

APPENDIX - 9
AGRICULTURAL DEVELOPMENT PLAN

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A-9.1 Socio-economic Situation of Oman

A-9.1.1 Economic Situation

(1) General Outline

Since oil went into production in 1967 Oman has had an oil-based economy, subject to the unpredictable changes of the world price of crude oil. This was well illustrated in 1986 when there was a sudden and violent slump in this international price, necessitating a 11.3% devaluation in the value of the Omani Rial, from OR 0.3454 to OR 0.3845 per US\$. This unpredictability also created difficulties for forward budgeting. Although the world price of crude oil has made a considerable recovery since 1986, during the latter half of 1980s it has hovered between US\$ 12 (1986) and US\$ 16 (1989), which was below the figure of US\$ 18 per a barrel, a comfortable value for the Omani economy.

In recent years, Omani economy showed a favourable development up to 1992, however it hovered around from 1993, under the influence of fall of the international price of crude oil that occupied more than 35% of GDP.

Growth Rate of GDP (%) and Crude Oil Price (US\$ / barrel)

GDP / Year	1989	1990	1991	1992	1993	1994
Substantially	3.3	7.5	9.2	6.8	1.7	-3.6
Nominally	10.4	25.4	21.3	12.8	0.8	-4.1
Sales Price of Oil by Government	16.25	21.28	17.44	18.00	15.59	16.12 (Jan-Sep)

Source: MOD

The Omani economy is centrally managed by virtue of the dominant role played by oil revenue, which all accrues to the Government. However, private enterprise is actively encouraged in agriculture, fisheries and manufacturing as well as banking and other financial services. All the new economic and social infrastructure has been funded by the Government, and private sector economic activity is subsidised in various ways.

The economic situation in 1995 was that the international price of crude oil which occupies an approximately 75 % of the national revenue, change with a level over 15 US\$ per barrel through a year, and contributed for a improvement of budget deficit. Some other time, a price also has been stable, though the economy showed a steady growth, hovering of a crude oil price drops a shadow on the national budget still, and a maximum reduction in budget deficit becomes a large task of the Government. In 1996, high oil prices slashed Oman's budget deficit by more than two-thirds in the first seven months of the year.

(2) Gross Domestic Product (GDP)

GDP growth rates during the periods of 1981 to 1985, 1986 to 1990 and 1991 to 1993 were 8.5%, 9.7% and 5.5% respectively. The average annual GDP growth rate exceeded GDP growth rates attained by East Asian and Pacific countries. Consequently, GDP per capita increased during the period of 1970 to 1993 to an annual average per capita growth rate of 9%.

The continued efforts of Oman to change the structure of the Omani economy have been reflected in the increase of the GDP shares of the non-oil sectors from 31% in 1970 to about 63% in 1994. The industrial and the public sectors scored highest growth rates among the non-oil sectors, increasing from 1.2% and 18.9% in 1976 to 7.4% and 29.8% in 1994 respectively.

Final overall consumption, as a percentage of GDP, increased from 52.2% in 1980 to 74.4% in 1994. Private consumption increased from 28% of GDP in 1980 to about 46.2% of GDP in 1994 as a result of a rise in the standard of living in the same period. Government consumption constituted 28.2% of GDP in 1994, compared to 24.2% in 1980. This increase reflects Government's commitment to provide a decent and comprehensive level of basic services. Overall investments, as a percentage of GDP, reached 19% on the average during the period of 1980 to 1994.

(3) National Budget and Balance of Government's Account

Nevertheless, the annual budget deficit has been increasing in recent years, necessitating reductions in departmental budgets in 1994. The estimated budget deficit for 1995 is RO 274 million, or 13% of total public revenues, which is still high. Estimated expenditure during 1994 was RO 2,253 million, while revenues totalled about RO 1,757 million, for a deficit of RO 496 million.

In accordance with budget estimates for the fiscal year 1996 effective as from January, total revenues were estimated at RO 1,934 million registering an increase for 4.7% over estimates for 1995 (RO 1,847 million). Total expenditure is expected to reach RO 2,152 million showing a small decrease of 0.3% compared to 1995 estimates of RO 2,159 million. Oil revenues were estimated at RO 1,473 million showing an increase of about 9% over 1995 budget (Central Bank of Oman).

(4) International Trade

Currently, oil is Oman's most important export item. Percentage of oil exports, as a part of overall exports, decreased from 91.7% in 1984 to 75.8% in 1994. Non-oil exports and re-exports, on the other hand, increased from 8.3% to 24.2% in the same period. As a result of the Oman's open door policy with the outside world, the percentage of goods and services exported during the period of 1980 to 1994 reached about 50% of GDP, while the percentage of imports ranged between 25% and 36% of GDP over the same period.

Oman's non-oil exports continue to grow rapidly. A preliminary estimate suggests that non-oil commodity exports rose nearly 19% in 1994 to RO 145 million, from RO 123 million in 1993. Oil exports were little changed from 1993 at about RO 1,627 million. When re-exports are included, total exports were in excess of RO 2,130 million, while imports were RO 1,505 million, to provide an estimated trade surplus of RO 625 million.

Oman's trade relations with the countries from which it imports underwent little change between 1984 and 1994. Japan, Britain, and the USA remain the Oman's most important trading countries. The imports from the UAE, for instance, reached 29.1%; from Japan 19.9%; and from USA 6.7% in 1994.

(5) Inflation

When the average GDP annual growth rate reached 3.7% in current prices though out the period of 1990 to 1994, the price indices reached an average annual growth rate of 0.5% in the same period. The GDP annual growth rate reached 7.3% in constant prices throughout the period of 1990 to 1993, whereas the price indices reached an average annual growth rate of 2.2% in the same period. Muscat consumer price index in 1995 is decreased to 1.3% compared with previous year. A general decline in world commodity prices together with the restrained monetary policy followed by the Central Bank have played a major part in keeping the rate of inflation well under control.

(6) Points of Issue of Economy

At present, as a domestic matter, an important item which rises to the social condition is 'Omanization'. As being a campaign that exchange as taking the workforce of the foreign workers who shoulder modernisation of Oman substantially with the Omani workforce, His Majesty by himself leads it. As the background: 1) Result of educational popularisation, supply of educated Omani workforce to laborious market will increase, 2) At present, the population of Oman is increasing with an annual rate of 3.5 to 4.0%, population under 20 years will reach more than the half of total population and a rapid increase of the Omani workforce will be avoidable state in the future, 3) Possible extraction of petroleum with current production speed seems to last for 20 years, etc. Therefore, an intentional reformation and a technological education to labour of the Omani people become an urgent matter.

Economic Indicators

Gross Domestic Product (1994)	RO 4,346 million
Growth Rate of GDP (1994/1995)	7.4%
GDP per Capita (1994)	RO 2,154 = US\$ 5,599
Oil Production (1994)	295 million barrel
Total Government Revenue (1996 estimate)	RO 1,934 million
Oil Revenue as a % of Total (1996 estimate)	76.2%
Total Government Expenditure (1996 budget)	RO 1,769 million
Budget Deficit (1996 estimates)	RO 165 million
Total Export Value (1994)	RO 2,132 million
Non-oil Exports Proportion (1994)	6.8%
Total Import Value (1994)	RO 1,505 million
Foreign Debt (1994)	RO 1,053 million
Dept Service Ration (1994)	11.7%
Currency (1995)	Omani Rial equals to US\$ 2.60
(1996/10)	Omani Rial equals to US\$ 2.58

Social Indicators

Total Population (1994)	2.018 million
Percentage of Omanis (1994)	74%
Percentage of Urban Population (1994)	72%
Families Number (1994)	287 thousand

Percentage of Economically Active Population

Omani	38%
Non-Omani	91%
Government Employees (1994)	106 thousand
Private Sector Employees (1994)	526 thousand
Births Rates per 1,000 (1994)	39.0
Infant Mortality per 1,000 (1994)	23.0
Average Life Expectancy (1993)	69 years
Illiteracy Rate among Omanis (1993)	41%
Drinking Water Services (1993)	82%

Source: MOD

A-9.1.2 Agricultural Situation

(1) General Outline

Before 1970, the Omanis economy, which was virtually a subsistence economy, was entirely based on agriculture and fisheries. Until oil went into production the meagre trading resources were limited to dates, limes and skins. After the initial construction phase of oil industry is completed, over half of the total population is still engaged in the agricultural and fisheries industry, and the 1993 census showed that 50% of the population still live in rural areas.

The agricultural sector is basic component of Oman's economy until now. Agricultural and fisheries sector occupies 5.6% of the total non-oil GDP in 1994. It helps diversify the sources of national income, contributes to food security and makes the country self-sufficient in agricultural produce. However, Oman is located in an arid zone and high temperature and low rainfall hamper the development of agriculture in spite of the availability of large area of arable lands, by reason of no water support farming activity in these area.

(2) Production

Only 55,000 ha (1995) of a total arable land area of 198,000 ha is under cultivation. More than half of cultivation area is located in Batinah coast. The majority of farmers is small-scale less than 1 ha, and productivity is low. Approximately 787 thousands people hold cultivable land and the total number of agricultural workers is around 188 thousands. Main crops are dates, lime, watermelon, beans, okra, cabbage etc.

The value of agricultural and fisheries production rose from OR 17 million in 1970 to OR 156 million by 1994. In 1994 agricultural production totalled around 802,000 t, of which livestock was about 23,000 t and fish production 114,300 t. Oman is now the leading livestock producer in the Gulf region. According to the 1994 census there are more than 225,000 cattle, 183,000 sheep, 854,000 goats and 98,550 camels, a growth of 6% over the previous year. Agriculture and fisheries are Oman's main non-oil exports, representing 70% of the country's non-oil exports.

The MAF was enabled to achieve nearly 50% self-sufficient in food production by the end of 1994. During 1990s the MAF has set itself the target of increasing the production of poultry meat, eggs and fresh milk by 100%, and the production of meat from grazing animals by 48% by the year 2000.

Local agricultural products face heavy competition from imported products. The cost of production is comparatively high in Oman as compared to other countries in the region. In addition, there are problems related to labour and marketing while finance is required for introducing modern methods and techniques. In view of these problems, the MAF has adopted package of measures to improve agricultural production in the country.

(3) Subsidies

Government subsidies to agriculture play an important role in Oman. The subsidy programme has been launched to promote economic diversification, food self-sufficiency and higher incomes. The programme provides subsidies in four main categories:

- a. Recurrent inputs including most of the seasonal production inputs like seeds, fertilisers, pesticides, etc.
- b. Durable inputs such as tractors, sprayers and pumps. The subsidy is reflected in the preferentially low interest loan to purchase them from Oman Bank for Agriculture and Fisheries.
- c. Government services including extension, veterinary services, chemical spraying and tractor hire services.
- d. Price support to agricultural produce.

New regulations on agricultural subsidies were issued in 1992. The MAF subsidises the cost of agricultural mechanical equipment to encourage farmers to use it. Items covered include ploughs, reapers, binders, chemical sprayers, mechanical saws and small agricultural implements. A Government subsidy of 75% for modern irrigation system upto 4ha farms is provided since 1991. Other subsidies cover chemical fertilisers, seeds,

pesticides, fruit seedlings, plastic covers, cloches and compost. The Government has also reduced unit prices of electricity and diesel used for farming and agricultural industry projects. It extends technical and financial help to introduce modern irrigation methods such as motor pumps and install pipes that will minimise water loss. These subsidies range from 25 to 100% of the basic cost of the appliance.

A-9.2 Development Plan

A-9.2.1 National Development Plan

(1) Previous National Development Plans

The national policy is a part of the long term development strategy of the nation. The economic development five-year plan that indicates short- and/or middle-term economic development of the Government, began from the First Five-year Plan of 1976-1980. With this, the main aims were put on improvement of social infrastructures and establishment of basic industry. At the Second Five-year Plan (1981-1985) the important points were kept by infrastructure improvement and industrial promotion continually, however as an influence of fall of oil price, the plan scale should be reduced. The Third Five-year Plan (1986-1990), though improvement of social infrastructures in the rural area and promotion of agriculture, fishery and small/middle industries as important marks, with an influence of large fall of the international oil price since beginning in the start year, it should be reconsidered of its new development projects and was unavoidably postponed.

The aims of the developmental strategy of the previous five-year plans include:

- a. Diversification of the resources of national income by developing new resources to augment and eventually to replace oil revenues.
- b. Increase in the ratio of investment directed to income-generating projects, particularly in activities of agriculture.
- c. Fair distribution of national investment among geographic regions, with special priority assigned to the less developed areas.
- d. Development of existing settlements to discourage undue migration to the larger cities.
- e. Protection of water resources and the environment.
- f. Development of human resources, particularly by improving opportunities for Omanis for training and employment.
- g. Provision of the infrastructure necessary to achieve the other aims.

(2) Fourth Five-year Plan

As started since 1991 the Fourth Five-year Plan (1991-1995), besides of the past aims of the strategy included the aims of establishing the components of a free market economy and the removal of constraints to free market operation and competition, and the following are considered as fundamental items:

- a. Development and promotion of the revenue sources of the nation replacing oil.
- b. Investment to the sectors of industry, mining, agriculture and fishery which will be able to new revenue sources of the nation.
- c. Improvement of a relative life level of citizens depending on investments to regions, especially priority investment to undeveloped area.
- d. Prevention of an immigration to urban areas depending on groups with preparation of residence in rural area.
- e. Security of water resources that is an important element for economic activation.
- f. Foster of talented persons of Omanis to be an important element for economic activation.
- g. Improvement of social infrastructures with national scale.
- h. Improvement of distribution and storage facilities with national scale for an activation of domestic commerce, establishment of an open economic market system of commercial activity and stabilisation of prices.
- i. Maintenance of a freedom commercial activity and reduction of tax with prohibiting monopoly, and lend by the Government with appropriate condition for the production projects.
- j. Activation of the Government institutions.

This plan was formed assuming an average oil price in 5 years with US\$ 20 per barrel.

(3) Vision for Oman's Economy - OMAN 2020

In 1995 as the last year of the Fourth Five-year Plan, in order to reference to prepare the next Fifth Five-year Plan and to obtain the economic future view to stand at long term of vision till 2020, "Vision for Oman's Economy" conference was held on June, and a recommendation about improvement of living standard to aim of income doubling by 2020 was presented. The policies necessary to realise this "Vision" are as follows:

- a. Sustainable development within a stable macro-economic framework.

- b. Well developed human resources.
- c. A strong, efficient, and competitive private sector.
- d. A diversified, dynamic and globalised economy.

Achievement of the objective of the "Vision" depends on the realisation of the following fundamental dimensions of Oman's strategy for sustainable development, and on adherence to the policies that emerge from those dimensions:

- a. Creation of a stable macro-economic framework.
- b. Developing Government's role in providing basic services.
- c. Human resources development.
- d. Enhancing economic diversification.
- e. Development of the private sector.
- f. Enhancing Oman's standard of living.
- g. Enhancing integration of the Omani economy with the global economy.

(4) Fifth Five-year Plan

The Fifth Five-year Plan (1996-2000), official gazette was issued on the 1st January, as the Royal Decree No. 1/96. Estimated total revenues, total applications and total current deficit are RO 10,092 million, RO 10,630 million and RO 538 million, respectively. This plan is calculated as the oil price is US\$ 15 per barrel up to realisation of US\$ 17.

At present, final detailed contents are adjusted by the Ministry of Development Affairs. The basic elements of development aims are summarised as follows:

- a. Development of human resources and upgrading the capabilities and skills of the citizens.
- b. Create stable economic environment in order to develop a private sector.
- c. Encourage creation of a private sector.
- d. Create the suitable environment for economic diversification and make full benefit of the available natural resources.
- e. Boosting the living standard of the Omani citizens and reducing differences between the regions and various income categories.
- f. Preservation of achievements realised during the last 25 years, maintaining and promoting them.

The current deficit is considered to be financed through the following means:

- a. Development of non-oil revenues.
- b. Realisation of better oil prices than those presumed in calculating the oil revenues.
- c. Amendment to some public spending policies.
- d. Revenues of the State General Reserve Fund.

The state general budget for the fiscal year 1996 which is the first year of the Fifth Five-year Plan is as the revenues, public spending and current deficit are RO 1,934 million, RO 2,152 million and 218 million, respectively. Estimates of the current revenue and total expenditure on the agriculture, forestry, fisheries and hunting affairs sector charging of the MAF are RO 1,127 thousand and 17,794 thousand including surplus and support budgets.

A-9.2.2 Agricultural Sector Development Plan

(1) Sector Development Plan

The main objectives of development on the agricultural sector are summarised to develop sustainable agriculture to diversify the economy, to increase domestic production and to achieve self-sufficiency in agricultural produce while conserving natural resources and the environment. The Government wishes to halt and if possible reverse migration from rural areas to urban settlements.

