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JORDAN AGRICULTURAL SECTOR REVIEW: LOW RAINFALL ZONE

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1. INTRODUCTION

1.1 Definition

The low rainfall zone includes the arid areas in Jordan that receive less than 200mm of annual rainfall. This zone covers most of the native rangelands, and the term "rangelands" will be used throughout to designate the low rainfall zone (LRZ). Rangelands are defined as uncultivated lands that provide forage resources for grazing and browsing animals. These lands have severe limitations for crop production and are characteristically too steep, rocky, and/or dry to cultivate. These limitations generally cannot be offset by modern technology, and consequently the most efficient use for rangeland resources is production of forage for grazing livestock.

1.2 Objectives

The ultimate objective of reviewing production systems in the low rainfall zone is to develop a sound strategy of management for efficient utilization of the available range resources. This strategy must consider both the economics of implementing proposed strategies and the sustainability of rangeland resources. To achieve those goals, the following will be discussed in this report:

- An analysis of the current situation of rangelands and identification of the strengths of present management systems and the constraints to improved production.
- Determination of the significance of rangelands to the agricultural sector and their impact and contribution to the national economy.
- Identification of the internal and external factors that affect production systems in the low rainfall zone.
- Development of action programs to implement the proposed strategies.

2. SUBSECTOR ANALYSIS

2.1 Rangeland Resources

2.1.1 Area

Rangelands in Jordan cover 7.958 million hectares (88.9% of the total surface of the country) (Table 2.1). The reported area of rangeland varies depending on whether the area of the West Bank is included or excluded (Table 2.2). This report defines rangelands as areas that receive less than 200mm of annual rainfall, including areas occupied by cities, villages, roads, and mining activities. On the basis of production, rangelands in Jordan are grouped into three grades: good, fair, and poor.

Production Grade	Precipitation (mm)	Area (km^2)	% of the Country
Good	100-200	11	12
Fair	50-100	10	11
Poor	< 50	59	60
Total		80	89

2.1.2 Location

The majority of rangelands are located in the eastern and southern parts of Jordan and may intrude into the mountainous regions. Rangelands are divided into two main categories: desert rangelands and steppe rangelands.

Desert rangelands occupy the eastern and northern parts of the country and account for 75.5 percent of total rangelands. These areas receive less than 100mm of annual rainfall. Sheep flocks graze these rangelands during short periods of time following rainfall.

Steppe rangelands are located generally east of the desert road, represent 24.5 percent of the total, and receive an annual rainfall of 100-200mm. These rangelands are used primarily for grazing, but sizable areas have been put under cultivation.

2.1.3 Vegetation

Rangelands have six vegetational or environmental zones (Tuttle 1968) based on existing vegetation that is assumed to be the result of climatic and edaphic factors.

Table 2.1: Distribution by Governorate of Areas Receiving Less than 200mm Rainfall

Governate	Area (km^2)	Area within Governate (km^2)	% of Area within Governate	% of Total Rangeland	% of Country
Maa'n	40220	39420	98	49.5	44.03
Mafraq	26500	25800	97.4	32.4	28.81
Amman	8690	6180	71.1	7.8	6.90
Zarqa	3970	3710	93.5	4.7	4.14
Karak	3780	2310	61.1	2.9	2.60
Irib	2720	----	----	----	-----
Tafilah	2440	1820	74.6	2.3	2.03
Balqa	1220	340	27.9	0.4	0.37
Total	**89540**	**79580**	**----**	**100**	**88.88**

Source: Ministry of Agriculture, Agriculture Policy Department, 1992, and personal calculations

Table 2.2: Areas of Rangelands in Several Regions of Jordan

Region	Area (dunums)	% of Country	Reference
Rangelands	80,382,000	80	Tuttle 1968
Rangelands	85,000,000	87	MOA 1974
Rangelands	85,000,000	87	Gunn Rural 1978
Arid-Zone	80,456,900	91.37	ESCWA, UNDP 1978
Arid-Zone	84,569,000	91.3	MOA 1988
Steppe Rangeland	10,280,000	91	World Bank 1990
Desert Rangeland	70,120,000		
Steppe Region	10,000,000	91	FAO 1991
Desert Region	70,000,000		
Semi-Desert	80,304,134	90	MOA 1991
Steppe Rangeland	10,000,000	91	IFAD 1991
Desert Rangeland	71,000,000		

Vegetational Zone 1 is located in northeastern Jordan and comprises about 67 percent of the total surface of the country.

Vegetation: Characteristic species of the zone include *Anabasis articulata, Retama raetum, Zilla spinosa, Artemisia herba-alba*, and *Stipa spp.*

Topography: The zone varies from 600-800 meters in elevation and is characterized by desert plains and alluvial fans intersected by drainage ways. Occasional rocky hills and low mountains occur throughout the area. A gravel pavement is common on many areas and many soils have a caliche layer.

Climate: The climate is hot and arid; mean temperatures of the hottest and coldest months are 35.60°C and 1.4°C, respectively. Average annual precipitation is 25-75mm.

Potential: Production of range forage is generally low and estimated grazing capacity is four feed units per dunum[1] (FU/D). Rangeland development in this zone has a very low priority, but production of range forage could be increased by applying water harvesting and spreading techniques.

Vegetational Zone 2 is located in southeastern Jordan and covers 9.1 percent of the country's total land surface area.

Vegetation: The common species in zone two are: *Aristida spp., Calligonum comosum, Haloxylon persicum, Haloxylon salicornicum*, and *Artemisia judica.*

Topography: The zone is characterized by dissected sandstone plateaus. The elevation varies from 800 to 1,000 meters.

Climate: The climate is hot and arid; mean temperatures of the hottest and coldest months are 38.2°C and 10.2°C, respectively. Average annual precipitation is 25-100mm.

Potential: Production of range forage is similar to that of zone 1. The estimated grazing capacity is 4 FU/D. The development of rangeland in this zone has a low priority.

Vegetational Zone 3 includes the escarpment east of the Jordan Valley and covers only 1 percent of the total surface of the country.

Vegetation: The common species are: *Acacia tortilis, Panicum turgidum, Artemisia herba-alba, and Retama raetum.*

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[1]Feed unit (FU) is the forage equivalent of 1 kilogram of barley; 1 kg of forage drymatter (DM) = 0.4 FU.

Topography: The zone is mountainous and highly dissected. The elevation varies from 300 to 950 meters.

Climate: The climate is hot and dry; mean temperatures for the hottest and coldest months are 38.8°C and 9.6°C, respectively. Average annual precipitation is 100–250mm.

Potential: Forage production is low due, in part, to the formation of a hard surface, which restricts water infiltration into the soil. The estimated grazing capacity is 4 FU/D. This zone has high priority for development, especially with the addition of soil amendments and planting of fodder shrubs.

Vegetational Zone 4 is located in southwest Jordan and covers 5 percent of the land surface of the country.

Vegetation: The common plants are: *Aristida spp., Retama raetum, Calligonum comosum, Zilla spinosa, Haloxylon salicornicum, Retama duriaei,* and *Acacia tortilis.*

Topography: Zone 4 consists primarily of steep rocky hills and mountains that range in elevation from below sea level to 300 meters above sea level.

Climate: The climate is very hot and dry; mean temperatures for the hottest and coldest months are 40.1° C and 10.2° C, respectively. Average annual precipitation is 50–100 mm.

Potential: This zone includes Wadi Araba, which is almost barren due to erosion. The production of range forage is low and the estimated grazing capacity is 4 FU/D. Rangeland development in this zone has the lowest priority of all vegetational zones.

Vegetational Zone 5 is located in the center of Jordan and covers 7 percent of the total land surface of the country.

Vegetation: Characteristic species are: *Dactylis glomerata, Phalaris tuberosa, Hordeum bulbosum, Poa bulbosa, Poa sinacia, Stipa lagascae, Artemisia herba-alba, and Anabasis aphylla.*

Topography: The zone is characterized by extensive, nearly level to gently rolling plateaus ranging in elevation from 700 to 1,200 meters.

Climate: The climate is hot and dry; mean temperatures for the hottest and coldest months are 32.6° C and 2.9° C, respectively. Average annual precipitation is 100–250mm.

Potential: Production of range forage in this zone is high due to favorable soil and moisture conditions. The estimated grazing capacity is 10 FU/D. This zone has the

highest potential for improvement of all vegetational zones with an estimated potential to increase forage production fivefold.

Vegetational Zone 6 is located in northeast Jordan and covers 4 percent of the total surface area of the country.

Vegetation: The most common plants are: *Artemisia herba-alba, Salsola rigida, Haloxylon articulatum, Poa sinacia,* and *Achillea fragrantissima.*

Topography: The nearly level zone ranges in elevation from 650 to 800 meters and is covered with basalt hamada.

Climate: The climate is hot and dry; mean temperatures of the hottest and coldest months are 36.3° C and 2.6° C, respectively. The average annual precipitation ranges from 75 to 200mm.

Potential: Forage production is regularly high due to good soil conditions, but moisture conditions are less favorable than in vegetational zone 5. The estimated grazing capacity is 10 FU/D. This zone has the second highest priority for range improvement. Forage conditions could be improved by protection and construction of earth dams for water spreading.

A comprehensive summary of vegetational zones in terms of area, precipitation, and potential for improvement is presented in Table 2.3. The vegetational zone classifications serve only as a general guide for broad areas of Jordan; they may be of limited value for determining specific characteristics of a specific range site. A range site may have a slightly higher or lower potential for forage production or range improvement than indicated by the vegetational zone in which it is located. Criteria used to classify range sites are usually based on physical characteristics, not vegetation. For proper management, a comprehensive survey is needed to determine the kind and location of different range sites within rangelands of Jordan.

2.1.4 Soils

In general, the soils of rangelands in Jordan are sandy clay and sandy loam, high in calcium carbonate and low in organic matter. The most limiting factors for forage production are the lack of water and the potential for severe erosion on steep slopes. Any attempt to improve rangeland productivity must consider soil characteristics and the amount of moisture. A recent description of rangeland soils in Jordan is summarized in Table 2.4.

Table 2.3: Ranking of Vegetation Zones and Potential for Improvement

Vegetation Zone	Zone Area as % of the Country	Average Annual Precipitation (mm)	Potential for Improvement*
1	68	25-75	5
2	9.1	25-100	4
3	1.0	100-250	3
4	5.0	50-100	6
5	7.0	100-250	1
6	4.0	75-200	2

* Rank 1 has the highest priority for improvement, Rank 6 the lowest

Table 2.4. Classification of Rangeland Soils in Jordan

Region	Physiography	Dominant Soil Type
North-Eastern Plateau	nearly level	Calciorthids
North-Eastern Basalt	basalt hammada	Calciorthids
Eastern Plateau	sloping to undulating	Gypsiorthiods
Jafr Basin	gently sloping	Calciorthids
Southern Sandstone Plateau	dissected sandstone plateau	Torripsamments
Northern Lava Flows	flat to gently sloping	Calciorthids
High Land Plateau	undulating to rolling	Calciorthids

Source: Swenne 1992

2.1.5 Water

Surface water resources are estimated at 29 Mm^3 per annum. Exploitable groundwater is estimated at 15 Mm^3 per annum because rainfall is relatively high, reaching around 1,630 Mm^3. Approximately 70 percent of all available water resources are surface water, 30 percent are groundwater. The actual quantity of water used is estimated at 50 percent of total runoff due to lack of storage facilities. The exploitation of most groundwater aquifers beyond their safe yield is causing depletion and salinization of the water, a practice that must be stopped to prevent permanent and irreversible damage to the aquifers (The Badia Bulletin, undated). Surface water and groundwater resources are listed in Tables 2.5 and 2.6, respectively.

Most rangelands in Jordan have a slope of less than 8 percent. Water harvesting in the LRZ should be given high priority to provide water for revegetating rangelands and as drinking water for grazing animals.

Table 2.5: Surface Water Resources in the Rangelands of Jordan (Mm^3/yr.)

Region	Base Flow	Flood Flow	Total Flow	Actual Use
Southern Desert	--	--	--	--
Al-Jafr	4	10	14	--
As-Sarhan	--	10	10	--
Al-Azraq	12	15	27	10
Al-Hammad	--	13	13	3
Total	**16**	**48**	**64**	**13**

Source: Badia Rural Development Bulletin (undated), prepared and published by HCST.

Table 2.6: Available and Exploitable Groundwater Resources in the Rangelands of Jordan

Water Fields	Safe Extraction Mm^3/year	Actual Extraction Mm^3/Year
Al-Jafr Basin	27	21
El-Disi	100	61
As-Sarhan	5	---
Al-Hammad	5	1.6

Source: Badia Rural Development Bulletin (undated), published and prepared by HCST

2.1.6 Range Condition

Due to the sharp increase in livestock numbers (Table 2.7), cultivation, and periodic drought, rangelands have become extremely degraded in the past 30 years (World Bank 1990). The impact of both rangeland cultivation and overgrazing on Jordanian rangelands may be described as follows:

- Some plants of high fodder value such as *Dactylis glomerata, Poa spp., Stipa spp.*, and *Orysopsis spp.* have been eliminated and replaced by plants of lesser forage value.
- Rangelands have been invaded by plants that are less productive, less palatable, and less nutritious than the original plants: *Peganum harmala, Noea mucronata, Prosopis farcta, Astragalus spinosus, Alhagi maurorum, Euphorbia spp.*, and *Carex stenophylla.*
- Severe soil erosion has occurred and gullies have formed, especially on steep slopes.

The overall condition of rangelands in Jordan could be classified as very poor to poor based upon the plant climax concept and on the present versus potential productivity.

Table 2.7: Development of Livestock Population in Jordan (1930-1991)

Year	Goats		Sheep		Camels	
	No. (000)	% increase	No. (000)	% increase	No.(000)	% increase
1930	289.5		229.1		26.2	
1940	506.0	43	265.0	16	8.0	- 70
1950	325.3	- 36	267.3	9	14.5	81
1960	513.3	188	608.9	342	20.5	41
1970	350.0	- 32	664.2	9	10.5	- 49
1980	453.0	29	852.0	28	12.0	14
1990	479.0	6	1556.0	83	8.3	- 30
1991**	1059.470	121	2522.597	62	33.007	298

** Department of statistics 1991.

Source: Ministry of Agriculture, Directorate of Animal Production and Health, 1992. (Discrepancies in the statistics between 1991 and prior years is likely due to inflated declarations of numbers given by stock owners to qualify for more subsidized feed). (World Bank 1990)

2.1.7 Infrastructure

Basic infrastructure (e.g., roads, electricity, and means of communication) is provided for more than 85 percent of the population that inhabits the rangelands. A total of 1,300 km of paved roads serve 88 percent of these Badia communities. Primary highways make up 960 km, secondary highways 244 km, and village roads 102 km of the paved roads. About 72 percent of the Badia communities are served by post offices equipped with telecommunication systems. Electricity extends to 81 percent of the Badia households, and 92 percent of the households are served with pure drinking water (Table 2.8).

Four social development centers have been established in the Badia to provide education and training and to improve the income and standard of living of the people. Health care is

provided by 22 primary centers and 47 clinics served by 47 medical doctors and 128 nurses. Educational standards are high in the schools of the Badia; the student/teacher ratio is 18 compared with 21 in the rest of the Kingdom. In addition, there are three central professional training schools equipped with laboratories and workshops (The Badia Bulletin, undated).

Services for livestock in the LRZ are provided by the Animal Production and Health Directorate (APHD) of the Ministry of Agriculture (MOA). These services include two agricultural centers and 18 veterinary clinics. The staff of APHD carries out extension programs on nutrition, reproduction, and herd management. The lack of trained personnel has limited extension programs in range management. In addition to the APHD, the Jordanian Cooperative Organization (JCO) and the National Center for Agricultural Research and Technology Transfer (NCARTT) have important roles in livestock husbandry and production in the LRZ.

Table 2.8: Infrastructure in the Badia of Jordan

	Roads (km)						
Region	Primary	Secondary	Rural	Total			Drinking Water%[1/]
Northern Badia	475	215	73	763	58	98	99
Central Badia	130	29	29	188	27	89	99
Southern Badia	355	--	--	355	15	86	99

Source: Ministry of Planning, 1988; Badia Rural Development Bulletin (undated), prepared and published by HCST.

[1/] Represents the percent of the people served.

2.2 Human Resources

2.2.1 Population

The exact number of nomadic and seminomadic people in the Badia is unknown, and estimates differ. The Ministry of Planning's 1988 estimate was 72,273, the World Bank (1990) estimated 146,330, and the FAO (1991) estimated 146,105. The population of the Badia from 1974 to 1991 is summarized in Table 2.9. The latter two reports are considered the most reliable estimates of the population of the Badia.

Over the 1974-1991 period the average annual increase in the Badia population is 2.6 percent, compared with 3.9 percent in the national population. The Badia population is not increasing as rapidly as the national average because of out-migration, especially of young adults (Abu-Jaber and Gharaibeh 1987). The average annual out-migration was estimated to be 1.3 percent of the total Badia population (MOP 1988). The living patterns of the Badia population, in terms of settled and transhumant people, are presented in Table 2.10.

The Badia population is distributed among 156 communities or villages as follows: 73, 30, and 53 villages in the northern, middle, and southern Badia, respectively (Table 2.11). The population density per km^2 of Badia is 2.53, 6.15, and 1.08 for the northern, middle, and southern Badia, respectively.

Table 2.9: Population of the Badia (1975–1988)

Region	Population			
	1974	1985	1988	1991*
Northern Badia	31956	36921	40643	73033
Central Badia	8141	9407	10359	40595
Southern Badia	16407	19148	21218	37477
Total	56504	65476	72273	146105

* FAO 1991.

Table 2.10: Living Patterns of the Population in the Badia of Jordan

Living Patterns	Northern Badia	Central Badia	Southern Badia	Total
Settled	70,380	39,568	29,217	139,165
Transhumant	2,653	1,027	3,260	6,940

Source: FAO 1991.

Table 2.11: Size and Population Distribution and Density in the Badia of Jordan

Region	Area (km^2)	%	No. of villages	%	Population	%	Population Density*
Northern Badia	28800	41.2	73	53	73,033	50	2.53
Central Badia	6600	9.4	30	22	40,595	28	6.15
Southern Badia	34600	49.4	53	25	37,477	22	1.08
Total	**70000**	**100**	**156**	**100**	**146,106**	**100**	**2.09**

* Average population density per km^2.
Source: FAO 1991.

2.2.2 Social Organization

The basic social organization of Bedouin society revolves around the tribe (*Quabila*). The tribe is a social unit of numerous patrilineal families descended from a common ancestor. The tribe is normally divided into several subtribes (*Ashira*) and lineages (*Fakhd*), the latter being the maximal lineage (Abu-Jaber and Gharaibeh 1987).

The leader of the tribe (*Sheikh*) or any of its subdivisions represents his tribe or group in government circles and before other tribes. Internal disputes are referred to him for resolution. Successive Jordanian governments have recognized the Sheikhs' leading position as a representatives of their tribes. The major tribes of Jordan are Beni Khaled, Al-Sirhan, Al-Isa, Ahl-Al-Jabal, Al-Sardieh, in the northeast; Beni Sakhr in the middle Badia; Beni Atiyeh, Al-Hajaya, Al- Huwaitat, Al-Eheiwat and Al-Saidiyin in the south and southeast (Abu-Jaber and Gharaibeh 1987).

2.2.3 Economic Status

The Bedouins are animal-oriented by occupation and tradition, and pastoralism is a way of life more than an exclusive source of income. In the past, herds of camels and sheep were regarded as the only form of wealth, and nobility and prestige were equated with the ownership of these animals (Abu-Jaber and Gharaibeh 1987).

Restrictions on the movement of herds across international boundaries, the improvement of educational and health services, and the use of the automobile have greatly modified the life of the Bedouins. In addition, joining the army and cultivating marginal lands adjacent to cropping lands have also contributed significantly to changes in life-style (Abu-Jaber and Gharaibeh 1987).

At present, sheep and goat raising in the Badia region is market-oriented. Livestock owners are rapidly shifting from subsistence production to commercial production. This modification is facilitated by subsidized feeds, availability of veterinary services, and higher prices for live animals for export markets.

Commercial livestock production in the harsh LRZ environment exerts heavy pressure on the depleted and fragile natural resources in this zone. The cultivation of rangelands and increasing herd size are direct results of market-oriented production. The need to control grazing and to properly manage rangeland resources in the LRZ is critical. This could be achieved by establishing a Badia Authority similar to the existing Jordan Valley Authority.

Labor Force. The labor force in the Badia was estimated to be 20,000 in 1985 and 22,000 in 1988 (about 30%of the Badia population). If FAO numbers are accurate, this estimate is too low. In 1985 and in 1988 the labor force of Jordan was 23 percent and 26 percent respectively of the national population. The high percentage of the labor force in the Badia may be the result of two primary factors:

- The younger ages of workers, especially those involved in herding activities. This fact is made obvious by the low average number of young children enrolled in Badia schools.

- More women than men are involved in grazing activities, because many men join the army or migrate to urban areas.

Herders. Labor requirements for herding are generally minimal. The amount of labor required is determined by the size and the composition of the herd. The larger the herd, the more shepherds are needed. A single shepherd can, with no difficulty, cope with a flock of 200 head of sheep and goats. Therefore, several households with herds too small to efficiently utilize the services of a herder may combine their herds. Alternatively, flock owners might choose to herd the animals themselves or jointly with kin rather than seek outside help (Abu-Jaber and Gharaibeh 1987).

Due to the out-migration from the Badia to urban areas in Jordan, the number of herders is gradually declining. However, the number of hired Syrian herders is increasing. This increased use of hired shepherds contributes to rangeland degradation because the hired shepherds, often of low economic and social status, have no interest in the land. If rangeland deterioration is to be stopped and productivity restored, the importation of hired shepherds must be limited and rangeland management practices must be improved.

2.3 Production Systems

2.3.1 Land Tenure

An understanding of the land tenure system of Jordan is essential to understand the pastoral system and therefore to form rational plans for development and improvement of rangelands. According to Agricultural Law No. 20 (1973), all rangelands are owned by the Government. However, this varies in practice. The actual rangeland tenure as described by FAO (1991) and existing legislation pertaining to land use and tenure are presented below:

Major types of rangeland tenure in Jordan. More than 90 percent of rangelands in the steppe are privately owned and used for erratic cereal production. Continuous plowing of these rangelands has eradicated a large proportion of the native forage species, and land productivity decreases as cultivation and erosion continue to degrade the basic soil resources. The probability of harvesting grain from the cultivated cereal crops is about 15 percent. In dry years, grain is not produced and the crop residue is leased for grazing.

The remaining 10 percent of steppe rangelands are state owned and are characterized by steep slopes and rugged topography, which hinders development and improvement. These rangelands are normally grazed by local sheep flocks.

A strip of Badia land (10–15 km wide) adjacent to the steppe rangeland is privately owned and most of it is used for cereal production under hazardous environmental conditions.

Another strip of the Badia (15–30 km wide) adjacent to and parallel to privately owned desert land mentioned in the paragraph above is also privately owned by tribes. These lands are partially cultivated. The tribal right of cultivation has been recognized since 1945. Plowing and/or cultivation is a technique used to claim the land for the future, and as a result more tribal and state lands are becoming privately owned.

The rest of the Badia, with less than 80mm rainfall, is considered desert land and is claimed by tribes. This *Hammad*, or state desert, is open to all Jordanian and non-Jordanian herds.

There are irrigated lands in Jordan owned and rented by the state. These lands are scattered over the steppe and desert (El-Azraq, El-Disi) and used for cereal, vegetable, and fodder production. Artesian wells (800 meters deep) are the only water resources for these lands. Water from these wells is fossil water and thus nonrenewable.

Legislation pertaining to rangeland tenure. Regulations for using the state rangelands are defined by Agricultural Law No. 20 (1973) in which the following points are made (Zarqa River Basin Development Project 1987):

Article 120

The Minister of Agriculture has the right to arrange the following:

- Improvement, development, and conservation of the rangeland.
- Preparation of a schedule for grazing in certain areas, and specification of grazing periods.
- Specification of the kinds and numbers of animals allowed to graze.
- Application of practices for increasing production of the rangeland, and the establishment of experiments.
- Use of surface water, construction of small dams, and management projects on the rangeland.
- Digging of wells, provision of pumps, and building of pools (drinking water for animals).

Article 125

Rangelands that receive 100-250mm rainfall per year can be rented for range use (i.e., fodder production). This requires a decision by the Prime Minister, based on recommendations made by the Minister of Agriculture in consultation with the Minister of Finance/Lands. As a part of this decision, land areas and boundaries are defined according to topographical, meteorological, and other technical criteria.

Article 129

The minister has the right to fix the price for grazing or to set taxes concerning animals and rangelands.

Article 131

A fine of 20-100 JD will be assessed to anyone who:

- Opens a rangeland, plows, digs a well, or constructs anything on rangeland.
- Establishes a quarry in the rangelands.
- Clears, eradicates, or burns fodder plants on the rangelands.

2.3.3 Forage Productivity

The matter of rangeland forage production has not been adequately addressed in Jordan nor is it well understood. Most statistics on forage production are the result of estimates, they are not based on field measurements. Even estimates of forage production are based on the production potential of protected rangelands. Forage production estimates on range reserves are usually extrapolated to rangelands under common grazing, thus overestimating actual forage production, which in turn contributes to over stocking. The exaggerated estimates of forage production are used to calculate the potential grazing capacity without consideration for the proper utilization level required to assure the survival and sustained productivity of perennial forage plants.

The method used in Jordan to express rangeland forage production is inconvenient, confusing and misleading. The present method of feed units is better adapted to express forage requirements for intensive animal production than for extensive rangeland grazing because it assumes that all nutrients, other than energy, are adequate. This is generally not the case with rangeland forages. Range plants undergo dynamic changes in terms of forage quantity and quality as they grow and mature. Thus, for extensive or semi-intensive rangeland sheep production in Jordan, a sheep unit is more convenient and better adapted to expressing forage requirements for grazing livestock. A sheep unit represents 1.5 kg of air-dry forage and is an expression of the daily forage requirements of a mature sheep weighing 60 kg. The results of studies of forage production on various rangeland areas of Jordan are presented in Table 2.12.

2.3.4 Livestock Numbers and Productivity

The number and kind of livestock produced in Jordan is shown in Table 2.13. The sheep are the Awassi breed with a broad fat tail. The total grazing animals on rangelands in Jordan is equivalent to four million sheep units (Table 2.14). The ratio of goats to sheep is about 0.42. The livestock numbers indicates that Jordan has the potential to achieve self-sufficiency in meat production and consumption if sheep flocks are properly managed. (World Bank 1990).

Annual fluctuations in the number of livestock and the number of animals slaughtered makes any attempt to estimate actual production commodities of livestock very difficult. The total red meat production from sheep, goats, and camels was around 9,372 tons in 1987-88 (excluding export of live animals to Saudi Arabia and the Gulf area) (MOA 1989). Data on the average daily weight gain of sheep, goats, and camels grazing on natural rangelands are lacking, but the average daily weight gain of sheep and goats under feedlot conditions ranges from 150 to 250 grams.

In 1989, estimated milk production from sheep, goats, and cattle was 69,426 tons, about 52 percent produced by sheep and goats (MOA 1989). For sheep and goats the milk produced per lactation period (60–90 days) ranges from 60 to 120 kg. Wool production per adult sheep is 1.5–2.0 kg. There are two categories of production systems carried out in sheep husbandry in the low rainfall zone: Nomadic Pastoralism and Transhumant System (World Bank 1991).

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Table 2.12: Rangeland Forage Production in Several Regions of Jordan

Region	Forage Production FU/dunum	Total Forage Production in the Region (FU)	Percipitation (mm)	Ref.**
1. Wadi Dhuleil Catchment	6.5	6,625,858	100-250	1
2. Steppe	10	1,000,000	100-250	2
Badia	4	2,988,000	< 100	
3. Mafraq Surrah	60 kg/dun		50-150	3
Sabha	55 kg/dun		50-150	3
Azraq Shumari	27 kg/dun		50	3
Tafilah Thawani	41 kg/dun		50-150	3
Shoubak Fujayj	79 kg/dun		50-200	3
Karak Lajjun	28 kg/dun		50-150	3
Ma'daba Daba'a	43 kg/dun		50-150	4
4. Al-Hammad Basin	14 kg/dun	514,000,000 kg		40-1704

** 1. Zarqa River Basin Project 1986. Forage production was calculated by vegetation type.
2. Ministry of Agriculture 1974. Forage production was estimated.
3. USDA 1986. Actual measurements of forage production.
4. ACSAD 1983. Actual measurements of forage production.

Table 2.13: Distribution of Livestock According to Governorates (1991)

Governorate	Sheep	Goats	Cattle	Camels
Amman	507710	195150	7911	1536
Zarqa	319264	75877	10464	5947
Irbid	237417	176101	24183	630
Mafraq	685058	124333	5613	1980
Balka	139760	119519	9403	330
Karak	216117	123852	803	1504
Tafila	70320	50905	93	1474
Ma'an	346951	193733	344	20506
Total	**2522597**	**1059470**	**58814**	**33007**

Source: Department of Statistics 1991.

Table 2.14: Number of Livestock in Terms of Sheep Units (1991)

Sheep	Goats	Goats/sheep	Camels	Sheep Units*
2522597	1059470	0.42	33007	4011158

* Sheep Unit (SU): is an abstract unit defined as a 60-kg mature sheep. The following assumptions were used to calculate the number of sheep units:

1. The average daily intake of grazing sheep equals 2.5% of body weight, which equals 1.5 kg dry matter of forage (60-kg body weight of sheep x 2.5% = 1.5 kg)
2. Almost all cattle in Jordan are raised on farms and rarely graze on rangelands. Therefore, they were not included in the grand total of sheep units.
3. The average body weight of a camel equals 780 kg. This means that forage intake by 1 camel equals the forage consumed by 13 sheep (780-kg body weight/1 camel x 2.5% = 19.5 kg of forage on dry matter basis; 19.5 kg/1.5 kg per 1 sheep = 13 sheep).
4. The sheep units of Irbid and Balka governorates were not included in the grand total because the areas receiving less than 200mm rainfall within these governorates are small. This means that about 70% of total sheep units are located in areas receiving <200mm.

2.3.5 Nomadic Pastoralism

The nomadic system is followed by an estimated 500 households. This system accounts for less than 5 percent of herders who own 10 percent of the sheep and goats in Jordan. The entire family lives permanently in the tent, and livestock production is their exclusive activity.

The past form of nomadic pastoralism practiced in Jordan was east-west: a migration eastward in winter to exploit the wadi vegetation of the desert, and a migration westward out of the desert in spring and summer to the edge of the agricultural zone, where rainfall was normally greater.

Commodities such as grain, which the nomads did not produce themselves, were purchased in markets or were extorted from farmers. Thus, the basic elements of nomadic pastoralism include regular seasonal migration to ephemeral desert pastures in the winter rainy season, and a retreat to pastures in better-watered, often agricultural, areas in the summer dry season. Maintenance of the resource was thus maintained through a pattern of movement that prevented overgrazing.

At present, nomads have become limited to the Badia and have lost access to steppe rangelands. Animals are now herded on rangelands, which are being continuously reduced in area. These changes have disrupted the spatial complementarity between ecological zones that, over the centuries, permitted a balanced exploitation of the environment. This intensification of land use without compensatory management improvement has often resulted in the degradation of the remaining rangelands.

2.3.6 Transhumant System

The transhumant system includes 70 percent of the sheep and goats produced in Jordan. (This production system also includes altogether most of the large flocks belonging to landless breeders who are settled in villages). Flocks are kept in villages during the winter, which is also the lambing season, and are fed with purchased feed (barley, bran, and straw). Flocks are taken to the surrounding Badia (not more than 100 km) in the spring and returned to the village in the summer, when crop residues are available (or to the western rainfed agriculture zone if they are not). Livestock is not the only source of income in this system, as income comes from other agricultural activities.

Other systems, such as mixed farming and sheep-lot fattening, are carried out by agriculturists in high rainfall areas or under irrigation. Feed sources for those operations are mainly crop residues and subsidized feeds with minimal grazing.

The movement patterns of sheep and goat flocks on rangelands can be summarized as follows:

In winter (November–February), herders move their flocks into the desert rangelands to graze on early growing ephemerals, which make up the bulk of feed (there is some supplemental feeding).

In late winter and early spring (February–March) flocks are moved to wadi areas to graze on annual plants and other perennial plants.

In late spring and early summer (April–June), herds are moved to agricultural (cropping) areas to feed on crop residues. Herds remain in these areas through the summer and early fall (July–October). Supplemental feeding is also used during this period.

Thus, native rangelands support the grazing animals for 4–6 months, and crop residues sustain them for 3–4 months. Supplemental feeding of livestock is practiced for 3–4 months, and this activity is increasing for several reasons: (1) feed supplements are subsidized, (2) there is a lack of herders due to out-migration to urban areas, (3) range forage production is low, and (4) there is a lack of programs to expand forage crop production either under irrigation or rainfed conditions.

2.3.7 Regional Grazing

Grazing on border rangelands has a great impact on the political relationships among neighboring countries. The issue of regional grazing is vital and led to a conference entitled "Development and Improvement of Border Rangelands," sponsored by the Arab Organization for Agricultural Development (AOAD) in 1981.

The movement of herds across the national borders of Jordan is frequent. Some Bedouins stay with their flocks year round on these border rangelands near permanent sources of water. Animals feed on perennial forage plants growing on the range, and are provided with supplemental feed during droughts.

Movement of herds across borders is triggered by:

- High prices for live animals (lambs) in some markets in neighboring countries, especially Saudi Arabia.
- Low prices of subsidized livestock feed, especially in Saudi Arabia and Jordan.
- Availability of veterinary and extension services in some countries.
- Availability of large trucks to transport feed, water, and livestock.
- Cultivation of rangelands, especially on the steppe, which for centuries was the traditional grazing domain for flocks of sheep and goats. The gradual decline of forage production

on local rangelands forces livestock owners to seek other feed sources outside the country to sustain their herds.

The drawbacks to the movement of herds across Jordan's borders include:

- Sheep husbandry in Jordan has become a commercial production system with subsidized feed, free grazing, and free veterinary and extension services. These elements stabilize the number of livestock grazing on rangelands, which results in more and more degradation of the range resources.

- High prices for live animals in outside markets encourage export. This results in a shortage of red meat for the domestic market, and the Government must import red meat.

- Spreading of livestock diseases in border rangelands increases the need for livestock health programs, which puts additional pressure on the treasury.

- Smuggling of subsidized livestock feed to neighboring countries.

- Neglecting the development of natural rangelands. Because most of the rangelands have deteriorated to a great extent, development or improvement of these lands will be overlooked because of the high requirements in terms of money and time.

In an attempt to control and organize the regional grazing, the Al-Hammad Basin Project (HBP) was established by the Arab Center for the Study of Arid Zones and Drylands (ACSAD)

2.3.8 Cultivated Agriculture

Rainfed. As the population of Jordan increased, settlements gradually spread into drier areas. This was accompanied by a rapid expansion in sheep population, largely due to an increase in demand (and subsequently price) for livestock products from a growing population with an improving standard of living. On the other hand, mechanization has expanded cultivation for rangelands, especially in the steppe. The estimated area of rangelands that were put under rainfed cultivation is more than 50 percent of the area located between the 100-200mm isohyte lines (personal judgment from a two-day field trip in December 1992, when (accompanied by Dr. Gates).

Barley is the principal crop cultivated in the rangeland, even though it is well known that this barley crop is harvestable only in two out of every ten years on average. When a barley crop is harvested, it is generally sold to the Jordan Cooperative Organization (JCO) for livestock feed. The JCO then sells this feed back to the graziers at a subsidized rate. The barley is used as a feed supplement when range forage production is inadequate to support the grazing herds. When there is insufficient locally grown barley available, the Government imports feed grain, which it issues in the same way. In years when barley crops are not harvestable, they are rented

to graziers for direct grazing by their flocks. The current grazing fees are 4-5 JD per dunum. A comprehensive study is needed to determine the areas of rangeland under cultivation and to evaluate the economics and environmental impacts of this destructive activity.

The reasons for cultivating barley on native rangelands were summarized by USDA (1986) as follows:

- On privately owned land, cultivation is practiced because:
  - Farmers find it easier to increase the amount of area under production than to use expensive high-technology inputs and to devote a great deal of effort to produce grain from a more limited area.
  - Cultivated and privately owned land is protected by law from unauthorized grazing.
  - Good years result in a harvestable crop and the stubble may produce a feed source that is better than the natural pasture would have provided.
- Establishing historic use of particular tracts. In former times, rangelands were considered a natural provision available to all. In modern Jordan, the Government owns and controls most rangelands, and most land in these areas are called state lands. To establish a right to use state land, people develop it and take it out of its natural state by fencing, planting, plowing, or developing a water supply.

  In fact, much of the range area being surveyed for registration at the present time. Cultivating these lands promotes soil loss through erosion, which will undoubtedly lead to desertification. This means in turn that a substantial portion of rangelands have been eliminated as permanent grazing land.
- High flexibility in utilizing barley, which explains its continuous cultivation on low potential lands. In good years, a harvestable grain crop is probable and the aftermath is stored for late use in winter. In dry years, the cultivated, but nonharvestable, barley is grazed by sheep flocks.

Irrigated Rangeland. The cultivated area of rangelands under irrigation is estimated to be around 450,000 dunums (Table 2.15). About 1,019,930 dunums of rangelands are leased to the private sector in southeastern Jordan (El-Disi and Mudawara). Only about 50 percent of the leased areas are actually cropped; wheat, barley, onion, garlic, potato, watermelon, vegetables, legumes, fruit trees, and alfalfa are the major crops. The source of irrigation water is 59 aquifers in the area (MOP 1988; MOA 1992).

Table 2.15: Cultivated Areas of Rangelands Under Irrigation

Region	Area (dun)	No. of Artesian Wells
Northern Badia		
Mafraq	146,000	217
Zarqa	55,000	216
Central Badia	46,000	113
Southern Badia	200,000	39
Total	**447,000**	**585**

Source: Ministry of Planning 1988.

2.3.9 Mining

Mineral ores, which are widely distributed across rangelands, include (The Badia Bulletin):

- Phosphates, which cover one-third of the Badia area, particularly in the middle and the south. An estimated 1 billion tons of high-quality rock phosphate (60–75% P_2O_5) is located at a depth of 12–17 meters. Exports in 1988 totaled 5.62 million tons.

- White cement ores. Estimated potential production in the northern Badia is 51 million tons.

- Pure limestone (97–98%) utilized for $CaCO_3$ production; dolomite limestone for the glass-quality quartz sand for glass sheets and containers; clay (naturally pure) for production of high-quality sanitary ware.

- Natural gas is produced mainly in the northeastern part of the Badia. Current production from two wells is 18 million cubic feet per day. Estimated potential reserves total 700 billion cubic feet (bcf), of which 500 bcf are considered recoverable reserves.

- Oil. In 1988, 413,000 barrels was produced from the northern Badia. Oil shale is widely distributed, with potential reserves of up to 50 billion tons, containing 6–11 percent oil by weight.

2.4 Administrative Framework

Rangelands in Jordan are administered by the Department of Forestry and Soil Conservation (DFSC). This department consists of five divisions: afforestation and nurseries, forest management, land and survey, land classification, and range.

The two-person range division staff does not have specialized training or experience in range management. Activities of the range division include setting up grazing schedules, revegetating high-potential sites with fodder shrubs, and protecting rangelands from intruders. The lack of trained personnel in range management is reflected in the lack of a national program for range resource management, and in deficiencies in the research and extension activities. Research activities are not systematic and do not deal with the current problems and obstacles of rangeland development in Jordan. There is an urgent need to establish Range Management Curricula in the universities of Jordan and to establish a Range Department with qualified personnel to deal with the real problems of rangelands.

2.5 Contribution to Agricultural GDP

Rangeland forage production in Jordan was estimated to be 400,000,000 feed units (FU) (MOA 1974; Juneidi 1992). It was mentioned earlier in this report that the rangelands can sustain 4 million sheep units for 4 months without supplemental feed. In terms of forage production, this means that the rangelands can produce 720,000 tons of forage on a dry matter basis to sustain these grazing animals, and that rangelands provide 30-40 percent of the feed requirements of grazing animals. Sheep husbandry systems in the low rainfall zone support a population of 100,000, mostly nomads and seminomads, directly engaged in grazing activities (Juneidi 1992).

2.6 Existing Range Policies

Range policy is the system for utilization of rangelands that is laid down (usually by governments) to create a friendly relationship between land resources and the people exploiting these resources. There are two range policies in Jordan: the Government policy and the Cooperative policy.

2.6.1 Government Range Policy

The Government's range policy establishes that the Government owns the rangelands and uses these lands for livestock, which are also owned by the Government. Livestock herders therefore work for the Government. This policy is in force in certain range reserves, such as at Khanasri and Fujeij.

The main advantages of this policy are that rangelands are protected from destructive activities such as uprooting of range shrubs, unsound cultivation for the production of cereals,

and overgrazing. This policy also makes it easy to implement proper management practices and plans so that rangeland conditions could quickly be improved.

The main disadvantage of this policy is the probability that livestock production would diminish as livestock herders become Government workers, because their personal interest in the livestock would be reduced.

2.6.2 Cooperative Range Policy

Cooperative range policy gives the rights to use specific rangelands to local groups, associations, or cooperatives. This policy is a modern modification of the old traditional grazing system called *El-Hema*, which was adopted by livestock herders centuries ago, and which proved effective in protecting and maintaining rangelands.

The main advantage of this policy is that local livestock herders would actually directly participate in protecting, improving, and managing their rangelands in cooperation with the Government. This policy has been adopted by the JCO and the Forestry Department and is in force in certain range reserves (e.g., Ma'in), where it is considered successful.

2.6.3 Present Range Policy

In actuality, there is no overall effective range policy at present. According to Agricultural Law No. 20 (1973), all areas of the country that receive less than 250mm average annual rainfall are considered rangelands and are state property. These lands are protected from uprooting of range shrubs and grasses, unsound cultivation, and overgrazing, but in fact local residents perform all these negative activities, which has led to serious deterioration of these lands.

Implementation of the law is very difficult, however, because the people consider these lands their own, to use as they wish. If this behavior continues, these rangelands of Jordan will soon become true desert. A clear, well-defined range policy must be formulated and implemented as soon as possible.

2.6.4 External Factors That Affect Existing Rangeland Policy

Land Tenure. Rangelands in the past were divided among the tribes for grazing; each tribe knew its range and respected the rights of the other tribes. After the foundation of the Kingdom in 1946, all unregistered lands, which included mainly the rangelands, were considered Government lands. This resulted in overgrazing and consequently in the deterioration of rangelands.

At present, theoretically, Government rangelands are protected by Agricultural Law No. 20 (1973), which authorizes the Minister of Agriculture to protect and improve conditions of the natural vegetation cover. However, actual implementation of such legislation is extremely

difficult because most land users consider themselves de facto owners of the lands (Juneidi 1992).

Subsidies. A subsidy system exists for barley. Domestic procurement prices are substantially above both import prices and the domestic selling price. The barley subsidy is divided between barley producers and livestock producers, who use subsidy in their feed rations. Overall, the users of barley have benefited more from the subsidy than the barley producers.

