# *ANNEX - D*

# *AGRICULTURE*

# ANNEX-D AGRICULTURE

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## 1. GENERAL

The study of the present conditions of agriculture in the study area was made to identify the present conditions including problems of the agriculture in the study area.

The various data and information on the existing agriculture were collected from following government authorities concerned:

1) Ministry of Planning
2) Ministry of Agriculture
3) Ministry of Supply
4) Department of Statistics
5) Agricultural Marketing Organization
6) Jordan Cooperative Organization
7) University of Jordan

Aside from data collection, the field reconnaissance and farm interview surveys were conducted so as to confirm the collected information and to make detailed investigation.

## 2. LOCATION AND POPULATION

### 2.1 Location

The study area covers about 4,000km$^2$ extending in west side of the Desert Highway and includes the highlands of the Karak governorate excluding Safi sub-region, Tafila governorate and a southern part of Amman governorate. There are the following 17 development units in the study area.

| governorate | sub-governorate | Development Unit | |
|---|---|---|---|
| Amman | Madaba | Aljeezeh | Ummleih |
| | | Jmail | Dhiban |
| Karak | Karak | Karak | Abdalia |
| | | Zahum | |
| | El-Qasr | El-Qasr | Faqu'a |
| | | Jada | |
| | Mazal Jandbi | Mazal Jandbi | Taybeh |
| | | Hosaynia | |
| | Ayy | Ayy | |
| | Qatraneh | Qatraneh | |
| Tafila | Tafila | Tafila | |
| | Bosarah | Bosarah | |

### 2.2 Population

According to the 1984 national Village Survey, population in the study area was estimated at about 166,800 for the year of 1990 comprising 109,300 in Karak governorate (except for Safi Sub-region), 42,500 in Tafila governorate and 15,000 in Madaba

sub-region of Amman governorate (see Table D.2.1). The average annual growth rate of Karak and Tafila governorates was 2.6%. There are 194 villages in the study area. The total number of households was estimated at about 20,600 which corresponds to 8.1 family members/household.

In 1985, the total number of workers in the study area was estimated at 28,800 which was 5.7% of the nation. Of this total, public and other service sectors accounted for 61%, followed by 17% in the agricultural sector, and 12% in the mining and manufacturing sector (see Table D.2.2).

## 3. ECOLOGICAL FEATURES OF THE STUDY AREA

### 3.1 Climate

The Department of Meteorology operates a weather observation network consists of 32 meteorological stations in the country. Out of these stations, 3 stations exists in the study area of this project. Those stations are Wadi Wala, Rabba and Tafila. Since Wadi Wala station is located in the wadi bottom, it is not representing the climatic feature of the priority areas.

Yearly change of the monthly average, daily maximum and minimum temperatures at Rabba and Tafila stations are very similar. Absolute daily maximum and minimum temperatures in both stations were about 40 °C and -6 °C respectively. Mean yearly number of days with maximum temperatures more than 35 °C is 6 and 4 days. Mean yearly number of days with minimum air temperature less than 0 °C is 6 and 15 days respectively in Rabba and Tafila stations.

Rain falls only in winter season during October to May with a mean annual precipitation of 326.5mm in Rabba and 250.2mm in Tafila. In both stations, more than 80% of the annual rainfall concentrates in 4 months between December and March. Mean yearly number of days with snow is about 3 to 4 days in both stations.

The mean daily relative humidity is relatively lower in summer season i.e around 40% and higher in winter season between i.e 60 and 70% at both stations.

Total wind run is high in summer season from June to August and low in winter season from October to December. Difference of wind run between two stations is much greater than the seasonal change. The total wind run at Rabba is about 200Km/day, while at Tafila it is about 300Km/day. At Rabba station, west wind frequency is very high compare to the other wind directions.

Mean daily evaporation from a class A pan is about 12mm/day in summer and about 4mm/day in winter at Rabba station. While it is between 2 and 10mm/day at Tafila station. The Department of Meteorology calculated the potential evapotranspiration according to the Penman equation. ETo for Rabba station ranged from 1.47mm/day in December to 6.73mm/day in July.

Mean yearly number of days with dew in Rabba and Tafila stations are 97.5 and 50.5 days respectively.

3.2 Agro-Meteorological Analysis of Climate Data

Several indexes have been proposed for the bioclimatic zoning of arid and semi-arid regions.

The Bailey moisture index (S) has been widely used to show the distribution of semi-arid climates on a global basis and to examine seasonal factors. According to the calculated S value, Wadi Wala, Rabba and Tafila stations are classified to semi-arid region.

$$S = \sum_{I=1}^{12} Si \; ; \; Si = 0.18p/1.045^{t}$$

p : Mean monthly precipitation in cm
t : Mean monthly temperature in °C

| | | |
|---|---|---|
| S<2.5 | : | Arid |
| 2.5<S<4.7 | : | Semi-arid |
| 4.7<S<6.37 | : | Dry sub-humid |
| 6.37<S<8.7 | : | Moist sub-humid |
| 8.7<S<16.2 | : | Humid |
| 16.2<S | : | Perhumid |
| Wala : S=2.7 | : | Semi-arid |
| Rabba : S=3.8 | : | Semi-arid |
| Tafila : S=3.1 | : | Semi-arid |

According to the precipitation index (L) proposed by R.Lang, Rabba station belongs to semi-desert and Tafila station belongs to desert.

$$L = P/t$$

P : Annual rainfall in mm
t : Mean annual temperature in °C

| | | |
|---|---|---|
| 0<L<20 | : | Desert |
| 20<S<40 | : | Semi-desert |
| 40<L<60 | : | Steppe |
| Wala : L=14.3 | : | Desert |
| Rabba : L=20.2 | : | Semi-desert |
| Tafila : L=16.1 | : | Desert |

According to the aridity index (I) proposed by de Martonne, Rabba station belongs to the area of dry farming, but Tafila station belongs to desert area.

$$I = P/t+10$$

P : Annual rainfall in mm
t : Mean annual temperature in °C

| | | |
|---|---|---|
| I<10 | : | Desert |
| I>10 | : | Potential area for dry farming |
| I<20 | : | Irrigation required |
| Wala : I=9.3 | : | Desert |
| Rabba : I=12.5 | : | Dry farming |
| Tafila : I=9.8 | : | Desert |

According to Long (FAO Botanist/Ecologist), the whole east Jordan falls within the Mediterranean bioclimate region which is characterized by the concentration of rainfall during cool season and very marked summer drought. Rainfall distribution have a direct influence on the natural vegetation as well as on the

cropping system. Long subdivided the Mediterranean bioclimate into 4 main zones in the eastern part of Jordan according to Emberger's aridity index (Q). Calculated Q value for Rabba and Tafila stations are 43 and 31 respectively and both stations belong to Semi-arid Mediterranean bioclimatic zone. According to the bioclimatological map (Fig. D.3.1) of east Jordan, 3 priority areas are situating in transition from Semi-arid Mediterranean to Saharan Mediterranean bioclimate.

$Q = 2000P/(M+m)(M-m)$

P : Annual rainfall in mm
M : Mean max. tem. (hottest month) in K
m : Mean min. tem. (coldest month) in K

| | |
|---|---|
| 70<Q<100 | : Sub-humid Mediterranean |
| 30<Q<70 | : Semi-arid Mediterranean |
| 10<Q<30 | : Arid Mediterranean |
| 2<Q<30 | : Saharan Mediterranean |

| | | |
|---|---|---|
| Wala | : Q=31.5 | : Semi-arid Mediterranean |
| Rabba | : Q=43.3 | : Semi-arid Mediterranean |
| Tafila | : Q=31.4 | : Semi-arid Mediterranean |

Bioclimatic sub-division (G.A.Long)

| Bioclimate zone | Class | Q-Value | Min. Tem. of Coldest month | Max. Tem. of Hottest month |
|---|---|---|---|---|
| 1. Sub-humid Mediterranean | (1) | 70 -100 | 2 - 5 | 27 - 33 |
| 2. Semi-arid Mediterranean | (2) | 30 - 70 | 3 - 7 | 29 - 34 |
| 3. Arid Mediterranean | | 10 - 30 | 1 - 11 | 34 - 40 |
| Cool | (3) | 10 - 30 | 1 - 3 | 34 - 40 |
| Warm | (4) | 10 - 30 | 3 - 7 | 34 - 40 |
| Very warm | (5) | 10 - 30 | 7 - 11 | 34 - 40 |
| 4. Saharan Mediterranean | | 2 - 30 | 1 - 12 | 36 - 42 |
| Cool | (6) | 2 - 15 | 1 - 3 | 36 - 42 |
| Warm | (7) | 2 - 15 | 3 - 8 | 36 - 42 |
| Very warm | (8) | 2 - 30 | 8 - 12 | 36 - 42 |

## 3.3 FLORA

Studies of the vegetation in East Jordan have been carried out by Kasaphigl and by Long. Very roughly speaking the natural vegetation in East Jordan can be subdivided into the following main zones.

(1) Forest Zone : Evergreen Oak forests are found in the area Jerash-Ajloun in the north and Tafila-Shobak in the south where the annual rainfall is between 500mm and 700mm. Deciduous Oak forests are found in scattered blocks mainly in the central and northern East Bank Uplands, at elevation of 100 to 700m and the

annual rainfall is 200-500mm. Pine forests occurs with the evergreen oak forests and are found in comparatively richer sites with moderate slopes and with the annual rainfall of about 500-700mm. Juniper forests can be found at the very steep western slopes of the Tafila-Shobak mountains extending to Petra and Wadi Musa with the annual rainfall of 200-300mm. Wild olive forests are found mainly at the western slope of Zarka basin with the annual rainfall of 300-500mm. Most of these forests have been disappearing as the results of direct and indirect human actions.

(2) Steppe Zone : This is the area with a 150-300mm annual rainfall which has, under natural condition, a fairly complete cover of perennial grasses and shrubs. Most important shrubs is Artemisia herba-alba. This vegetation extend from Nejar in the south to the Syrian border north of Mafrak. The Hijaz railway is approximately the eastern boundary of Artemisia. However it penetrates the eastern desert through valleys and gullies. This region has a great potentiality as range land. Considerable area is in agriculture and dry farming. Due to overgrazing and mismanagement a part of this area is deteriorated, but if left along, the vegetation will cover the soil within a short period of time.

(3) Desertic Zone : The vegetation cover in this area is usually incomplete. In the typical flint strewn desert, large surfaces bare of vegetation are present. Sandy desert occurs in the southern desert where sand dunes are common. Haloxylon percicum is the dominant species, associated with Anabasis articulata. This provides excellent fodder for goats and camels. But the vegetation is very sparse due to heavy uncontrolled grazing.

According to the physiographical study of East Jordan, the area can be divided into the following regions.

(1) The mediterranean region : This region comprises the area of the northern and southern highlands and it includes the important forest areas of Jordan and the bulk of the cultivated land. Average annual rainfall varies between 250mm and 600mm. This region is not managed properly. Soil and water losses are remarkable due to mis-land use.

(2) Brush vegetation : This area extends from Naqab in the south to Qatrana in the north, varying in the width between 3 and 8Km from the western edge of the Jordan plateau. The predominant vegetation is woody perennials mostly Artemisia herba-alba. Rainfall varies between 150-200m annually. This region should have the priority for management as range land. Recovery of vegetation needs a good management and reduction in grazing animals.

(3) Grassland : This is the northern extension of the brush vegetation region. This region is devoid of shrubs and perennial grasses such as Poa spp. and Carex spp. which form the dominant cover and protect the soil. This region has a good potentiality as range land. Range land should be managed properly and developed by reseeding etc.

(4) The south eastern desert : This area comprises the extreme

south eastern portion of Jordan. An average annual rainfall is about 75mm. This area has very low priority even for the range development and improvement.

(5) The south western mountainous desert : This region includes the area south east of the highway to Aqaba after passing Naqab. It continues south to the Saudi Arabian border and almost as far east as Mudawara. Vegetation cover is very sparse and heavily deteriorating under the effect of the uncontrolled grazing.

(6) Wadi araba and Rift valley Escarpment : This region includes the escarpment area between the western edge of the forest region and Jordan valley extending to Wadi Araba in the south. Annual rainfall is below 100mm. Perennial grasses are sparse and erosion is severe and most of the area denuded of vegetation and soil .

(7) The north eastern and eastern desert : This area consists of limestone, marls and chart together with an extensive basalt lava flows. Vegetation is sparse, mainly annuals and unpalatable perennials. Rainfall is very low not exceeding 100mm annually.

Fig. D.3.2 shows the location of 3 priority areas of the project on the physiographical map. Most of the Dhiban area belongs to Grassland region and a very limited part in the east side of King's highway and Wadi Mujib belongs to Mediterranean region. Most of the eastern part of Abyad area belongs to the eastern desert region and Brush vegetation is extending in its western part. Brush vegetation region is crossing the central part of Tafila area from north to south. Western edge of the area belongs to Mediterranean region. The south eastern corner of the area belongs to desert region.

## 3.4 Forestation

The total area of Jordan is about 9,000,000 ha and only 139,600 ha (equal to 1.5%) is declared as forest land. From this forest land only about 70,000 ha are covered by forest, about half of the area is still without forest cover. The forests are very important in Jordan as a mean for soil and water conservation in water sheds. The policy of the Department of Forests and Soil Conservation is to protect and improve existing forests and to cover bare forest land through afforestation in order to improve the semi-arid conditions of the country.

The Department of Forests and Soil Conservation started during 1950s the afforestation project at a pace of 100-500 ha/year. Approximately 1,000,000 seedlings were produced every year for this project. The FAO project was started in 1960 to improve the afforestation technic and the annual plantation area and seedling production were doubled by 1965. On the other hand, natural forests were disappearing due to continuous degradation. Before 1965 annual planting area was almost equal to the degrading area. Since 1965, the annual planting area increased year by year and exceeded the degrading area. The annual planting area was 500-1000 ha/year during 1965-1970, 1000-2000 ha/year during 1970-1980 and 2000-3000 ha/year after 1980. The total area of artificial forest is now 33,000 ha and 40,000 ha of natural forests are being reserved.

The majority (61%) of the forests in Jordan exists in the northern part of the East Bank. The total area of natural forests was estimated at 36,513 ha in 1986 and were classified under the following five main forest types :

| | | |
|---|---|---|
| 1. | Evergreen oak forests | 20,985 ha |
| 2. | Deciduous oak forests | 4,480 ha |
| 3. | Pine forests and mixed forest | 3,169 ha |
| 4. | Juniper forests | 7,773 ha |
| 5. | Wild olive forests | 106 ha |
| | Total | 36,513 ha |

The main objective of the Department of Forests and Soil Conservation has been the establishment of new plantation on bare lands classified as forest land. Artificial forests are mainly distributed in the northern part of the East Bank. Only 25% of the artificial forests exists in the southern part. In 1985-1986, newly planted area in Karak & Tafila region was only 12% of the total planted area. The method applied in afforestation has been the planting of seedlings, raised in polyethylene bags, on narrow terraces prepared mainly by hand. Recently, better tree growth was observed in the test plantation area where terraces were deeply plowed by machinery. Pinus hellepensis and Acacia cyanophylla are the main two species used in afforestation. Other species such as Eucalyptus camaldulensis, Casuarina equisetifolia, Pinus brutia and Tamarix articulata are also planted in recent years. Trees planted in various area are shown in Table D.3.1 to D.3.3.

One of the main hazards to the forest development are forest fires. Relatively large areas have been badly affected by fires. To overcome this problem the Department introduced wireless system for early detection of forest fires. Other major problem to forestry is grazing. Although grazing is legally prohibited in the forests, grazing is still observed in natural forests and even in the artificial forest.

Desertification in crop land and range land is another serious problem in study area. The main causes of the desertification in range land are (i) The number of livestock is in excess of the carrying capacity and (ii) Unregulated or incorrectly regulated grazing. When the natural vegetation is overgrazed, unpalatable weeds and noxious shrubs invade and increase. Excessive grazing affects the plant growth and the biomass of individual plants will be reduced. In worse case all valuable fodder plants will disappear completely and dominant plant species will not be eaten by any grazing animals. The deterioration of the plant cover has also serious consequences on microclimate of the region. It increases soil compactness, decreases soil fertility through exposure of the surface layer to sun and air and causes excessive run-off and gullying.

Taking such low productivity in low rain fall area and current land degradation into account, converting marginal crop land to pasture land by reseeding grasses and legumes annually and transplanting perennial grasses, legumes and shrubs would be

a proper management method of marginal rainfed crop land. The preliminary observation at Muwaqar experimental station of Jordan University showed that regeneration of good fodder plants in the protected area was comparatively fast even in the area of rain fall between 100 and 200mm. It is also mentioned in desert land prefeasibility study (1986) that economic returns by improved pasture are estimated to be 3.6 times greater than grain production on marginal crop land.