(2) Master Plan for Agricultural Development (1990)

The master plan study for the agricultural development was carried out from 1989 to 1990 by the Japanese Government assistance, to prepare a 10-year development plan for 2000. This was one of most attended component of diversification planning of the Fourth Five-year Plan to commence 1991. The agricultural development plan was formulated by 3 alternatives: 1) Full Master Plan, 2) Alternative 1, and 3) Alternative 2.

The full Master Plan comprised the priority projects selected to achieve the agricultural development objectives in line with the development strategy. The required public budget was RO 589 million. Alternative 1 proposed a budget outlay necessary strictly in terms of macro-economies. The budget was RO 404 million and priority projects were selected from within full plan. Alternative 2 expanded upon Alternative 1 by adding funding to those projects where investment was considered lacking, particularly in the irrigation and dam sector, and the livestock sector. Total budget was RO 480 million, and the budget shares for the irrigation and dam, agriculture, and livestock sectors were 54%, 13% and

16%, respectively. In the plan, the implementation of the Alternative 2 was recommended. And the recommendations were mentioned as follows:

- a. Human resources development
- b. Straightening of the MAF
- c. Farm organisations
- d. Integrated strengthening of both agricultural production and rural living environment
- e. Natural environment
- f. Co-ordinated effort among agencies

A-9.2.3 Water Resources Sector Development Plan

(1) Master Plan for National Water Resources (1991)

The master plan study for the investigation, development and management of the water resources was carried out from 1989 to 1991 by the Mott MacDonald International in association with Watson Hawksley. This study has reviewed the Sultanate's water resources and the demands upon those resources. A plan for their future development and management has been prepared.

In general, economic evaluation of alternative policies highlighted: Low returns to agricultural use of water, and the present high cost of desalination of sea water. The master Plan for water resources in Oman therefore envisages:

- a. The strengthening of the institutional and legal framework to provide effective management of water resources in the interests the Oman's long term development.
- b. Giving priority to domestic and industrial water supplies. Despite the high cost, desalination of sea water will be used where the social costs of reallocating groundwater from agriculture are too great.
- c. Conservation policies to curb demands for potable water and improve the efficiency of agriculture without increasing water use.
- d. Restricting future agricultural development strictly in accordance with the available resources and changing agricultural cropping patterns and irrigation practices where resources are presently overdrawn.
- e. Controlled development of non renewable resources.
- f. Augmenting the resource wherever possible

According to the Master Plan, the Nejd is a gently sloping plain, from the Dhofar Jebels towards the sand dunes of the Rub al Khali. It is underlain by the same sequence of Tertiary sediments as the Central region, but the Lower Umm er Radhuma formation in this region contains water of near potable quality. The aquifer is confined and flowing artesian wells occur in the north of the Nejd. Recharge is thought to be low, but the large volume of water stored offers significant scope for development based on "mining" a non-renewable resource. Other formations may also contain large volumes of water, but generally of poorer quality than the Lower Umm er Radhuma.

The Nejd has large, but mainly non-renewable, reserves of water suitable for agricultural use, but generally with fluoride levels significantly above the limits for potable supplies. There is very little agricultural development at present. Present data on the Nejd aquifers does not allow a regional evaluation to be made, though in specific locations data is more detailed. A 50 ha pilot farm is planned in one of the areas where adequate data exists to allow groundwater development to be planned. In the meantime, typical groundwater investigations and monitoring is in progress to extend the understanding of aquifer characteristics and resource availability over the whole region. This programme will allow the national planning of long term development and will complement a investigation of the agricultural potential of upto 1,000 ha of land in the Nejd.

Subject to the results of ongoing detailed studies, a slow phased development of the Nejd is recommended. Pilot projects should be established. Water levels should be monitored and further development plans must be subject to continuing reassessments of the resource. The production of forage appears the most appropriate use of water at present. However development of the Nejd needs careful evaluation and only projects with clearly established high economic returns should be implemented. Efficient use of water both for irrigation and potable water supplies is paramount, because losses are not returned to productive aquifers. Losses from productive to non productive aquifers in production wells must be prevented.

A-9.2.4 Regional Development Plan

The principal development studies and plans (full titles and other details are given in the bibliography) related to the agricultural development in the Nejd region are reviewed in approximate chronological order, with particular emphasis on their recommendations for the agricultural development. The following are therefore not balanced precise reviewed.

(1) Development Plan in the Dhofar Region

Within above mentioned national framework, number of planning policies for the Dhofar Governorate have been accepted. The main directions of the regional development plan policies are towards: 1) improvement of agricultural productivity, 2) rationalisation of irrigated agriculture and 3) balancing of livestock production of the Jebels with the capacity of the rangeland resource and the domestic market for beef. Principal previous regional development studies and plans in the Dhofar region are as follows:

1) Preliminary Population Projections for the Southern Region (1985)

This paper concentrated on existing population data that were census results of 1983 and before and projections. Population projections of the total southern region were estimated to 75 - 165 thousand, 84 - 185 thousand and 94 - 207 thousand in 1995, 2000 and 2005 respectively, depend on alternative scenarios and growth rates. The projections in the Nejd area show 1,750 - 17,600, 2,000 - 19,800 and 2,150 - 22,200 respectively.

2) Rural Occupations and Employment in the Southern Region (1988)

This study explained a gross frequency distribution for self-employment and salaried employment in the Nejd area. It is quite common to be engaged in part time livestock management activities with mainly camel and goat keeping and also to have a salaried job, usually with the militia forces.

3) Regional Development Plan for the Southern Region (1989)

This plan was concerned with realising the full economic development potential of the Southern region through promoting policies and investment in projects which make the best use of available natural and human resources up to the year 2010. It set the aims and objectives of development within the four subregions of Salalah, the western Jebel, the eastern Subregion and the Nejd. The subregional plans have been prepared to be consistent with the policies and proposals established in this plan.

4) Subregional Land Use Plans for the Southern Region (1990)

This was a comprehensive and detailed multi-sector land use plan. The proposals were in the form of a programme that incorporates and updates the relevant projects previously mentioned in the Regional Development Plan.

In addition to the above-mentioned, there are many studies and development plans regarding to the Jabal mountains and coastal plains.

(2) Development Plan in the Nejd Region

Principal previous development studies and plans in the Nejd region are as follows:

1) Preliminary Soil Survey of Selected Areas around Hanfit and Qitbeet in Nejd, Southern Region (1987)

This study was carried out in 1986, over 50,000 ha near Hanfeet and Quitbeet to assess the suitability of lands for irrigated agricultural development. The survey results have shown: Hanfeet area, the suitable lands for irrigation is distributed in 4,885 ha (12.1%), the soil on the suitable lands are all formed on alluvial formations that have been deposited along the edge of the hilly rock land that stretches away to the north. Quitbeet area, the suitable lands is only amount to 140 ha (1.4%), and an area of marginal soils in the northern part of the areas amounts to 420 ha in extent.

2) The Study on Agriculture Development Project in the Nejd Region (1989)

This study was carried out from 1987 to 1989 to prepare an agricultural development plan for the Nejd region based on the groundwater and land resources potential. The study proposed the "Phased Agricultural Development" for the region, while encouraging continuous and detailed investigation of groundwater and another resources because of their high uncertainties.

3) Subregional Land Use Plans for the Southern Region (1990)

The proposals for the agricultural development in the Nejd region were in the form of a programme. The main features of the programme are:

- a. Technical evidence suggests that there is a large, but finite groundwater resource beneath the Nejd. The Regional Development Plan promoted exploitation of this groundwater, in conjunction with suitable soil resources to expand the irrigated crop area, with some integrated livestock production, on the Nejd in a phased and dispersed manner.
- b. The broad area of search for land with irrigation potential, this work was commenced in mid 1989 under the MAF with the objective of identifying 1,000 ha of land suitable for irrigated agriculture.

- c. Significant areas should be used to develop fodder production. The fodder can then be used locally or, if more effective, can be palletised to reduce storage and transport costs. Other areas should be used for irrigated fruit and vegetables.
- d. Integrated with the extension of irrigated agriculture in the Nejd there should be a programme for livestock management in the extensively grazed areas that focus on the wadis.
- e. The capital cost of developing systematic irrigation in the Nejd will be very high, and recurrent expenditure on inputs, services and management will also be high.
- f. A large zone in the Nejd has been identified on the basis of preliminary assessment as potentially suitable for irrigated cultivation. Detailed work undertaken by the MAF will enable precise definition of some areas while other areas will be demarcated following further studies recommended in the Regional Development Plan.
- g. Within the 8,000 ha already mapped with soil suitability classes S1, S2 or S3 a maximum of 6,500 ha should be reserved for irrigated agriculture within the Plan period.
- h. Irrigated blocks, ultimately each up to 600 ha in size, should be dispersed throughout the Nejd according to hydrogeological requirements, soil suitability, traditional social groupings, the settlement pattern and road network.
- i. In view of the importance of monitoring rates of water abstraction, no more than 60 ha should be developed annually in any one irrigation block. A phased approach to exploitation of the water resources is required.
- j. The majority of these irrigated blocks should be available for large scale commercial fodder production.
- k. Where the water quality is adequate, selected areas within blocks and dispersed throughout the Nejd should be made available to Bedu, to be cultivated for fruit and vegetables for home consumption and sale on a co-operative basis. This dispersal will result in a mix of smallholder and large scale commercial cultivation within each block.
- l. Within these areas the Government should give a form of leasehold on the land to the cultivators, in return for their compliance with standards of management laid down by government and advised by extension agents.
- m. A Proportion of the investment costs for such a pioneer project would necessarily be borne by the Government. The benefits would be employment creation, increased production of fodder, fruit and vegetables, integrated agricultural and settlement development and strategic colonisation of the Nejd.
- n. Potable standard water should not be permitted to be used for agriculture wherever it is available in the Nejd.

- o. The extensive areas between those used for agriculture should be designated for continued nomadic type grazing. A study should be conducted to assess the present status of this stocking system and future requirements for it to be sustained as part of an integrated programme of developing in the Nejd.

On the other hand, main features for the water resource development in the Nejd region are as follows:

- a. There are a number of aquifer zones in the Nejd with a principal aquifer in the upper part of the Lower Umm er Rhaduma Formation. The reserves available for use are limited and due to the lack of data, accurate estimates of the lifetime of the reserves are not possible. Only a small proportion of the reserves are able to be used either due to poor water quality or due to problems in abstracting the water from the aquifers when pumped water levels become very deep.
 - b. The MWR estimate that as much as three times the annual recharge to the deep artesian aquifer of the Nejd is lost by leakage from the LUER aquifer to overlying zone through improperly constructed wells. as the LUER regionally has the best quality irrigation water this is a great resource loss to the Nejd.
 - c. The Regional Development Plan proposed that the large groundwater resource known to exist in the Nejd is exploited for agricultural development in a tightly controlled way. Detailed studies have been initiated by the MAF for the first phase of this development.
 - d. It is imperative that the development and use of this water resource is carefully managed and proceeds in accordance with the regional plan proposals.
 - e. There is a serious shortage of potable quality water in the Nejd so potable water should be used only for domestic use unless studies identify significant new resources.
- 4) Detailed Investigations for Development of up to 1,000 ha of Irrigated Land: Nejd Region (1992, 1994)**

This investigations were carried out for the feasibility of development of 1,000 ha of irrigated land in the Nejd at sites of Dauka and Hanfeet West. Within an original 10,000 Km² area, soil survey at reconnaissance and finally at detailed level, identified about 1,500 ha of soils generally suitable for development; of this, 1,000 ha of land within generally contiguous blocks, 700 ha at Hanfeet West, and 300 ha at Dauka, was selected for the proposed MAF² development. The soils at both sites are at best only marginally suitable for agriculture. The most feasible developments will be highly mechanised large farms growing almost entirely Rhodes grass hay, in 30-60 ha land parcels irrigated by centre

pivots or linear move systems.

5) Detailed Soil Survey to Identify 1,300 ha of Land Suitable for Irrigated Agriculture in the Nejd at Dawka, Hanfeet, Dameet and Wadi Bani Khwatar (1995)

This survey was carried out for the soils and land suitability assessments of land at Dameet and Bani Khwatar in the Nejd region, with reviews the MMI findings for the Hanfeet and Dauka areas. However, Dameet and Wadi Bani Khwatar areas are located out of the Study Area. The survey lands of the following areas were ranked as overall marginally suited (S3) for irrigation development: Hanfeet, 1,002 ha of soils of similar quality to Dameet but with a higher proportion of shallow gravelly soils, this includes 700 ha previously nominated by MMI as a development area. Dauka, 505 ha of soils identified by MMI as S3 rating, 300 ha of this area had been previously nominated by MMI as a development area. Much of those areas cannot be recommended for development without extensive subsoil drainage works.

6) Detailed Soil Survey and Land Evaluation of an Area Near Hanfeet, Thumrait Wilaya, Dhofar (1996)

This is the latest in a series of soil surveys and land evaluations in the Nejd region. The survey area covers 2,000 ha about 2.5 Km to the south-west of a track that leaves the Salalah-Muscat highway 37 Km north of Thumrait and runs north-westward to Shasr. The results show that a considerable proportion of the survey area is marginally suitable for the development of irrigated trees or fodder crops in the survey area. The survey area is atypical, and it is essential that the evaluation of proposals for future irrigation development in the Nejd should always include detailed soil surveys and land suitability assessment. The land is evaluated for overhead irrigated Rhodes grass, drip irrigated non-root vegetables, and bubbler irrigated fruit trees.

7) Salalah Farm Transfer Plan

The plan made by a proposal of His Majesty in 1992, that the Dhofar Cattle Feed Company's farm (approximately 500 ha) located near the Salalah Civil Airport in the Salalah city will be transferred to the Nejd region. At present, details are discussed in the Supreme Committee for Town Planning.

A-9.2.5 Points of Issue of Agricultural Development

(1) Water Resource

The basic requirement of human life, water is the fundamental prerequisite for the survival of living creatures. It is a significant resource for the economic growth and whereon agriculture. The success of water resources development policy relies on the maximum and ideal exploitation of available water resources in the most possible and economic ways. In 1988, the country's water resources were declared "Natural Wealth" by a Royal Decree assigning the Government with all the power to control them in the most advantageous way so as to serve all kinds of development plans in the country. In 1989 it was decided that water was of such paramount importance that the MWR was established by a Royal Decree. In January 1994, a Royal Decree was issued making the development and maintenance and the jurisdiction and records of dams and aflaj the responsibility of the MWR.

(2) Water Rights

1) Traditional Water Rights

According to the National Water Resources Master Plan (1991), the traditional laws related to water use and ownership of water rights have been described by the Water Resources Policy, Administration and Legislation (Caponera, 1975?). The basis of all traditional water rights was Islamic law. Well water was normally freely available to all for drinking, but may only be used by the owner for irrigation. Wells were traditionally normally owned by the person responsible for their construction and he had the right to abstract unlimited quantities of water for any purpose. In Dofar water rights were normally linked inseparably to land.

Water sources on land which was not privately owned, were to be used in the public interest. A well could be specified for drinking water and other uses were then not allowed.

2) Existing Regulations

Two important legislation presently relate to the control of water resources development in Oman are:

- a. Well permits.

b. The registration and control of drilling contractors.

MWR has issued regulations covering the registration of drilling contractors and permits for well construction. There are as yet no regulations for controlling abstractions from existing wells.

The existing regulations on well permits and registration of contractors cover this aspect. They should be reviewed however for consistency with new legislation controlling abstractions. A register of water rights is required. This will in part result from an inventory of wells and the establishment of water use licences.

Well permits should only be issued for economically viable projects and only where either resources are available, or an arrangement is made by the applicant to purchase an existing water right. Well permits should be given initially for test wells, and a water use license given after the yield has been confirmed.

According to a response to the question from JICA Study Team concerning with the Royal Decree 82/85, all existing wells were registered at MWR about 6 years ago. New wells require a MWR permit which specifies well construction details, pump size and sometimes specifies a water meter. In theory, this should limit well production. The use of water meters is being investigated and studied by MWR. Without water meters reports of consumption would probably be very inaccurate, in addition, who would pay for the installation of water meters on old wells.

(3) Sustainable Development

Cattle are bred on the coast-facing mountain slopes of the coastal plain and traditional cattle-breeding areas of the Jabali tribesmen. Until recently, they reared cattle only for milk and the pastures were taking the strain. Now, with good road communications with northern Oman, where beef is increasing demand, the Jabali are being encouraged to export their cattle to the north. This will not only profit the local population, but also relieve the pressure on the grazing lands. This pressure has been building up recently, not only due to overstocking with cattle, but also to the grazing habits of camels, of which there are a large number on these lands. Camels not only graze on the pastures, but destroy them by consuming the roots of the grasses as well.

(4) Labour Force

In both agricultural production, services and marketing nearly all the labour force is expatriate. Expatriates are often involved in the management of the farms hence rendering the decision making process more complicated. They are also more interested in immediate profit and therefore little motivated for long term investment and conservation of natural resources.

