj is unknown, it is estimated by MAF that there are more than 4,000. The target number of aflaj for repair and maintenance under the Master Plan is 3,000, of which many will need repair and maintenance more than two times over the 10-year period of the Master Plan.

(ii)NW-6-2 Distribution System Improvement Pilot Project in Oases (Study)

One of major constraints of aflaj is the deficiency of a water-distribution system in the oasis. Without any improvement of the system, an increase of agricultural productivity in oases cannot be expected. The JICA team has proposed an idea accompanied with a reasonable and fair institutional change of the water distribution system in oases. There are also other ideas proposed to improve the aflaj systems. This study evaluates these possibilities to enhance the physical and institutional

efficiency of aflaj systems and proposes the most appropriate and implementable falaj-improvement plan. Ten studies will be conducted over the ten years.

(iii) NW-6-3 Improvement and Maintenance of Major Aflaj

The Improvement and Maintenance of Major Aflaj Project aims at the complete repair of one or two major aflaj in each wilayat in order to reduce maintenance costs and preserve continuous flow. One of the major problems of aflaj is a shortage of labor for maintenance work. Without complete repair work, the demand under the Repair and Maintenance of Falaj Project will increase in the future. Major aflaj will be selected according to criteria of agricultural area, number of beneficiaries, falaj condition etc. Forty projects are the target under the Master Plan over the ten years.

Timing:

The Repair and Maintenance of Aflaj Project, and the Distribution System Improvement Project in Oases will be continuously implemented over the ten years. The studies on the Improvement and Maintenance of Major aflaj will start in 1991, and construction will commence in 1992.

Budget:

Total budget of the projects is as follows.

NAME OF PROJECT	QUANTITY	COST(R.O.)
NW-6-1 Repair and Maintenance of Aflaj	3,000 Projects	90,000,000
NW-6-2 Distribution System Improvement Pilot Project in Oases	10 Studies	1,500,000
NW-6-3 Improvement and Maintenance of Major Aflaj	40 Aflaj	21,920,000
Total		113,420,000

[NW-7] Wells

Objective:

The objective of the Wells program is to secure stable agricultural production and reduce farmers' expenditure for repair of hand-dug wells by giving subsidies, and providing running aflaj with supplementary water by drilling new wells.

Description:

The program comprises the following two projects;

(i) NW-7-1 Subsidy for Repair of Existing Open Wells
(ii) NW-7-2 Assistant Wells for Aflaj

Taking into account the importance of the hand-dug wells, which, together with the aflaj, are indispensable facilities for maintaining agricultural production and rural society in Oman, a constant effort should be made to maintain them. Following the intentions of the Third Five-year Development Plan, the subsidy for repair of existing open wells is incorporated into this Master Plan.

Under the project for building assistant wells for aflaj, new wells will be drilled in order to provide running aflaj with supplementary water, especially in the dry season. The possibility of further dropping of groundwater, which adversely affects the aflaj, should be carefully assessed in implementing the project. This project will require close co-operation with MWR.

Timing:

The Wells program will be implemented continuously throughout the period of the Master Plan.

Budget:

The budget of the program is as follows.

	NAME OF PROJECT	QUANTITY	COST(R.O.)
NW-7-1	Subsidy for Repair of Existing Open Wells	10,240 wells	10,240,000
NW-7-2	Assistant Wells for Aflaj	500 wells	20,000,000
	Total		30,240,000

[NW-8] Springs

Objective:

The objective of the spring program is to secure drinking water for animals in the Jabal and to provide maintenance costs for springs and spring facilities.

Description:

This program is specific to the Southern Region. The program consists of following two projects;

(i) NW-8-1 Improvement of Springs
(ii)NW-8-2 Annual Maintenance of Open Channels for Springs

The Improvement of Springs project preserves drinking water facilities for livestock in the Jabal by improving the spring facilities. There are about 400 springs in the Jabal, 300 of which are targeted under the Master Plan.

The project for the Annual Maintenance of Open Channels for Springs provides annual cleaning and maintenance cost for two large springs, Jarsis and Sahalnawt, and the other 99 small springs which are expected to be completed by the end of 1990 under the project for the Improvement of Springs. The maintenance costs are expected to be incurred every year in the case of large springs and every five years for small springs.

Timing:

The two projects under this program will be continuously implemented from 1991 to 2000.

Budget:

The budget of the projects is as follows.

NAME OF PROJECT	QUANTITY	COST(R.O.)
NW-8-1 Improvement of Springs	300 Springs	5,250,000
NW-8-2 Annual Maintenance of Open Channels for Springs	1 Item	664,000
Total		5,914,000

[NW-9] Erosion Control and Protection of Agricultural Land against Floods

Objective:

The objective of the project is to protect the plantations, arable land and farmers' property from damage and soil erosion caused by flash floods in wadis.

Description:

The flood flow of wadis in Oman is characterized by the high flood peak discharge. The flood erosion risks are different in the mountains and in the plains. In mountainous areas the palm groves along narrow valleys are under permanent flood risks. On the other hand, newly developed farms and new buildings encroaching on the wadi beds in the plains are facing risks of heavy losses from occasional floods.

MAF plans to formulate a master plan for erosion control and flood protection for agricultural land against floods.

The detailed design of the erosion control and flood protection project in four areas has been already worked out by MAF. In addition to the four projects, the other fifteen projects that will be identified by the MAF plan to be conducted are included in this Master Plan.

Timing:

The up-dating of the four detailed designs will be carried out in 1991. The other detailed designs will be conducted from 1991 to 1998. The construction of facilities will be implemented from 1992 to 2000.

Budget:

The budget for the study and construction under the project is R.O. 410,000 and R.O. 11,100,000, respectively.

[NW-10] Survey and Monitoring

[NW-10-1] Long-term Plan for Aerial Photography and Orthophoto Mapping

Objective:

The primary objective of the project is to provide basic data detected from orthomaps for the Repair and Maintenance of Aflaj project.

Description:

The continuous activity of surveying in order to collect basic data is essential, because it provides vital information for planning. Aerial photography is a tool for data collection and resource appraisal. Ground-controlled coordinated maps provide a basis for compiling collected data.

The aerial photography and orthophoto mapping project should be continuously implemented step by step now that the first of four stages has been completed. In the meantime, efforts should be made to use the existing aerial photographs as much as possible to minimize the expenses for survey.

Timing:

The project period is from 1991 to 2000.

Budget:

Total budget of the project is R.O. 2,200,000 including necessary cost, R.O. 44,000, for equipment.

[NW-10-2] Establishment and Operation of Hydrological Monitoring Network for Recharge Dam

Objective:

The objective of this program is to collect data in and around the recharge dam sites, and evaluate the effectiveness of the structures and improve on their performance.

Description:

The current MAF hydrological monitoring and evaluation unit has been collecting and monitoring data from the aquifer recharge sites. Data collected will be used to assess the effectiveness of individual recharge facilities and to evaluate and plan the overall direction of the MAF aquifer recharge program. The proposed pilot project for effective use of recharged water in the Master Plan will be conducted in close connection with this hydrological monitoring network program.

The components of the project are as follows.

(i) Improvement of network coverage, installation of necessary equipments and operation.

(ii) Collection and analysis of data such as rainfall, surface flow, falaj flow, consumption and aquifer parameters.

(iii) On-the-job and abroad training for Omani technical staff.

(iV) Employment of technical assistance staff, Omani engineers and field technicians.

Timing:

The project will be implemented over all ten years.

Budget:

The total budget of the project is R.O. 3,740,000. The cost of improvement of network coverage and installation of necessary equipment is to be decided according to the number of recharge dams to be constructed.

The necessary recurrent budget for employment of new staff is estimated at R.O. 658,800. Six Omani engineers (two engineers in each year over three years from 1991 to 1993) will be employed. Eleven Omani field technicians (ten in 1991 and one in 1993) will be employed.

Table 3.1.10 Unit Price for Cost Estimation

UNIT PRICE

NW-1
(Study)

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Well drilling	Well	4.0	10,000	40,000
Electric resistivity, Pumping test,Water quality test etc.	Site	50.0	400	20,000
F/S,D/D	Set	1.0	60,000	60,000
Total				120,000

The cost estimations assume the study area is about 500 ha where farmland is concentrated in the study area and access to the site is easy, like the Batinah coast. The study cost per ha of study area of less than 500 ha in other regions seems to be higher than that in the Batinah coast because of the dispersal of farm lands, difficulty of access to the study site, shortage of existing data and the need for supplementary study. Under such circumstances, the costs necessary for all studies were assumed equal except for the studies for which the feasibility studies have been already completed.

(Construction)

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Production wells	Well	25.0	7,000	175,000
Pumping plant	Set	25.0	9,000	225,000
Main water storage	Set	2.0	160,000	320,000
Branch water storage	Set	20.0	70,000	1,400,000
Transmission pipeline	Unit	1.0	800,000	800,000
Main pipeline	M	10,000.0	40	400,000
Branch pipeline	M	40,000.0	15	600,000
Electricity supply	Unit	1.0	100,000.0	100,000
Water superintendent's office	Unit	1.0	10,000	10,000
Sub-total				4,030,000
Preliminaries & contingencies	%	15.0	4,030,000	604,500
Total	ha	500.0		4,630,000
			Cost/ha	9,000

(Al-Kamil(2))
The construction cost, RO 300,000, is based on the result of the F/S.

Table 3.1.10 (continued)

(Buzayli project)

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Rehabilitation of the conveyance section	M	6,100	45	274,500
Storage tank	Unit	1	40,000	40,000
Booster	Unit	1	170,000	170,000
MV power cable	M	4,000	11	44,000
Transformer and generater set	Unit	1	14,000	14,000
Pipeline	M	4,600	14	64,400
Irrigation hydrants	Unit	21	1,000	21,000
Irrigation equipment (Drip & sprinkler)	Farm	42	4,600	193,200
Land levelling	ha	125	400	50,000
Access road	M	8,500	2	13,600
		2,600	11	28,600
Fence	M	19,500	10	195,000
				1,108,300
Preliminaries & contingencies	%	15		166,245
Total				1,274,545
			Round	1,270,000

NW-2

The cost of a new irrigation system depends on its irrigation methods such as sprinkler, bubbler and drip. The cost varies from 1,500 RO/ha to 3,600 RO/ha. 2,500 RO/ha is used as an average unit cost per hectare.

NW-3

(Study(Phase 1))

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Expert manpower and supporting staff	M/M	14.0	5,000	70,000
Other charges	%	25.0	70,000	17,500
Sub-total				87,500
Contingencies	%	5.0	87,500	4,375
Total				91,875
			Round	90,000

(Study(Phase 2 & 3))

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Expert manpower and supporting staff	M/M	12.5	5,000	62,500
Other charges	%	25.0	62,500	15,625
Sub-total				78,125
Contingencies	%	5.0	78,125	3,906
Total				82,031
			Round	80,000

Table 3.1.10 (continued)

NW-4-1

(Study Phase)
10% of the construction cost is allocated for the F/S and D/D

(Construction Phase)
The construction cost is based on the results of the P/S and the on-going F/S.

NW-4-2

Maintenance cost is an average cost of the following projects which are representative projects in future in each region.