The Department of Forest and Soil conservation therefore has been implementing the Rangelands Reservation Project. Range land in Jordan defined as areas which receive less than 200mm annual rainfall, covers about 91% of the total area of the East Bank. Thirteen range reserves have been established by now. The total area of these reserves is about 17,000 ha, 5,000 ha of which have been planted to fodder shrubs. The project area is protected from grazing by fencing and the recovery of natural vegetation is remarkable in the area. Small dikes were constructed at the suitable points in wadi stream inside the project area to reserve run-off water. Various kinds of seeds such as Atriplex halimus, Atriplex leucoclada, Salsola spp. and Tamarix spp. were sown in the project area. Some of the species showed very good growth and are expanding their covering area naturally. In some case, even Eucalyptus showed a good growth under such condition without any irrigation. For the project 1,500,000 seedlings of fodder shrubs have been produced every year. Main species for the transplantation are Atriplex halimus, Atriplex nummularia, Atriplex canesence, Acacia cyanophylla, Prosopis cineraria, Prosopis spicigera, Prosopis juliflora etc, but all Prosopis species are not growing well in the cold weather. Faculty of Agriculture, the University of Jordan is conducting a project of Agricultural production in the semi-arid land and areas suffering from desertification in cooperation with the European Economic Community (EEC). The project site is located 30 Km south east of Amman, 14 Km east of Muwaqar village. According to the preliminary results in this project, the growth of Atriplex nummularia, Atriplex leucoclada and the local Atriplex halimus is satisfactory. While the growth of Atriplex canesence is very poor. In case of direct sowing, the germination percentage of Atriplex was between 50 - 70% depending on row spacing. Direct sowing would be a better practice for Atriplex halimus.

## 4. PROBLEM CENSUS AND FARM SURVEY

### 4.1 Problem Census

#### 4.1.1 Methodology

The survey of farmer's opinions was conducted in order to reflect farmer's opinions on the development plan. The contract was made between Mu'tah University and JICA study team for the implementation of the farm survey. The main objectives of the survey are to identify the problems of farmers, to involve farmers in the planning for the smooth implementation of the project and to establish the basic concept of the project.

Prior to the problem census, the results obtained through the previous survey done by the Development Council were studied.

The structure of problem census was designed according to the general recommendations proposed by the Development Council for Agriculture Sector in Southern Area (Karak, Tafila and Ma'an) of Jordan.

Problem census was then conducted at the Mu'tah University on 16th Nov. 1989 to identify the problems recognized by farmers in and around Karak area. Randomly selected farmers (38 in total) were divided into 5 groups, 2 cereal crop production groups (14 farmers), 2 animal husbandry groups (13 farmers) and 1 fruit and vegetable production group (11 farmers). Free discussions were carried out in each group under the chairmanship of the university staff on the specific problems in the following areas.

a. Availability of seeds, seedlings, fertilizers, chemicals, and reasonableness of their prices.
b. Availability of water.
c. Availability of land to be planted.
d. Availability of labour forces and agricultural machinery power.
e. Availability of extension services and credits.
f. Availability of markets, transportation means, storage facilities.
g. Administrative restrictions on cropping patterns, prices, market outlets and transportation.
h. Others.

### 4.1.2 Results and Discussion

Since general problems which farmers face were outlined by the study report of the Development Council, attention was paid to identify the specific problems existing in the study area in this problem census. Report of the survey results was prepared and submitted by the research team of the Department of Academic Research, Mu'tah University(Annex D.1). Problems pointed out by farmers during free discussion in each group are summarized as follows;

(1) Cereal Production farmers

a)Farm Land
- Inconveniently fragmented holdings
- Decrease of arable land due to urban encroachment and soil erosion
- Mismanagement in land conservation

b)Water supply
- Shortage of water source specially in the year of annual rainfall less than 200 mm
- High cost for irrigation water
- Insufficient and unpredictable rainfall
- Restriction in utilization of underground water

c)Machinery and Labors
- Shortage of machinery such as tractors, sprayers, harvesters and threshers
- High cost of spray machine
- Insufficient modern machineries

- Difficulty to own agricultural machinery due to high expenditure for maintenance and spare parts
- Insufficient knowledge of workers for machinery operation
- Unavailability of legume harvesting machine
- High percentage of migrant workers
- Unstable migrant workers
- Unavailability of Jordanian workers during busy season
- High wage for agriculture labor

d)Seeds and Seedlings
- Unavailability of green fodder seeds
- Shortage of improved seeds supply and their high prices
- Untimely seeds distribution
- Low quality of seeds distributed
- Insufficient seeds distribution center

e) Fertilizers and Chemicals
- High price of fertilizer
- Untimely fertilizer distribution
- Ineffectiveness of fertilizer due to improper storage
- High price of agro-chemicals
- Unavailability of certain pesticide
- Insufficient knowledge of farmers regarding pesticide application

f)Extension services
- Shortage of advice regarding proper land use
- Weak function of mass-media in advising and directing farmers
- Weak leadership of the government in modernizing and mechanizing agriculture

g)Credit
- Poor distribution of loans to farmers
- Less chance of obtaining loans for small holders
- Strict condition to obtain loans for farmers such as necessity of permanent financial source
- Short repayment period of loans
- High interest
- Influence of favoritism to the granting of loans
- No correspondence between repayment period and harvest season

h)Marketing and transportation
- Exploitation of middle man
- Influence of favoritism to the judgement of quantity and quality of products
- Insufficient number of agricultural product receiving center
- Restriction of red meat exportation

i) Post harvest facilities
- Shortage of storage facilities

(2) Fruit and vegetable production farmers

a) Farm land

- Improper management of jointly owned land
- Insufficient study of soil property and suitability for each crop

b)Water supply
- Shortage of irrigation water during summer season
- Restriction of WAJ to use underground water for agricultural purpose
- Limited number of water tanker for water transportation
- Insufficient study of water quality such as suitability for irrigation

c) Machinery and labors
- High wage for Jordanian labor
- Unavailability of farm workers
- Dependence on unstable migrant labor
- High price of agricultural machinery
- Insufficient machinery in public sector
- Shortage of certain machinery such as tomato harvester and small tractor
- High rental charge of agricultural machinery
- Unavailability of spare parts and insufficient maintenance skill

d) Seeds and seedlings
- Certain kind of seeds are not available
- High price of improved seeds
- Insufficient quantity and quality of improved seeds
- Seedlings are sometimes not appropriate to the climate and soil
- No scientific agent to test seeds

e) Fertilizers and chemicals
- High price of fertilizers and chemicals

f) Extension services
- Shortage of extension agent
- Shortage of proper technical advice

g)Credit
- High interest
- No correspondence between repayment period and production season

h)Marketing and post-harvest facilities
- Improper pricing
- Insufficient storage facilities
- Improper management of warehouse (e.g. Temperature control is not appropriate to the kind of crop)

(3) Animal husbandry farmers

a) Feed
- Insufficient feed source
- Insufficient green fodder
- Insufficient seed supply of green fodder

b)Grazing

- Limited utilization of public grazing area
- Limited grazing area
- Limited grazing period

c)Water supply
- High cost of drinking water for animals
- Unavailability of water during summer season

d)Animal diseases
- Frequent occurrence of animal diseases
- Negative effects of treatment to animals
- Unavailability of veterinarians and veterinary treatment

e)Marketing
- Excess production of red meat in the market
- Monopoly of export market by limited merchants
- Unavailability of special trucks for lamb transportation
- Low market price
- Improper organization of importing and exporting process of lamb

f)Processing
- Insufficient milk-product processing plant in the area between Wadi Mujib and Wadi Hasa

According to the above mentioned problems recognized by farmers following recommendations can be considered;

1) An appropriate land use programme should be established to prevent the urban encroachment of arable land and also to prevent the desertification of grazing area taking into account the proper soil and water conservation management.

2) Since extraction of ground water is strictly restricted, water supply during summer season should be augmented by constructing dams and cisterns specially in the remote grazing area. Moreover, water harvesting schemes such as contour furrow and micro catchment system should be extended in the crop production area not to fully depend on portable water of ground water origin.

3) The number of agricultural machinery service center should be increased and also the existing stations should be improved by providing new machines, necessary spare parts and maintenance facilities to offer better services for farmers.

4) The number of seed distribution center should be increased and the center should provide the farmers with tested seeds and sound seedlings suitable to the natural condition of the area.

5) Wide range of fertilizers and agro-chemicals should be supplied to farmers with cheaper prices and proper instruction of application practices should be

provided.

6) The number of extension agent should be increased to enhance the effective communication between farmers and extension agents to give appropriate advice to farmers.

7) Marketing and post harvest facilities such as agricultural product receiving center, cereal product storage facility and dairy product processing facility should be developed according to the kind and volume of agricultural products.

## 4.2 Farm Survey

### 4.2.1 Methodology

Farm surveys were conducted to investigate economic backgrounds of the farmers and the farmers opinions on development plans.

The following items were surveyed.

* Economic backgrounds of farmers (holding size, employment, family size, family income, daily average expenditure, etc.)
* Comments on the basic concept of existing projects.
* Necessary improvement/adjustment for the projects.
* Willingness to participate in development projects, etc.

The surveys were executed by the Mu'tah University using questionnaires which was prepared by the joint work of the Mu'tah University staff and JICA study team based on the results obtained through the problem census. The questionnaires are shown in Annex. D-1. The regional agricultural offices of the Ministry of Agriculture were consulted for the selection of the sample farmers.

The following numbers of randomly selected farmers were surveyed for the respective regions.

| Regions | Animal Farmers | Cereal Farmers | Fruit Farmers | Total |
|---|---|---|---|---|
| Amman: | 20 | 20 | 20 | 60 |
| Karak: | 20 | 20 | 20 | 60 |
| Tafila: | 20 | 20 | 20 | 60 |
| Total | 60 | 60 | 60 | 180 |

The schedule was as follows.

Preparation (Basic concept, questionnaires, sampling, etc.) Dec. 2-14, 1989
Implementation: Dec. 16-21, 1989
Reporting: Dec. 23-28, 1989

Data collected were compiled in a personal computer and analyzed by the present study team.

4.2.2 Results and Discussion

Answers to the questionnaires were given in Annex D-2. Meanings of the question numbers in the results can be referred in the questionnaires. The following chapters presents major points of the finding by the surveys.

(1) General

General conditions of the interviewed farmers including animal, cereal and fruit farmers were explained in the following.

A. Household Condition of a Respondent

As shown in the next table farming is managed absolutely solely by an old male with an age of 50 to 54. Family size is large ranging from 7 to 10. Particularly animal farms have the largest family size of 10. animal farmers have almost year-round working days i.e. 322 days, while cereal farmers have seasonal work of 170 days. Educational level of farmer is rather law i.e. primary school level or no school education, in most cases. Animal farmers have the lowest educational backgrounds. As many as 56% of animal farmers received no school education.

Household Conditions of a Respondent

| | Unit | Farmers | | |
|---|---|---|---|---|
| | | Animal | Cereal | Fruit |
| 1. Sex (Male) | (%) | 100 | 100 | 100 |
| 2. Age | (years old) | 50 | 54 | 53 |
| 3. Family member 1. Non-farming | (persons) | 3 | 2 | 3 |
| 2. Farming | ( " ) | 3 | 2 | 2 |
| 3. Pupil/Student | ( " ) | 4 | 4 | 2 |
| 4. Ill/aged | ( " ) | - | - | - |
| 5. Others | ( " ) | - | 1 | - |
| Total | | 10 | 9 | 7 |
| 4. Annual farming days | (days) | 322 | 170 | 253 |
| 5. Educational background | | | | |
| 1. Primary school | (%) | 35 | 51 | 48 |
| 2. Secondary/high school | (%) | 7 | 15 | 9 |
| 3. Collage/university | (%) | 2 | 2 | 7 |
| 4. No schooling | (%) | 56 | 32 | 36 |
| Total | | 100 | 100 | 100 |

B. Holdings of Respondents

An average landholding size of animal farmers is about 19ha consisting of 8.2ha of owned land, 4.3ha of rented land, 0.7ha of leased land and 6ha of jointly-owned land. Most of the landholdings are field crop land. About 30% of the holdings are jointly-owned. Traditional Bedouin farmers are very few. About 17% of the animal farmers seems to be the traditional Bedouins

having no land.

Crop growing and animal husbandry are closely inter-dependent.

Land Holdings of an Animal Farmer

(unit: ha)

| Kinds of Land | Land Ownership: Owned Rain-fed | Owned Irri-gated | Rented Rain-fed | Rented Irri-gated | Leased Rain-fed | Leased Irri-gated | Jointly-Owned Rain-fed | Jointly-Owned Irri-gated |
|---|---|---|---|---|---|---|---|---|
| Field crops | 7.9 | 0.1 | 4.2 | 0.1 | 0.7 | 0 | 6.0 | 0 |
| Grass land | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fruit land | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Green-house | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Forest land | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 8.2 | 0.2 | 4.2 | 0.1 | 0.7 | 0 | 6.0 (19.2) | 0 |

An average land-holding of cereal farmers is rather large, i.e. 38ha, but, of which, 20.3ha is jointly-owned. The cereal farmers have small fruit land which covers only about 4% of the total landholdings.

Land Holdings of a Cereal Farmer

(unit: ha)

| Kinds of Land | Land Ownership: Owned Rain-fed | Owned Irri-gated | Rented Rain-fed | Rented Irri-gated | Leased Rain-fed | Leased Irri-gated | Jointly-Owned Rain-fed | Jointly-Owned Irri-gated |
|---|---|---|---|---|---|---|---|---|
| Field crops | 12.4 | 0.3 | 3.0 | 0.1 | 1.3 | 0 | 19.3 | 1.0 |
| Grass land | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fruit land | 0.4 | 0.6 | 0 | 0 | 0 | 0 | 0.4 | 0 |
| Green-house | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Forest land | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 12.4 | 0.9 | 3.0 | 0.1 | 1.3 | 0 | 19.7 (38.4) | 1.0 |

An average landholding of fruit farmers was estimated at 14.1ha, of which 24% (3.4ha) is fruit land. Irrigation is very important in fruit growing in this area. About 62% of the fruit land is irrigated. Joint-ownership covers about 39% of the total landholdings of the fruit farmers.

Land Holdings of a Fruit Farmer

(unit: ha)

| Kinds of Land | Land Ownership: Owned Rain-fed | Owned Irri-gated | Rented Rain-fed | Rented Irri-gated | Leased Rain-fed | Leased Irri-gated | Jointly-Owned Rain-fed | Jointly-Owned Irri-gated |
|---|---|---|---|---|---|---|---|---|
| Field crops | 4.9 | 0.3 | 0.4 | 0.1 | 0 | 0 | 4.9 | 0.1 |
| Grass land | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fruit land | 1.1 | 1.8 | 0 | 0 | 0 | 0 | 0.2 | 0.3 |
| Green-house | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Forest land | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 6.0 | 2.1 | 0.4 | 0.1 | 0 | 0 | 5.1 | 0.4 |
| | | | | | | | (14.1) | |

An animal farmer keeps 119 sheep and 67 goats on an average, while a cereal farmer raises 30 sheep, 4 goats and 502 chicken on an average. Animal husbandry is not so important for fruit farmers with average holding sizes of 10 sheep, 4 goats and 100 chickens.

Most farmer have no deep wells but have a water tank of 5 to 25 $m^3$ on an average.

Other Holdings of Farmers

| | Unit | Household: Animal | Cereal | Fruit |
|---|---|---|---|---|
| Animal | head/household | | | |
| Horse | | 0 | 0 | 0 |
| Sheep | | 119 | 30 | 10 |
| Goat | | 67 | 4 | 4 |
| Cow | | 0 | 0 | 0 |
| Camel | | 1 | 0 | 0 |
| Chicken | | 2 | 502 | 100 |
| Deep wells | unit/household | 0 | 0 | 0 |
| Water tank | $m^3$/household | 25 | 5 | 9 |

About 95% of the farmers surveyed use farm machinery. Main sources of machinery power are their own machinery , and these of the other private farmers. Cooperatives and farmers' groups play minor roles in farm mechanization. There are different degrees of mechanization in respective farming practices. Harrowing is most mechanized, i.e., 73% to 97%. About 40% of the sowing by cereal farmers is mechanized. In case of animal farmers, sowing is seemed to be done by hand in most cases. It should be noticed that the plowing is not always done by farmers.

Farm Machinery

(unit: %)

| | Household | | |
|---|---|---|---|
| | Animal | Cereal | Fruit |
| Sources of power | | | |
| Cooperatives | 2 | 15 | 10 |
| Private farmers | 64 | 71 | 81 |
| Its own | 32 | 14 | 9 |
| Groups | 2 | 0 | 0 |
| Mechanization | | | |
| Plowing | 39 | 49 | 36 |
| Harrowing | 73 | 97 | 88 |
| Planting (Sowing) | 14 | 42 | 24 |
| Harvesting | 4 | 61 | 19 |
| Spraying | 4 | 46 | 50 |
| Transportation | 18 | 69 | 67 |
| Weeding | 2 | 7 | 5 |

C. Employment of Labourers

Average members of farm labourers (permanent or casual) employed by a farmer are 1.8 persons for animal farmers, 3.2 persons for cereal farmers and 2.4 persons for fruit farmers. In this calculation extraordinary figures like 201 persons were omitted for the calculation of the average.

