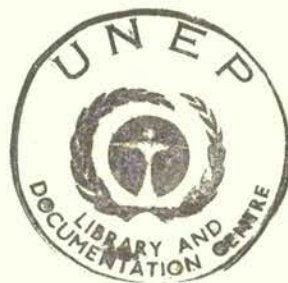


RESOURCE CONSERVATION AND WATERSHED MANAGEMENT
IN WADI MANSHIYAH, MAGHRIB ANS DISTRICT
YEMEN ARAB REPUBLIC



ECONOMIC AND SOCIAL
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Economic and Social Commission for Western Asia
Joint ESCWA/FAO Agriculture Division
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RESOURCE CONSERVATION AND WATERSHED MANAGEMENT IN WADI MANSHIYAH
MAGHRIB ANS DISTRICT (YEMEN ARAB REPUBLIC)

Project duration	7 years
Project cost	US\$ 6 145 100
Government contribution	US\$ 801 300
Additional financing required	US\$ 5 343 800
- International personnel	US\$ 2 480 800
- Equipment	US\$ 1 923 000
- Training and extension	US\$ 80 000
- Miscellaneous expenses (travel, etc.)	US\$ 860 000

ABSTRACT

The project was identified by a consultant mission* organized by ESCWA in collaboration with FAO and UNEP. In March 1986, the mission spent a period of three weeks in the Yemen Arab Republic, held discussions with officials at the Ministry of Agriculture and Fisheries, and studied the physical conditions and land use in the area selected for the project, namely the Manshiyah watershed in the Maghrib Ans District of the Governorate of Dhamar.

The Manshiyah watershed covers an area of approximately 3 100 hectares in the Upper Escarpment region and is representative of the mountainous farming area of Yemen. The watershed is subject to severe degradation due to:

- Overgrazing and overcutting of grasses, shrubs and trees
- Abandonment of marginal terraced lands due to out-migration of people and rising labour costs.

*Mission Composition: Mr. Alim Mian (Pakistan) Mission Leader/Land Land-Use Specialist; Mr. A.K. Toma (Iraq) Forester/Range Specialist; Mr. J. Skoupy (UNEP) Ecologist; Mr. L. Pancel (FRC) Forest Economist; & Ms. B. Schnabb (FRC) Agronomist

The project aims at meeting the requirements of initiating a pilot watershed management programme which would lead to a nation wide programme to control resource degradation and to optimize the utilization of natural resources. The project would attempt to adapt and apply proven conservation measures to the specific physical conditions of the project area.

In addition, objectives of the project include:

- Increase in cereal and forage production in the cultivated area through appropriate agronomic measures.
- Formulation and implementation of a plan for the establishment of a nursery to provide planting material for reforestation and horticulture.
- Forestation and improvement of the denuded rangelands.
- Training of the local population and providing demonstrations to enable them to apply watershed management practices to the remaining area. The Ministry of Agriculture and Fisheries will be the counterpart organization acting on behalf of the Yemen Arab Republic.

The project will include the following activities:

- Establishment of a nursery for forest, fodder and fruit plants, with a capacity of 180 000 seedlings per year.
- Forestation of approximately 490 hectares.
- Improvement of rangeland over an area of approximately 700 hectares.
- Construction of water disposal facilities on terraced fields over an area of 350 hectares.
- Demonstration of improved tillage practices in each village.

- Establishment of a veterinary station.
- Training of local staff, including preparation of training aids.

In the first year of the project the work plan foresees the establishment of the project centre, recruitment of expatriate and counterpart staff, dialogue with the local people, and field activities designed to increase crop production on the terraced land. Furthermore, investigation of socio-economic conditions, survey of the area and preparation of the project sites, etc., will also be undertaken in the initial phase of the project. During the next six years the above-mentioned development activities will be carried out. Dialogues with the local population, as well as demonstrations on a regular basis, should be important features of the work plan, to ensure their full cooperation in project activities.

The total budget amounts to US\$ 6.15 million, of which approximately US\$ 5.4 million are required from external assistance. Technical personnel, representing approximately US\$ 2.5 million, would include international staff for:

- Crop production
- Nursery supervision
- Forestation and range management
- Anthropological and socio-economic studies
- Veterinary assistance
- Apiculture
- Pest management
- Training and extension.

Remaining components of the required external assistance will be approximately US\$ 1.9 million for equipment, US\$ 80 000 for training and extension, and US\$ 860 000 for travel and miscellaneous operations.

1. JUSTIFICATION OF THE PROJECT

The Yemen Arab Republic is located in the southwestern part of the Arabian peninsula between latitudes 12°40' and 17°26' north and longitude 42°30' and 46°31' east, covering an area of approximately 200 000 km², and is divided into four natural topographical regions. These are (i) the Tihama Lowlands, (ii) the Foothills and Escarpment region, (iii) the Central Highlands, and (iv) the Eastern semi-desert plain. The topography of the Foothills and Escarpment region is very rugged and dissected by wadis ^{1/}, draining west towards the Tihama Lowlands. This area is extremely susceptible to the destruction of land resources. Most of the cultivated land has been terraced which, when well designed, constructed and maintained, manages to limit the rate of erosion.

Soil losses occur, however, after heavy rains through either overtopping or the collapse of earthen bunds on terrace walls, or through piping caused by rodents. On steeper slopes where terraces have been constructed far apart, or not properly maintained, or have been abandoned because of marginal quality and labour shortages, sheet and hill erosion has taken place.

The natural plant cover of the rangeland, comprising nearly two-thirds of the area, has undergone severe change through excessive grazing and livestock trailing. Thorny shrubs have increased at the expense of desirable grasses and forbs. Forests have been almost completely eliminated through overcutting.

Geologic or man-induced erosion produces enormous loads of sediment, which is carried along by streams and causes flooding and considerable damage to water-diversion structures and civil works in the wadis and on

^{1/} "Wadi" is a widely used local term for the strips of floodplains, both in the valleys and piedmont plains.

the Tihama plain. It is estimated that 92.8 percent of the Yemen Arab Republic is at desertification risk.^{1/}

A watershed management programme, comprising erosion control and water conservation practices to increase the consumptive use of water, will improve vegetative cover. This will lead to the optimal use of the scarce and erratic resource of water, which at present is the constraining factor in agricultural production. Quality and quantity of the perennial flows in the wadis downstream will also be improved.

Forming part of the Escarpment region, the watershed is representative of the mountainous regions of the Yemen Arab Republic with its unique constraints but great potential for development. The activities in the project area will provide valuable solutions to many problems (including desertification, soil conservation, etc.) which will have to be dealt with in other watershed areas in the future.

This pilot project will establish an extension service for effectively communicating the concepts of resource conservation to rural populations and will aim at securing their participation in its beneficial conservation activities.

The project responds directly to Recommendation 4 of the Plan of Action to Combat Desertification (PACD) calling for a combined and integrated approach to development in arid areas, and to Recommendation 6 of the PACD calling for the protection and amelioration of degraded rangelands.