Name of the project	Wadi	Maintenance cost
Shinas	Hatta	21,317 RO
Barka-Rumais	Bani Kharus	33,840
Dariz	Kabir	23,225
Suq Qadium	Halfan	14,720
Al Ghulaji	Al Batha	17,500
Total		110,602
	Average	22,120
Contingencies	15 %	3,318
Total		25,438
	Round	25,000

NW-4-3

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Expert manpower and supporting staff	M/M	19.5	5,000	97,500
Other charges	%	25.0	97,500	24,375
Sub-total				121,875
Contingencies	%	5.0	121,875	6,094
Total				127,969
Cost/Project for 5 years			*Round*	*125,000*

NW-5

(Reconnaissance study)

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Expert manpower and supporting staff	M/M	12.0	5,000	60,000
Other charges	%	25.0	60,000	15,000
Sub-total				75,000
Contingencies	%	5.0	75,000	3,750
Total				78,750
			Round	75,000

Table 3.1.10 (continued)

(Preliminary study)

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Expert manpower and supporting staff	M/M	23.0	5,000	115,000
Other charges	%	25.0	115,000	28,750
Sub-total				143,750
Contingencies	%	5.0	143,750	7,188
Total				150,938
			Round	150,000

(Feasibility study(1))

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Expert manpower and supporting staff	M/M	15.5	5,000	77,500
Other charges	%	25.0	77,500	19,375
Sub-total				96,875
Contingencies	%	5.0	96,875	4,844
Total				101,719
			Round	100,000

(Feasibility study(2))

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Expert manpower and supporting staff	M/M	31.0	5,000	155,000
Other charges	%	25.0	155,000	38,750
Sub-total				193,750
Contingencies	%	5.0	193,750	9,688
Total				203,438
			Round	200,000

(Observation & monitoring)

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Hydrogeologist	Person	1.0	120,000	120,000
Monitoring well recorder	Set	25.0	1,200	30,000
Total				150,000

NW-6-1

Repair and maintenance cost (RO/Falaj)	30,000

NW-6-2

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Expert manpower and supporting staff	M/M	23.0	5,000	115,000
Other charges	%	25.0	115,000	28,750

Table 3.1.10 (continued)

Sub-totai				143,750
Contingencies	%	5.0	143,750	7,188
Total				150,938
			Round	150,000

NW-6-3

(Preliminary study)

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Expert manpower and supporting staff	M/M	12.5	5,000	62,500
Other charges	%	25.0	62,500	15,625
Sub-total				78,125
Contingencies	%	5.0	78,125	3,906
Total				82,031
			Round	80,000

(Feasibility study)

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Expert manpower and supporting staff	M/M	6.5	5,000	32,500
Other charges	%	25.0	32,500	8,125
Sub-total				40,625
Contingencies	%	5.0	40,625	2,031
Total				42,656
			Round	40,000

(Construction)

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Collecting section	M	1,000.0	50	50,000
Transport section	M	4,000.0	50	200,000
Open channel	M	10,000.0	15	150,000
Storage tank	Unit	1.0	40,000	40,000
				440,000
Preliminaries & contingencies	%	15.0	440,000	66,000
Total				506,000
			Round	500,000

NW-7-1

Well owned by one person	RO 1,000
Well owned by more than two persons	RO 2,000

NW-7-2

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Well	Well	1.0	7,000	7,000
Pump & pipeline	Unit	1.0	30,000	30,000
Sub-total				37,000
Contingencies	%	15.0		5,550
Total				42,550
			Round	40,000

Table 3.1.10 (continued)

NW-8-1
Improvement cost of one well Average RO 17,500

NW-8-2
Jarsis ; RO. 7,000 is annually required for maintenance.
Sahalnat ; RO.7,000 is annually required for maintenance.
Small spring ; RO.1,500/spring is required every five years.

NW-9
(Study)

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Expert manpower and supporting staff	M/M	4.0	5,000	20,000
Other charges	%	25.0	20,000	5,000
Sub-total				25,000
Contingencies	%	5.0	25,000	1,250
Total				26,250
			Round	26,000

(Construction)

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Bank construction	M	1,250.0	350	437,500
Preliminaries and contingencies	%	15.0	437,500	65,625
Total				503,125
			Round	500,000

Al Khadra Bin Daffa	RO	710,000
Al Kharma	RO	485,000
Al Hamitha	RO	885,000
Al Hagir	RO	1,520,000
Total	RO	3,600,000

The F/S of the above four areas has finished. The cost is the result of the F/S.

NW-10-1(For 10-year period)

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Contribution to MD	Unit	1.0	2,156,119	2,156,119
Equipment(Plotter, Computer-aided designs & mapping system)	Unit	1.0	44,000	44,000
Total				2,200,119
			Round	2,200,000

Table 3.1.10 (continued)

NW-10-2(For 10-year period)

ITEM	UNIT	QUANT.	UNIT PRICE	COST (RO)
Senior Hydrologist	Person	1.0	367,000	367,000
Staff Hydrogeologist	Person	1.0	308,000	308,000
Supplemental wells	Well	330.0	7,000	2,310,000
Monitoring well recorder	Set	330.0	1,200	396,000
Vehicle		6.0	7,000	42,000
Technical training				
Engineer	Person	6.0	32,400	194,400
Field technician	Person	16.0	8,100	129,600
Total				3,747,000
			Round	3,740,000

3.2 Agriculture

[NAR-1] Support for Agricultural Research Stations

Objective:

To support research through the upgrading and expansion of research facilities and provision of materials and equipment for research activities.

Description:

Due to a present shortage in Oman of trained research management staff and research experts, further aggravated by insufficient facilities and equipment, the agricultural research sector in general -- although achieving some partial success in the development of practical innovations -- has not been able to achieve results commensurate with requirements and expectations at the farmer level.

In the case of the Rumais Agricultural Research Center, the main research building has been completed but the annex wing and procurement of research equipment and materials remain to be completed. It is expected that this institution will continue to carry out broad, basic research which affects the entire country. In addition to intensively providing the latest, most sophisticated equipment to the center, it will also be necessary to support its activities in the initial stages with expatriate experts.

Only the field workshop has been completed at the Jimmah Agricultural Research Station. A research building, as well as research equipment are still required. These should be provided as promptly as feasible given the importance of the Interior Region for Omani agriculture, as well as the uniquely wide range of natural conditions it encompasses from Jabal to the arid interior plain.

At the Salalah Agricultural Research Station, the research and administration building and equipment should be urgently strengthened to keep pace with research requirements which have rapidly increased in

recent years.

The Rumais Agricultural Research Center is not capable of completely meeting the research requirements of the Batinah Region, important because it accounts for over half of Oman's agricultural production as well as because its weather and soil conditions differ from those in the north and south. Accordingly, the present Sohar Experimental Farm in northern Batinah should be upgraded to research station status, particularly with a view to accelerating research in vegetable and fruit cultivation important to the area.

Additionally, establishment of agricultural research stations at Sharqiya and Dhahira, which exhibit unique regional conditions as well would make an effective contribution to improving Omani agricultural technology.

Necessary costs estimated for establishing the above are shown in Table 3.2.1. Establishing and operating costs for the above, as well as staff expected to be deployed to the facilities are shown in Tables from 3.2.7 to 3.2.15.

Table 3.2.1 Cost Estimation of NAR-1 Project

PROJECT NUMBER	NAME OF PROJECT/PROGRAME	NUMBERS	UNIT PRICE (1,000RO)	TOTAL COST (1,000RO)
NAR-1	SUPPORT FOR AGRICULTURAL RESEARCH STATIONS		5,300	
NAR-1-1	AGRICULTURAL RESEARCH FACILITIES AT RUMAIS		1,100	1,100
	(1)LABORATORIES EQUIPMENT AND INSTRUMENTS	1 SET	350	350
	(2)FIELD EQUIPMENT , INSTRUMENTS AND IRRIGATION SYSTEMS	1 SET	400	400
	(3)RESEARCH GREENHOUSES	1 SET	50	50
	(4)SCREENHOUSES	1 SET	10	10
	(5)FIELD WORKSHOP	1 SET	40	40
	(6)RESEARCH INPUT REQUIREMENTS	1 SET	250	250
NAR-1-2	AGRICULTURAL RESEARCH FACILITIES AT JEMMAH		850	850
	(1)BUILDING AND LABORATORIES	1 SET	350	350
	ADMINISTRATION & FINANCE OFFICES, LIBRARY, COMPUTER ROOM, MEETING ROOM, SOIL LAB., PLANT PATHOLOGY LAB., ENTOMOLOGY LAB, PLANT LAB., MECHANICAL WORKSHOP, GREENHOUSES, COLD STORAGE, PLANT SHADE AREA, CAR & MACHINERY PARK			
	(2)LABORATORIES EQUIPMENT AND INSTRUMENTS	1 SET	200	200
	(3)FIELD EQUIPMENT , INSTRUMENTS AND IRRIGATION SYSTEMS	1 SET	150	150
	(4)RESEARCH INPUT REQUIREMENTS	1 SET	150	150
NAR-1-3	AGRICULTURAL RESEARCH FACILITIES AT SALALAH		1,000	1,000
	(1)BUILDING AND LABORATORIES	1 SET	350	350
	ADMINISTRATION & FINANCE OFFICES, LIBRARY, COMPUTER ROOM, MEETING ROOM, SOIL LAB., PLANT PATHOLOGY LAB., ENTOMOLOGY LAB, PLANT LAB., MECHANICAL WORKSHOP, GREENHOUSES, COLD STORAGE, PLANT SHADE AREA, CAR & MACHINERY PARK			
	(2)LABORATORIES EQUIPMENT AND INSTRUMENTS	1 SET	200	200
	(3)FIELD EQUIPMENT , INSTRUMENTS AND IRRIGATION SYSTEMS	1 SET	300	300
	(4)RESEARCH INPUT REQUIREMENTS	1 SET	150	150
NAR-1-4	AGRICULTURAL RESEARCH FACILITIES AT SOHAR		900	900
	(1)BUILDING AND LABORATORIES	1 SET	300	300
	ADMINISTRATION & FINANCE OFFICES, LIBRARY, COMPUTER ROOM, MEETING ROOM, SOIL LAB., PLANT PATHOLOGY LAB., ENTOMOLOGY LAB, PLANT LAB., MECHANICAL WORKSHOP, GREENHOUSES, COLD STORAGE, PLANT SHADE AREA, CAR & MACHINERY PARK			
	(2)LABORATORIES EQUIPMENT AND INSTRUMENTS	1 SET	200	200
	(3)FIELD EQUIPMENT , INSTRUMENTS AND IRRIGATION SYSTEMS	1 SET	300	300
	(4)RESEARCH INPUT REQUIREMENTS	1 SET	100	100
NAR-1-5	AGRICULTURAL RESEARCH FACILITIES AT SHARQIYA		850	850
	(1)BUILDING AND LABORATORIES	1 SET	300	300
	ADMINISTRATION & FINANCE OFFICES, LIBRARY, COMPUTER ROOM, MEETING ROOM, SOIL LAB., PLANT PATHOLOGY LAB., ENTOMOLOGY LAB, PLANT LAB., MECHANICAL WORKSHOP, GREENHOUSES, COLD STORAGE, PLANT SHADE AREA, CAR & MACHINERY PARK			
	(2)LABORATORIES EQUIPMENT AND INSTRUMENTS	1 SET	200	200
	(3)FIELD EQUIPMENT , INSTRUMENTS AND IRRIGATION SYSTEMS	1 SET	250	250
	(4)RESEARCH INPUT REQUIREMENTS	1 SET	100	100
NAR-1-6	AGRICULTURAL RESEARCH FACILITIES AT DHAHIRA		600	600
	(1)BUILDING AND LABORATORIES	1 SET	250	250
	ADMINISTRATION & FINANCE OFFICES, LIBRARY, COMPUTER ROOM, MEETING ROOM, SOIL LAB., PLANT PATHOLOGY LAB., ENTOMOLOGY LAB, PLANT LAB., MECHANICAL WORKSHOP, GREENHOUSES, COLD STORAGE, PLANT SHADE AREA, CAR & MACHINERY PARK			
	(2)LABORATORIES EQUIPMENT AND INSTRUMENTS	1 SET	150	150
	(3)FIELD EQUIPMENT , INSTRUMENTS AND IRRIGATION SYSTEMS	1 SET	150	150
	(4)RESEARCH INPUT REQUIREMENTS	1 SET	50	50

[NAR-2] Establishment of New Research Units and Laboratories

Objective:

To establish new research units and laboratories for urgent development of technology tailored to the needs of Omani farming and future agricultural development.

Description:

In line with the direction of agricultural production development, research units and laboratories will be established to address research requirements in new fields. Basic research with impact for the entire nation will be centralized at the Rumais Agricultural Research Center. As the research program progresses, it is anticipated that practical field experimentation tailored to the requirements of specific regions will become necessary. Regional sites for such research units and laboratories will be determined at a future date. Research specific to conditions of particular regions would be carried out as well as units and laboratories to be established at agricultural stations in these regions.