D. Agricultural Credit and Marketing

Very few farmers use agricultural credits. About 20% to 30% of farmers use the credits. The biggest reason for the non-usage of the credit is the religion, which denies the interest. Every credit problem cognized by the problem census was confirmed by the farm survey. Low cognizance of the favoritism by animal farmers might be attributable to the fact that they are the majority in politics.

Agricultural Credit

(unit: %)

| | Household | | |
|---|---|---|---|
| | Animal | Cereal | Fruit |
| Usage of agricultural credit | | | |
| 1. Yes | 23 | 22 | 33 |
| 2. No | 77 | 78 | 67 |
| Reasons for the no-usage | | | |
| 1. religions | 42 | 27 | 48 |
| 2. no ability to repay | 14 | 27 | 12 |
| 3. high interest rate | 26 | 21 | 21 |

(unit: %) continued

| | Household | | |
|---|---|---|---|
| | Animal | Cereal | Fruit |
| 4. no necessity | 18 | 25 | 12 |
| 5. Other | 0 | 0 | 7 |
| Total | 100 | 100 | 100 |
| Cognizance of problems in crediting | | | |
| 1. restriction by holding size | 94 | 73 | 80 |
| 2. necessity of reliable income | 92 | 96 | 70 |
| 3. high interest rates | 95 | 96 | 90 |
| 4. insufficiency in loan amount | 89 | 76 | 89 |
| 5. favoritism (waste) | 29 | 81 | 62 |
| 6. inappropriate repayment period | 95 | 100 | 85 |
| 7. necessity of loan guarantee | 97 | 93 | 82 |
| 8. short repayment period | 95 | 92 | 81 |

The biggest problem of animal and fruit farmers is the price drop in harvesting (marketing) seasons. About 80% to 90% of the farmers cognize that problem. While, high transportation costs are the biggest problem of the cereal farmers, and are the second biggest problem of the animal and fruit farmers. Other problems cognized in the problem census were also confirmed in the farm survey. Insufficient export facilities, high export costs and limited issuance of export licenses are the major problems in the export of agricultural produce

## Agricultural Marketing

(unit: %)

| | Household | | |
|---|---|---|---|
| | Animal | Cereal | Fruit |
| Cognizance of problems in marketing | | | |
| 1. favoritism (waste) | 33 | 34 | 32 |
| 2. insufficient marketing centers | 62 | 50 | 56 |
| 3. exploitation by middle men | 36 | 33 | 55 |
| 4. price drop in harvesting period | 79 | 57 | 86 |
| 5. high competition between farmers | 55 | 21 | 47 |
| 6. competition with imported ones | 69 | 32 | 53 |
| 7. difficulty in transportation | 67 | 54 | 54 |
| 8. high transportation costs | 74 | 71 | 69 |

(unit: %) continued

| | Household | | |
|---|---|---|---|
| | Animal | Cereal | Fruit |
| 9. insufficient storage facilities | 44 | 29 | 39 |
| 10. high storage costs | 41 | 16 | 39 |
| Cognizance of problems in export | | | |
| 1. restriction by the government | 77 | 95 | 79 |
| 2. insufficient export facilities | 85 | 94 | 100 |
| 3. low export prices | 67 | 38 | 77 |
| 4. high export costs | 91 | 100 | 100 |
| 5. limited issuance of export licenses | 89 | 100 | 92 |

The Highland Development Project which was renamed Development of the Highland Agricultural Regions has been implemented to conserve soil and water since 1965 on areas with an annual rainfall of over 250mm and a land slope of between 18% and 35%. This project covers a part of the present study area. About 10% to 30% of the interviewed farmers participated in the project. The major reasons for non-participation are a lack of information on the existence of the project, and a lack of eligibility without suitable land. Effectiveness of the soil conservation measures of the project is sufficiently recognized by the participants. About 50% to 80% of the participated farmers recognized the effectiveness. Fruit farmers which are most concerned with the project admit the effectiveness most of all. Tenants and labourers have no authority to decide to participate in the project. Food for work approach, i.e food assistance for the construction of the facilities, plays decisive rule for the promotion of the project. About 40% of the participated farmer noted that they participated in the project because of the food for work approach of the project. Farmers like the stone walls most of all followed by fences and terraces. Contour furrows have least supports from the farmers.

Highland Development Project

(unit: %)

| | Household | | |
|---|---|---|---|
| | Animal | Cereal | Fruit |
| Experience in participation in the project | | | |
| 1. Yes | 9 | 22 | 32 |
| 2. No | 91 | 78 | 68 |
| Reasons for no-participation | | | |

(unit: %)continued

| | Household | | |
|---|---|---|---|
| | Animal | Cereal | Fruit |
| 1. no information | 20 | 19 | 32 |
| 2. no authority to decide | 15 | 5 | 14 |
| 3. no suitable land | 30 | 38 | 14 |
| 4. complicated procedures | 30 | 21 | 24 |
| 5. no merits | 5 | 0 | 11 |
| 6. rejection of the application | 0 | 10 | 3 |
| 7. others | 0 | 5 | 3 |
| Person who decided the participation | | | |
| 1. landowner | 100 | 100 | 70 |
| 2. tenant | 0 | 0 | 0 |
| 3. labourers | 0 | 0 | 0 |
| 4. joint-owners | 0 | 0 | 30 |
| 5. others | 0 | 0 | 0 |
| Reasons for the participation | | | |
| 1. free construction of facilities | 40 | 40 | 37 |
| 2. tenant's willingness | 20 | 5 | 0 |
| 3. landowner's willingness | 10 | 9 | 17 |
| 4. to conserve soils | 30 | 41 | 43 |
| 5. others | 0 | 5 | 3 |
| Effectiveness of the facilities | | | |
| 1. good | 50 | 79 | 84 |
| 2. No | 25 | 14 | 11 |
| 3. not understandable | 25 | 7 | 5 |
| Most effective measures experienced | | | |
| 1. stone walls | 50 | 44 | 32 |
| 2. contour furrows | 0 | 6 | 12 |
| 3. wind breakers | 0 | 11 | 12 |
| 4. fences | 50 | 17 | 20 |
| 5. terraces | 0 | 17 | 19 |
| 6. not-understandable | 0 | 5 | 5 |

About 20% to 30% of the farmers interviewed replied that they are against land reclamation projects like ponds, dams, terraces because, in most cases, they don't like changes. The animal farmers have least trust in government projects. This might be because their range land has been diminished by the development policy of the government.

Farmers like best the soil and water conservation structures which physically store water like ponds and water tanks. About 60% to 80% of the interviewed farmers replied they like best ponds or water tanks. Check dams and stone walls have some popularity among the farmers, i.e. about 20% to 30% of the farmers chose them their best choice. Contour furrows and terraces have least supports by the farmers.

Opinion on Soil Conservation Works

(unit: %)

| | Household | | |
|---|---|---|---|
| | Animal | Cereal | Fruit |
| On land reclamation projects | | | |
| 1. object unconditionally | 27 | 33 | 18 |
| 2. accept conditionally | 73 | 67 | 82 |
| Reason for the objection | | | |
| 1. no trust in projects | 31 | 0 | 0 |
| 2. preference of statusque | 54 | 91 | 69 |
| 3. objection of landowner | 0 | 5 | 0 |
| 4. objection of tenant | 0 | 0 | 0 |
| 5. objection of joint owner | 0 | 4 | 8 |
| 6. no economic viability | 15 | 0 | 23 |
| 7. others | 0 | 0 | 0 |
| Farmers' choice of measures | | | |
| 1. ponds | 50 | 40 | 14 |
| 2. contour furrows | 0 | 0 | 6 |
| 3. check dams | 18 | 5 | 14 |
| 4. water tank | 29 | 30 | 47 |
| 5. terraces | 0 | 5 | 3 |
| 6. stone walls | 3 | 15 | 17 |
| 7. others | 0 | 5 | 0 |

(2) Cereal Farmers

1) Seeds

Cereal seeds are mainly supplied from government distribution-centers. Last year's products of each farmer is another important source of seeds. Present situation of seed distribution is more or less better in Tafila and worse in Dhiban area. In Dhiban, the number of government seed distribution centers is not sufficient and also the quantity of seeds from the centers is not sufficient. Moreover many farmers in Dhiban area have difficulties to obtain seeds from the centers due mainly to complicated procedures. It is therefore much easier for them to obtain seeds from private shops than from the distribution centers. Though the quality of seeds from the private shops is usually lower than those from the distribution centers.

Availability of Seeds

( Unit : Persons(%))

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Seeds are obtained from (total answers = 74) | | | |
| a) Distribution centers | 14 (51.9) | 15 (57.7) | 8 (38.1) |
| b) Private shops | 4 (14.8) | 1 ( 3.8) | 5 (23.8) |
| c) Last year's product | 9 (33.3) | 10 (38.5) | 8 (38.1) |
| d) Others | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) |
| Total | 27 | 26 | 21 |

( Unit : Persons(%)) continued

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Number of seed distribution center (total answers = 50) | | | |
| a) Sufficient | 1 ( 6.3) | 8 (47.1) | 10 (58.8) |
| b) Insufficient | 15 (93.8) | 9 (52.9) | 7 (41.2) |
| Total | 16 | 17 | 17 |
| Quantity of seed from center (total answers = 49) | | | |
| a) Sufficient | 4 (23.5) | 10 (58.8) | 11 (73.3) |
| b) Insufficient | 13 (76.5) | 7 (41.2) | 4 (26.7) |
| Total | 17 | 17 | 15 |

2) Fertilizer and Pesticides

More than 60% of the sampled cereal farmers don't use fertilizers for the cereal crop production due mainly to their high prices. Main supplier of fertilizers is cooperative societies and private shops but not the government centers. Farmers knowledge level about fertilization practices is generally low. Out of 44 farmers only 6 persons answered that they had sufficient knowledge about fertilization. About 40% of the farmers don't use pesticides because of their high prices. Pesticides are mainly supplied by private shops. Most of the farmers believe that agro-chemicals are effective for better crop production but most of the chemicals are very expensive and some of them are not always available. Furthermore, quite a large number of farmers don't have proper knowledge on timing and methods of pesticides application.

Availability of Fertilizers and Pesticides

( Unit : Persons (%) )

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Do you use fertilizers? (total answers = 58) | | | |
| a) Yes | 6 (31.6) | 5 (25.0) | 9 (47.4) |
| b) No | 13 (68.4) | 15 (75.0) | 10 (52.6) |
| Total | 19 | 20 | 19 |
| Do you use pesticides? (total answers = 59) | | | |
| a) Yes | 8 (40.0) | 14 (70.0) | 8 (42.1) |
| b) No | 8 (40.0) | 6 (30.0) | 8 (42.1) |
| c) Sometimes | 4 (20.0) | 0 ( 0.0) | 3 (15.8) |
| Total | 20 | 20 | 19 |

3) Water Sources

Approximately three quarter of sample farmers depend on rain water as main water source for their cereal production. Most farmers in these 3 areas don't utilize well water for the crop production because of government restrictions. Regarding surface water sources such as dams and springs, most of Karak farmers don't have any such sources, while many farmers in Dhiban and Tafila have such water sources for their cereal production.

Availability of Water

( Unit : Persons (%) )

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Main water source for cereals (total answers = 69) | | | |
| a) Rainfall | 18 (69.2) | 20 (95.2) | 15 (68.2) |
| b) Surface water | 8 (30.8) | 0 ( 0.0) | 5 (22.7) |
| c) Underground water | 0 ( 0.0) | 1 ( 4.8) | 2 ( 9.1) |
| Total | 26 | 21 | 22 |
| Do you have surface water source? (total answers = 58) | | | |
| a) Yes | 10 (50.0) | 1 ( 5.0) | 12 (66.7) |
| b) No | 10 (50.0) | 19 (95.0) | 6 (33.3) |
| Total | 20 | 20 | 18 |

4) Agricultural Land

The percentage of cereal farmers who have uncultivated land is higher in Karak and Tafila areas and comparatively lower in the Dhiban area. The main reasons for having uncultivated land are the extremely high cost for the land preparation and joint ownership (musha'a) in Dhiban and Karak areas. About 70% of the sample farmers have musha'a land and the main reason for not dividing the land is the large expenditure of money which will be necessary to divide their land. The main reason for the decrease in arable land and land degradation is unavailability of water in the area. About 25% of the Tafila farmers pointed out that the other important cause of the land degradation is soil erosion.

Availability of Land

( Unit : Persons (%) )

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Do you have uncultivated land? (total answers = 59) | | | |
| a) Yes | 7 (35.0) | 14 (70.0) | 12 (63.2) |
| b) No | 13 (65.0) | 6 (30.0) | 7 (36.8) |
| Total | 20 | 20 | 19 |
| Reasons for not cultivating the land (total answers = 43) | | | |
| a) Musha'a | 2 (28.6) | 7 (31.8) | 0 ( 0.0) |
| b) Unsuitable | 1 (14.3) | 4 (18.2) | 4 (28.6) |
| c) High expenditure | 4 (57.1) | 7 (31.8) | 8 (57.1) |
| d) Far away from house | 0 ( 0.0) | 4 (18.2) | 2 (14.3) |
| e) Others | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) |
| Total | 7 | 22 | 14 |

( Unit : Persons (%) )continued

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Do you have Musha'a land? (total answers = 56) | | | |
| a) Yes | 11 (61.1) | 16 (80.0) | 12 (66.7) |
| b) No | 7 (38.9) | 4 (20.0) | 6 (33.3) |
| Total | 18 | 20 | 18 |
| Reasons for not dividing the land (total answers = 71) | | | |
| a) Many partners | 2 (11.1) | 11 (33.3) | 7 (35.0) |
| b) High expenditure | 7 (38.9) | 14 (42.4) | 9 (45.0) |
| c) Government regulation | 9 (50.0) | 8 (24.2) | 4 (20.0) |
| d) Others | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) |
| Total | 18 | 33 | 20 |
| Reason for the land degradation (total answers = 91) | | | |
| a) Erosion | 2 ( 7.4) | 7 (21.2) | 8 (25.8) |
| b) Cultivation methods | 6 (22.2) | 7 (21.2) | 6 (19.4) |
| c) Unavailability of water | 19 (70.4) | 19 (57.6) | 17 (54.8) |
| d) Others | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) |
| Total | 27 | 33 | 31 |

5) Supporting system

More than 65% of the sampled cereal farmers are interested in the agricultural broadcasting programmes by various mass media. A half of them think that these programmes are not so useful because broadcasting time is not suitable for farmers and also programmes are sometimes not well understood by farmers. Although most farmers get extension services, many of them are not satisfied with the current services and need these extension services to be improved. For the improvement of the services, the number of extension agents should be increased and more visits by extension agents to each farm are required.

Availability of Extension Services

( Unit : Persons (%) )

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Do you need extension services? (total answers = 58) | | | |
| a) Yes | 19 (95.0) | 17 (85.0) | 14 (77.8) |
| b) No | 1 ( 5.0) | 3 (15.0) | 4 (22.2) |
| Total | 20 | 20 | 18 |
| Are extension services available? (total answers = 59) | | | |
| a) Yes | 16 (80.0) | 13 (65.0) | 13 (68.4) |
| b) No | 4 (20.0) | 7 (35.0) | 6 (31.6) |
| Total | 20 | 20 | 19 |

( Unit : Persons (%) )continued

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Are extension services useful? (total answers = 59) | | | |
| a) Yes | 5 (25.0) | 5 (25.0) | 4 (21.1) |
| b) No | 13 (65.0) | 13 (65.0) | 12 (63.2) |
| c) Sometimes | 2 (10.0) | 2 (10.0) | 3 (15.8) |
| Total | 20 | 20 | 19 |
| Reasons for ineffective services (total answers = 59) | | | |
| a) Unavailability of agent | 6 (42.9) | 13 (44.8) | 4 (25.0) |
| b) Limited visit of agent | 8 (57.1) | 12 (41.4) | 8 (50.0) |
| c) Advice is not useful | 0 ( 0.0) | 4 (13.8) | 4 (25.0) |
| d) Others | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) |
| Total | 14 | 29 | 16 |

(3) Fruit Farmers

1) Fertilizer and Pesticides

About 85% of the sampled fruit farmers use fertilizers for their fruit production. Main reason for not using fertilizers is very high prices of them. Most farmers in Dhiban and Tafila purchase their fertilizers from private shops, while in Karak mainly from cooperative societies. Their knowledge about fertilization practices seems more or less to be higher than those of the cereal farmers. About 80% of sample farmers use pesticides for their fruit production. The main reason for not using pesticides is the very high price of them. Most pesticides are supplied by both private shops and cooperative societies. Most chemicals are available but all the farmers suffer from very high prices of chemicals and about a half of the farmers also suffer from the lack of knowledge on the application of practices.