1/ S.T. Hopkins and D.E. Jones, Research Guide to the Arid Lands of the World, Oryx Press, 1983.

2. THE PROJECT

2.1 Long-term objectives

The long-term objectives of the project are to achieve a high degree of food security, self-sufficiency in fuelwood, and to raise the farmer's income and standard of living through increased production of crops and improved management of rangelands and forests on a sustained yield basis.

The integrated approach of the project further aims at the

- Development of site-specific and ecologically-sound land use practices to arrest land degradation
- Dissemination of the acquired information through demonstration and extension service.

2.2 Short-term objectives

The immediate objectives of the project are:

- (i) Develop and implement a site classification survey as a planning base for agriculture, rangeland management and forestry
- (ii) Develop and implement a socio-economic survey
- (iii) Develop and implement a strategy plan based on (i) and (ii) above for the appropriate coordination of all interdisciplinary activities
- (iv) Based on sound data from (i), (ii) and (iii) above and regular extension work, agricultural production will have to be increased on a short-term basis by the application of the following measures:

- introduction of suitable crop varieties
 - introduction of improved tillage
 - improvement of irrigation water-use efficiency
 - soil fertility management
 - provision of water disposal structures
 - adjustment in land use
- (v) Based on (i), (ii) and (iii) and the initial results of (iv), estimate the optimal carrying capacity of the existing rangelands
- (vi) In accordance with (i), (ii) and (iii), planning and implementation of a nursery, preferably within the watershed for the production of range, forest and fruit tree species
- (vii) Restoration of the vegetation cover to the extent that it will provide sufficient fodder for livestock
- (viii) Planning and implementation of veterinary measures to improve the health of livestock.

Special considerations

- Basic data on nutrition and the health status of the local population will have to be collected within the framework of the socio-economic survey in order to evaluate the impact of the project
- Improvement of existing roads within the project area.

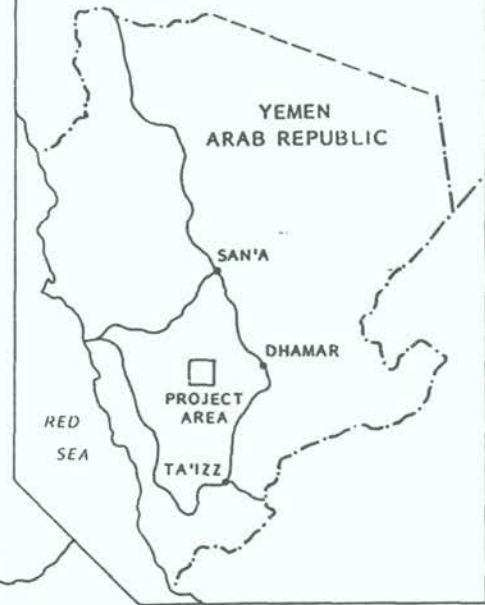
2.3 Location

The watershed is located in Maghrib Ans District in the Dhamar Governorate, about 60 kilometers west of the city of Dhamar.

SKETCH MAP OF
WADI MANSHIYA WATERSHED
MAGHRIB ANS DISTRICT
DHAMAR, Y.A.R.

0 1 2 3 Km

- 1 TERRACED CROPLAND
- 2 RANGE LAND
- 3 PLANTATION
- 4 ROCK OUTCROP



A dirt road, passing through several valleys and hill ranges, leads to this watershed. It lies between 14°30' - 14°35'N and between 43°52' - 43°58'E.

With altitudes ranging from 1 600 m to about 2 800 m above sea level, the area is highly dissected with deep gorges and narrow water courses. The terrain has gentle to very steep slopes, and terraced fields cover about one-third of the area.

The total surface area of the watershed is about 3 100 ha, of which 1 170 ha (38 percent) is terraced cropland, 1 140 ha (37 percent) is rangeland and forest, and 590 ha (19 percent) is unused land. Roads and villages cover the remaining 200 ha (about 6 percent).

2.4 Geology

The Manshiyah watershed has geological features similar to many other parts of the country, in particular the Precambrian basement rocks which make up the major part of the watershed. The Precambrian rocks consist of crystalline schists, slate and conglomerate. They are somewhat resistant to weathering and, therefore, soils developed on these rocks are generally stony and shallow.

2.5 Climate

Climatic data for the watershed are not available; the conditions presented here are deduced from comparable regions and from observation of site indicators, such as existing plant species, land use patterns and soil conditions.

The watershed is located on the north-facing slopes of a high mountain range which separates it from the adjoining watershed, partially obstructing the rainbearing monsoon winds from the south west.

Annual rainfall is estimated at 400 mm with pronounced fluctuations.^{1/}

Two rainfall seasons can be distinguished, i.e. two months of moderate precipitation in March/April and heavier falls, generally of high intensity, from July to September. Clouds and mists in the early morning hours and evening are common throughout the year and favour plant growth. The annual temperature is likely to average 18°C or less, with possible frosts above 2 500 m during the winter. Frost caused by temperature inversion mechanisms, with cold air settling in the lower areas, is unlikely to occur because the dissected terrain promotes air movement.

2.6 Soils

There are only two distinct landforms encountered in the watershed:

- mountain slopes
- wadis.

2.6.1 Soils of mountain slopes

The upper parts of the slopes are very steep and comprise mainly bare rock or very shallow soils (Lithosols). The moderately deep but stony soils on scree^{2/} slopes support native vegetation and hold promise for forestation and range improvement.

The middle parts of the mountain slopes are generally steep (20° - 45°), stony, calcareous (pH 7.8 - 8.1), have low organic matter content (0.7 - 1.0 percent) and are moderately structured. Terraces have been built on these slopes, using the removed stones for the construction of walls, and the soil has been enriched and improved by silt deposits caught through rain harvesting techniques.

1/ Years of abundant rain: 1973-79; dry years: 1980-84.

2/ Scree refers to loose stony material mixed with soil, accumulated at the base of very steep slopes.

The lower parts of the mountain slopes which have also been terraced have silty soils (silt loams and silty clay loams). These are free of stones and are moderately or strongly calcareous (pH 7.8 - 8.1) with organic matter content of 0.6 - 1.0 percent. In some places a buried soil profile is found with a dark layer relatively high in organic matter (1.2 - 1.5 percent). These soils are classified as Yermosols.

2.6.2 Soils of wadis

The wadis comprise a small area in the northern part of the watershed. The narrow floodplains of the wadis have gravelly loamy soils. These soils are characteristically layered and laminated (platy structure). They are highly calcareous with low organic matter content (0.4 - 0.6 percent). They are being used for growing trees and shrubby vegetation for fuelwood and fodder.^{1/}

2.7 Water supply

The erratic rainfall causes great fluctuations in crop production. The four main sources of water supplies are:

2.7.1 Rain harvesting

This is an old and highly developed technique in Yemen. The runoff from hill slopes is diverted into terraced fields for irrigation, so that the inadequate soil moisture derived from direct rainfall is supplemented to store enough water in the soil to grow a crop. Most of the sorghum and other crops are sown in April and May after a soaking irrigation is obtained through rain harvesting. During the July/September growing period the crop receives several irrigations of this type.