It was suggested in the MOA report (1988) that support should be given to farmers engaged in green fodder or barley production, that the Government should buy 60 percent of the total production of barley from farmers at promotional prices (75 JD per ton) and sell this barley to the livestock owners at 42 JD per ton. It was also suggested that the Government should buy 75 percent of the total production of green fodder at promotional prices equal to that of barley and sell it to the livestock owners at the same price as barley.

This policy should be continued at present because it reduces the country's dependence on imports of these two feed commodities, but it should be stopped once the rangelands are improved and properly managed.

Water. Water plays a vital role in the development of range management and policies. By devoting more to the production of green fodder or forage, the grazing pressure on rangeland will be reduced and the conditions of the range will be improved (Juneidi 1992). Three types of water could be used to increase the production of green fodder:

- **Surface Water.** The more scarce water is, the greater the need for technical and management skills to conserve it. In arid areas, measures to increase the use efficiency of available water resources are as important as additional sources of water. Rainfall harvesting techniques can be use to provide water for human and livestock consumption and for limited agriculture.

  Rainfall harvesting can be used to improve rangeland productivity. It is of particular importance for artificial seedings to revegetate rangelands in low rainfall areas. Other technical methods for utilizing surface water in range areas are water spreading systems and construction of desert dams and dikes.

- **Groundwater.** Specified amounts of groundwater should be used to raise green fodder in certain locations. It is estimated that 194,000 dunums could be used to produce green fodder and grains in sites in the eastern part of the country (Development of Animal Wealth study, MOA 1988).

- **Reclaimed Water.** It may be more beneficial for the country to use wastewater than surface water or groundwater for the production of green fodder and forage. It is estimated, that the amount of wastewater that would be available up to the year 2000 is 100 million m^3. This quantity would be adequate to plant 100,000 dunums with green

fodder or maize or sugar beet. It also could produce about 150,000 tons of dry clover (MOA 1983).

Budget Restrictions. One of the main obstacles to range management development is the lack of funds to implement many necessary range development projects. Up to the present, however, and despite recommendations by national and international experts to give more attention to range improvement and management, this field is still neglected and not receiving the attention nor the funds it deserves and needs.

Trained Manpower. Another major obstacle to range development is the shortage of qualified personnel trained in range management. Practically, there are only three people in the entire country who are fully qualified in range management: one is retired, one is teaching at Jordan University, and one is in the Ministry of Agriculture (NCARTT).

As a result, solutions to range problems are being prescribed by professionals from other disciplines (agriculturists, veterinarians, and foresters) and their prescriptions are often incomplete (Juneidi 1992). It is worth stating here that range management is a distinct discipline that requires specialized study.

2.7 Constraints to Range Development

2.7.1 Organization/Administration

Range management is a relatively new discipline in Jordan and its objectives, principles, and practices, and the results that might be expected from its implementation are not fully understood. As a result, these are many misconceptions.

One of the major obstacles to range improvement and management is the lack of one central organization with a clear mandate to manage the rangeland resource. The rangelands are at present managed mainly by a small section in the Forestry Department within MOA, whose staff are chiefly foresters, by a smaller number of staff in the Jordan Cooperative Organization (JCO), and by one official in NCARTT.

2.7.2 Lack of Trained Personnel

Closely allied with the lack of organization is the extreme shortage of trained and qualified personnel in the field of range management.

2.7.3 Neglect of Rangelands

Closely allied with the previous items is the fact, that rangelands are not receiving the attention they deserve and the funds they need; consequently, they are deteriorating and being

desertified due to abuse and are currently only producing a fraction of their potential in best cases.

2.7.4 Lack of a Range Policy

The lack of a well-defined range utilization and management policy prohibits the wide-scale implementation of range management practices and principles. Closely allied to the lack of range policy is the lack of an overall land use policy that integrates the range, livestock, and agricultural husbandries. This fact is often overlooked by agricultural planners.

2.7.5 Lack of Awareness

Lack of awareness of the contribution of the rangelands to the Jordanian economic and social welfare. Rangelands are the main and cheapest source of animal feed in Jordan. The total annual fodder production of rangelands is estimated at 400 million feed units, which is more than 50 percent of the total feed requirement of the livestock available in the country (about 2 million, mainly sheep and goats).

Lack of awareness of the value of rangelands is due to the lack of educational and extension services for local residents of range areas, due to lack of qualified range staff. There is also a lack of awareness about the detrimental effects of the negative practices exercised in these areas, such as uprooting of fodder shrubs for fuel wood, overgrazing, and unsound cultivation methods, which usually result in soil and water erosion and desertification (Juneidi 1992).

2.8 Agencies Involved (National, Regional, International)

2.8.1 Reports

More than 40 reports have been written on range protection, improvement, and management since range studies and activities began in 1955. Following is a list of the most important of these reports/projects and the agencies involved.

There were 22 national reports and publications on range management (e.g., range production, socioeconomic studies, feasibility studies, research, range development, and natural plants of rangelands).

On the regional level, there were two reports: one written by the Arab Organization for Agricultural Development dealt with the technical and economic feasibility of range development in southern Jordan, and the second written by ACSAD, which dealt with development of the Hamad Basin in northern Jordan. Both reports included specific information on specific areas in the southern and northern parts of the country plus a program for range development in the south.

On the international level, there were 17 reports, written mainly by FAO, ESCWA, UNEP, USAID, Hunting Technical Services, Gunn Rural, IFAD, and the Japanese Cooperation Agency. FAO reports dealt with natural resources such as soils, climate, and vegetation. The FAO reports also provided programs for range development. USAID reports provided information on the economics of rangeland, which is a basic step for convincing decision makers to give high priority to range rehabilitation programs and projects. ESCWA, FAO, and UNEP reports laid down a national plan for combating desertification in which they recommended the establishment of a range department to deal with all aspects of rangeland. The report drew the attention of the authorities in Jordan to the ill effects of desertification, which is spreading at a rapid rate, and recommended a plan to combat this process.

National

- Working paper of the Animal Production and Range Directorate (MOA 1974) and a Five Year Plan 1976–1980.
- Socio-Economic and Farming System in Ma'in Pilot Area (Forestry Department 1987).
- Development of Animal Wealth in Jordan (MOA 1988).
- Annual Reports of the Forestry and Soil Conservation Department (MOA 1984–85).
- Zarqa River Basin Project, Feasibility Study (MOA 1983).
- Agricultural Production in Semi-Arid Lands, (Faculty of Agriculture, University of Jordan).
- NCARTT Annual Report (1988–1989).
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2.8.2 Projects (Past, Current, and Planned)

The most important, current, and planned projects related to range management include the following:

Range Development Project. This project consists of yearly plans for range rehabilitation by the Forestry Department in the range reserves. There are about 20 fenced range reserves scattered all over the rangelands in the country, an area greater than 0.5 million dunums. The yearly plan of the Forestry Department consists of planting about 20,000 dunums to fodder shrubs, mainly *Atriplex* species. Some of these reserves are opened to controlled grazing during specific periods depending on the conditions of the range vegetation.

The main objective of this project is to reverse rangeland degradation by protecting (fencing), improving (planting) fodder shrubs, and managing (controlled grazing) some areas of rangelands. This is an ongoing project and has proved effective in checking range deterioration.

Range Development Master Plan. This project is carried out by the Forestry Department with the assistance of an FAO expert. The main objectives of this project are to:

- Increase the contribution of range resources and reduce dependence on imported red meat.
- Protect the natural resources, optimize their use, and preserve the environment.

- Create optimum full-time employment opportunities in the exploitation of the rangelands.

- Provide rangeland users with facilities and possibilities to ensure a standard of living commensurate with that of other sectors of society.

This is an ongoing project. Work is also proceeding for the preparation of survey and mapping at a scale of 1:250,000 for the entire country. Also, it will include the collection of data on livestock, available infrastructure, and other relevant factors.

UNDP/FAO - RAB/84/025 Range Management Project. This is an intercountry project by Algeria, Jordan, Morocco, Syria, and Tunisia that is aimed at reversing the degradation process and desertification, and promoting rehabilitation of rangelands. The implementation of this project will also contribute to food security by increasing animal production. The main objectives of the project are to:

- Establish a research, training, extension, and planning network among institutions, and projects that deal with rangeland development.

- Elaborate a regional rangeland improvement methodology based on the experimental approach in the region.

- Prepare new rangeland development investment projects.

In Jordan, the Ma'in area was selected as a pilot project. Soils and socioeconomic aspects were studied and about 82,000 dunums have been developed and put under controlled grazing in the first phase. Further financing will be needed to continue this project.

WFP-Assisted Rangeland and Forage Development Project. In 1985, this project was renamed the "Development of Range Land and Meat Production Project." Since 1981 WFP has been providing assistance to cooperatives under JCO to:

- Improve rangelands by planting fodder shrubs and protecting range reserves.

- Produce forages by adopting a system of cereal/legume crop rotations.

The assistance of WFP included distribution of food rations to those engaged in cooperative activities to plant *Atriplex* species and 50 kg of free wheat for each dunum of land planted to forage legumes by private farmers and members of cooperatives.

The first phase of the project ended in 1983, the second in 1986. From 1983 the project also supported the range development activities conducted by the Forestry Department by providing food rations to forestry workers to supplement their wages. In 1985, this project was reviewed by a WFP/FAO mission and was found to be satisfactorily implemented. The third phase of the project was approved by WFP. Preparation for implementation of this phase is

ongoing. It will be started shortly and will cover 35,000 dunums in the Salt and Madaba areas, and some area in the south. Protection and maintenance of previously planted range reserves are to be continued.

Al-Hammad Project. The Arab Center for Studies of Arid Lands and Dry Areas (ACSAD) prepared, in cooperation with Jordan, Syria, Iraq, and Saudi Arabia, a project to develop the Al-Hammad area located on the borders and shared by these countries. The main objective is to improve the range, animal production, the water resources, and the socioeconomic conditions in the area.

In Jordan, the project aimed at integrated development of the H4 area in the entire Al-Hammad Basin (Jordanian part), a very dry area (85mm of rainfall per year) of about 3.7 million hectares.

The aim of this study was to evaluate the fodder resources in Al-Hammad by determining the quantities of the plant communities scattered over the area, which will assist in drawing up economic and social development plans for this area.

Total fodder production of the Al-Hammad area was 342,500 tons of dry matter in spring and 147,800 tons of dry matter in autumn. The average plant production was 93.2 kg/ha in spring and 40.2 kg/na in autumn. The results of this study, together with the results of surveys in other fields (e.g., groundwater, surface water, soils, livestock, economic, and social studies) will help to select areas of high priority for utilization of all natural resources in the Al-Hammad area.

Jordan/Australian Dryland Farming Project. This project was agreed upon in 1979, operations started in 1981 and continued, in three phases, until 1988. The main objective was to increase the productivity of the main rainfed cereal growing areas in Jordan (Karak, Madaba, and Irbid districts) by improving cereal production through the introduction of fodder legumes into the cropping rotations. Because the technical and socio-economic requirements for achieving these objectives are very complex, a research component was incorporated into the project.

Traditional grazing customs and common grazing practices proved to be a major constraint for expanding medic husbandry. Therefore, it was realized that the introduction of medic husbandry into Jordan, although technically feasible, would require a substantial long-term extension effort to organize careful grazing practices at the community level.

The project was much more successful with annual legumes. Native vetches and forage varieties were more suitable than those introduced from Australia (IFAD 1991). After 1985, emphasis was shifted to develop and extend annual forages either in pure stands or in mixtures with cereals. Vetches have been traditionally grown in Jordan for grain and as a field crop and they are generally respected by nomadic herders. Improved varieties such as common and woolly-pod vetch have been introduced to increase the yield of fodder. Recent yields of up to

700 kg of dry matter per dunum were quoted. During 1986, which was a very dry year, dry matter yields varied from 30 to 300 kg/dunum (IFAD 1991).

National Agricultural Development Project (NADP). Previously called the Highland Agricultural Development Project (HADP), it is a seven-year Jordan-USAID project that started in 1988. Its objectives are to:

- Improve NCARTT's applied research and extension capacity.
- Develop improved and adapted extension methods for technology transfer to farmers.

The total budget of the project is $62.4 million, of which $34.8 million are Government contributions of land, staff, and operational expenses.

The Agriculture Development Fund (ADF) projects that are related to range development include:

- Implementing and testing machinery for direct seeding of fodder shrubs.
- Resource inventory of six range reserves.
- Production of barley for fodder in the 200-250mm rainfall zone of the Jordan highlands.

Zarqa River Basin Project. This project covers an area of 820,000 dunums of the lower catchment of the Zarqa River. The objectives include:

- Improving productivity of agricultural lands and raising the sustainable income of the rural population.
- Reducing siltation at the King Talal Reservoir to retain its storage capacity and increase the life span of the dam as an important source of irrigation and drinking water.

It is an ongoing project and is effectively fulfilling its objectives.

Agricultural Production in Semi-Arid Land and Areas Suffering from Desertification Project (Al Muwagar), University of Jordan.

The total proposed area to be rehabilitated is 200 hectares leased by the Government to the University of Jordan.

This project was carried out by Jordan University with financial cooperation of the European Community. The duration of the project was seven years, in two phases: 1985-1988 and 1988-1991. It is difficult to evaluate this project because the released data are scarce. The main objectives of this project were to:

- Introduce economical, easy to execute, agricultural practices suitable for areas that receive annual precipitation of 100-200mm.

- Develop areas to effectively utilize surface water for agricultural activities.

- Improve soil fertility and preserve soil production using local inputs.

- Improve natural plant cover.

- Select and introduce crops suitable for the local environment.

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

The total budget of the first phase was 1,315,000 ECU (424,000 JD), of which the EC provided 700,000. The Jordan University contributed the balance. The budget of the second phase (1988-91) was estimated to be 1,134,746 JD, of which the EC would provide 625,494 JD, while Jordan University would provide the balance.

Range Improvement Project, IFAD 1991. This is a proposed project at Lajjun (Karak Governorate) and Ma'an (Amman Governorate). Estimated area is about 120,000 dunums (60,000 dunums at each location). The main objectives are to:

- Increase forage production through rehabilitation and improvement of range vegetation and controlled grazing.

- Improve forage quality through the reseeding of palatable and nutritious species and introduction of suitable fodder species.

- Increase local animal production and consequently, family income and standard of living of the range target group.

- Improve vegetative cover to improve the environment, protect the soil, and reduce desertification.

- Train local staff to secure and sustain project implementation and extend the development activities to other areas in Jordan.

The cost of the project was estimated at 2.3 million JD for the total area of 120,000 dunums. This cost did not include the cost to be covered by MOA, such as staff, personnel transport, training, and so forth. The cost is to be spread over five years.

3. POLICY OBJECTIVES AND STRATEGIES

3.1 Assumptions

Rangelands cover about 8.0 million hectares (about 89%) of Jordan's total land area. For this report they are classified, on the basis of annual precipitation, into two types: areas that receive less than 100mm, which includes most of the rangeland; and areas that receive 100-200mm.

Rangelands are deteriorating at an alarming rate as desertification encroaches on agricultural and even residential land. Theoretically, rangelands are Government lands, and it is the Government's responsibility to stop and reverse the desertification process by implementing rehabilitation programs. Range development programs should be accorded a high priority because rangeland is the most important renewable resource in the country.

The protection of rangelands is one of the most difficult tasks facing the Government at this time, and to ensure the success of any range project or program, the Government must encourage the local residents to actively support and participate in this process.

Rangeland rehabilitation and development projects or programs also need adequate Government funds for their implementation. The Government should also actively seek help from international donor agencies to secure funds for the implementation of rangeland projects and programs.

3.2 Objectives

A well-defined range policy should be formulated and implemented. The cooperative range policy, which was adopted by the Jordan Cooperative Organization (JCO), seems to be a good policy for use in Jordan because it ensures the protection, improvement, and management of rangelands on a large-scale basis and at the same time gains the support and participation of local rangeland residents, a key factor in any successful rangeland development program (Juneidi 1992).

The most important objectives of this policy will be to:

- Protect range areas and range reserves from unsound cultivation, fuelwood collection, and overgrazing; and establish new range reserves and demonstration plots.

- Apply sound rangeland improvement practices that will reverse the range deterioration process and lead to maximum sustained animal production (e.g., proper stocking rates based on actual grazing capacity, water harvesting and water spreading systems, reseeding, and fodder shrub planting operations).

- Conduct experiments and trials on all aspects of the range, investigating their economic and technical feasibility, recording the results, and disseminating relevant information to the stakeholders.

- Establish a Rangeland Department in MOA that has the mandate and adequate manpower and financial resources to carry out activities related to the protection, improvement, and management of rangelands.

- Increase fodder production by encouraging production in irrigated or rainfed areas.

- Increase animal production, which will result from increased fodder production from improved rangelands, rainfed areas, and irrigated areas.

- Reverse rangeland degradation by adopting well-defined range policy (e.g., the cooperative policy) and by mending and enforcing the present range law or drafting a new range law directed toward this new policy.

- Enhance wildlife habitat and restore wildlife through effective cooperation with the Royal Society for Conservation of Nature, which is currently responsible for several wildlife reserves in Jordan.

3.2 Specific Strategies and Alternatives

Prohibit plowing of rangelands. Plowing or cultivation is the primary cause of desertification. Large areas of the rangelands have been cultivated to produce cereal crops, which are usually profitable only once every seven years. This has resulted in the destruction of the natural vegetation cover, especially after the 1950s, when tractors where used to cultivate large areas easily and quickly. Another reason for cultivation of the rangelands is to claim ownership. It is imperative that this practice be stopped, even if it means implementing a new range law.

Develop plant cover in specific areas. Development of plant cover will help protect soil from wind and water erosion, thus increasing fodder production in range areas and consequently increasing livestock production.

Some range have been protected by fencing for more than 40 years, and studies of these areas have shown that protection by fences alone resulted in a considerable increase in vegetative cover and a fivefold increase in fodder production.

Planting fodder shrubs in these protected areas further increased fodder production. This practice has been supported by the Forestry Department (FD) in MOA and by the Jordan Cooperative Organization (JCO).

A total area of about 120,000 dunums and 50,000 dunums have been planted to fodder shrubs by the FD and the JCO, respectively (Tables 3.1 and 3.2). The main fodder shrubs were *Atriplex* species and *Salsola vermiculata* (IFAD 1991).

Protect and manage land of good productive capacity. Good productive rangelands are those that receive 100–200mm average annual rainfall. These lands should be protected from unsound cultivation, from uprooting of shrubs for fuelwood, and from overgrazing.

It is estimated that about 182 million shrubs are uprooted every year to be used as fuel by the local residents of range areas (FAO 1976), the second most destructive factor of range areas. The policy implication is that the Government should make alternative fuels available and possibly subsidize them. Overgrazing results from too many animals on the range or by keeping these animals on the same land for too long.

Discontinue distribution of land to eastern rangeland tribes. Distribution of eastern rangeland to local tribal individuals should be discontinued because such a policy puts the land under the control of individuals who are not concerned with conserving the nation's resources. They merely obtain as much temporary benefit as they can from the land by unprofitable cultivation of the land for cereal production, by uprooting shrubs for fuel, or by overgrazing.

Long-term leases of rangelands should be restricted to agricultural or range cooperatives, and these leases should be carried out only after the cooperatives have agreed to follow the recommendations of Government officials for rangeland development.

Impose grazing fees on public grazing lands. Imposing fees on protected or improved grazing lands will serve a dual purpose: first, there is direct revenue for the Government (or for the range cooperative if it exists). Second, it will enable the Government or the cooperative to regulate grazing capacity of the rangeland. All fees collected should be used to improve rangeland conditions in the area where they were collected.

Control movement of livestock across the national border. One of the main constraints to range development is the lack of coordination between Jordan and the neighboring countries concerning the migration of livestock and grazing rights. The Government must seek agreements to regulate the movement of livestock across the national borders.

Table 3.1: Range Reserves Established by the Ministry of Agriculture

District	Range Reserve Name	Year Estabished	Total Area (ha)	Average Annual Rainfall (mm)	Area Planted to Fodder Shrubs (ha)
Mafraq	Khanasreh	1940	455	200	300
Mafraq	Surra	1940	396	180	300
Ma'an	Fujij	1958	1,000	200	400
Amman	Dab'a	1968	300	120	50
Ma'an	Manshieh	1979	300	150	200
Mafraq	Sabha	1980	1,054	150	900
Karak	Lajjun	1980	1,100	150	1,100
Karak	S. Mujib	1981	976	150	400
Tafilah	Twaneh	1981	2,000	150	1,200
Ma'an	Ae'shieh	1983	1,000	100	750
Amman	Adasieh	1983	2,000	200	1,200
Ajlun	Rajib	1983	2,000	200	600
Madaba	Ma'in	1986	2,000	200	1,200
Ma'an	Ras-Nagb	1986	1,200	120	900
Zarqa	Wadi Butum	1986	1,500	80	100
Balqa	Eira	1986	2,000	250	1,200
Karak	Nikhel	1987	900	200	500
Zarqa	Azraq	1987	32,000	70	1,000
Madaba	N. Mujib	1988	1,000	150	500
Karak	New Lajjun	1989	5,000	150	100
Total			**58,181**		**12,900**

Source: IFAD 1991

Table 3.2: Range Reserves Established by the Jordan Cooperative Organization

District	Range Reserve	Total Area (ha)	Area Planted to Fodder Shrubs (ha)	Year Established
Madaba	Theiban	375	210	1980
Ma'an	Manshieh	300	140	1980
Ma'an	Qurein	700	700	1982
Karak	Lajjun	1,123	1,123	1983
Madaba	Bani-Hamidah	1,500	450	1987
Madaba	Salia	1,500	300	1987
Madaba	Ma'in	3,500	2,877	1988
Ma'an	Ali	62	62	1988
Total		**9,060**	**5,862**	

Source: IFAD 1991

3.4 Recommendations and Priorities

Establish a Rangeland Resources Department. A Rangeland Management Department should be established immediately in the Ministry of Agriculture. This department should have the mandates, qualified manpower, and financial resources necessary to carry out activities related to the care, development, and improvement of rangelands. It may be useful to establish a central Badia Authority, similar to the Jordan Valley Authority, to address rangeland problems.

Qualified Personnel. Range Management is a distinct discipline that requires a specialized study. Therefore, the Rangeland Management Department must be staffed with qualified range professionals if it is to successfully carry out its duties and programs. The department should also be provided with enough range technicians to assist the professionals in their day-to-day activities and to carry out field activities. Due to the lack of people qualified in range management, a training program that includes study abroad, as well as training in local institutions, should be started at the earliest possible time. Establishment of Range Management programs at Jordan's universities is essential.

Adequate Funds. To carry out its activities, this department must be allocated sufficient funds.

Plan and Conduct Needed Research Activities. Although the National Center for Agricultural Research Technology Transfers carries out some rangeland research activities, a detailed program of research activities should be planned and implemented by the proposed Rangeland Management Department. A research program could include the following activities.

- Determination of native and exotic plant species adapted to different rangeland sites. To increase the quality and quantity of fodder production in range areas, studies should be conducted on the introduction of new native and exotic trees, shrubs, grasses, and legumes. Priority should be given to native species such as *Acacia* species, *Prosopi specigera*, *Colutea istaria*, and *Atriplex halimus*.

- Rangeland Inventory. A rangeland inventory was conducted in 1956 by the Hunting Company to provide information for the planning of a national range management policy. A new survey is needed to compare previous range conditions with present conditions. This will enable the responsible staff department to plan development programs or projects based on scientific and realistic data.

- Studies on grazing capacity were conducted by FAO (1968) using the clipping method. Grazing capacities were estimated in different range reserves (e.g., Surra, Khanasri, Dab'a, Fujeij, and Jarba). New scientific studies should be conducted to develop a realistic figure on grazing capacity. Some studies on grazing capacity were conducted recently by NCARTT to survey the economic, social, agricultural and range systems within the pilot area. Another socioeconomic study was conducted in September 1991 on Lajjun Area (IFAD report 1991). Socio-economic studies should be conducted prior to the implementation of any management plan of range areas.

- Rangeland Economic Studies. In 1983, an economic study was conducted by UNEP for the Lajjun project (Karak Governorate). The objectives of this study were to increase by four times the safe carrying capacity of the rangeland and to increase the gross return per sheep from 10.150 JD to 22.050 JD. The cost of land rehabilitation was estimated at 22.066 JD per dunum, based on the following:

  Fencing 3.672 JD (1,500 JD per km), and erection of fences 0.918 JD

  Planting 14.314 JD, and preparation 3.162 JD.

  The technology selected is expensive, due to the high cost of fencing and high labor requirements for planting seedlings.

In 1986, another economic study was conducted at Wadi Duleil, which is located in the lower Zarqa River Catchment Basin. The project objective was to increase by five times the safe carrying capacity of the range and to increase the gross return per breeding sheep from an annual 19.50 JD to 28.50 JD. The average cost per reclaimed dunum on the project area was estimated at 3.051 JD.

In 1986, a prefeasibility study for desert lands (Badia) was conducted by a team of experts from USAID in cooperation with the Government of Jordan. The objective of the program was to increase by 7.5 times the safe carrying capacity of the rangeland under the option of range improvement based on simple soil and water conservation practices and control of grazing; and to increase the safe carrying capacity 10.8 times under the second option of range improvement plus the creation of a plant material center. The cost per dunum (rehabilitation plus seedlings) was estimated at JD 3.300 based on a 60-year period. Their economic analysis indicated an internal rate of return (IRR) of 17.75 percent for the simple range improvement option and 10.90 percent for the plant material center option.

Establish Rangeland Extension Programs. An intensive publicity and extension program is badly needed to educate rangeland users, local residents, and policymakers so that they can understand the importance of this natural resource and the beneficial effects of controlled grazing, and the harmful effects of overgrazing, uprooting of fodder shrubs, and unsound cultivation. This will be a major responsibility of the proposed Rangeland Management Department.

Promote Incentives for Field Staff. Once a Rangeland Management Department is established and staffed with qualified personnel they should be encouraged to work in the field. An intensive field campaign is needed to contact rangeland users and try to convince them to adopt sound and scientific principles of range management (e.g., controlled and rational grazing, use of liquid fuel instead of uprooting fodder shrubs for fuel, and stopping unsound cultivation of rangelands). This job requires a great deal of effort and is not limited to office hours. Therefore, it is essential that these officials have monetary incentives to do their jobs satisfactorily.

Rangeland Legislation and Law. To implement and enforce range policy, there should be a range law. The existing range law (Agricultural Law No. 20 of 1973) needs to be revised and amended to keep pace with the new proposed range policy, which is now directed toward the cooperative policy. This will be one of the main tasks of the proposed Rangeland Management Department.

It is important to realize that law by itself is not an instrument of resource management. Most of the existing relevant legislation has been drafted for specific sectors, but not from an integrated environmental perspective. The legislation has been generally negative in its impact and has usually stressed what should not be done without providing any guidance on how the problems should be solved (Juneidi 1992).

Effective legislation must consider the social and economic reasons for the misuse of resources, and should provide workable alternatives. Legislation should then be drafted in the context of a comprehensive and constructive resource management program. It is not simply a question of preserving the environment at the expense of the local population, rather the challenge is to find a way to provide the people with the opportunity to make a decent living without degrading the resource base.

However, it is very important that the modified range law indicate that utilization of rangeland should be through cooperatives, not individuals. Priority of utilization of rangelands should be given to range cooperatives only after they agree to implement development programs and management plans as formulated by the Government (Juneidi 1992).

4. SUMMARY AND CONCLUSIONS

The low rainfall zone (rangelands) receives less than 200mm of rainfall annually, and is the main and cheapest source of animal feed. It represents 89 percent of the total area of Jordan and its fodder production is about 400 million feed units, which contribute to more than 50 percent of the total livestock feed requirements. The livestock industry contributes about 32 percent of the agricultural production and 2 percent of the national income.

The condition of these rangelands is poor and it is deteriorating at an alarming rate due to the neglect of this resource during the last 40 years.

To stop and to reverse rangeland deterioration and to ultimately obtain maximum sustained fodder and animal production, MOA needs to take steps to overcome the obstacles to range development. The most important step is establishment of a Range Management Development Department to address all the problems of rangelands in the country and alleviate all constraints to range development. This department should have the authority and adequate qualified manpower and financial resources to carry out all activities related to the protection, development, and improvement of rangelands. One of the major tasks of this department will be to formulate and implement a well-defined range policy supported by appropriate Range Law and regulations.

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1. INTRODUCTION

The purpose of this report is to give a concise yet comprehensive account of the current situation of the forestry subsector in Jordan, of the policy framework in which it operates, and to draw conclusions and make suggestions for the improvement of subsector policies and the programs for implementing them. This improvement is based on proposed subsector policy objectives and a series of strategies to achieve them. These strategies include all levels of necessary policy actions—from the reaffirmation or adjustment of existing policies, their legislative and regulatory expression, the needs related to institutional strengthening, and the plans and programs for implementing these policy statements.

The report is divided into several chapters. Following the introduction, chapter 2 presents an assessment of the situation of the subsector. In addition to accounting for the physical conditions of the forest resource base, information is also provided about the contributions of the forestry subsector to the national economy. The latter element is particularly important and necessary as a justification for the intended changes and because hopefully, it will enable policy decision-makers to strengthen the arguments for attention and support to the subsector.

In chapter 3, a proposed series of policy objectives have been outlined along with the strategies that have been identified for the full development of the subsector. Each strategy has been considered in terms of its coherence with the overall objectives of the subsector development. Finally, an account is given of a workshop held in Amman to discuss the policy objectives and identified strategies with the stakeholders interested in the subsector.

2. ANALYSIS OF THE FORESTRY SUBSECTOR

2.1 Forestry Resources

Jordan has a total area of 89,725 square kilometers, located between northern latitudes of 29°11' and 33°22', and eastern longitudes of 34°59' and 39°12'. The country is bordered by Syria to the north, Iraq to the east, Saudi Arabia to the east and south, and Israel to the west. The population of Jordan is 3.9 million (1991) with an annual increase of 3.9 percent from 1980 to 1985. Approximately 20 percent of Jordan's inhabitants depend on the agricultural sector (1983 agricultural census) and it offers job opportunities to 38,000 laborers (1989), 7.2 percent of the country's work force. The forestry subsector provides about 11,000 job opportunities on a temporary or permanent basis. A classification of Jordan's forestlands and forests according to type and ownership is given in Table 1. (All tables are presented in the Appendix.) The areal distribution by district is given in Table 2.

Physiographic units. Jordan can be subdivided into four main physiographic units: the Jordan Rift Valley (Ghors), the mountain heights, the marginal steppe, and the eastern desert (Badia).

The Jordan Rift Valley (Ghors) extends from Lake Tiberias in the north to the Gulf of Aqaba in the south, is about 370 km long, and covers an area of 325,000 hectares. This unit is divided by the Dead Sea into the northern and southern Ghors. The climate is characterized by a very hot summer and a warm winter, resembling that of tropical zones. The soil is derived from sediments and differs according to their variation (Lisan sedimentation, Damia Lake sedimentations surrounding mountain sedimentations, and Jordan River sedimentation). The most productive agricultural lands of Jordan (35,000 ha) lie in this area. These are mainly irrigated areas, dependent on irrigation water from the Yarmouk River through the King Abdullah Channel, Zarqa River, and the side valleys of the Rift Valley.

The Jordan Rift Valley is poor in plant cover. From the remanent plant species still found in the valley, it is evident that the area was once covered with *Acacia* savannahs. The sparsely growing *Acacia* species in Wadi Araba and around the Dead Sea, the existing older *Ziziphus spp.* trees in northern parts of the valley, and other tree species (*Salvadora persica, Calotropis procera, Balanites aegyptiaca*) are proof of this claim.

At the northern end of the valley, the elevation is approximately 200 meters below sea level, dropping to about 400 meters below sea level near the Dead Sea, rising to about 200 meters above sea level in Wadi Araba, and finally dropping to sea level near the Gulf of Aqaba. Average annual rainfall varies from about 350mm at Shuna in the north to about 50mm at the Gulf of Aqaba. Average annual temperature ranges between 22°C and 25°C.

The Mountain Heights Region extends from the Yarmouk River in northern Jordan to Ras Al-Naqab in the south. It is bordered by the Rift Valley to the west and the Badia Desert to the

east, and covers approximately 550,000 hectares. The region is dissected at several locations by incised wadis such as Wadi Mujeb. Elevation is 800 meters above sea level in the Irbid area, rising to 1,000 meters in Ajloun and Balqa, and rising again to exceed 1,200-1,500 meters in the Tafila and Shoubak areas.

Rainfall ranges between 500mm (Ajloun and Salt) to 250mm (Shoubak) and decreases eastward. The average annual temperature ranges is 14-18°C. More than 80 percent of the country's settlements are located in this region and the bulk of agricultural activities are being practiced (rainfed agriculture, horticulture, forestry, irrigated agriculture, etc.). Most of this region's land is composed of limestone and basalt. There are indicators that some large areas evolved under a more humid climate than that presently prevailing. Deep soils are found in areas with a slope of less than 8 percent. Vertisols occupy areas with a slope of less than 5 percent; inceptisols can be found in central areas with an inclination of less than 12 percent. The main soils are used to cultivate field crops. Entisols, found on slopes greater than 12 percent, are of medium mixture, shallow, and suffer from continuous erosion. Forest vegetation, either natural or artificial, covers about 76,000 hectares (approximately 14%) of the mountain heights region.

The Marginal Steppe Region, a transition zone between the Mountain Heights Region and the Badia, stretches from the Naqab in the south to the Syrian border and eastward to the Iraqi border. It comprises an area of about 1 million hectares and receives an average annual rainfall of 100-200mm. This region includes the most potentially productive rangelands of the country, and it suffers from misuse, overgrazing, uprooting of the remaining shrubs, and uncontrolled traffic movement.

The Eastern Desert (Badia) Region covers about 7 million hectares, receiving an average annual rainfall between 200mm in the western part and 50mm in the eastern part, and consists of a plateau with an elevation of 600-800 meters, rising to the east. The desert climate is hot in summer and cold in winter; average annual temperature range is 18-21°C.

Bioclimates. Jordan falls within the Mediterranean bioclimate, which is characterized by winter rainfall, prolonged dry, warm summers, and general aridity. Long (1957) classified the sites, according to Embergers rainfall/temperature quotient, into four main bioclimatical zones.

1. **Sub-Humid Mediterranean Bioclimate**. Covers 1.2 percent of the country's total area; average annual rainfall exceeds 600mm. This bioclimate is found in the Salt and Ajloun Districts (warm and cool varieties).

2. **Semiarid Mediterranean Bioclimate**. Covers 8.3 percent of the country's total area; average annual rainfall is 300-600mm. This type of bioclimate and the main areas of its occurrence are between Irbid and Amman, around Madaba, and around Kerak.

3. **Arid Mediterranean Bioclimate.** Covers 19 percent of the country's total area; average annual rainfall is 150-300mm. This bioclimate is subdivided into:

- The cool variety, which covers the eastern slopes of Ajloun and the Amman-Madaba plateau. It is transitional between the semi-arid and arid bioclimates, found in the Mafraq and Jiza area.

- The warm variety, which covers the steppe portions to the west and the east of the highlands from north to south characterized by the Zarqa area.

- The very warm variety, which covers the upper part of the Jordan Valley, characterized by Deir Alla, Wadi Al-Jirm, and north Shounah.

4. **Saharan Mediterranean Bioclimate.** Covers 71.5 percent of the total area of the country; average annual rainfall is 25-150mm, with occasional rains or no rains at all. The Saharan Mediterranean bioclimate is subdivided into:

- The cool variety, which covers the northern portions of the eastern desert, characterized by Azraq, Ruwaished, and Safawi.

- The warm variety, which covers the southeastern part of the country and is characterized by Ma'an, Jafir, and Bayer.

- The very warm variety, which covers the lower portions of the Jordan Valley, Dead Sea area, Wadi Araba, and the area between Aqaba and Mudawarah.

Forest Vegetation Areas. The forest vegetation (natural or artificial) in Jordan is classified (for the purpose of this study) into natural and man-made forests.

Natural Forests include the following subclasses:

- Coniferous Forests (3 types)

Pinus halepensis forests. Pure stands of *P. halepensis* cover only a small area (1,098 hectares) in the Dibbin Forest within the Jerash District. Mixed forests of *P. halepensis* and *Quercus coccifera*, which occur naturally around Zai village (Salt District) and in the area between Jerash and Ajloun, cover an area of about 3,000 hectares. The remaining pine trees south of Fuheis indicate that *P. halepensis* covered a much larger area than at present. *P. halepensis* forests are found on white calcareous soils deposited on limestone rocks and marls at an altitude of 550-1000 meters (above sea level) in areas with annual rainfall of 500-700mm.

Juniperus phoenicea forests. *J. phoenicea* grow on the western slopes extending from Tafila to Wadi Musa through Shoubak. *J. phoenicea* forms pure stands on the Nubian sandstone, or is associated with *Pistacia atlantica* in Buseira (Tafila district). *Quercus coccifera*

forests occur side by side with juniper but are restricted to calcareous soils. Juniper forests cover an area of about 7,660 hectares of very steep slopes of unsettled land. These lands are at altitudes of 850-1500 meters and have annual rainfall of 200-400mm, although juniper occurs in areas where precipitation is even less than 200mm. The soil type found in juniper forests, deposited over sandstones, is a light brown, sandy loam with very little humus.

Cupressus sempervirens forests. A small stand of this type of forest can be found in a depression at an altitude of 1,500 meters near Ein Lahda. It is a very important gene resource for this species, and this area is now protected and being managed as a seed stand.

- Broad-leaved Forests (evergreen and deciduous)

Evergreen broad-leaved forests:

The main element of the Evergreen Broad-leaved Forest is *Quercus coccifera*, which is found in the northern region (Salt, Jerash, Ajloun, Amman) associated mainly with *Pinus halepensis, Olea europea, Quercus infectoria, Ceratonia siliqua, Quercus aegilops, Arbutus andrachne*, and with *Daphne linearifolia* and *Colutea istria* in the southern areas (Tafila and Shoubak). In the northern region, *Quercus coccifera*, and the associated trees cover an area of 19,118 hectares from Wadi Elsir in Amman district, to Deir Abu Said in the north, at altitudes of 600-1,000 meters above sea level and between the rainfall isohytes of 500-700mm. The soil in this type of forest is red to brown Terra Rossa formed on limestone rocks. The physical nature of the soil is sandy loam. In the southern regions, *Quercus coccifera* is an extremely drought resistant variety that occurs between isohytes 200-300mm. It occupies the western slopes of the Tafila-Shoubak mountain range at altitudes of 1,100-1,700 meters. The total area covered by this southern type is 5,916 hectares. The soil type is calcareous, sandy loam.

Wild olive (*Olea europea*) covers about 410 hectares mostly north of the Zarqa River in Burma village in the Jerash district, and in Kufranja village in the Ajloun district. Wild olive grows mixed with *Quercus coccifera, Q. aegilops*, and *Pistacia palestina*.

Deciduous Broad-leaved Forests:

Quercus aegilops forests. The main tree species is *Q. aegilops*, which is associated with *Pistacia atlantica, Ceratonia siliqua*, and *Styrax officinalis*. The total area covered with this type is 4,194 hectares, extending from Al-Bahath village in the Amman District in the south to the Yarmouk Valley in the north. This type can also be found in Al-Alouk (to the west of Zarqa District). It occurs at altitudes of 100-750 meters above sea level and between the isohytes of 400-500mm average annual rainfall. The soil type is light to dark brown Terra Rossa formed on limestone rocks.

Quercus infectoria forests. The total area of the forest dominated by *Q. infectoria* is 95 hectares. It occurs mixed with *Q. coccifera* to the east of Shtafeina and Shatana at an altitude of 900 meters on areas receiving 700mm annual rainfall.

Grasslands:

Scattered Acacia grassland:

This is the characteristic vegetation type of areas near or below sea level, and extends from the southern shores of the Dead Sea to the Gulf of Aqaba in the south through Wadi Araba. This area is extremely dry and warm. Average annual rainfall does not exceed 50mm, and so the acacia, which requires more soil moisture, is therefore confined to wadi bottoms and desert depressions. The soils are terrestrial gravels and alluvial sands. The main species are *Acacia spirocarpa* and *A. raddiana* (in Wadi Araba area), *A. seyal* (in Ram-Mudawara area), accompanied by *Ochradenus baccatus, Calligonium comosum, Salvadora persica, Balanites aegyptiaca, Haloxylon persicum, Retama spp.*, and *Tamarix spp.* The area covered by forest shrubs is estimated at 200 hectares.

Scattered Ziziphus grasslands:

This type is confined to the shores of the Dead Sea and Jordan Valley. The main species are *Ziziphus spina-christi* and *Z. lotus* associated with *Calotropis procera, Prosopis stephaniana*, and *Tamarix spp.* The vertical range of *Ziziphus* grasslands is from 400 meters below sea level to higher altitudes in protected side valleys running to the Jordan Valley from the east. The distribution of this type is between the isohytes of 100-350mm. They occur on well-aerated sandy loams. The area covered by forest trees and shrubs is estimated to be 350 hectares.

Man-made Forests:

These areas have been established as plantations during the last 40 years, and cover about 35,400 hectares. The species used in plantations are either local (*Pinus halepensis, Cupressus sempervirens, Ceratonia siliqua, Tamarix spp.*, and *Pistacia spp.*) or exotic (*Pinus pinea, P. brutia, P. canariensis, Acacia spp., Eucalyptus spp., Casuarina spp., Cupressus spp., Prosopis spp.*, and others). Man-made forests include relatively thin belts of roadside plantations of about 1,000 km, windbreaks and shelterbelts of about 10,000 km, and plantations along wadi courses of about 100 km length.

Forest Productivity. The natural forests of Jordan are of relatively poor quality and grow slowly due to the harsh environmental conditions under which they exist (eroded, rocky, steep, poor sites) and the misuse and exploitation they have undergone for generations. The first forest inventory was carried out in 1964, although it excluded volume and increment measurements of the forests in southern Jordan because they covered only a small area, they were highly degraded, and they occurred on very steep slopes. The northern forests were classified according to species associations, height, and canopy density into nine classes (Table 3). Standing volume and volume increment per hectare were estimated for each class (Table 4).

The forests in the lower Zarqa River Basin were inventoried by the Zarqa River Basin Development Project (Pancel 1990) during 1988-1990. According to this inventory, the total

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volume increment (for all forest types) per year is 3,573 m^3 of wood and the average increment is 0.345 m^3/ha/year. These results are similar to those for other forests in similar climatic conditions. Also according to this inventory, the highest production comes from natural *Pinus halepensis* forests (0.782 m^3/ha/year with average density of 523 trees/ha). The pine plantations also have relatively high production (0.748 m^2/ha/year with average density of 906 trees/ha). It is important to note that the annual increment values are higher in forests of higher density.

Other important information related to the economic status and value of the forests in Jordan includes:

- Jordan's current volume of standing timber is approximately 2.3 million m^3.
- The average volume of standing timber per hectare ranges from 10 to 70 m^3 per hectare.
- The annual increment per hectare ranges from 0.2 to 4.0 m^3/hectare/year.
- The total annual increment is approximately 150,000 m^3 with an estimated value of 5 million Jordanian Dinars.
- Annual cutting in the forests currently produces about 12,000 tons of wood and fuelwood.
- The annual value of forest revenue ranges from 150,000 to 200,000 Jordanian Dinars and includes timber, charcoal, fuelwood, licenses, fees and fines.