A-9.3 Present Situation of the Study Area

A-9.3.1 General Outline

The Nejd region is located in southern part of Oman between the coastal mountain chains (Al-Qara and Al-Qamar) and the great sand desert "Rub Al-Khali (The Empty Quarter), and belonging to the Dhofar Governorate. The Area is approximately 40,000 km² and the centre of the region is the Thumrayt town, locating the only urban area in this region.

The Study Area for the agricultural development plan covers 8,100 km² which extends about 90 Km both from east to west and from north to south, and lies at the interior area between 120 Km to 200 Km from Salalah town which is the capital of the Dhofar Governorate. The Area is consists of mainly four sub-zones of Dauka, Shasr, Hanfeet and Quitbeet. Principal settlements are only Shasr which is an oasis from the ancient age and Quitbeet which is a Bedouins nomadic camp.

A-9.3.2 Natural Conditions

The topography of the Nejd region is moderately sloping towards north from the coastal mountains at the southern border. The mountains are not only the northern limit of monsoon rain, but also the watershed between the coastal region and the Nejd. The northern margin of the Nejd is bordered by the Rub Al-Khali desert at 190 Km from the coast.

The Nejd has a hot desert climate with low humidity during most of the year and the moist air masses of the south-west monsoon. According to the Thumryt meteorological data, the annual mean temperature is 26°C and the daily variation is very large with a range of 20°C is common throughout the year. The hottest part of the year is the May to September period when the mean maximum temperature is generally over 40°C. December and January are the coolest months and during this period the minimum temperatures of 2 to 6°C are recorded.

The monsoon produces rainfall from June to September, however, the rainfall area is limited only to the coastal plains and the southern slopes of the mountains. Aridity increases in the inland area, forming parallel climatic zone to the coastline. Annual precipitation is highly variable, ranging from 0 to 150 mm. Major rainfall is caused by isolated tropical cyclones which occasionally surmount the divide and cause intense thunderstorms of short duration. Large scale cyclones are supposed to occur floods in the Nejd once in every five years.

The Study Area is covered by soils derived from limestone and calcareous mudstone or deposits associated with the erosional and depositional processes that have shaped the Nejd region.

A-9.3.3 Population

Population density in the Nejd region is quite low. According to the 1993 census, the total population is 7,439 while the total population of Dhofar Governorate is approximately 189 thousand. Percentage of Omanis on total population in Nejd is 55%, and the number of families is 912. Most of the people are nomads who don't have their own permanent residences except some settlers, and therefore the population varies season wise. The most part of settlers is living in the Thumrayt urban area. Actually, the Nejd is facing a transition from traditional nomadic pastoralism to urbanisation.

A-9.3.4 Land Use

The most part of the Study Area is within a remote, almost un-populated, treeless, sparsely vegetated land and is substantially flat with little topography and with wide sandy wadis. There are a few agricultural lands in the Area from the view point of extension. Small area of cropping land exists at Shasr village where there are some farms with irrigation from the shallow watertable in the Wadi Ghadun, and at Quitbeet village there are some rather stunted date palms. Presently, large scale commercial farms with centre pivot irrigation system are establishing in Dauka, Hilat Al-Rakah and Hanfeet. In Hilat Al-Rakah many small farms are distributed. Generally, desert is utilised by grazing of camels and goats, especially near Shasr and Quitbeet. Livestock is main economic activity in the Area up to now.

A-9.3.5 Agriculture and Livestock

The agricultural development in the Nejd region started at the beginning of 1980s with utilisation of hand-dug well and flowing well by the local people in Shasr, Dauka and Hilat Al-Rakah. Small scale farms were established from the latter half of 80s to the first half of 90s, and recently the large scale agricultural farms by commercial company are progressing rapidly in Hilat Al-Rakah North and Hanfeet areas.

According to the survey of the extension centre in 1995, the total number of farm household in the Nejd region is 155 which is consisted by 28 fodder cultivation farms and 127 vegetables and fruit cultivation farms. Total cultivation area is 1,337 ha which is consisted by 608 ha of fodder cultivation areas and 729 ha of vegetables and fruit cultivation areas.

The most of the fodder grass cultivated is Rhodes grass (*Chloris gayana*). It is said that Rhodes grass is the most suitable crop to improve the soil structure and is highly tolerant for drought and salinity. At present, some farms are trying to introduce new fodder crops such as Alfalfa, Barley, etc. and also vegetable crops.

According to the MAF study in 1994, the numbers of livestock in the Nejd region are as follows: 16,919 goats, 15,149 camels, 1,558 sheep and 38 cattle. This shows a characteristic that rate of Cattle (0.1%) is remarkably smaller with bigger rates of goats and camels (50% and 45%) compared with the coastal mountain areas.

A-9.3.6 Social Infrastructures

The Muscat - Salalah National Highway (Road No. 31), paved dual carriageway is crossing from north to south just centre of the Study Area. Three wide graded main roads are extended from this highway on Thumrayt to east, west and north-west: Thumrayt - Mar'aul road (Road No. 39), Thumryt - Rakhyut road (Road No. 45) and Thumryt - Shasr road (Road No. 43), however the former two roads are located out of the Area. A graded secondary road of Shasr - Dauka road is passing on the north-west part of the Study. And many motor traces are crossing in desert. The main flow of traffic is in the Muscat - Salalah road.

In general, the social infrastructure facilities and services such as domestic water supply, electricity, health, etc. are undeveloped in the Study Area. Thumrayt urban area where these facilities and services are prepared and functions both administrative and commercial centre of the Nejd region.

A-9.4 Development Strategies

A-9.4.1 Background

The Phase-I Study on the Agricultural Development Project in the Nejd Region was carried out as a master plan study from 1987 to 1989. Main objective of the study was to prepare an agricultural development plan for the Nejd region based on the water and land resources in the region, especially the groundwater potential as water resources. As the result of the Phase-I Study, a guideline for agricultural development and a plan for pilot farm were formulated. Besides, a "Phased Agricultural Development" concept was proposed in the guideline, while encouraging continuous and detailed investigation of groundwater and other resources because of their high uncertainties.

(1) Phased Agricultural Development

Because of high uncertainties of groundwater and other resources, it was not advisable to introduce large scale development projects. The three stages of the Phased Agricultural Development were proposed as follows:

1. First Phase: Establishment of the Pilot Farm
2. Second Phase: Development of up to 500 ha area based on the results of the First Phase
3. Third Phase: Further development based on the results of the Second Phase

(2) Tentative Pace and Scale of Development

The following two items were considered in the Phase-I Study, which need to be clarified for the successful implementation of the agriculture development in the Nejd region.

1. Development Pace (Suitable development velocity)
2. Development Scale (Maximum development area)

It was proposed that in the Second Phase of the development plan, the development scale is assumed temporarily as 500 ha and the prosperity of this development scale should be verified at first. If the expected results could not be achieved, the development scale should be revised and the prosperity should be studied once again.

(3) Evaluation Items to Step Up from One Stage to the Next Stage

The problem points of each stage of the Phased Agricultural Development were considered to be clarified to shift from one stage to the next stage. The items to be evaluated before shifting from the First Phase to the Second Phase of the development plan were as follows:

1. Groundwater drawdown accompanying with pumping up should be within the reasonable value.
2. Quality of groundwater should not become worse because of the pumping up operation.
3. There should not be any problems regarding the cultivation technology for fodder grass.
4. Marketability of fodder grass should not be decreased remarkably.
5. Supporting systems to proceed with farm management under commercial base should be clarified.
6. Systematic control system of groundwater should be established.
7. Soil survey for the development area should be carried out in detail.
8. Training and extension systems should be established for the farmers.

The following items should be evaluated for shifting from the Second Phase to the Third Phase of the development plan:

1. Clarification of groundwater conditions by the groundwater investigation in the whole area.
2. Confirmation of the suitable project development pace and the limitation of the project area based on the groundwater conditions.
3. Confirmation of the cropping pattern, cultivation technology, and marketability for different crops.
4. Establishment of marketing system for the fodder grass and the other crops to be introduced.

(4) Water Resources

In the Phase-I Study, particular attention was paid to the fact that the groundwater in the Nejd region was categorised as fossil water and was a limited water resource like oil. The conditions of groundwater development potential, which was considered as prerequisite for the agriculture development of the region, was planned to be surveyed and analysed by MWR. As concluded in the Phase-I Study by all the relevant ministries, the Phased Agricultural Development should be made based on water resource conditions.

The Regional Development Plan for the Southern Region (1989) mentioned that the development of agriculture in the Nejd using the finite reserves of fossil water offers a unique chance for the region's inhabitants to be part of one of the largest resource evaluation exercises in the world.

According to the National Water Resources Master Plan (1991), economic evaluation of development projects in the Nejd should include resource depletion costs in addition to the normal construction, operation and maintenance costs. It was designed to ensure that depletion of a non renewable resource would be approved only if economic returns are substantial. In the Phase-I Study, it was considered that farming could be done up to a groundwater depth of 100 m, since the pumping head of the ordinary pump for farming is within 100 m and groundwater pumping from the confined aquifer below 100 m depth is considered as uneconomical.

(5) Phase-II Study

The Phase-II Study was started in 1991 succeeding to the previous Phase-I Study. One of the major objectives of the Phase-II Study was to formulate a Agriculture Development Plan in the Nejd region (500 ha) for the next agricultural development phase. During the construction period of the pilot farm (NARS) from 1991 to 1994, the study had been given a pause for about 2 years. Groundwater monitoring in the area outside of NARS and groundwater assessment for the next agricultural development plan were deleted from the original Scope of Works.

A-9.4.2 Agricultural Development Policy

The main development policies of the Government on the agricultural sector are summarised as follows:

1. to develop sustainable agriculture
2. to increase domestic production
3. to achieve self-sufficiency in food for import substitution
4. to create employment opportunities
5. to conserve natural resources and the environment

The specific development objectives of the Agricultural Development Project in the Nejd Region are recognised in the governmental development policy, as well as with the physical and socio-economic conditions of the Study Area, as shown below:

1. Expansion of agricultural production area through optimum exploitation of water resources to make a contribution to self-sufficiency.
2. Creation of new employment source for local Omanis and improvement of agricultural labour force.
3. Strengthening and modernisation of institutional services for agricultural experimentation and extension support.

A-9.4.3 Present Situation on Agricultural Development in the Nejd Region

(1) Nejd Agricultural Research Station (NARS)

The Nejd Agriculture Research Station (NARS) was constructed by the proposal of the Phase-I Study as a Pilot Farm, where agricultural experimental trials can be carried out to find out an optimum and suitable agronomic conditions for the Nejd region and prospecting the groundwater development potential by continuous monitoring survey. NARS was originally planned as a pilot farm but later the name was changed to the present name, and there were some modification in the objective of the original pilot farm concept, as much importance is given to scientific research than experimentation in the pilot farm. Presently, it seems that the role of NARS is expected as a centre of investigation and research for the desert agriculture.

(2) Agricultural Development

As mentioned in the previous chapters, number of centre pivots and cultivated area with irrigation in the Study Area have been increasing very fast during the past two or three years. Already the groundwater development area for agricultural production of more than 800 ha have been executed and adding constructing and planning areas, the total developed area can be estimated as more than 1,000 ha. Besides, drastic drawdowns of the groundwater level have been observed and there are some production wells which were already abandoned. According to the existing development studies concerning possibility for agricultural development, it seems that already there is not much more possibility for development than present situation, and a large scale development concept might be unrealistic from the view point of sustainable development.

On the other hand, according to the response of MWR to the question from JICA Study Team concerning the agricultural development in the Nejd region, recent monitoring data and modelling indicates that large drawdowns can be expected if pumping is concentrated in a few areas. A decentralised development strategy with sites across the Nejd would

decrease drawdown and give an indication of where water resources could be developed further. An area of 30 to 50 ha would allow an economically sized centre pivot at each site which could be supported by one or two wells sited 500 to 1,000 meters apart. A reasonable development speed would be two or three sites per year (MWR, June 1996).

(3) Water Resource Conditions

According to the conclusions of the Nejd Groundwater Modelling Brief Report (Draft, February 1996, MWR), the simple analytical modelling indicates that to obtain the maximum amount of groundwater from the aquifer it is better to spread pumping wellfields across the Nejd and not have concentrated pumping centres. Once Aquifer C become unconfined the rate of drawdown will decrease significantly because of the higher storage coefficient.

On the other hand, according to the comments of MWR concerning the Nejd Aquifer C monitoring (June 1996), significant groundwater drawdown has occurred over the passed two years. Most drawdown is occurring at Hanfeet where irrigation using centre pivots has recently expanded dramatically. It is expressed in the conclusions and recommendations that the following points could form a basis for justifying the formulation of a Nejd Action Plan:

1. Significant Aquifer C drawdown is occurring in the Nejd caused by the recent expansion in irrigated agriculture.
2. Groundwater drawdown will have important implication for the economics of the Nejd irrigation such as increasing well construction costs, accelerating pump replacement and increasing energy needs.
3. The drawdown at NARS farm is mostly caused by on site pumping but also to a lesser extent by pumping at Hanfeet and perhaps at Hilat Al- Rakah.

It is said that over 85% of drawdown established in the first year of operation, only minor reductions in drawdown if farm development is staged over 1 - 3 years (MMI, 1994). However, actual phenomena of wells in the Nejd are very different.

9.4.4 Restrictive Factors and Potentiality of Development

Generally, to formulate an agriculture development plan, natural factors (such as land resources, water resources, meteorological conditions, biological adaptations, etc.), social factors (such as economy, human resources, impacts to the environment, national profit, etc.), etc. should be considered as the important elements of the plan. Soon, for the

Agricultural Development Project in the Nejd Region, it is clear in the results of the Phase-I Study and the field survey of the Phase-II Study that the water resources is the largest restrictive factor against agricultural development and development pace and scale will be decided by the development potential of the groundwater conditions.

According to the opinion of MWR for the "Policy for Water Resources Development" (August 1996), it is clear that the hydrogeology of the Nejd is not well understood and more assessment work is required for the better understanding of the aquifer characteristics and to evaluate the sustainable yield. To fulfil this objective, the policy of MWR will be cautious and limit the use of water resources at the beginning. Therefore, MWR suggests that at the beginning there will be a small scale agricultural development and during the first three to five years there will be a continuous assessment of the aquifer behaviour. The results of the assessment will help to understand the aquifer characteristics and to propose the long term development strategy in the Nejd.

A-9.4.5 Basic Concept for Development

As the overall evaluation in the end of the First Phase of the development plan, land resource research and agricultural research have been able to achieve their purposes almost all except some items, through the activities of monitoring survey during two years at NARS. However, significant groundwater drawdown is occurring in the Study Area and it seems that this phenomenon is not within the reasonable value which was considered as evaluation item to step up of development stage. Also, many uncertainties regarding groundwater research exist still now.

Consequently, before shifting to the Second Phase of the development plan intending a development of 500 ha which was proposed in the Phase-I Study, it is judged that feedback concerning the basic concept for development should be necessary. Still more, considering the actual situation of agricultural development during these years, reconsideration of the basic development concept of the further agricultural development plan in the Nejd region which was proposed in the Phase-I Study should be necessary.

Principally, three articles are proposed as a basic concept for the Agricultural Development Project in the Nejd Region for the next agricultural development phase.

1. Reconsideration of the Concept regarding the Large Scale Agricultural Development (Expansion Scale Scheme)
2. Establishment of the New Pilot Farm(s) to Confirm Detail Conditions of Water Resources and to Realise Sustainable Agriculture

3. Elaboration of the Farming Technology for Water Saving and of Technical Transfer to the Existing Farms for Sustainable Farming

(1) Agricultural Development Concept and Sustainable Development

At the Phase-I Study, the Phased Agricultural Development was proposed as agricultural development concept, and though development pace and development scale were considered, the actual agricultural development situations during this two or three years became a phenomenon exceeding these considerations. Especially, development pace was drastic. Also, from the view point of water resource development, it seems that this phenomenon is going toward the total possible area for development. Still more, there are characteristics that development is unevenly distributed and concentrated, and there has been a progress of unlimited development.

These present situations are evaluated as a over development. Considering the tendency of recent development, it is judged that reconsideration of the agricultural development concept is necessary. Especially, prudent correspondence for this concept is necessary from a view point of sustainable development depending on effective utilisation of the limited water resources. Once more, at present it can be judged that reconsideration for a future large scale agricultural development should be necessary. For an effective utilisation of limited resources for a long term, the agricultural development concept should be considered once again. Without this care, the prospects for the coming generations in the Nejd and of the Sultanate will be limited.

(2) Establishment of New Pilot Farm

The pilot farm plan was developed based on the Phased Agricultural Development concept. And some parts of the original purpose of the pilot farm concept wasn't achieved and is remaining now also. For example, 1) establishment of systematic control system of groundwater, 2) establishment of training and extension systems and 3) clarification of supporting systems for farm management under commercial base of the overall evaluation on the First Phase have not been able to achieve their purposes. Further, there are many uncertainties concerning groundwater. Consequently, the main purpose of establishing the New Pilot Farm(s) is considered as achieving these objectives. Principal roles of the New Pilot Farm are as follows:

1. Evaluation of the groundwater potential in the Nejd region for the next development phase.

2. Achievement of the desert agricultural management of the Nejd region for the next development phase.

The most important factor for the agricultural development in the Nejd region is groundwater conditions. Sustainable development is necessary, to avoid coming generation to suffer because of over exploitation of the limited resources and to ensure future sustainable resource exploitation in the Nejd region. This is a plan including a part of purposes of the Second Phase of the development plan in the Phased Agricultural Development concept such as settlement, farm management, technical extension, etc., and the New Pilot Farm concept is made as the 1.5th Phase of the development plan.