1/ ECWA/FAO, Integrated Development of Mountain Farming Areas of the ECWA Region: A Case Study of Yemen Arab Republic (E/ECWA/AGR/84/9)

2.7.2 Spring water

About one percent of the cultivated land of the watershed is irrigated by perennial springs. The amount of spring water is affected by the yearly rainfall. The lands irrigated are located at some distance from the springs, and the flow is conveyed through unlined channels. A considerable part of the precious water is lost during conveyance. The land served with perennial water supplies is used for growing qat^{1/} and alfalfa.

2.7.3 Wadi flow water

Some small patches in the Wadi Manshiyah are irrigated with the perennial water flow. In addition to this, diversion channels have been constructed to make use of flood water on the wadi beds.

2.7.4 Groundwater

The watershed is dissected by V-shaped valleys which are largely devoid of sediment. The lower reaches of Manshiyah Wadi, however, comprise a narrow floodplain, where an aquifer is expected to exist. The groundwater resources in the aquifer will need to be quantified by hydrogeological surveys.

2.3 Natural vegetation

Natural vegetation in the watershed is degraded through severe overgrazing and the excessive cutting of woody species for cooking and heating. As in other regions in the Yemen Arab Republic, fuelwood is much in demand but is preferred to other sources of energy and therefore sold at premium prices.

1/ Qat (Catha Edulis) is an easily cultivated shrub/tree, growing at elevations between 1 000 and 2 500 m and selling at very high prices in local markets. Chewing the fresh leaves of the shoots releases the alkaloid Cathin, said to be both a stimulant and sedative. A high percentage of the population in YAR consumes qat fairly regularly and spends a high proportion of their income on it. Qat consumption has a social aspect, as local community members meet for joint chewing sessions.

The forest cover has become very sparse, and it is dominated by Acacia negri which is used for fodder and fuel. Other tree species which may be encountered here and there in lower elevations are Zyziphus spina christi, Ficus salicifolia, Acacia tortilis, A. humulosa and A. nubica.

Surface vegetation has become much degraded quantitatively, as well as qualitatively. Palatable and nutritious grasses, herbs, and perennials have largely disappeared and have been replaced by useless species. In the upper slopes where there is some perennial vegetation, it consists mainly of Peganum hermala, Cleome arabica and Daernia spp. (Draz, 1983)

Despite continuous and indiscriminate grazing, however, there are still localized sites in remote areas where valuable rangeland species such as Medicago, Poa, Andropogon, Lolium, Bromus and Hordeum grow. Other species which may be encountered are: Paronychia nivea, Commelina glabescens, Chenopodium spp., Artemisia abyssinica, Cineraria abyssinica, Pulicaria orientalis, Euphorbia spp., Geranium moscatense, Eragrostis spp., Malva spp., Astragalus fatmensis, Melilotus alba, Hibiscus trionum, Glenus lotoides, Galium hamatum, Solanum villosum, and Verbena officinalis. (GTZ, 1985 S.A. Chaudhary and R. Revri).

2.9 Livestock

The project aims at higher livestock productivity by increasing the availability of fodder and improving animal health.

The rearing of livestock is practised by nearly all the farmers in the watershed. Besides providing food and draught power, livestock also represents a means for accumulating wealth and balancing the risk of crop failure in lean years. Livestock has a complementary role to crop production. To maintain the highest level, farmers keep different types of animals with differing grazing habits and requirements. Cattle are mainly kept for milk, ghee, meat production and draught power, while sheep and goats primarily provide meat. Donkeys are used as draught and transport animals.

Veterinary services for livestock in the area are totally lacking. Periodic outbreaks of dangerous diseases, such as foot-and-mouth, cause great loss in livestock population (UN/ESCWA 1984); attacks of black disease and other parasites greatly diminish their productivity.

The unpublished test results on performance of exotic and local sheep, conducted by the Range and Livestock Improvement Project (RLIP) near Dhamar, indicate that the local breed compares very favourably with the best of the exotic breeds in weight increase and lambing rate.

2.10 Present land use

2.10.1 Rainfed cropping

The predominant form of land use in the watershed is rainfed cropping of mainly sorghum and some millet, wheat and barley.

The rainfall deficiency is compensated to some extent through rain harvesting techniques. Crop yields depend on the amount and distribution of rainfall, the facility for rain-harvesting, and the depth and texture of the soils. On average, the yield of sorghum is approximately one ton per hectare, ranging from 0.5 to 3.0 tons. Sorghum and millet are sown in May and harvested in October. A substantial part of sorghum and millet is interplanted with pulses, primarily cowpeas and mung beans. Sorghum grains are used for human consumption; leaves and stalks are fed to livestock with the roots being used for fuel.

No systematic crop rotation is followed; sorghum and millet are grown in the same fields every year. Some fields remain fallow and their proportion increases in low rainfall years. The tillage operations are performed with bullocks or manual labour. Dung manure is applied to the cropland once every two or three years.

2.10.2 Irrigated cropping

Spring water, wherever available, is used for irrigation to grow alfalfa, wheat, maize, some vegetables (potatoes, tomatoes, onions, cucumbers, etc.) and qat. Fields are sub-divided into small plots to increase efficiency in water application.

The proportion of cultivated areas under irrigated cropping is very small, especially during the dry season (May to June and October to March). Irrigation wells in the watershed do not exist.

2.10.3 Grazing

All accessible and uncultivated land, which comprises about 36 percent of the watershed area, as well as cultivated land when lying fallow, is used extensively for livestock grazing. Grazing rights are generally held collectively by the local population, and in tribally-owned lands each member is free to use the land for his own animals. Depletion of rangeland through overgrazing is so severe that the energy spent by livestock in searching for food is often greater than the energy derived.

3. STRATEGY

To ensure successful implementation of agricultural, range and forestry activities, appropriate planning is presently crucial for the following reasons:

- (i) Range and forest improvement is only possible if the areas for improvement are protected from grazing until a controlled system of grazing and utilization can be implemented.
- (ii) Fodder supply for livestock from the protected areas will have to be substituted from other sources for a period of at least two years.
- (iii) One of the results of agricultural improvement will be the increased availability of fodder, which will aid the restoration of vegetative cover in the protected areas.

3.1 Anthropology/sociology

Development assistance appropriate to the rural communities of the watershed must be based on mutual understanding, and can only be given if fundamental sociological problems are understood and attitudes accepted.

The initial collection of data will consist of:

- (i) Demographic survey.
- (ii) Anthropological survey, with special reference to the readiness of social groups to cooperate in the recommended improvement measures.
- (iii) Socio-economic survey including information on existing and planned infrastructure (i.e. availability of potable water and sanitation).
- (iv) Survey of administrative and legal aspects - property, water use, grazing and forestry rights.

Data should be collected in an informal way, and its importance for the success of the project implementation must be explained to the people to ensure their cooperation in the preparatory stage before project achievements can be visible.