Research units and laboratories to be provided under the project are:

(1) Agricultural Machinery Research Unit (Rumais)

MAF considers farm mechanization to be a central issue to improvement of farm management. Unfortunately, there has been little study in this regard in Oman to date. Accordingly, various experiments are considered necessary for selection and improvement of type, model and size of agricultural machinery best-suited to the crops, natural conditions and cropping methods in Oman. Such experiments would also explore the durability and maintenance problems affecting candidate equipment. Study of the "soft" aspect of farm mechanization, including economical methods for machinery use would also be carried out.

(2) Toxicology Laboratory (Rumais)

In recent years, the types of agricultural chemicals have increased and methods of application have become more complicated. Also, most of the conventional plant diseases have become possible to control. Unfortunately, plant diseases which had not been a problem until now are occurring more frequently. In the future still more types of agricultural chemicals are expected to be used.

Increasing importance must also be attributed to studies on toxicity and residual duration of agricultural chemicals, from the standpoint of their environmental and health impact.

The toxicology laboratory will be established at Rumais to carry out the above research. This laboratory is expected to work in line with the regulation of agricultural chemicals which will be introduced in the near future.

(3) Seed Tuber Production Research Unit (Rumais)

Research at this unit will include introduction and selection of existing varieties bred in countries outside Oman where conditions are similar, collection and selection of traditional Omani varieties, cross-breeding of genetically superior foreign and domestic varieties, and bio-technological breeding. Considering that the gestation period is long in the case of bio-technological breeding methods other than tissue culture, such would, for the time being, be excluded from consideration. Nevertheless, well-organized combinations should be made among the above-mentioned methods.

Maximum application of existing traditional Omani varieties of fruit trees, feed crop, etc., which have been confirmed as having superior genetic characteristics well-suited to the Omani environment, should be emphasized.

Seed production requires a higher technological ability than general cultivation, and the development and transfer to Omani farmers of appropriate techniques should be pursued. Crops to be considered for seed production include vegetables (carrots, onions, chilli peppers), wheat and barley in the Interior, and potatoes in

the Southern Region and Jabal Akhdar. Seed production of other vegetable such as radishes, gourds, spinach and okra should be considered in the future.

(4) Central Soil, Plant and Water Analysis Laboratory (Rumais)

As with pest, disease and weed control, fertilizer application technology in Oman is at a low level of development. For this reason improvement and expanded application of fertilizer is expected to greatly increase agricultural productivity. Along with research on plant physiology, research towards development and improvement of fertilizer application technology responsive to plant type, planting season, and cropping method is important.

Also, in line with the above, the establishment of facilities properly equipped for soil analysis, including systematic data-processing are necessary to identify soil characteristics in areas already under cultivation as a basis for developing fertilizer application methods better-suited to such soil conditions. Water analysis for irrigation would also be carried out.

(5) Library and Documentation Center (Rumais)

Establishment of a library and documentation center for collection, compilation and collation of documents relevant to agricultural research is recommended. The library would have the two-fold function of (a) pooling information from outside Oman relevant to its conditions which would help in avoiding redundancy of research efforts inside the country, as well as serve as a data base for development of new technologies practical for Oman, and (b) raising the academic standards of, and providing intellectual stimulus for research staff. It would be effective to equip the library with a computerized information-processing system, connected on-line with databases outside Oman for ready transfer of information.

(6) Plant Water Requirement Determination Unit (Salalah)

Effective use of limited water resources is the most critical issue in terms of increasing agricultural productivity in the Sultanate. Efforts to alleviate this heaviest of constraints will require research on crop-wise water requirements, appropriate irrigation methods, and feasibility of irrigation using brackish water.

This unit will be established at Salalah Agricultural Research Station.

(7) Medicinal and Perfume Plant Research Unit (Salalah)

Facilities and equipment would be provided for research on special crops including medicinal and perfume plants, particularly those found in the Southern Region.

(8) Disease and Pest Forecasting Unit (Rumais)

Some research on use of biological methods for pest control such as application of sex pheromone, natural enemies, etc. has begun. However, intensification of these efforts would be carried out at this unit. Also, research on pest physiology and ecology would be pursued towards development of a disease and pest forecasting system.

(9) Salt-Tolerant Plants and Halophytes Research Unit

In order to maintain long-term, stable agriculture in an arid region such as Oman, comprehensive research on prevention of and counter-measures for salinization of soil, salt-tolerant crops and varieties, etc. is necessary. These subjects relate to a wide spectrum of technical fields including agricultural engineering, horticulture, plant breeding, pedology, plant physiology, etc. Research in this regard would be carried out at this unit.

(10) Honey Bee Research Unit

To date, bee keeping in Oman has been principally carried out in Rustaq, Nizwa and Salalah by the traditional method. Bee keeping

under such practice is of low productivity.

Nevertheless, domestic demand for Omani honey is higher than that for imported honey. Modernization of this industry will provide a valuable income source for bee-keeping farmers.

A bee-keeping research laboratory or unit should be established at Rumais, Jimmah and Salalah for development of bee-keeping technology best-suited to conditions in the Sultanate.

In particular, research would be conducted on the following items.

(a) Survey, diagnosis and prevention of infectious disease among bees (this activity to be principally carried out at Rumais)

(b) Development and raising of new species

(c) Research on effective management and use of bee-keeping resources

(d) Development of bee-keeping practices best-suited to conditions in Oman

In addition to permanent staff at the centers, foreign experts would be periodically invited to advise and participate in this research.

(11) Date Palm Research Unit

Most fruit trees in Oman are date palms. The important research subjects concerning date palms are utilization of the spaces under date palms and thinning and replacing of old date palms. When the old trees, the productivity of which has become relatively low, are gradually thinned out, there are two possibilities. One is replacing these with superior new varieties by application of tissue culture, etc. The other is utilization of the space under these trees through modern agricultural production techniques. These subjects need to be

investigated in the future, from the viewpoint of farm economy and from the viewpoint of crop science. Also, it is important to develop technology for processing date by-products.

In relation to the above, the following subjects should be studied in the future: improvement of irrigation system for date cultivation; development of intercropping systems under date palms which includes mechanization; crop cultivation under the shelter of trees in summer; development of simple tunnel cultivation methods using plastic material; and development of processed foodstuffs which have added value and will serve to stimulate demand for dates etc.

Necessary costs estimated for establishing the above laboratory and units are shown in Table 3.2.2. Personnel and operating costs necessary for the above are also shown in Tables from 3.2.16 to 3.2.24.

Table 3.2.2 Cost Estimation of NAR-2 Project

PROJECT NUMBER	NAME OF PROJECT/PROGRAME	NUMBERS	UNIT PRICE (1,000RO)	TOTAL COST (1,000RO)
NAR-2	ESTABLISHMENT OF NEW RESEARCH UNITS AND LABORATORIES		5,600	
NAR-2-1	AGRICULTURAL MACHINERY RESEARCH UNIT AT RUMAIS		800	800
	(1)MACHINERY WORKSHOP	1 SET	100	100
	(2)IRRIGATION WORKSHOP	1 SET	50	50
	(3)EQUIPMENT AND MACHINERY	1 SET	550	550
	(4)ELECTRICAL, ELECTRONIC, WELDING, DICING, TESTING EQUIPMENT	1 SET	100	100
NAR-2-2	TOXICOLOGY LABORATORY (RUMAIS)		300	300
	(1)BUILDING OF THE LABORATORY	1 SET	75	75
	(2)EQUIPMENT AND INSTRUMENTS	1 SET	150	150
	(3)LABORATORY INPUT REQUIREMENTS	1 SET	75	75
NAR-2-3	SEED AND TUBER PRODUCTION RESEARCH UNIT (RUMAIS)		650	650
	(1)PLANT BREEDING EQUIPMENT AND INSTRUMENTS	1 SET	100	100
	(2)SCREENHOSES AND GREENHOUSES	1 SET	100	100
	(3)SURVEY AND COLLECTION OF GERM PLASM	1 SET	25	25
	(4)COLD STORAGE	1 SET	100	100
	(5)PILOT PROJECT AREAS	1 SET	325	325
NAR-2-4	CENTRAL SOIL, PLANT AND WATER ANALYSIS LABORATORY (RUMAIS)		800	800
	(1)BUILDING OF THE LABORATORY	1 SET	300	300
	(2)EQUIPMENT AND INSTRUMENTS	1 SET	300	300
	(3)LABORATORY INPUT REQUIREMENTS	1 SET	200	200
NAR-2-5	LIBRARY AND DOCUMENTATION CENTER (RUMAIS)		250	250
	(1)BUILDING OF THE LIBRARY	1 SET	160	160
	(2)EQUIPMENT AND INSTRUMENTS	1 SET	60	60
	(3)LIBRARY INPUT REQUIREMENTS	1 SET	30	30
NAR-2-6	PLANT WATER REQUIREMENT DETERMINATION UNIT (SALALAH)		100	100
	EQUIPMENT AND INSTRUMENTS	1 SET	100	100
NAR-2-7	MEDICAL AND PERFUME PLANT RESEARCH UNIT (SALALAH)		75	75
	(1)SURVEY AND COLLECTION	1 SET	25	25
	(2)EQUIPMENT AND INSTRUMENTS	1 SET	50	50
NAR-2-8	DISEASE AND PEST FORECASTING UNIT (RUMAIS)		100	100
	BIOTRON	1 SET	100	100
NAR-2-9	SALT-TOLERANT PLANTS AND HALOPHYTES RESEARCH UNITS (RUMAIS)	1 SET	650	650
	(1)EQUIPMENT AND INSTRUMENTS	1 SET	300	300
	(2)PLANT SHADE AREA	1 SET	50	50
	(3)PILOT PROJECT AREAS (3 NOS.)	1 SET	300	300
NAR-2-10	HONEY BEE LABORATORY (RUMAIS)		200	200
	(1)BUILDING	1 SET	75	75
	(2)BEE KEEPING AREAS	1 SET	25	25
	(3)EQUIPMENT , INSTRUMENTS AND INPUT REQUIREMENTS	1 SET	100	100
NAR-2-11	HONEY BEE RESEARCH UNIT (SALALAH)		100	100
	(1)BUILDING OF SMALL LAB., STORE AND WORKING AREA	1 SET	25	25
	(2)BEE KEEPING AREAS	1 SET	25	25
	(3)EQUIPMENT , INSTRUMENTS AND INPUT REQUIREMENTS	1 SET	50	50
NAR-2-12	HONEY BEE RESEARCH UNIT (JEMMAH)		75	75
	(1)BEE KEEPING AREA	1 SET	25	25
	(2)EQUIPMENT, INSTRUMENTS AND INPUT REQUIREMENTS	1 SET	50	50
NAR-2-13	DATE PALM RESEARCH UNIT (RUMAIS)		1,500	1,500
	(1)BUILDING AND LABORATORIES	1 SET	200	200
	BIOLOGICAL LAB., CHEMICAL LAB., DATE PALM PATHOLOGY LAB., DATE PALM ENTOMOLOGY LAB., DATE PROCESSING LAB., DATE PALM FIELD WORKSHOP, OFFICES, STORES			
	(2)EQUIPMENT AND INSTRUMENTS FOR LABORATORIES	1 SET	300	300
	(3)FIELD EQUIPMENT AND INSTRUMENTS	1 SET	150	150
	(4)RESEARCH INPUT REQUIREMENTS	1 SET	250	250
	(5)DATE PALM PILOT PROJECT	1 SET	600	600

[NAR-3] Development and Establishment of Experimental Farms and Nurseries

Objective:

To develop and establish experimental farms and nurseries to improve efficiency in research and extension on new varieties and provide a stable supply of sound, superior seedlings.

Description:

New experimental farms and nurseries will be established, and existing ones upgraded.

(1) Experimental Farm

(a) Arabic Coffee Experimental Farm (Janubiya)(new)
(b) Wadi Quriyat (existing)
(c) Musandam (new)
(d) Sharqiya (new)
(e) Dhahira (new)

(2) Nurseries (existing facilities)

(a) Rumais and Barka (Central Nursery) (mangoes, citrus, etc.)
(b) Sohar (mangoes, limes, etc.)
(c) Interior (date palms, citrus, grapes, pomegranates, etc.)
(d) Southern Region (coconuts, papayas, etc.)

Necessary costs estimated for these farms and nurseries are shown in Table 3.2.3.