Availability of Fertilizers and Pesticides

( Unit : Persons (%) )

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Do you use fertilizers? (total answers = 58) | | | |
| a) Yes | 17 (89.5) | 19 (95.0) | 14 (70.0) |
| b) No | 2 (10.5) | 1 ( 5.0) | 3 (15.0) |
| c) Sometimes | 0 ( 0.0) | 0 ( 0.0) | 3 (15.0) |
| Total | 19 | 20 | 20 |
| Do you use pesticides? (total answers = 60) | | | |
| a) Yes | 18 (90.0) | 15 (75.0) | 14 (70.0) |
| b) No | 2 (10.0) | 4 (20.0) | 3 (15.0) |
| c) Sometimes | 0 ( 0.0) | 1 ( 5.0) | 3 (15.0) |
| Total | 20 | 20 | 20 |

2) Water sources

Almost a half of the sampled fruit farmers depend on rain water for the fruit cultivation and the other half depend on various types of surface water. Farmers depend on underground water are very few. Because the utilization of wells in the area is regulated by the government, around 70% of the farmers utilize certain type of surface water such as dams and springs for their fruit production.

Availability of Water

( Unit : Persons (%) )

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Main water sources for cereals (total answers = 72) | | | |
| a) Rainfall | 7 (35.0) | 12 (46.2) | 14 (53.8) |
| b) Surface water | 12 (60.0) | 14 (53.8) | 10 (38.5) |
| c) Underground water | 1 ( 5.0) | 0 ( 0.0) | 2 ( 7.7) |
| Total | 20 | 26 | 26 |
| Do you have surface water source? (total answers = 60) | | | |
| a) Yes | 12 (60.0) | 15 (75.0) | 13 (65.0) |
| b) No | 8 (40.0) | 5 (25.0) | 7 (35.0) |
| Total | 20 | 20 | 20 |

3) Agricultural land

More than 60% of the sampled fruit farmers have uncultivated land and the main reason for that is the high expenditure for land preparation. About 50% of sample farmers (85% in Karak) have musha'a land and the main reason for not dividing the land is a large expense which is necessary to divide the land. Various reasons such as urbanization, fragmentation of holdings and the unavailability of water were raised as a cause for the decrease of arable land.

Availability of Agricultural Land

( Unit : Persons (%) )

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Do you have uncultivated land? (total answers = 59) | | | |
| a) Yes | 8 (40.0) | 18 (90.0) | 12 (60.0) |
| b) No | 12 (60.0) | 2 (10.0) | 8 (40.0) |
| Total | 20 | 20 | 20 |
| Reasons for not cultivating the land (total answers = 49) | | | |
| a) Musha'a | 2 (18.2) | 0 ( 0.0) | 1 ( 7.1) |
| b) Unsuitable | 1 ( 9.1) | 10 (41.7) | 4 (28.6) |
| c) High expenditure | 7 (63.6) | 10 (41.7) | 7 (50.0) |
| d) Far away from house | 1 ( 9.1) | 4 (16.7) | 2 (14.3) |

( Unit : Persons (%) )continued

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| e) Others | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) |
| Total | 11 | 24 | 14 |
| Do you have Musha'a land? (total answers = 59) | | | |
| a) Yes | 7 (35.0) | 17 (85.0) | 8 (42.1) |
| b) No | 13 (65.0) | 3 (15.0) | 11 (57.9) |
| Total | 20 | 20 | 19 |
| Reasons for not dividing the land (total answers = 50) | | | |
| a) Many partners | 5 (45.5) | 11 (40.7) | 3 (25.0) |
| b) High expenditure | 3 (27.3) | 13 (48.1) | 6 (50.0) |
| c) Government regulation | 3 (27.3) | 3 (11.1) | 3 (25.0) |
| d) Others | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) |
| Total | 11 | 27 | 12 |
| Reasons for land degradation (total answers = 95) | | | |
| a) Erosion | 2 ( 7.1) | 5 (14.7) | 8 (24.2) |
| b) Cultivation methods | 8 (28.6) | 14 (41.2) | 9 (27.3) |
| c) Unavailability of water | 18 (64.3) | 15 (44.1) | 16 (48.5) |
| d) Others | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) |
| Total | 28 | 34 | 33 |

4) Supporting system

About 80% of the sampled fruit farmers are interested in the agricultural broadcasting programmes by various mass media and most of them are satisfied with the programmes. More than a half of the farmers did not get any extension services and many farmers are not satisfied with the current services. Most farmers require better extension services by increasing the number of extension agents and the visit frequency.

Availability of Extension Services

( Unit : Persons (%) )

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Do you need extension services? (total answers = 59) | | | |
| a) Yes | 16 (80.0) | 20 (100.0) | 17 (89.5) |
| b) No | 4 (20.0) | 0 ( 0.0) | 2 (10.5) |
| Total | 20 | 20 | 19 |
| Are extension services available? (total answers = 60) | | | |
| a) Yes | 9 (45.0) | 6 (30.0) | 13 (65.0) |
| b) No | 11 (55.0) | 14 (70.0) | 7 (35.0) |
| Total | 20 | 20 | 20 |
| Are extension services useful? (total answers = 52) | | | |
| a) Yes | 7 (35.0) | 2 (14.3) | 6 (33.3) |
| b) No | 13 (65.0) | 9 (64.3) | 8 (44.4) |
| c) Sometimes | 0 ( 0.0) | 3 (21.4) | 4 (22.2) |
| Total | 20 | 14 | 18 |

( Unit : Persons (%) )continued

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Reasons for ineffective services (total answers = 53) | | | |
| a) Unavailability of agent | 7 (43.8) | 7 (36.8) | 5 (27.8) |
| b) Limited visit of agent | 8 (50.0) | 12 (63.2) | 8 (44.4) |
| c) Advice is not useful | 1 ( 6.3) | 0 ( 0.0) | 5 (27.8) |
| d) Others | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) |
| Total | 16 | 19 | 18 |

(4) Animal Husbandry Farmers

1) Feed

Main feed used by animal husbandry farmers are hay and grains harvested from their own land. Subsidized feed is available only at the government distribution centers and most of the farmers are obliged to purchase animal feed from the government centers. The purchasing procedure of animal feed at the center is rather complicated and not satisfactory for farmers because they usually have to wait for a long time and also the availability of the feed is not always assured. Most of the farmers don't utilize green fodder due mainly to unavailability of water and land to grow fodder crops.

Availability of Animal Feed

( Unit : Persons (%) )

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Main feed source (total answers = 106) | | | |
| a) Hay and grains | 15 (45.5) | 15 (44.1) | 18 (46.2) |
| b) Green fodder | 0 ( 0.0) | 0 ( 0.0) | 1 ( 2.6) |
| c) Public grazing land | 8 (24.2) | 6 (17.6) | 10 (25.6) |
| d) Unharvested product | 3 ( 9.1) | 6 (17.6) | 7 (17.9) |
| e) Others | 7 (21.2) | 7 (20.6) | 3 ( 7.7) |
| Total | 33 | 34 | 39 |
| Reason for not using green fodder (total answers = 111) | | | |
| a) No land to grow | 15 (38.5) | 17 (39.5) | 10 (34.5) |
| b) No seeds of fodder | 3 ( 7.7) | 3 ( 7.0) | 2 ( 6.9) |
| c) High cost for seeds | 5 (12.8) | 4 ( 9.3) | 2 ( 6.9) |
| d) Unavailability of water | 16 (41.0) | 19 (44.2) | 15 (51.7) |
| e) Others | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) |
| Total | 39 | 43 | 29 |

2) Grazing

Approximately 50% of the animal farmers in these 3 areas have no public grazing area near their farms. The grazing areas far from their farms is not fully utilized because of insufficient water supply for the animals. Only 25% of the sample farmers have water sources in their remote grazing area such as water

pools, springs and wells. Many farmers have to transport water by tanker to their grazing areas in spite of high transportation charges.

Availability of Grazing Land

( Unit : Persons (%) )

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Do you have grazing area near the farm (total answers = 59) | | | |
| a) Yes | 10 (50.0) | 8 (40.0) | 10 (52.6) |
| b) No | 10 (50.0) | 12 (60.0) | 9 (47.4) |
| Total | 20 | 20 | 19 |
| Water supply in far grazing area (total answers = 22) | | | |
| a) Sufficient | 2 (33.3) | 4 (57.1) | 3 (33.3) |
| b) Insufficient | 4 (66.7) | 3 (42.9) | 6 (66.7) |
| Total | 6 | 7 | 9 |

3) Water supply

Pipes and tankers are the main sources of water for animals in general. But in Tafila naturally stored water in depressions is one of the important water sources. About three quarter of the sample farmers suffer from the shortage of water for animals. Wells are available only for some of the farmers and in many cases those wells are not fully utilized due to the government restriction.

Water Sources for Animals

( Unit : Persons (%) )

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Main water source for animals (total answers = 108) | | | |
| a) Well | 1 ( 3.1) | 1 ( 2.4) | 5 (14.3) |
| b) Pond | 6 (18.8) | 7 (17.1) | 5 (14.3) |
| c) Pipe | 7 (21.9) | 19 (46.3) | 2 ( 5.7) |
| d) Tank | 15 (46.9) | 11 (26.8) | 11 (31.4) |
| e) Spring | 1 ( 3.1) | 0 ( 0.0) | 1 ( 2.9) |
| f) Natural pool | 2 ( 6.3) | 3 ( 7.3) | 11 (31.4) |
| g) Dams | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) |
| h) Others | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) |
| Total | 32 | 41 | 35 |

4) Animal Diseases

In case of animal diseases, most of the farmers go to the veterinary centers. But in Karak area, the number of veterinary centers is not sufficient. Most of the farmers have difficulty in getting medication and the prices of the medication is very expensive in both veterinary centers and private hospitals. The survey result also showed that the facilities available at the veterinary center were comparatively better in Tafila area than

the other two areas. Specially about free medication, most of the farmers in Dhiban and Karak areas are not satisfied with the situation.

Availability of Veterinary Services

( Unit : Persons (%) )

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Are veterinary centers available? (total answers = 60) | | | |
| a) Yes | 16 (80.0) | 8 (40.0) | 17 (85.0) |
| b) No | 4 (20.0) | 12 (60.0) | 3 (15.0) |
| Total | 20 | 20 | 20 |
| Are veterinary doctors available? (total answers = 41) | | | |
| a) Yes | 10 (62.5) | 5 (62.5) | 15 (88.2) |
| b) No | 6 (37.5) | 3 (37.5) | 2 (11.8) |
| Total | 16 | 8 | 17 |
| Is free medication available? (total answers = 41) | | | |
| a) Yes | 1 ( 6.3) | 0 ( 0.0) | 10 (58.8) |
| b) No | 15 (93.8) | 8 (100.0) | 7 (41.2) |
| Total | 16 | 8 | 17 |

5) Marketing

Generally animal farmers sell their products almost evenly to whole sellers, friends and retailers. Their dairy and wool products tend to be sold to their friends, while their meat products are mainly sold to whole sellers and retailers.

Marketing of Animal Products

( Unit : Persons (%) )

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Market outlet of dairy products (total answers = 74) | | | |
| a) Friends | 13 (50.0) | 12 (50.0) | 10 (41.7) |
| b) Whole seller | 10 (38.5) | 9 (37.5) | 3 (12.5) |
| c) Retailer | 3 (11.5) | 1 ( 4.2) | 11 (45.8) |
| d) Middle man | 0 ( 0.0) | 2 ( 8.3) | 0 ( 0.0) |
| Total | 26 | 24 | 24 |
| Market outlet of meat products (total answers = 51) | | | |
| a) Friends | 2 (22.2) | 4 (19.0) | 5 (23.8) |
| b) Whole seller | 5 (55.6) | 7 (33.3) | 5 (23.8) |
| c) Retailer | 0 ( 0.0) | 4 (19.0) | 11 (52.4) |
| d) Middle man | 2 (22.2) | 6 (28.6) | 0 ( 0.0) |
| Total | 9 | 21 | 21 |
| Market outlet of wool products (total answers = 64) | | | |
| a) Friends | 12 (54.5) | 10 (50.0) | 9 (40.9) |
| b) Whole seller | 5 (22.7) | 7 (35.0) | 4 (18.2) |
| c) Retailer | 3 (13.6) | 1 ( 5.0) | 8 (36.4) |
| d) Middle man | 2 ( 9.1) | 2 (10.0) | 1 ( 4.5) |
| Total | 22 | 20 | 22 |

6) Processing

Most of the farmers in 3 areas process their products within their farms due to an insufficient number of processing factories. Only few farmers utilize processing machines such as wool cutting machines, butter and cheese processing machines. The products are made by hand in most cases.

Processing of Animal Products

( Unit : Persons (%) )

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Places to process products (total answers = 46) | | | |
| a) Factory | 0 ( 0.0) | 0 ( 0.0) | 0 ( 0.0) |
| b) Farm | 12 (85.7) | 12 (70.6) | 15 (100.0) |
| c) Others | 2 (14.3) | 5 (29.4) | 0 ( 0.0) |
| Total | 14 | 17 | 15 |
| Are there processing factories? (total answers = 60) | | | |
| a) Yes | 1 ( 5.0) | 0 ( 0.0) | 1 ( 5.0) |
| b) No | 19 (95.0) | 20 (100.0) | 19 (95.0) |
| Total | 20 | 20 | 20 |

7) Supporting system

Only about 15% of animal farmers think that the agricultural education by mass media is useful and the others don't appreciate. The main reason of the low usefulness is that the programme is not dealing with the actual problems which will be really important for farmers. More than 90% of the sample farmers need the services of extension agents. In Dhiban and Karak areas most of the farmers don't get enough extension services. But in Tafila, about 80% of the farmers are satisfied with the extension services. The main reason of insufficient extension services pointed out by farmers in Dhiban and Karak is insufficient visiting frequency of extension agents to the farms and many farmers think that the advice given by the extension agents are not useful.

Availability of Extension Services

( Unit : Persons (%) )

| | Dhiban | Karak | Tafila |
|---|---|---|---|
| Usefulness of agricultural program (total answers = 57) | | | |
| a) High | 3 (15.0) | 2 (10.0) | 3 (17.6) |
| b) Medium | 4 (20.0) | 4 (20.0) | 9 (52.9) |
| c) Low | 13 (65.0) | 14 (70.0) | 5 (29.4) |
| Total | 20 | 20 | 17 |
| Are extension services available? (total answers = 54) | | | |
| a) Yes | 8 (44.4) | 1 ( 5.6) | 14 (77.8) |
| b) No | 10 (55.6) | 17 (94.4) | 4 (22.2) |
| Total | 18 | 18 | 18 |

## 5. AGRICULTURAL PRODUCTION

### 5.1 Crop Production

#### 5.5.1 Planted Areas

Planted areas by crops in the highland area of Amman, Karak and Tafila Governorates were summarized as below based on the crop production data of the Ministry of Agriculture during 1981 and 1987 (Table D.5.1). The major crops planted in these Governorates are field crops such as wheat and barley. Field crop area covers about 85% of the cropped area in both Karak and Tafila Governorate, while in Amman Governorate field crop area covers only 75% of the cropped area. Tree crop area covers around 12% of the cropped area in every relevant governorate. Area covered by vegetable crop is more than 10% of the cropped area in Amman Governorate, while in the other two Governorates it is only a few percents. Olive and grape are the main fruit trees and tomato is the main vegetable crop.

Planted Areas by Crops in Related Governorates

| | Amman Governorate | | Karak Governorate | | Tafila Governorate | |
|---|---|---|---|---|---|---|
| | (ha) | (%) | (ha) | (%) | (ha) | (%) |
| Field Crops | 41,097.6 | 76.9 | 17,323.5 | 87.0 | 5,219.5 | 84.0 |
| Wheat | 22,404.2 | 41.9 | 11,768.4 | 59.1 | 3,278.6 | 52.8 |
| Barley | 11,463.5 | 21.5 | 3,905.7 | 19.6 | 1,345.7 | 21.7 |
| Others | 7,230.0 | 13.5 | 1,649.4 | 8.3 | 595.2 | 9.6 |
| Tree Crops | 6,622.7 | 12.4 | 2,157.9 | 10.8 | 828.0 | 13.3 |
| Olive | 3,195.4 | 6.0 | 883.2 | 4.4 | 491.6 | 7.9 |
| Others | 3,427.3 | 6.4 | 1,274.7 | 6.4 | 336.4 | 5.4 |
| Vegetables | 5,690.9 | 10.7 | 422.4 | 2.1 | 164.9 | 2.7 |
| Total | 53,411.2 | 100.0 | 19,903.8 | 100.0 | 6,212.4 | 100.0 |

Remark: Average from 1981 to 1987
Source: Ministry of Agriculture

Planted areas by crops in the priority areas were also summarized as below based on the results of farm interview survey. Farmers in Dhiban area concentrate on the cultivation of wheat rather than barley as field crop compared to the average figures in Amman Governorate. Although Abyad area belongs to Karak Governorate, areas for tree crops and vegetables are very limited compared to the average figures in Karak Governorate.