(3) Farming Technology and Technical Transfer

In order to advance the future agriculture development in the Nejd region, fundamental scientific principles such as research and investigation regarding the desert agriculture should become more important. Therefore, it is necessary that NARS should enforce more fundamental, special and scientific activities concerning the desert agriculture not only in the Nejd region but also the whole Sultanate. Also, NARS should take the responsibility of execution and operation of the New Pilot Farm plan as an administrative centre. In this context, the role of NARS as an experimental station would be progressed to a research centre and a management centre of the New Pilot Farm. Future main roles of NARS will be considered as three systems of research, monitoring and training and extension as mentioned below:

1. Centre of research and investigation and of laboratory analysis of soil, water, crop element, etc. for the desert agriculture.
2. Experimental cultivation of the newly introducing crops and generation of appropriate cultivation technology for the Nejd region.
3. Demonstration of the new crops and technology to the local farmers and the function of training and technical transfer centre using own farm and the New Pilot Farm sites.
4. Administration office of the New Pilot Farm(s).
5. Collecting and publicising technical information of the desert agriculture.

Future NARS plan is considered as the Second Phase of the development plan in the Phased Agricultural Development concept, but it will be executed with the New Pilot Farm plan parallelly.

A-9.5 New Pilot Farm Plan

A-9.5.1 Objective

In the Nejd region, many data necessary for planning and implementing of the further agricultural development is insufficient still now. Especially, data such as groundwater potential, meteorological variation, appropriate cultivation technology, farming management, etc. are lacking which restrict planning and implementing of suitable agricultural development. For this purpose, the New Pilot Farm plan is proposed to be executed. The major objectives of the New Pitot Farm are summarised as follows:

1. Continuous and systematic observation of groundwater and meteorological conditions and evaluation of groundwater potential in the Nejd region.
2. Sub-centre of technical transfer of appropriate farming techniques from NARS to the Nejd region through extension services.
3. Training field where the farmers and agricultural students who will be engaged in agriculture in the future could learn and experience the actual farming techniques by guidance of NARS.
4. Agricultural management trial as a model farm of the Nejd region.

A-9.5.2 Scale

The farm size is considered with irrigation plan, production plan, cropping pattern plan, etc. Irrigated crop area of the New Pilot Farm would be proposed as approximately 30 ha, consisting of one centre pivot, one production well and one monitoring well. It is considered that the short term development period is the first four years and the long term development period is from fifth year. The number of farms proposed would be about three considering the objectives of the Farm,

A-9.5.3 Selection of Locations

For selection of establishment location of the New Pilot Farm, the following points should be considered :

1. Locations, which have insufficient information of groundwater data, which is essential for further planning of the Nejd region.
2. Locations, which will have a smaller influence with regard to groundwater utilisation with existing farms.

3. Locations, which is balanced and not biased or concentrated to one location.
4. Locations, where the soil conditions are suitable for agriculture production.
5. Locations, which is easily accessible to NARS.
6. Locations, where the farming is beneficial with regard to financial aspect.

Three sites which are located along the existing roads would be proposed for the New Pilot Farms as follows:

1. North of Quitbeet village
2. North-east of Shasr village
3. Wadi Mokhawrim

A-9.5.4 Farmers

One of the main objectives of the agricultural development in the Nejd region is to create employment opportunities through the "Omanization" concept. This means that an innovative group of Oman people should take the full responsibility for complete management of the farm and this group would act as the pioneers for the future generation who will shoulder the responsibility of further agriculture in the Nejd region.

Hence, local people who are living in the settlements around the New Pilot Farms such as Shasr village, Quitbeet village, Dauka village and Thumryt Town, should be selected to take this responsibility. Before the farming, the new farmers group should be given enough training at NARS and after the commencement of the New Pilot Farm, they should be given technical transfer from NARS as on-the-job training. Farmers would not live permanently inside of the Farm and each Farm would accept 15 farmers.

A-9.5.5 Farming

(1) Farming Character

It will enable economically efficient physical development to take place in harmony with the social and environmental needs in the Nejd region. Therefore, the self-sufficiency agriculture would be engaged for the purpose of the technical transfer to the new farmers and if some surplus would be produced it will be supplied for the rural and regional markets. Farm management practice would be investigated in more detail than the original pilot farm concept as a model farm of the Nejd region. After completion of the technical transfer at first stage, the New Pilot Farms would be transferred to the farmers and managed by themselves with the technical supports from NARS as smallholders.

(2) Crop Selection

It is advisable to cultivate fodder grass, especially Rhodes grass which is agronomically more suitable for the Nejd region. The advantages of Rhodes grass are that it produces good returns and at the same time improves the soil structure sufficiently for a wide range of crops to be grown successfully at the end of the reclamation period. Actually, most of the farms in the Nejd region are cultivating it although the farm sizes are different.

Concerning with the agricultural diversification, other crops such as vegetables for self-consumption should be considered. Later, after become self-support of farm, in accordance with the progress of the agricultural development, the commercial crops such as more vegetables and fruits crops could be introduced based on the experimental cultivation at NARS, considering the following criteria:

1. National conditions
2. Appropriate cultivation technology
3. Reasonable yields (Production value)
4. Ease of transport and storage
5. Marketing potential, etc.

According to the MAF study (1994), on agronomic grounds alone, highly suited crops in the Nejd region include:

1. Cereals: Wheat, Barley, Maize
2. Oil seeds: Sunflower, Maize
3. Fodder: Rhodes grass, Barley, Wheat, Oats, Maize
4. Vegetables: Onions, Carrots, Cabbage, Tomatoes, Okra, Egg plant, Cauliflower, Turnip, Spring onion, Sweet corn, Cucumber, Beetroot, Squash, Spinach, Radish
5. Fruits: Dates, Sweet melon, Water melon

(3) Crop Rotation and Cropping Pattern

Soil reclamation would be required for the first three to five years depending upon soil conditions. In the post-reclamation stage from fifth year, there are various ways of development by diversifying the crop mix and the irrigation systems. For the post-reclamation stage, acceptable cropping patterns are restricted to a wide range of winter crops (chiefly vegetables) plus a choice of either short season Rhodes grass or melons in the summer.

Cultivation with saving water system especially during summer season should be considered on the cropping pattern. Therefore, cropping patterns proposed are based on a reclamation period of four years; perennial cropping of Rhodes grass would be carried out over the whole cropped area of 30 hectares, followed by some limited post-reclamation diversification into winter vegetables such as onions, carrots and cabbage which would be introduced in a half of the cropped area. The cultivation areas of Rhodes grass and the vegetables should be inter changed in every five years. In addition, the cropping area of each vegetable should also be changed each year by changing the area of one vegetable crop to the other vegetable crop, in order to prevent the problem of replanting failures caused by cultivating the same crop successively.

After the New Pilot Farm would be transferred to the farmers, each farmer should manage two hectares of cropped area covering one hectare of Rhodes grass cultivation and one hectare of vegetable cultivation independently. However, Rhodes grass cultivation of total 15 ha would be cultivated in a collaborative farm works by the farmer's association, and melons could be introduced as the summer crops in the future.

(4) Farm Arrangement

Farm arrangement would be planned considering the following points:

1. Concepts of agricultural technical transfer, water management, etc. which are very essential for the New Pilot Farm formulation.
2. Farm machinery and equipment can be purchased and maintained together by the farmer's association.
3. Infrastructure facilities such as agricultural roads, electricity, potable water supply, etc. can be established at few locations.

(5) Supporting System

The New Pilot Farm would be established mainly under control and management of NARS with the co-ordination of different related organisations for the effective progress. The various activities to be performed in course of introducing the agriculture development for the New Pilot Farm are as follows:

1. Technical transfer / extension service to the new farmers
2. Procurement of production materials and services for storage and marketing of farm products

3. Financing for farming

4. Operation and maintenance of farm roads, electricity, machinery, etc.

Hence, co-ordination of different organisations would become necessary to perform all these activities and NARS with the representative of different organisations is required for this purpose. Besides, a project office of NARS would be responsible for the execution and management of the New Pilot Farm. The sub-stations of extension activities of NARS would be established in the New Pilot Farms in the future.

9.6 Project Evaluation of the New Pilot Farm Plan

Table A-9.6.1 Cost and Benefit Flow of FIRR

(Unit: RO)

Year in Order	Cost				Benefit		Net Cash Flow	Present Value		
	Initial Cost	Replace- ment Cost	O/M Cost	Outflow Total	Agricul. Product	Inflow Total		Cost	Benefit	Net
1	372,333		18,709	391,042	11,350	11,350	-379,692	393,795	11,430	-382,365
2			37,418	37,418	68,100	68,100	30,682	37,947	69,062	31,116
3			37,418	37,418	68,100	68,100	30,682	38,214	69,549	31,335
4			37,418	37,418	68,100	68,100	30,682	38,483	70,038	31,555
5			37,418	37,418	67,920	67,920	30,502	38,754	70,345	31,591
6			37,418	37,418	67,920	67,920	30,502	39,027	70,840	31,813
7			37,418	37,418	67,920	67,920	30,502	39,302	71,339	32,037
8			37,418	37,418	67,920	67,920	30,502	39,578	71,841	32,263
9		100,915	37,418	138,333	67,920	67,920	-70,413	147,350	72,347	-75,003
10			37,418	37,418	67,920	67,920	30,502	40,138	72,856	32,719
11		113,927	37,418	151,345	67,920	67,920	-83,425	163,488	73,369	-90,118
12			37,418	37,418	67,920	67,920	30,502	40,705	73,886	33,181
13		2,500	37,418	39,918	67,920	67,920	28,002	43,730	74,406	30,676
14			37,418	37,418	67,920	67,920	30,502	41,280	74,930	33,650
15			37,418	37,418	67,920	67,920	30,502	41,571	75,458	33,887
16		6,510	37,418	43,928	67,920	67,920	23,992	49,147	75,989	26,842
17		100,915	37,418	138,333	67,920	67,920	-70,413	155,857	76,524	-79,333
18			37,418	37,418	67,920	67,920	30,502	42,455	77,063	34,608
19			37,418	37,418	67,920	67,920	30,502	42,754	77,605	34,852
20			37,418	37,418	67,920	67,920	30,502	43,055	78,152	35,097
21		113,927	37,418	151,345	67,920	67,920	-83,425	175,370	78,702	-96,668
22			37,418	37,418	67,920	67,920	30,502	43,663	79,256	35,593
23			37,418	37,418	67,920	67,920	30,502	43,971	79,814	35,843
24			37,418	37,418	67,920	67,920	30,502	44,280	80,376	36,096
25		103,415	37,418	140,833	67,920	67,920	-72,913	167,834	80,942	-86,892
26			37,418	37,418	67,920	67,920	30,502	44,906	81,512	36,606
27			37,418	37,418	67,920	67,920	30,502	45,222	82,086	36,864
28			37,418	37,418	67,920	67,920	30,502	45,540	82,664	37,123
29			37,418	37,418	67,920	67,920	30,502	45,861	83,246	37,385
30			37,418	37,418	67,920	67,920	30,502	46,184	83,832	37,648
Total	372,333	542,109	1,103,831	2,018,273	1,981,570	1,981,570	-36,703	2,219,458	2,219,458	0

F. B / C = 1.00000

FNPV = 0.00000

FIRR = -0.69915 %

Table A-9.6.2 Cost and Benefit Flow of F.B/C and FNPV

(Unit: RO)

Year in Order	Cost			Outflow Total	Benefit		Net Cash Flow	Present Value		
	Initial Cost	Replace- ment Cost	O/M Cost		Agricul. Product	Inflow Total		Cost	Benefit	Net
1	372,333		18,709	391,042	11,350	11,350	-379,692	367,176	10,657	-356,518
2			37,418	37,418	68,100	68,100	30,682	32,990	60,041	27,051
3			37,418	37,418	68,100	68,100	30,682	30,976	56,377	25,400
4			37,418	37,418	68,100	68,100	30,682	29,086	52,936	23,850
5			37,418	37,418	67,920	67,920	30,502	27,311	49,574	22,263
6			37,418	37,418	67,920	67,920	30,502	25,644	46,548	20,904
7			37,418	37,418	67,920	67,920	30,502	24,079	43,707	19,628
8			37,418	37,418	67,920	67,920	30,502	22,609	41,039	18,430
9		100,915	37,418	138,333	67,920	67,920	-70,413	78,484	38,535	-39,949
10			37,418	37,418	67,920	67,920	30,502	19,934	36,183	16,249
11		113,927	37,418	151,345	67,920	67,920	-83,425	75,705	33,974	-41,730
12			37,418	37,418	67,920	67,920	30,502	17,575	31,901	14,326
13		2,500	37,418	39,918	67,920	67,920	28,002	17,605	29,954	12,349
14			37,418	37,418	67,920	67,920	30,502	15,495	28,126	12,631
15			37,418	37,418	67,920	67,920	30,502	14,549	26,409	11,860
16		6,510	37,418	43,928	67,920	67,920	23,992	16,038	24,797	8,759
17		100,915	37,418	138,333	67,920	67,920	-70,413	47,422	23,284	-24,138
18			37,418	37,418	67,920	67,920	30,502	12,044	21,863	9,818
19			37,418	37,418	67,920	67,920	30,502	11,309	20,528	9,219
20			37,418	37,418	67,920	67,920	30,502	10,619	19,275	8,656
21		113,927	37,418	151,345	67,920	67,920	-83,425	40,330	18,099	-22,231
22			37,418	37,418	67,920	67,920	30,502	9,362	16,994	7,632
23			37,418	37,418	67,920	67,920	30,502	8,791	15,957	7,166
24			37,418	37,418	67,920	67,920	30,502	8,254	14,983	6,729
25		103,415	37,418	140,833	67,920	67,920	-72,913	29,172	14,069	-15,103
26			37,418	37,418	67,920	67,920	30,502	7,278	13,210	5,933
27			37,418	37,418	67,920	67,920	30,502	6,833	12,404	5,570
28			37,418	37,418	67,920	67,920	30,502	6,416	11,647	5,230
29			37,418	37,418	67,920	67,920	30,502	6,025	10,936	4,911
30			37,418	37,418	67,920	67,920	30,502	5,657	10,269	4,611
Total	372,333	542,109	1,103,831	2,018,273	1,981,570	1,981,570	-36,703	1,024,767	834,276	-190,492

F. B / C = 0.81411

FNPV = -190,492

FIRR = 6.50000 %

Table A-9.6.3 Cost and Benefit Flow of FIRR (Case 2: 15% Subsidy)

(Unit: RO)

Year in Order	Cost				Benefit		Net	Present Value		
	Initial Cost	Replace- ment Cost	O/M Cost	Outflow Total	Agricul. Product	Inflow Total	Cash Flow	Cost	Benefit	Net
1	316,752		18,709	335,461	11,350	11,350	-324,111	334,088	11,304	-322,784
2			37,418	37,418	68,100	68,100	30,682	37,112	67,544	30,431
3			37,418	37,418	68,100	68,100	30,682	36,960	67,267	30,307
4			37,418	37,418	68,100	68,100	30,582	36,809	66,992	30,183
5			37,418	37,418	67,920	67,920	30,502	36,658	66,541	29,883
6			37,418	37,418	67,920	67,920	30,502	36,508	66,269	29,760
7			37,418	37,418	67,920	67,920	30,502	36,359	65,997	29,639
8			37,418	37,418	67,920	67,920	30,502	36,210	65,727	29,517
9		100,915	37,418	138,333	67,920	67,920	-70,413	133,318	65,458	-67,861
10			37,418	37,418	67,920	67,920	30,502	35,914	65,190	29,276
11		113,927	37,418	151,345	67,920	67,920	-83,425	144,667	64,923	-79,744
12			37,418	37,418	67,920	67,920	30,502	35,620	64,657	29,037
13		2,500	37,418	39,918	67,920	67,920	28,002	37,845	64,393	26,548
14			37,418	37,418	67,920	67,920	30,502	35,329	64,129	28,799
15			37,418	37,418	67,920	67,920	30,502	35,185	63,866	28,682
16		6,510	37,418	43,928	67,920	67,920	23,992	41,137	63,605	22,468
17		100,915	37,418	138,333	67,920	67,920	-70,413	129,014	63,344	-65,670
18			37,418	37,418	67,920	67,920	30,502	34,754	63,085	28,331
19			37,418	37,418	67,920	67,920	30,502	34,612	62,827	28,215
20			37,418	37,418	67,920	67,920	30,502	34,470	62,570	28,099
21		113,927	37,418	151,345	67,920	67,920	-83,425	138,852	62,313	-76,539
22			37,418	37,418	67,920	67,920	30,502	34,189	62,058	27,870
23			37,418	37,418	67,920	67,920	30,502	34,049	61,804	27,755
24			37,418	37,418	67,920	67,920	30,502	33,909	61,551	27,642
25		103,415	37,418	140,833	67,920	67,920	-72,913	127,105	61,299	-65,805
26			37,418	37,418	67,920	67,920	30,502	33,632	61,048	27,416
27			37,418	37,418	67,920	67,920	30,502	33,495	60,798	27,304
28			37,418	37,418	67,920	67,920	30,502	33,357	60,549	27,192
29			37,418	37,418	67,920	67,920	30,502	33,221	60,301	27,081
30			37,418	37,418	67,920	67,920	30,502	33,085	60,055	26,970
Total	316,752	542,109	1,103,831	1,962,692	1,981,570	1,981,570	18,878	1,857,464	1,857,464	-0