Table 3.2.3 Cost Estimation of NAR-3 Project

PROJECT NUMBER	NAME OF PROJECT/PROGRAME	NUMBERS	UNIT PRICE (1,000RO)	TOTAL COST (1,000RO)
NAR-3	DEVELOPMENT AND ESTABLISHMENT OF EXPERIMENTAL FARM AND NURSERIES		2,000	
NAR-3-1	DEVELOPMENT OF ARABIC COFFEE EXPERIMENTAL FARM IN SALALAH		200	200
	(1)OFFICE, STORES, FIELD WORKSHOP, PLANT SHADE AREAS	1 SET	25	25
	(2)IRRIGATION SYSTEM	1 SET	35	35
	(3)EQUIPMENT	1 SET	50	50
	(4)INPUTS REQUIREMENTS	1 SET	90	90
NAR-3-2	DEVELOPMENT OF NURSERIES AT RUMAIS AND BARKA		300	300
	(1)OFFICE, STORES, FIELD WORKSHOP, NURSERIES	1 SET	100	100
	(2)IRRIGATION SYSTEM	1 SET	30	30
	(3)EQUIPMENT	1 SET	70	70
	(4)INPUTS REQUIREMENTS	1 SET	100	100
NAR-3-3	DEVELOPMENT OF NURSERIES AT SOHAR		150	150
	(1)OFFICE, STORES, FIELD WORKSHOP, NURSERIES	1 SET	25	25
	(2)IRRIGATION SYSTEM	1 SET	25	25
	(3)EQUIPMENT	1 SET	40	40
	(4)INPUTS REQUIREMENTS	1 SET	60	60
NAR-3-4	DEVELOPMENT OF NURSERIES IN INTERIOR		400	400
	(1)OFFICE, STORES, FIELD WORKSHOP, NURSERIES	1 SET	100	100
	(2)IRRIGATION SYSTEM	1 SET	100	100
	(3)EQUIPMENT	1 SET	100	100
	(4)INPUTS REQUIREMENTS	1 SET	100	100
NAR-3-5	DEVELOPMENT OF NURSERIES IN SOUTHERN REGION		150	150
	(1)OFFICE, STORES, FIELD WORKSHOP, NURSERIES	1 SET	25	25
	(2)IRRIGATION SYSTEM	1 SET	25	25
	(3)EQUIPMENT	1 SET	40	40
	(4)INPUTS REQUIREMENTS	1 SET	60	60
NAR-3-6	DEVELOPMENT OF EXPERIMENTAL FARM AT WADI QURIYAT		150	150
	(1)OFFICE, STORES, FIELD WORKSHOP, NURSERIES	1 SET	50	50
	(2)IRRIGATION SYSTEM	1 SET	20	20
	(3)EQUIPMENT	1 SET	40	40
	(4)INPUTS REQUIREMENTS	1 SET	40	40
NAR-3-7	DEVELOPMENT OF EXPERIMENTAL FARM AT MUSANDAM		100	100
	(1)FIELD WORKSHOP, NURSERIES	1 SET	20	20
	(2)IRRIGATION SYSTEM	1 SET	15	15
	(3)EQUIPMENT	1 SET	35	35
	(4)INPUTS REQUIREMENTS	1 SET	30	30
NAR-3-8	DEVELOPMENT OF EXPERIMENTAL FARM AT SHARQIYA		300	300
	(1)OFFICES, STORES, FIELD WORKSHOP, NURSERIES, FENCING	1 SET	140	140
	(2)IRRIGATION SYSTEM	1 SET	50	50
	(3)INSTRUMENTS AND EQUIPMENT	1 SET	60	60
	(4)INPUTS REQUIREMENTS	1 SET	50	50
NAR-3-9	DEVELOPMENT OF EXPERIMENTAL FARM AT DHARIRA		250	250
	(1)OFFICES, STORES, FIELD WORKSHOP, NURSERIES, FENCING	1 SET	110	110
	(2)IRRIGATION SYSTEM	1 SET	35	35
	(3)EQUIPMENT	1 SET	60	60
	(4)INPUTS REQUIREMENTS	1 SET	45	45

[NAR-4] Forestry-Improvement Program

Objective:

To select and preserve tree varieties well-suited for Oman, to develop afforestation methods and pilot projects using these varieties, and thereby contribute to overall environmental conservation.

Description:

Due to the economical and cultural impact of forest conservation and afforestation, and in order to impress upon the young generation the importance of conserving precious natural resources, research in this area should be addressed from an integrated governmental approach to include all concerned agencies in addition to MAF.

The following impact could be expected from afforestation:

- o Conservation of existing tree species in Oman (genetic resources)
- o Preservation of the natural environment and its beauty
- o Flood and soil erosion (wind or water erosion) control
- o Control of sand dune drift and desertification
- o Groundwater recharge
- o Climate improvement
- o Protection and nurturing of honey bee resources
- o Fodder supply
- o Creation of recreation sites

Although all the components involved in this project are not necessarily pure research work, careful research with particular attention to the selection and conservation of tree types suited to Oman, as well as pilot afforestation methods should be on the agenda. Careful attention would also have to be given to the degree that afforestation would compete with agriculture in terms of water consumption.

With regards to afforestation in Janubiya, efforts ought to be directed at the application of fog water interception for groundwater recharge on rangelands.

Necessary costs for this project are shown in Table 3.2.4. The personnel necessary for the above are also shown in Table 3.2.25.

Table 3.2.4 Cost Estimation of NAR-4 Project

1.COST OF AVERAGE ONE PILOT PROJECT

	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1. FENCING	3,000 m	5	15,000
2. LAND PREPARATRION	35 ha	100	3,500
3. IRRIGATION	35 ha	460	16,100
4. OTHER EXPENSES	35 ha	100	3,500
5. OUT HOUSE CABIN	1 NOS.	1,900	1,900
TOTAL			40,000

2.COST PER YEAR

@ 40,000 × 5 (PLACES) = 200,000

3.COST FOR 10 YEARS

@ 200,000 × 10 (YEARS) = 2,000,000

[NAR-5] Establishment of Locust Survey and Central Unit

Objective:

To research, monitor and control periodic, large-scale outbreaks of desert locusts.

Description:

Desert locusts periodically occur, and the most recent outbreak was in May/June 1990. The damage was so serious that large government expenditures were necessary to respond to and control the situation.

Although Oman is an important path for locusts moving from Africa to India and back again, sometimes locust breeding grounds are found inside Oman. Adequate research programs to investigate the mechanism behind the periodic, large outbreaks, as well as an effective monitoring and emergency control program, have not been sufficiently established. Since desert locust outbreaks occurring in Oman spread to neighboring countries as well, it is essential in the early stages of breeding to contain it and to implement prompt and effective eradication procedures.

These would be performed under the project, with the establishment of a new unit at the Rumais Research Center.

Necessary costs for this project are shown in Table 3.2.5. Personnel and operation costs necessary for the above are also shown in Table 3.2.26.

Table 3.2.5 Cost Estimation of NAR-5 Project

LOCUST SURVEY AND CONTROL PROJECT

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1. EQUIPMENTS			
(1)VEHICLES	6 NOS.	8,000	48,000
(2)SPRAYING EQUIPMENT			
HIGH VOLUME EQUIPMENT	2 SET	5,000	10,000
ULTRA LOW VOLUME EQUIPMENT	2 SET	20,000	40,000
(3)WIRELESS COMMUNICATION EQUIPMENT	6 NOS.	1,000	6,000
(4)COMPUTERS	2 SET	4,000	8,000
(5)OTHER EQUIPMENT	2 SET	4,000	8,000
SUBTOTAL			120,000
2, CONTINGENCY FOR LOCUST INVASIONS			
(1)COST PER ONE INVASION			
PESTICIDE	1 SET	150,000	150,000
AIR CRAFT RENTAL CHARGE	1 SET	300,000	300,000
OTHERS	1 SET	20,000	20,000
SUBTOTAL			470,000
(2)TOTAL COST IN 10 YEARS	4 TIMES	470,000	1,880,000
3. GRAND TOTAL 1.+2.(2)=			2,000,000

[NAR-6] Soil Surveys

Objective:

To implement soil surveys necessary for the horizontal expansion of agricultural production.

Description:

In the 10-year Master Plan, the primary objective is the vertical expansion of crop production because of the limitations of short-term development of new water sources. However, in the mid-and long-term, considerable potential for the horizontal expansion of cropped areas is anticipated once effective levels of water use are achieved through facility construction and the extension of irrigation technology to farmers.

However, in implementing horizontal expansion, not only securement of a suitable water supply, but also soil surveys to ascertain maximum appropriateness of land for farming, must be done keeping in mind the finite resources in order to ensure that land with the most production potential is targeted for development. Therefore, soil surveys should be carried out along with the water resources surveys of MWR.

At present, with cooperation from FAO, a soil survey project for 10,000 ha of virgin land is in progress. Upon completion of the project, a soil survey will be carried out at sites ranked for priority in order to assess the potential for horizontal expansion.

In carrying these out under the 10-year Master Plan, priority will be given to the Nejd Region where a high potential for water resource development exists. However, areas with particularly promising water and soil conditions would first be selected for stage-by-stage pilot farm projects to confirm first the water source, then to carry out the soil survey.

Under the project, soil surveys would also be implemented in the Sharqiya, Dakhliya and Dhahira Regions where some areas are suitable for

agricultural development.

Necessary cost estimates are allocated and shown in Table 3.2.6, but these costs should be re-examined according to the results of the above FAO project.

Table 3.2.6 Cost Estimation of NAR-6 Project

SOIL SURVEY PROJECT

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1. SHARQIYA REGION	1 SET	300,000	300,000
2. DAKHLIYA REGION	1 SET	150,000	150,000
3. DHAHIRA REGION	1 SET	150,000	150,000
4. JANUBIYA REGION	1 SET	700,000	700,000
TOTAL			1,300,000

Table 3.2.7 Staff Requirements of NAR Projects

STAFF REQUIREMENT OF PROJECTS IN AGRICULTURE RESEARCH SECTOR

NAME OF THE PROJECT	NUMBER OF STAFF REQUIRED			
	TOTAL	RESEARCHER	ASSISTANT RESEARCHER	TECHNICIAN
1. AGRICULTURAL RESEARCH FACILITIES AT JEMMAH	45	8	17	20
2. AGRICULTURAL RESEARCH FACILITIES AT SALALAH	22	11	5	6
3. AGRICULTURAL RESEARCH FACILITIES AT SOHAR	18	6	10	2
4. AGRICULTURAL RESEARCH FACILITIES IN SHARQIYA	14	5	8	1
5. AGRICULTURAL RESEARCH FACILITIES IN DHAHIRA	7	2	4	1
6. AGRICULTURAL MACHINERY RESEARCH UNIT	19	2	6	11
7. TOXICOLOGY LABORATORY	8	2	3	3
8. SEED AND TUBER PRODUCTION RESEARCH UNIT	7	1	3	3
9. CENTRAL SOIL, PLANT AND WATER ANALYSIS LABORATORY	18	2	6	10
10.LIBRARY AND DOCUMENTATION CENTER	2	1	1	
11.DISEASE AND PEST FORECASTING UNIT	5	2	2	1
12.SALT TOLERANT PLANTS AND HALOPHYTES RESEARCH UNIT	6	2	2	2
13.HONEY BEES RESEARCH UNIT	10	1	5	4
14.DATE PALM RESEARCH UNIT	28	6	10	12
15 FORESTRY IMPROVEMENT PROGRAM	6	1	5	
16.LOCUST SURVEY CENTRAL UNIT	11	1	2	8
TOTAL	226	53	89	84