Planted Areas by a Farm Household

| | Dhiban Area | | Abyad Area | | Tafila Area | |
|---|---|---|---|---|---|---|
| | (ha) | (%) | (ha) | (%) | (ha) | (%) |
| Field Crops | 6.5 | 79.3 | 24.2 | 96.8 | 14.1 | 90.4 |
| Wheat | 6.0 | 73.2 | 17.3 | 69.2 | 6.3 | 40.4 |
| Barley | 0.2 | 2.4 | 6.6 | 26.4 | 7.5 | 48.1 |
| Others | 0.3 | 3.7 | 0.3 | 1.2 | 0.3 | 1.9 |
| Tree Crops | 0.9 | 11.0 | 0.8 | 3.2 | 1.2 | 7.7 |
| Olive | 0.6 | 7.3 | 0.2 | 0.8 | 0.8 | 5.1 |
| Others | 0.3 | 3.7 | 0.6 | 2.4 | 0.4 | 2.6 |
| Vegetables | 0.8 | 9.8 | 0.0 | 0.0 | 0.3 | 1.9 |
| Total | 8.2 | 100.0 | 25.0 | 100.0 | 15.6 | 100.0 |

Remark: Average area per one farmer
Source: Farm interview survey by the study team

Cropping periods are generally affected by the seasonal distribution of rainfall, and the planted areas fluctuate year by year, depending on rainfall. In the highland area of Amman, Karak and Tafila Governorates, the cultivation of crops under rainfed condition is concentrated in the winter season, while irrigated crops (vegetables) are generally planted in the both seasons.

The present cropping pattern in and around the priority areas is illustrated in Fig. D.5.1. In general, most of field crops such as wheat and barley are sown from November to January and are harvested from June. With exception of olives, mixed culture of fruit tree crops is the common practice in the study area.

### 5.5.2 Crop Production

Study Area

The crop production and yield in Amman, Karak and Tafila Governorates are shown in Table D.5.1 to D.5.3. Wheat and barley yields showed wide annual fluctuations. Average yield of wheat per ha for the period 1981-1987 was 770 Kg for Amman, 670 Kg for Karak and 780 Kg for Tafila Governorate. Wheat yield is generally higher than barley yield. Average yields of lentil and chick pea were higher in Tafila Governorate. Yields are determined mainly by the timing and amounts of rainfall and much fluctuates due to erratic rainfall. Growing of wheat and barley is risky industry and the farmers don't apply fertilizers and chemicals to them in most cases.

Planted areas of fruit crops showed constant increase during

1981-1987 in every related governorate. Olive and grape yields also fluctuated annually. Average yields of these crops were higher in Tafila Governorate than the other two governorates. While the average yields of fig, pomegranate and citrus were higher in Amman Governorate. Since apple production is very limited in Karak Governorate, the high average yield might not reflect the actual situation.

Planted areas of vegetables also fluctuated year by year and more various kinds of vegetable crops are cultivated in Amman Governorate than the other two governorates. Generally the yield of most vegetables have been increasing during 1981-1987 specially tomatoes and water melons. There are no major yield differences among 3 governorates.

Priority Areas

In three priority areas (Dhiban, Abyad and Tafila), there is no published information on crop production. These were therefore estimated on the basis of the data obtained from above three governorates and the results of farm interview survey. The estimated production is as follows, and the details of yields are shown in Table D.5.4.

| Crops | Priority Areas (Dhiban, Abyad and Tafila) | | |
|---|---|---|---|
| | Area/1 (ha) | Yield/2 (Kg/ha) | Production (tons) |
| Wheat | 26,100 | 600 | 15,700 |
| Barley | 12,800 | 600 | 7,700 |
| Olive | 600 | 2,000 | 1,200 |

/1 According to the farm interview survey, the area of wheat accounted for about 67% of total field crops, and the remaining 33% was barley. Vegetables, chick peas and other tree crops as grape and apricot have been cultivated, but they are negligibly small (see Table D.5.5).

/2 The yields were estimated on the basis of the data of Karak and Tafila and the results of farm interview survey (see Tables D.5.6 and D.5.7).

As shown in the above table, the yields of wheat and barley are very low as compared with that national average in 1987 (920 and 730 Kg/ha). In the priority areas these crops have been cultivated even in the area less 200mm of annual rainfall. According to the farmers, the good yield of 1,000 - 1,500 Kg per ha is possible only twice or three times during every 10 years, and the remaining years are less than 300 Kg or no yield. The cultivation of wheat and barley is not only for obtaining foods but also for feeding livestock.

### 5.5.3 Farming Practices

Field Crops

Wheat and barley are grown extensively under a rainfed condition, as mentioned earlier. These are sown normally in November after sufficient rainfall, and harvested in June and July.

In Jordan hard wheat (Triticum durum L) is mainly grown. Their main varieties are traditional Hourani Nawawi, F-8 and Hourani 27. Quality seed distribution has been improved by the JCO certified seed distribution project. According to the information from spot surveys, about 50% of the seeds are annually replaced by farmers. Mixture of local varieties are commonly used for barley growing. Beside these, Deir Alla 106 and ACSAD 176 are mainly used as the identified varieties.

Plowing is done normally by a disc plow drawn by a tractor. In hilly areas, animal plowing is practiced. Sowing is carried out by hand broadcasting. Weeding after sowing is rarely done. The plowing consists of deep plowing and shallow plowing (soil covering of seed). The period of deep plowing has been taken wide range from just after harvesting to before seeding period, while the shallow plowing has been done under the beginning of rainfall season. According to the farm interview survey, the peak requirement of plowing occur at this shallow plowing period in November and December, and the farmers cannot sown in suitable period due to insufficient mechanical power.

Combine harvesting is adopted in flat areas, while in steep areas, manual harvesting is practiced. Custom services of plowing and harvesting are undertaken by JCO and private companies but their availability is not always sufficient, particularly at the peak season.

Fruit Tree Crops

There are no large fruit gardens more than 100 ha except gardens in Aina, Tafila City and Ain sara, which have been developed based on the large springs. Old fruit gardens are mostly developed using spring water. Some new gardens has been expanding under drip irrigation using deep wells. Old fruit gardens are operated extensively investing a few farm inputs.

The main variety of olive is Nabali. Others of less importance are Nasohi, Barouni, Grossardi and Mansanila. Grape in Jordan is the table grape. Main varieties are Ajlouni, Salti, Halwani, and Balout.

Weeding is made by hand on around the tree trunks. Mechanized plowing is found only in large gardens. Fertilization is carried out mostly using animal manure. Training and pruning of the trees are seldom carried out except some regenerative pruning for old trees and staking for young trees. Wind breaks are rarely observed except government gardens. Plant protection is rarely carried out for olive and grape. Fungal diseases such as monilia and mildew are rarely observed. Some insects such as lice and Scarabeoides damage olive trees causing fruit losses but

to a negligibly small extent.

### 5.5.4 Crop Budgets

The crop budget analysis for each crop grown in the priority areas was made on the basis of the data and information obtained from agricultural offices and the farm interview surveys. The results of analyses are presented in Table D.5.8, and are summarized below.

(Unit : JD/ha)

| Crops | Gross Income | Production Cost | Net Income | |
|---|---|---|---|---|
| | | | Excluding Family Labor Cost | Including Family Labor Cost |
| Wheat | 84 | 130 | -46 | 31 |
| Barley | 54 | 126 | -72 | 5 |
| Olive | 510 | 393 | 117 | 100 |
| Grape | 675 | 567 | 108 | 270 |
| Apricot | 990 | 495 | 495 | 700 |
| Apple | 868 | 319 | 549 | 680 |
| Vegetables/1 | 1,236 | 1,380 | -144 | 336 |

/1 Average of tomatoes, water melon, cauliflower, etc.

The net income of wheat and barley are negligible due to extremely low yields, while the fruit trees and vegetables have a good balance. In the budget analysis of wheat and barley, a value as the grazing land is not included. In general, the farmers pay a grazing fee of 5 JD/ha for grazing livestock in the field of wheat and barley.

As a results of crop budget analysis, it can be said that the cultivation of wheat and barley has been carried out in the marginal zone in financial viewpoint. If these yields will decrease less than 0.4 tons/ha, the balance will have a deficit condition, as shown below.

| Yields (ton/ha) | 0.6 | 0.5 | 0.4 | 0.3 |
|---|---|---|---|---|
| Wheat (JD/ha) | | | | |
| - Gross Income | 84 | 70 | 56 | 42 |
| - Production cost | 130 | 130 | 129 | 128 |
| - Net Income | | | | |
| Excluding F.L./1 | -46 | -60 | -73 | -86 |
| Including F.L. | 31 | 17 | 4 | -9 |
| Barley (JD/ha) | | | | |
| - Gross Income | 54 | 45 | 36 | 27 |
| - Production cost | 126 | 126 | 125 | 125 |
| - Net Income | | | | |
| Excluding F.L. | -72 | -81 | -89 | -98 |
| Including F.L. | 5 | -4 | -12 | -20 |

/1 F.L. : Family labour cost

## 5.2 Livestock Production

Animal industry is more important economically than crop industry in the study area. The main livestock is sheep and goats (see Table D.5.9). Chicken is also important. According to the 1983 National Village Survey, livestock population per farm household in Karak old Governorate was estimated at 14 for sheep, 12 for goats, 242 for chicken. Sheep and goats are grazed in natural range or field crop areas after their harvesting using crop residues.

The rangelands is often plowed even with steep slopes and barley is sown to increase the fodder production resulting in acceleration of soil erosion and decrease in soil fertility. Due to insufficient grass production from rangelands concentrated fodder such as barley, bran and sorghum are given supplementally. When annual rainfall exceeds 400mm, the farmers can feed their animal more than 6 months on the public rangelands. But if the rain falls below 200mm/year, the farmers can feed only 3 to 4 months on the public rangelands.

Since natural rangelands should provide the main forage source with the animals, this area must be cared and improved to raise its productivity. Specially the narrow strip area with an average annual rainfall of 120-250mm, where the dominant vegetation is Artemisia herba-alba, will be the best potential area with a possibility to raise its carrying capacity several times if the suitable methods of improvement and protection were applied.

Alfalfa and berseem are considered as the main green forages. The production of these crops are extremely limited because these crops are mainly cultivated in the irrigated areas with artisan wells.

The rough dry forages such as straws of wheat, barley, lentil and vetch are important feed sources for animals in the study area. Almost the same quantity of straw as grain is estimated to be produced by cereal production. The straw of legumes such as lentil and vetch is considered richer in nutrition than wheat and barley straw. Residues of field crops after harvesting is also important feed source for animals. The estimated yield per dunum is about a half of its yield of straw. The animals are grazed in the field directly after harvesting.

Barley is considered as a main crop of forage cereals. But the cropped area and the yield fluctuate year by year according to the timing and amount of rainfall as mentioned earlier. Bran as a residue of food industry is one of the important part of concentrated feeds. It is added to the forage to enrich the feed value.

There are 2 main breeds of sheep in the study area, i.e. Awassi and Najdi. Awassi has a small fat tail white wool and a black or brown head. Najdi has a long tail and black wool.

Most of Awassi sheep are the locally mixed breed of Najdi and the other kind. Such crossing made the Jordanian Awassi sheep tolerable against hard environmental conditions. Awassi sheep is

good producer of milk if good nutritional conditions are provided. Najdi sheep are black sheep of middle size with long tails that touch ground surface, but their numbers are limited.

In general, the average liveweight of a sheep is about 50Kg. Mating season is normally June to July. Average birth rate of ewe is about 56%/year. Lambs are sold at 3 to 4 month old having a liveweight of 20 to 25 Kg.

The main goat breed in the study area is Baladi. Shami breed brought from Syria for improvement of meat and milk production is also exists. Baladi goat is the local tough breed being able to live with little care. Goat meat is consumed mostly locally. Shami goat is characterized with its high milk production and is mostly kept in village compounds fed supplemented feeds.

Main diseases of animals are:

a) Anthrax
b) Brucellosis
c) Cowpox
d) Intestinal parasite
e) Mastitis
f) Ethrotoximia

Veterinary service of Agricultural Directorates is insufficient in manpower and facilities including transport means. Lambs are sold alive at farms. Sheep/goat milk is generally self-consumed by farmers.

On the basis of farm interview survey, the livestock production per one flock (100 heads) of sheep and goats was estimated as follows.

| | | |
|---|---|---|
| Mortality | | 9 % |
| Delivering rate | | 56 % |
| - Selling of live sheep and goats | (heads) | 13 |
| - Selling of lambs and kids | (heads) | 47 |
| - Wool | (Kg) | 85 |
| - Milk | (Kg) | 1,850 |
| (Yogurt) | (Kg) | 227 |
| (Milk oil) | (Kg) | 111 |

Lactating period: 3 months

The livestock grazed in and around the priority areas are mainly sheep and goats. The income of one flock (100 heads of sheep and goats)/2 is estimated as follows, and the details are shown in Table D.5.10.

| | | |
|---|---|---|
| 1) Gross Income | | 3,040 |
| - Live sheep and goats | 13 heads | 460 |
| - Lambs and Kids | 47 heads | 1,410 |
| - Wool | 85 Kg | 60 |
| - Yogurt | 227 Kg | 550 |
| - Milk oil | 111 Kg | 560 |
| 2) Production cost | | 2,200 |
| 3) Net Income | | 830 |

/2 Including some lambs and kids for raising.

The feeding of concentrates such as sorghum, barley and bran is common among the farmers. The quantity in total per one flock is 13.9 tons/year. Annual income derived from livestock raising is significant for the farm economy. As far as livestock raising in the area is concerned, it plays an important role not only in farmers' economy but also in protein food supplies for local people.

It is considered that there is no big deference for the balance of livestock raising between the priority areas and the study area.

## 6. PAST AND EXISTING SOIL AND WATER CONSERVATION PROJECTS

There are the following 7 projects relating to the soil and water conservation in Jordan.

a) Development of Rangelands and Meat Production Project
b) The Highland Development Project
c) Hamad Basin Development Project
d) Zarqa River Basin Project
e) Range Rehabilitation in the Eastern Low Rainfall Area of Jordan, Lajjun Area of Karak Range (Lajjun Range Rehabilitation Project)
f) Experiment on Water Harvesting by University of Jordan
g) Experiment on Water Harvesting by NCARTT

### 6.1 Development of Rangelands, and Meat Production Project (The Fodder Shrub Planting Project)

Jordan is increasingly dependent on imports to meet the demand for meat, which rose from 6,600 tons in 1975 to about 42,500 tons in 1984 (carcass weight), representing almost 94% of all red meat consumed in the country, in spite of her potentialities to support livestock development in the country. The low development of the potentialities can be attributable to range degradation, which was caused mainly by the following reasons.

(a) the low, erratic and uncertain rainfall, and high temperatures,
(b) shortened rest period of ranging by modern transport of animals and permanent availability of water,
(c) fire-wood collection through uprooting of trees and shrubs,

shrubs,
(d) ploughing of steppe rangelands for grain production
(e) urban expansion and desert encroachment over agricultural land and rangelands

In this context, FAO World food Programme (WFA) has been assisting the Jordan Cooperative Organization (JCO) since 1980 aiming at finding effective ways and means to improve productivity of rangelands, promote forage production and encourage fattening of lambs thereby increasing red meat production and limiting the imports.

The following 3 activities were adapted.

i) Range management

Food rations are distributed as an incentive to cooperative members labourers of the Ministry of Agriculture to plant and maintain Atriplex plantations. JCO planned to develop about 6,000ha of leased government, while the Department of Forestry and Soil Conservation (DFSC), the Ministry of Agriculture (MOA) planned about 13,700ha of government land. The range management has been implemented satisfactory to date. In April 1989, 12,650ha of the rangelands was grazed for 1 to 2 weeks by 63,000 heads of sheep. In October 1989, 11,350ha of the rangelands was opened for 2 to 4 weeks for 39,000 heads of sheep. The sites selected covered a part of highland ranges within 100 to 250mm isohyets in the areas of Ma'an, Amman, Irbid, Madaba, Karak, Tafila and Mafraq.

ii) Fodder production

Wheat is distributed as an incentive to farmers to convert their marginal land from a cereal/fallow rotation to cereal/legumes cycle. In a 3-year pilot project (1981-1984), 2,250ha were planted with forage legumes. In the expansion phase of the project from 1983/84 to 1986/87 6,000ha of land was planned to be planted with forage legumes, but only 46% of the target was attained by 1984/85 because of the insufficient rainfall and of the insufficient development in technology for the legume production. In the 2nd phase of the expansion of the project this activity was omitted.

iii) Lamb fattening

Wheat was supplied to the Jordan government by WFP to make a revolving fund, which has been used as a short-term loans for the purchases of lamb and forages by farmers belonging to cooperatives where fattening has been carried out. Between 1981 to 1987, about 6,000 tons of wheat was given by WFP making a revolving fund of JD 397,000. Individual loans not exceeding JD 600 per fattening cycle for no more than 20 sheep were expected in the project.