All natural forests in Jordan need to be reinventoried. This activity is the main task of the Forest and Rangeland Development Project (JOR/92/004/A/01/13), which is financed by UNDP/FAO. The forest plantation inventory, carried out during 1988-90, provided valuable information about man-made forests in Jordan, especially the pine plantations. The values of this inventory show great variation among different site conditions such as climate, topography, age, density, and associated species.

2.2 Forestry Activities

The principal forestry activities being carried out in the country are: protection of forests, expansion of forest cover, utilization of forests, range management, and wildlife and habitat conservation.

2.2.1 Protection of Forests, Forestlands, and Trees

In order to safeguard the forests (public and private) and secure their protection, the Ministry of Agriculture (MOA) and the Department of Afforestation and Forests (DAF) recruits forest guards and forest watchmen and organizes their training and posting, and supplies them

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with the necessary means to implement the laws and regulations concerning forest protection. To ensure the effectiveness of the forest guards, a certain amount of forest protection infrastructure has been established for the forest areas. It includes forest stations, watchtowers, a country-wide wireless radio system, forest roads, fire lines, vehicles, and water tanks for irrigation.

Although only in its early stages, a forestry extension program is being implemented to increase public awareness of environmental questions and of the need to protect the forests. Despite these efforts, the forests of Jordan are vulnerable to various types of damage (see Table 5), which are briefly discussed below.

- **Grazing.** Grazing is the major problem for forestry in Jordan. Although legally prohibited in forests and plantations, grazing still takes place in natural forests and sometimes even in new plantations. This illegal grazing causes the disappearance of natural vegetation; and as a consequence, the increase of water runoff, soil erosion, and the reduction of natural regeneration; finally, therefore, a reduction in the overall productivity of the forests.

- **Illicit Cutting.** Villagers are allowed to obtain firewood for their domestic requirements by pruning trees and collecting dry branches of fallen trees and fruits from both government-owned and private forest. Illicit cutting, however, still occurs in both private and government forests. Fortunately, however, this type of damage has been declining in recent years, both in the number of offenses and the trees damaged, due to the tendency of farmers to use other fuel sources (butane gas or petroleum products) as substitutes for firewood and because of the increased awareness of the population.

- **Encroachment on Forestland.** Some people who live in areas adjacent to the forests construct buildings or houses on government forestlands or use the government lands for crop or fruit tree production.

- **Forest Fires.** Fire is another of the principal hazards for forest development in Jordan. Over the years, relatively large areas (and large numbers of trees) have been affected by fires (see Table 6). To overcome this problem, in 1979 the MOA through the DAF introduced a wireless communication system and constructed an extensive network of fire lookouts and stations for early detection and communication. To control forest fires, well-trained fire fighting crews patrol the forest areas with their tools, equipment, and vehicles. As a result of the above activities and of increased public awareness, the number of forest fires and of fire-damaged trees have significantly decreased in recent years.

- **Smuggling.** The transportation of forest products and materials must be fully licensed by the MOA and DAF, otherwise they are considered smuggled goods and should be confiscated.

- **Forest Pests and Diseases.** Forest insects and diseases are not a major problem for Jordanian forestry and their effect is negligible, except for some plant parasites in certain areas. Natural disasters can sometimes be of great importance. For example, heavy snow during the winter of 1992 resulted in damage to more than 75,000 trees. Some of the damaged and accumulated timber was extracted in a desperate attempt to avoid further biotic and abiotic catastrophes associated with this downed timber.

2.2.2 Expansion of Forest Cover

Reforestation, afforestation, and tree-planting are the most important activities of the department at this time. In this context, the main activities being carried out are:

- **Collection of Forest Seeds.** These activities are primarily concerned with meeting the needs of the forest nurseries. In addition, in July 1992, the Forest Seed Center was established within the DAF with assistance provided by the German Technical Cooperation (GTZ). The objectives of this center are to secure high-quality forest seeds through:

  - Selection and establishment of mother trees, seed stands, and seed orchards
  - Collection of seeds of selected species
  - Processing, testing, and storage of seed material
  - Certification of collected seeds
  - Handling of forest seeds
  - Experimentation on the most appropriate methods for germination of local forest species

- **Production of Forest Seedlings.** The annual production of forest and shrub seedlings has increased from 1.8 million seedlings in 1953 to nearly 7 million seedlings in 1992. These seedlings are produced in thirteen forest nurseries in different regions, representing the different bioclimatic zones of the country (Table 7). About half of the seedlings produced are planted within the annual afforestation and range reserves revegetation program of the DAF. The rest of the production is distributed free of charge to public and private institutions. Large numbers of seedlings have been donated to neighboring countries (Iraq, Kuwait, and Saudi Arabia).

One-year-old forest seedlings are raised in polyethylene bags. The species regularly raised in nurseries include *Pinus halepensis* (9.2%), *Pinus pinea* (2.4%), *Cupressus sempervirens* (7.3%), *C. macrocarpa* (1.0%), *C. arizonica* (2.9%), *Acacia cyanophylla* (11.8%), *Atriplex spp.* (21.6%), *Eucalyptus spp.* (4.1%), and *Casuarina spp.* (5.0%). These production figures are for

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the period 1992-1993. The production cost for seedlings is calculated to be on average 214 Fils (JD 0.214) per seedling, is based on the production of 2,000 seedlings.

- **Plantations.** The main objective of the DAF is to protect existing natural forests and expand the forest cover on all government forestlands. Therefore, high priority is given by the DAF and other government authorities to the establishment of new plantations. Accordingly, relatively high budget allocations are made for this purpose. Reforestation efforts are carried out by planting containerized seedlings on terraces prepared either by hand or by machinery. The main species used in these programs are *Pinus halepensis, P. pinea, Acacia cyanophylla, Eucalyptus camaldulensis, Casuarina equisetifolia, Cupressus spp., Ceratonia siliqua, Prosopis spp.*, and *Tamarix spp.* In recent years, special emphasis has been given to the use of indigenous species such as *Quercus spp., Amygdalus communis,* and *Pistacia spp.*

Table 8 shows the development of planted areas from the start of reforestation activities to the present. The average establishment cost for 1 dunum[1] of plantation is 68.800 JD (see the breakdown of plantation costs in Table 9).

2.2.3 Utilization of Forest Areas

Since Jordan has a limited forest area and the average growth rate is relatively low (until now), the forests are managed mainly for their protective values; that is, their main function is soil and water conservation and environmental protection. In government forests, tree cutting used to be limited to dry, defective trees, and to trees that blocked planned forest roads or firebreaks. Tree felling is done either directly by trained DAF laborers or by contractors. The cutting operations are mainly carried out using chainsaws although handsaws and axes are also used.

Most locally produced forest products come from private forests. The owners are allowed to prune or cut trees that grow on their lands with a commitment to replace them with fruit trees after carrying out the necessary soil conservation measures. They can also cut, tend, or thin forest trees planted as windbreaks around their fields or along their water channels. Tree cutting operations are licensed by DAF/MOA according to the existing Agricultural Law and related regulations. Transportation of forest products, forest products manufacturing, and handling operations also must be licensed by DAF/MOA. Table 10 provides a summary of forest products produced from government and private forests in the period 1970-1992.

2.2.4 Range Management

Rangelands constitute about 91 percent of the total area of Jordan. These lands currently suffer deterioration and desertification at an increasing rate due to misuse of the soil and

[1] There are approximately 10 dunums to the hectare. The present (1993) exchange rate of Jordanian Dinars (JD) to U.S. dollars is: JD 0.68 = US $1.

vegetative cover. Due to financial, technical and socioeconomic reasons, the DAF/MOA can only carry out range management activities in mountainous regions and marginal areas that are registered as forestlands and where no tribal claims are recorded.

Range management as such takes into account three main aspects:

- **Protection of Rangelands.** Rangelands are protected for a specified period (not less than 3 years) against grazing, cultivation, and uprooting of range plants, which will allow the natural vegetation to recover. Protection operations started in 1946 on a limited scale. There are now 20 protected locations (range enclosures; see Table 11) with a total area of 661,063 dunum. Protection operations generally include guarding and fencing.

- **Range Development.** Development includes conducting soil conservation practices, water harvesting/spreading practices, planting fodder shrubs, and reseeding of suitable range plants. Table 12 shows the areas improved in range enclosures.

- **Grazing Management.** The first controlled grazing operations in range reserves took place in 1977 in the Rajib reserve with the introduction of 3,000 head of sheep for one month. The operation was successful and encouraging. Therefore, the decision-makers decided to open other reserves in the following years. In every year since 1989, a comprehensive grazing program, both in forests and range reserves, has been carried out with careful consideration given to the grazing capacity of the land. Free grazing in the forest is prohibited by Agriculture Law No. 20 of 1973. The same law gives the right to the Minister of Agriculture to issue grazing licenses to farmers allowing them to graze their animals in the forests and range reserves. Accordingly, controlled grazing can be carried out in natural forests which have no natural regeneration, in man-made forests more than fifteen years old, and in range reservations on plantations older than three years. Grazing by goats is completely prohibited in forests. In range reserves, both sheep and goats are allowed to graze.

2.2.5 Wildlife and Habitat Conservation

Jordan is located between Asia, Europe, and Africa and has four different biotopes (Oriental, Afrotropical, Palaeoarctic, and Desertic). The presence of these biotopes provides a wide range of diverse habitats and therefore protection of Jordan's rich biodiversity is extremely important. There are more than 70 species and subspecies of mammals, 350 species of birds, 73 species of reptiles, 4 amphibian species, and 18–20 freshwater and 1,000 marine fish species, and about 2,300 species of vascular plants. To conserve the habitat with its fauna and flora, the government started planning and establishing wildlife reserves (see Table 13).

Agriculture Law No. 20 (1973) provides the legislative base for the protection of wildlife. A voluntary organization—The Royal Society for Conservation of Nature (RSCN), established in 1966 under the patronage of His Majesty King Hussein—is dedicated to the protection of

wildlife and its habitat and the regulation of hunting. The RSCN functions under the umbrella of the MOA and its duties include:

- Protection of natural flora and fauna
- Reintroduction of extinct species
- Hunting regulation and control
- Establishment and management of wildlife reserves for the protection of flora and fauna
- Protection of marine life
- Prevention of environmental pollution and countryside littering
- Public environmental education to improve natural resource management and to reduce environmental damage

2.3 Forestry Subsector Contribution to the National Economy

The forests and forestlands of Jordan contribute to the national economy in three basic ways: the production of goods (commodities); the provision of services (environmental influences and amenity); and, through the social and economic impacts of the sector.

2.3.1 Forest Production

Although the protective functions of Jordanian forests are rightly considered their primordial contribution, the forests, woodlands and forestlands do indeed contribute directly by producing valuable forest products such as roundwood, fuelwood, charcoal, and nontimber forest products.

Forest products outputs. Primary forest products may be categorized under three broad headings:

- Roundwood includes the wood produced from pines, cupressus, casuarina, eucalyptus, and poplar from both government and private lands. The quality of the wood is relatively low by international standards, and is used locally to manufacture container boxes for fruits and vegetables. On a smaller scale, poplars can be used to partially meet the demands of the match industry. Table 10 and 14 show the amount and value of locally produced forest products.

- Fuelwood includes all the wood materials produced from broad-leaved forest species such as oaks, acacias, pistacia, carob, and others. This wood is very low quality and can only

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be used for fuel for cooking, baking, heating, and charcoal making, and on a small scale, for the manufacture of wooden implements used in farm services (Table 10).

- Charcoal, which represents a substantial portion of the fuelwood produced (especially from private forests), is used in restaurants and barbecues. Charcoal produced from oak trees is the highest quality and commands the highest prices. Locally, other species are rarely used to make charcoal. Farmers generally use traditional techniques to make charcoal, and the DAF, to improve the charcoal-making process and reduce losses and waste, imported a kiln and trained two technicians in its use for improved charcoal production techniques. This kiln was used only once and then abandoned because of uneconomic production resulting from government procedures. It is assumed that the same kiln, managed by private entities, would result in a reduction in operating costs and an increase in quality and quantity of the produce. Table 10 indicates the amounts of charcoal produced.

Nontimber Forest Products. Available records do not reflect the real dimensions and the diversity of use of nontimber forest products. Large amounts of these products are produced from private forests and are used at the home-level without licenses and thus without exact records. These nontimber forest products include foods from both plants and animals.

- **Plants:** Many rural people are dependent on forests for critical portions of their food supplies, especially in dry years. These foods include the fruits of oak, pistachio, carob, ziziphus, rubus, and rhus species. Little is known about the quantities produced, the seasonality of production, or its variability from year to year, and thus it is difficult to assess their relative importance as food sources. Broadly, forest plant foods can be categorized according to the part of the plant or the type of plant: leaves (*Laurus nobilis*, and many wild grasses found in Jordanian forests); seeds (*Pinus pinea, Pinus halepensis, Amygdalus communis*, and *Pistacia spp.*); fruits (*Ceratonia siliqua, Olea europea, Quercus spp., Crataegus azarolus, Celtis australis*, and *Ziziphus spina-christi*); tubers and roots (of wild grasses and wild plants found in forests); fungi or mushrooms; gum and sap.

- **Wild Animals:** Forest wildlife is the second main category of food derived from the forests. For local people living in the vicinity of forests, natural woodlands, and forest fallow areas, wild animals can provide a significant source of animal protein. Smaller wildlife (game) such as rabbits and birds have real importance, while larger mammals such as *Gazelle spp., Copra ibex*, and *Oryx lencoryx* have largely been exterminated. Hunting of small game and larger animals is often carried out illegally. Some wild animals play an additional role in facilitating the production of food from trees and agricultural crops through their action as pollinators, especially wild bees, and as natural predators of insect or rodent pests. By maintaining a portion of forest cover within farming areas and providing a habitat for wildlife, the agricultural benefits gained from animals can be preserved at the same time a certain supply of wild food is ensured.

Collectively, these nontimber forest products add diversity and flavoring as well as protein, energy, vitamins, and essential minerals to the human diets. Mushrooms are favorites in many parts of Jordan, especially in Jerash, Ajloun, and Irbid districts, and are often consumed as meat substitutes. Forests and wild plants are considered the main sources for honey bee fodder and breeding, especially after the extensive use of pesticides for protection of agricultural crops in other areas. The honey collected each year in Jordan varies from 70 to 160 tons. The stone pine plantations that were established by DAF/MOA are expected to produce enough pine nuts within 5-10 years to meet the needs of the country. Some private and government stone pine plantations have already started to produce.

During the Christmas season each year the DAF prepares trees obtained during pruning and thinning operations and gives them free of charge to anyone interested. This operation is designed to protect trees from illegal cutting. In 1992, for the first time, the DAF, with the assistance of the Jordanian-German Forestry project, organized the sale of 200 Christmas trees potted in 30-liter containers, which were sold for 10 JD each. There is also a great potential to produce humus, through the fermentation of chipped wood, which could be used by the DAF and sold on the market.

Sand, Soil, and Stone. Sand, soil, and stone extraction is forbidden on government-owned areas covered completely or partially by natural or man-made tree cover. In bare areas of forestland, small sites can be rented on a temporary basis for sand extraction or for stone quarries. The rental procedures are carried out by the Department of Lands and Survey after approval by DAF/MOA. and in accordance with the Government Properties Release and Rent Law No. 60 of 1964 and its amendments. Technical issues for mining operations such as supervision and licensing are carried out by the Natural Resources Authority of the Ministry of Energy and Mineral resources. For such purposes, the government earns a rent of 300 JD per dunum. The rental contract and mining license requires the renter to refill the mine or quarry with soil and plant it with forest trees after mining, but up to now, this condition has not been fulfilled.

Seed and Plant Material. Because of its geographic location and its diversity of flora, Jordan can take the lead in production of some seed species through its Seed Center (section 2.2.2). These species include *Pinus halepensis, Cupressus sempervirens, Pistacia spp., Pyrus syriaca, Salvadora persica, Ceratonia siliqua, Juniperus phoenica*, among others.

To market its products and thus increase the income for the government, the center has adopted two price lists for its seeds: one for domestic sales and one for international sales. As the center is newly established, it needs more support from different entities to ensure the full implementation of its program and activities and the attainment of its national and international objectives.

Forestry, Medicinal Plants, and Nutrition. The linkages between forestry and human health and nutrition are extremely important. Many intestinal diseases in Jordan cause

malnutrition by preventing the absorption of food by the body. Disease also debilitates and can affect food production by reducing labour efficiency during peak periods in the agricultural calendar. For a large proportion of the local population in Jordan forests provide the only medicines available. Many studies and observations have catalogued the use of medicinal products gathered from the forests, and many species contain high concentrations of chemicals that are the base for modern drug equivalents. For example, *Crataegus azarolus* contain flavonoids, luleolin, isoquercitrin and nicotine; *Dedonaea viscosa* has saponin, citirol, tannin, glycosides, and flavonoids; and *Nerium oleander* has neriin, oleandrin, folinerin, and toxic materials. It is very difficult to find a forest tree which is free from medicinal compounds.

Some trees have properties that can directly affect the quality of water supplies; *Moringa optera*, for example, is used to clarify turbid water. The seeds of the tree contain natural coagulants that can clear water to tap water quality in 1 to 2 hours. The elimination of turbidity is accompanied by a 98–99 percent elimination of indicator bacteria. Thus the use of *Moringa* seeds can provide a low-cost water treatment technology, thereby improving the health of rural communities.

Handicrafts. The wooden handicraft industry has limited importance in Jordan. Governmental efforts to develop this industry are limited and most of the activities are carried out by NGOs who act through rural development societies. The forests are the source of the wood raw material for this industry. Local forests produce good-quality wood that can be worked with many types of small tools. The species of interest are olive, pistacia, carob, juniper, and oak. Another of the traditional handicrafts is basket weaving. The raw material for baskets comes from the reeds of *Fragmyites communis*, which grow along water courses. Different types of pine cones, oak acorns and other tree fruits, flowers, and branches could also play a role in decorative handicrafts.

Farm Forestry. Within settled agriculture areas, the most widespread direct contribution of forests to food production is through food-producing trees on farm and fallow land and around the homesteads. Home gardens are found in Jordan in most ecological regions although the majority are concentrated in highland regions. The average size of a home garden is usually less than 0.5 hectare. Food production is the primary function of most home gardens and much of what is produced is consumed by the household; therefore people concentrate on fruit-bearing forest trees, or wild trees that can be grafted with different fruit varieties.

Every year more than one million seedlings of multipurpose species and hedge plants are distributed to residents free of charge. The trees include multipurpose trees, hedges, flowering trees, and bushes and species useful for windbreaks in addition to fruit trees and other crop-producing species. The preferred multipurpose trees in Jordan are *Ceratonia siliqua, Pinus pinea, Amygdalus communis, Rhus cariaria*, and *Ziziphus spina-christi*.

Agroforestry. Over the last decade, a great deal of attention has been focused on the development potential of agroforestry. Agroforestry techniques seek to combine both the production and protection functions of selected tree species by incorporating them directly into

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the farming practices. Agroforestry-type practices, which have been followed in Jordan for centuries (although the expression agroforestry is very new), can help maintain soil organic matter, promote nutrient cycling, reduce soil erosion, and improve the microclimate. Under some circumstances, incorporating woody trees on farmland can result in marked improvement in soil fertility. A systematic inventory and study of the agroforestry techniques already applied in Jordan and their possible potential has not yet been carried out.

Trees and Shrubs as a Source of Livestock Fodder. Another very important way in which trees and shrubs contribute to food security in Jordan is by providing fodder for livestock. In some cases, such as with the *Acacia spp.*, trees are deliberately planted for their fodder and foliage and then are often lopped for stall feeding. More commonly, livestock is allowed to browse on trees and shrubs growing naturally or in older man-made forests, under managed grazing arrangements supervised by the DAF. Fodder from forest areas, whether browsed or harvested, helps to sustain livestock production and ensure a year-round supply of milk and meat products. The amount of fodder materials extracted from the Jordanian forests is estimated at 30,000 tons dry matter.

Trees and shrubs are particularly important in pastoral production systems, where they are recognized as an essential component. The range of woody species that are used for animal fodder in Jordan is extremely wide. The importance of browse depends on the type of livestock and the palatability of the plant species. Camels and goats are great consumers of leaves and small branches of woody species, while cattle and sheep rely mainly on grasses and annual herbs. In many Jordanian pastoral areas, fodder from trees and shrubs is an indispensable part of livestock diets. This is particularly true during the dry season when the herbaceous layer is reduced, especially in late summer, autumn, and winter, and the nutritional quality of the herbaceous layer is markedly poor. Animals eating only dry grass without fodder from trees and shrubs would suffer from malnutrition, both because of the shortage of energy and protein and because of the lack of vitamin A and essential minerals, especially phosphorus.

An increasing problem is the growing pressure on tree fodder resources. Overgrazing leads to reduced regeneration of trees and shrubs and destruction of the vegetation cover. On rangelands, possibilities also exist for increasing livestock productivity through greater use of tree and shrub species. A number of species have proved to be of particular potential, for example, *Atriplex nummularia, Atriplex halimus, Prosopis spp., Acacia spp., Ceratonia siliqua, Ziziphus spina-christi*, and *Quercus spp.*

2.3.2 Forest Protection Function

An important part of forestry sector concerns in countries around the world is the impact of the forests and trees on the general environment—a discipline known as forest influences. This discipline is very important in the arid countries. The role of forests and trees in Jordan is perhaps most important as it relates to watershed management and the impact on the hydrological cycle and the supply of water for human consumption and for irrigation. Sustainable food production depends on a favorable and stable environment, and forest and tree

cover can control soil erosion and help maintain fertility. Similarly, forests and trees can have climatic influences that ameliorate the harsh extremes at both the macro and micro levels. Trees and green areas provide shelter, amenity, and recreational opportunities for society, which are very much appreciated.

Watershed Stability. In a country such as Jordan, where almost every citizen is cognizant of the limitations to the water supply, the impact of forest cover on groundwater supply and stream flow is an important issue. More water of better quality is released from forestlands into streams than from land under other uses. By slowing the runoff of rainfall and improving the conditions for increased water infiltration, an overall increase in groundwater levels, and hence a recharge and increase of wells and springs, can be reached under forest cover. Hydrological systems are complex, however, so the assumption that forest cover can have a significant and positive impact on water supply is not always true. Much depends on parent material, density of the forest cover, type of species and other factors.

Forests in Jordan play a variety of useful watershed management roles. Excessive storms and the floods they cause can have disastrous impact on downstream agriculture, an effect that can be observed each year in the Jordan Valley and other catchment areas of the Kingdom. When forestland is converted to agriculture, the effect on storm flows depends on the type of agricultural practices that were introduced. Unfortunately, too often in Jordan, conversion from forest to agriculture has a negative effect on the land because there is a failure to safeguard the soil and water conservation needs of the sites. Cropping or grazing methods that cause soil compaction and that expose the soil for prolonged periods tend to reduce infiltration rates and result in more water entering streams than would be the case if the land were still forest, thus increasing the likelihood of floods. By breaking up the soil and improving infiltration, trees help to increase water storage capacity. The specifics of these effects depend on the local site conditions.

Experiments performed within the Ziqlab catchment area (Irbid District) demonstrated that soil erosion in the bare land was as much as 6–300 times greater than the erosion that occurred in forest areas. Removing forest, and leaving the soil exposed, radically increases the rate of soil erosion and flooding. It is very clear in Jordan that the flooding occurs every year in the desert areas, steppe, and on the bare slopes of the Jordan Valley due to the lack of forest and vegetation cover, while the flooding does not occur in the forested and vegetation rich mountainous areas, although rainfall and slope are more pronounced.

Forests, Sediment, and Water Quality. Sustainable food production depends on water quality as well as quantity. High levels of sediment and dissolved minerals in rivers and streams can have a variety of negative effects on downstream agriculture and fisheries as well as on people's nutritional well-being. By helping to preserve the quality of water supplies, trees and forests play on important role in maintaining food security. Water quality is directly linked to the prevalence of human diseases, especially gastrointestinal disorders, which directly affect people's ability to absorb food.

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From the point of view of nutrient cycling, undisturbed forests are the most efficient of all land use systems. These systems are even capable of removing and immobilizing some potentially harmful pollutants that are rain deposited. Forests also reduce sediment yields from watersheds. In studies in Jordan, it was found that sediment yield from areas that had been reforested was only one-quarter of that from an agricultural watershed.

Removal of the forest, partially or completely, breaks this tight chemical cycling and releases minerals and nutrients into the drainage water. The effects of increased sediment levels are usually serious. It can bury crops in floodplains, especially in the lowland near the Zarqa River and other valleys, clog the gills of fish within the rivers and near coasts, damage marine fisheries, impair the quality of drinking water leading to increased prevalence of diseases, reduce irrigation reservoir capacity, block irrigation canals, and aggravate flooding by filling up flood control dams. These phenomena are very clear in the King Talal Dam and other dams in Jordan. Studies in the lower Zarqa catchment area showed that forests can reduce the sedimentation and erosion by as much as 75 percent. It is estimated that reforestation programs could increase the useful life of the King Talal Dam by five times.

Forestry and Food Production. Trees and forests can have an impact on food production by influencing soil, water, temperature, and light regimes. The influences of forest cover on agricultural productivity include the following:

Windbreaks and Shelterbelts: One of the most widely recognized benefits of forest trees on their immediate environment is their ability to reduce wind speeds. Farmers in many parts of Jordan use windbreaks or more elaborate multispecies shelterbelts to protect crops, water sources, soils, and settlements. In addition, windbreaks are the essential first steps to stabilizing sand dunes.

There are numerous examples that can be cited. Tall rows of casuarina and cupressus trees line thousands of canals, border irrigated units in the Jordan Valley and steppe areas, and surround the rainfed orchards and farms in the highlands of Jordan. In the desert, irrigated areas are also protected through windbreaks against desertification, especially in Azraq, Moduwwara, and Desi areas. Reducing wind speeds helps substantially in preventing damage from wind erosion. This includes damage due to the loss of nutrient-rich topsoil, growth loss, damage as a result of physical injury to crops, or the partial burial of fields. Soils are most susceptible to wind erosion when they are dry and bare. Thus, overgrazing or any cropping activity that removes the plant cover makes soil more vulnerable to wind erosion. The hazard increases with the length of time the soil surface is bare and with the degree of soil dryness, which is severe in most of the deserts in southeastern Jordan.

A well-developed windbreak or shelterbelt can considerably reduce wind velocity at the soil surface. Where the barrier is at right angles to the wind direction, the effect is 30 to 35 times the height of the windbreak to the leeward, or downwind, side. Small

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reductions in wind speed can have a significant impact on soil erosion, partly because the drying of the soil is reduced after rainstorms.

A windbreak with a mixture of different species, an approach seldom used in Jordan, provides an efficient semipermeable wind barrier. In addition, a mixture of species reduces the risk from unexpected pests. In Jordan, more than 10,000 km of windbreaks have been planted and about 1 million forest seedlings are distributed annually for this purpose.

Moisture Availability and Soil Conservation: Trees influence the availability of soil moisture in their immediate vicinity. The interception of precipitation by tree foliage influences the amount of moisture reaching the soil. In addition, a tree influences the distribution of moisture once it reachs the ground surface. Soil erosion caused by water is a serious problem for agricultural production in different areas of Jordan. It strips the most fertile top layers of soil, and can destroy crops by flooding, which occurs every year in Jordan especially in the areas which lack a forest cover. Forests and trees can provide protection against some types of water-induced soil erosion. Surface erosion caused by water in undisturbed forests is generally nonexistent.

As slopes increase, in both steepness and length, the dangers of erosion increase. A variety of soil conservation techniques can be used to reduce erosion on slopes. When physical measures, such as terracing, are combined with tree planting, water erosion could be prevented. This is precisely the work that the DAF encourages farmers to carry out annually for their sloping fields and other areas. In addition, leaf litter falling into fields from adjacent trees can add both organic matter and nutrients that are essential to agricultural productivity. It is also widely recognized in Jordan that combining trees with other soil conservation techniques can greatly extend the possibilities for sustainable crop cultivation on sloping land.

Forest, Climate, and Atmosphere. One of the most important ways in which forests influence the human environment is through their effect on the climate by altering rainfall pattern, temperatures, and seasonal climate variations. Due to Jordan's limited forest area, the effect of the forests on the country's climate is likely to be very limited and only applicable to local sites.

The closed canopies of forests absorb more solar radiation than any other vegetation type and reflect less heat back into the atmosphere. Deforestation may affect the local climate and even, to a lesser extent, the regional climate. Forests fix carbon by their biomass production and thereby contribute directly by reducing atmospheric carbon dioxide while simultaneously releasing oxygen to the atmosphere.

Forests also play an important role in removing dust from the atmosphere. They perform this atmospheric purification on the mountainous heights and limit the influence of dusty winds that blow toward the cities in the steppe areas. Locally, windbreaks and trees reduce the dust

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in desert areas. They take part in providing the residents of such areas with a healthy environment. The forests also help neutralize the poisonous gases, smokes, and car exhausts that are becoming ever more common in the expanding urban areas of the country.

Tree cover in Jordan, as in other arid countries, helps to moderate air and soil temperatures and increase relative humidity. This becomes clear when meteorological data (collected by Meteorological Department) from forested areas are compared with data from bare lands in Irbid, Karak, and Shoubak. These effects are generally beneficial to crop growth, a fact that is made use of in many agroforestry systems in the country. The extent to which these benefits are realized in practice depends on the number of trees involved. From an isolated scattered forest in Madaba, Mafraq, or Kerak, only a minor and localized effect could be expected, while in Ajloun, Jarash, and Tafila, the closed forest cover could provide a beneficial effect on humidity and temperature.

Some studies have reported a decrease in rainfall after forest decline, and others have noted an increase following reforestation. However, this effect depends on many factors such as extent of forest cover, available air humidity, prevailing wind directions and speeds, and so on. Although there may well be some relationship between forest cover and rainfall, the extent to which the climate has been altered in Jordan by the decline of the forest cover is difficult to verify. Further study is needed to ascertain if the changes that have occurred in the last 100 years are related in fact to the availability of plant-induced humidity.

Shade and Amenity. The shade cast from trees can have both negative and positive effects. Shade on crops or pasture near forests or trees reduces the crops' photosynthesis and beyond a certain point it will reduce their growth rates. However, because trees alter temperature and humidity as well, these factors may more than compensate for the reduction in light. Shade is also desirable in animal husbandry, particularly in a hot climate like the one in the Jordan Valley and other areas of Jordan, especially in the summer time.

The shading and amenity of forest trees in Jordan is very important for tourism and recreational purposes. It is now common to see the residents sitting under the forest trees, road side plantations and even under individual trees. For this purpose, several national parks were established in Dibbin-Jerash, Ishtafina-Ajloun, Zaij-Salt, and Um Al-Kundum-Amman. More than two million residents visit the forests of Jordan several times annually for its shading and amenity. Forests also help diminish the noise from vehicles, factories, and other human activities.

Protection of Critical Areas. Tree roots can substantially increase the stability of slip-prone slopes, especially important along roads and highways. It is clear in Jordan that an effective and important method for stabilizing the cut-and-fill areas of the road system and other unstable slopes is through planting forest trees and shrubs. The DAF plants trees and shrubs along about 100 kilometers of roadside every year for this purpose. Forest trees, because of their deeper root systems, stabilize slopes much more effectively than crops, grass, or fruit trees. Studies suggest that the removal of forest trees can increase the frequency of slides by as much

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as seven times. Additionally, vegetative protection of hazardous sites has the advantage that with age its positive effect increases, while those of physical structures have a natural limited life span.

In environmentally sensitive areas, such as some parts of Amman and some villages in the Karak and Weilih area, forests play an important indirect role in enhancing food security by protecting cropland, buildings, and grazing areas from natural hazards such as landslides. In such hazardous areas, the removal of forests can seriously jeopardize agricultural production, and the effect of landslides on human settlements can be disastrous.

Forest trees, in addition, can help stabilize river-banks and prevent erosion damage and flooding during storms. In streamside areas that are experiencing problems (e.g., Zarqa River, Jordan River, Wadi Hassa, Wadi Kerak, Wadi Kufrenga, and many other wadis) establishing a forest strip can be an important supplement to man-made structural measures. Landslides, in addition to the immediate physical destruction they cause, dump large amounts of sediment into streams, roads, rivers, and dams, which also affects the quality of the water and the holding capacity of reservoirs. These examples were very clear in the lower Zarqa catchment, especially near the Amman-Jarash highway and near Naour in the Amman District and along the Amman–Dead Sea road.

Although Jordan's coastal areas are very limited and ocur in very dry areas in Aqaba and the Dead Sea, trees playan important role in protecting coastlines against wave damage during storms. They also protect settlements and agricultural land adjacent to the sea from the effects of saline winds.

Areas Prone to Salinization. Soil salinization and related phenomena are among the most serious problems threatening land productivity in arid and semiarid regions characteristic of Jordan. In the irrigated areas of the Jordan Valley, Azraq, and irrigated farming in the steppe and desert areas where salinization has already taken place, the introduction of forest trees can often help rehabilitate the land for agriculture. Forest removal will result in increased salinization. Certain forest trees can tolerate high salinity and can reduce the salinity in the lands by absorbing significant amounts of salty water and helping to lower high water tables, a common cause of salinity in such soils.

Sand Dune Stabilization. Moving sand dunes pose a major threat to agriculture in southeastern Jordan. Studies show that more than 80 percent of Jordan lies under the direct influence of desert climate, and the rest lies under the indirect influence of the same climate. Forest trees and bushes can play an important part in stabilizing dunes and preventing the damage they cause. The maintenance of vegetative cover, as complete as possible, and reduction in wind velocities by windbreaks, are often the best ways to prevent soil movement. Soil loss due to wind erosion in the desert area of Jordan exceeds 200 tons/km^2/year. In these areas, the planting of forest trees and bushes as windbreaks and man-made forests may be a prerequisite to facilitating the natural regeneration of the vegetation cover. In such areas, agricultural cultivation alone will not suffice for the reclamation of land.

Forests and Genetic Resources. Forest environments provide a habitat for a great diversity of plant and animal species, which makes them an important key to protecting the biological resources of the country. Jordan lies within the basin of the Mediterranean Sea, and its animals and plants are similar to those of southern Europe and North Africa. Jordan is also home to the lowest land on earth, which extends from the Gulf of Aqaba to the Araba Valley to the Dead Sea, Tibres Lake, and Holah Plain. The hot climate of this low-lying region and its animals and plants are similar to those of East Africa. Hence, one can find some African animals like the Palestine Sun Bird, the African crocodile (formerly found in the Jordan River), and various other African animals. African plants can be also found: *Acacia spp.*, *Ziziphus spp.*, *Calotropis spp.*, and *Albizzia spp.*

Forest areas represent the largest single store of genetic diversity. The species they contain—both known and yet to be discovered—may have a critical role to play in providing the genetic variation needed to combat the ever-adapting pests and diseases that prey on food crops. They may also provide a range of entirely new foods and medicines—of both plant and animal origin—that could have a major impact on human health and nutrition.

The forests of Jordan play an important role in the maintenance of biological diversity because the variety of the plant groups are among the most wealthy in the world. The locally variable conditions have led to an extensive variety of very rich genetic resources. The forests contain the main elements guaranteeing the continuity of these species. They form shelter for birds, insects, animals, and other living creatures and various wild plants. The number of rare plants is estimated at 250 species and the number of the endangered species at 150, while the number of extinct species exceeds 30.

It is increasingly recognized as both a moral and practical imperative that these genetic resources be preserved. Conservation of genetic resources using gene and seed banks through the forestry seed center will undoubtedly be important. There are limitations to these methods, however, so the conservation of species within their natural habitats will have to play the major part in genetic resources conservation.

2.3.3 Socioeconomic Contribution of the Subsector

The forestry subsector makes a positive contribution to socioeconomic conditions in the country through employment, revenue generation for the government, and forest products trade.

Employment. Forestry, annually, provides about 1,000 permanent and 10,000 seasonal job opportunities in the administration, management, and protection of forests, and in the plantation and seedling production activities. Most of the job opportunities provide employment for rural populations in remote rural areas and thus help reduce the emigration from rural to urban areas. The seasonal forestry activities enable the farmers to improve their income while at the same time continuing to practice their regular farming activities on their own lands. The income generated from forestry activities improves the quality of life for the farmers and helps to meet their needs related to the education of their children and family health care.

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The food material (wheat or wheat flour, vegetable oil, sugar, pulses, and others) provided by the World Food Programme and distributed to workers (in addition to their wages) helps to improve the conditions of the employees and encourages them to contribute to forestry activities.

All the employees, permanent and seasonal, are managed through the Civil Service Law or the Labour and Laborers Law and are subject to the retirement regulations according to the Civil Retirement Law, or Social Security Law, and its conditions. In addition to direct job opportunities provided by DAF/MOA through its activities, there are indirect job opportunities provided by the private sector in such forestry activities as:

- Merchandising and transportation operations of forestry products
- Manufacturing and processing of forest products such as: charcoal making, carpentry works, handicraft works, mining of sand, rocks, and gravel
- Collection of plant parts and grasses form forestlands such as thyme, flowers, medicinal plants, in addition to benefits gained from grazing operations

There are no available records on the number of indirect beneficiaries of the forestry subsector, but in any case, this number is not less than the total number of direct employees of forestry subsector.

Revenue Generation for the Government. The forestry subsector contributes a considerable amount to the government budget. Revenues are generated from the following (see Table 15):

- **Licenses:** DAF/MOA regulate activities, either private or governmental, that involve utilization of forest products such as manufacture, handling, transport, and grazing by requiring licenses.
    - Forest utilization licence: for cutting trees from forests. The fee for each license is 0.5 JD, in addition to 0.2 JD /ton or m^3 of wood as wood material fees.
    - Charcoal manufacturing licence: for the manufacture of wood into charcoal. The fee for each licence is 0.5 JD.
    - Forest products handling license: this license enables its holder to merchandise forestry goods. The fee is 1.0 JD.
    - Grazing licence: grazing has to be licensed. The herders of the flocks must obtain grazing licenses. The fee is 0.5 JD in addition to 0.05 JD/head for grazing in forest areas (usually two months) or 0.002 JD/head/grazing day in range reservations.

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- Forest products transportation license: for transportation of wood products. The fee is 0.25 JD.

- **Fines:** Fines are the consequence of transgressions on forests by cutting, burning, grazing, encroaching on land and smuggling of forest products according to court judgment, and follow the articles of Agriculture Law No. 20 of 1973.

- **Confiscation:** If forestry products are transported or handled without a license and their source cannot be determined, that means they have been smuggled and should be confiscated. The confiscated products are sold for the benefit of the government after issuance of a court order according to Agriculture Law No. 20 of 1973 and its regulations.

- **Sale of forestry products:** All forestry products generated from government forests, roadsides, and public lands are subject to sale for the benefit of the government. Sale operations are carried out in two ways: Sale according to official prices provided by law, or sale by auction to the highest bidder. Because market prices for forestry products are higher than official prices, sale by auction is the usual practice.

- **Rental of forestlands:** Bare forestlands can be rented for:

  - Agricultural use, if irrigation water is available, to grow vegetables, fruit trees, and fodder plants

  - Mining of sand

  - Stone quarries

  Mining licenses are issued under the Authority of Natural Resources of the Ministry of Energy and Natural Resources after approval by DAF/MOA. The rental procedure is carried out by the Department of Lands and Survey (DLS). Revenues from the rental of forestlands go to the central budget through DLS; due to lack of data, they are not reflected in this report.

Commercial Forest Products Trade. Revenue from forest products for the commercial sector is derived from:

- **Locally produced forest products:** These forest products are sold by owners, either directly or through contractors (middlemen), to the carpentries or wood sellers. There is no set price, the market and the agreement between the seller and buyer determine the price of forest products.

- **Imported forest products:** Because the domestic forest products cannot meet the country's needs, especially of industrial wood products, Jordan is dependent upon

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imported forestry products. Table 16 shows the imports and re-exports of these imported products compared with total government imports and exports.

2.4.1 Institutional Framework

The Department of Afforestation and Forests, a part of the Ministry of Agriculture, is the government entity responsible for the management of all forest and soil conservation in the country. The department consists of the following divisions (see Figure 1):

- Afforestation and Nurseries
- Planning and Studies
- Range
- Protection and Utilization
- Land and Survey
- Soil Survey and Land Classification
- National Plantation
- Administration Division

In each district of the country, there is a Divisional Forestry Office under the control of the Agriculture Directorate. The Forestry Office is staffed by a forest officer, forest rangers, and forest guards in the field. The Divisional Forest Officers hold university degrees while the

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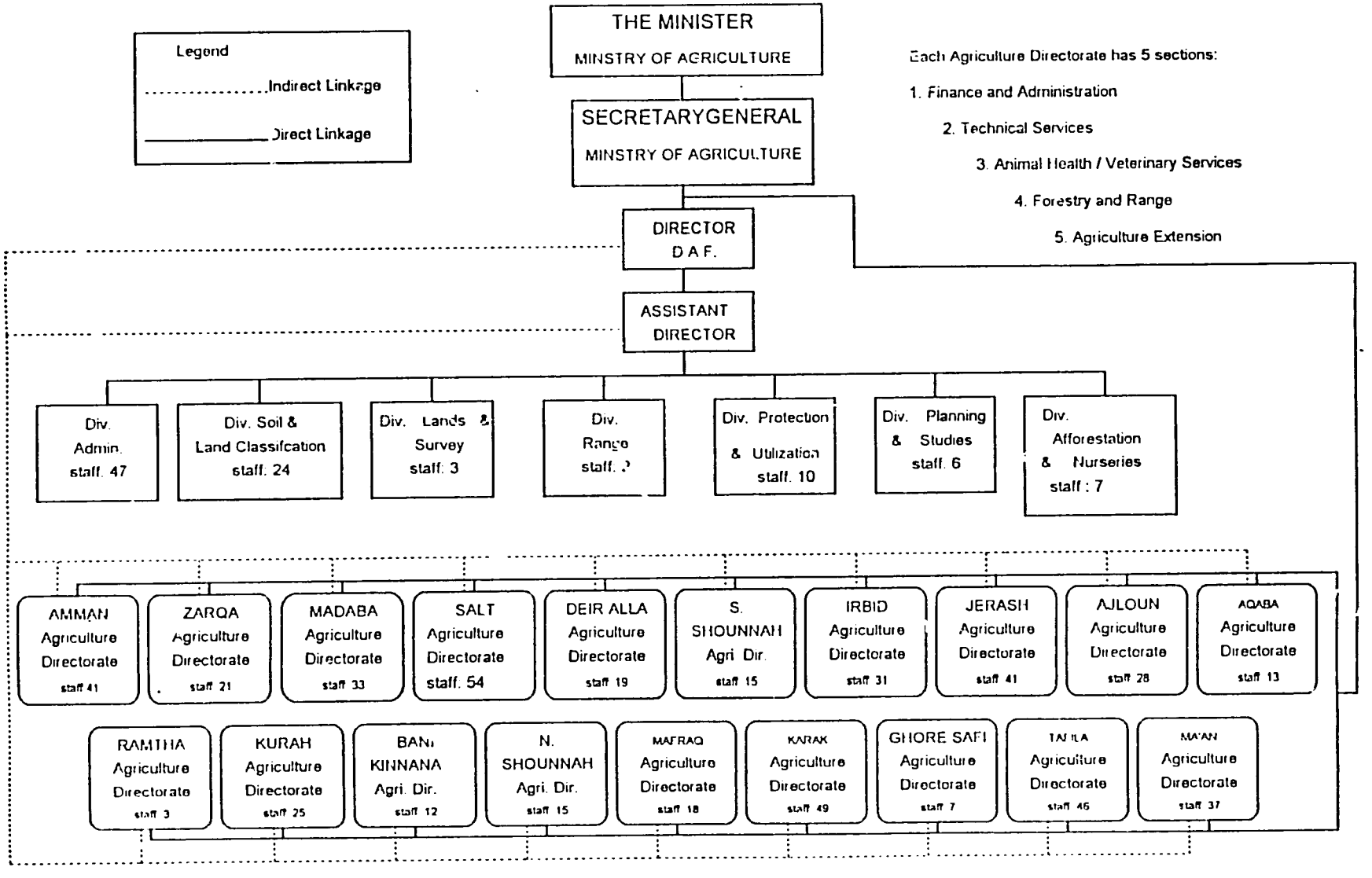

Figure 1. Organizational Chart of Department of Afforestation and Forests (DAF) as of 31 July 1993.

forest rangers hold diplomas and are graduates of the Forest Ranger Schools at either Latakia, Syria, or Cyprus. Forest guards are either graduates of a secondary agricultural school or have received in-service training. The Forests Department has a total staff of 525, 90 of whom work at the headquarters at Kamaliya-Amman; the rest are distributed in 19 Forest District Offices.