F. B / C = 1.00000

FNPV = 0.00000

FIRR = 0.41110 %

Table A-9.6.4 Cost and Benefit Flow of FIRR (Case 3: 33% Subsidy)

(Unit: RO)

Year in Order	Cost				Benefit		Net	Present Value		
	Initial Cost	Replace- ment Cost	O/M Cost	Outflow Total	Agricul. Product	Inflow Total	Cash Flow	Cost	Benefit	Net
1	250,780		18,709	269,489	11,350	11,350	-258,139	263,523	11,099	-252,424
2			37,418	37,418	68,100	68,100	30,682	35,780	65,118	29,339
3			37,418	37,418	68,100	68,100	30,682	34,988	63,677	28,689
4			37,418	37,418	68,100	68,100	30,682	34,213	62,267	28,054
5			37,418	37,418	67,920	67,920	30,502	33,456	60,728	27,272
6			37,418	37,418	67,920	67,920	30,502	32,715	59,383	26,668
7			37,418	37,418	67,920	67,920	30,502	31,991	58,069	26,078
8			37,418	37,418	67,920	67,920	30,502	31,283	56,783	25,501
9		100,915	37,418	138,333	67,920	67,920	-70,413	113,090	55,526	-57,564
10			37,418	37,418	67,920	67,920	30,502	29,913	54,297	24,384
11		113,927	37,418	151,345	67,920	67,920	-83,425	118,310	53,095	-65,215
12			37,418	37,418	67,920	67,920	30,502	28,603	51,919	23,316
13		2,500	37,418	39,918	67,920	67,920	28,002	29,839	50,770	20,931
14			37,418	37,418	67,920	67,920	30,502	27,351	49,646	22,295
15			37,418	37,418	67,920	67,920	30,502	26,745	48,547	21,802
16		6,510	37,418	43,928	67,920	67,920	23,992	30,703	47,472	16,769
17		100,915	37,418	138,333	67,920	67,920	-70,413	94,547	46,421	-48,125
18			37,418	37,418	67,920	67,920	30,502	25,008	45,394	20,386
19			37,418	37,418	67,920	67,920	30,502	24,454	44,389	19,934
20			37,418	37,418	67,920	67,920	30,502	23,913	43,406	19,493
21		113,927	37,418	151,345	67,920	67,920	-83,425	94,580	42,445	-52,135
22			37,418	37,418	67,920	67,920	30,502	22,866	41,506	18,640
23			37,418	37,418	67,920	67,920	30,502	22,360	40,587	18,227
24			37,418	37,418	67,920	67,920	30,502	21,865	39,688	17,823
25		103,415	37,418	140,833	67,920	67,920	-72,913	80,472	38,810	-41,663
26			37,418	37,418	67,920	67,920	30,502	20,907	37,950	17,043
27			37,418	37,418	67,920	67,920	30,502	20,445	37,110	16,666
28			37,418	37,418	67,920	67,920	30,502	19,992	36,289	16,297
29			37,418	37,418	67,920	67,920	30,502	19,549	35,485	15,936
30			37,418	37,418	67,920	67,920	30,502	19,117	34,700	15,583
Total	250,780	542,109	1,103,831	1,896,720	1,981,570	1,981,570	84,850	1,412,575	1,412,575	-0

F. B / C = 1.00000

FNPV = 0.00000

FIRR = 2.26390 %

Table A-9.6.5 Cost and Benefit Flow of FIRR (Case 4: 55% Subsidy)

(Unit: RO)

Year in Order	Cost				Benefit		Net	Present Value		
	Initial Cost	Replac- ment Cost	O/M Cost	Outflow Total	Agricul. Product	Inflow Total	Cash Flow	Cost	Benefit	Net
1	167,844		18,709	186,553	11,350	11,350	-175,203	174,952	10,644	-164,308
2			37,418	37,418	68,100	68,100	30,682	32,909	59,894	26,985
3			37,418	37,418	68,100	68,100	30,682	30,863	56,169	25,307
4			37,418	37,418	68,100	68,100	30,682	28,943	52,676	23,733
5			37,418	37,418	67,920	67,920	30,502	27,144	49,270	22,127
6			37,418	37,418	67,920	67,920	30,502	25,456	46,206	20,751
7			37,418	37,418	67,920	67,920	30,502	23,873	43,333	19,460
8			37,418	37,418	67,920	67,920	30,502	22,388	40,638	18,250
9		100,915	37,418	138,333	67,920	67,920	-70,413	77,621	38,111	-39,510
10			37,418	37,418	67,920	67,920	30,502	19,690	35,741	16,051
11		113,927	37,418	151,345	67,920	67,920	-83,425	74,689	33,519	-41,170
12			37,418	37,418	67,920	67,920	30,502	17,318	31,434	14,117
13		2,500	37,418	39,918	67,920	67,920	28,002	17,326	29,480	12,154
14			37,418	37,418	67,920	67,920	30,502	15,231	27,646	12,416
15			37,418	37,418	67,920	67,920	30,502	14,284	25,927	11,644
16		6,510	37,418	43,928	67,920	67,920	23,992	15,726	24,315	8,589
17		100,915	37,418	138,333	67,920	67,920	-70,413	46,443	22,803	-23,640
18			37,418	37,418	67,920	67,920	30,502	11,781	21,385	9,604
19			37,418	37,418	67,920	67,920	30,502	11,049	20,055	9,006
20			37,418	37,418	67,920	67,920	30,502	10,362	18,808	8,446
21		113,927	37,418	151,345	67,920	67,920	-83,425	39,303	17,638	-21,665
22			37,418	37,418	67,920	67,920	30,502	9,113	16,542	7,429
23			37,418	37,418	67,920	67,920	30,502	8,546	15,513	6,967
24			37,418	37,418	67,920	67,920	30,502	8,015	14,548	6,533
25		103,415	37,418	140,833	67,920	67,920	-72,913	28,290	13,644	-14,647
26			37,418	37,418	67,920	67,920	30,502	7,049	12,795	5,746
27			37,418	37,418	67,920	67,920	30,502	6,611	11,999	5,389
28			37,418	37,418	67,920	67,920	30,502	6,200	11,253	5,054
29			37,418	37,418	67,920	67,920	30,502	5,814	10,554	4,739
30			37,418	37,418	67,920	67,920	30,502	5,453	9,897	4,445
Total	167,844	542,109	1,103,831	1,813,784	1,981,570	1,981,570	167,786	822,439	822,439	0

F. B / C = 1.00000

ENPV = 0.00000

FIRR = 6.63083 %

Table A-9.7.1 Staffing Plan of NARS

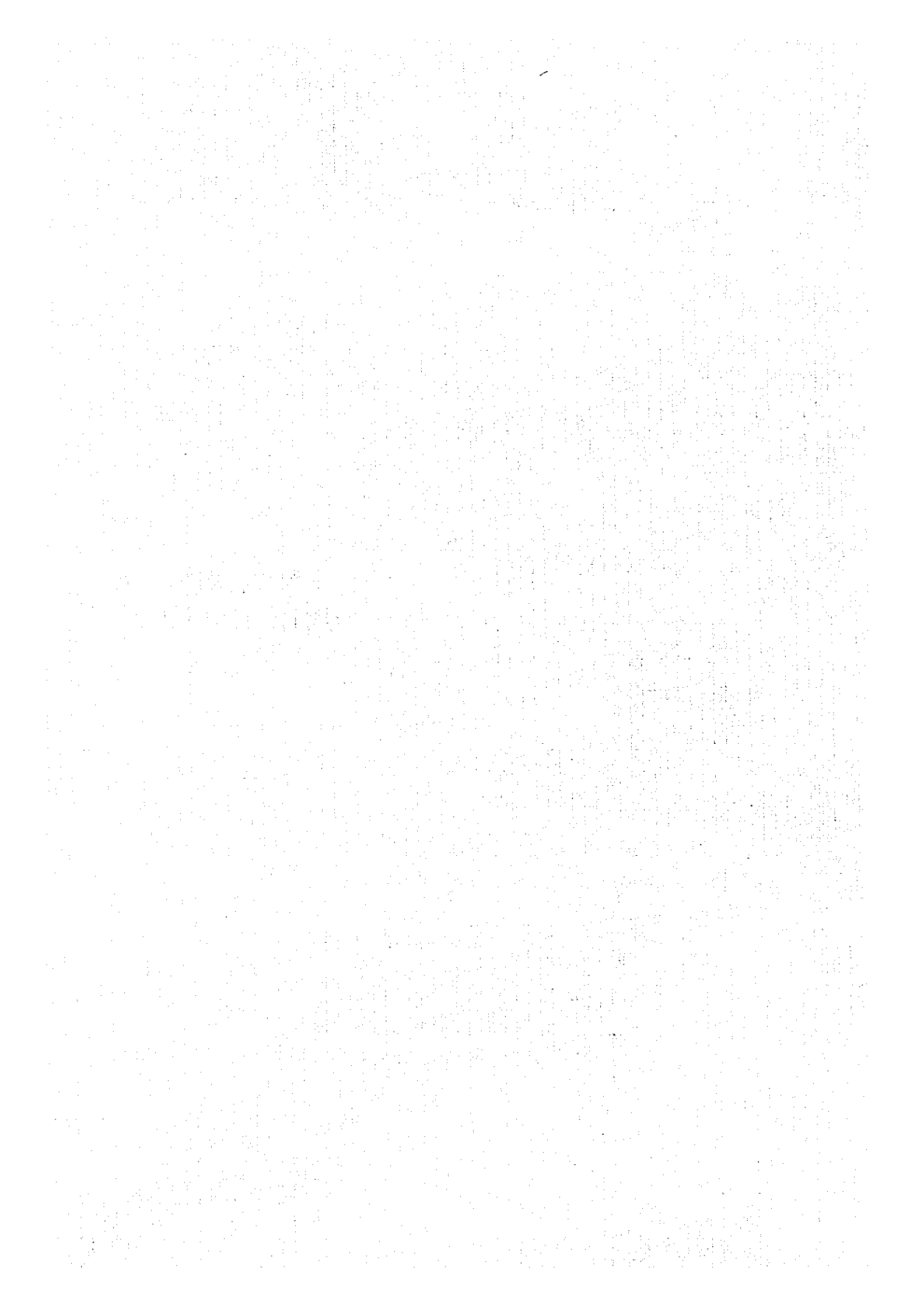
NO.	Position	Number of Staffs	
		Proposed by DGAF, in 1994	Proposed by JICA, in 1996
1	Director	-	1
2	Research and Development Section		
1)	Agronomist	1	1
	Assistant agronomist	1	1
2)	Soil and Water Engineer	1	1
	Assistant Soil and Water Engineer	1	1
3)	Researcher of Field Crops	1	-
	Assistant Researcher of Field Crops	1	-
4)	Researcher of Vegetables	1	1
	Assistant of Researcher of Vegetables	1	1
5)	Researcher of Fruits	1	1
	Assistant of Researcher of Fruits	1	1
6)	Researcher of Pest Control	1	1
	Researcher of Disease Control	-	1
7)	Chemical Analyst	-	1
	Assistant Chemical Analyst	-	2
8)	Animal husbandry Specialist	1	1
	Assistant Animal Husbandry Specialist	1	1
9)	Veterinarian	-	1
10)	Farm foreman	-	1
11)	Farm labors	20	15
	Sub-total	33	32
3	Monitoring Section		
1)	Monitoring technician (Irrigation)	-	1
	Monitoring technician (Agronomy)	-	1
	Sub-total	-	2
4	Operation and Maintenance Section		
1)	Mechanic	1	1
2)	Electrician	1	1
3)	Farm Machinery Specialist	1	-
4)	Tractor Operator	2	2
5)	Operator of Irrigation Facilities	-	2
6)	Truck Driver	-	1
	Sub-total	5	7
5	Administration Section		
1)	Administrator	-	1
2)	Clark	-	1
3)	Typist	-	1
4)	Store Keeper	-	1
5)	Heavy Duty Driver	2	-
6)	Light Duty Driver	4	1
7)	Guard	9	3
8)	Cook	-	1
9)	Office Boy	-	1
	Sub-total	15	10

NO.	Position	Number of Staffs	
		Proposed by DGAF, 1994	Proposed by JICA, in 1996
6	Training and Extension Section		
1)	Extension Engineer	1	1
	Assistant Statistical Enumerator	-	1
2)	Plant Protection Engineer	1	1
3)	Agriculture Statistician	1	-
	Assistant Agriculture Statistician	1	-
4)	Statistical Enumerator	1	-
5)	Tractor Operator	-	1
6)	Truck Driver	-	1
7)	Labor	1	2
	Sub-total	6	7
7	Each Pilot Farm		
1)	Assistant Agronomist	-	2
2)	Tractor Operator	-	1
3)	Truck Driver	-	1
4)	Labor	-	5
	Sub-total	-	9
	Grand Total	59	59 + (9x) *

Note : * x is number of the pilot farms

Note : Assistant agronomist, assistant irrigation engineer and the similar posts are the positions equal to the technician level.

APPENDIX - 10
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Appendix 10

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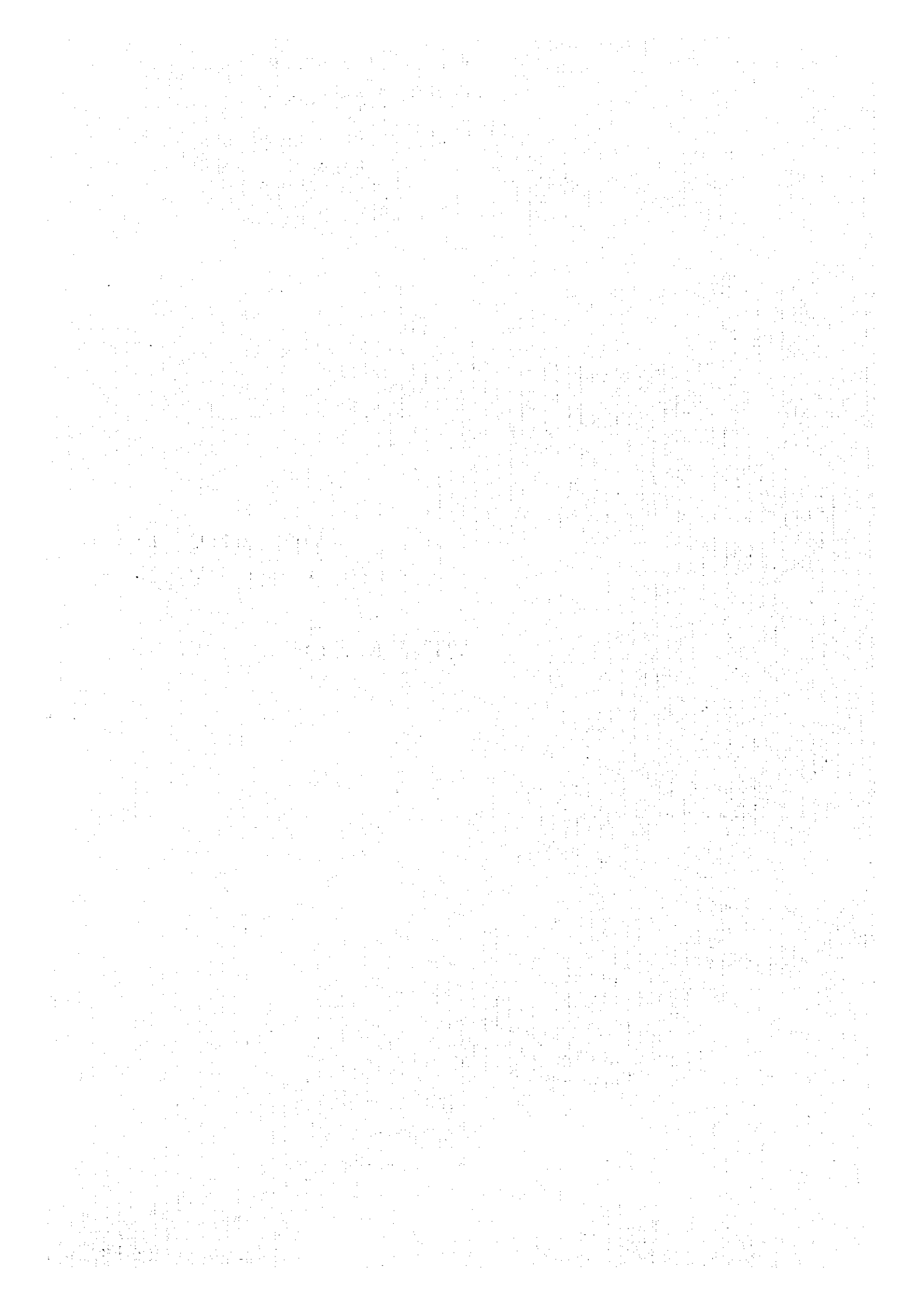
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APPENDIX - 11
SCOPE OF WORK
AND
MINUTES OF MEETING



Scope of Work (22 October, 1990)

SCOPE OF WORK.
FOR
THE STUDY
ON
THE AGRICULTURE DEVELOPMENT PROJECT II
IN
THE NEJD REGION
THE SULTANATE OF OMAN

AGREED UPON
BETWEEN
THE MINISTRY OF AGRICULTURE AND FISHERIES
AND
THE JAPAN INTERNATIONAL COOPERATION AGENCY

Signed in Muscat,

22nd October, 1990



ENG. MUSALLAM BIN SALEM BIN MAHAD
BIN QATAN
UNDERSECRETARY
MINISTRY OF AGRICULTURE
AND FISHERIES

後藤光弘

MR. MITSUHIRO GOTO
LEADER OF JAPANESE
PRELIMINARY SURVEY TEAM
JAPAN INTERNATIONAL
COOPERATION AGENCY

I. INTRODUCTION

In response to the request of the Government of the Sultanate of Oman (hereinafter referred to as "the Sultanate of Oman"), the Government of Japan has decided to conduct the Study on Agriculture Development Project II in the Nejd Region (hereinafter referred to as "the Study"), which is based on the Agricultural Development Project that was conducted from March 1987 to January 1989 (hereinafter referred to as "the Agricultural Development Study"), in accordance with the relevant laws and regulations in force in Japan.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programmes of the Government of Japan, will undertake the Study in close cooperation with the Ministry of Agriculture and Fisheries (hereinafter referred to as "MAF"), who is the authority concerned in the Sultanate of Oman.