The Project was reviewed by a WFP/FAO mission in October 1985. The followings are the recommendations made by the mission on the range management, which is most concerned with the present

study.

1. At the beginning of operations on each range the eventual method of exploitation should be decided upon and the future users identified. In the case of cooperative ranges, there is no problem but for ranges developed by the Forest and Range Management Department (experimental areas excepted) the range should be for the use of the neighbouring graziers and not given to semi-public companies. Suitable grazing rules should be established for each range and fees charges to cover running and maintenance costs. Ranges should be handed over within a period not exceeding four years after planting.

2. At the outset of development operations on any range a working plan should be established, with a simple map, probably a scale of 1:10000 for most ranges. A provisional grazing programme should be prepared as part of the plan. A simple recording system of inputs, used in conjunction with the plan, will provide much valuable information for costings of other similar ranges.

3. Planting of fodder shrubs should be limited to areas of deep soil, to old arable land within the range and to denuded areas. Good rangelands with an adequate cover of palatable species should not be systematically planted with shrubs just to reach a target. Very poor soils where shrubs are unlikely to succeed should also be avoided.

4. Different species of shrub should not be mixed within a plot in order to avoid subsequent management difficulties. Areas should be planted at one time, young patches should not be mixed with old.

5. While Atriplex nummularia is suited to quite a wide range of conditions, a much greater selection of varieties and species is required to suit the various ecological niches within the ranges.

6. Smaller, hardier seedlings should be produced, this should lead both to savings in the nursery and a better success in the field. Wherever possible seedlings supplied for fodder production should be from selected varieties of known palatability and fodder quality. Close cooperation is required between the Range management specialists and the nursery.

7. Attention must be paid to the grazing of the various shrubs, in the case of the larger Atriplex (A. nummularia and A. halimus). Controlled grazing must begin early enough to give the plant a bushy shape suitable for grazing by small ruminants. Long grazing time is necessary on this type of pasture. If concentrate supplements are to be fed to flocks grazing on Atriplex then they should be given in the evening and not in the morning before the flock goes out to graze.

8. Careful estimation of the probable mean annual rainfall and minimum temperatures should be made for prospective sites, both through study of the nearest data and of the vegetation present on the site.

9. An expansion of the middle-echelon staff dealing with range and management is necessary since the exploitation phase will require more staff with more varied skill than does the "improvement" phase. In-service training of existing staff is likely to prove the most satisfactory way of achieving this.

10. In order to help service the expansion and intensification of small-ruminant production within the project area which will result from the range improvements it will be necessary to reinforce the veterinary services, so that they can cope with the increased demand for prophylactic, diagnostic and curative work.

11. In order to implement the recommendations on working plans, selection of a wider range of species and varieties, better seed for nursery use and on in-service training, the services of a Range Management specialist is required. Applications should be presented to multilateral of bilateral agencies for the financing of such an expert for at least 3 years.

12. Control of grazing intensity should be by limiting the time which the herd has access to the pasture. The actual duration of the grazing period should be determined by inspection by the field staff and the stock removed before the range

## 6.2 The Highland Development Project

This project has been implemented since 1965 by the Ministry of Agriculture with technical and financial support from FAO through WFP. The project aims principally at soil and water conservation by construction of stone walls and by planting fruit (mainly olive) and forest tree in hilly areas which has been severely affected by soil erosion. Farmers with an area of 0.4 ha to 5 ha, a land slope between 8 and 30 degrees, and rainfall at least 250mm/year can get food materials with free of charge after their construction of stone walls, contour furrows, or fences. As the end of August, 1987, 7,600ha been covered with this project with 5,500 farmers and 3,000 sites. In Karak/Tafila regions, the following acreage, sites and farmers have been covered.

| | No. of Farmers | No. of Sites | Average |
|---|---|---|---|
| Karak | 269 | 109 | 297ha |
| Tafila | 108 | 47 | 173ha |

The project has been extended several times and between 1990 and 1994, 15,000ha will be covered benefiting about 7,500 farmer in Jordan. The followings are the recommendations for the project in March, 1989. Only recommendations related to present study were listed. It is suggested that planting holes(pits) for olives be ammended to 70m*70m*70m.

1. It is proposed to plant double line windbreaks to protect orchards from excessive wind damage. Extension agents should only advise the planting of windbreaks on two boundaries of the farm to protect the trees from the effects of prevailing winds.

2. It is suggested that for the construction of new cisterns extension agents give more emphasis to the correct construction of run-off channels to increase the efficiency of the collection system.

3. It is proposed that all new farm roads in areas with heavy soils should be adequately compacted and that side drainage channels be excavated to ensure adequate removal of surplus drainage water.

4. It is proposed that a land use plan be prepared for the project according to the agro-climatic zones in the project areas. A land resources evaluation survey is required in order to provide data on land suitability for different fruit trees, taking into consideration the economic returns of the various crops and their marketing potential.

5. It is suggested that earth crescents be introduced for water harvesting on deep soils with slopes of more than 12%. These crescents are required to promote the early establishment of trees by conserving water in the root zone, particularly during dry periods.

6. It is suggested that all beneficiaries who have previously grown cercals on their land registered with the Project should receive an annual wheat allocation of 250kg/ha/annum for planting olives and fruit trees, as partial compensation for loss of income. The allocation should be given annually, for a period of 4 years, beginning after tree establishment has been completed.

7. As a means of preventing damage to stored commodities, it is suggested that nets should be attached to all warehouse windows to prevent bird entry.

8. To facilitate the checking of balances of existing stocks in warehouses, cards which indicate the current stock situation should be prepared for each warehouse and kept up-to-date by the manager of the store.

9. Since the main objective of the WFP-assisted project is to increase the revenue of the poorer farmers through a combination of soil conservation works and fruit tree planting, the mission recommends that:

- The total land owned by the farmer should not exceed 5 ha. However, this figure is indicative and necessary flexibility should be applied with regard to both marginal land and high yielding land.

- The maximum area eligible for WFP assistance per farmer should not exceed 2.5 ha. However in low productivity lands this area could reach 3 ha. In cases of partnership, the maximum area could be 5 ha.

- The appraisal of an individual project request should include special attention to off-farm income. This income should not exceed 10,000 JD per household per ha.

- Farmers assisted by the project should live in the village and should be mainly involved in agriculture. Verification of these conditions should be obtained from the village Moukhtar.

- The farmer's cash expenditure for reclaiming and planting one hectare of land should not exceed 700 JD and is considered essential in order to focus WFP assistance on farmers who can only afford a minimum of mechanized work.

- When determining the regional distribution of project sites, priority should be given to remote and poor rural areas, provided that the technical selection criteria can be met. With regard to the distribution of project activities between the northern, central and southern regions of the highlands, an attempt should be made to increase the share of the south from presently 12 percent to 25 percent of the total project sites.

10. While the mission is aware of the fact that the weakness of the extension services is not specific to the WFP-assisted project, it is recommended that the extension component be re-inforced both from the staffing point of view as well as with regard to the logistics side.

11. It is suggested that a viable integration of livestock husbandry and fruit tree cultivation can be achieved in some areas where climate and soil conditions are favourable for fodder crop production. Several suitable species of fodder crop are available and can be grown in most climatic areas. It appears likely that, in the initial stages, only those beneficiaries who already own animals will undertake the planting of fodder crops for livestock feeding.

12. It will be necessary for animal sheds of a minimum size of 8x4x2 m to be constructed and used during the winter months for feeding, lambing of calving and for protection from winds and low temperatures. These sheds should be of a design and size appropriate to the type and number of animals being housed. A fenced area of at least 12x8 m will also be necessary for daytime exercise.

13. A review mission should be carried out after a period of two years, in order to ascertain the implementation of the current recommendations and the progress achieved.

6.3 Hamad Basin Development Project

This project covers about 166,000$m^2$ of Arab Badia areas lying between Jordan, Syria, Iraq and Saudi Arabia, in which, 36,700$km^2$ corresponds to nearly one fifth of the total Hamad Basin is shared by Jordan. The project is the integrated rural development designed to improve the livelihood of the people in the basin by exploiting the natural resources, increasing the animal stick, and providing the basic human needs such as health and educational facilities. The project started in 1987 with the 1st phase. Rweishid pilot scheme covering an area of 750,000ha. The scheme extends along Amman-Baghdad main road under the average rainfall of 70-80mm/year. the soils are generally loamy sand covered by small gravel layer. The population of bedouins and semi bedouins was estimated at 2,880 for 1987.

The scheme includes 6 components. i.e.

1) Surface water development programme

   a) Construction of 8 small reservoirs (cistern) with a capacity of 50,000 - 100,000 $m^3$, each 0.5 MCM in total.

   b) Construction of earth dams with a total capacity of 4 MCM.

2) Ground water development programme

   a) Drilling 2 exploration deep bure wells with more than 800m depth.

   b) Drilling 2 shallow wells with less than 400m depth to provision safe water for man and livestock, with 50,000 - 100,000 $m^3$/year.

3) Range development programme

   a) Revegetation of about 5,000ha of poor range through water-harvesting and water spreading techniques.

   b) Revegetation of about 1,000ha through contour lines operation which captures and holds run-off water.

   c) Plantation of edible drought-resistant shrubs for regeneration of the plant cover in some selected pilots in above areas.

4) Range management and sheep improvement programme

   a) Improvement in management of natural range of about 180,000ha by reintroducing the concept of controlled grazing management in replacement of the destructive

uncontrolled open range utilization to increase range productivity to about 12,500 tons which feeds about 12,500 animal heads.

b) Establishment of sheep fattening center. In order to induce effective off-take of grazing awasi sheep from the range lands. The annual capacity will be about 13,000 in the second year and will increase to 39,000 in full stage.

5) Essential services programme

The programme aims to strengthen the existing services and create new ones in the Al-Ruwashid, this programme includes:

a) Build up 3 schools for different educational stages

b) Create cooperative, training, extension and research and different purposes communities branches.

c) Establishment settlements range center including houses for staff.

6) Wind energy utilization programme

This programme aims to generating electricity and pumping water in pilot areas.

The total cost for proposed plan of action be about US$ 11 million (JD 3.6 million). Arab fund loan of US$ 5.25 million (JD 1.5 million), the government contributions will be US$ 5.75 million.

## 6.4 Zarqa River Basin Project

The project covers 83,600ha in the Lower Zarqa river catchment area. The altitude of it varies between 150 and 1,000m. Average annual rainfalls are 200mm/year in the eastern part and over 500mm/year in the western part of the project area. The population in the area estimated in 1987 was 170,000 of which 52% live in 3 palestinian refugee camps. Rural population in the area amounts to 5,700 farm families. The main objectives of the project are to curb the accelerated soil erosion and to stabilize the income of the rural population to safeguard the production potential and to reduce the siltation into the reservoir of the King Talal Dam. The project has 3 components. i.e.

1) On-farm development on the private land excluding private forests

a) Safe land use
b) Construction of soil conservation structures
c) Improvement in farming techniques and management

2) Forestry and Range Development on the government land and private forests

3) River Banks Protection along the Zarqa river

This sub-project aims at the protection of valuable irrigated land along the Zarqa river against floods by a combination of structural and vegetative measures, and also at reducing siltation into the reservoir of the King Talal Dam.

The project started implementation in 1986 and will end in 1993. The total project cost was estimated at JD 32 million.

6.5 Lajjun Range Rehabilitation Project

This project covers about 5,000ha of governmental land in Lajjun area in Karak governorate. The annual rainfall is between 100 and 250mm. The long-term objective of the project is to establish a model operation project for rehabilitation of degraded rangelands in the low rainfall area. The short-term objectives are:

1) Rehabilitation of rangelands of 5,000ha through improvement in density and composition of the vegetative cover and through prevention of soil erosion.

2) Increase in marketed output of animal leading to decrease in rural poverty and

3) Promotion of the interest of local people in the rehabilitation effort through membership of mutually equitable societies.

The project has been implemented since 1985 under the assistance of the United Nations Environmented Programme, Arab gulf Programme for United Nations Development Organization and USAID.

The project has the following components. i.e.

1) Base line ecological and socio-economic survey of the Karak eastern lands;

2) Rehabilitation of vegetative cover (Lajjun project area):

   a) Expansion of MOA nurseries to supply additional Atriplex and other grazing species.

   b) Seed determination and collection.

   c) Selection of water harvesting methods.

   d) Fencing of area to be reseeded.

   e) Mechanically-assisted reseeding with water harvesting and soil conservation works-in stages.

   f) Reseeding of cultivated land to provide additional grazing/fodder for livestock, increase food production and combat soil erosion.

3) Training of technicians and range management specialists:

   a) Fellowships for post graduate education of project personnel.

   b) On site farmer education.

4) Organization of mutually beneficial cooperative formula for access to land, marketing of products and provision of services.

## 6.6 Experiment on Water Harvesting by University of Jordan

The experimental site is 30km southeast of Amman, 14km east of Muwaqar village and covers about 200ha of governmental land. The climate is arid with an annual rainfall of 100-200mm. The mean annual air temperature is 17 degree centigrade. Annual absolute maximum and minimum temperatures are 41 and -3 degree centigrade respectively. The site has an undulating topography. Soils are calcarious with a carbonate content of 20-70%, and deep with effective depth of more than 1m.

The objectives of the experiment are to:

1) Introduce economical-easy-to-execute agricultural practices suitable for areas receiving annual precipitation of 100-200mm.

2) Develop means to effectively utilize surface water for various agricultural activities.

3) Improve soil fertility and preserve soil productivity using local inputs.

4) Improve natural plant cover by preserving existing species and introducing new varieties adaptable to the local environment.

5) Select and introduce crops suitable to the local environment.

6) Test appropriate farming systems for areas suffering from desertification.

7) Determine most efficient land use by evaluating the actual agricultural potential.

The experiment was started in 1985 and will end in 1991. significant data have been accumulated to support the hypothesis that the agriculture using surface water is possible even in arid areas with an annual rainfall of 100-200m applying micro-catchments, contour furrows, winter irrigation utilizing water from small ponds etc.

## 6.7 Experiment on Water Harvesting by NCARTT

The experiment is being carried out in collaboration with the Arab Center for the Study of Arid Zones and Dry Lands (ACSAD) since 1985 in 20ha private land 6km northwest of Balama village. The experimental site has an average annual rainfall of 180mm. The land is not necessarily satisfactory for farming with relatively shallow soils, high gravel/rock contents and steep slopes (3-15%). Objective of the experiment is to study the feasibility of the various water harvesting techniques such as microcatchments, level terraces and roaded catchments, and that of check dams and ponds. Pistachios, olives, almonds and apricots are being tested. According to the information from a engineer in charge Mr. Shammunt the microcatchments are very effective in growing fruit trees in the area. The experimental site had been used for grazing. Very limited areas had been devoted for barley production but its yields were negligibly small. It can be said that the site has become productive land by introduction of water harvesting techniques even under the adverse soil condition.

# 7. BASIC CONCEPT OF THE AGRICULTURAL DEVELOPMENT

## 7.1 General Backgrounds

The study area is characterized as the least developed area in the country due mainly to unfavorable natural conditions, scarcity of population, insufficiency of infrastructures, etc. According to the Household Expenditure and Income Survey in 1986/87, average annual household income of the Karak/Tafila governorates in 1986/87 was JD 2,188, which as equal to 63% of the natural average and to 48% of Amman.

The regional economy is much dependent on the service sector which covered 37 % of GRDP in 1985. Agricultural sector accounted for 10% of GRDP.

Agriculture in the study area is not necessarily endowed with natural resources. However, considering the facts that substantial parts of inhabitants earn their major parts of income from agriculture including livestock and vast land are still left under-utilized, the potential of agricultural development would be much larger than the other sectors.

## 7.2 Constraints on the Agricultural Development

Low productivity of the agricultural production is the fundamental constraint of the agriculture in Jordan resulting in large inflow of agricultural produce from abroad. This trend will be accelerated by the reduction in agricultural subsidies and relaxing of import restriction of agricultural produce by the government.

The followings are thought to be the main factors for the low productivity.

1) Low and unpredictable rainfall

Crops like field crops in the study area dependent on rainfall without using stored water in ponds and dams are much susceptible to low and erratic rainfall in the area. Improved capital-intensive technology packages recommended for field crops by the government have not yet been substantially adopted by the farmers due to high risks involved.

2) Insufficient agricultural extension services

Agricultural extension services to farmers are insufficient in terms of manpower, facilities (vehicles) and messages (technical, marketing, management). There are only 17 extension workers in Karak/Tafila governorate. Extension workers don't have specified vehicles for the extension services. Twenty seven cars (sedan, pick-up) are jointly used by 291 personnel of the agricultural offices in both governorate. There are no leaflets on crop or animal husbandry for the distribution to farmers in the agricultural offices. Some technical leaflets are personally owned by the officers.