Table 3.2.8 Staff Requirements of NAR Projects for 10 Years

STAFF REQUIREMENT OF PROJECTS IN AGRICULTURE RESEARCH SECTOR FOR 10 YEARS

NAME OF THE PROJECT	NUMBER OF STAFF REQUIRED									
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. AGRICULTURAL RESEARCH FACILITIES AT JEMMAH	45	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>
2. AGRICULTURAL RESEARCH FACILITIES AT SALALAH	22	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>
3. AGRICULTURAL RESEARCH FACILITIES AT SOHAR	18	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>
4. AGRICULTURAL RESEARCH FACILITIES IN SHARQIYA	14	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>
5. AGRICULTURAL RESEARCH FACILITIES IN DHAHIRA						7	>>>>>	>>>>>	>>>>>	>>>>>
6. AGRICULTURAL MACHINERY RESEARCH UNIT	19	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>
7. TOXICOLOGY LABORATORY			8	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>
8. SEED AND TUBER PRODUCTION RESEARCH UNIT				7	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>
9. CENTRAL SOIL, PLANT AND WATER ANALYSIS LABORATORY	18	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>
10.LIBRARY AND DOCUMENTATION CENTER		2	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>
11.DISEASE AND PEST FORECASTING UNIT			5	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>
12.SALT TOLERANT PLANTS AND HALOPHYTES RESEARCH UNIT				6	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>
13.HONEY BEES RESEARCH UNIT	10	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>
14.DATE PALM RESEARCH UNIT	28	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>
15.FORESTRY IMPROVEMENT PROGRAM	6	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>
16.LOCUST SURVEY CENTRAL UNIT	11	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>	>>>>>
TOTAL	191	193	206	219	219	226	226	226	226	226

Table 3.2.9 Operation Cost of NAR Projects for First Year and Other Years

NAME OF THE PROJECT	FIRST YEAR OPERATING COST (R.O.)	ANNUAL OPERATING COST (R.O.)
1. AGRICULTURAL RESEARCH FACILITIES AT JEMMAH	488,970	388,970
2. AGRICULTURAL RESEARCH FACILITIES AT SALALAH	248,725	188,725
3. AGRICULTURAL RESEARCH FACILITIES AT SOHAR	429,141	304,141
4. AGRICULTURAL RESEARCH FACILITIES IN SHARQIYA	314,838	239,838
5. AGRICULTURAL RESEARCH FACILITIES IN DHAHIRA	175,676	133,676
6. AGRICULTURAL MACHINERY RESEARCH UNIT	330,217	192,217
7. TOXICOLOGY LABORATORY	96,753	70,753
8. SEED AND TUBER PRODUCTION RESEARCH UNIT	109,299	69,299
9. CENTRAL SOIL, PLANT AND WATER ANALYSIS LABORATORY	211,846	150,846
10.LIBRARY AND DOCUMENTATION CENTER	58,954	32,954
11.DISEASE AND PEST FORECASTING UNIT	47,322	37,322
12.SALT TOLERANT PLANTS AND HALOPHYTES RESEARCH UNIT	64,798	49,798
13.HONEY BEES RESEARCH UNIT	170,810	117,810
14.DATE PALM RESEARCH UNIT	362,255	260,255
15.FORESTRY IMPROVEMENT PROGRAM	438,200	182,200
16.LOCUST SURVEY CENTRAL UNIT	159,415	104,415
TOTAL	3,707,219	2,523,219

Table 3.2.10 Operation Cost of NAR Projects for 10 Years

NAME OF THE PROJECT	ANNUAL OPERATING BUDGET									
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. AGRICULTURAL RESEARCH FACILITIES AT JEMMAH	488,970	388,970	388,970	388,970	388,970	388,970	388,970	388,970	388,970	388,970
2. AGRICULTURAL RESEARCH FACILITIES AT SALALAH	248,725	188,725	188,725	188,725	188,725	188,725	188,725	188,725	188,725	188,725
3. AGRICULTURAL RESEARCH FACILITIES AT SOHAR	429,141	304,141	304,141	304,141	304,141	304,141	304,141	304,141	304,141	304,141
4. AGRICULTURAL RESEARCH FACILITIES IN SHARQIYA	314,838	239,838	239,838	239,838	239,838	239,838	239,838	239,838	239,838	239,838
5. AGRICULTURAL RESEARCH FACILITIES IN DHAHIRA						175,676	133,676	133,676	133,676	133,676
6. AGRICULTURAL MACHINERY RESEARCH UNIT	330,217	192,217	192,217	192,217	192,217	192,217	192,217	192,217	192,217	192,217
7. TOXICOLOGY LABORATORY	96,753	70,753	70,753	70,753	70,753	70,753	70,753	70,753	70,753	70,753
8. SEED AND TUBER PRODUCTION RESEARCH UNIT		109,299	69,299	69,299	69,299	69,299	69,299	69,299	69,299	69,299
9. CENTRAL SOIL, PLANT AND WATER ANALYSIS LABORATORY	211,846	150,846	150,846	150,846	150,846	150,846	150,846	150,846	150,846	150,846
10.LIBRARY AND DOCUMENTATION CENTER		58,954	32,954	32,954	32,954	32,954	32,954	32,954	32,954	32,954
11.DISEASE AND PEST FORECASTING UNIT			47,322	37,322	37,322	37,322	37,322	37,322	37,322	37,322
12.SALT TOLERANT PLANTS AND HALOPHYTES RESEARCH UNIT				64,798	49,798	49,798	49,798	49,798	49,798	49,798
13.HONEY BEES RESEARCH UNIT	170,810	117,810	117,810	117,810	117,810	117,810	117,810	117,810	117,810	117,810
14.DATE PALM RESEARCH UNIT	362,255	260,255	260,255	260,255	260,255	260,255	260,255	260,255	260,255	260,255
15.FORESTRY IMPROVEMENT PROGRAM	438,200	182,200	182,200	182,200	182,200	182,200	182,200	182,200	182,200	182,200
16.LOCUST SURVEY CENTRAL UNIT	159,415	104,415	104,415	104,415	104,415	104,415	104,415	104,415	104,415	104,415
TOTAL	3,251,170	2,368,423	2,349,745	2,404,543	2,389,543	2,565,219	2,523,219	2,523,219	2,523,219	2,523,219

Table 3.2.11 Operation Cost of Agricultural Research Facilities at Jimmah

AGRICULTURAL RESEARCH FACILITIES AT JEMMAH

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1.STAFF			
(1) SENIOR CHEMICAL ANALYST	1 NOS.		
(2) CHEMICAL ANALYST	2 NOS.		
(3) ENTOMOLOGIST	1 NOS.		
(4) SOIL CHEMIST	1 NOS.		
(5) PATHOLOGIST	1 NOS.		
(6) AGRICULTURAL ENGINEER	6 NOS.		
(7) VEGETABLE RESEARCHER	1 NOS.		
(8) FRUIT RESEARCHER	1 NOS.		
(9) RESEARCH ASSISTANTS	11 NOS.		
(10)TECHNICIANS	20 NOS.		
(11)OTHER SUPPORTING STAFF	40 NOS.		
SUBTOTAL	85 NOS.		314,970
2.MATERIALS	1 SET	39,000	39,000
3.SERVICES	1 SET	24,000	24,000
4.TRANSFERRED EXPENDITURE	1 SET	11,000	11,000
5.CAPITAL EXPENDITURE	1 SET	100,000	100,000
TOTAL			488,970

Table 3.2.12 Operation Cost of Agricultural Research Facilities at Salalah

AGRICULTURAL RESEARCH STATION AT SALALAH

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1.STAFF			
(1) COCONUT SPECIALIST	1 NOS.		
(2) POTATO SPECIALIST	1 NOS.		
(3) CLOVER SPECIALIST	1 NOS.		
(4) BANANA SPECIALIST	1 NOS.		
(5) PLANT NUTRITION SPECIALIST	1 NOS.		
(6) BIOLOGICAL CONTROL SPECIALIST	1 NOS.		
(7) WEED CONTROL SPECIALIST	1 NOS.		
(8) AGRICULTURAL SYSTEMS SPECIALIST	1 NOS.		
(9) AGRO-ECONOMY SPECIALIST	1 NOS.		
(10)PLANT WATER SPECIALIST	1 NOS.		
(11)MEDICAL & PERFUME PLANT SPECIALIST	1 NOS.		
(12)ASSISTANT RESEARCHER	5 NOS.		
(13)TECHNICIAN	6 NOS.		
(14)OTHER SUPPORTING STAFF	11 NOS.		
SUBTOTAL	33 NOS.		153,725
2.MATERIALS	1 SET	20,000	20,000
3.SERVICES	1 SET	10,000	10,000
4.TRANSFERRED EXPENDITURE	1 SET	5,000	5,000
5.CAPITAL EXPENDITURE	1 SET	60,000	60,000
TOTAL			248,725

Table 3.2.13 Operation Cost of Agricultural Research Facilities at Sohar

AGRICULTURAL RESEARCH FACILITIES AT SOHAR

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1.STAFF			
(1)FIELD CROP SPECIALIST	1 NOS.		
(2)VEGETABLE SPECIALIST	1 NOS.		
(3)FRUIT SPECIALIST	1 NOS.		
(4)INSECT SPECIALIST	1 NOS.		
(5)PATHOLOGIST	1 NOS.		
(6)SOIL SPECIALIST	1 NOS.		
(7)HONEY BEE TECHNICIAN	2 NOS.		
(8)RESEARCH ASSISTANTS	10 NOS.		
(9)OTHER SUPPORTING STAFF	67 NOS.		
SUBTOTAL	75 NOS.		260,641
2.MATERIALS	1 SET	22,500	22,500
3.SERVICES	1 SET	12,000	12,000
4.TRANSFERRED EXPENDITURE	1 SET	9,000	9,000
5.CAPITAL EXPENDITURE	1 SET	125,000	125,000
TOTAL			429,141

Table 3.2.14 Operation Cost of Agricultural Research Facilities in Sharqiya

AGRICULTURAL RESEARCH FACILITIES IN SHARQIYA

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1.STAFF			
(1)FIELD CROP SPECIALIST	1 NOS.		
(2)VEGETABLE SPECIALIST	1 NOS.		
(3)FRUIT SPECIALIST	1 NOS.		
(4)INSECT SPECIALIST	1 NOS.		
(5)PATHOLOGIST	1 NOS.		
(6)RESEARCH ASSISTANT	8 NOS.		
(7)HONEY BEE TECHNICIAN	1 NOS.		
(8)OTHER SUPPORTING STAFF	53 NOS.		
SUBTOTAL	67 NOS.		205,338
2.MATERIALS	1 SET	20,500	20,500
3.SERVICES	1 SET	9,000	9,000
4.TRANSFERRED EXPENDITURE	1 SET	5,000	5,000
5.CAPITAL EXPENDITURE	1 SET	75,000	75,000
TOTAL			314,838

Table 3.2.15 Operation Cost of Agricultural Research Facilities in Dhahira

AGRICULTURAL RESEARCH FACILITIES IN DHAHIRA

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1.STAFF			
(1)FIELD CROP SPECIALIST	1 NOS.		
(2)VEGETABLE SPECIALIST	1 NOS.		
(3)RESEARCH ASSISTANTS	4 NOS.		
(4)HONEY BEE TECHNICIAN	1 NOS.		
(5)OTHER SUPPORTING STAFF	29 NOS.		
SUBTOTAL	36 NOS.		115,176
2.MATERIALS	1 SET	10,000	10,000
3.SERVICES	1 SET	5,000	5,000
4.TRANSFERRED EXPENDITURE	1 SET	3,500	3,500
5.CAPITAL EXPENDITURE	1 SET	42,000	42,000
TOTAL			175,676

Table 3.2.16 Operation Cost of Agricultural Machinery Research Unit

AGRICULTURAL MACHINERY RESEARCH UNIT

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1.STAFF			
(1) AGRICULTURAL MECHANIZATION EXPERT	1 NOS.		
(2) AGRICULTURAL MECHANIZATION RESEARCHER	1 NOS.		
(3) AGRICULTURAL MECHANIZATION RESEARCH ASSISTANTS	2 NOS.		
(4) AGRICULTURAL MECHANIZATION ENGINEERS	4 NOS.		
(5) AGRICULTURAL MECHANIZATION TECHNICIANS	4 NOS.		
(6) DIESEL MECHANIC	2 NOS.		
(7) PETROL MECHANICS	1 NOS.		
(8) ASSISTANT MECHANICS	4 NOS.		
(9) OTHER SUPPORTING STAFF	17 NOS.		
SUBTOTAL SUBTOTAL	36 NOS.		155,217
2.MATERIALS	1 SET	22,000	22,000
3.SERVICES	1 SET	10,000	10,500
4.TRANSFERRED EXPENDITURE	1 SET	4,500	4,500
5.CAPITAL EXPENDITURE	1 SET	138,000	138,000
TOTAL			330,217