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

II. OBJECTIVE OF THE STUDY

The objectives of the Study are;

1. to prepare the detailed design and tender document for pilot farm (50ha),
2. to enhance groundwater knowledge from the viewpoint of agricultural development and to formulate the next agricultural development plan,
3. to undertake on-the-job training of the Omani counterpart personnel in the course of the Study.

III. OUTLINE OF THE STUDY

1. Study Area

- (1) The Study area covers about 8,100km² which consists of Dauka, Wadi Makhawrim and Shasr in Nejd Region.
- (2) The pilot farm of 50ha, is located 150km to the north of Salalah adjacent and 1.2km west of the Muscat-Salalah National Highway.

2. Scope of the Study

The outline of the Study to be undertaken by JICA on the basis of the results of the Agricultural Development Study shall be divided into the following two works.

Work I - To prepare the detailed design and tender document.

Work II - To enhance groundwater knowledge from the viewpoint of agriculture development in the Nejd Region and to formulate the next agricultural development plan.

Major items of each works are:

1. Work - I

(1) Formulation of Farm Management Plan

1. Crop cultivation plan,
2. Training plan,
3. Extension plan,
4. Groundwater, meteorology and soil observation plan,
5. Operation and Maintenance plan .

(2) Topographic Survey

1. Site Survey of facilities,
2. Other necessary Survey.

(3) Determination of fundamental matters

To determine fundamental matters based on the review of the Agricultural Development Study and detailed investigations.

1. Determination of specifications of the facilities such as farm size, water supply facilities, irrigation facilities, appurtenant facilities and others,
2. Clarification of design conditions on the basis of the results of field survey and its analysis,
3. Clarification of design criteria for designing the facilities,
4. Determination of unit price for construction cost estimation,
5. Determination of the basic matters on construction schedule,
6. Clarification of the basic matters on tender documents.

(4) Preparation for Detailed Design

On the basis of the definitive plan, the following works shall be

carried out :

1. Structural and irrigation design of each facility,
2. Preparation of design drawings of each facility on the basis of the design,
3. Preparation of chart of quantities calculation on each construction work on the basis of the design drawings,
4. Preparation of unit price chart on each construction work,
5. Estimation of construction cost,
6. Preparation of detailed construction plan,
7. Preparation of construction schedule chart.

(5) Preparation of Specification and Tender Document

In accordance with the forms used in OMAN, specification and tender document on the construction works of the project shall be prepared as follows:

1. Form of tender,
2. Form of Agreement,
3. General conditions of contract,
4. Particular conditions of contract,
5. General and particular specifications of construction work,
6. Contract drawings,
7. Bill of quantities,
8. Construction schedule chart,
9. General information for tender.

2. Work-II

(1) Electric Prospecting

1. Conduct the two prospecting methods, MI and Schlumberger.
The prospecting covers about 8,100 km²,
2. Formulation of three dimension geological map,
3. Data collection and review of the existing relevant study,
4. Geological and hydrogeological analysis of study results.

(2) Construction of two observation wells

1. Selection of suitable site of two observation wells,
2. Drilling and construction of two observation wells including supervision of works.

(3) Monitoring and management in the pilot farm for two years from the start of farming operation

1. Monitoring of groundwater drawdown,
2. Monitoring of the quality of groundwater,
3. Monitoring and management of soil and cultivation technology for fodder grass.

(4) Formulation of the next agricultural development plan.

1. Clarification of groundwater conditions in Nejd region,
2. Outline of the suitable project development pace and the limitation of the project area.
3. Formulation of the next agricultural development plan

IV. STUDY SCHEDULE

The Study shall be executed in accordance with the attached tentative work schedule.

V. REPORTS

JICA shall prepare and submit the following reports in English to MAF;

1. Inception Report:

Twenty (20) copies at the commencement of the Work I study.

2. Definitive Plan:

Twenty (20) copies at the end of the field work in the Work I study.

3. Draft Detailed Designs Report, Specification and Tender Document:

Twenty (20) copies at the completion of the Study. Within a month after the presentation of the Draft Final Report, MAF shall forward the final comments on the Draft Final Report to JICA through the Embassy of Japan.

4. Detailed Design Report, Specification and Tender Document:

Fifty (50) copies within two (2) months after receiving the comments from MAF on the Detailed Design Report.

5. Progress Report (I)

Twenty (20) copies at the end of the electric prospecting work.

6. Interim Report

Twenty (20) copies at the end of the observation well drilling work.

7. Progress Report(II)

Twenty (20) copies at the middle of the monitoring in the pilot farm.

8. Draft Final Report

Twenty (20) copies at the end of the Work II.

9. Final Report

Fifty (50) copies within two (2) months after receiving the comments from MAF on the Draft Final Report.

VI. UNDERTAKING OF THE GOVERNMENT OF THE SULTANATE OF OMAN (MAF)

1. To facilitate smooth implementation of the Study, the sultanate of Oman (MAF) shall take necessary measures:

- 1) to secure the safety of the Japanese study team, (hereinafter referred to as the "Team"),
- 2) to permit the members of the Team to enter, leave and sojourn in the sultanate of Oman for the duration of their assignment therein, and exempt them from alien registration requirements and consular fees,
- 3) to exempt the members of the Team from taxes, duties, fees and any other charges on equipment, machinery and other materials brought into the sultanate of Oman for the conduct of the Study,
- 4) to exempt the members of the Team from income tax and other charges of any kind imposed on or in connection with any emolument or allowance paid to the members of the Team for their services in connection with the implementation of the Study,
- 5) to provide necessary facilities to the Team for remittance as well as utilization of the funds introduced into the sultanate of Oman from Japan in connection with the implementation of the Study,
- 6) to secure permission for entry into private properties or governmental areas for the conduct of the Study, subject to the permission of respective authorities,
- 7) to secure permission for the Team to take all data and documents related to the Study out of the sultanate of Oman to Japan by the Team, subject of the clearance of respective authorities,
- 8) to provide medical services as needed. Its expenses will be chargeable on the members of the Team.

2. MAF shall bear claims, if any arising against the members of the Team resulting from occurring in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or wilful misconduct on the

part of the members of the Team.

3. MAF shall act as counterpart agency to the Team and also as coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.
4. MAF shall, at its own expense, provide the Team with the following ,in cooperation with relevant organizations :
 - 1) Available data and information related to the Study,
 - 2) counterpart personnel as available,
 - 3) suitable office space with necessary equipment (furniture, telephone and copy-machine) both near to the project site during farming operation, in Salalah and Muscat,
 - 4) 5 No,s of four-wheel-drive vehicles (2 equipped movable telephone) with drivers in the Study area, in Salalah, and in Muscat with their running cost,
 - 5) credentials or identification cards.



VII. UNDERTAKING OF JICA





















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

1. to dispatch, at its own expense, study team to OMAN, including domestic air tickets,
2. to carry out ,at its own expense, the drilling and construction of two observation wells and electric prospecting,
3. to pursue technology transfer to Omani counterpart personnel in the course of the Study.

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

TENTATIVE WORK SCHEDULE

 : Activities in Oman
 : Activities in Japan

Description	Month																				
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
(1) WORK- I	 																				
(2) WORK- II	        																				
(4) REPORT	        																				

Note: Actual monitoring and management in the pilot farm will commence upon the start of farming.

Minutes of Meeting (22 October, 1990)

MINUTES OF MEETING ON SCOPE OF WORK

FOR

THE STUDY

ON

THE AGRICULTURE DEVELOPMENT PROJECT II

IN THE NEJD REGION

THE SULTANATE OF OMAN

AGREED UPON BETWEEN

MINISTRY OF AGRICULTURE AND FISHERIES

AND

THE JAPAN INTERNATIONAL COOPERATION AGENCY

MUSCAT, 22nd Oct, 1990



ENG. MUSALLAM BIN SALEM BIN
MOHAD BIN QATAN
UNDERSECRETARY
MINISTRY OF AGRICULTURE
AND FISHERIES.

後藤 光弘

MR. MITSUHIRO GOTO
LEADER OF THE PRELIMINARY
SURVEY TEAM,
THE JAPAN INTERNATIONAL
COOPERATION AGENCY

MINUTES OF MEETING

The Japanese Preliminary Survey Team (hereinafter referred to as "The Team") sent by the Japan International Cooperation Agency (hereinafter referred to as "JICA") headed by Mr. MITSUHIRO GOTO visited the Sultanate of Oman from October 11 to October 23, 1990 for the purpose of getting mutual agreement on the scope of work for the Study on the Agriculture Development Project II in Nejd Region in the Sultanate of Oman (hereinafter referred to as "The Study").

The Team has series of discussion with the representatives of Ministry of Agriculture and Fisheries (hereinafter referred to as "MAF") and Ministry of Water Resources (hereinafter referred to as "MWR"), and carried out field study in the Nejd region.

Through these discussions, both sides reached mutual agreement on the scope of work.

The salient results of the discussions are as follows:

1. Both sides have acknowledged that this scope of work shall be effective after the two countries have exchanged the note verbales concerning the Study.
2. Regarding with the number of Study team members, MAF requested to specify the number and speciality of proposed staff. The Team replied that at present temporary about 6 personnel considered, but this figure will be subject to confirmation from the JICA. JICA will be in a position to inform MAF officially exact no. of staff.
3. Both sides agreed that MAF should take all necessary actions and obtain necessary permission from concerned authorities to ensure proper implementation of the field investigation program. Particularly, JICA is concerned about safely working condition for its personnel and insist on

the granting of necessary authorization to use radio-transceiver, mobile telephone.

4. According to the "UNDERTAKING OF THE GOVERNMENT OF THE SULTANATE OF OMAN 4- 2) in the scope of work", the Team requested 13 counterpart personnel (leader 1, hydrogeologist 2, agronomist 2, farm planner 1, design/cost estimation 1, electric prospecting 4, drilling 1, irrigation engineer 1). MAF replied that it is difficult but will do its best fulfill request of JICA.
5. MAF requested that technology transfer to Omani counterpart personnel would be done through technical training (especially for farming system, management system and irrigation system) in Japan, in addition to on-the-job training in the sultanate of Oman. The Team have promised to convey the above request to the Government of Japan.
6. MAF requested that JICA would held the seminar about the result of the study for the technology transfer to Omani counterpart personnel at the end of the study. The Team promised to convey the above request to the Government of Japan.
7. MAF requested that apart from fodder grass experiment as proposed by the Team other suitable crops should be taken in consideration for cultivation on the pilot farm. The Team have promised to convey the above request to the Government of Japan.
8. Both sides agreed that MAF would manage the pilot farm.
9. MAF requested JICA to provided survey equipments (soil survey equipment, irrigation survey equipment, etc.,) for the technology transfer to Omani counterpart personnel through the study, and to donate it after the termination of the Study.

Minutes of Meeting (27 July, 1992)

MINUTES OF MEETING
FOR
THE STUDY
ON
THE AGRICULTURE DEVELOPMENT PROJECT (PHASE - II)
IN THE NEJD REGION
THE SULTANATE OF OMAN

AGREED UPON BETWEEN

MINISTRY OF AGRICULTURE AND FISHERIES
AND

THE JAPAN INTERNATIONAL COOPERATION AGENCY

MUSCAT, JULY 22, 1992

1995/V/55
S.A.H.

MR. SAUD BIN SALIM AL-HARTHY
DIRECTOR GENERAL OF
IRRIGATION AFFAIRS,
MINISTRY OF AGRICULTURE
AND FISHERIES

川崎 敏

MR. SATOSHI KAWASAKI
LEADER OF THE JAPANESE
MISSION

A Japanese Mission (hereinafter referred to as "the Mission") sent by the Japan International Cooperation Agency (hereinafter referred to as "JICA"), headed by Mr. SATOSHI KAWASAKI, visited the Sultanate of Oman from July 16 to July 23, 1992 for the purpose of settling issues on the groundwater survey of the Study on the Agriculture Development Project in the Nejd Region (Phase-II) in the Sultanate of Oman (hereinafter referred to as "the Study").

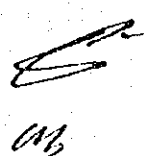
The Mission had a series of discussions with the representatives of the Ministry of Agriculture and Fisheries (hereinafter referred to as "MAF") on the most realistic and appropriate sharing method of the groundwater survey of the Study between MAF/JICA and the Ministry of Water Resources (hereinafter referred to as "MWR").

Consequently, the Mission agreed to MAF's proposal that the construction of two observation wells including groundwater tests, groundwater monitoring in the outside of Pilot Farm, and groundwater assessment for the next agricultural development plan be undertaken by MWR in close cooperation with MAF/JICA.

In this context, both sides agreed to amend the original Scope of Work for the Study signed by MAF and JICA on the 22nd October, 1990 as follows ;

1) Following paragraph in (2), Construction of two observation wells of Work-II, stipulated in III. OUTLINE OF THE STUDY shall be deleted:

2. Drilling and construction of two observation wells including supervision of works.



2) Following paragraph stipulated in VI . UNDERTAKING OF JICA shall be deleted:

2.To carry out, at its own expense, the drilling and construction of two observation wells and electric prospecting.

and substituted by:

2.To carry out, at its own expense, the electric prospecting.

3) Following paragraph stipulated in V . REPORTS shall be deleted:

5.Interim Report

Twenty (20) copies at the end of the observation well drilling work.

and substituted by:

5.Interim Report

Twenty (20) copies at the commencement of the monitoring in the pilot farm.

4) All the other stipulations in the original Scope of Work shall remain unchanged.



M.

GROUNWATER SURVEY PROCEDURE

A Japanese Mission (hereinafter referred to as "the Mission") sent by the Japan International Cooperation Agency (hereinafter referred to as "JICA") headed by MR. SATOSHI KAWASAKI visited the Sultanate of Oman from July 16 to July 23, 1992 for the purpose of settling issues on the groundwater survey of the Study on the Agriculture Development Project in the Nejd Region (Phase II) in the Sultanate of Oman (hereinafter referred to as "The Study").

The Mission had a series of meetings with the representatives of the Ministry of Agriculture and Fisheries (hereinafter referred to as "MAF") and the Ministry of Water Resources (hereinafter referred to as "MWR"). A list of participants of these discussions is given in Attachment - I. Minutes of these meetings are given in Attachment - II.