2.4.2 Legislative Framework

The first forestry law was established in 1923 and was followed by various forest legislation: the Wood and Forests Law (1927), the Prohibition of Grazing Goats in Forests (Act 13 of 1952), the Compulsory Tree Planting Law (1953), and the Compulsory Afforestation Law (1961). This legislation was fragmentary and inadequate because it was unrelated to overall forest policy. For example, the Wood and Forests Law of 1927 was the basic law administered by the Forests Department, but was generally inadequate because it did not apply throughout the country and contained no objectives nor definitions. The law also overestimated the production potential of the forests and prescribed protection measures scarcely suitable for enforcement.

Such laws did, however, lay a foundation, and served the country well in the early stages of forestry administration. At the present stage of development, even the existing Agriculture Law No. 20 (1973) no longer meets the requirements and still has a lot of gaps. It has failed to conserve the forests and does not adequately address the new understandings of the importance of forests and their role in environmental protection and food security. A revised and comprehensive forest law is needed that incorporates existing laws and sets out additional provisions.

2.4.3 Forest Ownership

Forest areas in Jordan are either owned by the government or are owned privately.

- **Government Forest Areas** are those areas registered as forestland in the name of the Jordan Government Treasury. They have a total area of about 130,900 hectares and can be subdivided into the following classes:

  - Natural forests: Totaling an area of about 300,000 dunums, covered completely or partially with natural forest vegetation.

  - Artificial forest plantation: These are government forest areas planted with forest tree species during the last 50 years, with a total area of 354,000 dunums.

  - Unforested forestlands: These lands are registered as forestlands in the name of the Government Treasury but are presently bare of forest cover. They are characterized by rough topography, poor conditions, soil erosion hazards, and overgrazing. The area of such lands is estimated to be about 600,000 dunums.

- Unsettled forest areas: These include areas covered completely or partially by forest trees, but that are still unsurveyed or unregistered. The total area of unsettled forest areas is estimated at 122,000 dunums. These areas are, in principle, government forestlands under the disposition of the DAF administration. They are located on the southern highlands facing Wadi Araba, and are characterized by very harsh climatic conditions. In the higher areas, they are dominated by *Juniperus phoenicea, Quercus calliprinos*, and *Pistacia atlantica*; the lower-lying Wadi Araba and Wadi Rhum-Mudawara areas they are dominated by *Acacia spp.*

- Range enclosures: Range enclosures are being established on areas registered as forestlands or as Government Treasury Land. The area of such range enclosures is about 600,000 dunums. These areas are being developed by planting fodder shrubs such as *Atriplex spp.*, *Acacia spp.*, and *Prosopis spp.*

- Roadside plantations: These amount to about 1,000 kilometers length of roadsides. All the roads and the trees planted belong to the government and are managed by the DAF.

- Wadi courses with forest vegetation: All wadi courses are owned by the government, and the management of vegetation growing along and within these courses is one of DAF activities.

All government forests, either registered in the name of the Jordan Government Treasury as forestlands or declared as forestlands such as unsettled forests, road side plantations, wadi course vegetation, and all forest trees growing on lands belonging to government institutions, are managed by DAF according to Agriculture Law No. 20 of 1973. The ownership status of these lands is regulated through the Government Property Law No. 17 of 1974 and Government Properties Release and Rent Law No. 60 of 1964.

- **Private Forests** are registered in the name of their private owners and are found mostly in the northern part of Jordan where higher rainfall prevails. They are covered partially, or in a few cases, completely, with forest trees. Private forests consist of natural forest vegetation and private forest tree plantations on farms, in the form of windbreaks and shelter belts. The area of natural private forests was estimated in the 1964 inventory to be 54,000 dunums. This figure has decreased by at least 15 percent due to the replacement of forest trees with fruit trees. The planted private forest trees are mainly irrigated and kept for windbreaks.

  Although precise figures are not available, the irrigated areas of the Jordan Valley include about 7,000 kilometers of windbreaks.

  Private forests are not more than 4 percent of the total declared forestlands or 7 percent of areas covered by forest trees. They are managed according to Agriculture Law No.

20 of 1973. These forests consist of small scattered parcels partially covered by broadleaf species, which are typically of lower wood value and only useable as fuelwood. The owners view their forest trees as obstacles to maximum use of their land; and therefore, they tend to clear-cut these trees and replace them with fruit trees. The DAF acknowledges their ownership and right to use their land for other agriculture production. The current Agriculture Law permits them to cut the existing forest trees on their lands, according to a schedule that ensures the replacement of these forest trees by successful fruit trees, after suitable soil conservation measures have been taken.

There has been an increased demand for forest seedlings in recent years as farmers, especially in the eastern parts of the country and in the Jordan Valley on irrigated lands, have realized the importance of planting forest trees as windbreaks around their farms. The private irrigated forest plantations are of relatively high value because of their relatively good growth performance and wood production in addition to their role as windbreaks.

2.4.4 Donor Projects

Over the years, Jordan has received technical and financial assistance in different fields of forestry. The assistance was either in the form of technical assistance or financial support including provision of equipment, training, fellowships, and study tours.

The first assistance was received from the United States in the 1950s through the program known as "Point Four." This was followed in the 1960s and 1970s by forest management and soil and water conservation programs financed by UNDP/FAO. These programs and projects were very effective and contributed to the conservation of the forests. The data collected and the changes proposed for forest policy highlighted the importance of the forestry subsector. The projects' activities included forest inventory, forest operations, nursery management, training and studies, and forest and range management.

The most effective assistance to the forestry subsector has been the technical assistance provided by the German government through the German Technical Assistance Agency (GTZ). This program started in 1974 and will last until the end of 1993. It has included different phases and in each stage a certain field and certain activities were developed. At the start in 1974, the program provided the Forests Department with the heavy machines used for forest road construction, site preparation, forest nurseries, and improved transportation. A Forest Training Center was established in 1978 and completed in 1980. That year, a new phase for improving nurseries and afforestation techniques was begun. A wireless communication system was also introduced for fire fighting in 1983 when the project concentrated on forest fire fighting, training, and improvement of different fields of forestry. In 1990, the final phase started, concentrating on the establishment of a seed center, a monitoring and evaluation system, and training of the department staff.

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Additional assistance has also been provided by: UNDP, FAO, WFP, USAID, IDRC/Canada, and by the governments of the Republic of Korea, Turkey, United Kingdom, Sweden, and Italy.

2.4.5 Subsector Finance

The Government of Jordan is fully aware of the importance of the subsector and its objectives and the necessity of extending its activities, but financial shortages and other government priorities do not presently permit a suitable increase in government allocations to the forestry subsector. To overcome this problem in part, the government has tried to involve other institutions in some forest operations, for example, reforestation by army members, school students, and youth clubs. The results of these contributions are still far below expectations.

In 1992, in response to requests by the DAF, the Cabinet agreed to establish a "National Plantation Project" aimed at the participation of community and private institutions in plantation activities on government lands allocated specifically to these individual institutions. Special legislative arrangements for this project were set up and a special account was opened in the Central Bank. Communication with different institution has already begun and a considerable positive response has been recorded. Some forest plantations have already been started under this project and will greatly enhance government efforts to extend the forest area.

The subsector is entirely administered by the DAF and its financing is in line with the National Five Year Plan. Each August, the budget for the DAF is defined and forwarded to the respective committee within the MOA. Thereafter, the Cabinet decides on the final level of the following year's financial commitment for the subsector. This procedure has been in place since 1972. Prior to that, the Forests Department budget was independent of the MOA, which had advantages over the present situation in that the Forests Department could carry out direct negotiation for its own finances within the government and could better allocate funds according to activities.

The effective allocation of finances (see Table 17) covers only the labor costs assigned for afforestation and production of nursery material. Salaries for regular government employees and operating costs (fuel, maintenance, etc.) are not included. According to rough estimates, however, the latter make up at least 50 percent of the finances of all activities within the subsector.

In general, present finances do not meet the requirement for important activities such as range development, protection, forest management, and the land and soil survey. The current budgetary situation is already having negative effects; for example, the outdated heavy machinery used does not allow the department to achieve its set performance targets.

Besides the budget provided by the government, additional funding and support contribute to the operational capability of the subsector. This is particularly true of the World Food Programme. Food rations are added to the forestry labor wage to improve the income of the

poor. The daily labor wage rate of 2.5 JD is supplemented with the addition of food valued at 0.750 JD. Without this addition, most of the works could not be financed. On the other hand, the budget set aside for reforestation labor wages is tapped by the MOA for operational costs such as for the payment of about 150 drivers of the MOA. This situation is less then satisfactory and needs a thorough and urgent solution.

2.4.6 Revenue Generation

As mentioned above, Jordan's forests are managed primarily for their environmental and social values. Obtaining direct financial benefits from the forestry subsector is not a priority of the government and therefore the cost-benefit concepts are not rigorously applied when considering the financial returns to forestry. In spite of this, the forestry subsector contributes to the government budget a considerable amount of revenue, which could cover 5-10 percent of government expenditures on the subsector. The generated revenues of the forestry subsector are derived from (see Table 15) fees for licenses, fines, confiscation of illicit forest products, sale of forestry products (wood and non-wood), and rent of forestlands

The above revenues do not exhaust the existing potential for revenues within the subsector. Income could also be generated on a sustained yield basis from selling seedlings at production cost and other products such as seeds, grass, medicinal plants, fruits, and others.

2.5 Government Policies Related to Forestry

After 1922, when the Emirate of Jordan was established, forest policy was implemented through different laws and regulations. The policy was changed from time to time depending on the decision-makers and the needs of the people.

Until 1960, forests did not have the benefit of any proper or regular management nor were they administered through a properly formulated forest policy. In spite of the enactment of the first forest law in 1923, the forests of Jordan received excessive and uncontrolled use, which caused deterioration of government forests and even disappearance of much of the privately owned forest. Efforts of the Forests Department to protect even the areas under their jurisdiction were not effective in the absence of a proper organization of the forest areas.

From 1960 to the present, some changes have occurred in forest policy, and written policy statements did produce some dramatic effects. A forest policy statement was drafted in 1955, although it was not adopted officially. It was redrafted in 1963 to further define the aims and objectives of the forestry subsector in the country and the means to attain them. Although the Forests Department has been in existence for more than 40 years, no comprehensive Government Forest Policy has yet been announced. A comprehensive forest policy for Jordan was drafted by FAO in 1967, but this policy has not been officially adopted, although parts of it were followed and considered within this period.

The forestry policy prepared in 1967 included the following elements:

- Adoption of a land use system whereby each type of land is allocated for the type of use under which it would produce most and deteriorate least.

- Conservation of existing forests, particularly in mountainous regions, which are key to the regulation of the water regime and watersheds, particularly the perennial water supply of rivers, streams, and springs.

- Soil and water conservation to prevent erosion and restore vegetative cover wherever necessary.

- Establishment of trees and forests wherever possible for the amelioration of the physical and climatic conditions of the country and for the general well-being of the people.

- Production of the timber, fuelwood, and other forest products required to meet the people's needs from existing or man-made forests on a sustainable yield basis.

- Regulation to the fullest extent possible of the use of land suitable for grazing and pasturing.

- Meeting the needs of the population for recreational areas and the improvement of the country's landscape.

- Preservation of both fauna and flora.

- Protection of agricultural lands, irrigation schemes, and public infrastructure such as roads.

- Regulation of the use of all land other than public land with regard to forest cover, grazing, watershed management, and soil conservation.

- Meeting the needs for research and education in forestry, range, and soil conservation.

- Protection of forest, range, and watershed resources.

Although this policy contains very important points, the strategies and the activities applied to achieve these policy goals were not stable enough to achieve the desired impact. In fact, in certain instances, the activities and strategy applied were contrary to the policy; for example, allowing uncontrolled grazing within the forests, permitting forest cutting to open roads or to be planted with other agriculture crops, plowing the marginal areas, and other activities that affect the forests negatively.

Thus, the history of land use in Jordan is one of steady and continual destruction of many forms of plant life and, particularly, of forest cover. The principal agents of such destruction have been:

- The repeated cultivation of every patch of soil, large or small, deep or shallow, fertile or poor, on hills and mountains regardless of slope and productivity of the site.

- The uncontrolled cutting and uprooting of all woody growth, trees, and shrubs for fuel and other domestic purposes whether found on mountain slopes or in the arid lands and deserts.

- The excessive and unregulated grazing of every accessible patch of land by large numbers of goats, sheep, and camels without regard for the capacity, maintenance, or improvement of the resources.

- The mechanized plowing of vast semiarid desert lands for raising chance crops of annuals, mainly cereals, regardless of rainfall inadequacy and drought in successive years.

These problems are still occurring, perhaps even at an accelerated rate, and the soils of Jordan are rapidly and progressively disappearing or deteriorating beyond the recovery stage. The areas with soils that can support any kind of vegetation are dwindling rapidly, and this reduction in area results in increasing pressures and excessive use and mismanagement of those areas that can still support vegetation.

Forest resources represent a major part of the country's rainfed area, and thus government policies from many different sectors affect forests and the activities related to them. Within this complex situation, it is possible to identify government sectors that have a pronounced influence on different aspects of the forestry subsector. These are: the agriculture sector as a whole, the public works sector, and the educational sector. Some specific examples of the effects of these policies include:

- **Subsidies for animal feeds:** At present, the government subsidizes different animal feeds at different rates (barley 35-40%, sorghum 35-40%, bran 10-15%). The consequences are that animal densities are higher than the actual carrying capacity of the range and thus grazing is much more intensive and range regeneration almost impossible.

- **Ownership regulation:** Despite the government's decree that forbids plowing in areas with annual average precipitation less than 150mm, plowing is carried out in these areas to establish customary ownership rights, which results in wind and water erosion of already fragile environments. This policy leaves a grey zone of uncertainty, and clearer legislation and stricter law enforcement is needed.

- **Road construction:** At present, road construction does not follow a planning approach that considers the environmental feasibility of the road designs, and the construction areas of roads are not secured on a regular basis through protective plantations. Such measures are indispensable to avoid road-induced landslides and destructive erosion, which also endangers the newly constructed roads.

2.6 Constraints to Forestry Development

Constraints in a number of areas need to be addressed if future forest policy is to achieve its objectives. These include resource limitations, and technical, institutional, legislative, and policy constraints.

2.6.1 Resource Limitations

Arable areas and forestlands, limited in Jordan, have experienced a considerable decrease. In 30 years, the area of arable land decreased from 379,640 hectares in 1961 to 246,780 hectares in 1991. Forestland remained nearly stable at 130,900 hectares. The country's population tripled between 1961 and 1991 and consequently the per capita arable land declined accordingly. This population pressure is especially acute on private forestland. Population density has reached sixteen persons/hectare on arable land.

Because good arable land is not readily available, there is a growing tendency to extend cultivation into areas not formerly cultivated, especially steppe areas in the mountainous regions. This is occurring at the expense of forests and/or natural range areas. Because of complex physical and social conditions, agriculture is extremely risky in these areas. It has resulted in the destruction of the vegetative cover, often with very little production, and in some dry years, without any production at all.

The absence of national land use policies has led to the complete loss of cultivable land in Jordan. Loss of agricultural land to other activities, especially urbanization, industry, highways and other nonagricultural projects has been remarkable in Jordan. The loss in agricultural land for these purposes reached more than 160,000 hectares in the last 30 years, while more than 15 percent of the private forests were cut and converted to other agricultural uses or to urbanization. More than 5,000 hectares of government forestland was transferred to nonagricultural purposes, especially for municipal purposes such as cemeteries, schools, roads. buildings, housing, and service centers.

As mentioned previously, the forestland area of Jordan is limited to mountainous areas or areas where rainfall exceeds 200mm annually. The remaining forests and woodlands are mainly in the marginal areas or on very steep or unreclaimed lands and only suitable for range purposes.

Limited water resources and water shortage in Jordan are the greatest constraint to agricultural, forest, range, and rural development. Insufficient precipitation on 81 percent of

the country means that large areas are incapable of supporting crop, forest, and range growth without irrigation. Even if suitable land could be found, it is doubtful the required water would be available, because there is also a shortage of drinking water during the summer in most of the Kingdom.

Jordan has a serious water shortage problem. Conventional water resources cannot meet the demand and therefore nonconventional measures must be increasingly introduced (e.g., desalinization, import of water, reclamation of wastewater). First priority for these water resources, however, must be assigned to meeting the demand for drinking water, industry, and agricultural purposes, leaving behind the interests of forestry. In Jordan, only the lands and water of very poor quality are allocated for forest and range purposes, so this limitation in resources is a serious constraint to forestry development.

2.6.2 Technical Constraints

The forestry subsector faces different kinds of technical constraints such as:

- **Insufficient knowledge** with regard to the best utilization of forestry resources as a result of the absence of research and the lack of studies, trials, and demonstrations. The existing technical cadre is presently incapable of carrying out research activities and training. Research work, demonstration, and trials should aim at the elaboration of the best use of forest resources to achieve maximum sustainable wood production in addition to other non-wood products and benefits. The biggest challenge to the forestry subsector is to identify and adopt a tested methodology to convert natural forests of low productivity to more highly productive ones without causing environmental damage.

- **Insufficient educated and trained manpower** (both in quality and quantity) responsible for the management of forestry activities. The reason behind this is the absence of forestry education facilities in the country and the insufficiency of these institutions in the region.

- **Inadequate data** related to forest areas, types and their productivity, standing volume and annual growth, in addition to the absence of information on site potential.

2.6.3 Institutional Constraints

The forestry subsector differs from other production sectors (especially agriculture) in many aspects. The land and the growing trees are the capital of the forest administration. This natural resources capital is distributed over a relatively large area under a variety of climatic conditions that cannot be controlled by the administration. In addition, investment in the forestry sector is a long-term investment that needs long-term and stable planning. The results of this planning can often only be measured over several generations and therefore there must exist a solid, strong forest administration supported by adequate legislation and protection from the interference by influential persons and decision-makers.

Due to its extensive responsibilities, the forestry administration needs a high degree of flexibility in central decision-making. The current status of the DAF within MOA does not fulfill or meet this requirement. The DAF presently has little direct influence on the personnel policies related to its employees, their working hours, and incentives; nor does it have direct control on the machinery used for its activities. In short, the DAF does not make many of its own decisions. This situation will continue as long as the DAF stays within the central structure of the MOA. To overcome these constraints, DAF should have a separate status with autonomous decision-making authority. In addition, an institutional organization should be created to give DAF responsibility for the coordination of activities and all bodies dealing with environmental issues.

2.6.4 Legislative Constraints

The current legislation plays an important role in protecting most of the government forests, but this legislation is not strong enough to conserve all the country's forest cover (private forests, roadside plantations). Furthermore, the existing legislation lacks instructions on safe land use and its planning. The result is continuing soil erosion of privately owned hilly slopes after removal of the existing tree cover.

Another legislative deficiency exists concerning the Government Land Tenure Management Laws. These laws fall within the jurisdiction of the Department of Land and Survey and their application presently does not favor the interests of forestry resources.

To overcome these legislative constraints, land use planning and land tenure legislation should be formulated immediately. This planning should secure protection of forests and extend its area to cover all endangered sites. The legislation should secure protection of government forestlands and provide sound guidelines for any conversion to any other use. Also all other types of government land in the low rainfall and steeply sloping areas should be converted to forest areas where feasible.

2.6.5 Policy Constraints

At present, there is no well-defined and officially announced or adopted forest policy. The policy reflected in the existing forest legislation provides the basis for the protection of forestlands and trees, but a comprehensive forest policy statement needs to be developed. This policy should take into consideration the extension of forest cover, improvement of forest productivity, development of forestry institutions and its public administration, the need for revenue generating activities, and forestry education.

2.7 Summary Assessment of Subsector Policy: Problems and Opportunities

From an economic point of view, the forestry subsector is a subsidized entity that does not provide a net return to the government. Nevertheless, the forestry subsector is an extremely important part of the national patrimony, which contributes essentially to the overall well-being

of Jordanian society. Therefore, it is the duty of the government to assure the prosperity and further development of this subsector by providing the appropriate forest policy framework.

In the previous sections, a detailed account of the situation of the subsector with its problems, shortcomings, and potentials was presented. The purpose of this summary is to again draw the attention of the reader to the main issues of the forestry subsector.

The major problems that a forestry policymaking body in Jordan should try to overcome are the following:

- Steady loss of forestlands, both private and government
- Uncontrolled grazing in forest areas
- Existing legislation that does not suit the administration and management of forestry resources
- Weak administrative structure of the DAF
- Shortage of well-trained and well-motivated DAF staff
- Budget allocations far below the actual requirements both in procedure and in budget availability
- A lack of background support work on forestry resources (research)

Opportunities to improve the development of the forestry subsector and its contribution to the national well-being exist through new approaches in problem-solving such as:

- **Diversifying forestry activities** to meet peoples' needs by changing the policy measures that prevent a broader use of forest resources (e.g., changing legislation that discriminates against users of nontimber forest products or the use of the forests or national parks for beekeeping; replacing legal and other constraints that discourage tree growing outside the forests and introduce incentives and other measures that promote more effective use of trees within farming systems, windbreaks, and agroforestry systems; and modifying the forestry laws to recognize the needs of local people and to promote and increase their involvement in forest management.
- **Promoting sustainable land use.** Government policies may encourage practices that are environmentally unsound, such as clearing vegetative cover to plant cereals or vegetables, construction of buildings and roads in forest areas, or granting permits that allow overgrazing. Therefore, a more careful and creative approach is needed, both in selecting land for conversion to agriculture, and in encouraging more sustainable use of the land, perhaps through agroforestry systems and other combinations of trees and crops

on farmlands. In many cases, there are alternatives that would allow the exchange of private forest areas for government-owned bare lands, thus promoting the expansion and consolidation of forest resources.

- **A holistic approach.** There is a clear need to strengthen the cooperation between foresters and agriculturists in planning and implementing extension programs so as to create more effective partnerships for working with farmers and the problems they face. This approach should draw on and integrate the experiences of many people and institutions. Coordination between forest policies and policies in other sectors is also important for appropriate problem-solving. There is an urgent need to shift away from the current narrow sector-based approach to policymaking, to one in which policies in forestry, agriculture, livestock, industry and development are integrated. Integrated programs have a greater potential for solving the problems of food security, environmental protection, and sustainable forest productivity, than forestry initiatives do on their own. The linkage between forestry and agriculture deserves special attention.

Some of the most important **research priorities** within the forestry subsector are:

- Research to develop efficient (cost-effective) and effective techniques for reclaiming denuded and degraded areas (especially arid lands and lands affected by salinization, desertification, and sliding) with drought-resistant forest species.

- Research on the effect of forestry on environmental protection in different sites including groundwater recharge, flooding, watersheds, riverbanks, and biodiversity.

- Research to develop low-cost alternatives to minimize the requirement for external inputs of fertilizer and pesticides and maximize the benefits from nitrogen fixation, nutrient cycling, and organic matter addition in tree and crop mixtures.

- Studies to increase sustainable production from forests and agroforestry systems through species selection, improvement of the genetic stock, and new breeding and propagation techniques.

- Research into the sustainable management of trees and forests for multipurpose uses.

3. POLICY OBJECTIVES AND STRATEGIES FOR THE FORESTRY SUBSECTOR

3.1 Overall Policy Objective

The principal and overall forestry subsector policy objective is:

to achieve maximum sustainable productivity of the renewable natural resources base.

Three primary and immediate objectives related to this principal policy objective are to:

- **Increase the area under forest cover.**
- **Improve the management of existing forests.**
- **Improve national capability for forestry development.**

These immediate objectives and possible strategy options to achieve them are outlined below.

3.2 Assumptions

Assumptions are external conditions that must be met if the objectives are to be reached. These involve conditions that the forestry subsector cannot bring about by itself or cause to be brought about. The Government and the MOA must take these conditions into account in guiding the subsector, and must monitor them continually. If an assumption is not met, the MOA must take action; if its own resources are not adequate, it must call on the services of other government agencies in good time. Important assumptions are necessary intermediate elements in the logical chain of hypotheses, they are not general conditions. Their purpose is to make clear the interface between the subsector and its policy environment with the associated influences and risks. The policy planning of the subsector must be structured so that there is adequate likelihood that the assumptions will be met, given existing knowledge and experience.

Taking the above into account, the following assumptions have been identified:

- Policy objectives for the forestry subsector are formulated in legislation, and there is a national governmental and public commitment to the environment through implementation of a national environmental strategy by law.
- Assure greater autonomy for the forestry institutions (department).
- Budget resources will match investment needs.
- Suitable technologies can be identified and employed.

If these assumptions are not met then any development plans for the forestry subsector are on a weak footing and without the substantial authority needed to tackle environmental issues on a national level.

3.3 Subsector Strategies to Achieve Policy Objectives

Strategies describe how to achieve the chosen policy objectives and targets. They include the guiding principles in the choice of the optimal tools to overcome obstacles that might arise on the way toward achieving the chosen objectives and targets. Strategies pose an intellectual challenge to decision-makers because they must maintain both flexibility, in the choice of the most appropriate alternative, and persistence, in the effort to achieve the objectives and targets. The same philosophy applies to the forestry subsector. The strategies identified here leave enough room to choose the best possible tools in achieving the chosen subsector policy objectives. In the following section, a brief description of the identified strategies is given.

3.4 Increasing the Area under Forest Cover

Several strategies and the means for achieving them should be considered as options for increasing the area under forest cover in Jordan. They include:

3.4.1 Definition of Forestry Resources

Further clarification regarding the definition of what constitutes forest resources and thus the total area covered will be essential to the successful achievement of sector policy objectives. More precise information related to four major questions: vegetation type, area coverage, special features and legal status of the land, will be useful in understanding the exact coverage of forestry resources in Jordan.

3.4.2 Solution of the Unsettled Land Situation and Acquisition of Potential Forestland

There is a good deal of confusion about the situation of unsettled lands, particularly in the south of the country. Much of this land can and should be designated forestlands because of the site limitations that restrict its use to forestry. To address this situation, the following tasks must be undertaken as part of the strategy:

- Locate and identify unsettled lands with potential for forestry.
- Corroborate the actual status of these lands.
- Establish the legal framework for the settlement and acquisition of these lands for forestry purposes.
- Allocate suffient funds to acquire the land.

This strategy must also establish the priorities as to which type of land, in which governorate, and in which ecological zone should be targeted for such a program.

3.4.3 Consolidation of Forestlands

Consolidation of forestlands refers to the formation of contiguous forest units by legal means. Contiguous units of forests are areas where private land in-holdings do not inhibit the practice of forestry management. There is presently legal precedent for trading privately held land found within high potential forest areas for other lands held by the government in areas with agricultural potential. As part of the strategy, this legal framework needs to be facilitated and working units identified in which such exchanges and consolidations would be focused as part of annual programs of this type. More agility in completing such activities must be guaranteed by a defined timetable agreed by government.

3.4.4 Expansion of Forest Cover

Expansion of the area covered by forests is a controversial issue, especially in forest areas adjacent to grazing grounds. In some cases the present opportunities must be taken promptly or the chance to protect unique genetic resources for future generations will be gone forever.

The real opportunities for the expansion of forest cover will depend on parallel activities aimed at acquiring unsettled lands, for resolving land-use prescriptions on other areas and, in general, on the capability of the government forestry institutions to carry out such work.

3.4.5 Establishment of Principles that Restrict Conversion of Forestlands

Given the conditions in Jordan, conversion of forestland to another land use must be carried out under strict guidelines that ensure that the protective functions of the site are safeguarded. For example, there is at present a strong tendency to convert private forestlands into fruit orchards. This should only be allowed if the owners are prepared to establish suitable soil and water conservation measures that will guarantee that the watershed function previously served by the trees is maintained. As part of this strategy and in order to tackle this controversial issue, action on two fronts will be necessary:

- Revision and updating of the present legislation governing all aspects of forest area management.

- Establishment of clear guidelines defining when, how, and why conversion of forestlands to other uses is acceptable or unacceptable.

In Jordan, the owners of forestlands (both public and private) have social duties related to the protection of the forest and its benefits and services for the local community. This is especially true where forests protect downslope agricultural lands, and transport, irrigation, and settlement infrastructure.

3.5 Improving the Management of Existing Forest Areas

It makes little sense to be promoting the expansion of the forest area if the present areas are not receiving a reasonably high level of management aimed at long-term sustained yield management. In Jordan, sustained yield management must clearly take into account both the production and protection capabilities of the forests. The following strategies are proposed to improve the management of the forests and thereby enhance their contribution to development.

3.5.1 Forestry as an Important Land-use Option in Jordan

Forestry must be viewed and acted upon as a viable management option in the overall land-use matrix of the country. Allowing land to remain as forest is sometimes viewed as the absence of management or a passive state of equilibrium, even by some foresters. Jordan has a great variety of forest resources with different conditions, on different sites, and in different developmental stages. To achieve maximum sustainable productivity (as mentioned in the overall objective), it will be necessary to take a much more affirmative approach to forest management throughout the country.

Much of the basic know-how for such activities is already available in the country as a result of the activities of earlier forestry sector development projects (e.g., Zarqa River Basin Project, FAO Forest Inventory Project, and the EEC Soil Project). It will be necessary to combine these experiences, prepare prescriptions for different conditions, legalize them, and finally apply them in managing the forest resources across the country.

3.5.2 Protection Strategies for Forest Resources

The first step in the management and improvement of the forest resource base is that of protection; that is, confirming that these resources are under the control of a responsible public entity capable of enforcing the management prescriptions and reacting in appropriate ways should they be contravened. Protection of forest resources is the creation of conditions that assure the natural development and sustained yield management of specific forest areas. It involves much more, however, than the mere physical protection against damage. It requires the safeguarding of the forest resources on the basis of a commonly understood social contract, whether by those living adjacent to the forests or by other members of society who use them less frequently.

In Jordan, therefore, a comprehensive protection strategy must include the following:

- Revision and updating of present legislation regarding all aspects of forest resources protection.

- Revision and updating of the present protection network operated by the Forestry Department.

- Strengthening the social compact regarding the importance of protecting forest resources by education, extension, and environmental awareness campaigns.

- Vesting the territorial forestry officers with special authority to facilitate law enforcement on the ground.

These needs for protection measures must be dealt with in a timely way in order to cope with the recent increases in population pressures and land-use changes being felt throughout the country. Without an affirmative action program aimed at protecting the existing forest resources, it will be difficult, if not impossible, to achieve sector policy objectives.

3.5.3 Extending the Knowledge Base on Forest Resources and Environment

Any comprehensive approach to improve the management of forest resources will have to rely on a sound scientific base. For this purpose, research needs must be clearly identified and must receive greater attention following a carefully prioritized research plan.

3.6 Improving National Capability for Forestry Development

Forestry in Jordan enjoys the interest and support of those at the highest levels, as manifested in His Majesty's call for a Green Jordan. Below that level, however, there is a need to widen the spectrum of public and popular understanding of and support for forestry.

3.6.1 Establishment of Forest Management Capabilities

By definition, forest management implies that the foresters will be more than the custodians of a passive resource base. Foresters must have all the means that are necessary to implement forestry management activities. Specifically, these include the legislative framework, the responsible public administration entity, a specialized staff, and a regular budget.

3.6.2 Institutional Coordination among Related Parties

Forestry, natural resources, and environmental issues have taken on new importance in recent years, thereby conferring prestige on the institutions involved in addressing these concerns. In Jordan, certain closely related institutions are competing to achieve the same objectives. In order to concentrate actions, maximize impact, and avoid needless duplication of effort or institutional confrontations, a strategy for coordination within the sector is needed. The following activities are likely to be part of such a strategy:

- Identification of the institutions involved in environmental issues.

- Elaboration of internal strategies and agreements to avoid overlaps between institutions.

- Elaboration of a mechanism to communicate and cooperate between institutions.

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3.6.3 Public Awareness and Involvement in Forest and Environment Issues

The best environmental strategy is bound to fail if the people concerned are not involved and supportive of it. This type of national awareness and environmental involvement needs to begin within the educational system. Isolated advertisements or short-lived campaigns are unlikely to have significant impact on behavior patterns. In consequence, the teaching curricula from the primary through secondary schools should be reviewed and revised to include environmental sensibilisation and engagement.

3.6.4 Direct Public Involvement and Funding

Although commitment to environmental protection by the general public is fundamental to success, more is needed as well. Given the magnitude of the problems and opportunities in the management of forestry and natural resources in Jordan, it is unlikely that government funding and programs through its regular budget will be adequate to reach the level of impact necessary. In Jordan, as elsewhere around the world, the general public is interested and must be challenged to take a hand. For this purpose, Non-Governmental Organizations (NGOs), government public relations services and local politicians have to be involved. Successful and cost effective financial investments have already been achieved by delegating environmental management responsibilities to such private sector organizations. In Jordan, for such an approach to expand and flourish, a chain of steps have to be followed:

- Design and introduce a legal background for the recognition, fund raising and operations of such private sector organizations.

- Identification and promotion of interested responsible institutions to handle these activities.

3.7 Subsector Policy Considerations

The principal contents of this report were discussed during a three day "Decision-Thinking Workshop" aimed at obtaining the views of stakeholders interested in the subsector on the policy objectives and strategies presented above. A summary paper, titled: *Forestry Subsector Policy Considerations* was prepared and presented to workshop participants as the basis for discussions. This workshop, held over the period 20 - 22 April, 1993 in Amman as part of the Ministry of Agriculture sponsored Agriculture Sector Review and Policy Implementation Plan, also discussed the findings and proposals related to four other subsectors: irrigated agriculture, rainfed agriculture, integrated livestock production, and low rainfall zone production systems.

After a comprehensive presentation by the leader of the Forestry Subsector Review and Planning Group, the discussion was opened to interventions by the workshop participants. The following important points were raised:

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- Several participants suggested that the Government reconsider its policy for the use of treated sewerage and wastewaters from the urban areas of the country. It was proposed that these waters might be used to competitive advantage in irrigating forestry plantations and thereby avoid contamination of food crops. The issue is, however, an extremely complex one which will require careful study.

- The importance of keeping in mind the economic values of forests were pointed out by several participants. In response to their comments, the RPG team leader reiterated a number of important points of information related to the economic value of the forests which had been mentioned in the body of the main report.

  It was also pointed out that although participants generally recognized the importance of the protective functions of the forests of Jordan, in providing environmental stability key to agricultural productivity, little work had been done on quantifying the economic values associated with these functions. More study of this nature on both the potential economic returns at the micro level to farmers conserving and managing forests on their land as well as on the macro economic values of forests to the country needs to be undertaken.

- Several participants suggested the need for the establishment of an information and data center for forests, range, environment and natural resources. Others, however, also pointed out in this regard the need for compiling, collecting updating the large number of existing studies and reports.

- Another proposal put forward was that the Government, and in particular, the Department of Afforestation and Forests consider introducing the means to allow private companies to act as contractors for the afforestation program. In this regard, the question of whether a budget would be available for such a program was also raised.

- Several participants proposed that the Government consider an incentives program to motivate private farmers to plant forests and to conserve existing forests on their lands.

- A proposal was also made that the Government must do more to ensure that quarries, mines and sand and stone extraction sites are rehabilitated and replanted with trees as called for in the rental agreements governing such enterprises.

- Several participants voiced their agreement with the recommended strategy put forward in this paper about the evident need for greater coordination among the agencies interested and involved in the forestry subsector. There is also an emerging non-governmental movement in Jordan whose efforts could usefully be channeled to address priority needs related to natural resources management and the environment.

- A proposal was put forward that only local forest species be used in the national afforestation program. This proposal is intended to promote the continuing conservation

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of the genetic diversity of the forest resource base and to ensure that species well adapted to the conditions, particularly as related to water use, are used in these programs.

- Several participants pointed out that the problems facing the forests in Jordan were largely social in nature and should be addressed accordingly.

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TABLE APPENDIX

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Table 1. Classification of Forestlands and Forests of Jordan in 1993 (area in hectares)

Ownership/ Category	Part of the Country	Evergreen Oak (ha)	Deciduous Oak (ha)	Mixed Pine + Oak (ha)	Coniferous (ha)	Wild Olive (ha)	Total natural (ha)	Plantations (ha)	Total Forest areas (ha)	Barelands (ha)	Total Forestland Forested + Nonforested (ha)
Government Forestlands	North	1638	2976	2731	109	96	22298	28020	50318	46378	96696
	South	1987	---	---	1502	--	3489	7341	10830	23391	34221
	Total	18373	2976	2731	1611	96	25787	35361	61148	69769	130917
Private Forestlands	North	3063	1218	226	14	9	4530	---	4530	---	4530
	South	114	---	---	21	--	135	---	135	---	135
	Total	3177	1218	226	35	9	4665	---	4665	---	4665
Unsettled Forestlands	South	3971	---	---	6171	--	10142	---	10142	5138	15280
Grand Total		25521	4194	2957	7782	105	40594	35361	75955	74907	150862

Table 2. Areal Distribution of Forests in Jordan by District in 1993 (in hectares)

District	Plantation (ha)	Natural Gov't. Forest (ha)	Natural Priv. Forest (ha)	Natural Unsettled Forest (ha)	Total Natural Forest (ha)	Total Forested Land (ha)	Total Forest Registered Land (ha)
Amman	3100	227	413	--	640	3740	7438
Zarka	2500	1331	646	--	1977	4477	7090
Madaba	1900	100	--	--	100	2000	17666
Balqa	4800	1208	385	--	1593	6393	19833
Jarash	4900	3860	837	--	4697	9597	9230
Ajloun	720	8393	1721	--	10114	10884	13983
Mafraq	2600	--	--	--	--	2600	6739
Kerak	2800	--	--	--	--	2800	19462
Ghor Safi	--	--	--	100	100	100	358
Tafileh	3100	1631	96	5342	8069	11169	11457
Ma'an	1441	1858	39	3600	5497	6938	2944
Aqaba	--	--	--	100	100	100	--
S.Shouneh	300	100	--	--	100	400	--
Deir Alla	3000	100	--	--	100	3100	--
N.Shouneh	200	50	--	--	50	250	--
Kurah	1987	2183	210	--	2393	4380	5276
Bani Kenaneh	1246	2346	218	--	2564	3810	5243
Irbid	769	2400	100	--	2500	3267	4198
Ramtha	--	--	--	--	--	--	--
Total	35361	25787	4665	10142	40594	75955	130917

Table 3. Types and Classes of Natural Forest in Northern Jordan

Class No.	Class Description
1	Evergreen oak (3-6m in height and 70-80% canopy density)
2	Evergreen oak (3-6m in height and 40-70% canopy density)
3	Evergreen oak (degraded with less than 10% canopy)
4	Deciduous oak (3-6m in height and 10-40% canopy density)
5	Aleppo pine (6m in height and 40-70% canopy density)
6	Mixed forest of Aleppo pine and evergreen oak (70-100% canopy density), oaks account for more than 50% and not less than 10% of canopy density
7	Mixed forest of Aleppo pine and evergreen oak with 40-70% canopy density
8	Mixed forest of Aleppo pine and evergreen oak with 10-40% canopy density
9	Wild olive forest (3-6m in height and 10-40% canopy density)

Table 4. Standing Volume and Volume Increment of Natural Forests in Northern Jordan

Class no.	Class Area (dunums)	Standing Vol. (dunum OB)	Volume Increment (m^3/dunum)	Total Standing Vol. (m^3 OB)	Total Increment (m^3)
1	17.431	3.348	0.0994	58.359	1.734
2	64.279	2.057	0.0606	132.333	3.893
3	not sampled				
4	44.803	0.975	0.0244	43.683	1.093
5	1.423	4.302	0.0793	6.122	0.133
6	3.704	3.629	0.1035	13.442	0.383
7	23.589	2.751	0.0819	64.823	1.932
8	2.974	3.193	0.0818	9.496	0.243
9	not sampled				
Total	158.203			328.147	9.382

OB = Over bark

Table 5. Classification of Forest Offences 1970–1992

Year	Grazing	Illicit Cutting	Forest Fires	Encroach-ment	Smuggling	Total	Number of Trees Damaged
1970	185	1893	16	341	136	2571	28104
1971	313	1282	20	510	133	2258	16557
1972	524	526	33	479	32	1594	15421
1973	389	768	41	754	73	2025	9510
1974	319	480	45	841	58	1645	5398
1975	284	549	47	500	36	1380	12228
1976	287	669	43	642	35	1676	11085
1977	342	637	41	607	28	1655	8472
1978	232	625	40	688	19	1604	21721
1979	266	792	37	683	34	1812	15580
1980	198	620	60	696	33	1607	11097
1981	211	649	78	557	64	1559	45167
1982	818	305	83	705	97	2008	18890
1983	434	715	85	462	105	1801	42821
1984	278	810	69	656	41	1854	42765
1985	145	698	53	489	63	1448	14260
1986	169	928	45	516	34	1692	22239
1987	164	924	88	527	44	1747	29759
1988	181	966	99	422	54	1722	18468
1989	377	1092	73	288	82	1912	36286
1990	245	1174	73	342	92	1926	32790
1991	118	928	75	364	105	1590	19433
1992	149	1961	46	476	208	2040	30985

Table 6. Forest Fires Recorded 1970–1992

Year	No. of Forest Fires	No. of Trees Burnt or Damaged	Area Affected (dunums)
1970	46	38788	2181
1971	16	104054	4915
1972	19	6833	191
1973	15	3468	27
1974	43	5647	295
1975	29	19491	613
1976	20	3300	173
1977	32	11314	442
1978	40	22808	716
1979	37	2674	154
1980	60	3409	235
1981	90	42441	7829
1982	58	32854	2154
1983	73	33850	3190
1984	48	18940	1390
1985	41	4249	380
1986	45	3997	390
1987	41	7996	512
1988	66	40045	2899
1989	22	3707	711
1990	21	12006	742
1991	11	4987	308
1992	25	4581	342

Table 7. Forest Nurseries in Jordan as of 1993

	Name	District	Area (dunums)	Production[4] (1000 seedlings)	Year Established
1	Yajous	Amman	60	1375	1969
2	Deir Alla	Jordan Valley	64	1303	1961
3	Khaldiyyah	Mafraq	50	835	1969
4	Agraba	Irbid/ Bani Kenanah	22	371	1984
5	Ein Jamla	Jerash	24	307	1953
6	Faisal	Jerash	10	698	1966
7	Wadi Shueib	Salt	7	407	1959
8	Wadi Wala	Madaba	10	441	1962
9	Karak	Karak	6	329	1948
10	Tafila[1]	Tafila	18	--	1968
11	Twanah	Tafila	20	510	1987
12	Shubak	Ma'an	20	275	1961
13	Wahaidah[2]	Ma'an	10	285	1993
14	Aqaba[3]	Aqaba	12	--	1984