Development priorities as stated by political leaders, the local Development Association (LDA) and farmers, have to be considered and all project services evaluated by the anthropologist to ascertain that they conform to cultural patterns. Continuous dialogue between project members and farmers will provide the necessary feedback for a flexible and effective approach.

Considering the fact that women play a crucial role in agricultural activities (particularly subsistence level crop production and animal husbandry), their participation in practical education on improved agricultural practices, which does not require literacy, is justified and should be promoted, supplemented by courses on nutrition and hygiene.

The traditionally high social status of landownership and rural living in the Yemen Arab Republic, and the fact that opportunities for work in neighboring countries are diminishing, these factors in themselves favour prospects for successful project implementation. If the vital importance of gaining and maintaining the ecological stability of their environment is clearly communicated to the local population, their participation in the project activities should be ensured.

3.2 Agriculture

The area figures assumed for various agricultural activities are only estimates based on aerial-photograph interpretations. The site classification survey proposed at the beginning of the project will have to provide precise statistics.

The scope of activities is as follows:

- immediate increase in crop production to convince the rural communities of the benefits of the project
- increased provision of fodder for livestock which would be a key factor towards range and forest improvement.

3.2.1 Adjustment in land use

About 15 percent (175 ha) of the terraced land is of marginal quality, partly abandoned due to outmigration and high labour costs. Some of the abandoned terraces are subject to accelerated erosion. The project aims to establish a permanent cover of vegetation comprising fruits, forest trees, shrubs and range species on these terraces.

3.2.2 Soil fertility management

Fertilizer application will be carried out on the rainfed and irrigated demonstration sites in each village. The actual addition of mineral nutrients through runoff collection is not

adequate for attaining higher crop yields. Soil tests show that cultivated soils are invariably low in nitrogen and phosphorus. Fertilizer trials ^{1/} on sorghum and barley indicate a significant response to nitrogen and phosphorus, applied separately as well as in combination.

The balanced use of fertilizers on various crops will not only increase grain yield, but also the amount of green leaves and stover. Thus, the forage production for livestock can immediately be increased by improved fertility management on crop land.

3.2.3 Introduction of suitable crop varieties

Improved crop varieties will be introduced on 25 percent (292 ha) of the rainfed area and on the entire irrigated land (15 ha). In the case of sorghum, for example, some varieties are of a short stem type, whereas others grow tall and are highly suitable for fodder production. By increasing the grain yield of short stem sorghum varieties, a part of the sorghum areas presently grown could be planted with fodder varieties. This measure would provide additional fodder for livestock.

3.2.4 Introduction of improved tillage

Improved tillage practices will be demonstrated on 4.2 percent (50 ha) of terraced land in order to conserve essential soil moisture for germination and growth in the initial

^{1/} Dhamar Agricultural Improvement Centre: Trials on sorghum and barley, 1979-1980. Dhamar 1981.

stages and to economize on manpower. The efficiency of commonly used cultivators is quite low, especially when the objective of cultivation is to eradicate weeds and create a mulch on the soil surface after rain. This objective could best be achieved by the introduction of improved tillage implements, such as duck-foot and tine sweeps to be developed for working with oxen and two-wheel tractors (3-5 hp).

3.2.5 Provision of water disposal structures

The terraced fields have varying height differences between them, with stone retaining walls, averaging 1-2 m. Usually an earthen bund runs along the top of the terrace wall. In years of high rainfall farmers split open the bunds to prevent the uncontrolled breaking of the terrace walls, causing damage to the terrace system, especially on the lower parts of the slope.

For about 30 percent (350 ha) of the lower terrace area, water disposal structures will be provided in order to channel excess run-off coming from the higher parts of the slope, to ensure proper maintenance of the terrace system.

3.2.6 Improvement of irrigation water use efficiency

It is estimated that the project will extend the area under irrigation by about 30 percent to 15 ha with the amount of water presently available.

Springs are the only source of irrigation water in the watershed, and a substantial part of the water is lost during conveyance. The method of irrigation also needs improvement. On a demonstration basis, the project will employ conduit pipes and polyethylene mulching facilities to reduce losses.

3.3 Horticulture

In order to improve the diet of the population and increase farm income, a wider crop mix through the introduction of vegetable and fruit cultivation will be encouraged.

Water will be the constraining factor, but with improved methods for crop management and irrigation practices (intercropping, mulching, furrow irrigation, pipe irrigation, etc.), a much larger area than the present ten hectares can be irrigated. To ensure a fair income throughout the year and to benefit from the marked seasonal price fluctuations, relay vegetable cropping will be promoted. Recommended vegetable crops are potatoes, tomatoes, peppers, onions, okra, cabbage and radish.

Some of the abandoned terraces can be utilized for the production of fruit trees with low site requirements, such as Ziziphus spina-christi, Ficus spp., etc.

High value fruit species to be introduced are peaches and apples with low chilling ^{1/} requirements (200-400 hours),

^{1/} Chilling hours are calculated as the number of hours at or below 7.2° C during dormant season.

apricots and pomegranates. Species with high soil and water requirements will have to be planted where irrigation water is available, i.e. at the periphery of the irrigated fields. During the first year of growth, intercropping with alfalfa is advisable.

At present coffee-growing cannot be recommended, being inferior to qat as a cash crop and requiring higher water supplies and labour input (and it sells at much lower prices).

3.4 Apiculture

Bee-keeping is important as a complementary activity in an integrated project. Bee pollination increases the productivity of agricultural and tree crops while nectar and pollen is utilized in providing the rural population with a nutritious food item and a source of considerable income, without the need for much land or a high investment. Research in bee-keeping has been undertaken in YAR, suitable hives have been designed (adapted Kenyan shallow bar hives), and training facilities for men and women are now available. When selecting plant species for the afforestation programme, nectar and pollen yielding potentials will be considered.

3.5 Range management and forestry

Range and forestry activities are to be exercised on bare and marginal lands; exceptions might be acceptable for application of agro-forestry practices on cultivated land. The necessary information regarding areas to be planted will be provided by the site classification survey.

3.5.1 Site selection

- Wadi beds would be given preference for the planting of quick-growing tree species.
- Strips of uncultivated land along the roads offer good opportunities for forestation because they are easily accessible.
- Based on the site classification survey during the early phase of the project and in consultation with the farmers in each village, sizeable areas would be selected from lands presently used for grazing. Site potential, distance from villages, and the willingness of village communities, are to be considered when choosing priority areas for forestation.

When the villagers have agreed to the forestation programme, a forest map will be produced, which will define the sites, the amount and types of species to be planted, and the priorities for undertaking the forestation work.

3.5.2 Species selection

The socio-economic survey in the project area will provide precise information on the forest and range products needed. The ongoing forestry projects in YAR provide sufficiently proven information on suitable species. The following species

types are considered for selection:

- fast-growing tree species mainly for wood/timber production to be planted in lower wadi beds
- tree and shrub species mainly for grazing purposes
- forest fruit trees to be planted wherever feasible
- tree species for multiple use (timber, fuelwood, forage, apiculture, conservation) will be preferred.

A list of prospective plant species can be found in the Appendix.