3) Fragmentation of agricultural land, joint ownership and farm absenteeism

Equal inheritance of land among heirs causes land fragmentation to small parcels and joint ownership of the land worsen the efficiency of farm machinery and farm management. Farm absenteeism associated with the land fragmentation and higher income in non-agricultural sectors lessens the motivation of landowners for higher farming productivity. Sustained improvement in soil fertility and long term investment in agriculture such as fruit tree growing which need long non-bearing periods are difficult to be anticipated in tenant farming.

4) Government restriction of the usage of groundwater/river runoff for irrigation

Due to the scarcity of water resources in the country the government of Jordan regulates its water use giving the priority to the municipal water supply and industry. Thus, the new irrigation development in the study area is strictly controlled and the new large irrigation development using ground water or wadi water is virtually prohibited.

In addition to the main constraints mentioned above, the following problems could be pointed out:

a) High wage of Jordanian agricultural labourers and instability in supply of seasonal foreign agricultural labourers.

b) Relative shortage of agricultural labor and insufficiency of agricultural machinery services especially in the period of the land preparation.

c) Insufficiency in improved public range-lands.

d) Difficulty in procurement of agricultural inputs such as seeds, fertilizers, and agro-chemicals in time and at reasonable prices.

## 7.3 Development Opportunities

### (1) Under-utilized Water and Land Resources

The project area (Karak-Talifa Regions) has extensive under-utilized arable land and under-utilized water resources. About 9% of the area i.e. 75,800ha, has been left abandoned even being arable land due mainly to the existence of more profitable job opportunities in the oil producing countries in Gulf and due to low productivity of agriculture in the project area. In the three priority areas with a total area of 136,000 ha, the following agricultural potential areas were identified through the land use study. Expansible area was calculated by deducting rock covered areas from non-farmland. In view of potential assessment of land resources, the expansible area excluding shallow soils (< 50cm deep) are summarized below.

(Unit: 1,000ha)

| Annual Rainfall(mm) | Land Slope (%) | | | | |
|---|---|---|---|---|---|
| | 0-8 | 8-12 | 12-30 | 30 < | Total |
| Dhiban | | | | | |
| 300-200 | 0.1 | 0.2 | 0.3 | 0.0 | 0.6 |
| 200-100 | 5.9 | 1.4 | 1.3 | 0.2 | 8.8 |
| Abyad | | | | | |
| 300-200 | 0.1 | 0.1 | 0.0 | 0.0 | 0.2 |
| 200-100 | 7.1 | 1.8 | 0.7 | 0.2 | 9.8 |
| Tafila | | | | | |
| 300-200 | 0.2 | 0.8 | 3.7 | 0.7 | 5.4 |
| 200-100 | 0.1 | 0.3 | 0.9 | 0.2 | 1.5 |

About 70% to 80% of the rainfall is estimated to be lost by evaporation from soil surface leaving about 5% for river run-off and about 35% to 15% for groundwater recharge. There are much room for utilization of the present-evaporated water for agricultural production.

### (2) Water Harvesting Techniques

Crops can thrive even under meager rainfall, say 100mm/yr, when the meager rainfall is collected sufficiently for growing. This method is called water harvesting and its adaptability to arid climate is successfully demonstrated in many countries like Pakistan, Kenya, Afghanistan, Burkina Faso, Morocco, etc. In Jordan also, the water harvesting is successfully demonstrated in experiments by Jordan University of the Ministry of Agriculture. Some progressive farmers in Jordan are adopting this technique commercially and get enough returns.

Runoff coefficient becomes larger for smaller watershed but too small watershed causes smaller runoff coefficient. The peak runoff coefficient of as high as 41 percent was obtained for a watershed of $500m^2$ in the case of 12mm rainfall in a country with similar climatological conditions.

When deep soil, say, more than 1.0m, is guaranteed, a rainfall of 100mm/yr can keep a fruit tree with conditions i.e.: a watershed is $500m^2$; water consumption by a fruit tree is $13m^3/yr$; and runoff coefficient is 41 percent. Artificial watersheds covered by embankments can prevent soil erosion and can conserve rain water. The water harvesting will increase agricultural production such as of fruit trees, forage crops making use of extensive under-utilized land and rainfall in the project area. The water harvesting technique includes microcatchments, contour furrows, check dams and weirs etc.

(3) Superiority of Agriculture in Economic Recession

The economic boom in the gulf countries have ceased due to over-supply of petroleum in the world markets. The Jordan economy which is much dependent on Gulf economy through export of labor forces and commodities has been experiencing severe economic recession since late 1980s. Generation of job opportunities for returning labourers as well as for young generation is the urgent issues to be solved. Improvement of the trade balance and financial deficit is also the priority problems for the country.

Agriculture has a characteristic of subsistence relieving financial burden of the government and has more capacity to absorb labour forces than other economic sector in Jordan in this economic conditions using under-utilized land and water resources.

(4) Low Self-sufficiency in Food and Development Priority Given to Agriculture

Apart from the above facts, considering the self-sufficiency in staple foods in Jordan is considerably low of about 20%, and the exportation of some horticultural crops contribute to the foreign currency earning, the Government has given its development priority to the agricultural sector in a consecutive national development plans and devoted a substantial share of the development budget to the agricultural sector. Furthermore, some water harvesting development projects such as rangelands development and the highland development project have already been launched in the study area.

## 7.4 Development Strategy

(1) Objectives

Taking the development constraints and opportunities into account, the following objectives of the project were formulated.

1) To increase the agricultural production, productivity and income making full use of natural under-utilized

and income making full use of natural under-utilized resources such as rainfall and land.

2) To conserve basic agricultural resources such as soils and water.

3) to generate new job opportunities in the rural areas through increase in agricultural production.

(2) Strategies

The strategies of the agricultural development in the Karak-Tafila region were set as follows:

1) Application of water harvesting measures, such as microcatchments, contour furrows, contour bands winter irrigation (runoff farming) to agricultural production.

2) Introduction of deep rooted crops such as fruit trees and fodder shrubs to the water harvesting project.

3) Encouragement of farmers to participate in the water harvesting development projects through the provision of enough agricultural supporting services by the government.

4) Promotion of the fodder shrub plantation with water harvesting measures under the initiative of cooperations.

## 8. AGRICULTURAL PRODUCTION PLAN

### 8.1 Crop Production Plan

#### 8.1.1 Development Area

The crop production plan will be realized through the development of water harvesting, check dams and winter irrigation.

Water Harvesting

Based on the land use guideline proposed in Annex C and the basic concept of the development target expansible development areas are 1,314ha for wheat/barley, 9,682ha for fruit trees, 7,462ha for fodder shrub and 3,645ha for mixture of barley, forage legume and fodder shrubs as shown below.

Development Area by Water Harvesting

(ha)

| | Wheat/barley | Fruit trees | Fodder shrub | Mixture(*) |
|---|---|---|---|---|
| Dhiban | 141 | 6,430 | 1,424 | 0 |
| Abyad | 192 | 3,151 | 5,689 | 0 |
| Tafila | 981 | 101 | 362 | 3,645 |
| Total | 1,314 | 9,682 | 7,462 | 3,645 |

Remark (*): barley, forage legume, fodder shrub.

Check Dams

The following area will be developped by check dams based upon the landuse guideline proposed in Annex C.

Development Area by Check Dams

| Priority Areas | Plantable Area(ha) |
|---|---|
| Dhiban | 29 |
| Abyad | 28 |
| Tafila | 36 |
| Total | 93 |

Winter Irrigation

As discussed in the chapter 3, Annex E, the following sites were selected as the appropriate sites for the winter irrigation scheme.

| Site | Name of Wadi |
|---|---|
| E-1 | Zabda |
| D-2 | Laban |
| J-1 | Khaur |
| Abyad | Sultan |

8.1.2 Proposed Crops

(1) Fruit Trees

The main technology proposed in the present project for fruit tree cultivation are check dam and water harvesting such as micro catchments. The prerequisite characteristic of crops suitable to check dam and the water harvesting is deep rooting, which can make easily use of stored water in the soil even in dryer season i.e. summer. Fruit trees and fodder shrubs are appropriate crops having deep rooting systems. Some field crops showed good results in the water harvesting experiments in other countries but the practical application of the water harvesting techniques to field crops in Jordan needs some actual trials and assurance.

Definite kinds of crops proposed were finally selected based on the crop performances shown in experiments in Muwaqar by the Jordan University, NCARTT experiments in Balama, experiments in Sapha by Ministry of Agriculture and others in Negev, Arizona, Mexico etc.

The following fruit trees showed good performances and seem to be suitable among others for check dam and the water harvesting projects.

- Olives
- Apricots
- Pistachio
- Grapes
- Apples
- Almonds

Olives are the most recommendable crop for its high drought resistance and good marketability in the future, followed by grapes and apricots.

As shown in Table D.8.1, figs, plums, pomegranates, which have shown good performance in water harvesting experiments in other countries would present problems in marketing in the future.

(2) Field Crops

Field crop development was proposed for winter irrigation and the common rainfed cropping. Winter irrigation utilizing weirs needs rather heavy investments and thereby needs intensive cultivation to recover the investments and also needs winter growing crops to make use of the winter rainfall as much as possible.

Wheat was selected as the most suitable crop for winter irrigation and for the common rainfed cropping because wheat:

a) is grown in winter, in which most parts of the rainfall concentrates,

b) is assured of a marketing outlet and a price by the government, and

c) is the main source of the staple food for the local population as well as urban population.

Lentils, vetch and chickpeas are harvested by hand and their harvesting is drudgery abhorred by labourers resulting in low productivity. There are no suitable harvesting machines for these crops. Without mechanized harvesting and government protection against imported ones, growing lentil, vetch and chickpeas could not be attractive for farmers.

### 8.1.3 Proposed Cropping Pattern and Farming Practices

No specific cultivation method will be applied to the projects. Common cultivation methods recommended by the government will basically be applied to the projects.

(1) Fruit Trees

Olives, grapes and apricots were selected as the representative fruit trees.

Seedling

Seedlings of the fruit trees are available at government nurseries. There are 6 government nurseries producing seedlings including budded and grafted ones. Other 5 government nurseries also produce both fruit seedlings and forestry seedlings.

Planting density

Planting density of the fruit trees was determined based on the water balance study. i.e. crop water requirements. vs. rainfall. The crop water requirements were estimated based on the modified Penman method recommended in "Crop Water Requirements", FAO irrigation and drainage paper No.24. Swaqa climatic observation station was selected as the representative area for the crop water requirement because it has the similar climate as in the project areas proposed in the present study and because it is observing solar radiation which is the necessary parameter for Penman method. The results of the estimation are given in Table D.8.2. Annual crop water requirements were estimated at 948mm for olives, 1,055mm for grapes and 1,320mm for apricots. Runoff coefficient was estimated at about 35% taking the rather small catchment size of the individual basins into consideration. In Nagev which has similar loess soils to those in the project area, the runoff coefficient of 41% was observed in a catchment area of $500m^2$ and rainfall 12mm. The conservative figure of 35% was taken.

Planting density is estimated as follows. Detailed calculations are shown in Tables D.8.3&4.

Planting Density for Water Harvesting

(plants/ha)

| Annual Rainfall | Olives | Grapes | Apricots |
|---|---|---|---|
| 100 - 150 (mm) | 5 | 44 | 3 |
| 150 - 200 (mm) | 6 | 61 | 5 |
| 200 - 250 (mm) | 8 | 79 | 6 |

Planting Density in Check Dam

(plants/ha)

| Annual Rainfall | Olives | Grapes | Apricots |
|---|---|---|---|
| 100 - 150 (mm) | 286 | 2500 | 286 |
| 150 - 200 (mm) | 286 | 2500 | 286 |
| 200 - 250 (mm) | 286 | 2500 | 286 |

Considering the good performances in experiments in Balama and Sapha, microcatchments might be best suited for fruit growing. Definite suitable methods of water harvesting should be decided based on experiments. A water collecting basin should be 5m x 5m x 0.5m to collect enough runoff for fruit growing. A planting hole should be 70cm x 70cm x 70cm to promote early rood development which will encourage early bearing. The basins and holes will be dug roughly by a tractor plow and final shaping will be done by hand. Humus and phosphorus fertilizer should be

applied in the pit. Collector channels for rainfall will also be made by a tractor plow and will be shaped by hand. Fences will be necessary to protect fruit trees from domestic animals and wild animals. A fence of 4m x 4m made of barbed wire and iron poles will be constructed for the individual plants. In the initial 2 years after planting, most trees will require at least 40 liters / tree per month to ensure establishment and root development.

Varieties

The following varieties might be recommendable.

a) Olive

| | |
|---|---|
| Nabali: | For oil extraction, yellowish than Rasseii, |
| Rasseii: | For oil extraction and pickling, yellow oil, originate in Tafila |
| Carotin: | Italian originate for oil extraction, disease/insect resistant, drought resistant. frost susceptible |
| Mansonella: | For pickling, big fruit. |

b) Grapes

| | |
|---|---|
| Adjlouni: | Table grapes, early maturing local variety |
| Salti: | - ditto - |
| Halwani: | Table grapes, late maturing local variety, red variety |
| Hamburg-Muscat: | Large fruit, black, imported, early maturing |

c) Apricots

Self-sterility is the common characteristic of apricots. Mixed planting of different varieties is necessary. Hamawi (Syria) and Angrska (French) varieties are recommendable.

Pruning

Pruning should be started form the 3rd year after planting to get good aeration, to let sunshine reach inside branches and leaves and to allow easy crop husbandry. Pyramidal shape of crown will be suitable for olives and apricots. Pruning to control water consumption by the plants might be necessary. Pruning will be done from November to December.

Fertilization

There are no definite guidelines for fruit tree fertilization except olives. According to a leaflet for olive growing produced by the Ministry of Agriculture, the following amount are recommended for the full development stage of the plants. Fertilizations for other fruit crops were determined making reference of Japanese standards and others.

Fertilization at Full Development Stage

| | Olives | Grapes | Apricots |
|---|---|---|---|
| N (kg/plant) | 0.53 | 0.16 | 0.63 |
| $P_2O_5$ (kg/plant) | 0.45 | 0.14 | 0.38 |
| $K_2O$ (kg/plant) | 0.75 | 0.28 | 0.50 |

Chemical fertilizers will be applied from December to January.

Plant protection

There are no serious insect pests and diseases against olives favored by dry and harsh climate in the project areas. Regular spraying of chemicals might not be necessary for olives. When insect pests like olive fruit fly are found an insecticide should be sprayed. Fungus diseases are very rare for olives.

For grapes and apricots, regular spraying of chemicals will be necessary against vine mildew, grape worms, fruit fly, and wood borers. Cu compound and malathion should be applied. Spraying should done from June to July.

Harvesting

Manual harvesting will be adopted. Olive fruits will be packed in jute bags. Grapes and apricots will be packed in styrofoam boxes. Olive will be harvested from mid October to mid December. Grapes and apricots will be harvested from July to September.

(2) Field Crops

Wheat will be grown for the common rainfed cropping and for the winter irrigation project. Various cultivation trials under the winter irrigation have not been tried. So definitely suitable methods should be decided after field tests. For the common rainfed cropping of wheat the recommended practices by the government will basically be followed. In the areas with slopes of 8-12%, wheat cultivation in tied contour furrows in combination with the stone walls or the earth banks should be tried. But actual extension of this method to farmers should be done after the assurance in experiments.

Land preparation

The first plowing should be done by chisel plows with plowing depth of about 15cm 2-4 weeks after the harvest of the preceeding crops. The 2nd plowing would be done also chisel plows during September and October before sowing.

Sowing

Seed should be drilled with fertilizers at a rate of about 80 kg seed/ha and $_4$20 kgDAP(21:11:0)/ha for the winter irrigation

and 80 kg seed/ha and 90 kgDAP/ha for the common rainfed cropping in November. Sowing depth will be 6 to 8cm. Hourani 2, Hourani Nawawa, ACSAD 65 varieties might be suitable. Definitive suitable varieties should be decided after actual fields tests under winter irrigation.

Weed control

Weeds should be controlled basically by tillage practices such as plowing and survived weeds should be controlled by chemicals such as 2.4-D. 2.4-D should be applied after emergence of weeds.

Harvesting

Harvesting can be undertaken by JCO machinery service centers or by private custom services.

### 8.1.4 Crop Yields and Crop Budgets

There are no data on yields of fruit trees under check dam and water harvesting techniques in Jordan. On-going experiments on water harvesting by Jordan University at Muwaqar or by NCARTT at Balama have not yet reached the fruit bearing stage. Wheat yield by the winter irrigation was measured only in the experiment of Jordan University. According to the information from a professor in charge, the wheat yield was 3.5 ton/ha with fertilization of 88/kg N/ha and 63kg $P_2O_5$/ha. In a conference on decertification in 1977, Nairobi, a wheat yield of 3.5 ton/ha under pumped winter irrigation was also reported from a case in Negev. Wheat yield by the common rainfed cropping was estimated at 1.8 ton/ha based on the JCO seed project record.