1 Planned to be closed in 1993 due to shortage of irrigation water
2 New nursery started during 1993
3 Planned to be closed in 1993 due to high production costs
4 1993-1994 production plan

Table 8. Development of Forest Plantation and Seedling Production 1946–1992

Year	Afforestation (ha)	Reforestation (ha)	Roadsides (km)	No. of Seedlings Produced (1000)
1946/50	40	70	--	1150
1950/55	300	220	--	4000
1955/60	1045	430	--	7160
1960/65	2363	1178	--	10930
1965/70	2988	1794	50	13950
1970/75	6852	2256	79	18470
1975	1855	500	128	4020
1976	1454	397	90	4900
1977	1095	618	49	4511
1978	1496	855	94	3013
1979	1768	854	50	3298
1980	1995	910	60	4425
1981	2500	577	33	4145
1982	2500	1263	34	5544
1983	1575	784	6	6500
1984	2850	986	13	7400
1985	2438	621	106	700
1986	2460	650	194	700
1987	2450	725	118	8500
1988	2786	473	185	8600
1989	2035	55	110	7656
1990	1436	60	207	6448
1991	3059	257	149	6622
1992	3072	587	15	6987

Table 9. Cost Calculation for Afforestation Activities (per 1000 dunums = 100 hectares)

Cost Effective Item	Units	Units required	Price/ Unit	Total
Site survey of afforestation area	man/days	5	7	35
Vehicles	km	250	0.10	25
Mapping administrative activities	man/days	14	5	70
Vehicles	km	700	0.10	70
Material (stationary)				75
Organization of start up (contacting officers, labours, organizing transport etc.)	man/days	3	6	18
Vehicles	km	150	0.1	15
Telephone calls (long distance)	tel/units	100	0.2	20
Transport of labours from home to the planting site and back	km	60x592	0.2	7104
Transport of seedlings from the nurseries and back	km	100x24	0.2	480
Transport of watering tank and other material to the planting site	km	30x140x2	0.4	3360
Alignment of planting rows and pits on the site	man/days	100	5	500
Supervision of activities on planting site	man/days	96	6	576
Preparation of planting holes with terraces	man/10holes/ day	1000	3	21000
Transport of seedlings from loading site to the plantation area	man/days (500 seedl./day)	140	3	420
Plantation of seedlings	man/days (50 seedl./day)	1400	3	4200
Watering the seedlings on the planting site (two times)	man/days (50 seedl./day)	1400x2	4	8400
Supervision of afforestation activities from the district and headquarters	man/days			3000
Seedlings	seedlings	10000	0.20	14000
Weeding 1st year	man/days (50 seedl./day)	1400	3	420
Protection 1st year	man/months	12	100	1200
GRAND TOTAL FOR 1000 DUNUM				6876
Costs for 1 Dunum J.D.				68.768

Table 10. Forest Material Produced from Government and Private Forests 1970–1992

Year	Wood (m^3)			Fuel Wood (ton)			Charcoal (ton)			Sand & Soil + lime m^3 Gov.	Esparto Govern. (1000)	Reeds Govern. (1000)	Oleander sticks Gov.(1000)	Small poles	Tan-bark Govern. kg.	Sumak Kg.
	Gov	Priv	Total	Gov	Priv	Total	Gov	Priv	Total							
1970	--	1392	1392	171	1153	1324	--	13	13	--	78	130	--	42	--	--
1971	25	3614	3639	502	1656	2158	--	15	15	--	288	130	--	160	1650	21350
1972	15	5171	5186	291	2860	3151	--	72	72	--	800	869	--	--	5600	21400
1973	43	5949	5992	13	2870	2883	--	91	91	--	912	479	--	950	2450	44000
1974	204	5476	5680	454	37	491	--	71	71	--	--	1011	--	1390	1750	20700
1975	20	4222	4242	131	2254	2385	--	348	--	--	--	--	--	--	-	--
1976	163	6692	6855	43	2338	2381	--	264	264	--	259	340	4	6329	--	17500
1977	36	3860	3896	140	2957	3097	--	765	765	932	--	923	8	--	-	--
1978	--	--	--	264	3618	3882	--	551	--	--	--	--	--	--	--	--
1979	--	--	--	206	4199	4305	--	296	--	--	--	--	--	--	--	--
1980	360	873	1233	84	2419	2503	--	556	--	--	--	--	--	--	--	--
1981	162	2088	2250	164	5349	5513	--	1232	--	456	175	38	--	8466	2500	--
1982	209	4220	4429	121	880	1001	--	196	--	--	30	--	--	--	--	--
1983	146	2098	2244	347	2239	2586	--	80	--	354	50	112	71	21990	100	--
1984	8	1603	1611	202	2252	2454	--	364	--	201	--	92	6	20	--	--
1985	562	851	1413	377	3038	3415	--	500	500	242	--	21	3	150	--	--
1986	411	713	1124	576	2921	3497	--	687	--	784	300	106	1	200	--	--
1987	172	997	1169	665	3147	3812	--	537	--	592	70	121	1	2100	260	--
1988	38	777	815	556	5516	6072	17	388	--	240	310	141	--	200	--	--
1989	196	3316	3512	805	5911	6716	69	396	--	600	420	194	2	4870	--	--
1990	21	805	826	900	7077	8777	18	409	427	--	62	78	--	2500	--	--
1991	31	1984	2015	592	7075	7667	329	419	748	410	10	111	10	2400	--	--
1992	123	493	616	2738	6591	9329	67	601	668	305	80	120	--	4150	--	--

Table 11. Range Reserves in Jordan as of 1993

	District	Reserve	Established	Area (ha)	Rainfall (mm)	Area Improved by man (ha)
1	Amman	Adasiyyah	1983	2000	200	1300
2	Amman	Dhabaa	1968	300	120	500
3	Madaba	Ma'in	1983	8330	200	6800
4	Madaba	N.Mujib	1988	1000	150	500
5	Zarqa	Wadi Butum	1986	1500	80	100
6	Zarqa	Shoumari	1987	26000	80	1000
7	Karak	Lajjun	1980	1100	150	1100
8	Karak	Nukhel	1987	900	150	750
9	Karak	New Lajjun	1989	5000	150	700
10	Karak	S. Mujib	1980	976	150	400
11	Tafila	Twanah	1981	2000	150	1200
12	Ma'an	Fujeij	1958	1000	200	400
13	Ma'an	Aishiyyah	1981	1000	100	800
14	Ma'an	Manshiyyah	1968	300	150	200
15	Ma'an	Ras Al Naqab	1986	1200	200	1000
16	Balqa	Ira/Yarqa	1986	4000	250	1600
17	Ajloun	Rajeeb	1983	2000	250	600
18	Mafraq	Khanasri	1946	455	250	300
19	Mafraq	Surra	1946	396	180	300
20	Mafraq	Sabha	1979	1054	150	900
TOTAL				60511		20000

Table 12. Improved and Planted Areas of Range Reserves 1982–1992

Year	Planting (ha)	Reseedling (ha)
1982	279	--
1983	302	--
1984	1165	300
1985	978	112
1986	1469	--
1987	1969	--
1988	1787	--
1989	1973	190
1990	918	4
1991	1550	12
1992	1500	200

Table 13. Existing and Planned Wildlife Reserves

A. Existing Wildlife Reserves

Name	Area (hectares)	Year of Establishment
Shomari W.R.	2200	1975
Azraq W.R.	1200	1977
Zobia W.R.	1000	1988
Mujib W.R.	21200	1987
Dana W.R.	12000	1989
Wadi Rum W.R.	56000	1989
Total	93600	

B. Planned Wildlife Reserves

Name	Area (hectares)
Burqa W.R.	95000
Rajil W.R.	86000
Abu Rukha W.R.	41000
Jerba W.R.	4000
Jabal Mas'ada W.R.	51000
Total	277000
Grand Total	370600

Table 14. Value of Forest Products 1970-1992 (in JD)

Year	Private Forests (JD)	Government Forests (JD)	Total (JD)
1970	6154	709	7863
1971	12590	2718	15308
1972	52866	1365	54231
1973	72139	1444	73583
1974	72810	6922	79732
1975	60250	13030	73280
1976	116680	3000	119680
1977	91627	2762	94389
1978	82117	5264	87381
1979	87150	9560	96710
1980	73426	6750	80176
1981	151264	5660	156924
1982	57500	4942	62442
1983	55692	21577	77269
1984	68939	3298	72237
1985	73463	14276	87739
1986	75337	16574	91911
1987	78562	14210	92772
1988	106284	9904	116188
1989	76697	91156	167853
1990	142625	14178	156803
1991	148552	19867	168419
1992	124673	47419	172092

Table 15. Government Returns from Forests 1970–1992 (in JD)

Year	Fines	Confisca-tions	Fees on Forest Prod. and Licenses	Value of Gov't. Forest Production	Total
1970	4767	221	537	709	6234
1971	11211	732	3311	2718	17972
1972	17068	232	2155	1365	20119
1973	13408	230	5037	1444	25714
1974	11714	237	6843	6922	25716
1975	17453	230	4535	13030	35248
1976	18546	235	8474	3000	30255
1977	17453	331	5819	2762	26365
1978	18612	239	5214	5264	29329
1979	19503	378	8911	9560	38252
1980	28784	375	11275	6750	47184
1981	29967	517	11432	5660	47576
1982	37870	820	15121	4942	58753
1983	40535	966	6407	21577	69485
1984	42627	1017	6843	3298	53785
1985	53094	658	9966	14276	77994
1986	51083	804	15482	16574	83943
1987	61304	527	15066	14210	91107
1988	67626	452	19184	9904	97166
1989	63859	327	28495	91156	183837
1990	58108	319	11297	14178	83902
1991	62417	601	2268	19867	85153
1992	45122	721	2464	47419	95726

Table 16. Imports and Exports of Forest Products (1000 JD)

Item	1986	1987	1988	1989	1990	1991
Total exports (including re-export)	256.029	315.709	381.271	534.1	612.3	598.627
Exports of forest products	4.648	6.724	8.856	15,763.9	13,082.5	9.332
2/1 %	1.8	2.1	2.3	2.95	2.14	1.6
Total Imports	850.199	915.555	1,021.617	1,230.0	1,725.8	1,710.463
Imports of forestry products	28.526	34.963	39.197	44,081.1	68,546.6	81.165
4/3 %	3.35	3.8	3.8	3.6	3.97	4.7

Table 17. Budget Allocation for the Rangeland Subsector 1985–1992 (1000 JD)

Year	Government of Jordan	Ministry of Agriculture	Department of Afforestation and Forests
1985	794 487	4 910	680
1986	745 923	7 036	695
1987	804 170	7 553	950
1988	953 326	8 309	1 241
1989	1 115 237	6 821	580
1990	1 181 603	7 532	885
1991	1 244 410	8 371	1 229
1992	1 270 111	11 819	1 290

AGRICULTURAL POLICY ANALYSIS PROJECT, PHASE II

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1. INTRODUCTION

The purpose of this study is first to objectively and concisely describe the rainfed agriculture subsector of the Jordanian agricultural economy, and second to make policy recommendations based on the facts presented.

Rainfed agriculture is the traditional agriculture of Jordan; it occurs primarily in the plains and mountains of the Jordanian highlands. In this study, rainfed agriculture is defined to include upland farming, which benefits from supplementary irrigation, and to include natural resource management.

The policies proposed here have three goals:

- To improve the welfare of the people who gain their livelihood from rainfed agriculture.
- To increase the contribution of rainfed agriculture to Jordan's economy.
- To protect the environment and to conserve the soil and water resources used for rainfed agriculture.

2. ANALYSIS OF THE PRESENT SITUATION

The rainfed regions of Jordan are dynamic, but with the exception of fruit tree and vine crop production, rainfed agriculture is not a major factor in the rapid development of these regions. In fact, development in these regions is equated with urbanization, which poses a serious threat to the existence of a significant agricultural subsector in Jordan's uplands.

While urban development of the rainfed uplands is booming, agriculture is languishing. The drive for self-sufficiency has stalled, agricultural research and extension services are ineffective (as they have been for years), and the high potential of the Jordan Valley has diverted government attention from the less spectacular but significant potential of the rainfed regions. In fact, for the last two decades the emphasis for government investment in Jordanian agriculture has been on irrigated agriculture in the Jordan Valley. While this policy was rational and has resulted in major benefits, there are now many compelling reasons for the government to reappraise this policy, among which are:

- High, rapid returns on investment were common in the initial stages of the development of irrigated agriculture in the Jordan Valley. That era is now over. It can now be argued that the best economic and social returns on government investment in agriculture can be found in upland rainfed agriculture. The improvement of rainfed agriculture would have a major positive impact on the economy of Jordan and the well-being of many rural families who have not yet fully participated in Jordan's economic progress.

- In contrast with the Jordan Valley, where foreign labor is dominant, the Jordanian highlands are worked by families who have depended upon this land for their livelihood for generations. Improving rainfed agriculture would have a direct, positive impact on the well-being of the vast majority of Jordanian farm families.

- The major rainfed field crops—wheat, barley, chickpea, and lentil—are also the basic food commodities of Jordan. Increased production of these crops would result in import substitution and increased self-sufficiency for the Jordanian economy. Tree (olive, apple, peach, pear, apricot, and almond) and vine (grape) crops of the rainfed sector are important for local consumption and for export to neighboring countries.

- The land resources of Jordan's uplands are severely threatened by urbanization, fragmentation, and erosion. If the government does not act quickly this land will be lost forever.

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2.1 Agricultural Resources

2.1.1 Land Resources

Productive agricultural land is scarce in Jordan, mainly the result of scarce and erratic rainfall. The total land area of Jordan is 88,945,149 dunums (1 dunum = 1,000 square meters), 89.7 percent of which is classified as marginal land (i.e., receives less than 200mm annual rainfall). The remaining 10.3 percent, which receives more than 200mm, is considered the main area of rainfed agriculture. About 93 percent of the cultivated land is located in the highlands, where most of the population centers are.

The major rainfed crops are distributed over four different regions, conventionally known as agroclimatic zones. The zoning is based mainly on the long-term average rainfall distribution. The area of each zone is presented in Table 2.1.

Table 2.1. Agroclimatic Zones in Jordan

Rainfall Zone (mm)	Land Area (dunums)	Percent of Total
< 200	80,963,370	91.0
200-300	3,951,070	4.5
300-400	1,795,990	2.0
< 400	2,234,940	2.5
Total	88,945,370	100.0

Source: "Field crops in Jordan," a study submitted to the Higher Council of Science and Technology (HCST). Similar figures were reported by FAO in the Regional Study on Rainfed Agriculture 1982 and Agriculture Policy Analysis in Jordan 1991 by A. Taimeh.

The total area that receives more than 200mm rainfall is about 7,982,000 dunums, but all of this area is not cultivable because it includes areas occupied by villages, population centers, and related infrastructures, and large areas of eroded and shallow soils that are not suitable for cultivation. The slope of the land also affects cultivation. At an 8-percent slope, land is more suitable for fruit production than for grain production; at a 25-percent slope, land is more suitable for forestry than for farming. Table 2.2 shows the extent of land in each slope classification for the three rainfed agroclimatic zones.

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Table 2.2. Distribution of Rainfed Areas According to Agroclimatic Zones and Slope

Rainfall Zone	0-8 percent slope		9-25 percent slope		> 25 percent slope		Total Rainfed Area(du)	Percent of Total Area in Jordan
	Area(du)	Percent of total rainfed	Area (du)	Percent of Total Rainfed	Area (du)	Percent of Total Rainfed		
200-300	1,302,180	16.3	1,757,820	22.1	891,070	11.1	3,951,070	4.4
300-400	591,900	7.4	799,050	10.1	405,040	5.1	1,795,900	2.0
> 400	736.590	9.2	994,310	12.4	504,040	6.3	2,234,940	2.5
Total	2,630,670	32.9	3,551,180	44.6	1,800,150	22.5	7,982,000	8.9

Source: Agroclimatical zoning in Jordan, MOA - working paper

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About 50 percent of the rainfed area (3,951,070 dunums) falls in the 200-300mm rainfall zone. The soil in most of this area is of poor quality, with low fertility and productivity.

The area that receives 300-400mm rainfall is the most suitable for the production of different crops with limited technical constraints.

Land in the rainfall zone that receives more than 400mm has limited crop production potential due to limitations related to soil depth and land slope. However, it is most responsive to suitable management.

Rainfed agriculture is practiced on about 3.7 million dunums,[1] and rainfall and slope are the two major criteria used to classify this area. Soil depth and texture are also important considerations, but no general criteria have been established until recently.

Table 2.3. Area of the Rainfed Subsector Classified by Rainfall Zone and Slope

Rainfall Zone	Slope percent		Total Area (dunums)
	0-8 (dunums)	9-25 (dunums)	
200-300mm	790,000	1,049,760	1,839,760
300-400mm	359,100	473,200	832,300
> 400mm	446,880	588,800	1,035,680
Total	1,595,980	2,111,760	3,707,740

Table 2.3 above shows that about half of the cultivated rainfed areas receive 200-300mm rainfall annually, and about 40 percent of the total cultivated area has a slope of 9-25 percent.

Jordan's limited productive resource base coupled with its high population growth rate has resulted in decreasing self-sufficiency in most food commodities. Recent studies suggest that by the year 2,000, Jordan will be about 7-8 percent self-sufficient in cereals and about 14 percent self-sufficient in terms of calories (FAO report, FAO at 200, Data file). This situation emphasizes the urgent national need to focus on conservation and efficient use and development of available land resources. Land under dryland farming has already reached its limits, and in

[1] Sunna and Abd Rabbou reported a figure of 3,535,000 dunums, (Agricultural Development in Jordan - Potential, Constraints and objectives, 1991)

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some areas it may be advantageous to abandon marginal lands already cultivated and allow them to revert to range.

2.1.2 Water Resources

Rainfall is the major source from of surface and underground water in Jordan. Rainfall ranges from 50mm in the desert regions to about 600mm in the eastern mountains adjacent to the Jordan Valley. The total annual amount of rainfall in Jordan is estimated at 7 billion cubic meters (7 BCM). About 85 percent of this water is lost to evaporation, while the remainder flows in wadis (valleys) and partially infiltrates to the deep aquifers.

Renewable water resources are estimated at 1,020 MCM annually, which includes underground water (270 MCM distributed among eleven catchment basins) and surface water (750 MCM distributed among thirteen catchment basins).

Of the renewable surface water, only 470 MCM is utilized. The reasons for this include: low utilization of the Yarmouk River, which is estimated to be only 100-125 MCM of 400 MCM; and low utilization of surface and floodwaters in valleys due to the lack of earth check dams.

At present, the total amount of water that can be economically used is about 855 MCM: 470 MCM as surface water, 270 MCM as renewable underground water, and 125 MCM as unrenewable underground water.

Future development in agriculture and industry as well as the rapidly increasing population will increase the demand for conventional water resources, and shortfalls are projected for Jordan's water supply (Table 2.4).

Table 2.4. Projections for Water Use and Availability in Jordan

Year	Comsumption (MCM)	Available (MCM)	Shortage (MCM)
1990	740	715	25
1995	890	865	25
2000	1045	865	180
2010	1430	865	565
2020	2145	865	1280

Source: A study by S. Boulos and A. Alem "water resources in Jordan" 1991 submitted to the Higher Council for Science and Technology (Amman, Jordan)

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Measures to conserve water resources must be undertaken to alleviate the ever increasing gap between available water resources and water demand. Conservation of water resources in rainfed areas is possible through: reuse of urban wastewater, water harvesting, aquifer recharge, check dams, and cultural practices. The most important of these is the reuse of wastewater.

The reuse of urban water supplies for agricultural production has been the object of major studies, research, and investment in the Middle East. Jordan has been a leader in this effort.

Most of Jordan's urban wastewater is generated in the rainfed sector and then channeled to the Jordan Valley for use in irrigation. Many upland areas, however, would give higher net returns per cubic meter of water used than the Jordan Valley.

Amman generates more than 120,000 cubic meters of wastewater per day, and treatment facilities are overloaded. If this water received secondary treatment, however, and was held in lagoons for fifteen days, it could be safely used to irrigate a wide range of crops including fruit trees, nut trees, cereals, and forage crops. Economics would dictate that the water was used in the immediate vicinity of treatment plants.

Supplementary irrigation in Jordan is limited to fruit trees and some vegetables. Farmers in the rainfed regions are hesitant to use the limited water resources for cereal or forage production because the gross margins of fruit trees are twelve times higher per hectare and four times higher per man/day than cereals (FAO 1980).

A feasibility study in the Shoubak area of Jordan indicated that net income from wheat can be increased 3-4 times by supplementary irrigation. At present, the main problem is the high cost of sprinkler systems for applying water to cereal crops. The installation cost of a sprinkler system was estimated at $3,000 per hectare as compared with $1,500 per hectare for drip irrigation for fruit trees, and $1,850 for vegetables (onion and garlic).

Results of the 1993 season from the "Supplementary Irrigation and Water Management Project in the Rainfed Areas/Jordan," supported by UNDP, showed the following response to supplementary irrigation in the Jordanian uplands:

Barley	:	JD 0.100/m^3
Wheat	:	JD 0.140/m^3
Onion	:	JD 0.500/m^3
Garlic	:	JD 0.750/m^3
Okra	:	JD 0.850/m^3

2.1.3 Climate

The midwinter climate of the Jordanian uplands is cold enough to vernalize crops that have a chilling requirement. During the spring, summer, and fall growing seasons, night

temperatures are cool enough to slow plant respiration, which results in higher yields and better quality summer fruits and vegetables than can be grown in the Jordan Valley.

- Annual rainfall varies drastically in the different zones of the rainfed areas. Rainfall in the northern mountainous region usually exceeds 400mm and decreases toward the east and south to 200mm. Mean monthly and yearly rainfall are indicated in Table 1 of the annex.

  Rainfall usually starts in October and ends by May. Highest rainfall occurs in the January-February period (Tables 2 & 3 of the annex). Farmers sow winter crops either before the rainy season starts, in early October, or after "effective" rain has fallen. Early planting is subject to the uncertainty of effective rainfall and, therefore, although seeds may germinate, they may fail to emerge. However, given sufficient rain, yield is improved as plants benefit from a longer growing season.

  For seeds sown after effective rain has begun, germination and emergence are more certain, but in many instances the continuous rain may delay sowing to the extent that large areas are not sown, or are sown as late as January, which shortens the growing season. Under such conditions, plants during the filling stage may suffer from drought or heat waves that cause crop failure.

- The average potential evapotranspiration (PE) varies during the season among the rainfed areas. The least PE occurs in January. In the northern region, PE is less than 50mm, while it exceeds 70mm in the southern region of the rainfed area. On the contrary, PE in July can be as high as 225mm (see Table 4 of the annex).

  Calculated evapotranspirations in Rabba, Irbid, and Shoubak indicate that it reaches 17 percent of the total soil moisture. This means that about 83 percent of the soil moisture could be lost by evaporation, therefore, the fallow system, which is commonly practiced as part of the field crop rotation, should be evaluated accordingly. There is an indication that the differences in the moisture loss from soil during fallow and nonfallow is not appreciable (Table 2.5).

- Mean temperature in the rainfed region is 25°C during the summer months and about 8°C during the winter. The highest temperature (approximately 40°C) occurs during July-August; during December, the temperature may drop below 0°C (Tables 5, 6, 7, and 8 of the annex).

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Table 2.5. Evaporation/Evapotranspiration Relationship in Rainfed Area

Location	Period	Mean daily potential Evaporation (mm)	Mean daily potential evapo-transp. (mm)	Mean annual trans-piration (mm)	Evaporation/ Evapo-transp. (%)
Irbid Nursery	1974-87	4.64	3.99	0.65	16.3
Rabba	1974-87	4.71	4.07	0.64	15.7
Shoubak	1974-87	4.35	3.68	0.67	18.2

2.2 Production Systems in the Rainfed Subsector

Production systems in the rainfed subsector can be broadly divided into two groups: those based on annual crops and those based on perennial crops. The main annual crops are wheat, barley, and lentil; the main perennial crops are olive, grape, stone fruit, and pome fruit. There is a continuing shift in land use from field crops to fruit trees, especially in the good land with the fewest constraints, regardless of rainfall patterns, because supplemental irrigation is now being used by many farmers. Also, there is a seasonal fluctuation in the areas planted with cereal, which depends on rainfall pattern. The average areas planted with different crops and the average production in tons were estimated for the period 1981-1991 (Table 2.6).

ANNUAL CROPS

2.2.1 Wheat

Wheat is the main field crop in rainfed areas with more than 300mm rainfall. It is usually grown in rotation with a clear fallow or, in some cases, in rotation with a legume crop. On large holdings, seed drills are used for planting and fertilizer (mainly diammonium phosphate, or DAP) is applied with the seed. The recommended seeding rate is about 10 kg/dunum in the higher rainfall areas (>350mm) and 8 kg/dunum in areas of lesser rainfall. On small holdings, hand sowing without fertilization is the common practice. Harvesting is done by combines or by hand depending on the size and shape of fields and the availability of combines.

Wheat straw is a valuable by-product, which is used for livestock feed. It can be grazed in the field or baled and used for winter feed. More feed is obtained if the straw is baled, but if the animals graze in the field their manure and trampled straw contribute to the fertility of the soil.

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During the period 1986-1990, the area planted to rainfed wheat averaged 877,000 dunums, while production averaged 81,000 tons. Average productivity of wheat fluctuates from 68 kg/dunum (1981-1985) to 92 kg/dunum (1986-1990), a fluctuation associated with shortages and erratic distribution of rainfall. Improved agricultural practices, including the use of high-yielding varieties, seed drills, early planting, and fertilizers have been shown to increase wheat productivity up to 100 percent.

2.2.2 Barley

Barley is an important rainfed crop, which is also used as livestock feed. It is the dominant cereal crop in areas with less than 300mm annual rainfall due to its high tolerance to water shortages and poor soil quality. It is also grown in some areas of the marginal rainfall zone, either to be used for grazing or to establish rights to ownership of the land.

Farmers give barley less care than they give to wheat. For example, fertilizer is seldom applied to barley fields. When barley is grown under better soil and water conditions and with the addition of some fertilizer, there are significant increases in its productivity.

During the period 1986-1990 the area planted to barley averaged 433,000 dunums; production averaged 31,000 tons during the same period.

Under present practices, average productivity of barley is low. Average yield from 1981 to 1985 was 46 kg/dunum, but increased to 72 kg/dunum from 1986 to 1990. This improvement was mainly the result of an increase in the amount and distribution of rainfall, although to some extent it may also have been the result of barley production expanding into areas traditionally used for wheat. Total area under barley has increased from an average of 361,000 dunums during the period 1984-1985 to 433,000 during the period 1986-1990 and to 518,000 during the period 1991-1992 (Table 2.6). This increase may be in response to a more balanced pricing policy.

2.2.3 Lentils

Lentil is grown as part of the cereal crop rotation in a nonsystematic way. Planting lentils early in the season assures a successful crop because its growing season is short, which makes it less dependent on the soil water than are cereal crops. Lentil is sown and harvested by hand; and with the shortage of labor this discourages the expansion of lentil areas.

Under present conditions, average productivity ranges from 53 to 79 kg/dunum depending on rainfall. Area, production, and productivity of lentils are given in Table 2.6.

2.2.4 Summer Crops

Summer crops are primarily vegetables planted within a crop rotation. The area planted with summer crops mainly depends on the amount of rainfall during the previous winter season,

and thus there is no consistent summer cropping pattern. Continuous rainfall usually prevents wheat planting, and in such cases farmers tend to grow more summer crops in the wheat areas, where the stored soil moisture adequately supports the planted crop. The average area planted with summer crops and their production during the last ten years are shown in Table 2.6.

PERENNIAL CROPS

2.2.5 Perennial Crops

Fruit tree planting is encouraged by the government especially for small farms on mountainous sloped land. However, because of their profitability, fruit crops are now competing with grain crops for the best soils on flat land. There are several reasons for the decrease in land planted to grain crops since 1980, but it is mainly attributed to the expansion of fruit tree plantings on land traditionally used for grain.

2.2.6 Olive

Olive trees are indigenous to the region and are well adapted to the climatological conditions. They can tolerate harsh conditions including poor soils and drought. A steady increase in the area planted to olive trees has occurred since 1980. This expansion has not been limited to steep sites in the hills and mountains, but also includes flat land with deep soils. In 1991 the total area planted to olives in rainfed areas was 547,000 dunums, of which 402,000 dunums were under production and 45,000 were not producing. During the period 1987-1991 production averaged 44.4 thousand tons, of which 10.7 thousand tons were pickled and 33.7 were used for production of olive oil. Production of olive oil averaged 6,800 tons per year. Imports amounted to 2,000 tons in addition to an average of 3,000 tons introduced from the West Bank.

2.2.7 Grape

Grapes are usually grown on sloping land with shallow soils. Local grape varieties as well as introduced varieties are of the table grape types. Soil conservation projects supported by the government greatly enhanced the expansion of the grape area from 1981 to 1990 (Table 2.6). Grape may be considered as a potential crop because it can be processed into different products that are easily stored or locally consumed.

2.2.8 Stone Fruit

Stone fruits include peach, almond, plum, and apricot, but the main crop is the peach, which is grown on flat and hilly areas in the rainfed region. Many new peach varieties, especially the high-yielding dwarf ones, have been introduced into the country. These varieties vary in their date of fruit setting, bearing behavior, and fruit maturity. The introduction of new varieties has been associated with the development of the know-how for the management of these orchards including fertilization requirements, training, pruning, and fruit handling. Table 2.6

shows the area and production of stone fruit trees. From 1981 to 1990 there was at least a 50-percent increase in peach tree planting as compared with the previous decade. Although further expansion into the high rainfall sloping regions is feasible, there was no appreciable increase during the last two years (1991-92).

2.2.9 Pome Fruit

The area planted with pome fruits consistently increased during the period 1981-92 (Table 2.6). New, mainly dwarf, high-yielding varieties of apple trees were introduced to the country. Most of the orchards that were established within the rainfed regions receive supplemental irrigation. Orchards of new varieties of pome fruit need proper management, fertilizer application, pest control, as well as training and pruning. Although a great deal of success was achieved, more technical information is still needed.

Table 2.6. Cropping Patterns in the Rainfed Areas (1981–1992)

Crop	1981–1985		1986–1990		1991–1992	
	Avg. Area (1,000 du)	Avg. Prod. (1,000 tons)	Avg. Area (1,000 du)	Avg. Prod. (1,000 tons)	Avg. Area (1,000 du)	Avg. Prod. (1,000 tons)
Wheat	860.16	58.50	877.98	81.48	650.80	60.39
Barley	361.30	16.80	433.12	31.30	518.15	37.14
Lentil	68.24	4.60	79.48	6.32	49.05	3.90
Vegetables	20.34	1.56	31.16	1.84	54.2	4.33
Tobacco	71.62	3.26	30.86	2.82	20.65	1.28
Total	1,381.66		1,452.6		1,292.85	
Olive	229.2	26.75	400.46	40.09	547.50	54.75
Grape	91.85	40.00	167.32	53.50	108.00	54.00
Stone fruit[a]	17.02	6.67	25.12	6.50	27.25	8.88
Pome fruit[b]	6.48	2.73	10.48	2.80	18.15	6.24
Total	344.55		603.38		700.9	

Source: Ministry of Agriculture

[a]Stone fruit includes the total average (5 yrs.) production of peach, plum, apricot, and almond.

[b]Pome fruit includes the total average (5 yrs.) production of apple and pear.

2.3 Institutional Framework

Main government institutions responsible for policy formulation that affect rainfed areas and their present mandate are as follows.

2.3.1 Agricultural Council (AC)

The Agricultural Council is chaired by the Minister of Agriculture and was created to coordinate policies and activities of the various institutions concerned with agriculture. Policies or other measures can be proposed by members of the AC and are expected to be reviewed before presentation. The AC has the authority to approve policies unless broader issues are involved, in which case the matter is submitted to the Cabinet of Ministers. The AC is to serve as a focal point for:

- Formulation of agricultural policies related to agricultural production, utilization of agricultural resources, taxation and customs exemptions for agricultural commodities, and agricultural production inputs.

- Coordination of the work of institutions concerned with servicing and developing the agricultural sector.

- Address, and where necessary recommend action on, urgent agricultural problems brought to its attention by the Minister of Agriculture.

The AC failed to fulfill its mandate for two reasons: (1) no core unit at the MOA or the Ministry of Planning was assigned to the AC for the preparation of the data and documents necessary to support its work and (2) the composition of the Agricultural Council did not facilitate a scientific debate. In practice the AC has become concerned mainly with ad hoc issues brought to its attention by the Minister of Agriculture.

The Agricultural Council (AC), chaired by the Minister of Agriculture, is made up of the following members:

- Under-secretary of Agriculture (Secretary General)
- Minister of Industry and Trade
- Minister of Supply
- Minister of Planning
- Vice-President of the Natural Resources Authority
- Dean, Faculty of Agriculture, University of Jordan
- President of the Jordan Valley Authority (JVA)
- Director General of the Jordan Cooperative Organization (JCO)
- Director-General of the Agricultural Credit Corporation (ACC)
- Director General, AMPCO
- Director from MOA, approved by Minister of Agriculture

- Two representatives from the private sector

2.3.2 Ministry of Agriculture

By Law No. 9 of the year 1990 the MOA was also made responsible for the formulation and implementation of agricultural policy. Action has been primarily ad hoc rather than systematic. The causes of ineffectiveness have been ill-defined roles for the institutions and the lack of follow-up by the MOA. Officially the MOA is responsible for policy action in the following areas that relate to the rainfed subsector:

- Agricultural research (in collaboration with the Higher Council for Science and Technology)
- Extension
- Price support policy for cereals (in collaboration with the Ministry of Supply and the Ministry of Finance)
- Land reclamation and development policies
- Production policies, including cropping patterns

2.3.3 Ministry of Supply

The Ministry of Supply has the dominant role in agricultural pricing and the monopoly for the import of basic food and feed commodities. It makes recommendations to the Cabinet of Ministers for the prices of these commodities, and since 1988 has enforced price controls at the retail level for fruits and vegetables. Since 1980, it has been responsible for the procurement of locally produced cereals and grain legumes at prices announced before the beginning of the planting season. The Ministry is also responsible for maintaining strategic reserves of basic food commodities.

2.3.4 Agricultural Credit Corporation (ACC)

Objectives and policies for agricultural credit are not clear. There are three formal credit institutions: the ACC, the JCO, and the Jordan Valley Farmers Association; each has its own lending policies.

The government has decided to merge the ACC and the Cooperative Bank into a single Rural Development Bank, which may lead to the establishment of a credit policy designed to serve overall agricultural development policy.

2.3.5 Agricultural Marketing Organization (AMO)

The AMO is responsible for formulation and implementation of trade policy and market regulations. At present, it deals only with fruits and vegetables; cereals and livestock feed are controlled by the Ministry of Supply.

2.3.6 Ministry of Municipal Affairs and Rural Development and the Environment

This ministry is responsible for land use policy in Jordan, which includes establishing village and town boundaries. The Ministry of Agriculture is not represented on the Board of the High Planning Council.

2.3.7 Land and Survey Department of the Ministry of Finance

This department is responsible for the management of lands registered as "government lands," and also makes recommendations to the Cabinet of Ministers as to their allocation.

2.3.8 Other Institutions

Three other government and semigovernment institutions have responsibilities for the formulation and implementation of sectorial policies: the Ministry of Higher Education, which is responsible for the policy of agricultural education (faculties of Agriculture at the various Jordanian universities); the Higher Council for Science and Technology, which is responsible for the national policy on science and technology, including the policy of agricultural research and transfer of technology; and the Jordan Cooperative Organization, which has been active in establishing agricultural cooperatives and farm mechanization centers in the rainfed areas.

From the above, it is clear that a large number of government organizations and institutions are involved in policy formulation and that the lines of responsibility are not clear. Many of the policies these organizations formulate are concerned with crisis management and are not analyzed to determine their long-term effects. Consequently many of the policies are in direct conflict with other policies.

On the other hand, and considering the role of the MOA in agricultural development, there is a big deficiency in the process of agricultural policymaking in that the MOA has no role in macroeconomic policies or in land use planning and only a minor role in the pricing policy of agricultural and food products.

2.4 Place of the Rainfed Subsector in the National Economy

2.4.1 Contribution of the Rainfed Subsector to Agricultural Gross Domestic Product

The value of production from rainfed agriculture has risen steadily from JD 20.2 million in 1989 (representing about 14.1 percent of the Agricultural Gross Domestic Product, AGDP) to about 35.4 million JD in 1991 (representing 19.7 percent of AGDP), an annual growth rate of 20.5 percent. The increase is due mainly to a steady increase in the value of the tree and vine crops as new areas enter production. The average share of grains (wheat, barley, and pulses) during the 1989–1991 period in the total value of rainfed production was about 37.5 percent; that of fruits 57.4 percent, and that of rainfed vegetables 5.1 percent.

The value of the share of rainfed production in the total value of plant production in Jordan has risen from 17.3 percent in 1989 to 23.3 percent in 1991. Rainfed cereals contribute about two-thirds (65.4%) of the total value of cereals (irrigated and rainfed) and rainfed fruits about 27.8 percent. The share of rainfed vegetables, however, has continuously decreased and represents only 2.3 percent of the total value of vegetable production in Jordan, because most vegetables are now produced under irrigation in the Jordan Valley and in the highlands.

2.4.2 Contribution of the Rainfed Subsector to Employment

Tables 9–19 in the annex for input-output data and gross margin per dunum for major rainfed crops give an estimate of labor requirement per dunum in two agroclimatic zones: the 200–350mm rainfall zone and the 350mm rainfall zone.

The total annual crop labor requirement per dunum varies from an average of 5.8 hours for wheat and barley to 47 hour for stone fruit, 53 hours for olive, and 80 hours for grape. The total time required for these crops in the entire rainfed sector was around 229,000 man-months in the year 1991 (a poor year for cereals and grain legumes). This is equivalent to about 19,000 full-time laborers (Table 2.7).

Most of the labor requirement for fruit tree production (about 80% of total labor requirements in the rainfed areas) is provided by family labor as the majority of fruit tree farms are small holdings. Only in very rare cases, and usually during periods of olive picking, is temporary labor needed.

Table 2.7. Total Annual Crop Labor and Time Requirement per Dunum

Crop	300–350mm Rainfall Zone			> 350mm Rainfall Zone			Total man-months labor
	Working hours	Area Planted (average)	Total man-months labor	Working hours	Area Planted (average)	Total man-months labor	
Wheat	5.8	233,200	6,502.69	4.5	207,900	4,497.80	11,000.49
Barley	5.8	169,100	4,715.29	6	32,200	928.85	5,644.14
Grape	75	57,200	20,625.00	86	71,300	29,479.80	50,104.80
Olive	48	115,000	26,538.46	59	331,800	94,116.34	120,654.80
Peach	41	6,300	1,241.83	46	5,300	1,172.11	2,413.94
Apricot	37		0.00	48	24,700	5,700.00	5,700.00
Pulses			0.00	26	271,100	33,887.50	33,887.50
Total	212.6	580,800	59,623.27	275.5	944,300	135,894.90	229,405.67

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2.4.3 Contribution of Rainfed Subsector to the Supply of Feed for Livestock

The rainfed subsector makes a major contribution to the feed supply for livestock. During the last three years (1989-1991), this contribution was estimated at:

5,200	tons of hay from legumes (80kg/dunum)
66,000	tons of wheat and barley hay (80 kg/dunum)
34,000	tons of barley
1,373	tons of vetch
10,000	tons of wheat bran

The total value was estimated at about 7.7 million JD distributed as shown below:

365,000	legumes hay (80 JD per ton)
3,985,000	wheat and barley hay (60 JD per ton)
3,570,000	grain barley
247,000	grain vetch
368,000	wheat bran

8,535,000	Total

2.4.4 Contribution of the Rainfed Subsector to Self-sufficiency in Food Consumption in Jordan

While total needs and requirements for cereals are increasing, the total local production is decreasing. Although the total supply of cereals increased from 343.3 thousand metric tons (MT) in the early 1970s to about 1,226 thousand MT in the 1980s, local cereal production decreased from 167 thousand MT to 113.7 thousand MT in the same period, and the self-sufficiency ratio (S.S.R) decreased from 48.6 percent to 9.3 percent. This situation resulted from the high population growth rate, the decreasing area cropped to cereals as a result of urbanization, the expansion of fruit tree production at the expense of cereals in the higher rainfall areas, and the fact that most cereals are grown in areas with very limited potential for increasing productivity because of limited and erratic rainfall.

The S.S.R for wheat decreased from about 55.1 percent during the period 1970-1972 to about 15.0 percent for the period 1988-90. that of barley from 71.1 to 19.6, and that of pulses from 101.8 to 26.8 percent (Tables 9-12). The contribution of cereals produced in the rainfed areas to the S.S.R of cereals as a whole is very small despite the fact that it represents most of the total cereals produced (about 65%).

Contribution of cereals produced in the rainfed area to total share in self-sufficiency is estimated at 5.3 percent. The rest (about 4%) comes from cereals produced under irrigation.

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Table 2.8. Self-sufficiency Ratios of Cereals

Time Period	Production (000 MT)	Total supply (000 MT)	S.S.R. (%)	Food as Percent of Supply	Feed as Percent of Supply	Waste as Percent of Supply	Per Capita kg/y
1970-72	167.0	343.3	48.6	74.6	15.2	3.5	169.1
1973-75	135.0	373.7	36.1	77.9	12.2	3.6	164.9
1976-78	75.7	473.3	16.0	68.5	23.7	3.2	161.4
1979-81	91.3	569.0	16.0	64.8	28.8	3.6	163.5
1982-84	99.7	679.7	14.7	61.2	32.3	4.2	165.4
1985-87	81.7	847.7	9.6	52.7	41.5	4.2	158.4
1988-90	113.7	1226.0	9.3	43.1	50.2	4.1	166.6

Table 2.9. Self-sufficiency Ratios of Wheat

Time Period	Production (000 MT)	Total Supply (000 MT)	S.S.R. (%)	Food as Percent of Supply	Feed as Percent of Supply	Waste as Percent of Supply	Per Capita kg/y
1970-72	144.3	262.0	55.1	89.2	--	3.8	154.3
1973-75	114.7	298.0	38.5	89.8	-	4.0	151.5
1976-78	61.0	325.3	18.7	91.3	--	3.3	147.7
1979-81	67.0	358.3	18.7	92.5	--	4.4	147.2
1982-84	77.7	400.0	19.4	92.2	--	5.0	146.8
1985-87	58.0	418.0	13.9	92.3	--	5.9	136.7
1988-90	72.3	480.3	15.0	92.8	--	5.8	140.6

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Table 2.10. Self-sufficiency Ratios of Barley

Time period	Production (000 MT)	Total Supply (000 MT)	S.S.R. (%)	Food as Percent of Supply	Feed as Percent of Supply	Waste as Percent of supply
1970-72	22.0	30.7	71.7	--	89.6	9.8
1973-75	19.3	22.7	85.0	--	71.9	19.1
1976-78	14.3	49.7	28.8	--	85.2	6.7
1979-81	20.7	52.7	39.3	--	85.4	6.9
1982-84	20.0	93.7	21.3	--	88.9	3.5
1985-87	20.7	156.3	13.2	--	92.3	2.3
1988-90	36.0	184.0	19.6	--	92.4	5.1

Table 2.11. Self-sufficiency Ratios of Pulses

Time period	Production (000 MT)	Total Supply (000 MT)	S.S.R. (%)	Food as Percent of Supply	Feed as Percent of Supply	Waste as Percent of Supply	Per Capita kg/y
1970-72	22.7	22.3	101.8	61.3	17.9	9.0	9.0
1973-75	21.7	21.3	101.9	64.2	15.5	7.8	7.8
1976-78	12.7	18.0	70.5	70.4	11.1	5.5	6.3
1979-81	8.3	19.0	43.7	82.4	7.0	5.3	6.8
1982-84	10.7	24.0	44.6	80.5	9.7	4.2	7.8
1985-87	6.7	23.3	28.7	85.8	5.7	5.7	7.0
1988-90	7.7	28.7	26.8	85.9	5.8	4.6	7.8

2.5 Impact of Existing Policies and Government Interventions on Rainfed Agriculture

2.5.1 Land Use and Land Allocation

The total area of registered agricultural landholdings decreased from 3.666 million dunums in 1975 to 3.404 million dunums in 1983, a net loss of 262,000 dunums from agriculture to other uses at a rate of 32,700 dunums per year. Most of the land was used for urban development. The land lost was probably some of Jordan's best land because most of the population centers were originally established in good agricultural areas. Further urban expansion is also expected to be at the expense of prime agricultural land. As Jordan's population doubles every nineteen years, it is expected that not only the cultivated land within the present boundaries of villages and cities will be used for nonagricultural purposes, but also that the rate of annual loss of agricultural land may be double the rate from 1975 to 1983.