3.5.3 Nursery.

The size of the nursery is determined by the extent of the area to be planted and the site characteristics. It is estimated that about 1 140 ha will be available for planting range and forest species at an appropriate density.

To accomplish the envisaged plantations within a period of five years, the nursery will be designed to produce about 180 000 seedlings per year. To meet this requirement, the nursery site will be established on an area of about 1.0 ha.

3.5.4 Planting activities

Project strategy is that site preparation and all planting activities will be undertaken by the rural people living in the watershed. The objective of this approach is to

give local people the opportunity for a full understanding of the purpose and proper technique of forestation. The people would be encouraged to participate in the forestation activities by supplying them with food for work.

3.5.5 Maintenance of plantations

The protection scheme against grazing and cutting will consider the socio-economic conditions and will be developed in careful consultation with the villagers.

4. INSTITUTIONAL FRAMEWORK

The project will be attached to the Ministry of Agriculture and Fisheries. Other participating government organizations are:

- Central Planning Organization
- Central Highland Development Project
- Agricultural Research Authority
- Local Council for Development
- Governorate of Dhamar.

The Ministry of Agriculture and Fisheries will be responsible for providing the counterpart staff and the other items earmarked for local funding as given in the section on the budget.

The Government will provide the logistic support for initiating the project. It will also take the necessary steps to provide the professional staff to be trained during the project.

The modalities of the project execution will be determined at a later stage in consultation with all concerned parties. The specific roles of each party will also be determined at that time.

5. INPUTS

5.1 Government inputs

5.1.1 Personnel

The proposed government contribution for providing counterparts and personnel is as follows:

<u>Position</u>	<u>No.</u>	<u>Man Months</u>
Agriculturists (University degree holders with field experience)	2	152
Anthropologists/Sociologists	2	48
Forestry and range managers	2	150
Extension specialists	1	75
Accountant	1	84
Nursery foreman	1	60
Mechanic	1	84
Secretary	1	84
Labourers	10	840
Guards	2	168

5.1.2 Travel

The Government will provide travel expenses and DSA for the local staff which amounts to an estimated YR 180 000, equivalent to approximately US\$ 23 000.

5.1.3 Miscellaneous

The Government will provide the following items:

- The land where the project centre is to be located. The area needed is estimated at 4 hectares at a total cost of YR 150 000, equivalent to US\$ 20 000.
- Well-digging and water supply for the project centre and nursery is estimated to cost YR 460 000, equivalent to US\$ 59 000.

The total value of counterpart contributions to the project is estimated at YR 6 170 400, equivalent to approximately US\$ 801 300.

5.2 External contribution

The estimated donor contribution for the project, namely US\$ 5 343 800, is designed to cover the costs of expatriate experts, equipment, facilities, operating expenses, travel and training. In order to ensure a smooth implementation of the project, and to achieve its objectives as stated in this document, an additional source for incentive has to be provided by the World Food Programme (WFP), as explained under "Special considerations" (section 5, page 31).

5.2.1 Personnel

- Project manager-cum-agronomist - responsible for the initiation, operation and overall coordination

of the project activities. The incumbent should have extensive experience in rainfed agriculture, soil conservation, extension work in similar climatic conditions. Management experience in multi-disciplinary projects is desirable.

- Agronomist - will assist the Project Manager, and should have experience in soil science, soil conservation, irrigated agriculture, horticulture. Knowledge of Arabic is a prerequisite of this post.
- Anthropologist - will evaluate project activities as to whether they are culturally appropriate and acceptable to the rural communities. Experience is required in statistical analysis, nutrition, home economics and extension work. Good knowledge of both Arabic and English required.
- Forestry and range management expert - responsible for the nursery and all activities concerning the establishment of range and forest plantations. The applicant should have experience in forestation and range management in semi-arid and sub-humid regions, selection of species for multiple use and, to a certain extent, in livestock management/erosion control and watershed management.

On a consultancy basis, the following services will have to be provided for the project:

- Veterinarian. Establishment of veterinary station, layout of scheme for health improvement of livestock, evaluation of potential breeds for the watershed area.
- Apiculturist. Evaluation of potentials for bee-keeping, training in bee-keeping, marketing of products.
- Plant Protection Specialist. Identification and treatment of the diseased crops and nursery plants.

Over the total project period of seven years, the appointment of international staff is planned as follows:

<u>Position</u>	<u>Man Months</u>
Project manager	84
Agronomist	80
Anthropologist	24
Forestry and range management expert	75
Consultants: Veterinarian	18
Apiculturist	6
Plant Protection Specialist	4
<u>Total expatriate experts in man-months</u>	<u>291</u>

Employment of Expatriate Experts

<u>Expert</u>	TOTAL man/months	Duration of Employment											
		1987	1988	1989	1990	1991	1992	1993	1994				
Project Manager	84	xxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxx
Agronomist	80	xxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxx
Anthropologist	24 3 visits	xxxxxx	xxxxxx		xxxxxx								xxxxxx
Forestry and Range management experts	75		xxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx	xxxxxxxxxxxxxx
Consultants: Veterinarian	18 2 visits			xxxxxxxxxxxxxx									xxxxxx
Apiculture	6 2 visits		xxx								xxx		
Plant Protection Specialist	4 2 visits		xx								xx		

5.2.2 Equipment and facilities

The external contribution will provide the following equipment and facilities:

	<u>US \$</u>
14 x prefabricated houses (family units)	980 000
1 x prefabricated office complex (200 m ²)	150 000
Generator	68 000
Workshop	20 000
Veterinary station	2 000
10 climatological installations	4 000
Office equipment, stationery, pc, etc.	50 000
Survey equipment	10 000
3 x cisterns (20 m ³)	9 000
Extension equipment (audio-visual aids)	20 000
Nursery	25 000
Sprinkler irrigation unit for nursery	15 000
Tillage implements	30 000
10 x two-wheel tractors (5 hp)	40 000
5 x 4 WD vehicles	60 000
3 x 4 WD pick-ups	45 000
1 x all-round vehicle (e.g. Unimog)	80 000
Fertilizers, pesticides, seeds, seedlings, plastic bags, fencing, irrigation facilities	300 000
Tools	15 000
<u>Sub-total equipment and facility expenses</u>	<u>1 923 000</u>

5.2.3 Operating expenses

Fuel and lubricants for generator	US\$
at station, vehicles and tractors	400 000
Repairs, spare parts, and miscellaneous expenses	90 000
<u>Sub-total operating expenses</u>	490 000
Replacement of vehicles after an amortization period of 5 years	225 000

5.2.4 Travel

Provision is made for travel costs of the expatriate experts, consultants, counterparts (US\$ 120 000), and for the mounting of an evaluation mission to be fielded between six months and one year prior to the termination of the project (US\$ 25 000).

Sub-total travel expenses 145 000

5.2.5 Training

Training of counterparts (courses abroad) 80 000

Special considerations

For incentivating rural communities in the undertaking of forestation, the World Food Programme (WFP) will be approached. On an estimated food aid basis of 3 500 Kcal per day, the total participation of WFP would amount to US\$ 450 000.