Expected yields of fruit trees by check dam and the water harvesting methods were estimated by referring to the yields under the Highland Development Projects (renamed as Development of the Highland Agricultural Regions by WFP), which is applying the similar soil and water conservation measures to areas with an annual rainfall of more than 250mm and land slopes of more than 8%. Expected yields of crops were given in the following table.

Expected Yields

(kg/plant, ton/ha)

| | Years after planting | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1-3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13-15 |
| Olives | 0 | 0 | 0 | 2.3 | 3.1 | 6.5 | 8.5 | 12.2 | 13.0 | 18.0 | 20.8 |
| Grapes | 0 | 1.1 | 2.1 | 3.1 | 3.5 | 3.7 | 3.8 | 4.0 | 4.3 | 4.6 | 4.7 |
| Apricots | 0 | 0 | 6.8 | 11.9 | 15.2 | 18.6 | 22.3 | 26.2 | 29.2 | 31.5 | 32.4 |
| Wheat,irr. | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 |
| Wheat,rain | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 |

The expected economic lives of the fruit trees and the fodder shrubs are 70 years for olives, 15 years for grapes, 20 years for apricots and 30 years for Atriplex.

The additional crop production expected in the project was given in the following table.

Expected Annual Additional Crop Production
at the Full Development Stage of the Project

| Crops | | Scheme: Water Harvesting | Winter Irrigation | Check Dam | Rainfed Wheat | Total |
|---|---|---|---|---|---|---|
| Wheat, | Area(ha) | * | 33.9 | * | 270 | 303.9 |
| | Yield(t/ha) | | 3.5 | | 1.8 | |
| | Pro.(t) | | 119 | | 486 | 605 |
| Olives, | Area(ha) | 2,387 | 11.3 | 31 | | 2,879.3 |
| | Yield(kg/ha) | 104 | 5,949 | 5,949 | | |
| | Pro.(t) | 295 | 67 | 184 | | 546 |
| Grapes, | Area(ha) | 2,837 | 11.3 | 31 | | 2,879.3 |
| | Yield(kg/ha) | 207 | 11,750 | 11,750 | | |
| | Pro.(t) | 587 | 133 | 364 | | 1,084 |
| Apricot, | Area(ha) | 2,837 | 11.3 | 31 | | 2,879.3 |
| | Yield(kg/ha) | 97 | 9,266 | 9,266 | | |
| | Pro.(t) | 275 | 105 | 287 | | 667 |
| Atriplex, | Area(ha) | 4,480 | * | * | | 4,480 |
| | Yield(kg/ha) | 650 | | | | |
| | Pro.(t) | 2,912 | | | | 2,912 |
| Total area(ha) | | 12,990 | 33.9 | 93 | 270 | 13,386.9 |

Remark:*;not applied

The crop budgets estimated for the agricultural development were given in Tables D.8.4 to 11. The followings are the net benefits expected in the respective schemes.

Annual Net Benefit
at the Full Development Stage of the Schemes

(JD/ha)

| Crops | Scheme: Water Harvesting | Winter Irrigation | or Check Dam | Wheat Irri. | Wheat Rainfed |
|---|---|---|---|---|---|
| Wheat | * | 340 | 340 | | 162 |
| Olives | 20.0 | 1093 | * | | * |
| Grapes | 76.0 | 4869 | * | | * |
| Apricot | 26.0 | 2412 | * | | * |
| Atriplex | 13.0 | * | * | | * |

Remark:Asterisk(*) means non application in the project.

## 8.2 Livestock Development Plan

### 8.2.1 Development Area

Existing rangelands can be classified into the following two areas:

a) Unproductive areas with shallow soils of less than 50cm deep, not suitable to growing field crops of fruit trees, even endorsed with an annual rainfall of more than 200mm.

b) Unproductive areas with an annual rainfall of less than 200mm.

Fodder shrub development by water harvesting will implemented in areas with an annual rainfall of 100-200mm, a land slope of less than 12% and a soil depth of 50-100cm.

The areas meeting the above conditions in the priority areas are:

| | | |
|---|---|---|
| Dhiban | : | 1,424ha |
| Abiad | : | 5,689ha |
| Tafila | : | 349ha |
| Total | | 7,462ha |

### 8.2.2 Proposed Fodder Crops

Atriplex halimus (north african salt bush) and Atriplex nummularia (old man salt bush) will be grown by the water harvesting or by run off farming. Atriplex halimus is a native fodder shrub grown in the project areas and are the important feed source for sheep and goats. It has a self-seeding characteristic and can be expanded by sowing. Feed value of 4kg of Atriplex (fresh) species is equal to 1 feed unit.

Atriplex numularia is australian origin and more palatable than A. halimns to animal, but is not self-reseeding under the local condition. Once completely grazed, it can't regenerate.

### 8.2.3 Husbandry of Fodder Shrub

Land Preparation

A pit 1.5$m^2$ x 0.1m (depth) should be dug to retain runoff. According to the an experiment on microcatchments for production of Atriplex halimus in Negev from 1962 to 1968 showed a 32$m^2$ catchment produced the highest feed production (160 feed unit/ha/year) among other test plots covering from 16$m^2$ to 1,000$m^2$, under annual rainfall ranging from 30mm to 159mm. So the plot size of a micro catchment should be 32$m^2$. The land preparation should be done in summer or autumn.

Planting

Seedlings can be obtained from the government nurseries. Planting should be done when the pits have enough moisture. The planting time might be from December to February. Too big seedlings should shortened to about 35cm to save water consumption.

Browsing

Browsing should be started 3 years after planting and be done in summer or autumn to save the grazing pressure on the existing grazing land, because the main purpose of the growing of fodder shrub is to reserve grazing resource in drought months. Atriplex can be browsed twice a year with a 3.5 month interval.

Maintenance

Every 9 years, Atriplex should be renewed by cutting at a height of 30cm in winter.

### 8.2.4 Proposed Feeding and Management Methods

Rangelands development normally covers a large acreage, of which management is normally done by government organizations or farmers' cooperatives. Permanent management of the rangelands by the government organizations are thought to be unsuitable from the view point of productivity. But during the initial development stage, in which various risks are involved, the management should be done by the Ministry of Agriculture or Jordan Cooperative Organization. After stabilization of the management, farmers' cooperative societies should succeed the management.

Browsing of the fodder shrub should be allowed to farmers or Bedous in summer or autumn when animal feed is most deficient.

## 8.3 Afforestation Development Plan

### 8.3.1 Development Area

According to the land classification by slope class in the study area, more than 60% of the area has a slope greater than 8% and considerable part of such slope area is subject to continuous degradation. The results of farmer's opinion survey also shows that soil erosion is one of the serious cause of land degradation. Soil erosion is thus a major constraint against agricultural development in the study area and soil conservation measures should be studied in depth for the development planning.

Based on the proposed guideline for land use planning, steeper land with over 30% slope was defined as an area for afforestation and natural pasture. The area with the soil depth of more than 50 cm under 200 - 300 mm of annual rainfall and with the soil depth of more than 100 cm under 100 - 200 mm of rainfall was proposed for afforestation area. The rest of the area with over 30% slope was proposed for natural pasture.

According to the land development potential in each area, expansible development areas for forest are 34 ha and 683 ha in Dhiban and Tafila respectively. These area should be covered by forest for the effective conservation of soil and water.

Another important role of afforestation is windbreak for the improvement of field microclimate conditions in arid zone. Installation of windbreak forests around the farm land would be one of the most promising technique to be applied not only for evapotranspiration control in the field but also as a soil conservation measure. According to the meteorological data collected the strong north/west wind is prevailing in the study area and this would be one of the constraints for the healthy plant growth specially of new shoots and young seedlings. By installing windbreak forests around planted area, wind speed will be reduced and consequently evaporation and transpiration from soil surface and plant leaves will be prevented. At the same time windbreak forests will act as a soil conservation measure by preventing wind and water erosion. Establishment of windbreak forests around farm land is thus very important to provide mild microclimate conditions within fields for better plant growth and also to maintain the fertile soil against erosion loss.

At present, windbreaks are mostly used around the big farms, the government facilities and other industrial establishments. Windbreaks should be established by ordinary farmers starting from the perimeter of the farm land.

### 8.3.2 Proposed Trees

#### (1) Forest Trees

Since steeper land with over a 30% slope was defined as forest, soil and water conservation measure proposed for tree plantation will be forest gradoni. Forest gradoni can be applied for the area with slope between 5 and 50%, with rock outcrop 0-75% not only as soil and water conservation measure but also as water harvesting measure. Forest gradoni is widely used for existing afforestation area and also for forage shrub plantation. Forest trees suitable for forest gradoni under annual rainfall of 100 - 300mm are as follows.

| (Scientific name) | (Arabic name) |
|---|---|
| Acacia cyanophylla | Acacia cyanophylla |
| Cupressus sempervirens | Saraw (Ofoqi, Amodi) |
| Pinus halepensis | Snobur (Halabi) |

#### (2) Windbreak Trees

Plantation of windbreaks are increasing in these years specially in Jordan valley by cooperatives under Jordan Valley Authority and in the irrigated desertic regions. Single lined and mono-variety windbreaks are common in Jordan, though there are some disadvantages. In case some trees fall down by diseases or any other reasons in single lined windbreaks, a slit will be formed and wind will blow through this slit with a strong current. This will harm the windbreak itself and also harm the

plants grown inside windbreaks. Furthermore, if plant diseases are spread over in mono-variety windbreaks, all the trees will be affected. Therefore multi lined mixed windbreaks are recommended. Combination and selection of varieties are also important for the better function of windbreaks. In case of 3 lines for example, bush types, middle height trees with broad leaves and tall coniferous trees should be distributed respectively at the outside, center and inside of the belt.

The suitable species for the windbreaks in Jordan include species which grow naturally in addition to foreign species which adapted with the environmental conditions of Jordan. The most important species of bushes and trees and are as follows :

| (Scientific name) | (Arabic Name) |
|---|---|
| Bushes | |
| Atriplex spp. | Qataf |
| Haloxylon spp. | Ghadha |
| Middle height trees | |
| Acacia cyanophylla | Acacia cyanophylla |
| Tamarix articulata | Athil |
| Tall trees | |
| Casuarina equisetifolia | Casuarina |
| Cupressus sempervirens | Saraw (Ofoqi, Amodi) |
| Eucalyptus camaldulensis | Kina |
| Pinus halepensis | Snobur (Halabi) |

(3) Characteristics of each species

Acacia cyanophylla (Blue-leafed acacia)

Acacia cyanophylla originated from western australia. It is the most suitable species on coastal sand dunes. It is used on shifting dunes on a large scale and also used as a fodder tree. It will suffer in successive drought years. It has proved adequate in areas with less than 200mm of rainfall in Egypt.

Casuarina equisetifolia (She-oak)

This large, upright evergreen tree has a tendency to lean when young. It needs good staking initially. It is a excellent tree for areas near the sea, especially in sandy soils. It is a good pioneer tree for afforestation purposes and for use with other species in shelter belts.

Cupressus sempervirens (Mediterranean Cypress)

Cupressus sempervirens is not so hardy as Pinus halepensis, and requires a deeper soil and more intensive tending during the first years after planting. The Cupressus species have rarely been used solely but these have been used very frequently along with Pinus halepensis. Cupressus have, however, been used in windbreak plantations because of their resistance to winds and

for their decorative effects.

Eucalyptus camaldulensis (Red gum)

Eucalyptus camaldulensis originated from australia. This tree is suited for use in large scale plantation. It is also ideal for avenues or wide streets as well as for shelter belts.

Pinus halepensis (Aleppo pine)

Pinus halepensis is native in hills in mediterranean regions. It is drought-resistant, able to grow on poor eroded soils and tolerates a high carbonate content of soils. It grows relatively fast and produces good timber yields in a comparatively short period.

Tamarix articulata (Athel tamarisk)

It is widely used on light soils. It is used on shifting dunes on a large scale owing to its fast growth, high resistance to sanding-over and extensive root system. It thrives well in sand dunes in the arid zone even under an annual rainfall of 100mm.

The following table shows climatic suitability of each species.

| Species | Temperature | | Rainfall (mm) | Mature height (m) |
|---|---|---|---|---|
| | max. | min. | | |
| Acacia cyanophylla | 38 | 4 | 250- 650 | 7 |
| Casuarina equisetifolia | 44 | 7 | 300- 400 | 25 |
| Cupressus sempervirens | 40 | 4 | 350-1000 | 30 |
| Eucalyptus camaldulensis | 45 | 6 | 250- 650 | 20 |
| Pinus halepensis | 42 | 2 | 400- 750 | 15 |
| Tamarix articulata | 50 | 4 | 100- 200 | 12 |

8.3.3 Afforestation procedure

No specific tree plantation method will be applied to the projects. Common tree plantation methods recommended by the Department of Forest and Soil Conservation will basically be applied to the project.

(1) Preparation of seedlings

Most of the tree seedlings will be available at nurseries of each directorate and will be distributed upon request. Suitable time for seed collection and sowing for each species will be as follows;

| Species | Collection of seeds | Sowing | Treatment of seed |
|---|---|---|---|
| Acacia cyanophylla | Summer | Feb/Mar | Soak in water 48hrs |
| Casuarina equisetifolia | Late summer | Apr/May | None |
| Cupressus sempervirens | Late summer to autumn | Dec/Jan | None |
| Eucalyptus camaldulensis | Spring to Autumn | May | None |
| Pinus halepensis | Summer to early autumn | Feb/Mar | None |

(2) Land preparation

Forest Gradoni will be used in afforestation area. The spacing for forest trees will vary from 4m to 10m with predominant spacing at 5m. Forest Gradoni has been made manually. Since this is expensive and time consuming, the mechanized construction will be adopted for Forest Gradoni by introducing the "Mouflon" which is a multipurpose agricultural machine developed by CINAM, Montpellier, France. This machine can make gradoni on slope up to 40%. Supportable walls and small dams will also be prepared as a protective work against erosion and effective conservation of rain water. Estimated cost for the construction of forest gradoni by using the "Mouflon" are as follows;

| Activities | Executor | Unit | Units/ha | Price per unit (JD) | Cost (JD) |
|---|---|---|---|---|---|
| Contour survey | surveyor+laborers | day | 1 | 1x4+2x3 | 10 |
| Gradoni making | mouflon | day | 0.125 | 12.3 | 1.54 |
| Manual finish | manpower | day | 4 | 3 | 12 |
| | | | | Total | 23.54 |

(3) Tree plantation

A seedling should be deep-planted in the middle of a pit prepared on gradoni to concentrate most of the rainfall around the roots. Organic matter such as sewage sludge, if available, should be applied to a pit to improve physical and chemical properties of the soil. Planting should be carried out in rainy season to secure fast and deep root penetration. At the end of winter and early spring, soils around seedlings should be hoed to clear all weeds to mitigate competition for soil moisture. In drought years or when rainfall distribution is uneven, watering should be carried out during the first summer to ensure survival.

8.3.4 Development Cost and Benefit

(1) Development Cost

Cost for seedling production was estimated at about 500 JD per 1000 pieces of one year old seedlings including labor cost. Cost for manual tree plantation was estimated at about 500 JD/ha as a work of 100 man-day (60 man-day for manual gradoni making, 30 man-day for pit digging and 10 man-day for planting) at 5.0 JD/day of labour charge. According to the estimated land preparation cost by using Mouflon, the total development cost per ha of mechanized afforestation will be as follows :

| Activities | Cost (JD) |
|---|---|
| Seedling production (1000 seedlings/ha) | 500 |
| Gradoni making (by Mouflon) | 23.54 |
| Pit digging (30 man-day x 5 JD) | 150 |
| Planting (10 man-day x 5 JD) | 50 |
| Total | 723.54 |

According to the land development potential in each area, expansible development areas for forest are 34 ha and 683 ha in Dhiban and Tafila respectively. Total development cost for these areas will be as follows :

| Area | Unit | Unit Cost (JD) | Cost (JD) |
|---|---|---|---|
| Dhiban | 34 ha | 723.54 | 24,600 |
| Tafila | 683 ha | 723.54 | 494,178 |
| Total | | | 518,778 |

(2) Benefit of Afforestation Development

Although under the present condition afforestation is hardly an economic proposition, trees fulfil many protective functions which are difficult to express in terms of money. Production of timber is insufficient to recover heavy investments required. But, tree planting in these area will have the following intangible benefits.

1) To provide greenery and shade for man and his herds.
2) To provide windbreaks to protect agricultural crops and settlements from wind and dust storms.
3) To protect soils against water and wind erosion.
4) To provide recreational grounds to meet the increasing demands for outdoor recreation.