There are no laws that regulate the utilization of agricultural lands in the rainfed areas. Farmers have the right to cultivate their land with crops of their choice or to leave the land idle.

2.5.2 Land Fragmentation

Inheritance law and free land sale has resulted in ever-increasing fragmentation in the rainfed areas. Figures available for the highland areas (mainly rainfed) show that during the period 1975–1983 (years in which a national agricultural census was carried out) the number of holdings with an area of less than 40 dunums (which account for more than 50 percent of the number of holdings) increased from 25,190 to 32,400 (28%), and that holdings with an area of less than 20 dunums increased from 17,090 to 23,,000 (28%).

In 1969, the government issued Law No. 49 limiting the minimum size of a holding outside village and city boundaries to 4 dunums. The Higher Council for Regional Planning, by its decision No. 6053 of the year 1982, raised this limit to 10 dunums. Land fragmentation and the small size of holdings poses a problem of economic viability of small holdings in the rainfed areas; small farmers in these areas who use traditional farming systems need additional income, other than that generated from farming, to provide for themselves and their families.

2.5.3 Soil and Water Conservation

In 1964, the government, through the MOA and with the support of the World Food Programme, started a soil and water conservation program aimed at the hilly areas with a slope of 9–25 percent. Farmers were provided with food commodities for work on land terracing, and with fruit tree seedlings at subsidized prices. This program is ongoing.

In 1987, the government undertook the implementation of another project, The Development of the Zarqa Cachement Area, for land and water conservation and agricultural development. Government support is provided for land terracing, water conservation measures,

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Table 2.12. Self-sufficiency of Olives and Olive Oil

Olives

Time Period	Production (000 MT)	Total Supply (000 MT)	S.S.R. (%)	Food as Percent of Supply	Processing as Percent of Supply	Per Capita kg/y
1970-72	21.3	21.0	101.4	15.9	84.1	2.3
1973-75	18.3	18.7	97.9	5.5	94.5	1.6
1976-78	22.7	24.3	93.4	27.3	72.7	3.2
1979-81	23.3	20.0	116.5	26.7	73.3	2.4
1982-84	37.3	34.0	109.7	36.3	63.7	4.9
1985-87	24.0	29.0	82.7	34.5	65.5	3.7
1988-90	53.7	50.7	105.9	21.8	78.2	3.5

Olive Oil

Year	Production (000 MT)	Supply (000 MT)	S.S.R. (%)
1970-72	4.7	8.0	58.7
1973-75	4.0	9.0	44.4
1976-78	4.7	10.0	47.0
1979-81	4.3	10.7	40.2
1982-84	6.3	11.7	53.8
1985-87	5.0	12.7	39.4
1988-90	9.3	14.3	65.0

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fencing, fruit tree planting, and other development activities. Erosion control is given the highest priority.

The above government policy is supported by soft loans provided by the Agricultural Credit Cooperation for land reclamation and development (long-term loans of 10–12 years and 6% interest). Much has been achieved in this respect, but more remains to be done.

2.5.4 Agricultural Research

Agricultural research is the responsibility of the MOA although other institutions are also engaged in agricultural research (e.g., Faculty of Agriculture at the University of Jordan, the Jordan University of Science and Technology, the Higher Council for Science and Technology). Despite intense discussions and efforts in 1991 and 1992, there is no final decision concerning the mandate for the research policy for setting research priorities, and for the implementation of research programs and projects. A task force was established in early 1993 to discuss these issues again and to propose an agricultural research strategy for Jordan

In the absence of research priorities or strategies, research projects were carried out through one of the following channels:[2]

- Initiated by individual researchers and agreed upon by the Department as in the case of most FAI research. This should also be approved by the committee of research at the university.

- Initiated through dialogue between researchers in FAO and NCARTT and international centers or granting agencies. Normally, this is approved by the university, MOA, and the Ministry of Planning.

- Initiated by individual researchers and reviewed, as in the case of most NCARTT projects.

In most cases, no known strategy, criteria, or evaluation methodologies were applied during the pre- or post-implementation phases.

There are no recent figures on the distribution of funds allocated for research to the various commodity groups. According to Dr. Gasem,[3] about 38 percent of total funds allocated for agricultural research during the period 1980–1984 were allocated for field crops, 54 percent for vegetables and fruits, and only 8 percent for livestock. The average contributions of these groups of commodities to the AGDP during that period were 11 percent, 64 percent, and 24 percent, respectively.

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[2] Agricultural Research, Technology & Training in Jordan, Dr. M. Duwayri

[3] Agricultural Policy in Jordan

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In the rainfed sector, some research accomplishments were achieved in the cereal subsector; most important were the packages of practices for wheat and barley production as well as the release of new varieties of wheat, barley, and chickpea. Very little has been achieved about fruit trees and dryland cultivated forage (leguminous species). The lack of a well-defined strategy for agricultural development and research is at the origin of this deficiency.

2.5.5 Agricultural Extension

The extension function of the MOA has been subject to various institutional arrangements, which have resulted in a weak extension service that performs regulatory functions on behalf of the MOA and does little in the fields of information and transfer of technology. A study on the structure that would best serve Jordan's needs was prepared by the Joint ESCWA/FAO Division in collaboration with specialists from MOA in early 1993, who proposed the establishment of an Agricultural Extension Department at the Ministry of Agriculture as an entity separate from NCARTT. The proposal contained a detailed organizational structure of the extension service, with particular attention to the relationship between the directorates of agriculture and headquarters and the linkage of the department with the agricultural research centers and sources of information. The MOA accepted the proposal and has already established the Department of Agricultural Extension. The development and training of highly motivated subject matter specialists (SMS) at the national level, of extension supervisors at the regional level, and of extension agents at the village level, the improvement of staff incentives, and the provision of means of mobility are key requirements for the success of this service.

In the rainfed areas, extension services are needed to provide transfer of improved technology packages in cereals and legumes, advice on fruit tree varieties suitable for different agroclimatic zones, training and information on agricultural practices for fruit tree production including fertilization, pruning, control of insects and diseases, and supplementary irrigation requirements.

Extension agents will also take a more active role in advising farmers on investment opportunities in rainfed agriculture and helping farmers overcome marketing problems, especially for fruit tree crops.

2.5.6 Agricultural Credit

Considerable effort has been made since 1960 to organize the provision of easy credit to farmers. Institutional credit to farmers of rainfed areas was mainly extended by the Agricultural Credit Cooperation (ACC) and on a very limited scale by the Jordan Cooperative Organization (JCO). Most of these loans were longterm loans for land reclamation, fruit tree planting, purchase of farm machinery, and drilling of deep wells. Seasonal production credit from ACC and JCO was very limited and constituted only 2 percent of the cash cost of production in 1988. Improving the system for the delivery of credit was the main issue debated since 1980 and the government has decided to merge the Agricultural Cooperative Bank (of the JCO) with the ACC

to avoid duplication in the delivery of credit. The ACC will later be developed into a full-fledged agricultural development bank.

2.5.7 Agricultural Mechanization

Government policy supports agricultural mechanization by exempting Farm machinery from taxes and levies, providing soft medium-term loans through the ACC for the purchase of such machinery, and supporting the JCO in establishing and running farm machinery services centers in the cereal zone of the rainfed areas. These centers, although far from satisfying the demand, were quite important to small farmers, who were given the opportunity to introduce new packages of technology into their production systems.

2.5.8 Pricing Policies and Subsidies in Rainfed Agriculture

Input Price Policy. All input prices for rainfed agriculture are market determined, although the government does provide some indirect support to agriculture by allowing the duty-free importation of all agricultural inputs and farm machinery.

Fruit tree seedlings produced by the MOA, however, are sold at subsidized prices to farmers participating in specific development projects (the Highland Development Project and the Zarqa Development Basin). This subsidy varies from year to year but its value is minimal.

Output Price Policy. A price support policy is applied by the government to the primary rainfed crops, namely wheat, barley, lentil, and chickpea. Support prices are announced before planting of cereals and are related to a specific quality of the crop (e.g., impurities and grain shrinkage).

The objective of this policy is twofold: (1) it supports the income of rainfed farmers by ensuring a suitable return, and (2) it stimulates production and ensures that field crop producers will continue to produce.

A policy analysis matrix (PAM) is used to evaluate the impact of the existing price policy for wheat and barley on the farmers' profitability. The PAM provides an effective tool for communication between the policy analyst and the policymakers to evaluate the impact of price distortions on the commodity markets.

Table 2.13 shows the producer prices and the corresponding import prices of wheat. From 1985 to 1991, on average, the producer price was 139.16 JD per ton. In comparison, the average c.i.f. price for imported wheat during the same period was 127 JD per ton, which includes local handling and transportation costs of 12.5 JD per ton. At these prices the nominal rate of protection, as indicated by the ratio of domestic price to imported price, is estimated at 1.09, implying a subsidy of 9 percent.

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Table 2.13. Producer and International Prices for Wheat (JD per ton)

	1985	1986	1987	1989	1990	1991	Average
Producer	120	132	142	147	147	147	139.16
Import	127	121	107	124	146	140	127
Tax/Subsidy	.95	1.09	1.33	1.18	1.00	1.15	1.09

Source: Producer prices, Ministry of Supply;
Import prices, FAO, State of Food and Agriculture, 1991

Table 2.14 shows (for the 1985-1991 period) the procurement and import price of barley and the level of price protection. The Nominal Protection Coefficient (NPC) is estimated at 0.74, indicating that barley prices are below international prices, implying an implicit tax of 26 percent.

Table 2.14. Producer and International Prices for Barley (JD per ton)

	1985	1986	1987	1989	1990	1991	Average
Producer	71	74	75	83	105	105	85.5
Import	111	102	100	118	129	134	115.6
Tax/Subsidy	.64	.72	.75	.70	.81	.78	.74

Source: Producer prices, Ministry of Supply
Import prices, FAO, State of Food and Agriculture, 1991

The above analysis indicates that current pricing policies provide better incentives for wheat than for barley. This encourages planting of wheat over barley and leads to larger crop failures because barley is a hardier crop and stands a better chance of survival in the rainfed conditions of Jordan.

While the above analysis would clearly support the removal of price discrimination against barley, any price adjustment for wheat must be handled with caution in view of the following facts:

- The current gap between the domestic and international wheat prices is rather moderate, especially in view of the unstable nature of international wheat prices.

- Due to the quality differentials, farmers seldom receive the declared procurement price. On an average, the prices received by farmers are 5-10 percent less than the standard procurement price.

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- Wheat grown in the rainfed areas of Jordan is Durum wheat. This type of wheat usually commands a 10-15 percent premium prevalent hard red wheats of international trade. However, no premium was factored into these calculations.

A further analysis indicates that wheat and barley grown in the low- and high-rainfall areas have a comparative advantage in production. Whereas all crops are grown using resources efficiently, wheat grown in high rainfall areas uses the resources most efficiently.

Based on average border prices, positive divergence (the difference between revenues and costs estimated at domestic and border prices) in the case of wheat, of revenues of 1.54 JD per dunum in the low-rainfall areas and 2.32 JD per dunum in the high-rainfall areas reflect a small subsidy per dunum given to wheat producers. Similarly the negative divergence in the case of barley of 1.48 JD and 1.56 JD per dunum indicates the level of per dunum implicit taxation.

For wheat and barley, the effect of policy distortion on traded inputs is almost minimal or neutral, but it is sizable (a subsidy) on domestic factors (land, labor, and capital). This is because farmers in the highland areas do not use many of the purchased inputs (e.g., fertilizers, pesticides, and farm machinery). The lower domestic factor cost is due to the subsidized capital available to the farmers and low rental values.

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PAM for Wheat in Rainfed Areas of Jordan

1. PAM for wheat in low-rainfall zones (<350mm).

	Revenues	Traded	Domestic	Profit
Private[a]	16.56	2.9358	8.6042	5.02
Social[b]	15.0117	2.24098	11.1156	1.65516
Divergence[c]	1.54827	0.69482	-2.5114	3.36484
NPC[d]	1.10314			
EPC[e]	1.06683			
DRC[f]	0.87039			

[a]Private Profitability is defined as the difference between the revenues of the commodity under study and the production costs of the tradable inputs and the domestic factors. It can be calculated by using private prices or market prices. This is equivalent to the estimation of private budgets in project analysis.

[b]Social Profitability of a commodity is the difference between the revenue less the tradable inputs and domestic factors, valued at their opportunity cost or at social prices.

[c]Divergence is the difference between the elements of the private profitability and the social profitability and is the result of government intervention policy or market failure.

[d]Nominal protection coefficient.

[e]Effective protection coefficient.

[f]Domestic resource cost (DRC) = (private price/social price).

2. PAM for wheat in high-rainfall zones (<350mm).

	Revenues	Traded	Domestic	Profit
Private	24.84	2.2232	8.4644	14.1524
Social	22.5176	1.88669	11.9561	8.67485
Divergence	2.3224	0.33651	-3.4917	5.47755
NPC	1.10314			
EPC	1.09626			
DRC	0.57952			

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PAM for Barley in Rainfed Areas of Jordan

1. PAM for barley in low-rainfall zones (200-300mm).

	Revenues	Traded	Domestic	Profit
Private	15.2	2.4985	8.727	3.9745
Social	16.6852	1.91657	10.6451	4.12355
Divergence	-1.4852	0.58193	-1.9181	-0.149
NPC	0.91099			
EPC	0.86003			
DRC	0.72079			

2. PAM for barley in high-rainfall zones.

	Revenues	Traded	Domestic	Profit
Private	16	3.093	9.166	3.741
Social	17.5633	2.50776	13.2857	1.76988
Divergence	-1.5633	0.58524	-4.1197	1.97112
NPC	0.91099			
EPC	0.85729			
DRC	0.88244			

2.6 Constraints on Rainfed Agriculture

2.6.1 Socioeconomic Constraints

Life patterns of people who live in rainfed areas have undergone significant changes associated with rural development. These include provision of and access to education, health care, social services, and infrastructure (roads, electricity, etc.), all of which have created a greater need for an adequate and stable income for farmers. However, the uncertainty of adequate and secured income from agriculture under the existing farming system based on cereals, has forced farmers to seek jobs outside the agricultural sector. Thus, farming has

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become of secondary importance for income generation, especially in the case of small farm holdings. This situation has led to land negligence and more reliance on foreign unskilled labor.

Shortage of Labor. In general there is no real shortage of unskilled labor in the rainfed areas. Land preparation, sowing, and harvesting of the main field crops (wheat and barley) is done by machinery, except in poor years or in small holdings where hand harvesting is necessary. Lentils, chickpeas, and olives are still harvested by hand.

The main issue is the ever-increasing cost of labor (as well as other inputs), without a corresponding increase in the value of production, that affects the crops that are more dependent on hand labor, such as chickpeas and lentils. In fact, many farmers are reluctant to plant lentils and chickpeas for that reason, which in turn is affecting the introduction of crop rotation using legumes instead of fallow. Mechanization of lentil and chickpea harvesting, which would reduce labor costs and also save the valuable hay, is essential for continued production of pulses.

The cost of picking olives is also increasing, and research for alternatives is essential for improving the economics of this important rainfed product.

The rainfed sector also suffers from a real shortage in skilled labor, especially in the fruit tree subsector. Improved know-how and training, especially of grafting and pruning, is most needed, in addition to improved cultivation practices such as fertilization and soil moisture conservation. A long-term plan for training of orchard owners and a number of skilled laborers would have a significant positive impact on fruit tree productivity.

Size, Shape, and Fragmentation of Holdings. Small-size farms and land fragmentation are two main constraints to agricultural development in rainfed areas, for technical and economic reasons.

1. Technical reasons. Small holdings limit the use of new packages of technology for field crops that require the use of proper farm machinery (seed drills, spraying equipment, etc.).

2. Economic reasons. Small holdings in rainfed areas do not generate enough income to support an average-size rural family, especially considering the low potential of most rainfed areas (more than 50% of rainfed areas receive less than 350mm of annual rainfall) (Table 2.15).

Because a large portion of holdings in the rainfed areas fall in the category of small-size farms, present laws should be amended to guarantee a minimum economic size of holdings. This should also be accompanied by government intervention to increase productivity through research and extension and increase income through suitable pricing policy of outputs.

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Table 2.15. Net income per dunum generated by different crops under present agricultural practices and number of dunums needed to generate JD 2,000, 3,000, 4,000

Crop (rainfall)	Net income (JD/dunum)	Number of dunums needed to generate an income of JD/year		
		2,000	3,000	4,000
Wheat (350mm +)	15.94	125.4	188.2	250.9
Wheat (200-350mm)	11.18	178.8	268.2	357.6
Barley (350mm +)	11.95	167.3	251.0	334.7
Barley (200-350mm)	10.52	190.0	285.0	380.0
Olives (350mm +)	60.95	32.8	49.2	65.6
Olives (200-250mm)	58.95	33.9	50.8	67.8
Grapes (350mm +)	85.86	23.2	34.9	46.5
Grapes (200-350mm)	11.60	172.4	258.6	344.8
Peaches (350mm +)	207.32	9.6	14.4	19.2
Peaches (200-350mm)	206.20	9.6	14.5	19.3
Apricots (350mm +)	164.20	12.18	18.2	24.3

Source: Calculated from Tables 9-19 in the Annex

Urban Expansion. Urbanization is rapidly progressing at the expense of good arable land. The high land value in urban areas is the main reason for pressures to expand boundaries of villages and municipalities, especially in the absence of effective land use policy. Although the problem of high population increase is recognized, the expansion of urbanization at the expense of cultivable lands suitable for agriculture is not justifiable; rocky areas and areas unsuitable for agriculture should be allocated for urbanization.

Low Potential Under Existing Farming System. The low potential of rainfed areas is mainly related to the erratic and limited rainfall. Land potential under the different agroclimatic zones has not been adequately evaluated and should be fully investigated. It is now thought that flat areas that receive more than 350mm of rainfall should be allocated to wheat production, while areas of similar topography that receive 250-350mm of rainfall should be allocated to barley, and lands that slope more than 12 percent should be allocated to fruit trees.

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2.6.2 Technical and Institutional Constraints

Much new technical information and know-how must be combined to create operational packages. Such packages should be able to provide properly balanced and efficient utilization of land and water resources as a part of integrated farming systems. Improved technical packages should be designed for different crops and different farm sizes, especially for the small holdings, and should be accessible to the farmers. This approach requires the utilization of both adaptable transferred technology and the results of adaptive research.

The implementation of these packages is the responsibility of the official institutions and the private sector, through an effective and efficient extension system. Therefore, the following constraints must be alleviated:

Weak Research and Extension Services. The weakness of extension services in Jordan is one of the major constraints to the application of improved know-how and technology in Jordan. For example, applied research carried out in universities and other institutions is not effectively applied to operations in the field due to the lack of an efficient mechanism (i.e., extension service) to transform the results of the research into a useful method for farmers. The same problem was encountered when improved technologies were transferred to Jordan, especially the improved packages of different practices in cereals.

The extension system cannot perform its duties because it lacks the necessary professional staff, tools, and institutionalized administration. All agricultural sectors in Jordan suffer from inadequate or absent extension service, which results in excessively high production costs, misuse of resources, deterioration of environmental quality, and improper allocation of the different components of the production systems.

Shortage of Proper Inputs and Services. There are severe shortages of the inputs recommended for improved rainfed agriculture, including improved seeds, herbicides, and machinery. In addition to the scarcity of machines, there is a shortage of spare parts and qualified personnel to maintain and repair them, and operators are often not qualified to run them, a factor that shortens the life of the agricultural implements. Some inputs, even when available, cannot be used by farmers because of their high cost.

Shortage of Skilled Agricultural Labor. Subsectors in rainfed areas have undergone many changes, such as the expansion of the fruit tree sector, which requires large numbers of skilled laborers. In addition, operating farm machinery and using different inputs, especially fertilizers and chemicals, requires skilled and professional laborers. At present there is a shortage of such labor, which has a negative impact on farm management, and thus reduces production and farmers' incomes.

2.7 Overall Assessment and Opportunities

The criteria used to assess the current situation in the rainfed sector and to identify opportunities for improvement will be responsiveness to intervention and sustainability or optimal use of resources.

Improvement in research and technology transfer will be a function of NCARTT. Top priority at NCARTT should be given to identifying target groups and prioritizing research. Until this work is completed, government policy should be directed toward obvious and well-defined goals.

The only expanding production in the rainfed subsector consists of olives, vines, and deciduous fruits. Like irrigation in the Jordan Valley and poultry production, planting of fruit trees in the rainfed zone is expanding with government assistance (Highlands Development Project, and Zarqa Basin Development Project) and private sector participation. Economically and environmentally, this development is rational for high rainfall (>400mm) areas and should be encouraged.

Cereal production is declining despite efforts to expand production. Aspects of the problem include:

- More marginal land is being used for cereals production.
- Urban encroachment and shifting of land to tree production has reduced the amount of area planted with cereals.
- Government support for cereal production (e.g., price supports, research) did not result in tangible increases in productivity or production in the rainfed area.

Decades of production packages to promote cereals production has been unable to overcome the effects of high risk, unavailability of recommended inputs and equipment, land fragmentation, low farm income, and absentee ownership. Any useful government intervention in cereal production must address these facts.

Given the economic pressures on the rainfed sector, the government has the responsibility to protect the natural resource base and to mitigate adverse economic impacts. Methods that could be used to achieve this include:

- Land use regulations that would prevent urban expansion onto good agricultural land.
- Research and extension programs that focus on the most responsive cereal production land and on technologies to reduce risk (expanding barley and livestock production to higher rainfall regions rather than to marginal land, etc.).

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- Natural resource and infrastructure projects that would bring income-generating activities to rural areas.

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3. POLICY OBJECTIVES AND STRATEGIES FOR SUBSECTOR DEVELOPMENT

The objectives and strategies put forth in this chapter were developed after making the following assumptions.

- Stable exchange rate of the Jordanian dinar.
- Gradual elimination of subsidies on agricultural inputs, including animal feed.
- Continued price support for selected cereals, within an acceptable limit and justified by economic and social development criteria.
- Continued intervention by the Ministry of Supply concerning the purchase of cereals.
- The government will encourage and support the private sector to provide agricultural services to farmers and progressively withdraw from providing these services itself.
- The government will adopt and implement policies to limit the expansion of cities and villages onto good agricultural land.
- The government will increase its budget allocation for agricultural research and extension services.
- The government will continue and expand its support for soil and water conservation programs.

3.1 Objectives

3.1.1 Economic Efficiency in Allocation and Utilization of Agricultural Resources (increased productivity of land, water, and labor)

The key element in this objective is setting priorities. Investments will be made to guide and improve rainfed agricultural production, which is already showing clear signs of strength and indications of high economic potential.

Top priority will be given to fruit production in areas with annual rainfall of more than 400mm. This will include research and technology transfer on:

- Varieties, adaptation, and market potential
- Production practices
- Marketing

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Cereal research and technology transfer efforts will focus on:

- Specifically designated regions, production technologies, and simple innovations, which when combined show clear promise for acceptance by predetermined target groups.
- Major increases in yields (over 50%) and in net income (over 25%)
- Significant decreases in risk
- Identification and termination of ongoing long-term, but unsuccessful, attempts at innovation.

3.1.2 Prevention of Urbanization of Class I Land and Erosion

Urbanization and erosion of arable land are the major threats to the soil resource base of the rainfed zone. Research and technology efforts will focus on:

- Class I cereal land will be identified and protected from urban expansion.
- Tilling of marginal land will be discouraged.
- Soil and water conservation measures will be encouraged.

3.1.3 Increased Income for Farm Families

The difficulty that farm families are having maintaining themselves on the land has serious social, economic, and environmental implications. Farmers should be viewed as the guardians of the soil resources and open lands of the nation. Consequently, care should be taken to assure that there is a flow of financial resources to the rural sector. Target activities will be to:

- Encourage public and private sector investment in rural areas.
- Encourage public and private sector involvement with natural resource conservation and development efforts in rural areas.
- Encourage government support to on-farm activities.

3.2 Strategies for the Development of the Rainfed Subsector

Rather than make policy recommendations, which could be interpreted as coercive, the approach here has been to recommend the strengthening of positive trends and to propose incentives.

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Direct government investment to increase productivity in the rainfed subsector is proposed in the form of research, extension services, and infrastructure. Strategies also include programs designed to support soil and water conservation and to encourage a flow of private capital from urban areas to rural villages and the countryside. No government subsidies for rainfed agriculture have been proposed.

Proposed policies are organized under three headings:

- Increasing Productivity
- Managing Natural Resources
- Improving Government Institutions

Increasing Productivity

A. Agricultural research and extension will be strengthened.

The most important constraint to increased productivity for rainfed agriculture is the lack of effective research and extension services in the Ministry of Agriculture.

In 1959 the Rural Extension Department (renamed Agricultural Extension Department in 1962) was established in the Ministry of Agriculture. Its activities were limited to extension and it functioned effectively.

In 1972 research and extension were combined under the Department of Agricultural Research and Extension (DARE). The extension program declined quickly and became ineffective, soon followed by the agricultural research program.

In 1985 the National Center for Agricultural Research and Technology Transfer (NCARTT) was established, but it has never functioned effectively in research or extension.

In early 1993, the Ministry of Agriculture established an extension and information department, which will make it possible for NCARTT to specialize in research and technology transfer. Qualified staff is the most serious constraint for both departments.

It is important that NCARTT be established as an autonomous organization within the Ministry of Agriculture, with its own board, budget, and cadre. The board of directors should have the authority to make the final decisions on issues concerning personnel, policy, and strategy. A major goal of this organization would be to restrict the ease with which personnel can be transferred between NCARTT and the Ministry of Agriculture or other government agencies, a move that would encourage the development of career researchers.

It is anticipated that NCARTT would serve as the focal point for coordination of all agricultural research activities in Jordan and as the conduit for all relevant research findings and recommendations to extension. In addition to the work of NCARTT's staff, significant scientific contributions would be expected from ICARDA, the University of Jordan, ACSAD, FAO, and the Science and Technology Council. NCARTT staff would also actively seek feedback from extension staff on research strategies, would make a liberal commitment of their time to work with extension on in-service training programs, to organize field days/demonstrations, and to serve as technical backup in direct work with farmers.

Research strategy should focus on developing technological packages for each agroclimatic zone, taking into account the physical conditions, the soil type, the relevant profitability, and the socioeconomic conditions, as well as the chances for adoption by farmers (i.e., within the means of farmers). The reasons for the low rate of adoption of certain packages by farmers should be investigated and identified and new policy measures should be taken to promote adoption of technically sound and economically viable packages.

B. Price support programs for grains will pay farmers at levels that correspond closely to international prices and will not discriminate against barley in comparison with wheat.

Analysis of world grain prices and prices paid to Jordanian farmers from 1985 to 1990 showed that on the world market the price of barley averaged 87 percent that of wheat, in Jordan the price of barley (procurement price of local barley fixed by the government) averaged 71 percent that of wheat (78% of the international price). This amounted to an implicit tax of 22 percent on barley, which has an adverse effect on productivity for two reasons:

- Low returns to farmers are a disincentive for grain production.
- Favoring wheat over barley results in wheat being planted where barley, a more hardy and drought-resistant crop, should be planted. This often results in a crop failure for wheat, when barley would have produced a harvest.

By guaranteeing a more adequate price for barley, it is expected that farmers in the 200–350mm rainfall zone will respond positively. Farmers will be more ready to adopt new technologies for increasing productivity and to shift to a mixed farming system (e.g., barley and livestock).

C. Measures should be taken to facilitate the adoption of new packages of technologies in the rainfed areas. These packages should be available to and within the reach of small farmers. The JCO should be supported to expand and strengthen its farm machinery

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centers to service small holders through long-term soft loans, and import taxes on spare parts for farm machinery should be removed.

D. The expansion of fruit production in rainfed agriculture regions will be encouraged on land with a slope greater than 8 percent.

The expansion of upland resources devoted to olive and deciduous fruit, nut, and vine production should be encouraged for three reasons:

- The economic return for fruit production is higher than that for traditional annual crops of the rainfed subsector.

- The establishment of orchards and vineyards, with their walls and terraces, is an effective means for soil and water conservation.

- Increased production of stone fruit will enhance the export of vegetables in certain Gulf markets that require mixed shipments of fruits and vegetables.

The trend toward tree and vine crop production in the uplands is found primarily on land with access to good roads and supplementary irrigation. The following strategies would encourage the expansion and productivity of tree and vine crops in the uplands:

- Strong, short-term training programs for extension staff and farmers on tree and vine crop husbandry should be part of an ongoing extension program. This program should be implemented as soon as possible.

- The diversity of tree crops should be increased. Olives are currently the most common fruit crop followed by grapes, peaches, and apples. Almonds and pistachios are examples of tree crops that have significant potential in the rainfed subsector.

- Expand the network of roads and infrastructure in the mountainous regions of rainfed areas. Roads are necessary for input delivery and product marketing. The expensive land development required for fruit production will not be undertaken unless land has good access to roads. In Jordan it has been demonstrated that road building encourages the investment required by landowners. The government must drastically increase funds allocated for rural and agricultural roads.

- The Ministry of Agriculture should concentrate more on its regulatory and control functions with respect to fruit tree seedling production rather than on the production of nursery stock ready for sale. The latter work should be progressively left to the private sector.

As a first stage, the Ministry could orient its program to producing young, rooted, labeled, and virus-free seedlings of olives, grape, and deciduous fruit. These could be sold to the private sector for growing in nurseries. As the private sector develops its production system, the MOA could progressively withdraw from seedling production. Its manpower resources could then be used for the control of nursery stock production in private nurseries (phytosanitary, varieties, labeling, etc.).

The present MOA nurseries could be used to maintain mother trees of recommended varieties, which could be used to provide grafting material to the private sector.

E. The use of treated wastewater for supplementary irrigation and on-farm water harvesting will be encouraged.

The reuse of urban water supplies for agricultural production has been the object of major study, research, and investment in the Middle East. Jordan has been a leader in this effort.

Most of Jordan's urban wastewater is generated in the rainfed sector and then channeled to the Jordan Valley for use in irrigation.

The use of wastewater for upland agriculture is important for three reasons: (1) it provides a way for agriculture to benefit from the results of water development for municipalities, (2) it provides a means for greatly increasing the productivity of agricultural land in the uplands, and (3) it provides a means of preserving prime agricultural land immediately adjacent to municipalities. It is also thought that many upland areas would give higher returns per cubic meter of water than the Jordan Valley. This is a function of two facts:

- Small quantities of water used for supplementary irrigation in the winter would greatly enhance the safe germination, growth, and productivity of rainfed grain production. Work by ICARDA has shown that the application of 150 cubic meters of water per dunum as supplementary irrigation in areas that receive 300mm of rainfall will increase average wheat yields from an average base of 1.2 tons per hectare to an average base of 4 tons per hectare. In effect, supplementary irrigation would ensure that the production would not be lost due to poorly timed or inadequate rainfall.

- The summer weather conditions in the uplands are more suitable than those of the Jordan Valley for the production of high-value fruit and nut crops. This is a function of the cool nighttime temperatures in the uplands. It is also possible that forage production could compete for available wastewater in the uplands.

On-farm water harvesting will be encouraged. The Ministry of Agriculture should support simple on-farm water harvesting methods including the establishment of impermeable slope, contour tillage, cisterns and check dams, and so forth.

Managing Natural Resources

A. Rapid expansion of municipal boundaries on agricultural land will be discouraged.

The rainfed regions are climatically the most desirable areas in Jordan for human habitation, and Jordan's expanding population must have housing and jobs, which in turn necessitates urban and industrial development of municipalities. The goal of the government is to ensure that development of the rainfed uplands brings progress, not decline, to the rainfed regions. It is not necessary for Jordan to choose between agriculture and urbanization; prosperous cities can be surrounded by prosperous agriculture, and the people, the environment, and the economy will all benefit.

During the years 1975 to 1983 rainfed farmland was converted to urban use in the uplands at a rate of about 32,700 dunums per year. Since then the conversion rate has doubled. There are about 3.6 million dunums of tillable land in the rainfed subsector, and at the present rate of conversion, most farming will disappear from the rainfed upland plains and mountains during the first quarter of the next century.

Population pressure is only part of the explanation for this problem. Extensive, low-density urban development has resulted in low infill percentages prior to the expansion of urban boundaries.

Five strategies are proposed to slow and possibly halt this process:

- The National Geographic Center should use archived remote sensing materials to document the rate of urbanization on prime, rainfed, agricultural land over the past twenty years.

- A five-year freeze should be imposed on the expansion of urban boundaries while policies and strategies for dealing with this problem are put in place. The freeze is required to avoid pressure by municipalities to expand their boundaries before new policies go into effect.

- A conversion tax should be levied on the price of farmland sold for urban and industrial development. This tax would discourage the sale of farmland for urban development purposes. Revenues generated would be used for the improvement of municipal services.

- Treated, urban wastewater should be allocated for irrigation of land immediately adjacent to urban boundaries. This would greatly increase

the agricultural value of this land and thus discourage its conversion to nonagricultural uses. For example about 20,000 cubic meters of wastewater per day are generated in the Irbid area. This is enough water for supplementary irrigation on about 16,000 dunums of winter grain crops and about 8,000 dunums of summer fruit and nut crops assuming that efficient irrigation methods are used.

- Current work on soil and land use classification of the rainfed regions should be accelerated.

The ministry of agriculture should be represented on the National Municipal Planning Council. This has been agreed to in principle but has not been implemented. The perspective of the Minister of Agriculture is crucial to good decision making on questions that involve municipal, village, and rural development, as well as to the conservation and use of natural resources.

B. Consolidation of fragmented holdings will be encouraged and fragmentation will be discouraged.

From 1975 to 1983, holdings in the rainfed subsector in all land size categories below 100 dunums increased at an average rate of 4.4 percent per year. Holdings in all land size categories larger than 100 dunums (except 5,000 to 10,000 dunums) decreased at a rate of 3.3 percent per year.

A law should be passed to make it illegal to parcel land. The only exceptions would be in the following cases: inheritance, dissolution of a joint ownership entity such as a company, or where a small parcel of land was being purchased to make it part of an adjacent, larger holding. Even in these cases, the following minimum plot sizes would be imposed on the basis of the production potential of the land: 10 dunums for tree and vine crops, 15 dunums for any land with access to irrigation, 25 dunums for any land located in regions with greater than 350mm annual precipitation.

Any land with greater than 75 percent of its surface covered with bedrock, which is in the path of development, could be subdivided for urban or industrial use. Such land would be certified by the High Council for Planning. Taxes on land being consolidated should be abolished to encourage the consolidation of fragmented land.

C. Soil and water conservation will be encouraged.

There are two major soil and water conservation projects in the mountainous areas in the rainfed subsector. The Highlands Project was started by the Ministry of Agriculture in 1964 and has been supported by the World Food Programme.

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In 1987, the government started implementing a water and soil conservation project in the Zarqa Catchment area. Support is provided for land terracing, water conservation measures, fencing, fruit tree planting, and other development activities, and erosion control is given high priority.

Both of these projects are on land with slopes greater than 8 percent. The implementation of soil and water conservation programs in the rainfed mountains is of interest both to local farmers and to prosperous urban dwellers. Public sector involvement should be expanded and continue to encourage the private sector to invest in fruit farm development, which increases the productivity of the land and protects water and soil resources.

D. NCARTT will develop specific recommendations for regions with less than 200mm average annual rainfall.

- As mechanized tillage expands in the flatter areas of the low rainfall areas (150-250mm) that are used for barley production, wind erosion and destruction of soil structure are becoming major causes of desertification in these marginal lands. One potential solution to the problem of desertification suggested for study by ICARDA, is to plant strips of windbreaks in already plowed areas. These windbreaks must be productive and utilizable in order to be accepted by farmers. It is suggested that hedges of native shrubs (*Atriptex halimos* or *Salsola vermiculata*), which can be established by direct seeding, and more important, are capable of self reseeding, be planted as multipurpose windbreaks. These hedges will not only control wind erosion, but also provide grazing resources in very dry years. The greater part of the land (strips between the shrub hedges) will continue to produce barley and other feed crop.

This practice, which ensures a sustainable source of feed, may be progressively accepted by farmers and it may lead to a land use dominated by grazing shrubs of high productivity and adaptability to the environment.

To ascertain the viability of this system, adaptive research and on-farm trials should be carried out by NCARTT in various parts of Jordan.

- The NCARTT, in cooperation with regional and international research institutions, should carry out a barley breeding program to develop dual-purpose barley cultivars (grain and forage) that are adaptable to the local environment; they could be grazed in years of low rainfall and left for grain in years of high rainfall. Such a program may be initiated in collaboration with ICARDA and/or other interested institutions.

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- It is normally assumed, given the present agricultural practices and the lack of proper technology for land use in marginal areas, that growing fodder shrubs has a net advantage over barley production in terms of soil conservation, net return on and stability of income, and adaptability to the harsh environment. No research has been carried out, however, to verify this assumption. The NCARTT should make a comparative study of the production of barley (alone and with forage legumes) and native forage shrubs under different agroecological conditions and using different levels of technology. Field trials might be carried out in collaboration with farmers.

Improving Government Institutions

A. The Ministry of Agriculture will be strengthened. Rainfed agriculture is the largest component of the responsibilities of the Ministry of Agriculture, and it follows that a strong, effective MOA is essential to the prosperity and progress of this subsector of the Jordanian economy. There should be a political commitment to this objective, translated into the provision of necessary resources and enabling legislation.

B. The Agricultural Council will be transformed into an active, effective policymaking body.

Requirements for strengthening the Agricultural Council are:

- Reduce the number of members of the Agriculture Council.

- Provide core staff for the council. This staff would work under the supervision of the Policy Analysis Department in the Ministry of Agriculture.

- Among the duties of the core staff would be to gather and analyze agricultural statistics. Current efforts in this area by the statistics department in the Ministry of Planning are not generating reliable and complete data. As a consequence planning and policymaking in the Ministry of Agriculture are seriously handicapped.

C. A national agricultural census will be carried out and agricultural statistics will be improved.

Reliable data and information on the agricultural sector are prerequisites for analyses of agricultural policies, evaluation of their impact, and introduction of corrections.

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Data on agriculture in Jordan is unreliable and incomplete because the last national agricultural census was carried out in 1983. During the last ten years, major changes have occurred and a national agricultural census should be carried out as soon as possible, preferably by 1995.

4. SUMMARY

Policy proposals for the rainfed subsector can be divided into three categories: increasing productivity, managing natural resources, and improving government institutions.

4.1 Increasing Productivity

Work with grain crops would bring marginal yield increases on extensive land areas. Work with fruit and vegetable crops with supplementary irrigation and wastewater would bring major increases in productivity to limited land areas.

Research and extension services should be careful to understand the economic and social context of their work when establishing research/extension strategies. The probable response to a given activity should be a major criterion in establishing priorities.

The value of fruit production in the rainfed subsector is already about 20 percent higher than that of grain production. Efforts to strengthen this trend will increase the productivity of the subsector, improve water and soil conservation, and encourage the flow of private sector resources from urban areas to rural areas.

Land fragmentation is a serious issue for both productivity and natural resource management. It was also found to be the most intractable problem dealt with in this report. A law to limit fragmentation was proposed, but no proposal was identified to provide a major incentive for consolidating land.

4.2 Managing Natural Resources

This issue has the most serious implications for the rainfed subsector. If current trends continue, the rainfed subsector would cease making a significant contribution to Jordan's agriculture by about 2025.

This report has proposed a five-year freeze on municipal boundaries, a conversion tax, and the use of wastewater to increase the value of farmland near municipalities. The ongoing development of a land use map is also supported. There is widespread concern in Jordan on this issue, but it is not clear if it is strong enough to focus official attention on the issue.

Concern for water and soil conservation has traditionally been strong in Jordan. The Highlands and Zarqa Catchment Basin projects are examples of this interest. The need for this type of work, however, is much larger than the scope of current activity.

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4.3 Improving Government Institutions

The contribution of the Ministry of Agriculture to national policymaking would be expanded and the ability of the MOA to make policy would be increased. The development of a qualified core staff (statistics/policy) within the ministry and renovation of the Agricultural Council would be central to this effort.

The reform of agricultural credit, which has already been initiated in Jordan, would be encouraged. Research would be directed by NCARTT, which would have autonomy within the MOA. Extension was recently established as an independent entity within the Ministry.

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5. CONCLUSIONS

The rainfed subsector of Jordanian agriculture would be responsive to innovation that would increase production and productivity. Marginal increases in grain production across the entire subsector as a result of improved research and extension would have a significant impact on national grain production.

The major limiting factor for crop production in the rainfed subsector is moisture. Major improvements in productivity would result if urban wastewater were used for supplementary irrigation. Economic productivity is being increased by the trend toward the establishment of orchards, groves, and vineyards. These improvements and trends are possible and comparatively noncontroversial, and should be vigorously pursued.

Protection of land resources is problematic. Urban pressure on municipal boundaries and fragmentation of land resources is common throughout the subsector. Any proposed remedies will contain controversial elements. This is an area where political will to preserve Jordan's resources will probably have to be exercised in order to assure that urban development is accompanied by an improvement, rather than a decline, in Jordan's agricultural and environmental well-being.