Table 3.2.17 Operation Cost of Toxicology Laboratory

TOXICOLOGY LABORATORY

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1.STAFF			
BIOCHEMISTRY EXPERT	1 NOS.		
ASST. BIOCHEMISTRY EXPERT	1 NOS.		
BIOCHEMISTRY TECHNICIANS	3 NOS.		
LABORATORY ASSISTANT	3 NOS.		
OTHER SUPPORTING STAFF	4 NOS.		
SUBTOTAL	12 NOS.		61,753
2.MATERIALS	1 SET	4,000	4,000
3.SERVICES & TRANSFERRED EXPENDITURE	1 SET	2,000	2,000
4.SERVICES & TRANSFERRED EXPENDITURE	1 SET	3,000	3,000
5.CAPITAL EXPENDITURE	1 SET	26,000	26,000
GRAND TOTAL			96,753

Table 3.2.18 Operation Cost of Seed and Tuber Production Research Unit

SEED AND TUBER PRODUCTION RESEARCH UNIT

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1.STAFF			
(1)BREEDING SPECIALIST	1 NOS.		
(2)ASSISTANT SPECIALIST	3 NOS.		
(3)TECHNICIAN	3 NOS.		
(4)OTHER SUPPORTING STAFF	6 NOS.		
SUBTOTAL	13 NOS.		56,799
2.MATERIALS	1 SET	6,000	6,000
3.SERVICES	1 SET	3,000	3,000
4.TRANSFERRED EXPENDITURE	1 SET	3,500	3,500
5.CAPITAL EXPENDITURE	1 SET	40,000	40,000
TOTAL			109,299

Table 3.2.19 Operation Cost of Central Soil, Plant and Water Analysis Laboratory

CENTRAL SOIL, PLANT AND WATER ANALYSIS LABORATORY

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1.STAFF			
(1)SOIL CHEMISTRY EXPERT	1 NOS.		
(2)SOIL CHEMIST	1 NOS.		
(3)CHEMICAL ANALYST	3 NOS.		
(4)SOIL ENGINEER	3 NOS.		
(5)LABORATORY TECHNICIAN	5 NOS.		
(6)ASST. LABORATORY TECHNICIAN	5 NOS.		
(7)OTHER SUPPORTING STAFF	6 NOS.		
SUBTOTAL	24 NOS.		130,346
2.MATERIALS	1 SET	11000	11,000
3.SERVICES	1 SET	4000	4,000
4.TRANSFERRED EXPENDITURE	1 SET	55000	5,500
5.CAPITAL EXPENDITURE	1 SET	61000	61,000
TOTAL			211,846

Table 3.2.20 Operation Cost of Library and Documentation Center

LIBRARY AND DOCUMENTATION CENTER

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1.STAFF			
(1)LIBRARIAN	1 NOS.		
(2)ASSISTANT LIBRARIAN	1 NOS.		
(3)OTHER SUPPORTING STAFF	1 NOS.		
SUBTOTAL	3 NOS.		15,954
2.MATERIALS	1 SET	10,000	10,000
3.SERVICES	1 SET	2,500	2,500
4.TRANSFERRED EXPENDITURE	1 SET	4,500	4,500
5.CAPITAL EXPENDITURE	1 SET	26,000	26,000
TOTAL			58,954

Table 3.2.21 Operation Cost of Disease and Pest Forecasting Unit

DISEASE AND PEST FORECASTING UNIT

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1.STAFF			
(1)ENTOMOLOGY SPECIALIST	1 NOS.		
(2)PLANT PATHOLOGY SPECIALIST	1 NOS.		
(3)RESEARCH ASSISTANT	2 NOS.		
(4)TECHNICIAN	1 NOS.		
SUBTOTAL	5 NOS.		31,322
2.MATERIALS	1 SET	3,000	3,000
3.SERVICES	1 SET	2,000	2,000
4.TRANSFERRED EXPENDITURE	1 SET	1,000	1,000
5.CAPITAL EXPENDITURE	1 SET	10,000	10,000
TOTAL			47,322

Table 3.2.22 Operation Cost of Salt-Tolerant Plants and Halophytes Research Unit

SALT-TOLERANT PLANTS AND HOLOPHYTES RESEARCH UNIT

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1.STAFF			
(1)PLANT PYSIOLOGY SPECIALIST	1 NOS.		
(2)BREEDING SPECIALIST	1 NOS.		
(2)RESEARCH ASSISTANT	2 NOS.		
(3)TECHNICIAN	2 NOS.		
(4)OTHER SUPPORTING STAFF	4 NOS.		
SUBTOTAL	10 NOS.		41,798
2.MATERIALS	1 SET	5,000	5,000
3.SERVICES	1 SET	2,000	2,000
4.TRANSFERRED EXPENDITURE	1 SET	1,000	1,000
5.CAPITAL EXPENDITURE	1 SET	15,000	15,000
TOTAL			64,798

Table 3.2.23 Operation Cost of Honey-Bee Research Unit

HONEY-BEE RESEARCH UNIT

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1.STAFF			
(1)HONEY BEE RESEARCHER	1 NOS.		
(2)HONEY BEE DISEASES RESEARCH ASSISTANT	1 NOS.		
(3)RESEARCH ASSISTANT	4 NOS.		
(4)HONEY BEE TECHNICIAN	4 NOS.		
(5)OTHER SUPPORTING STAFF	15 NOS.		
SUBTOTAL	25 NOS.		98,810
2.MMATERIALS	1 SET	14,000	14,000
3.SERVICES	1 SET	2,000	2,000
4.TRANSFERRED EXPENDITURE	1 SET	3,000	3,000
5.CAPITAL EXPENDITURE	1 SET	53,000	53,000
TOTAL			170,810

Table 3.2.24 Operation Cost of Date Palm Research Unit

DATE PALM RESEARCH UNIT

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1.STAFF			
(1)SENIOR DATE RESEARCHER	1 NOS.		
(2)DATE -DISEASE RESERCHER	1 NOS.		
(3)DATE -INSECT RESEARCHER	1 NOS.		
(4)TISSUE CULTURE SPECIALIST	1 NOS.		
(5)DATE -INDUSTRY SPECIALIST	1 NOS.		
(6)RESEARCH ASSISTANTS	12 NOS.		
(7)OTHER SUPPORTING STAFF	23 NOS.		
SUBTOTAL	40 NOS.		221,255
2.MATERIALS	1 SET	21,000	21,000
3.SERVICES	1 SET	13,500	13,500
4.TRANSFERRED EXPENDITURE	1 SET	4,500	4,500
5.CAPITAL EXPENDITURE	1 SET	102,000	102,000
TOTAL			362,255

Table 3.2.25 Operation Cost of Forestry-Improvement Program

FORESTRY-IMPROVEMENT PROGRAM

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1. STAFF			
(1)FOREST RESEARCHER	1 NOS.	10,000	10,000
(2)FOREST RANGER	5 NOS.	4,800	24,000
(3)FOREST GUARD OR LABOUR	58 NOS.	2,400	139,200
(4)DRIVERS	5 NOS.	1,800	9,000
SUBTOTAL	69 NOS.		182,200

Table 3.2.26 Operation Cost of Locust Survey Central Unit

LOCUST SURVEY CENTRAL UNIT

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1.STAFF			
(1)LOCUST CONTROL SPECIALIST	1 NOS.		
(2)ENTOMOLOGIST	2 NOS.		
(3)TECHNICAL ASSISTANTS	8 NOS.		
(4)OTHER SUPPORTING STAFF	5 NOS.		
SUBTOTAL	16 NOS.		69,415
2.MATERIALS	1 SET	21,000	21,000
3.SERVICES	1 SET	2,000	2,000
4.TRANSFERRED EXPENDITURE	1 SET	12,000	12,000
5.CAPITAL EXPENDITURE	1 SET	55,000	55,000
TOTAL			159,415

[NAE-1] Improvement and Development of Extension Centers and Facilities

Objective:

To raise agricultural productivity and to improve farm management by establishing new extension sub-centers in remote areas and by upgrading extension center facilities and providing necessary extension materials and equipment.

Description:

[NAE-1-1] Establishment of Extension Centers in Remote Areas

As a result of efforts to construct agricultural extension centers under the Third Five-year Development Plan, these facilities now exist at 43 locations and provide services to major farming areas.

However, the serious lack of extension staff, facilities and equipment has constrained extension activities in remote areas. As a result, levels of cropping technology, farm production and farm management in such areas are lower than the general average for farming in the Sultanate.

As a result, under the 10-year Master Plan, extension sub-centers (including one extension center) to support the current system and extend activities to remote areas will be established. Agricultural extension staff, spray teams and livestock extension officers will be permanently stationed at the sub-centers.

The sub-centers will store agricultural chemicals, fertilizers, seed and other equipment for the farmers, as well as serve as a depot for the tractor-hire service.

Locations of extension facilities to be established are indicated below and illustrated in Figure 3.2.1. Of these facilities, the five in the Batinah Region will be implemented in the second 5-year period, and the rest will be established in the first 5-year period.

	Agriculture Extension Center	Sub-center
1. Batinah		5
2. Sharqiya		1
3. Dakhliya	1	
4. Dhahira		3
5. Musandam		2
Total	1 location	11 locations

Necessary costs estimated for the establishment of the above facilities are shown in Table 3.2.27.

In addition to the above, a pilot farm including research and extension components is to be established at Nejd in the Janubiya Region for large-scale development of agriculture. Technology developed under the project would be extended to local farmers. Components of the project are shown in section 3.6 of this volume.

As discussed in the development strategy of agricultural extension in volume 3, section 4.2.2.4, the number of extension staff vis-a-vis the farming population is seriously deficient compared to developed countries. Consequently, a nation-wide program to increase the number of extension staff and to train them for both existing and envisaged facilities is necessary.

The number of farming households in Oman according to the 1978/1979 census was 83,000. MAF estimates that the current number is in excess of 100,000. A desirable ratio of extension worker to farm household is 1 : 250 given the urgent requirements for farmer education and the need to raise their low levels of technology. In other words, 400 extension officers are required nation-wide.

Also, 20 extension supervisors to manage and monitor extension officers should be deployed.

In addition to guidance in traditional cropping methods, a portion of the extension staff will be actively managing the dissemination of

irrigation techniques in order to ensure smooth execution of Subsidy for New Irrigation System Project. This would include guidance in the operation of irrigation facilities and the measuring of water requirements, as well as collation, analysis and reporting to MAF about water-use data obtained from farmers.

Thus far, only five subject matter specialists in vegetable, fruit and field crop cultivation have been deployed. This number will be increased to include specialists in date cropping, plant protection and socio-economic specialties. As in the case of extension officers, a portion of them will provide guidance in irrigation technology towards the effective implementation of Subsidy for New Irrigation System Project. The total number of SMSs would be 49.

In implementing this project, attention will be paid to the following:

(1) In order to rectify as early as possible the gap between the existing level of farmer technology and that expected under the 10-year Master Plan, an adequate number of extension staff will be secure from the initial stage. These will be secured during the 10-year period.

(2) At the outset, new extension center personnel will be obtained largely from outside Oman, with steady Omanization of extension officers through a planned program of technology transfer from expatriate to local staff. Therefore, a well-planned adoption of Omani extension personnel is anticipated.

(3) It would be feasible to gradually phase out the number of expatriate extension workers once farmer levels of training and technology have been raised to a point where stable farm self-management is attained.

(4) A combination of classroom programs and on-the-job training for extension officers will be established to include basic academic, specialized and extension technology aspects. Components of this training program are described in "NAE-3" of this section.

(5) Extension officer candidates should be selected on the basis of examinations and interviews to determine their academic ability, knowledge and general motivation. In the future, it is recommended that some form of qualification system be introduced. The JICA team has tentatively proposed the following:

(a) Subject matter specialist : Ph.D. or M.Sc. with several years experience, or B.Sc. with many years of experience

(b) Extension Supervisor : M.Sc. or B.Sc. with several years experience in extension, or junior college or agricultural high school graduate with many years of experience

(c) Extension Officer : B.Sc. or junior college or agricultural institute graduate with several years experience in extension

(d) Extension Support Staff : Junior college or agricultural high school graduate

Deployment of the above extension personnel is indicated in Table 3.2.28, and the recurrent budget for them is shown in Table 3.2.29. This deployment under the Master Plan is expected to remain at the same level until 2000.