6. ACTIVITIES

Main activities, their starting dates and duration are as follows:

<u>Activity</u>	<u>Starting date</u>	<u>Duration</u> (months)
- Formulation of work programme	July 1987	1
- Selection of site for project centre	July 1987	0.25
- Collection of tenders and evaluation of offers	July 1987	1
- Ordering of installations and equipment:		
Housing and office facilities		
Workshop		
Vehicles		
Survey equipment		
Extension equipment	August 1987	3
- Dialogues with the villagers to get their cooperation and participation	August 1987	2
- Survey and compilation of previous research work and results	August 1987	2
- Preparation of site classification survey: Site maps, definition of land use	September 1987	4
- Preparation of the anthropological and socio-economic surveys: Basic data, living conditions, etc.	September 1987	6
- Installation of the project centre	October 1987	3

<u>Activity</u>	<u>Starting date</u>	<u>Duration (months)</u>
- Improvement of the existing road network within the watershed	October 1987	2
- Planning and installation of small-scale climatological stations	October 1987	1
- Training of women in animal husbandry, home economics and apiculture	December 1987	1 year
- Selection of demonstration sites for improved agricultural practices	February 1988	0.5
- Construction of water disposal facilities	February 1988	Continuous
- Ordering and collection of seed material for agriculture and horticulture	February 1988	---
- Training of local staff, including preparation of training aids	February 1988	Continuous
- Layout of demonstration activities in agriculture and horticulture	March 1988	6 months, then at regular intervals
- Use of improved tillage implements on demonstration sites	March 1988	2
- Monitoring of qat consumption patterns during course of project activities	March 1988	Continuous
- Preparation of a strategy for a regular extension service	June 1988	3
- Implementation of regular extension service on a yearly performance basis	September 1988	Continuous
- Pest control with emphasis on horticulture	September 1988	Continuous
- Selection of sites for range management and forestation	September 1988	2

<u>Activity</u>	<u>Starting date</u>	<u>Duration</u> (months)
- Ordering installations and equipment for nursery and veterinary station	October 1988	1
- Species selection for range management and forestation	November 1988	1
- Establishment of nursery	November 1988	3
- Ordering and collection of seed material for range and forestation	November 1988	Continuous
- Establishment of the small-scale veterinary station	December 1988	2
- Establishment of an incentivisation scheme based on WFP donations for range and forestry works	January 1989	1
- Elaboration and implementation of livestock feeding plan, based on agricultural products and residues	March 1989	4
- Site preparation for forestation	May 1989	Continuous, but preferably in dry season
- Planting of range and forest species	July 1989	Continuous, but preferably at the beginning of rainy season

7. OUTPUT

Expected output is estimated as follows:

- (i) Data and background information on the project area:
 - site classification survey and respective maps
 - detailed anthropological socio-economic survey
 - meteorological data of the watershed
 - observation of erosion processes during the project period
- (ii) Incentivation of rural communities:
 - better understanding of environmental factors
 - diversification of production resulting in improved diet
 - acceptance of new methods and techniques in land use
- (iii) Institutional framework:
 - strengthening the role of forestry as a component for conservation and land use improvement
 - linking remote areas to the country's overall development
- (iv) Improved production of agriculture, range and forestry, as shown in detail on pages 36 - 40.
- (v) Creation of a local extension service, particularly in agriculture and forestry.

7.1 Rainfed agricultural land

Present area	:	approx. 1 160 ha
Present production of cereals and other food grains/year	:	approx. 900 kg/ha
Area improved by project	:	approx. 1 155 ha
Expected production of cereals and other foodgrains on the improved area/year	:	approx. 2 500 kg/ha
		1 700 after 1 year
		2 500 after 2 years

Additional production induced by the project

<u>Year</u>	<u>Annual area increase</u> ha	<u>Cereals and others</u> kg
1	-	-
2	192	153 600
3	384	460 000
4	576	768 000
5	768	1 075 200
6	960	1 382 400
7	1 152	1 689 000

* sorghum and millet-74 percent, wheat-8 percent, barley-10 percent, maize-4 percent, pulses-4 percent

7.2 Irrigated agricultural land

Present area : approx. 10 ha

Present production/year

alfalfa : approx. 4 000 kg/ha
(70 percent of total area: 28 000 kg)

vegetables : approx. 7 300 kg/ha
(2 percent of total area: 1 500 kg)

qat : 28 percent of total area

Area irrigated by project : approx. 15 ha

Expected production after project implementation/year

alfalfa : approx. 17 000 kg/ha
approx. 7 ha : 50 percent of area

vegetables : approx. 15 000 kg/ha
approx. 5 ha : 33 percent of area

qat : remains on same area as before

Additional production induced by the project

<u>Year</u>	<u>Area</u> ha	<u>Alfalfa</u> kg	<u>Area</u> ha	<u>Vegetables*</u> kg
1	7	91 000	5	73 500
1	7	91 000	5	73 500
3	7	91 000	5	73 500
4	7	91 000	5	73 500
5	7	91 000	5	73 500
6	7	91 000	5	73 500
7	7	91 000	5	73 500

* onions, tomatoes, cabbage, potatoes

7.3 Forest on the watershed slopes

Present area : --
Present production/year : --
Area improved by the project : approx. 440 ha
Expected annual production
of timber, poles, fuelwood
after project implementation : 4 m³/ha

Implementation and production schedule

<u>Year</u>	<u>Annual area increase ha</u>	<u>Wood m³</u>
1	-	-
2	-	-
3	80	-
4	90	-
5	90	-
6	90	160
7	90	400

7.4 Forest in the wadi beds

Present area : approx. 15 ha
Present production/year : approx. 10 m³/ha
Area improved by the project : approx. 50 ha
Expected annual production
of timber, poles, fuelwood
after project implementation : 20 m³/ha

Additional production induced by the project

<u>Year</u>	<u>Area</u> ha	<u>Wood</u> m ³
1	-	-
2	-	-
3	50	-
4	-	-
5	-	-
6	-	400
7	-	500

7.5. Range management

Present area : approx. 1 140 ha

Present fodder production/year : approx. 400 kg/ha

Area to be improved by the project : approx. 700 ha

Expected annual fodder
production after
project implementation : approx. 2 000 kg/ha

Additional production induced by the project

<u>Year</u>	<u>Annual area increase ha</u>	<u>Fodder kg</u>
1	-	-
2	-	-
3	140	22 000
4	140	44 000
5	140	66 000
6	140	88 000
7	140	110 000

It is expected that the quality and productivity of livestock will increase considerably with project implementation. Estimates on this cannot be made at present, as the livestock population and the scale of possible impact are not known.

8. WORK PLAN

The proposed activities described in Chapter 6 (Activities), will be carried out in two phases:

(i) Preparatory phase (1987 to beginning of 1988)

The preparatory phase is kept as short as possible.