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TABLE ANNEX

Table 1: Mean monthly and yearly rainfall amount "mm"

No	Month / Station	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul	Aug	Sep	Oct.	Nov.	Dec.	Yearly	Period
	Eastern Hills														
8	Ramtha	37.4	46.4	46.7	11.7	4.1	0.0	0.0	0.0	0.2	8.9	28.4	37.5	221.3	1976-87
9	Irbid Nursery	110.2	91.9	89.2	28.8	7.2	0.0	0.0	0.0	0.7	14.1	52.7	84.6	478.7	1938-87
10	Taiyiba	105.9	96.8	73.4	37.5	4.8	0.2	0.0	0.0	0.3	20.8	58.7	89.9	488.3	1971-87
11	Ras-Muneef/Ajlun	115.9	107.1	96.4	39.9	4.8	0.2	0.0	0.0	0.2	17.4	64.5	101.1	547.5	1968-87
12	Univ.of Jord.	110.5	98.7	87.6	25.1	5.5	0.0	0.0	0.0	0.2	10.1	48.3	90.0	476.0	1938-87
13	Amman Airport	63.6	63.1	44.0	15.7	3.7	Tr.	0.0	0.0	0.4	6.5	29.4	48.8	275.2	1923-87
14	Amman/Roman Amph.	96.9	100.7	72.2	17.6	6.9	0.1	0.0	0.0	0.2	14.4	45.4	64.8	418.9	1974-87
15	Na'ur Transmitting	135.1	98.6	88.6	27.6	2.4	0.1	0.0	0.0	0.2	8.7	53.9	85.1	500.5	1973-87
16	Madaba	83.5	72.8	69.4	18.4	4.8	0.0	0.0	0.0	0.2	5.2	39.9	64.2	358.4	1937-87
17	Wadi Wala	64.3	44.7	45.1	23.8	2.0	0.0	0.0	0.0	0.0	5.4	25.5	54.1	265.9	1962-87
18	Er-Rabah	74.8	66.1	61.8	20.9	3.1	0.0	0.0	0.0	0.0	4.2	32.2	63.4	326.5	1952-87
19	Al-Hassan/ Tafila	65.8	53.2	35.9	16.4	1.9	0.0	0.0	0.0	0.0	3.6	17.9	55.5	250.2	1973-87
20	Shoubak	67.2	65.8	63.3	19.8	8.4	0.0	0.0	0.0	0.1	3.1	23.6	63.8	315.1	1938-87
21	Al-Qurein	29.3	30.6	41.1	9.7	3.0	0.0	0.0	0.0	0.0	1.6	13.5	41.3	170.1	1967-87

Table 2: Max. monthly and seasonal rainfall amount, mm.

No	Month / Station	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul	Aug	Sep.	Oct.	Nov.	Dec.	Seas-onal	Period
	Eastern Hills														
8	Ramtha	63.9	125.5	116.6	29.9	23.4	0.2	0.0	0.0	2.3	20.0	106.4	91.3	376.3	1976-87
9	Irbid Nursery	270.5	245.9	216.5	192.9	40.4	1.0	Tr.	0.0	23.1	126.0	214.5	276.0	756.9	1938-87
10	Taiyiba	238.5	247.4	121.1	193.9	50.9	3.1	0.0	0.0	3.5	42.5	193.6	227.0	808.0	1971-87
11	Ras-Muneef/Ajlun	249.4	263.3	198.2	253.8	41.1	1.5	0.0	0.0	3.0	48.1	204.9	232.1	862.0	1968-87
12	Univ.of Jord.	345.8	285.1	234.0	268.3	54.7	Tr.	0.0	0.0	5.0	92.0	204.5	305.0	755.8	1938-87
13	Amman Airport	235.2	190.8	168.7	151.3	30.6	1.1	Tr.	Tr.	15.4	54.6	136.8	179.8	503.5	1923-87
14	Amman/Roman Amph.	334.0	240.8	138.2	89.5	71.3	2.0	0.0	0.0	2.0	48.6	187.3	132.6	680.9	1974-87
15	Na'ur Transmitting	377.5	163.4	159.2	103.5	19.6	1.6	0.0	Tr.	2.5	42.4	190.0	276.3	787.2	1973-87
16	Madaba	276.4	254.0	172.0	118.5	41.0	1.1	0.0	0.0	5.4	43.8	179.9	253.5	675.5	1937-87
17	Wadi Wala	261.0	152.5	119.0	262.0	16.0	0.0	0.0	0.0	0.0	40.0	101.3	218.7	563.1	1961-87
18	Er-Rabah	357.9	208.5	164.5	238.5	36.2	0.2	0.0	0.0	1.3	52.7	137.9	19.0	606.4	1951-87
19	Al-Hassan/ Tafila	395.5	174.3	84.9	94.5	10.2	Tr.	0.0	0.0	0.1	22.7	82.9	16.9	781.5	1972-87
20	Shoubak	350.5	192.2	315.5	104.0	180.0	2.3	0.0	1.2	2.5	25.0	117.0	352.3	702.0	1938-87
21	Al-Qurein	146.4	99.5	144.0	62.9	25.2	0.0	0.0	0.0	Tr.	9.3	42.4	134.5	339.1	1967-87

Table 3: Maximum rainfall amount in 24 hours , mm

No	Month / Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul	Aug	Sep.	Oct.	Nov.	Dec.	Yearly	Period
	Eastern Hills														
8	Ramtha	28.0	25.0	60.0	14.0	4.0	0.2	0.0	0.0	2.3	12.1	37.0	26.0	60.0	1976-87
9	Irbid Nursery	71.0	58.3	63.3	54.8	36.4	10.6	0.0	0.0	12.5	29.2	57.0	69.0	71.0	1955-87
10	Tafyiba	51.0	52.0	54.0	45.8	34.5	3.1	0.0	0.0	3.5	21.0	71.0		71.0	
11	Ras-Muneef/Ajlun	43.1	51.1	120.0	45.0	27.0	1.5	0.0	0.0	3.0	40.0	87.0		170.0	1976-87
12	Univ.of Jord.	76.5	60.0	83.4	93.4	24.5	0.0	0.0	0.0	4.5	60.3	80.6		93.4	1961-87
13	Amman Airport	75.6	80.0	66.2	52.4	24.1	1.1	0.0	0.0	15.4	40.5	79.2		80.0	1973-87
14	Amman/Roman Amph.	60.0	58.9	73.4	31.7	67.0	2.0	0.0	0.0	2.0	25.2	80.1	106.5	106.5	1974-87
15	Na'ur Transmitting	80.0	68.0	88.0	47.5	19.0	1.6	0.0	Tr.	2.5	35.0	80.0	107.0	107.0	1973-87
16	Madaba	44.5	58.3	53.8	28.0	24.5	1.1	0.0	0.0	5.4	24.2	85.2	78.4	85.2	1976-87
17	Wadi Wala	80.0	53.0	50.0	120.0	14.0	0.0	0.0	0.0	0.0	24.0	88.0	90.0	120.0	1962-87
18	Er-Rabah	108.0	65.0	55.0	79.9	32.0	0.2	0.0	0.0	1.3	24.0	90.0	91.0	108.0	1961-87
19	Al-Hassan/ Tafila	75.0	121.0	34.0	38.0	4.8	0.0	0.0	0.0	0.1	15.6	54.6	93.5	121.0	1973-87
20	Shoubak	73.7	72.5	68.5	44.7	30.0	2.3	0.0	0.9	2.5	18.0	75.0	78.0	78.0	1965-87
21	Al-Qurein	36.4	67.0	120.0	59.2	14.5	0.0	0.0	0.0	0.0	6.4	29.8	55.5	120.0	1967-87

Table 4: Mean daily potential evapotranspiration, mm

No	Month / Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Yearly	Period
	Eastern Hills														
8	Ramtha														
9	Irbid Nursery	1.57	2.09	3.02	4.27	5.39	6.41	6.71	6.04	4.99	3.61	2.27	1.52	3.99	1971-87
10	Taiyiba														
11	Ras-Muneef/Ajlun														
12	Univ.of Jord.														
13	Amman Airport														
14	Amman/Roman Amph.														
15	Na'ur Transmitting														
16	Madaba														
17	Wadi Wala														
18	Er-Rabah	1.51	2.14	3.20	4.57	5.62	6.56	6.73	6.20	4.94	3.69	2.24	1.47	4.07	1974-87
19	Al-Hassan/Tafila														
20	Shoubak	1.45	1.99	3.00	4.16	5.15	5.83	6.05	5.43	4.49	3.26	2.03	1.35	3.68	1974-87
21	Al-Qurein														

Table 5: Mean daily and yearly max air temperature , C°

No	Month / Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Yearly	Period
	Eastern Hills														
8	Ramtha	13.5	15.4	17.7	23.2	28.0	30.9	31.9	31.8	30.5	26.6	20.0	14.6	23.7	1976-87
9	Irbid Nursery	13.1	14.3	17.2	21.8	26.7	30.0	31.0	31.3	29.7	26.6	20.7	14.9	23.1	1955-87
10	Taiyiba	15.0	16.3	19.0	23.9	28.5	31.7	33.3	33.2	32.0	28.5	22.0	16.6	25.9	1973-87
11	Ras-Muneef/Ajlun	8.2	9.6	12.4	17.1	21.8	24.8	26.3	26.5	25.4	21.3	15.2	9.8	18.2	1976-87
12	Univ.of Jord.	10.1	11.6	15.0	19.5	24.7	27.9	29.0	29.1	27.8	24.6	17.7	11.9	20.8	1961-87
13	Amman Airport	12.4	13.9	17.4	22.5	27.7	30.8	31.9	32.4	30.7	27.1	20.5	14.4	23.5	
14	Amman/Roman Amph.	14.4	16.0	19.1	24.1	28.5	31.5	32.7	32.9	32.1	28.7	22.2	16.1	24.9	
15	Na'ur Transmitting	10.1	12.1	15.1	19.9	24.7	28.2	29.5	29.1	27.8	25.1	18.2	12.7	21.0	
16	Madaba	13.4	14.8	17.3	22.2	26.7	29.5	30.6	30.6	29.3	26.1	20.1	13.7	22.3	
17	Wadi Wala	15.6	17.3	20.3	25.1	29.6	32.7	33.2	33.5	32.1	29.2	23.4	17.3	25.8	1962-87
18	Er-Rabah	12.0	13.4	16.4	21.0	25.6	28.6	29.7	29.6	28.1	25.4	19.4	13.5	21.9	1961-87
19	Al-Hassan/ Tafila	11.0	12.8	15.7	21.1	25.1	28.0	29.5	29.7	28.3	24.5	17.8	12.7	21.4	1973-87
20	Shoubak	9.2	11.1	14.0	18.5	22.8	25.6	26.8	27.2	26.1	22.3	16.0	10.9	19.2	1965-87
21	Al-Qurein	9.8	11.8	14.7	19.1	23.5	26.9	28.1	28.8	27.3	23.2	16.2	11.3	20.1	1967-87

Table 6: Mean daily and yearly min. air temperature, C°

No	Month / Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year-ly	Period
	Eastern Hills														
8	Ramthe	4.1	4.9	5.9	9.1	12.1	15.2	16.8	17.4	15.9	13.0	8.5	4.9	10.7	1976-87
9	Irbid Nursery	4.9	5.5	7.3	10.4	13.9	17.4	18.9	19.4	17.9	14.9	10.2	6.3	12.3	1955-87
10	Tafyiba	6.9	7.5	9.1	12.0	15.0	17.6	19.8	20.3	19.3	16.7	12.1	8.4	13.7	1973-87
11	Ras-Muneef/Ajlun	2.9	3.6	5.3	8.4	12.3	14.6	16.2	16.1	15.4	14.1	8.6	4.4	10.2	1976-87
12	Univ.of Jord.	2.4	3.1	5.2	8.4	11.6	15.0	16.8	16.7	15.0	11.9	7.3	3.7	9.8	1963-87
13	Amman Airport	3.5	4.2	6.1	9.3	13.3	16.4	18.2	18.3	15.3	13.5	9.3	5.1	11.1	1923-87
14	Amman/Roman Amph.	4.2	5.1	7.2	10.8	14.4	17.8	19.5	19.3	17.7	14.4	9.4	5.6	12.1	1974-87
15	Na'ur Transmitting	2.4	3.4	5.2	8.1	11.1	13.8	15.8	15.2	14.3	12.3	7.6	4.3	9.1	1973-84
16	Madaba	3.2	4.1	5.7	8.6	11.8	14.8	17.4	17.1	15.8	12.4	8.0	3.9	10.2	1970-87
17	Wadi Wala	4.7	5.5	7.1	10.3	13.3	16.2	17.4	17.6	16.4	13.4	9.4	6.1	11.5	1962-87
18	Er-Rabah	3.7	4.2	6.1	8.8	11.9	14.9	16.8	16.9	15.5	12.9	9.0	5.2	10.5	1961-87
19	Al-Hassan/Tafila	2.1	3.1	4.7	8.2	11.7	14.6	16.9	16.6	14.7	11.8	7.1	3.4	9.6	1973-87
20	Shoubak	-1.2	-0.3	1.7	4.8	7.3	10.6	12.9	12.7	10.0	6.7	2.9	0.2	5.7	1965-87
21	Al-Qurein	0.4	1.7	4.2	7.5	11.0	13.6	16.8	16.3	13.8	10.3	5.5	2.1	8.6	1967-87

Table 7: Absolute daily and yearly max air temperature, C°

No	Month / Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year -ly	Period
	Eastern Hills														
8	Ramtha	24.8	27.0	31.5	37.5	39.4	40.5	41.5	41.5	41.4	37.0	30.1	28.1	41.5	1976-87
9	Irbid Nursery	24.6	28.0	30.0	36.0	39.8	40.8	41.0	41.0	39.0	38.0	32.5	28.0	41.0	1955-87
10	Tafyiba	25.0	27.4	30.9	35.5	40.0	41.1	42.4	41.7	40.5	37.7	32.7	26.2	42.4	1973-87
11	Ras-Muneif/Ajlun	20.6	21.6	24.5	29.8	33.4	34.0	36.6	37.4	35.0	32.2	25.8	21.2	37.4	1976-87
12	Univ.of Jord.	24.0	25.1	26.3	33.0	39.0	38.3	39.0	41.5	39.0	34.6	28.0	24.8	41.5	1961-87
13	Amman Airport	26.3	29.4	32.5	39.2	40.6	42.8	42.4	42.8	40.6	37.4	32.8	27.2	42.8	1923-87
14	Amman/Roman Amph.	26.1	29.1	31.2	37.2	40.0	40.3	43.8	44.0	41.1	39.2	31.5	26.7	44.0	1974-87
15	Na'ur Transmitting	19.8	25.0	27.0	32.5	36.0	36.5	39.7	38.4	35.5	34.0	29.4	24.5	39.7	1973-84
16	Madaba	27.3	27.9	30.5	36.5	40.5	38.8	39.2	41.8	40.8	36.2	36.8	25.8	41.8	1970-87
17	Wadi Wala	28.3	29.5	35.5	38.5	42.4	43.4	42.6	43.5	43.3	39.0	34.0	29.5	43.5	1962-87
18	Er-Rabah	26.4	28.0	32.0	33.8	39.0	38.7	39.0	40.4	38.5	36.0	30.4	25.5	40.4	1961-87
19	Al-Hassa/ Tafila	24.4	25.3	29.4	33.0	35.8	36.5	41.0	38.6	36.4	34.0	28.0	24.9	41.0	1973-87
20	Shoubak	22.6	24.3	28.5	31.0	35.0	34.7	38.2	36.8	34.0	31.7	26.4	23.0	38.2	1965-87
21	Al-Qurein	21.0	23.0	26.3	30.0	34.4	34.0	36.6	37.0	33.6	31.8	25.5	22.5	37.0	1967-87

Table 8: Absolute daily and yearly min air temperature , C°

No	Month / Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Yearly	Period
	Eastern Hills														
8	Ramtha	-0.3	- 1.5	- 4.5	1.0	2.5	8.5	11.2	10.5	11.0	6.5	1.6	- 1.6	- 4.5	1976-87
9	Irbid Nursery	-4.5	- 4.5	- 1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	- 0.6	- 0.5	- 0.5	1955-87
10	Taiyiba	0.5	1.3	- 0.4	5.6	8.7	12.7	16.3	16.9	15.5	8.6	4.7	2.0	- 0.4	1973-87
11	Ras-Muneef/Ajlun	-0.4	- 3.6	- 3.5	-0.2	4.2	8.4	11.5	12.0	9.5	5.4	- 1.6	- 1.6	- 4.0	1976-87
12	Univ.of Jord.	-8.3	- 4.5	- 4.5	-1.5	1.4	4.5	8.5	8.8	4.5	3.4	- 2.0	- 4.8	- 8.3	1961-87
13	Amman Airport	-7.5	- 6.5	- 3.9	0.0	3.0	7.8	11.0	11.5	8.9	4.9	- 3.2	- 5.3	- 7.5	1923-87
14	Amman/Roman Amph.	-1.6	- 2.0	- 2.5	3.7	7.0	11.9	14.2	14.3	12.4	7.4	1.9	- 2.5	- 2.5	1974-87
15	Na'ur Transmitting	-4.0	- 5.6	- 5.6	1.0	3.0	7.1	10.2	10.5	8.5	6.0	- 1.6	- 2.0	- 5.6	1973-84
16	Madaba	-6.8	- 2.7	- 1.8	0.2	2.6	6.2	10.5	10.8	9.4	4.5	- 0.4	- 0.7	- 0.7	1970-87
17	Wadi Wala	-5.0	- 1.5	- 0.2	2.0	5.5	8.0	10.0	12.0	7.0	6.0	0.0	- 3.0	- 5.0	1962-87
18	Er-Rabah	-5.1	- 3.0	- 3.5	0.6	3.0	6.5	10.9	10.0	8.0	3.5	0.1	- 4.8	- 5.1	1961-87
19	Al-Hassan/ Tafila	-6.8	- 5.5	- 6.5	0.0	2.8	6.3	10.3	11.0	8.4	4.7	- 3.5	- 3.0	- 6.8	1973-87
20	Shoubak	-10.0	-12.0	-11.2	-6.3	-3.2	-2.0	4.2	4.0	1.0	-2.4	-11.4	-10.0	-12.0	1965-87
21	Al-Qurein	-7.0	- 6.8	- 8.5	-3.5	2.5	6.0	10.5	10.0	4.5	1.5	- 3.0	- 7.5	- 8.5	1967-87

TABLE 9

Activity :WHEAT

Input-output data & gross margin per annum for Wheat in Agro-ecological Zone >350 mm

A1	GROSS MARGIN CALCULATION	Ag.ec.Z.:	4	Irrigated:	
2	FOR ANNUAL CROPS			Rain fed:	X
3	Enterprise (CROP):	WHEAT	WINTER	Technology:	Level B*)
4		Unit		Price JD	TOTAL
5		Definition:	Unit:	Unit:	JD
6	Crop produce 1:	kg	120.000	0.135	16.200
7	Crop produce 2: Hay		120.000	0.060	7.200
8					0.000
9	Other produce:				0.000
10	TOTAL GROSS OUTPUT		240.000		23.400
11	Irrigation: Water requirements:	Cubicmet.			0.000
12	Seed/seedling: Owned	kg			0.000
13	Seed/seedling: Bought	kg	10.000	0.140	1.400
14	Manure - Fertilizer	m^3			0.000
15	Total mineral fertilizer	kg	4.000	0.115	0.460
16	N		0.720		0.000
17	P		1.840		0.000
18	K				0.000
19	Compound or other fertil.				0.000
20	Chemicals:	Du	0.050		0.250
21	-		0.050	5.000	0.250
22	-				0.000
23	-				0.000
24	Costs of hired machinery	JD	0.650		3.100
25	- land preparation	hr	0.400	6.000	2.400
26	- sowing / planting	hr	0.150	4.000	0.600
27	- husbandry	hr	0.100	1.000	0.100
28	- harvesting	hr			0.000
29	- transportation (crop specific!)	hr			0.000
30	Variable costs of owned machinery	JD / Du.			0.000
31	TOTAL VARIABLE COSTS	JD			7.460
32	GROSS MARGIN	JD			15.940
33					
34	Labour requirements:	Man.hr	4.500		2.250
35	- for land preparation				0.000
36	- sowing / planting		0.500	0.500	0.250
37	- husbandry				0.000
38	- harvesting		4.000	0.500	2.000
39	- transportation (crop specific!)				0.000
40	TOTAL for crop growing season	Man.hr	4.500		2.250
41	GROSS MARGIN per man hour	JD/m.hr			3.542
42	GROSS MARGIN / cbm irrig. water	JD/ cbm			0.000

Source of information : MOA (Economic Department)

TABLE 9 (cont.)

MONTHLY MACHINERY,LABOUR & WATER REQUIREMENTS
FOR WHEAT

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Hired machinery	0	0.1	0	0	0	0	0	0	0	0	0	0.55	0.65
Land preparation												0.4	0.4
Sowing												0.15	0.15
Husbandry		0.1											0.1
Harvesting													0
Transportation													0
Labour Requirements	0	0	0	0	0	4	0	0	0	0	0	0.5	4.5
Land preparation													0
Planting												0.5	0.5
Husbandry													0
Harvesting						4							4
Transportation													0
WATER Requirements													0

MACHINERY :- hr/du

LABOUR :- hr/du

* TECHNOLOGY LEVEL A :- NON CONVENTIONAL IRRIGATION SYSTEM (MAINLY DRIP), PLASTIC - CULTURE ,INTENSIVE APPLICATION OF CHEMICALS AND FERTILIZERS . HIGH YIELDING VARIETIES.

* TECHNOLOGY LEVEL B :- FLOOD OR SURFACE IRRIGATION , OPEN FIELDS , MINIMAL APPLICATION OF CHEMICALS AND FERTILIZERS , AND USE OF TRADITIONAL VARIETIES .

Activity : WHEAT

TABLE 10

Input-output data & gross margin Per dunum for Wheat in Agro-ecological Zone 200 - 350 mm

A1	GROSS MARGIN CALCULATION	Ag.ec.Z.:	3	Irrigated:	
2	FOR ANNUAL CROPS			Rain fed:	X
3	Enterprise (CROP):	WHEAT	WINTER	Technology:	Level B*)
4		Unit		Price JD	TOTAL
5		Definition:	Unit:	Unit:	JD
6	Crop produce 1:	kg	105.000	0.135	14.175
7	Crop produce 2: Hay		105.000	0.050	6.300
8					0.000
9	Other produce				0.000
10	TOTAL GROSS OUTPUT		210.000		20.475
11	Irrigation: Water requirements:	Cubicmet.			0.000
12	Seed/seedling: Owned	kg			0.000
13	Seed/seedling: Bought	kg	10.000	0.140	1.400
14	Manure - Fertilizer	m^3			0.000
15	Total mineral fertilizer	kg	6.000	0.115	0.690
16	N		1.080		0.000
17	P		2.760		0.000
18	K				0.000
19	Compound or other fertil.				0.000
20	Chemicals:	Du	0.120		0.600
21	-		0.120	5.000	0.600
22	-				0.000
23	-				0.000
24	Costs of hired machinery	JD	0.850		3.700
25	- land preparation	hr	0.400	7.000	2.800
26	- sowing / planting	hr	0.150	4.000	0.600
27	- husbandry	hr	0.300	1.000	0.300
28	- harvesting	hr			0.000
29	- transportation (crop specific!)	hr			0.000
30	Variable costs of owned machinery	JD / Du.			0.000
31	TOTAL VARIABLE COSTS	JD			9.290
32	GROSS MARGIN	JD			11.185
33					
34	Labour requirements:	Man.hr	5.800		2.900
35	- for land preparation				0.000
36	- sowing / planting		0.800	0.500	0.400
37	- husbandry				0.000
38	- harvesting		5.000	0.500	2.500
39	- transportation (crop specific!)				0.000
40	TOTAL for crop growing season	Man.hr	5.800		2.900
41	GROSS MARGIN per man hour	JD/m.hr			1.928
42	GROSS MARGIN / cbm irrig. water	JD/ cbm			0.000

Source of information : MOA (Economic Department)

TABLE 10 (cont.)

MONTHLY MACHINERY,LABOUR & WATER REQUIREMENTS
FOR WHEAT

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Hired machinery	0	0	0.2	0	0	0	0	0	0	0	0	0.55	0.85
Land preparation												0.4	0.4
Sowing												0.15	0.15
Husbandry			0.2										0.3
Harvesting													0
Transportation													0
Labour Requirements	0	0	0	0	0	5	0	0	0	0	0	0.8	5.8
Land preparation													0
Planting												0.8	0.8
Husbandry													0
Harvesting						5							5
Transportation													0
WATER Requirements													0

MACHINERY - hr/du

LABOUR - hr/du

* TECHNOLOGY LEVEL A - NON CONVENTIONAL IRRIGATION SYSTEM (MAINLY DRIP), PLASTIC - CULTURE ,INTENSIVE APPLICATION OF CHEMICALS AND FERTILIZERS HIGH YIELDING VARIETIES

* TECHNOLOGY LEVEL B - FLOOD OR SURFACE IRRIGATION . OPEN FIELDS . MINIMAL APPLICATION OF CHEMICALS AND FERTILIZERS . AND USE OF TRADITIONAL VARIETIES .

TABLE 11

Activity : BARLEY

Input-output data & gross margin per dunum for Barley in Agro-ecological Zone >350 mm

A1	GROSS MARGIN CALCULATION	Ag.ec.Z.:	4	Irrigated:	
2	FOR ANNUAL CROPS			Rain fed:	X
3	Enterprise (CROP):	BARLEY	WINTER	Technology:	Level B*)
4		Unit		Price JD	TOTAL
5		Definition:	Unit:	Unit:	JD
6	Crop produce 1:	kg	135.000	0.100	13.500
7	Crop produce 2: Hay		135.000	0.060	8.100
8					0.000
9	Other produce:				0.000
10	TOTAL GROSS OUTPUT		270.000		21.600
11	Irrigation: Water requirements:	Cubicmet.			0.000
12	Seed/seedling: Owned	kg			0.000
13	Seed/seedling: Bought	kg	10.000	0.100	1.000
14	Manure - Fertilizer	m^3			0.000
15	Total mineral fertilizer	kg	10.000	0.115	1.150
16	N		1.800		0.000
17	P		4.600		0.000
18	K				0.000
19	Compound or other fertil.				0.000
20	Chemicals:	kg			0.500
21	- 2,4,D		0.100	5.000	0.500
22	-				0.000
23	-				0.000
24	Costs of hired machinery	JD			4.000
25	- land preparation	hr	0.500	6.000	3.000
26	- sowing / planting	hr	0.200	5.000	1.000
27	- husbandry	hr			0.000
28	- harvesting	hr			0.000
29	- transportation (crop specific!)	hr			0.000
30	Variable costs of owned machinery	JD / Du.			0.000
31	TOTAL VARIABLE COSTS	JD			9.650
32	GROSS MARGIN	JD			11.950
33					
34	Labour requirements:	Man.hr	6.000		3.000
35	- for land preparation		1.000	0.500	0.500
36	- sowing / planting				0.000
37	- husbandry				0.000
38	- harvesting		5.000	0.500	2.500
39	- transportation (crop specific!)				0.000
40	TOTAL for crop growing season	Man.hr	6.000		3.000
41	GROSS MARGIN per man hour	JD/m.hr			1.992
42	GROSS MARGIN / cbm irrig. water	JD/ cbm			0.000

Source of information : MOA (Economic Department)

TABLE 11 (cont.)

MONTHLY MACHINERY,LABOUR & WATER REQUIREMENTS

BARLEY

	JAN	FEB	MAR	APRI	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Hired machinery	0	0	0	0	0	0	0	0	0	0	0	0.7	0.7
Land preparation												0.5	0.5
Sowing												0.2	0.2
Husbandry													0
Harvesting													0
Transportation													0
Labour Requirements	0	0	0	0	0	5	0	0	0	0	0	1	6
Land preparation												1	1
Planting													0
Husbandry													0
Harvesting						5							5
Transportation													0
WATER Requirements													0

MACHINERY - hr/du

LABOUR - hr/du

* TECHNOLOGY LEVEL A - NON CONVENTIONAL IRRIGATION SYSTEM (MAINLY DRIP), PLASTIC - CULTURE, INTENSIVE APPLICATION OF CHEMICALS AND FERTILIZERS, HIGH YIELDING VARIETIES

* TECHNOLOGY LEVEL B :- FLOOD OR SURFACE IRRIGATION, OPEN FIELDS, MINIMAL APPLICATION OF CHEMICALS AND FERTILIZERS, AND USE OF TRADITIONAL VARIETIES

TABLE 12

Activity :BARLEY

Input-output data & gross margin per dunum for barley in Agro-ecological Zone 200 - 350 mm

A1	GROSS MARGIN CALCULATION	Ag.ec.Z.:	3	Irrigated:	
2	FOR ANNUAL CROPS			Rain fed:	X
3	Enterprise (CROP):	BARLEY	WINTER	Technology:	Level B*)
4		Unit		Price JD	TOTAL
5		Definition:	Unit:	Unit:	JD
6	Crop produce 1:	kg	120.000	0.100	12.000
7	Crop produce 2. Hay		120.000	0.060	7.200
8					0.000
9	Other produce:				0.000
10	TOTAL GROSS OUTPUT		240.000		19 200
11	Irrigation: Water requirements:	Cubicmet.			0.000
12	Seed/seedling: Owned	kg			0.000
13	Seed/seedling: Bought	kg	8.000	0.100	0.800
14	Manure - Fertilizer	m^3			0.000
15	Total mineral fertilizer	kg	5.000	0.115	0.575
16	N		2.300		0.000
17	P		0.900		0.000
18	K				0.000
19	Compound or other fertil.				0.000
20	Chemicals:	L	0.100		0.500
21	- 2,4,D		0.100	5.000	0.500
22	-				0.000
23	-				0.000
24	Costs of hired machinery	JD	1.150		3.900
25	- land preparation	hr	0.400	6.000	2.400
26	- sowing / planting	hr	0.250	4.000	1.000
27	- husbandry	hr	0.500	1.000	0.500
28	- harvesting	hr			0.000
29	- transportation (crop specific!)	hr			0.000
30	Variable costs of owned machinery	JD / Du.			0.000
31	TOTAL VARIABLE COSTS	JD			8.675
32	GROSS MARGIN	JD			10.525
33					
34	Labour requirements:	Man hr	5.800		2.900
35	- for land preparation				0.000
36	- sowing / planting		0.800	0.500	0.400
37	- husbandry				0.000
38	- harvesting		5 000	0.500	2.500
39	- transportation (crop specific!)				0.000
40	TOTAL for crop growing season	Man hr	5.800		2.900
41	GROSS MARGIN per man hour	JD/m.hr			1.815
42	GROSS MARGIN / cbm irrig. water	JD/ cbm			0.000

Source of information : MOA (Economic Department)

TABLE 12 (cont.)

MONTHLY MACHINERY,LABOUR & WATER REQUIREMENTS

FOR BARLEY

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Hired machinery	0.1	0.1	0.1	0.1	0	0	0	0	0	0	0	0.75	1.15
Land preparation												0.4	0.4
Sowing												0.25	0.25
Husbandry	0.1	0.1	0.1	0.1								0.1	0.5
Harvesting													0
Transportation													0
Labour Requirements	0.8	0	0	0	4	0	0	0	0	0	0	0	5.8
Land preparation													0
Planting	0.8												0.8
Husbandry													0
Harvesting					4								5
Transportation													0
WATER Requirements													0

MACHINERY :- hr/du

LABOUR :- hr/du

• TECHNOLOGY LEVEL A :- NON CONVENTIONAL IRRIGATION SYSTEM (MAINLY DRIP), PLASTIC - CULTURE ,INTENSIVE APPLICATION OF CHEMICALS AND FERTILIZERS . HIGH YIELDING VARIETIES.

• TECHNOLOGY LEVEL B :- FLOOD OR SURFACE IRRIGATION , OPEN FIELDS , MINIMAL APPLICATION OF CHEMICALS AND FERTILIZERS , AND USE OF TRADITIONAL VARIETIES .

TABLE 13

Activity : OLIVES

Input-output data & gross margin per dunum for Olives in Agro-ecological Zone (>350)mm

1	GROSS MARGIN CALCULATION	Ag.ec.Z.	4	Irrigated		Technology level	B *	
2	FOR PERENNIAL CROPS			Rain fed	X			
3	Enterprise / Crop:	OLIVE	Established (1 - 3) years			(4 - 7) years		(8 - 20) years
4		Unit	Price JD		TOTAL		TOTAL		TOTAL
5		Definition	Unit:	Unit:	JD	Unit:	JD	Unit:	JD
6	Crop produce 1	KG	0.36	0	0	100	36	300	108
7	Crop produce 2				0		0		0
8					0		0		0
9	Other produce:				0		0		0
10	TOTAL GROSS OUTPUT			0	0	100	36	300	108
11	Irrigation Water requirements:	Cubicmeti	0.05	0	0	0	0	0	0
12	Seedlings: Bought / Owned	KG/Nrs	0.5	10	5		0		0
13	Supporting material				0		0		0
14	Manure	TON	10	0.3	3	0.9	9	1.6	16
15	Fertilizer - Subtotal	KG			0		0		0
16	N		0.087	0	0	0	0	0	0
17	P		0.135	0	0	0	0	0	0
18	K		0.24	0	0	0	0	0	0
19	Compound and other		5	0	0	0	0	0	0
20	Chemicals - Subtotal	KG			1		2		4
21	-		1	1	1	2	2	4	4
22	-				0		0		0
23	-				0		0		0
24	Costs of hired machinery	JD			4.6		5.1		5.6
25	- land preparation	hr	3.6	1	3.6	1	3.6	1	3.6
26	- sowing / planting				0		0		0
27	- husbandry		1	1	1	1.5	1.5	2	2
28	- harvesting				0		0		0
29	- transportation (crop specific!)				0		0		0
30	Variable costs of owned machinery	JD			0		0		0
31	TOTAL VARIABLE COSTS	JD			18.46		25.16		47.05
32	GROSS MARGIN	JD			-18.46		10.84		60.95
33									
34									
35	Labour requirements	Man hr			4.86		9.06		21.45
36	- for land preparation		0.5	2	1	1	0.5	2	1
37	- sowing / planting		0.5	1	0.5		0		0
38	- husbandry		0.7	4.8	3.36	8	5.6	16	11.2
39	- harvesting		0.37		0	8	2.96	25	9.25
40	- Others		0.375	0	0	0	0	0	0
41	TOTAL for crop growing season	Man hr		7.8		17		43	
42	GROSS MARGIN per man hour	JD/m.hr			-2.367		0.638		1.417
43	GROSS MARGIN / cbm irrig. water	JD/ cbm			0		0		0

Source of information : MOA (Economic Department)
Production cost guide (ACC 1991)

MONTHLY MACHINERY , LABOUR & WATER REQUIRMENT
FOR OLIVES

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Hired machinery	4.5	0	1 5	0	0	0	0	0	0	0	1.5	0	7.5
Established(1-3)	1	0	0.5	0	0	0	0	0	0	0	0.5	0	2
Land preparation			0 5								0 5	0	1
Husbandry	1												1
(4 - 7) Years	1 5	0	0 5	0	0	0	0	0	0	0	0 5	0	2.5
Land preparation			0 5								0.5		1
Husbandry	1.5												1.5
(8 -20) Years	2	0	0 5	0	0	0	0	0	0	0	0 5	0	3
Land preparation			0 5								0 5		1
Husbandry	2												2
Labour Requirement	29.8	0	0	3	0	0	0	0	0	0	35	0	67.8
Established(1-3)	5.8	0	0	0	0	0	0	0	0	0	2	0	7.8
Land preparation											2		2
Planting	1												1
Husbandry	4.8												4.8
(4 - 7) Years	8	0	0	1	0	0	0	0	0	0	8	0	17
Land preparation				1									1
Husbandry	8												8
Harvesting											8		8
(8 -20) Years	16	0	0	2	0	0	0	0	0	0	25	0	43
Land preparation				2									2
Husbandry	16												16
Harvesting											25		25
Water Requirement	0	0	0	0	0	0	0	0	0	0	0	0	0
Established(1-3)					0	0	0	0	0	0			0
(4-7) Years					0	0	0	0	0	0			0
(8 -20) Years					0	0	0	0	0	0			0

Machinery :-hr/du
Labour :-hr/du

* TECHNOLOGY LEVEL A : NON CONVENTIONAL IRRIGATION SYSTEM (MAINLY DRIP), PLASTIC CULTURE, INTENSIVE APPLICATION OF CHEMICALS AND FERTILIZERS, IMPROVING SEEDLING

* TECHNOLOGY LEVEL B : FLOOD OR SURFACE IRRIGATION, OPEN FIELDS, MINIMAL APPLICATION OF CHEMICALS AND FERTILIZERS, AND USE OF TRADITIONAL VARIETIES

TABLE 13 (cont.)

TABLE 14

ctivity : OLIVES

t-output data & gross margin per dunum for Olives in Agro-ecological Zone (200-350)mm

1	GROSS MARGIN CALCULATION	Ag.ec.Z :	3	Irrigated:		Technology level:		B *	
2	FOR PERENNIAL CROPS			Rain fed:	X				
3	Enterprise / Crop:	OLIVE	Established (1 - 3) years			(4 - 7) years		(8 - 20) years	
4		Unit	Price JD		TOTAL		TOTAL		TOTAL
5		Definition:	unit:	Unit:	JD	Unit:	JD	Unit:	JD
6	Crop produce 1:	KG	0.36	0	0	100	36	250	90
7	Crop produce 2:				0		0		0
8					0		0		0
9	Other produce:				0		0		0
10	TOTAL GROSS OUTPUT			0	0	100	36	250	90
11	Irrigation: Water requirements:	Cubicmet	0.05	0	0	0	0	0	0
12	Seedlings: Bought / Owned	KG/Nrs	0.5	10	5		0		0
13	Supporting material				0		0		0
14	Manure	TON	10	0.3	3	0.9	9	1.6	16
15	Fertilizer - Subtotal	KG			0		0		0
16	N		0.087	0	0	0	0	0	0
17	P		0.135	0	0	0	0	0	0
18	K		0.24	0	0	0	0	0	0
19	Compound and other		5	0	0	0	0	0	0
20	Chemicals - Subtotal:	KG			1		2		4
21	-		1	1	1	2	2	4	4
22	-				0		0		0
23	-				0		0		0
24	Costs of hired machinery	JD			4.6		5.1		5.6
25	- land preparation	hr	3.6	1	3.6	1	3.6	1	3.6
26	- sowing / planting				0		0		0
27	- husbandry		1	1	1	1.5	1.5	2	2
28	- harvesting				0		0		0
29	- transportation (crop specific!)				0		0		0
30	Variable costs of owned machinery	JD			0		0		0
31	TOTAL VARIABLE COSTS	JD			20.46		16.16		31.05
32	GROSS MARGIN	JD			-20.46		19.84		58.95
33									
34									
35	Labour requirements	Man.hr			4.86		9.06		21.45
36	- for land preparation		0.5	2	1	1	0.5	2	1
37	- sowing / planting		0.5	1	0.5		0		0
38	- husbandry		0.7	4.8	3.36	8	5.6	16	11.2
39	- harvesting		0.37		0	8	2.96	25	9.25
40	- Others		0.375	0	0	0	0	0	0
41	TOTAL for crop growing season	Man.hr		7.8		17		43	
42	GROSS MARGIN per man hour	JD/m.hr			-2.623		1.167		1.371
43	GROSS MARGIN / cbm irrig. water	JD/ cbm			0		0		0

rce of information : MOA (Economic Department)
Production cost guide (ACC 1991)

MONTHLY MACHINERY , LABOUR & WATER REQUIRMENT
FOR OLIVES

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Hired machinery	4.5	0	1.5	0	0	0	0	0	0	0	1.5	0	7.5
Established(1-3)	1	0	0.5	0	0	0	0	0	0	0	0.5	0	2
Land preparation			0.5								0.5	0	1
Husbandry	1												1
(4 - 7)Years	1.5	0	0.5	0	0	0	0	0	0	0	0.5	0	2.5
Land preparation			0.5								0.5		1
Husbandry	1.5												1.5
(8 -20) Years	2	0	0.5	0	0	0	0	0	0	0	0.5	0	3
Land preparation			0.5								0.5		1
Husbandry	2												2
Labour Requirement.	29.8	0	0	3	0	0	0	0	0	0	35	0	67.8
Established(1-3)	5.8	0	0	0	0	0	0	0	0	0	2	0	7.8
Land preparation											2		2
Planting	1												1
Husbandry	4.8												4.8
(4 - 7)Years	8	0	0	1	0	0	0	0	0	0	8	0	17
Land preparation				1									1
Husbandry	8												8
Harvesting											8		8
(8 -20) Years	16	0	0	2	0	0	0	0	0	0	25	0	43
Land preparation				2									2
Husbandry	16												16
Harvesting											25		25
Water Requirement	0	0	0	0	0	0	0	0	0	0	0	0	0
Established(1-3)					0	0	0	0	0	0			0
(4-7) Years					0	0	0	0	0	0			0
(8 -20) Years					0	0	0	0	0	0			0

Machinery :-hr/du
Labour :-hr/du

* TECHNOLOGY LEVEL A :- NON CONVENTIONAL IRRIGATION SYSTEM (MAINLY DRIP), PLASTIC - CULTURE ,INTENSIVE APPLICATION OF CHEMICALS AND FERTILIZERS IMPROVING SEEDLING.

* TECHNOLOGY LEVEL B :- FLOOD OR SURFACE IRRIGATION , OPEN FIELDS , MINIMAL APPLICATION OF CHEMICALS AND FERTILIZERS , AND USE OF TRADITIONAL VARIETIES .

TABLE 14 (cont.)