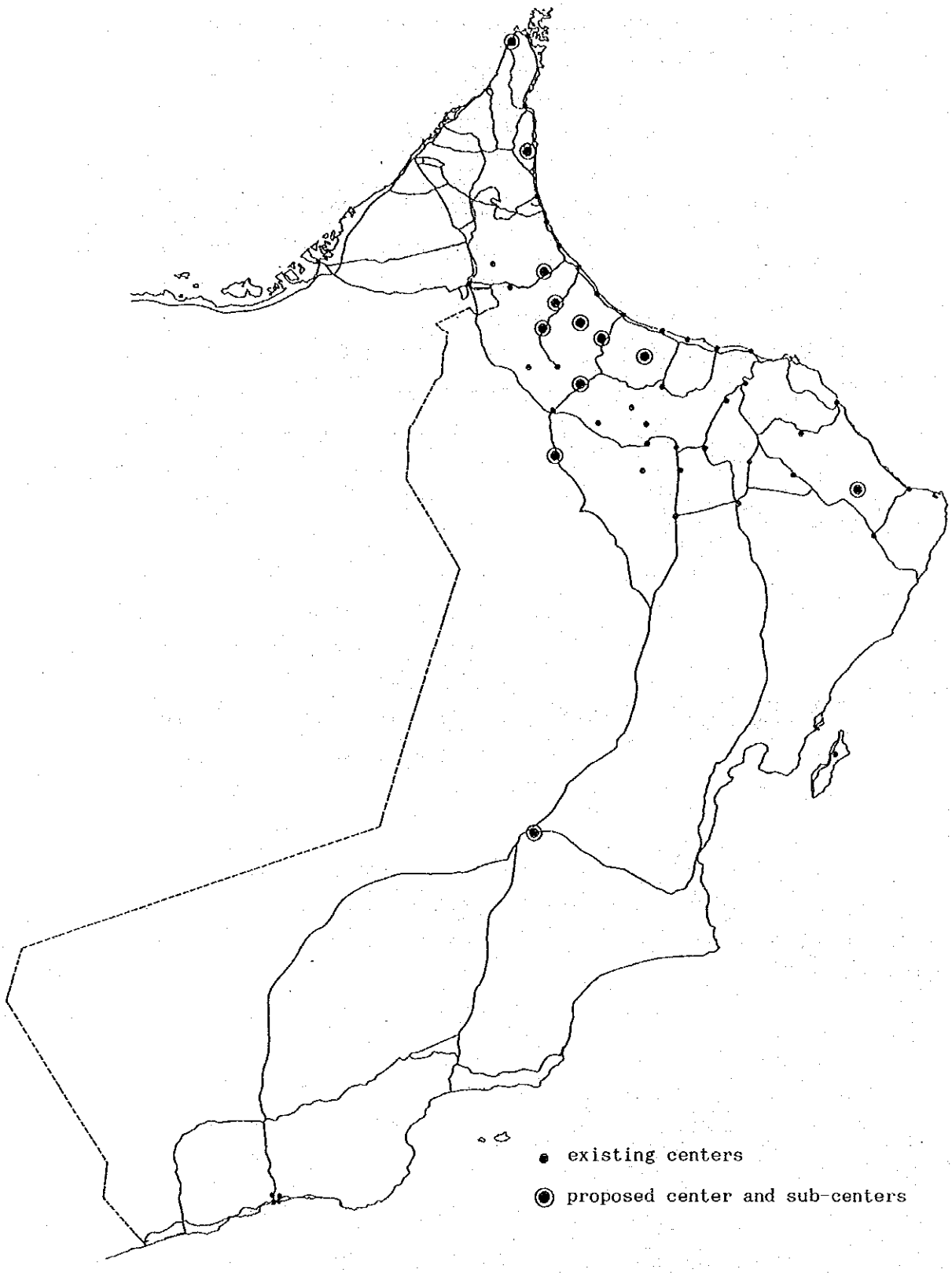


Figure 3.2.1 Location of Extension Centers and Sub-centers

Table 3.2.27 Cost Estimation of NAE-1-1 Project

1. EXTENSION CENTER
@ 100,000 (R.O./CENTER) (1 CENTER)

	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
BUILDING	300 m²	200	60,000
WORKSHOP & STORAGE	150 m²	100	15,000
OTHER CONSTRUCTION	1 SET		15,000
FURNITUIRE	1 SET		6,000
OTHER OFFICE EQUIPMENT	1 SET		4,000
TOTAL			100,000

2. EXTENSION SUB-CENTERS
@ 50,000 (R.O./CENTER) × 11 CENTERS = R.O. 550,000

	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
BUILDING	125 m²	200	25,000
WORKSHOP & STORAGE	100 m²	100	10,000
OTHER CONSTRUCTION	1 SET		10,000
FURNITUIRE	1 SET		3,000
OTHER OFFICE EQUIPMENT	1 SET		2,000
TOTAL			50,000

GRAND TOTAL 1+2= R.O. 650,000

Table 3.2.28 Extension Staff Increase Plan

EXTENSION STAFF INCREASE PLAN

NO	AGRICULTURAL REGION NAME	EXTENSION STAFF 1989 OFFICER	1989 OFFICER ASSISTANT	NUMBER IN 1995 SUPER-VISOR	1995 OFFICER	1995 OFFICER ASSISTANT	INCREASE 1989→1995 SUPER-VISOR	INCREASE 1989→1995 OFFICER	INCREASE 1989→1995 OFFICER ASSISTANT	SUBJECT MATTER SPECIALIST NUMBER IN 1989	NUMBER IN 1995	INCREASE 1989→95
1	SOUTH BATINAH	1	10	2	19	59	2	18	49		6	6
2	NORTH BATINAH	1	13	3	22	68	3	21	55	1	5	4
3	SHARQIA	1	14	2	12	37	2	11	23	2	6	4
4	OMAN INTERIOR	1	20	2	12	33	2	11	13	2	6	4
5	WUSTA	1	5	2	5	14	2	4	9		2	2
6	DAHIRAH	2	10	2	11	33	2	9	23		6	6
7	BURAIMI	1	3	1	3	9	1	2	6		5	5
8	MUSANDAM	1	4	1	5	12	1	4	8		6	6
9	SOUTH REGION	1	6	2	11	35	2	10	29		7	7
MI	NISTRY'S OFFIC	1		3			3	-1	0			0
	TOTAL	11	85	20	100	300	20	89	215	5	49	44

Table 3.2.29 Operation Cost of NAE-1-1 Project

Item	Character	Numbers	Unit Price (R.O.)	Total Cost (R.O.)
1. Staff				
Extension Supervisor	2.2	20 Nos.	6,912	138,240
Extension Officer	4.2	89 Nos.	3,372	300,108
Extension Officer Assistant	5.2	215 Nos.	2,808	603,720
Subject Matter Specialist	2.2	44 Nos.	6,912	304,128
Sub Total		368 Nos.		1,346,196
2. Operation				
Vehicle Operation		400 Nos.	600	240,000
Maintenance		0.01 %	650,000	6,500
Running		0.05 %	650,000	32,500
Sub Total				279,000
Total				1,625,196

[NAE-1-2] Improvement of Extension Center Facilities

The following equipment and materials will be needed to strengthen extension activities:

(1) Mobile A/V Unit

Opportunities for direct contact between extension officers and as many farmers as possible should be increased. At such times, it will be important to deploy audio-visual material effectively and to maximize the benefits of the extension services.

Audio-visual materials will be taken in these mobile A/V units to places where farmer groups gather. There, previously agreed upon daily topics will be illustrated with materials on VTRs and other equipment. After, the contents will be discussed with the farmers to ensure their understanding.

One in each agricultural region, nine units in total, will be provided.

(2) Computers

Since the latter part of the Third Five-year Development Plan, files have been created containing current information on management and cropping patterns for each of the 2,500 key farmers. Under the "Supporting Key Farmer Extension Program", the number of key farmers is to be expanded to 3,000 (see "NAE-4-1" project in this section).

For the training of these new key farmers, extension staff will require a rapid data processing system. To provide this, data management with computer is to be introduced for prompt processing of information pertinent to farm management, crops, cropping seasons, cultivation areas, harvest seasons and pest control.

Computers will also be utilized for the collation, analysis and report to MAF by extension officers regarding water use data obtained from farmers under Subsidy for New Irrigation System Project.

One computer will be provided for each extension center.

(3) Simple Analytical Equipment for Soil and Water

All samples of soil and water are sent to the Rumais Agricultural Research Center and analyzed there. This takes a long time and makes it impossible to respond promptly to needs in the field. The work also takes up a disproportionate amount of the work time at the Agricultural Research Center. Simple analytical equipment provided to the extension centers would allow for analysis to be conducted there. This in turn would speed up the process of extending guidance to the farmer.

The necessary costs estimated for this project are shown in Table 3.2.30. This equipment will be provided within the first 5-year period.

[NAE-1-3] Development of Agricultural Technology Information Units (ATIU)

These Agricultural Technology Information Units (ATIU) will be established at the 44 extension centers (43 existing centers and 1 new center). These units will provide technical information to general and key farmers on agriculture and horticulture. Simple introductions to farming practices and farm inputs will be performed through a free access program for farmers and rural housewives alike, with facilities for viewing video tapes, diagrams, etc., and places for meetings. The units will provide significant information towards improving farm management, including crop market prices, etc.

In addition to improving farm income, a general enhancement of daily rural life is important for raising the standard of living in farming villages. Such aspects include improving health, sanitation, and nutrition.

These information units will undertake to provide the training, support and guidance for activities on promoting ways to address these aspects. However, to confront this wide range of issues, cooperation between the ministries concerned will be necessary. The Agricultural

Development Support Communication Center described in "NAE-2" in this section will be fully utilized in conjunction with activities under this project.

Necessary costs for this project are shown in Table 3.2.31. These units will be established within the first 5-year period.

Table 3.2.30 Cost Estimation of NAE-1-2 Project

1. MOBILE AUDIO/VISUAL UNIT				
@ 20,000 (R.O./UNIT) ×	9 REGIONS = R.O.			180,000
2. VEHICLES				
1/2 (NOS./STAFF) ×	400 STAFF = NOS.			200
@ 6,000 (R.O./VEHICLE) ×	200 VEHICLES = R.O.			1,200,000
3. OTHER EQUIPMENT				
@ 5,000 (R.O./CENTER) ×	44 CENTERS = R.O.			220,000
	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)	
COMPUTER SYSTEM	1 SET	1,500	1,500	
SIMPLE ANALYZER (SOIL & WATER)	1 SET	3,500	3,500	
TOTAL			5,000	
4. COMPUTOR SOFTWARE DEVELOPMENT		R.O.		20,000
DEVELOPMENT BUDGET GRAND TOTAL		R.O.		1,620,000

Table 3.2.31 Cost Estimation of NAE-1-3 Project

@ 50,000 (R.O./CENTER) × 44 CENTERS = R.O. 2,200,000

	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
BUILDING	400 ㎡	100	40,000
VISUAL DISPLAY	1 SET	6,000	6,000
FURNITURE AND OTHERS	1 SET	4,000	4,000
TOTAL			50,000

[NAE-2] Establishment of Development Support Communication Center (DSCC)

Objective:

Development and application of audio-visual materials to upgrade the level of farm knowledge and technology.

Description:

In keeping with the increase in farmer knowledge, the following step-by-step procedure will be aimed at.

(1) Information is disseminated to farmers by radio and other audio equipment.

(2) It is ensured that farmers understand the meaning of the information.

(3) Farmers are motivated to use the information to change traditional practices.

(4) Videos and other visual aids are used to impress upon farmers and convince them of the advantages of applying the new information.

(5) Under the guidance of extension staff, farmers are encouraged to try new technology.

(6) Through continued implementation, farmers master the new technology.