It is characterized by organizational aspects regarding site selection for project centre,

recruitment of staff, provision of equipment

and facilities, site survey, anthropologic socio-economic survey, and the detailed formulation of

the work programme. This will be prepared by

the Project Manager in consultation with the appropriate government institutions. The work programme will be ready one

month after the Project Manager's arrival in the country and will be revised periodically whenever

necessary.

(ii) The implementation phase can start, (estimated six months from project commencement) with the

implementation of demonstration activities on rainfed

cultivated land. Improvement in agricultural practices

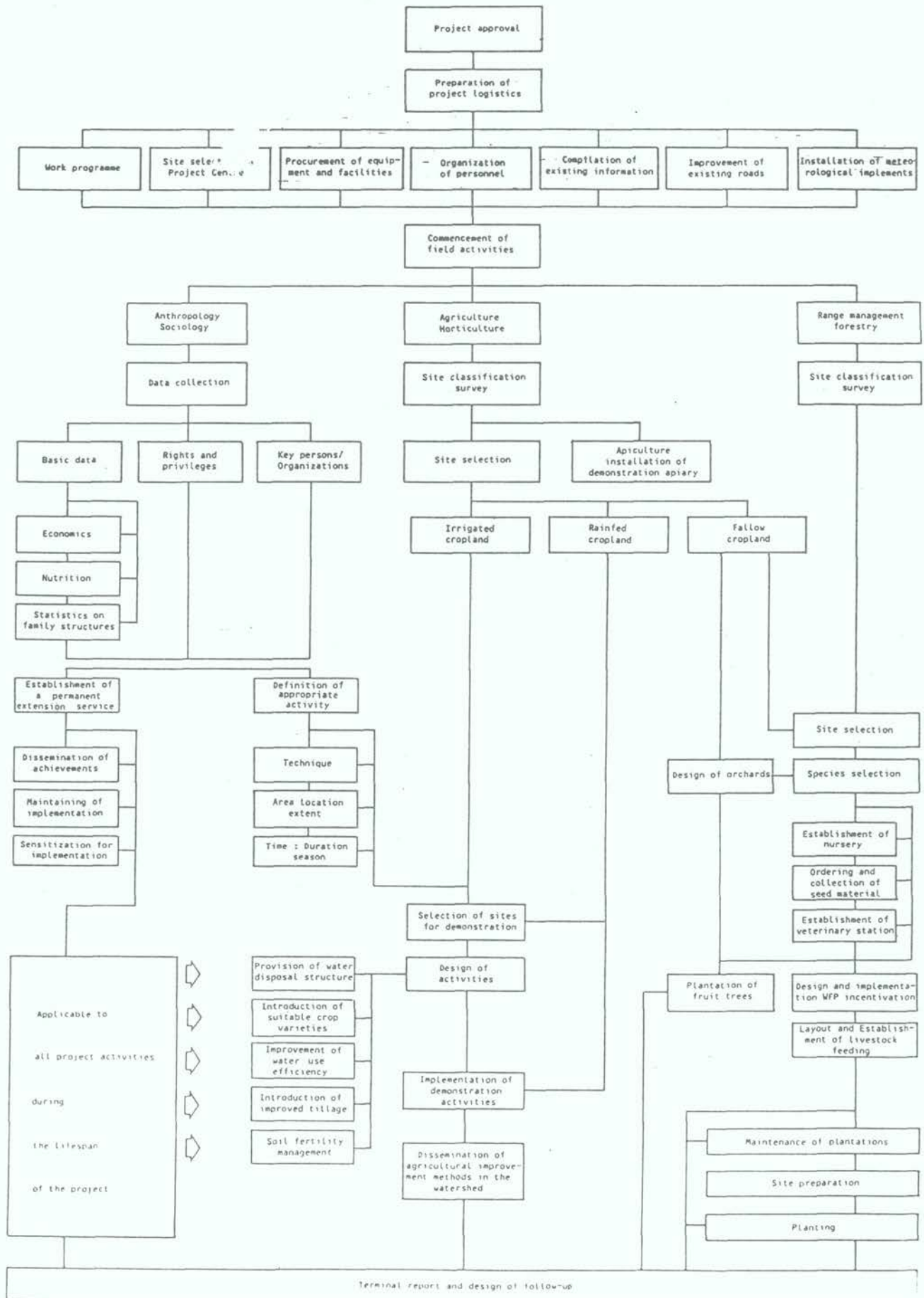
for irrigated areas would also be commenced on a demonstration basis simultaneously. The construction of

water disposal facilities is one of the most important

activities and would therefore start in the early stages

of the implementation phase.

Operation plan



YEMEN ARAB REPUBLIC

Project Budget covering Government Contribution

(March 1986: US\$ 1 = YR 7.7)

	No.	TOTAL		1st year		2nd year		3rd year		4th year		5th year		6th year		7th year	
		m/m	YR	m/m	YR	m/m	YR	m/m	YR	m/m	YR	m/m	YR	m/m	YR	m/m	YR
<u>Project Personnel</u>																	
Agricultural counter-	2	152	1 064 000	8	56 000	24	168 000	24	168 000	24	168 000	24	168 000	24	168 000	24	168 000
parts (National Director																	
and Technical Officer)																	
Counterparts in	2	48	288 000	24	144 000	4	24 000	4	24 000	4	24 000	4	24 000	4	24 000	4	24 000
anthropology/sociology																	
Forestry and range	2	150	900 000	6	36 000	24	144 000	24	144 000	24	144 000	24	144 000	24	144 000	24	144 000
Extension	1	75	450 000	3	18 000	12	72 000	12	72 000	12	72 000	12	72 000	12	72 000	12	72 000
Accountant	1	84	420 000	12	60 000	12	60 000	12	60 000	12	60 000	12	60 000	12	60 000	12	60 000
Nursery foreman	1	72	360 000	—	—	12	60 000	12	60 000	12	60 000	12	60 000	12	60 000	12	60 000
Mechanic	1	84	252 000	12	36 000	12	36 000	12	36 000	12	36 000	12	36 000	12	36 000	12	36 000
Secretary	1	84	168 000	12	24 000	12	24 000	12	24 000	12	24 000	12	24 000	12	24 000	12	24 000
Labourers	10	840	1 260 000	120	180 000	120	180 000	120	180 000	120	180 000	120	180 000	120	180 000	120	180 000
Guards	2	168	218 400	24	31 200	24	31 200	24	31 200	24	31 200	24	31 200	24	31 200	24	31 200
Component total	23	1757	5 380 400	221	585 200	256	799 200	256	799 200	256	799 200	256	799 200	256	799 200	256	799 200
<u>Travel and DSA costs</u>																	
Component total			180 000		30 000		25 000		25 000		25 000		25 000		25 000		25 000
<u>Miscellaneous</u>																	
Component total			150 000		150 000												
Well-digging			460 000		460 000												
Component total			610 000		610 000												
TOTAL			6 170 400		1 225 200		824 200		824 200		824 200		824 200		824 200		824 200
Government contribution																	
Equivalent in US\$			801 300														