Through these meetings, both Japanese and Omani side reached mutual understanding on the groundwater survey issues of the Study as follows:

- (1) MWR will cooperate with MAF/JICA in conducting the groundwater survey for the Study.
- (2) MAF/JICA and MWR will conduct the groundwater survey in accordance with the work flow chart as shown in the Attachment - III.
- (3) A Technical Committee composed of MAF/JICA and MWR may be organized to implement the Study smoothly.
- (4) MAF/JICA and MWR will consult with each other on the implementation schedule, survey methods and reports etc. stage by stage.
MAF/JICA and MWR will provide the survey data to each other stage by stage.
- (5) With regard to the Drilling Works
 1. MWR will drill the two observation wells southwest of the pilot farm instead of JICA study team.
 2. MWR will complete the drilling and aquifer testing by the end of July, 1993, when the monitoring for the pilot farm operation is to begin.
- (6) With regard to the Monitoring for the Pilot Farm Operation
 1. MAF/JICA is responsible for monitoring wells inside the pilot farm.

2. MWR is responsible for monitoring wells outside the pilot farm.

(7) MAF/JICA and MWR will share their knowledge on groundwater assessment for formulation of the next agricultural development plan as follows:


1. MAF/JICA

- a. Estimation of groundwater requirement for the plan.
- b. Disposition of appropriate pumping sites for the plan.

2. MWR

- a. Estimation of drawdown caused by groundwater pumping.
- b. Estimation of the radius of influence of groundwater pumping and inter-well drawdown.
- c. Determination of appropriate groundwater development rate and sustainability of developed area.
- d. Estimation of groundwater development potential for the plan.

(8) MWR will provide the results of the regional groundwater assessment to MAF/JICA by January, 1995 for formulation of the next agricultural development plan.



M.

ATTACHMENT - I

Attendant's List

MAF

- (1) Mr. Nasser Al Maqbal : Department of Dam, DGIA
(2) Mr. Paul Barriere : Hydrogeologist, DGIA
(3) Mr. Sayed Rashid Ali : Hydrogeologist, DGIA
(4) Dr. Thomas Riekel : Hydrogeologist, DGIA

MWR

- (1) Mr. Philip Johnson : Deputy Director General of
Water Resources Assessment
(2) Mr. Harley Young : Deputy Director of Research,
DGWRA
(3) Dr. Peter Hadwen : Project Director, Salalah,
DGWRA

JICA

- (1) Mr. Satoshi Kawasaki : Leader of Japanese Mission,
Ministry of Agriculture
Forestry and Fisheries
(2) Mr. Norio Matsuda : Project Coordinator
JICA Head Office
(3) Mr. Manabu Masuo : Aid Policy Planner
Ministry of Foreign Affairs
(4) Mr. Takao Sakamoto : Leader of JICA Study Team
(5) Mr. Hiroshi Ibaragi : Member of JICA Study Team

MINUTES OF MEETINGS -- JULY 19-20, 1992

1. JICA gave a general overview to HWR of the Agricultural Development Project in the Nejd Region, explaining especially the work programme relating to groundwater surveys for the Pilot Farm.

2. HWR agreed in principle with the Work Flow Chart and took note of the tentative and revised Work Programme (see Attachment II) for the HAF-JICA Pilot Farm.

3. HWR emphasized that monitoring, regional assessment and management of groundwater in the Nejd will be carried out by HWR.

4. HWR explained its ongoing programme of regional groundwater assessment in the Nejd. This programme in turn depends greatly on completion of a substantial part of another programme to rehabilitate many existing leaky wells. These wells do not provide accurate potentiometric heads for aquifer C because the head in these wells is a composite of the heads of more than one aquifer.

5. HWR stated that results of its assessment of the groundwater resources in the Nejd would be available by the end of 1994 to meet JICA's schedule for formulation of their Agricultural Development Plan.

6. JICA/HAF agreed to provide copies of all hydrological data to HWR.

7. HWR agreed to participate in informal technical coordinating meetings as well as formal meetings both in Salalah and Muscat in cooperation with JICA/HAF.

8. HAF agreed that HWR could have access to the existing Pilot Farm wells for further geophysical logging and inspection for leakage prior to beginning of pumping operations. HWR noted that one of the existing wells is suspected to be leaking.

9. It was confirmed that drilling of the two observation wells outside of the Pilot Farm will be conducted by HWR rather than JICA. HWR informed the meeting that the contract to drill these wells was advertised on July 9 and tenders were opened on July 18. HWR confirmed that drilling and testing is expected to be completed by the end of 1992.

The location of these wells, as previously proposed by HWR, was agreed upon. They will be 2 and 5 km southwest, respectively, of the Pilot Farm production wells. The major considerations in the location were:

a. For maximum benefit in analysis of an aquifer pumping test with two observation wells, the wells should be placed along a line through the pumped well location.

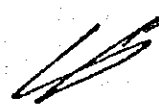
b. The locations are aligned with the hydraulic gradient and upgradient from the Pilot Farm.

c. The distances of 2 and 5 km are based on drawdown experienced during HWR 14-day and 7-day aquifer pumping tests at Hanfeet West about 35 km south of the Pilot Farm.

10. HWR said an additional permit may be required before the two production wells are put in operation. Enquiry will be made to the Directorate General of Regional Affairs. HWR and HAF will be advised accordingly.

11. HWR emphasized the need to consider competing demands for groundwater use in the Nejd in relation to expansion of agriculture as may be suggested in the Agricultural Development Plan.

12. JICA/HAF and HWR will coordinate on development of the ground-water monitoring programme inside the Pilot Farm.



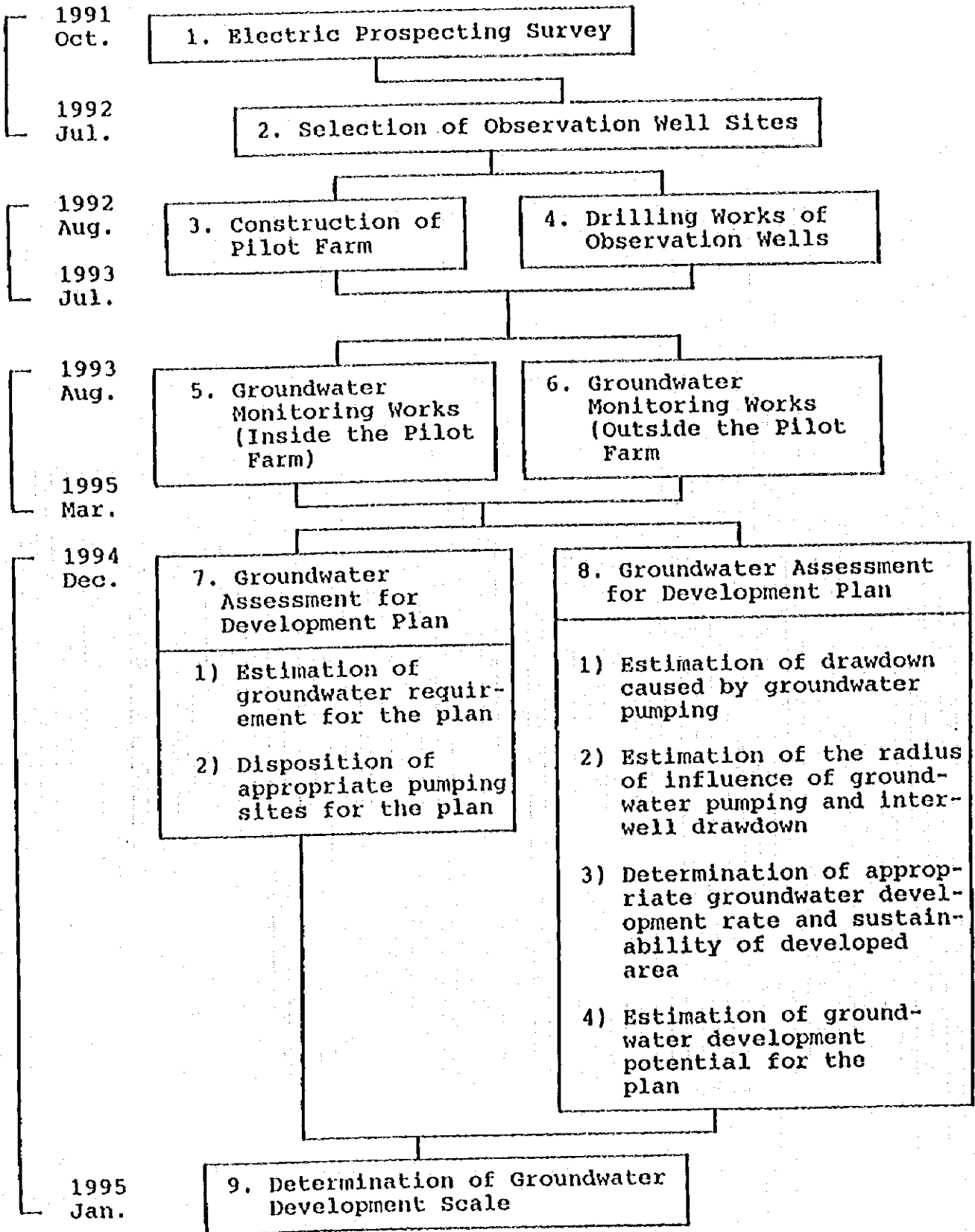
M.

ATTACHMENT III

SCHEDULE

MAF / JICA

MWR



M.

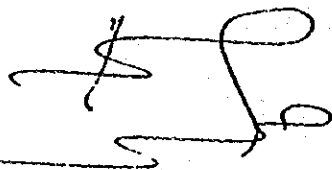
Minutes of Meeting (18 December, 1994)

V. 添付資料

(1) M/M コピー

Minutes of the Meeting held between
Directorate General of Agriculture and Fisheries, Dhofar Governorate
and
The Japan International Cooperation Agency (JICA) Mission
for Resumption on
THE AGRICULTURE DEVELOPMENT PROJECT (PHASE-II)
IN THE NEJD REGION, THE SULTANATE OF OMAN

Salalah, Dated 16th December, 1994



Mr. Mohamed bin Ahmed bin Mahfooz Al Sheikh
Acting Director General
Directorate General of Agriculture and Fisheries,
Governorate of Dhofar
Ministry of Agriculture and Fisheries



Mr. Yutaka Sasaki
Team Leader
JICA Mission for Resumption of the Project

A Japanese Mission (hereinafter referred to as 'the Mission') sent by the Japan International Cooperation Agency (hereinafter referred to as 'JICA'), headed by Mr. YUTAKA SASAKI, visited the Sultanate of Oman from December 6 to December 21, 1994 for the purpose of settling issues on the resumption of the study on the Agriculture Development Project in the Nejd Region (Phase-II) in the Sultanate of Oman (hereinafter referred to as 'the Study').

The Phase-I Study was commenced initially in response to the request of the Government of Sultanate of Oman in October 1989 under the Scope of Works dated on 8th December 1986.

The objectives were;

1. to study and evaluate groundwater, with a view to develop agriculture in the Nejd Region,
2. to formulate agriculture development plan.

The above mentioned study concluded that the development concept in the region should be 'Phased development', while encouraging continuous detailed investigation of groundwater development potential.

This Phase-II Study was started in accordance with the scope of works dated on 22nd October 1990, succeeded to the previous Phase-I study, with objectives of:

1. to prepare the detailed design and tender documents for pilot farm (50ha),
2. to enhance groundwater knowledge from the viewpoint of agricultural development and to formulate the next agricultural development plan,
3. to undertake on-the-job training of the Omani counterpart personnel in the course of the Study.

The JICA Study Team prepared and submitted the design and tender documents on December 1991 and the Sultanate of Oman started the construction of the Pilot Farm (hereinafter referred to as the Farm) from December 1991 to the present. During the period, the study has been given a pause for about 3 years up to now. Matters of construction of two observation wells including groundwater tests, groundwater monitoring in the outside of the Farm and groundwater assessment for the next agricultural development plan were deleted from the original Scope of Works on 22nd July, 1992.

This Mission aims to evaluate the existing conditions and to settle the issues for resumption of the Study. The Mission had a series of discussions with the representatives of the Directorate

General of Agriculture and Fisheries, Dhofar Governorate (hereinafter referred to as 'DGAF,Salalah') and Head Office of Ministry of Agriculture and Fisheries (hereinafter referred to as 'MAF,Muscat') on the most realistic conditions for resumption of the Study.

Through the meetings, both Japanese and Omani side reached mutual understanding on the aspects as follows:

1. The Study should be executed under the original scope of works in accordance with attached tentative work schedule (Attachment-I).
2. DGAF, Salalah informed the Mission that the Farm is administrated directly by DGAF, Salalah as described in Attachment-II, with named 'Agriculture Research Station in Nejd' newly.
3. The conditions prepared by DGAF, Salalah was sufficient to continue the Study, excepting the items listed below. DGAF,Salalah promised to complete the preparation before the end of February 1995. Hence the DGAF, Salalah requested the continuation of the Study in early in March 1995 and promised to make their best to receive the JICA Study Team. The Mission promised to convey the above request to the Government of Japan.
 - a. Construction of Laboratory and Store and provision of furniture for buildings.
 - b. Provision of agricultural machinery for daily farm works in the Farm.
 - c. Appointing personnel and let them mobilize to establish initial organization of the farm.
 - d. Sufficient annual required budget for running the Farm.
4. The Mission requested the DGAF, Salalah to inform the progress of aforementioned subjects at the beginning of February 1995 to JICA head office through official channel and the DGAF, Salalah accepted it.
5. DGAF, Salalah requested the Mission that the subjects listed below will be provided by JICA and the Mission promised to convey them to the Government of Japan.
 - a Equipment and tools for the experiment and monitoring works at the Farm.
 - b Dispatching experts of Vegetable, Fruits and Irrigation.
 - c Renovation of the existing weather stations (Dawkah and the Farm)
 - d Counterparts' training in Japan through JICA training program

Reference

Attendance in Meeting at DQAF Headquarters in Salalah

Date : 17th December 1994

Venue : Conference Room, Ground Floor, DQAF, in Salalah

DQAF, Salalah Side

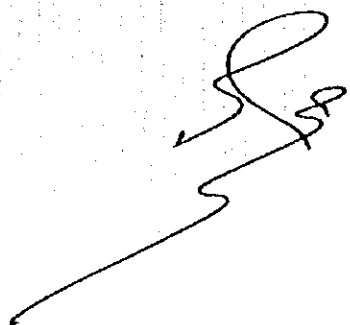
- (1). Mr. Mohamed bin Aluned bin Mahfooz Al Sheikh : Acting Director General of DQAF, Salalah
- (2). Mr. Ahmed bin Alwi Al-Dheeb : Director General for Technical Affairs
- (3). Mr. Ahmed bin Suleimen Ba-Omar : Director of Irrigation Dept.
- (4). Mr. Mohd S. Shamas : Director of Research Station.
- (5). Mr. Abood Mubarik Al-Shasbai : Soil and water Dept.
- (6). Mr. Musalemi bin Ahmed Tabook : Soil and water Dept.

Embassy of Japan

Mr. Kunio Noguchi

JICA Mission Side

- (1). Mr. Yutaka Sasaki : Team Leader of the Mission
- (2). Mr. Izuru Nakanura : Project Coordinator, JICA Head Office
- (3). Mr. Seishiro Suzuki : Member of the Mission



LENAIIVE WORK SCHEDULE

Description	Month in order																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Activities in Japan																															
Activities in Uman																															
Reports																															
Inception report-1																															
Interim report																															
Progress report																															
Draft final report																															
Final report																															




Record of Meeting (26 February, 1989)

MEETING
BETWEEN
THE OMANI TECHNICAL PERMANENT COMMITTEE
AND
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA) STUDY TEAM
ON
INTERIM REPORT (II)
OF
THE AGRICULTURE DEVELOPMENT PROJECT
IN
THE NEJD REGION

Date & Time : 26 February, 1989
10.00 A.M. TO 01.00 PM

Place : Meeting Room, Ground Floor,
Ministry of Agriculture & Fisheries

AGENDA

1. Welcome address by the chairman of Technical Permanent Committee, Director General of Irrigation Affairs, MAF.
2. Approval of the minutes of the previous meeting (held at MEWR on 27th December 1988).
3. Opening of the meeting by the chairman, and inviting JICA team. to present the Interim Report (II).
4. Presentation of the Report by JICA.
 - (a) Summary and conclusions on Groundwater.
 - (b) Summary and conclusions on Agriculture.
5. Opening of the discussions by the chairman.
6. Session of discussions.
7. JICA's presentation of future programme of study and preparation of Final Report.
8. Preparation of minutes of the meeting.
9. Closing of the meeting by the chairman with a vote of thanks.

DELIBERATIONS

The meeting was conducted as per the agenda attached.

MR. ABDULLA BIN HAMDAN, CHAIRMAN

The Chairman opened the meeting by welcoming JICA team, Technical Permanent Committee and other members. He expressed that the Interim Report (II) was received from JICA only yesterday and was delivered to all the members on the same day. He regretted that the report was not delivered sufficiently in advance. Further, he advised to use this opportunity to hear what JICA has to say regarding its re-evaluation of the water resources and agricultural potentials in Nejd. He advised that detailed comments on the report could be presented later.

Chairman requested Sayyid Bargash, Deputy Chairman and other members to approve the previous minutes of the meeting held on 27th December 1988 (in MEWR) and effect their signatures.