In order to support the above, the DSCC, as a part of MAF's overall extension activities, will develop videos, radio and TV programs, and printed materials. These efforts will be integrated with those of other agencies such as MSA towards overall improvement of the standard of living in rural areas. Materials developed under this project will be used as well by training centers, agricultural technology information units and mobile A/V units.

Developed materials will make up a program in line with that set out in "Audio-visual Farmers Training" in volume 3, section 4.2.2.4 -- development strategy of agricultural extension.

A subsequent review and analysis of the effect of media use, timeliness of topics, ease or difficulty of understanding, farmer reaction, and effectivity in extension will be essential in the improvement of future extension activities. Research experts will be permanently deployed for this purpose. The report on the foregoing items will be fed back to the DSCC research experts for study and analysis, and the application of findings will be used for the development of new materials.

Necessary costs for the establishment of this center are shown in Table 3.2.32. Necessary personnel and operating costs for the DSCC are shown in Table 3.2.33.

A committee centering around MAF but including representatives from all concerned agencies will monitor operation of the DSCC in light of its integrated role in the development of rural areas.

These agencies will be:

(1) The Ministry of Agriculture and Fisheries
(2) The Ministry of Social Affairs
(3) The Ministry of Education and Youth Affairs
(4) The Ministry of Health
(5) Public Authority for Marketing Agricultural Produce
(6) Oman Bank for Agriculture and Fisheries

Coordinators will be included in the necessary personnel of DSCC in Table 3.2.33 and will specifically work to ensure a smooth liaison between all the concerned agencies.

Table 3.2.32 Cost Estimation of NAE-2 Project

Items	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1. BUILDING	1,500 ㎡	400	600,000
2. COMPUTER SET	1 SET	13,000	13,000
3. VIDEO STUDIO AND OTHERS			
①VIDEO STUDIO SYSTEMS	1 SET	50,000	50,000
②FIELD PRODUCTION SYSTEM	1 SET	45,000	45,000
③EDITING SYSTEM	1 SET	50,000	50,000
④DUPLICATING SYSTEM	1 SET	5,000	5,000
⑤VIDEO LIBRARY, LECTURE ROOM,etc.	1 SET	25,000	25,000
4. A/V MOBILE SYSTEM	1 SET	38,000	38,000
5. PRINTING EQUIPMENT	1 SET	180,000	180,000
6. AUDIO STUDIO & OTHERS			
①AUDIO STUDIO	1 SET	25,000	25,000
②OTHERS	1 SET	50,000	50,000
7. PHOTOGRAPHIC EQUIPMENT	1 SET	20,000	20,000
8. SCREENING & DISSEMINATION EQUIPMENT	1 SET	20,000	20,000
9. OFFICE EQUIPMENT & OTHERS	1 SET	15,000	15,000
10.VEHICLES	9 SET	6,000	54,000
TOTAL			1,190,000

Table 3.2.33 Operation Cost of NAE-2 Project

ITEM / YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1.STAFF										
DIRECTOR COMMUNICATION EXPERT (HEAD CREATIVE SERVICES) OR (HEAD ADMINISTRATION AND FINANCE)	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
SENIOR EDITOR (RESEARCHER) SENIOR GRAPHIC DESIGNER SMALL FORMAT MEDIA PRODUCER PHOTOGRAPHER SENIOR VIDEO PRODUCER SENIOR SOUNDMAN HEAD OUTREACH PROGRAMME		50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
EDITOR (RESEARCHER) (2 PERSONS) ILLUSTRATOR GRAPHIC DESIGNER AUDIO/RADIO PRODUCER (2 PERSONS) VIDEO CAMERAMAN/EDITOR TRAINING SPECIALIST (3 PERSONS) INTEGRATED DEVELOPMENT COODINATOR (2 PERSONS) ACCONTS CLERK SENIOR SECRETARY SECRETARY PRINT SHOP OPERATOR (2 PERSONS) DARKROOM TECHNICIAN TAPE LIBRARIAN EQUIPMENT MAINTENANCE TECHNICIAN(2) OTHERS (11 PERSONS)			132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000
2.OVERTIME	5,000	15,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
3.MATERIALS FOR PRODUCTION		30,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000
4.MAINTENANCE		21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000	21,000
5.SPARE PARTS:VIDEO,AUDIO,VEHICLES,etc.		5,000	5,000	15,000	20,000	20,000	20,000	20,000	20,000	20,000
6.CONSUMPTION OF WATER & ELECTRICITY	3,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000
7.FUEL, OIL, etc.	10,000	30,000	35,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000
TOTAL	43,000	183,000	355,000	370,000	375,000	375,000	375,000	375,000	375,000	375,000
	GRAND TOTAL FOR FIRST 5 YEARS				1,326,000	GRAND TOTAL FOR SECOND 5 YEARS				3,201,000

[NAE-3] Training of Research, Extension and Statistics Staff

Objective:

To establish facilities for training research, extension and statistical staff. To carry out above-mentioned training.

Description:

The proper training of a sufficient number of extension workers is essential. This should begin with basic classroom training particularly in the case of those with only high school level educations. This should be supplemented by on-the-job training for all trainees to develop skills applicable to the field. These will include quick response to actual situations, and communication and leadership skills.

The following points will be focused upon:

(1) Establishment of necessary facilities, equipment and materials for training

Centers for the training of extension staff will be established and training equipment and materials provided.

(2) Establishment of training program

A training program will be established under the project. It will be carefully formulated with units forming a curriculum progressing smoothly from one level of difficulty to the next. Single units will be of sufficiently modest scope to be readily digestible by trainees. The training program will include (or try to include) university professors and agricultural research experts to reinforce specialized instruction.

(3) Practical leadership skills

The effective extension of new technology to farmers is not possible without practical experience on the part of the extension

officer. On-the-job training in providing practical guidance to farmers will thus be an important part of the curriculum.

The research staff, at the agricultural research stations to be established at various points in the country under the 10-year Master Plan, will receive training in basic and analytical techniques developed at the Rumais Agricultural Research Center and attend lectures by expatriate research experts who will be invited from outside Oman in a range of specialities.

The agricultural statistical staff will receive training under the project in statistical surveys and analytical methods.

One-year study-abroad opportunities at foreign universities and research institutions will be extended to a select number of extension officers each year for exposure to the latest agricultural research and technology being pursued in developed countries.

<Training Center Description>

(1) Rumais Training Center

Training centers for extension officers are to be established at the Rumais Agricultural Research Center. Research experts will assume the roles of instructors, and training will be provided in such areas as cropping techniques, crop protection, farm management, and new developments in experimental research.

Facilities should include classrooms, a laboratory, a workshop, a library, meeting rooms and basic living facilities such as a dormitory, cafeteria, etc. Practical learning facilities will include an experimental farm and post-harvest facilities. Teaching aids to support training will include slides, photographs, charts, models, tape recorders and VTR's and other audio-visual equipment.

These training centers are primarily to train extension officers but they should also undertake the following activities:

(a) The centers should function as a forum for exchange between researchers and extension officers, thereby providing feedback to research institutions, universities, and other entities engaged in agricultural research.

(b) Audio-visual educational materials considered indispensable to providing effective extension and training services should be developed in cooperation with the Development Support Communication Center (see "NAE-2" in this section).

(c) Outside experts from PAMAP and elsewhere should be invited to assist in providing not only extension officers and research staff, but also any other interested parties with short-term training on agricultural production, gathering and selling crops, marketing and other specialized areas of concern.

(d) The research staff at the agricultural research stations should receive training in basic and analytical techniques as well as receive lectures by expatriate research experts.

(e) Training ought to be provided on the methodology of agricultural statistical surveys.

(2) Southern Region Training Center

In this training center, training will not only be provided extension staff and researchers, but also for farmers who are to settle in the Nejd development area. Training for the latter will be carried out in cooperation with the pilot farm in the Nejd area (see section 3.6). This center will be at Salalah or in the Nejd area.

The necessary costs estimated for the establishment of these centers and the training programs are shown in Table 3.2.34. The staff to be deployed and the operation costs are shown in Table 3.2.35.

Table 3.2.34 Cost Estimation of NAE-3 Project

1. ESTABLISHMENT OF TRAINING CENTER (RUMAIS)

	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
CENTER BUILDING (INCLUDING DORMITORY)	1,500 ㎡	150	225,000
WORKSHOP	1000 ㎡	50	50,000
COMPUTER SYSTEM	10 SET	1,500	15,000
SIMPLE ANALYZER (SOIL & WATER)	10 SET	3,500	35,000
OTHER EQUIPMENT	1 SET	9,000	9,000
VEHICLE	2 NOS.	6,000	12,000
MINI-BUS	3 NOS.	13,000	39,000
TOTAL			385,000

2. ESTABLISHMENT OF TRAINING CENTER (SOUTHERN REGION)

	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
CENTER BUILDING (INCLUDING DORMITORY)	400 ㎡	150	60,000
MECHANICAL WORKSHOP	200 ㎡	50	10,000
FIELD WORKSHOP	200 ㎡	50	10,000
OTHER EQUIPMENT	1 SET	2,000	2,000
VEHICLE	3 NOS.	6,000	18,000
TOTAL			100,000

3. TRAINING OF RESEARCHERS IN THE TRAINING CENTER

100 (PERSONS /10 YEARS) × 220 R.O. = 22,000

	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
TRANSPORTATION EXPENSES	1 SET	40	40
ACCOMODATION CHARGE	10 DAYS	15	150
OTHERS	10 DAYS	3	30
TOTAL			220

4. TRAINING OF EXTENSION STAFF IN THE TRAINING CENTER & THE DSCC

2,000 (PERSONS /10 YEARS) × 410 R.O. = 820,000

	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
TRANSPORTATION EXPENSES	1 SET	50	50
ACCOMODATION CHARGE	20 DAYS	15	300
OTHERS	20 DAYS	3	60
TOTAL			410

Table 3.2.34 Cost Estimation of NAE-3 Project (continued)

5. TRAINING OF EXTENSION STAFF ABROAD

80 (PERSONS /10 YEARS) × 12,350 R.O. = 988,000

	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
TRANSPORTATION EXPENSES	1 SET	250	250
ACCOMODATION CHARGE	360 DAYS	30	10,800
OTHERS	1 DAYS	1,300	1,300
TOTAL			12,350

6. TRAINING OF AGRICULTURAL STATISTIC STAFF IN THE TRAINING CENTER

500 (PERSONS /10 YEARS) × 410 R.O. = 205,000

	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
TRANSPORTATION EXPENSES	1 SET	50	50
ACCOMODATION CHARGE	20 DAYS	15	300
OTHERS	20 DAYS	3	60
TOTAL			410

DEVELOPMENT BUDGET GRAND TOTAL 1+2+3+4+5+6= 2,520,000

Table 3.2.35 Operation Cost of NAE-3 Project

TRAINING CENTER (RUMAIS)

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1.STAFF			
(1)SUPERVISOR FOR THE CENTRE	1 NOS.		
(2)TRAINING COORDINATOR	1 NOS.		
(3)TYPIST	1 NOS.		
(4)PUBLIC RELATIONS OFFICER	1 NOS.		
(5)OTHER SUPPORTING STAFF	7 NOS.		
SUBTOTAL	11 NOS.		30,784
2.MATERIALS	1 SET	15,500	15,500
3.SERVICES	1 SET	3,000	3,000
4.TRANSFERRED EXPENDITURE	1 SET	6,500	6,500
5.CAPITAL EXPENDITURE	1 SET	55,000	55,000
TOTAL			110,784

TRAINING CENTER (SOUTHEN REGION)

ITEMS	NUMBERS	UNIT PRICE (R.O.)	TOTAL COST (R.O.)
1.STAFF			
(1)SUPERVISOR FOR THE CENTRE	1 NOS.		
(2)TRAINING COORDINATOR	1 NOS.		
(3)TYPIST	1 NOS.		
(4)OTHER SUPPORTING STAFF	4 NOS.		
SUBTOTAL	7 NOS.		17,964
2.MATERIALS	1 SET	5,000	5,000
3.SERVICES	1 SET	2,000	2,000
4.TRANSFERRED EXPENDITURE	1 SET	1,000	1,000
5.CAPITAL EXPENDITURE	1 SET	15,000	15,000
TOTAL			40,964