YEMEN ARAB REPUBLIC

Project Budget covering Donor Contribution

	TOTAL		1st year		2nd year		3rd year		4th year		5th year		6th year		7th year	
	m/m	US\$	m/m	US\$	m/m	US\$	m/m	US\$	m/m	US\$	m/m	US\$	m/m	US\$	m/m	US\$
<u>Experts</u>																
Project Manager (01)	84	772 800	12	110 400	12	110 400	12	110 400	12	110 400	12	110 400	12	110 400	12	110 400
Agronomist (P3)	80	592 000	8	59 200	12	88 800	12	88 800	12	88 800	12	88 800	12	88 800	12	88 800
Anthropologist (P4)	24	204 000	12	102 000	--	--	3	25 500	3	25 500	3	25 500	3	25 500	3	25 500
Forestry and range expert (P5)	75	660 000	3	26 400	12	105 600	12	105 600	12	105 600	12	105 600	12	105 600	12	105 600
Consultants	28	252 000	--	--	9	81 000	8	72 000	--	--	5	45 000	3	27 000	3	27 000
Component total	291	2 480 800	35	298 000	45	385 800	47	402 300	39	330 300	41	349 800	42	357 300	42	357 300
<u>Equipment and Facilities</u>																
Component total	1	923 000	1	683 000	40 000	40 000	40 000	40 000	40 000	40 000	40 000	40 000	40 000	40 000	40 000	40 000
<u>Travel costs</u>																
Component total		145 000		21 000		16 500		16 500		16 500		16 500		16 500		16 500
<u>Training</u>																
Component total		80 000		--		13 000		13 000		15 000		15 000		15 000		15 000
<u>Operation costs</u>																
Component total		715 000		70 000		70 000		70 000		70 000		70 000		70 000		70 000
<u>TOTAL Donor contribution</u>	5	343 800	2	072 000		525 300		541 800		471 800		491 300		723 800		517 800

9. ONGOING PROJECTS

Ongoing projects in the region:

- (i) The Dhamar Agricultural Improvement Centre (DAIC), supported by the British Government and staffed with six expatriate engineers, concentrating on
- (a) production of forest tree seedlings at an annual rate of 120 000 seedlings, as from 1983;
 - (b) field trials under rainfed and irrigated conditions in order to establish a technical package for the improvement of plant production on the Montane plains. Research activities started in 1980. Available results show a considerable potential for yield increases under medium rainfall and irrigated conditions, and on terraces;
 - (c) animal production and nutrition;
 - (d) agricultural extension, through direct contact with interested farmers and increased cooperation with the Regional Office of Agriculture.
- (ii) The Veterinary Service Project supported by the British Government with regional offices in Sana'a and Dhamar, staffed with 5 veterinarians, 6 assistants and vaccinators. The working programme includes vaccination campaigns against rinderpest, foot-and-mouth disease and sheep pox, and also some clinical services.

- (iii) The Potato Seed Multiplication Project, established in Dhamar, with the support of the Dutch Government. Project activities include the production of high-quality seed potatoes for distribution to farmers and the operation of a seed storage centre in Dhamar.
- (iv) The Dutch-supported Range and Livestock Improvement Project at Dhamar. Project activities concentrate on research and demonstration of range management techniques, and on the introduction of new fodder crops, but have not yet generated a technical package suitable for introduction on a large scale.
- (v) The IDA-assisted agricultural research station in the Dhamar area. The project components include appropriate crop and livestock research in the Central Highlands, and the provision of funds for the construction of extension centres.

10. FOLLOW-UP

After completion of the project activities within the Manshiyah watershed, a follow-up service is planned which will be worked out in detail in the final report. The tentative outline of this service is currently as follows:

- Provision of extension service for bringing about improvement on all the remaining croplands
- Provision of seedlings from nursery to neighbouring areas
- Layout and establishment of a cooperative marketing system. This service should be manned by a team of former counterparts.

The existing project facilities offer an excellent opportunity for training local extension experts on the technician and professional level in the following fields:

- agriculture
 - horticulture
 - home-economics
 - range management
 - forestry
 - apiculture.
 - food crops, nutrition, for women
- In the present project formulation, two local counterparts are provided

for each post for the following reasons:

- this provision will facilitate foreign training without disrupting project activities;
- it will enable a follow-up service in the project area after project termination;
- it will help in the establishment of permanent extension courses in the above-mentioned fields.
- it will encourage the implementation of a similar project in the neighbouring Utmah district, as proposed by the Central Highland Development Project.

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Species Recommended for Planting in Rangeland and Forests of
Manshiyah Watershed, Maghrib Ans District

<u>Species</u>	1	2
Acacia acuminata	t	f, fw
A. aneura	t	f, fw
A. arabica	t	f, fw, e
A. cavana	t	f, fw
A. cyanophylla	t	f, fw, e
A. cyclops	t	f, fw
A. humulosa	t	f, fw
A. negri	t	f, fw
A. numbica	t	f, fw
A. raddiana	t	f, fw
A. senegal	t	f, fw
A. spirocarpa	t	f, fw
A. tortilis	t	f, fw
Agropyron cristatum	g	f
A. elongatum	g	f
Albizzia lebbeck	t	T
Argania spinosa	t	f
Atriplex canescens	S	f
A. halimus	S	f
A. numularia	S	f
Azadirachta indica	t	f, T
Bouteloua curtipendula	g	f
B. gracilis	g	f
Brachychiton populneum	t	f

<u>Species</u>	1	2
Bulnesia retama	t	e
Calotropis spp.	t	e
Cenchrus ciliaris	g	f
Ceratonia siliqua	t	f, T
Cupressus sempervirens	t	e, T
C. arizonica	t	e, T
Cordia rothii	t	fw, T
Elaeagnus angustifolia	t	e
Eragrostis curvula	g	f
Eucalyptus camaldulensis	t	e, fw, T
E. gomphocephala	t	e, fw, T
E. hemiphloia	t	e, fw, T
E. sideroxylon	t	e, fw, T
Laratea compacta	t	fw
Lolium multiflorum	g	f
L. rigidum	g	f
Medicago littoralis	l	f
M. sativa	l	f
M. trunculata	l	f
Melilotus alba	l	f
Panicum coloratum	g	f
P. maximum	g	f
Parkinsonia aculeata	t	f, e
Petuge de soleman	l	f
Phalaris tuberosa	g	f
Populus nigra	t	fw, T
Prosopis alba	t	f, e

<u>Species</u>	1	2
Prosopis caldenia	t	f, e
P. specigera	t	f, e
P. tamarugal	t	f, e
Recinus communis	t	e
Retama roetam	t	e
Saccharum aegypticum	t	e
Salvadora oleoides	t	f
S. persica	t	f
Schinus molle	t	e, T
Sola diblema	l	f
Sporobulus aeroides	g	f
Tamarix aphylla	t	e
Tecoma undulata	t	f, T
Trifolium alexandrium	l	f
T. subterraneum	l	f
Zizyphus spina christi	t	e, T

Legend:

1 - Type :

g = grass
l = legume
S = shrub
t = tree

2 - Use :

e = erosion control
f = fodder
fw = fuelwood
T = timber and pole

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