Original minutes were circulated among the members and were signed by the remaining members. The Chairman then invited JICA team leader to present the Interim Report II and requested all members to hold their questions till the presentation is completed.

JICA team leader, Mr. Makato Tanaka; JICA

Mr. Tanaka presented a brief background of the study and informed that the Study is in Stage II and Phase I of it is completed. Interim Report (I) was presented in December 1988. Sort surveys have been completed and Pilot farm location has been identified. Two test wells and two observation wells have been drilled and tested.

Results of groundwater survey and guidelines for agricultural development etc. are prepared as per the contents of Interim Report No. II. The difference between Interim report I and II was highlighted. Additional model-evaluations of ground water resource availability was more encouraging than previously presented in report I. Mr. Tanaka informed that the comments on Interim Report I were received very late (only 2 weeks before) but have been attended. However, comments of PDO were received only yesterday (25-2-89) so could not be included in the report.

He promised to brush-up expressions in English in the forthcoming reports. Mr. Tanaka then requested Mr. Sakamoto to present the results of Groundwater and Agricultural Surveys.

Mr. Takao Sakamoto, Irrigation Engineer, JICA

Mr. Sakamoto presented groundwater survey results as follows :

- 1) Good quality water (1500 - 2000 micromhos/cm EC) availability has been established from Lower Umm-er-Redhuma formation from a depth of 300 m, with positive Piezometric head under high hydrostatic pressure.
- 2) Transmissivity of Umm-er-Redhuma aquifer (Karstic Limestone) ranges widely,

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reaching 10,000 m³/days.

- 3) Groundwater resource availability has been evaluated based on the three GW models:
- (i) Isolated confined aquifer
 - (ii) Residual gradient groundwater model - without recharge
 - (iii) Residual gradient groundwater model - with recharge.

Lifetime of water resources is now more as per this report.

Agricultural Survey results were as follows :

- 1) Soil survey for establishing 50 ha Pilot farm has been completed and agricultural conditions in existing farms Mailat Al Rakah, Danka, Shisr, Qitbit and PDO farms have been studied.
- 2) Leaching tests have been carried out.
- 3) Design and Cost estimates are in progress.

Proposed guide lines are as described below :

- a) Phased agricultural development is recommended.
- b) There are many constraints such as groundwater resources. Agricultural development has to be phased according to groundwater trends during at least two years of the observation period.
- c) Groundwater pumping from the confined aquifer below 100m depth was considered un-economical as it would require special pumps.
- d) Small scale farms scattered at a distance of 30 kms. were recommended. Each farm unit will be of 50 kha.
- e) Crop selection
Initially fodder grass is recommended which has easy management and is in local demand. Rhodes grass is produced in PDO experimental farm (Marmul) and other local farms.
- f) Pilot farm plans
It involves evaluation of groundwater availability, effective use of groundwater, local technology, experimentation of farm management, demonstration and date collection.
- g) Large scale farming could be handled by Government or private sector with 30 ha independant cultivation of fodder grass etc.
- h) Irrigation - Crop water requirement ranged between 4.6 to 14.3 mm/day. Total water requirement ranged between 2300 - 7150 m³/day. Total annual requirement was considered 1.75 MCM. Maximum requirement of water was 110 l/sec. A production well was considered capable of supplying 55 l/sec for 18 hrs. operations/day.

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- i) Proposed facilities: Production well, pump house, Farm Pond and water distribution pipe line etc. were among the proposed facilities.
- j) Agricultural machines : Tractor, trucks etc.
- k) Other facilities : Road, Power, buildings and agro-meteorological station.
- l) Project implementation :
The construction works in principle should be carried out on contract basis under the supervision of engineering consultant and under the responsibility of DG Agriculture and Fisheries, S. Region. Regarding the monitoring of groundwater levels, the assistance and advise of DGWRR, MEWR will be required.
- m) Construction and maintenance cost of the farm is the matter for draft final report to be prepared in Japan.

The Chairman thanked all the JICA participants for their useful presentation and invited discussions on the report.

H.H. Sayyid Bargash : Please consider feasibility and economical way of

Please consider feasibility and economical way of using this fossil water. We do not want coming generations to suffer because of overexploitation of this resource.

Don Devison (Jr.)

Marketing of agricultural produce is a problem in Southern Region.

Mr. Paul Barriere

Mr. Barriere mentioned that he was the one who objected the results of JICA in its Interim Report I and considered the results to be pessimistic. He was happy that PDO also supported his view point. He emphasised that as per his calculations, the quantity of water flowing in the aquifer is of the order of 3 M³/sec (or 3000 liters/sec). Further, he expected storage coefficient of the aquifer to be bigger than what is presented by JICA. He declared that there was no 40m drawdown in PDO farm even after 3 - 4 years of development. He suggested more pumping tests with extended duration to be conducted for evaluation of aquifer parameters. He, however, supported phased agricultural development and stressed on the willingness of MAF to develop pilot farm.

H.H. Sayyid Bargash :

Objecting on International tender on Nejd, Sayyid Bargash said that groundwater resource evaluation is a function of the Ministry of

Environment and Water Resources. He said "I want to say that there is no co-ordination". He also said that he was not aware about the terms of reference for this Tender.

Mr. Barrier

This is the way H.E. wanted a comprehensive study of Nejd on groundwater, soil and agriculture etc.

Mr. Abdulla Hamdan

Co-ordination is there. We are meeting here for co-ordinating our efforts. When the agreement was signed with JICA, MAF was responsible for the groundwater resource evaluation for the entire country, later this responsibility was shifted to CCEWR/MEWR. Ministry of Agriculture has decided to develop Nejd area on priority, that is why International Tender was invited.

Dr. Robert Whitcombe

Please circulate terms of reference formally to all the members so that there is an agreement that these are appropriate.

Mr. Ushiki, Hydrogeologist, JICA

JICA has covered 10,000 km² for resource estimation due to the large areal extent Nejd should not be regarded as one unit. There are various zones to be differentiated such as Marmul, Danka, etc. Environmental Isotope studies have established four zones (see Fig 4.1.3 of the report).

In confined aquifers drawdown has two components, one is initial drawdown which occurs instantaneously as the pumping is started and other is sustained drawdown. Therefore, long-term pumping tests are needed to understand the behaviour (longterm) of the aquifer.

He explained the initial model of groundwater resources in his Interim Report (I) which was based on Isolated confined aquifer model. It may not be realistic but it was intended to evaluate minimum available resource. However, now more realistic models are presented. It is also revealed by the recent studies that the recharge area of Umm-er-Redhuma aquifer extends westwards to South Yemen border (Mahra Mountains - 1200 m amsl), and its discharge area is Umm As Samim. A width of 60 km of this aquifer strip stretches from South-west to North-east.

Dr. Robert Whitcombe:

We need further studies, more detailed inventory with the development of number of farms.

Don Davison (Jr.)

Supporting the concept of 50 ha farms separated by a distance of 30 km, stressed the need for long-term pumping tests. He said various farm units pumping in different areas can be considered long-term pumping tests for groundwater modelling purposes. However, he stressed the need for being conservative, as we cannot ignore water land decline in Ihumrait (35 - 18m). He recommended borehole I.V. logging for identifying Karstic aquifer in Limestones.

H.H. Sayyid Bargash

We should consider economics for the sale of agricultural produce. It's fossil water with no recharge. We have not to satisfy this generation but have to conserve for the next generations (this resource).

Mr. Don Davison (Jr.):

We require large exploration programme in Wadi Gadon area. Regional groundwater study with 3 to 4 drilling contracts. Quality control, reconnaissance study and then detailed study.

Mr. Paul Barriere

We need full scale pumping tests for years (and not 72 hrs.) before spending too much money.

Mr. Don Davison (Jr.)

Exploratory wells define existence of the aquifers and Isotope studies provide we have to collect as much data as possible.

Mr. Paul Barriere

100 ha farm was the first idea.

Dr. Abdel Ghani Suirji

50,000 ha Soil area has been mapped and 10,000 ha have been proposed.

Mr. Don Davison

Regional groundwater studies have to be continued.

Mr. Ushiki, (JICA)

Need for one observation well in Phreatic zone was stressed (by Mr. Ushiki) in order to monitor water level fluctuation with development of agriculture in Nejd. This well is proposed 20 km East of the Yemen border.

Mr. Ushiki anticipated initial drawdowns during 3-6 years in response to the mining of piezometric head in the aquifer and later slow decline as the local flow system establishes. He did not favour large agriculture areas of 500 to 1000 ha in initial development as he warned about the great drawdowns.

Dr. Robert Whitcombe :

Dr. Robert enquired about the possibility of a pipeline to one central area and pumping from distant wells.

Mr. Don Davison (Jr.)

Recommended levelling network of wells for groundwater studies and modelling etc.

Mr. Ushiki

Mr. Ushiki mentioned recently discovered phenomenon of residual ground water gradient, presently steady decline in four wells out of 5 wells of the order of 15-30 cms/months. He considered leakage from Danka well of the order of 18 l/sec. Filling time of water tanker has increased.

In conclusion he proposed that development of farm units of 50 ha are highly advisable.

Dr. Robert

How long you require monitoring to advise farm expansions ?

Mr. Bernard Blasco

May be 3 - 1000 years.

Dr. Robert

How long specifically.

Mr. Ushiki

One or two years minimum after water extraction in the farm area.

Mr. Don Davison

Ithumraite has large drawdown, however, two years observations are advisable.

Dr. Robert

Can we develop 6 farms of 50 ha in different areas step by step.

Dr. Suirji

Dr. Suirji also suggested development of the farms in different locations instead of having a large farm at one location.

Mr. Ushiki

Data collection on water level and meteorology has already been started by a person technically trained by JICA. If he fails there will be problem. Increasing technically qualified staff is highly recommended.

Mr. Don Davison (Jr.)

For long term data collection (on water level monitoring) financial resources are required. It would be difficult for MEWR to take up the work in Nejd without extra funding as it is a remote area.

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Chairman : How many persons are required ?

Mr. Ushiki: More than two

H.H. Sayyid Bargash

Then employ a Phillipino worker or contract the work.

Mr. Ushiki

Why we need foreigners ?

Mr. Paul Barriere

Farm people should monitor the water levels.

Mr. Ushiki

Pakistani and Bangladeshi people can manage, but some strong minded local people will not be able to monitor water levels etc.

Mr. Don Davison

Two technicians with car radios are required because of remoteness of the area. Fasad and Shiser are remote areas in Nejd region.

H.H. Sayyid Bargash

Supply monitoring team

Mr. Don Davison

Regional monitoring is required, but again it will require money.

Dr. Robert Whitcombe

Is it feasible to mix/blend poor quality water with good quality water in order to increase the life time of the resource ?

Mr. Ushiki

Why don't you utilise superior quality water ?

Mr. Paul Barriere

Drainage conditions of the farm soils are not known, this is the purpose of this study.

Mr. Ushiki

In some limited areas shallow groundwater of 1000 micromhos/cm (EC) is available, here you can mix the waters.

Dr. Robert

Apart from Rhodes grass what other crops are feasible?

Mr. Sakamoto

We have not enough data on marketing and shopping centres, so fodder grass is proposed in the initial stages. Vegetables are not recommended initially as it requires careful handling and packing technology. So after we proof the groundwater conditions and better improvement of agricultural techniques (are applied) crop selection will be taken up.

Dr. Robert

Include crop selection in the final report.

Dr. Suirji

For reclamation many other crops can be selected, but National Marketing authority has to decide the crops. We have bad quality areas in Batinah where I would like to grow fodder rather than other crops. In Nejd I would grow other crops with good water.

Mr. Sakamoto

Price of Rhode grass is high, but it is hard to estimate the market. Data is required. However, grass is transported from Sohar to Salalah.

Dr. Robert

W.S. Atkins will give data on Marketing.
Regarding trainees, Dr. Robert required more specific details/skills, for staff to be trained for farm management.
Attracting settlements in Nejd by providing facilities, Nuclei farming, etc. was agreed.

Mr. Don Davison (Jr).

Subsidise development in Nejd.

Dr. Robert

In draft final report executive summary should be included in Arabic.

Team Leader JICA

It would not be possible to include.

Chairman

Mr. Abdulla Hamdan requested JICA team to provide their programme of further studies and preparation of Final report.

JICA's Team leader

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JICA's Team Leader

Comments on Interim Report II are expected within a month for incorporation in the draft final report which is due in August 1989 as per schedule. Final Report is due in November 1989. In view of the importance of Nejd, if Government requires these reports earlier then our head office in Japan has to be requested.

Chairman

We have this request in these minutes.

Mr. Don Davison

Why early submission 'of report' it requires time for data analyses; report may suffer in quality.

Dr. Robert

Without losing quality of the report could be completed one or two months earlier. - Draft final report in July 1989 and Final report in September/October 1989.

JICA

We will inform the date of Report submission from Japan.

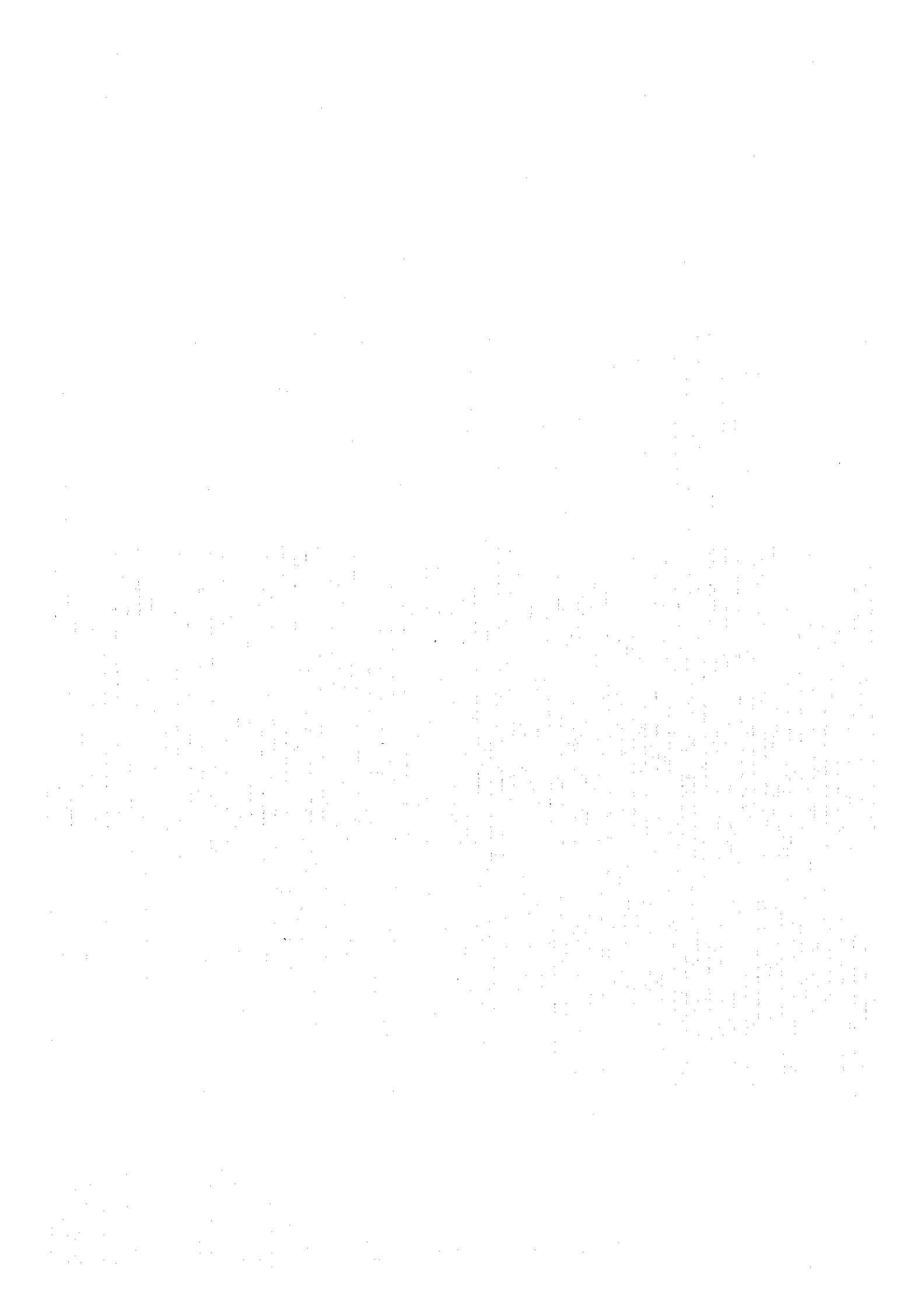
Mr. Blasco

Please bring back all CCEWR and PDO data back for MAF records.

Chairman

I thank JICA team and all the members of the Technical Permanent Committee for attending this meeting and participating in the fruitful discussions. I hope now everybody has a copy of the Interim report (II) and if you have any comments, please put them in writing and send it to me.

Thank you very much once again for making this meeting a success.



JICA