TABLE 15

Activity : GRAPES

Input-output data & gross margin per dunum for Grapes in Agro-ecological Zone (>350)mm

1	GROSS MARGIN CALCULATION	Ag.ec.Z.:	4	Irrigated:		Technology level:		B *	
2	FOR PERENNIAL CROPS			Rain fed:	X				
3	Enterprise / Crop:	GRAPE	Established (1 - 3) years			(4 - 7) years		(8 - 20) years	
4		Unit	Price JD		TOTAL		TOTAL		TOTAL
5		Definition:	unit:	Unit:	JD	Unit:	JD	Unit:	JD
6	Crop produce 1:	KG	0.15	0	0	600	90	1000	150
7	Crop produce 2:				0		0		0
8					0		0		0
9	Other produce:				0		0		0
10	TOTAL GROSS OUTPUT			0	0	600	90	1000	150
11	Irrigation: Water requirements:	Cubicmet	0.05	0	0	0	0	0	0
12	Seedlings: Bought / Owned	KG/Nrs	0.2	100	20		0		0
13	Supporting material				0		0		0
14	Manure	TON	10	0.6	6	0.8	8	1	10
15	Fertilizer - Subtotal	KG			0		0		0
16	N		0.087	0	0	0	0	0	0
17	P		0.135	0	0	0	0	0	0
18	K		0.24	0	0	0	0	0	0
19	Compound and other		5	0	0	0	0	0	0
20	Chemicals - Subtotal:	KG			2.5		4.6		10
21	-		1	2.5	2.5	4.6	4.6	10	10
22	-				0		0		0
23	-				0		0		0
24	Costs of hired machinery	JD			2.8		6.9		9.2
25	- land preparation	hr	3.6	0.5	1.8	1.5	5.4	2	7.2
26	- sowing / planting				0		0		0
27	- husbandry		1	1	1	1.5	1.5	2	2
28	- harvesting				0		0		0
29	- transportation (crop specific!)				0		0		0
30	Variable costs of owned machinery	JD			0		0		0
31	TOTAL VARIABLE COSTS	JD			44.82		45.83		64.14
32	GROSS MARGIN	JD			-44.82		44.17		85.86
33									
34									
35	Labour requirements	Man/hr			13.52		26.33		34.94
36	- for land preparation		0.35	8	2.8	12	4.2	18	6.3
37	- sowing / planting		0.5	8	4		0		0
38	- husbandry		0.7	9.6	6.72	18.4	12.88	24	16.8
39	- harvesting		0.37		0	25	9.25	32	11.84
40	- Others		0.375	0	0	0	0	0	0
41	TOTAL for crop growing season	Man/hr		25.6		55.4		74	
42	GROSS MARGIN per man hour	JD/m.hr			-1.751		0.797		1.160
43	GROSS MARGIN / cbm irrig. water	JD/ cbm			0		0		0

Source of information : MOA (Economic Department)
Production cost guide (ACC 1991)

MONTHLY MACHINERY , LABOUR & WATER REQUIRMENT
FOR GRAPES

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Hired machinery	4.5	0	2	0	0	0	0	0	0	0	1.5	0	8
Established(1-3)	1	0	0 25	0	0	0	0	0	0	0	0.25	0	1.5
Land preparation			0.25								0.25	0	0 5
Husbandry	1												1
(4 - 7)Years	1.5	0	0 75	0	0	0	0	0	0	0	0.75	0	3
Land preparation			0 75								0.75		1.5
Husbandry	1.5												1.5
(8 -20) Years	2	0	1	0	0	0	0	0	0	0	0.5	0	3.5
Land preparation			1								0.5		1.5
Husbandry	2												2
Labour Requirement	60	0	0	30	0	0	5.7	22.8	22.8	5.7	8	0	155
Established(1-3)	17.6	0	0	0	0	0	0	0	0	0	8	0	25.6
Land preparation											8		8
Planting	8												8
Husbandry	9 6												9.6
(4 - 7)Years	18.4	0	0	12	0	0	2.5	10	10	2.5	0	0	55,4
Land preparation				12									12
Husbandry	18.4												18 4
Harvesting							2.5	10	10	2.5	0		25
(8 -20) Years	24	0	0	18	0	0	3.2	12.8	12.8	3.2	0	0	74
Land preparation				18									18
Husbandry	24												24
Harvesting							3.2	12.8	12.8	3.2	0		32
Water Requirement	0	0	0	0	0	0	0	0	0	0	0	0	0
Established(1-3)					0	0	0	0	0	0			0
(4-7) Years					0	0	0	0	0	0			0
(8 -20) Years					0	0	0	0	0	0			0

Machinery :-hr/du
Labour :-hr/du

* TECHNOLOGY LEVEL A - NON CONVENTIONAL IRRIGATION SYSTEM (MAINLY DRIP), PLASTIC - CULTURE ,INTENSIVE APPLICATION OF CHEMICALS AND FERTILIZERS . IMPROVING SEEDLING.

* TECHNOLOGY LEVEL B - FLOOD OR SURFACE IRRIGATION . OPEN FIELDS , MINIMAL APPLICATION OF CHEMICALS AND FERTILIZERS , AND USE OF TRADITIONAL VARIETIES

TABLE 15 (cont.)

TABLE 16

Activity : GRAPES

Input-output data & gross margin for Grapes in Agro-ecological Zone (200-350)mm

A.1	GROSS MARGIN CALCULATION	Ag.ec.Z.:	3	Irrigated:		Technology level:		B *	
2	FOR PERENNIAL CROPS			Rain fed:	X				
3	Enterprise / Crop:	GRAPE	Established (1 - 3) years			(4 - 7) years		(8 - 20) years	
4		Unit	Price JD		TOTAL		TOTAL		TOTAL
5		Definition:	unit:	Unit:	JD	Unit:	JD	Unit:	JD
6	Crop produce 1:	KG	0.15	0	0	350	52.5	500	
7	Crop produce 2:				0		0		
8					0		0		
9	Other produce:				0		0		
10	TOTAL GROSS OUTPUT			0	0	350	52.5	500	
11	Irrigation: Water requirements:	Cubicmetl	0.05	0	0	0	0	0	
12	Seedlings: Bought / Owned	KG/Nrs	0.2	100	20		0		
13	Supporting material				0		0		
14	Manure	TON	10	0.6	6	0.8	8	1	
15	Fertilizer - Subtotal	KG			0		0		
16	N		0.087	0	0	0	0	0	
17	P		0.135	0	0	0	0	0	
18	K		0.24	0	0	0	0	0	
19	Compound and other		5	0	0	0	0	0	
20	Chemicals - Subtotal:	KG			2.5		4.6		
21	-		1	2.5	2.5	4.6	4.6	10	
22	-				0		0		
23	-				0		0		
24	Costs of hired machinery	JD			2.8		6.9		9
25	- land preparation	hr	3.6	0.5	1.8	1.5	5.4	2	7
26	- sowing / planting				0		0		
27	- husbandry		1	1	1	1.5	1.5	2	
28	- harvesting				0		0		
29	- transportation (crop specificl)				0		0		
30	Variable costs of owned machinery	JD			0		0		
31	TOTAL VARIABLE COSTS	JD			44.82		42.5		63
32	GROSS MARGIN	JD			-44.82		10		11
33									
34									
35	Labour requirements	Man.hr			13.52		23		34
36	- for land preparation		0.35	8	2.8	12	4.2	18	6
37	- sowing / planting		0.5	8	4		0		
38	- husbandry		0.7	9.6	6.72	18.4	12.88	24	16
39	- harvesting		0.37		0	16	5.92	30	11
40	- Others		0.375	0	0	0	0	0	
41	TOTAL for crop growing season	Man.hr		25.6		46.4		72	
42	GROSS MARGIN per man hour	JD/m.hr			-1.751		0.216		0.1
43	GROSS MARGIN / cbm irrig. water	JD/ cbm			0		0		

Source of information : MOA (Economic Department)
Production cost guide (ACC 1991)

MONTHLY MACHINERY , LABOUR & WATER REQUIRMENT
FOR GRAPES

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Hired machinery	4.5	0	2	0	0	0	0	0	0	0	1.5	0	8
Established(1-3)	1	0	0.25	0	0	0	0	0	0	0	0.25	0	1.5
Land preparation			0.25								0.25	0	0.5
Husbandry	1												1
(4 - 7)Years	1.5	0	0.75	0	0	0	0	0	0	0	0.75	0	3
Land preparation			0.75								0.75		1.5
Husbandry	1.5												1.5
(8 -20) Years	2	0	1	0	0	0	0	0	0	0	0.5	0	3.5
Land preparation			1								0.5		1.5
Husbandry	2												2
Labour Requirement.	60	0	0	30	0	0	4.6	18.4	18.4	4.6	8	0	144
Established(1-3)	17.6	0	0	0	0	0	0	0	0	0	8	0	25.6
Land preparation											8		8
Planting	8												8
Husbandry	9.6												9.6
(4 - 7)Years	18.4	0	0	12	0	0	1.6	6.4	6.4	1.6	0	0	46.4
Land preparation				12									12
Husbandry	18.4												18.4
Harvesting							1.6	6.4	6.4	1.6	0		16
(8 -20) Years	24	0	0	18	0	0	3	12	12	3	0	0	72
Land preparation				18									18
Husbandry	24												24
Harvesting							3	12	12	3	0		30
Water Requirement	0	0	0	0	0	0	0	0	0	0	0	0	0
Established(1-3)					0	0	0	0	0	0			0
(4-7) Years					0	0	0	0	0	0			0
(8 -20) Years					0	0	0	0	0	0			0

Machinery :-hr/du
Labour :-hr/du

* TECHNOLOGY LEVEL A NON CONVENTIONAL IRRIGATION SYSTEM (MAINLY DRIP), PLASTIC - CULTURE ,INTENSIVE APPLICATION OF CHEMICALS AND FERTILIZERS IMPROVING SEEDING.

* TECHNOLOGY LEVEL B FLOOD OR SURFACE IRRIGATION , OPEN FIELDS , MINIMAL APPLICATION OF CHEMICALS AND FERTILIZERS , AND USE OF TRADITIONAL VARIETIES

TABLE 16 (cont.)

TABLE 17

Activity : PEACHES

Input-output data & gross margin per dunum for Peaches in Agro-ecological Zone (>350)mm

GROSS MARGIN CALCULATION FOR PERENNIAL CROPS	Ag.ec.Z..	Irrigated: / Rain fed: X			Technology level B *			
Enterprise / Crop:	PEACH	Established (1 - 3) years			(4 - 7) years		(8 - 20) years	
	Unit Definition:	Price JD unit:	Unit:	TOTAL JD	Unit:	TOTAL JD	Unit:	TOTAL JD
Crop produce 1	KG	0.42	0	0	300	126	600	252
Crop produce 2.				0		0		0
				0		0		0
Other produce:				0		0		0
TOTAL GROSS OUTPUT			0	0	300	126	600	252
Irrigation: Water requirements:	Cubicmet	0.05	0	0	0	0	0	0
Seedlings: Bought / Owned	KG/Nrs	0.5	40	20		0		0
Supporting material				0		0		0
Manure	TON	10	0.5	5	0.75	7.5	1	10
Fertilizer - Subtotal	KG			0		0	0	0
N		0.087	0	0	0	0	0	0
P		0.135	0	0	0	0	0	0
K		0.24	0	0	0	0	0	0
Compound and other		5	0	0	0	0	0	0
Chemicals - Subtotal:	KG			1.3		2.6		5.6
.		1	1.3	1.3	2.6	2.6	5.6	5.6
.				0		0		0
				0		0		0
Costs of hired machinery	JD			5.6		7.1		8.6
- land preparation	hr	3.6	1	3.6	1	3.6	1	3.6
- sowing / planting				0		0		0
- husbandry		1	2	2	3.5	3.5	5	5
- harvesting				0		0		0
- transportation (crop specific!)				0		0		0
Variable costs of owned machinery	JD			0		0		0
TOTAL VARIABLE COSTS	JD			39.88		31.1		44.675
GROSS MARGIN	JD			-39.88		94.9		207.325
Labour requirements	Man hr			7.98		13.9		20.475
- for land preparation		0.5	5	2.5	2	1	3	1.5
- sowing / planting		0.5	2	1		0		0
- husbandry		0.7	6.4	4.48	12	8.4	18	12.6
- harvesting		0.375	0	0	12	4.5	17	6.375
- Others		0.375	0	0	0	0	0	0
TOTAL for crop growing season	Man hr		13.4		26		38	
GROSS MARGIN per man hour	JD/m.hr			-2.976		3.650		5.456
GROSS MARGIN / cbm irrig. water	JD/ cbm			0.000		0.000		0.000

Source of information : MOA (Economic Department)
Production cost guide (ACC 1991)

TABLE 17 (cont.)

PORT LACHIES

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Hired machinery	10.5	0	1.5	0	0	0	0	0	0	0	1.5	0	13.5
Established(1-3)	2	0	0.5	0	0	0	0	0	0	0	0.5	0	3
Land preparation			0.5								0.5	0	1
Husbandry	2												2
(4 - 7)Years	3.5	0	0.5	0	0	0	0	0	0	0	0.5	0	4.5
Land preparation			0.5								0.5		1
Husbandry	3.5												3.5
(8 -20) Years	5	0	0.5	0	0	0	0	0	0	0	0.5	0	6
Land preparation			0.5								0.5		1
Husbandry	5												5
Labour Requirement.	38.4	0	0	5	2.9	5.8	8.7	8.7	2.9	0	5	0	77.4
Established(1-3)	8.4	0	0	0	0	0	0	0	0	0	5	0	13.4
Land preparation											5		5
Planting	2												2
Husbandry	6.4												6.4
(4 - 7)Years	12	0	0	2	1.2	2.4	3.6	3.6	1.2	0	0	0	26
Land preparation				2									2
Husbandry	12												12
Harvesting					1.2	2.4	3.6	3.6	1.2				12
(8 -20) Years	18	0	0	3	1.7	3.4	5.1	5.1	1.7	0	0	0	38
Land preparation				3									3
Husbandry	18												18
Harvesting					1.7	3.4	5.1	5.1	1.7				17
Water Requirement	0	0	0	0	0	0	0	0	0	0	0	0	0
Established(1-3)					0	0	0	0	0	0			0
(4-7) Years					0	0	0	0	0	0			0
(8 -20) Years					0	0	0	0	0	0			0

Machinery :-hr/du
Labour :-hr/du

* TECHNOLOGY LEVEL A NON CONVENTIONAL IRRIGATION SYSTEM (MAINLY DRIP) PLASTIC - CULTURE ,INTENSIVE APPLICATION OF CHEMICALS AND FERTILIZERS IMPROVING SEEDLING

* TECHNOLOGY LEVEL B FLOOD OR SURFACE IRRIGATION , OPEN FIELDS MINIMAL APPLICATION OF CHEMICALS AND FERTILIZERS , AND USE OF TRADITIONAL VARIETIES

TABLE 18

Activity : PEACHES

nput-output data & gross margin per dunum for Peaches in Agro-ecological Zone (200-350)mm

GROSS MARGIN CALCULATION FOR PERENNIAL CROPS	Ag.ec.Z.: 3	Irrigated:		Technology level: B *			
	Farm Si.:	Rain fed:	X				
Enterprise / Crop:	PEACH	Established (1 - 3) years		(4 - 7) years		(8 - 20) years	
	Unit Definition:	Price JD unit:	Unit:	TOTAL JD	Unit:	TOTAL JD	Unit:	TOTAL JD
Crop produce 1:	KG	0.42	0	0	300	126	600	252
Crop produce 2:				0		0		0
				0		0		0
Other produce:				0		0		0
TOTAL GROSS OUTPUT			0	0	300	126	600	252
Irrigation: Water requirements:	Cubicm-1	0.05	0	0	0	0	0	0
Seedlings: Bought / Owned	KG/Nrs	0.5	40	20		0		0
Supporting material				0		0		0
Manure	TON	10	0.5	5	0.75	7.5	1	10
Fertilizer - Subtotal	KG			0		0	0	0
N		0.087	0	0	0	0	0	0
P		0.135	0	0	0	0	0	0
K		0.24	0	0	0	0	0	0
Compound and other		5	0	0	0	0	0	0
Chemicals - Subtotal:	KG			1.3		2.6		5.6
-		1	1.3	1.3	2.6	2.6	5.6	5.6
-				0		0		0
-				0		0		0
Costs of hired machinery	JD			5.6		7.1		8.6
- land preparation	hr	3.6	1	3.6	1	3.6	1	3.6
- sowing / planting				0		0		0
- husbandry		1	2	2	3.5	3.5	5	5
- harvesting				0		0		0
- transportation (crop specific!)				0		0		0
Variable costs of owned machinery	JD			0		0		0
TOTAL VARIABLE COSTS	JD			39.88		32.6		45.8
GROSS MARGIN	JD			-39.88		93.4		206.2
Labour requirements	Man.hr			7.98		15.4		21.6
- for land preparation		0.5	5	2.5	2	1	3	1.5
- sowing / planting		0.5	2	1		0		0
- husbandry		0.7	6.4	4.48	12	8.4	18	12.6
- harvesting		0.375	0	0	16	6	20	7.5
- Others		0.375	0	0	0	0	0	0
TOTAL for crop growing season	Man.hr		13.4		30		41	
GROSS MARGIN per man hour	JD/m.hr			-2.976		3.113		5.029
GROSS MARGIN / cbm irrig. water	JD/ cbm			0.000		0.000		0.000

Source of information : MOA (Economic Department)
Production cost guide (ACC 1991)

TABLE 18 (cont.)

MONTHLY MACHINERY , LABOUR & WATER REQUIRMENT
FOR PEACHES

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Hired machinery	10.5	0	1.5	0	0	0	0	0	0	0	1.5	0	13.5
Established(1-3)	2	0	0.5	0	0	0	0	0	0	0	0.5	0	3
Land preparation			0.5								0.5	0	1
Husbandry	2												2
(4 - 7)Years	3.5	0	0.5	0	0	0	0	0	0	0	0.5	0	4.5
Land preparation			0.5								0.5		1
Husbandry	3.5												3.5
(8 -20) Years	5	0	0.5	0	0	0	0	0	0	0	0.5	0	6
Land preparation			0.5								0.5		1
Husbandry	5												5
Labour Requirement	38.4	0	0	5	3.6	7.2	10.8	10.8	3.6	0	5	0	84.4
Established(1-3)	8.4	0	0	0	0	0	0	0	0	0	5	0	13.4
Land preparation											5		5
Planting	2												2
Husbandry	6.4												6.4
(4 - 7)Years	12	0	0	2	1.6	3.2	4.8	4.8	1.6	0	0	0	30
Land preparation				2									2
Husbandry	12												12
Harvesting					1.6	3.2	4.8	4.8	1.6				16
(8 -20) Years	18	0	0	3	2	4	6	6	2	0	0	0	41
Land preparation				3									3
Husbandry	18												18
Harvesting					2	4	6	6	2				20
Water Requirement	0	0	0	0	0	0	0	0	0	0	0	0	0
Established(1-3)					0	0	0	0	0	0			0
(4-7) Years					0	0	0	0	0	0			0
(8 -20) Years					0	0	0	0	0	0			0

Machinery :-hr/du
Labour :-hr/du

* TECHNOLOGY LEVEL A : NON CONVENTIONAL IRRIGATION SYSTEM (MAINLY DRIP), PLASTIC - CULTURE ,INTENSIVE APPLICATION OF CHEMICALS AND FERTILIZERS IMPROVING SEEDLING

* TECHNOLOGY LEVEL B : FLOOD OR SURFACE IRRIGATION , OPEN FIELDS , MINIMAL APPLICATION OF CHEMICALS AND FERTILIZERS , AND USE OF TRADITIONAL VARIETIES

TABLE 19

Activity : APRICOTS

Input-output data & gross margin per dunum for Apricots in Agro-ecological Zone (>350)mm

GROSS MARGIN CALCULATION FOR PERENNIAL CROPS	Ag.ec.Z.: 4	Irrigated: / Rain fed: X			Technology level: B •			
Enterprise / Crop:	APRICOT	Established (1 - 3) years			(4 - 7) years		(8 - 20) years	
	Unit Definition:	Price JD unit:	Unit:	TOTAL JD	Unit:	TOTAL JD	Unit:	TOTAL JD
Crop produce 1:	KG	0.7	0	0	200	140	300	210
Crop produce 2:				0		0		0
				0		0		0
Other produce:				0		0		0
TOTAL GROSS OUTPUT			0	0	200	140	300	210
Irrigation: Water requirements:	Cubicmet.	0.05	0	0	0	0	0	0
Seedlings: Bought / Owned	KG	0.5	40	20		0		0
Supporting material				0		0		0
Manure	TON	10	0.5	5	0.75	7.5	1	10
Fertilizer - Subtotal	KG			0		0	0	0
N		0.087	0	0	0	0	0	0
P		0.135	0	0	0	0	0	0
K		0.24	0	0	0	0	0	0
Compound and other		5	0	0	0	0	0	0
Chemicals - Subtotal:	KG			1.3		2.6		5.6
		1	1.3	1.3	2.6	2.6	5.6	5.6
.				0		0		0
.				0		0		0
Costs of hired machinery	JD			5.6		7.1		8.6
- land preparation	hr	3.6	1	3.6	1	3.6	1	3.6
- sowing / planting				0		0		0
- husbandry		1	2	2	3.5	3.5	5	5
- harvesting				0		0		0
- transportation (crop specific!)				0		0		0
Variable costs of owned machinery	JD			0		0		0
TOTAL VARIABLE COSTS	JD			39.88		31.1		45.8
GROSS MARGIN	JD			-39.88		108.9		164.2
Labour requirements	Man hr			7.98		13.9		21.6
- for land preparation		0.5	5	2.5	2	1	3	1.5
- sowing / planting		0.5	2	1		0		0
- husbandry		0.7	6.4	4.48	12	8.4	18	12.6
- harvesting		0.375	0	0	12	4.5	20	7.5
- Others		0.375	0	0	0	0	0	0
TOTAL for crop growing season	Man hr		13.4		26		41	
GROSS MARGIN per man hour	JD/m.hr			-2.975		4.188		4.005
GROSS MARGIN / cbm irrig. water	JD/ cbm			0.000		0.000		0.000

Source of information : MOA (Economic Department)
Production cost guide (ACC 1991)

MONTHLY MACHINERY, LABOUR & WATER REQUIRMENT
FOR APRICOTS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Hired machinery	10.5	0	1.5	0	0	0	0	0	0	0	1.5	0	13.5
Established(1-3)	2	0	0.5	0	0	0	0	0	0	0	0.5	0	3
Land preparation			0.5								0.5	0	1
Husbandry	2												2
(4-7)Years	3.5	0	0.5	0	0	0	0	0	0	0	0.5	0	4.5
Land preparation			0.5								0.5		1
Husbandry	3.5												3.5
(8-20) Years	5	0	0.5	0	0	0	0	0	0	0	0.5	0	6
Land preparation			0.5								0.5		1
Husbandry	5												5
Labour Requirement	38.4	0	0	5	3.2	6.4	9.6	9.6	3.2	0	5	0	80.4
Established(1-3)	8.4	0	0	0	0	0	0	0	0	0	5	0	13.4
Land preparation											5		5
Planting	2												2
Husbandry	6.4												6.4
(4-7)Years	12	0	0	2	1.2	2.4	3.6	3.6	1.2	0	0	0	26
Land preparation				2									2
Husbandry	12												12
Harvesting					1.2	2.4	3.6	3.6	1.2				12
(8-20) Years	18	0	0	3	2	4	6	6	2	0	0	0	41
Land preparation				3									3
Husbandry	18												18
Harvesting					2	4	6	6	2				20
Water Requirement	0	0	0	0	0	0	0	0	0	0	0	0	0
Established(1-3)					0	0	0	0	0	0			0
(4-7) Years					0	0	0	0	0	0			0
(8-20) Years					0	0	0	0	0	0			0

Machinery -hr/du
Labour -hr/du

* TECHNOLOGY LEVEL A NON CONVENTIONAL IRRIGATION SYSTEM (MAINLY DRIP), PLASTIC - CULTURE, INTENSIVE APPLICATION OF CHEMICALS AND FERTILIZERS IMPROVING SEEDLING

* TECHNOLOGY LEVEL B FLOOD OR SURFACE IRRIGATION, OPEN FIELDS, MINIMAL APPLICATION OF CHEMICALS AND FERTILIZERS, AND USE OF TRADITIONAL VARIETIES

TABLE 19 (cont.)

AGRICULTURAL POLICY ANALYSIS PROJECT, PHASE II

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LIST OF ACRONYMS

ACC	Agricultural Credit Corporation
AGR	Agriculture
AMO	Agricultural Marketing Organization
DAP	Diammonium Phosphate
DOS	Department of Statistics
ECC	European Economic Community
ESCA	Economic and Social Commission for West Asia
FAO	Food and Agricultural Organization of the United Nation
HCST	Higher Council for Science and Technology
JD	Jordan Dinar
JUST	Jordan University of Science and Technology
JVA	Jordan Valley Authority
MCM	Million Cubic Meter
MOA	Ministry of Agriculture
MOIT	Ministry of Industry and Trade
MOF	Ministry of Finance
MOP	Ministry of Planning
MOWI	Ministry of Water and Irrigation
NCARTT	National Center for Agricultural Research and Technology Transfer
RSS	Royal Scientific Society
UOJ	University of Jordan
USAID	United States Agency for International Development

1. PRODUCTION SYSTEMS IN IRRIGATED AGRICULTURE

1.1 Land and Soil Resources

The limiting factor of irrigated agriculture in Jordan is water, not land. In all regions where water may be made available for irrigation, the water demand of land that may be cropped under irrigation far exceeds water supply. Although the amount of land under irrigation has increased about sixfold since the late 1970s, the proportion of irrigated land in 1991 was less than 15 percent of the area considered suitable for agricultural production. If the land that can be reclaimed for agricultural use is added to that considered suitable for agriculture, the proportion of irrigated area is far less than 15 percent. The amount of area cropped fluctuates greatly from year to year because of the extreme variations in the quantity, seasonal distribution, and location of rainfall. Because of this instability much of the land considered cultivable is not cropped every year. In years of good rainfall the area cropped may range from 65 to 70 percent of cultivable land, in years of low rainfall the percent of cropped area ranges from 48 to 55 percent. The cropped area includes the irrigated land, which represents about 30 percent of total cropped area in 1991.

The location of irrigated areas in the country is closely linked to the availability of water from all sources. In 1980, 70 percent of irrigated cropped land was in the Ghors, the rest was distributed in the side wadis leading to the Ghors, scattered along the inside streams, and adjacent to groundwater aquifers. By 1991, however, due to the large increase in irrigation in the Highlands, irrigated land in the Ghors represented only 49 percent of the total. The total cropped area increased from 404 thousand dunums in 1980 to 699 thousand in 1991. The cropping intensity of irrigated lands in 1991 was calculated to reach 111 percent. The multicropped lands are usually those cultivated with vegetables. Therefore, the net area of irrigated lands in 1991 was actually 625 thousand dunums. The distribution of the cropped area by major regions in 1980 and 1991 are given in Table 1.1.

Table 1.1. Distribution and Changes in Total Cropped Area Under Irrigation (1980–1991)

Region	Irrigated Area (000 dunums)		% share of total	
	1980	1991	1980	1991
Ghors	283	337	70	49
Highlands	121	362	30	51
Total	404	699	100	100

The irrigated areas outside the Ghors region are distributed unequally across the eight Governorates of the Kingdom. In 1991 each Governorate's percentage of irrigated areas in the Highlands was as follows: Maan 26 percent, Mafraq 22 percent, Zarqa 18 percent, Amman 16 percent, Irbid 8.6 percent, Karak 3 percent, Tafila 1 percent, and Balqa 5.6 percent.

Eighty percent of the irrigated areas are in arid and semidesert climates, 20 percent in a semiarid climate. The distribution of cropped area by agroclimatic condition and major regions are given in Table 1.2.

Table 1.2. Distribution of Areas Cropped Under Irrigation by Agroclimatic Zone

Major region	Areal distribution (000 dunnums) of annual rainfall				
	300-400mm	200-300mm	100-200mm	< 100mm	Total
Jordan Valley	96	64	110	9	279
Southern Ghors	-	-	-	58	58
Highlands, West	37	74	11	-	122
Highlands, East	-	5	198	87	240
Total	133	138	269	154	699
% of Total	19	21	38	22	100

Irrigated areas include most of the soil types that occur in agricultural areas across the country. Soils of the Jordan Valley are alluvial and vary from north to south and east to west along the Jordan River. These soils have low to moderate fertility and a high pH (7.8-8.4). The most significant problem is soil salinity, both indigenous and due to accumulation of salts from irrigation water. In good rainfall years, the salts are washed out. Most of the soils in the Jordan Valley have been supplied with adequate drainage systems. Some of the soils in the middle and south of the Jordan Valley may have marl layers, which vary in depth from zero to several meters from the surface, that require site-specific drainage systems.

Soils in the Highlands are clayey, and their profiles are deep in wadis and shallow in the foothills. All soils contain some calcium carbonate, which in some cases may become problematic. The pH ranges from 7.2 to 7.6 and may reach 8 in some irrigated areas. Similar to those in the Jordan Valley and Ghors, these soils require continuous monitoring of salinity and special fertilization regimes. The greatest problem is availability of trace elements to crops as it is influenced by pH and level of calcium carbonate. Most of the soils in the steppe zone have crust formation problems, which reduce infiltration rates and thus limit the use of sprinkler irrigation systems.

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Soils in the southeast are sandy. They have deep profiles, are low in fertility, and have a low water holding capacity. Therefore they require special irrigation and fertilization regimes. In some location gypsum may be a problem.

1.2 Water Resources for Irrigation

1.2.1 Decreasing Share of Irrigation Water from Total Resources

Although the per capita consumption of water is among the lowest in the region, the share of Municipal and Industrial (M&I) water of total resources has increased steadily over the years. Projections for the next twenty years indicate an increase in the share of M&I from total water resources. In 1980, the share of irrigation water of total resources was 78 percent. In 1991, however, that share had decreased to 74 percent, and it is projected to decrease to 53 percent of available resources by the year 2010 (Table 1.3).

Because Jordan had already developed most of its surface water resources by the year 1990 and is overutilizing its groundwater resources, the rate of development of new water resources is expected to slow in the coming years. Consequently, the amount available for irrigation is expected to decrease in the mid-1990s (Table 1.3).

In fact, shortages in irrigation water actually occurred in the late 1980s and early 1990s. The impact of water shortages was most pronounced in the Jordan Valley when water was not available to irrigate the fall planting of 1989. In the fall of 1991, the government had to compensate farmers for not planting part of their lands with vegetables in the middle and southern parts of the Jordan Valley.

Table 1.3. Water Resources Available (1980, 1986, 1991) and Expected (2000 and 2010)

	Volume of water (million cubic meters)				
	Actual			Expected	
Type of Use	1980	1986	1991	2000	2010
Municipal and Industrial	80	115	230	353	525
Irrigation	285	428	657	627	588
Total	365	543	887	980	1113
% of Total Used for Irrigation	78	79	74	64	53
Rate of Increase per Period from Previous Period (%)	-	8.0	13.0	1.0	1.3

1.2.2 High Share of Groundwater of Total Irrigation Resources

The share of groundwater of total irrigation resources ranged from 43 to 53 percent during 1980–1991, a much higher share than in the 1960s and 1970s. What is significant, however, is the high share of groundwater resources available for irrigation in the Highlands. This share was 76 percent of total resources in 1980 and rose to an average of 86 percent in the late 1980s and early 1990 (Table 1.4).

The groundwater resources in several aquifers are being overexploited. In view of the expanding future demand for the irrigated areas, especially for fruit trees, groundwater resources require urgent rationalization and sound management measures.

Table 1.4. Water Resources Available for Irrigation from All Sources and Distribution by Source and Major Region (1980–1991)

Water Source	Volume of Water (million cubic meters)				
	1980	1986	1989	1990	1991
Surface Water	147	224	242	257	285
Groundwater	138	183	318	329	326
Recycled Water	-	21	41	44	46
Total	285	428	601	630	657
% of groundwater of total	48	43	53	52	50
% share of Ghors	53	55	46	46	49
% share of Highlands	47	45	54	54	51
% share of groundwater of total Highlands	76	80	86	87	85
% share of surface water of total Highlands	24	20	14	13	15
% share of groundwater of total Ghors	21	12	14	13	13
% share of surface water of total Ghors	79	88	86	87	87

1.2.3 Increasing Water Quality Problems

Water quality has been deteriorating in several irrigated areas in the country. The main problem is increasing salinity and its impact on types of crops, soil salinity, interruption of mobility of micronutrients, and low productivity of existing crops grown.

The most important problem is the high salinity level of effluent from wastewater treatment plants. Salinity may reach summer highs of 1,500 to 1,800 parts per million (ppm).

The effluent from the Samra treatment plant dominates the Zarka River stream in the summer and in some years becomes the major constituent of the King Talal reservoir. Soils in the Zarka River basin, including the middle and southern parts of the Jordan Valley, are the soils threatened by this low-quality water, especially in the summer and fall.

Groundwater has also begun to show a higher salt content in certain locations. These include the southern part of the Jordan Valley, Duleil, Azraq, Mafraq, and Shoubak. Overexploitation of aquifers has been cited as the reason for this deterioration. In the Duleil area, one of the first areas where salinity problems appeared, the cropping pattern has already changed. Olives, barley, and wheat are now grown in areas where vegetables, pome, and stone fruits once dominated.

1.2.4 Differential Prices of Irrigation Water

Water developed by the public sector is ten times less expensive than water produced by the private sector. Privately produced water is primarily groundwater, and the cost of operation and maintenance of wells vary with depth. The cost of water developed by the public sector in the Jordan Valley and Southern Ghors is 6 fils per cubic meter, while the average cost of private water is 65 fils per cubic meter.

Some farmers use trucked water to irrigate plastic house crops such as cucumber, strawberries, flowers, or houseplants, and to supplement irrigation for fruit trees. The cost per cubic meter ranges from 200 to 300 fils.

The issue of water prices is linked to social equity as well as water use efficiency. Subsidized water to farmers in the Jordan Valley and southern Ghors warrants urgent resolution.

1.2.5 Future Water Budget and Cropping Pattern

The amount of cropped area at present does not reflect the actual demand for irrigation water. The overall cropping intensity, for example, is about 112 percent, which means that while the actual cultivated area in 1991 was 625 thousand dunums, the cropped area was 699 thousand. Fruit trees accounted for 34 percent of the area actually cultivated (Table 1.5). Of the 234 thousand dunums planted with fruit trees in 1991, about 100 thousand dunums (43%) were either in the non-bearing or early-bearing stages (Table 1.5). Within the next five years, the demand for irrigation water by fruit trees that were planted in 1991 will increase by 21 percent. In view of the expected decrease of available water for irrigation in 1996 from the 1991 level, and the expected increase in the consumption of irrigation water by present areas, measures must be taken as soon as possible to mitigate the impact of the water shortages that will arise. The impact of these shortages will be manifested in a decrease in cropping intensity, a decrease in areas of annual crops, and a threat of drought to tree plantations in areas where shortages may occur.

1.3 Trends in Areas, Production, Productivity, and Performance

1.3.1 Major Groups of Cultivated Crops

Three groups of crops are cultivated in the irrigated areas of Jordan: vegetables, fruit trees, and field crops.

Although about 25 species of vegetables are grown in Jordan, 6 species (tomato, eggplant, watermelon, potato, squash, and cucumber) dominated the cropping pattern and accounted for an average of 65 percent of the total area cropped annually during the 1980s. Tomato had the largest share of cropped area, averaging 31 percent in the 1980s. Most vegetables were grown to meet domestic market demand as well as the traditional export market demand of the region. Fennel, broccoli, and red cabbage were recently added to the list of vegetables grown in the country.

There are also about 25 species of fruit trees grown in Jordan. These include evergreen and deciduous species; evergreens occupied 62 percent of the total area planted with fruit trees in 1991. Traditionally citrus species occupied the most area planted with fruit trees under irrigation, but in recent years olives have occupied more area. In 1991, only six species accounted for about 75 percent of the area planted with fruit trees. These, in order of size of area occupied by each, are olives, clementines, grapes, bananas, apples, and peaches (Table 1.6).

Field crops, especially cereals, are traditionally cultivated under rainfed conditions. However, the irrigated area cropped with field crops has increased; wheat, barley, alfalfa, and clover are dominant. Wheat occupied the largest area, with an average share of about 60 percent of total area cropped with field crops in 1991.

In recent years, production of cut flowers and houseplants have attracted several entrepreneurs. Although the area used is small, the value and potential of these commodities are promising. Other crops such as sugar beet, maize, oil seeds, and cotton have been grown on a limited scale or at the experimental level, but they have not become part of the cropping pattern in irrigated areas.

1.3.2 Changes in Size of Area and Cropping Pattern

In 1991, the area cropped under irrigation reached a record total of 699 thousand dunums, 72 percent higher than the 404 thousand dunums planted in 1980. During 1980–1991, therefore, the cropped areas under irrigation increased at an average of 6.5 percent per year.

The most striking change in the increase in irrigated area has occurred in the Highlands and not in the Ghors (Jordan Valley and southern Ghors), a region known traditionally to have the largest share of irrigated area in the country. In 1980, for example, 70 percent of total irrigated lands was in the Ghors, and 30 percent in the Highlands (see Table 1.1). In 1991,

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however, the share of the Highlands was 51 percent. The average annual increase in cropped area in the Ghors was about 1.7 percent while for the Highlands it was 8.1 percent. There were two reasons for this development: (a) the dramatic increase in the number of groundwater wells operated in the Highlands and the slow increase in water available for irrigation in the Ghors, and (b) the increasing quantities of water consumed by fruit trees in the Jordan Valley. (The area planted with fruit trees almost doubled during the 1980s). This development left less water for vegetables and other annual crops, especially in the fall. In the Highlands, however, the cropping intensity of vegetables increased steadily as more water became readily available for irrigation throughout the year. The cropping intensity of vegetables in the Ghors fluctuated in recent years from a low of 104 percent during a water shortage year such as 1989 to a high of 116 percent in a good water year such as 1991. In the Highlands, however, the cropping intensity ranged from an average of 127 percent in the late 1980s and early 1990s to 131 percent in 1991. Another reason for the expanding cropping intensity of vegetables in the Highlands is that farmers have adopted methods of cultivation that extend the growing season. The area planted with vegetables early in the spring under plastic tunnels and plastic houses has increased in recent years and has made it possible to grow at least two crops per year in several regions.

Another striking change in areas cropped under irrigation in the 1980s was the major shift from growing vegetables, which dominated in 1980, to growing fruit trees, which accounted for more and more area by 1991. In 1980, vegetables occupied 72 percent of irrigated cropped area while fruit trees occupied only 16 percent (Table 1.5). In 1991, however, the share of vegetables decreased to 49 percent while that of fruit trees increased to 34 percent of total cropped area (Table 1.5). About 50 thousand dunums of the fruit trees (21 percent of total tree area) are in the non-bearing stage while another 50 thousand are in the early bearing stage. About 93 percent of these two groups are in the Highlands. As these trees reach the bearing stage, they will require greater amounts of water, a situation that will put increasing pressure on the water resources available in the Highlands. This development will either increase the overutilization of groundwater or decrease the amount of area presently cropped with vegetables.

A summary of the changes that have occurred in the size of cropped areas in the Ghors and the Highlands is presented in Table 1.5.

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Table 1.5. Cropped Areas Under Irrigation in the Ghors and the Highlands

Major Crop	Cropped Area (000 dunums) 1980	Cropped Area (000 dunums) 1991	% Change 1980 to 1991	% Increase 1980 to 1991
Ghors				
Vegetables	199	209	5	30
Fruit trees	39	76	95	11
Field crops	44	52	13	8
Subtotal Ghors	282	337	20	49
Highlands				
Vegetables	93	143	54	19
Fruit trees	23	157	582	23
Field crops	6	62	933	9
Subtotal Highlands	122	362	197	
Total for Jordan	404	699	71	51
Share of Ghors (%)	70	49	-	-
Share of Highlands (%)	30	51	-	-

1.3.3 Changes in Cropping Pattern

During the period 1980-1991 substantial changes occurred in the cropping pattern of irrigated areas. During 1980, few crops dominated the irrigated areas with regard to areas allocated to each. For example, tomato, cucumber, eggplant, citrus, and squash dominated in irrigated lands and occupied 64 percent of the cropped area (Table 1.3). The rest of the irrigated areas were cropped with some 40 other crops. In 1991, however, these same five crops occupied only 31 percent of total cropped area, a little less than half of their share in 1980. Crops that gained a larger share of the cropped area were olive, potato, grape, watermelon, peach, and apple. In 1991 these crops occupied 28 percent of the cropped area compared with 7 percent in 1980. The share of tomato of total cropped area, although it has decreased from 29 percent in 1980 to 16 percent in 1991, remained the single most cultivated crop. Citrus and banana maintained their high share of cropped area in the Jordan Valley, with banana occupying in 1991 twice the area it did in 1980 (Table 1.6).

Table 1.6. Changes in Cropping Pattern of Fruit Trees from 1980 to 1991

Crop	Area (in 000 dunums)		% Share of Total Irrigated	
	1980	1991	1980	1991
Olive	9	72	2.0	11.0)
Citrus	33	59	8.0	9.0)
Grape	5	31	1.0	4.0)
Banana	6	13	1.4	2
Apple	2	16	0.4	2
Peach	1	11	0.2	2
Other	7	32	2.0	5
Total Fruits (I)	63	234	16	35
Tomato	118	114	29	16
Potato	4	38	1	5
Watermelon	8	26	2	4
Eggplant	31	21	8	3
Squash	33	18	8	3
Cucumber	47	15	11	2
Other	51	116	13	17
Total Vegetables (II)	292	348	72	50
Wheat	31	66	8	10
Other	19	47	4	6
Total Field Crops (III)	50	113	12	16
Grand Total (I+II+III)	404	699	100	100

There were many reasons for the changes that took place in size of area cropped and cropping pattern. These reasons may be grouped according to government intervention, differential market risks between vegetables and fruit trees, and the impact of technology on vegetable productivity.

Government Interventions. A number of policy interventions were executed by the government. Some achieved the desired objectives, others did not.

1. **Ban on imports of apples in 1984:** This intervention encouraged farmers and entrepreneurs to invest in the establishment of apple orchards. Areas planted with apples increased from about 2,000 dunums in 1984 to 16 thousand dunums in 1991 (Table 1.6).

Importation is rationalized and is allowed only when either domestic production is not available or prices become too high due to very short supply.

2. **Limitation of fruit imports:** Domestic production of all fruits is protected from competition of imports when they are in season. This policy was instituted in the mid-1990s and is still in force. The area planted with pome fruit, banana, fig, citrus, olive, pomegranate, and other fruits increased dramatically from 63 thousand dunums in 1980 to 234 thousand dunums in 1991.

3. **Ban on imports of flowers, garden plants, and houseplants in 1985:** The production of these plants flourished after the mid-1980s and some are even exported, although they do not occupy a large area. The protective measures encouraged entrepreneurs to invest in the propagation and marketing of these plants.

4. **Relaxation of ban on licensing groundwater wells in 1986:** The government relaxed its regulatory ban on licensing of groundwater wells in several basins. The number of wells in operation for irrigation increased from a low of 524 in 1980 to a record level of 1,669 in 1991. The largest increase in the number of wells was in regions where irrigated areas also increased the most.

5. **Enforcement of cropping pattern of some vegetables:** In 1985–1986 the Ministry of Agriculture decided to limit the area cropped with four vegetables: tomato, eggplant, cucumber, and squash. The objectives of this program were to rationalize supply, increase prices of targeted vegetables, and promote production of certain vegetables that were in short supply in domestic markets (e.g., potato and onion). The program was partially terminated in 1989 and totally abandoned in 1990. The area planted with the targeted vegetables, especially tomato, was reduced during the years of enforcement by 15 to 25 percent from the base year of 1985, but the prices of these vegetables did not increase. In addition, the area of promoted vegetables did not substantially increase. In fact, the production of potato and onion increased when the program was terminated.

6. **Promotion of cereal production:** In 1986, the government decided to lease lands in Disi and Mudawara, an area known to have rich soil and good-quality groundwater resources. The land, together with approved licenses to drill wells, was leased for 25 years to private sector companies at nominal rents, but with the condition that they grow wheat and barley and sell it to the government at predetermined and promotional prices. The area cropped with cereals in this scheme increased in the first three years of operation but stabilized at about 40 thousand dunums after 1989. Although the prices given to companies prior to 1989 were acceptable, they were not viewed so favorably after 1989, when the Jordanian dinar was devalued by 50 to 60 percent against hard currencies. The overall objective of this plan was to reduce imports of cereals, mainly wheat, but production was not substantial and never exceeded 5 percent of the amount of wheat imported.

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Differential Market Risks Between Vegetables and Fruit Trees. Experience of farmers in Jordan has shown that growing fruit trees is less risky than growing vegetables with regard to their respective prices. This is especially true in the domestic market. Throughout the 1980s, farmers faced great risks, from fluctuating and often low prices due to oversupply and poor market demand, both domestically and abroad. Prices of fruits like banana, citrus, pome fruit, and stone fruit have proven to be much more stable than prices of most vegetables. These risk differences were among the reasons, if not the only important reason, for farmers to plant fruit trees rather than vegetables.

Technology Impact on Vegetable Productivity. Substantial improvements have occurred in the type and level of technology inputs used in the production systems of all major groups of crops grown under irrigation, but especially in the vegetable production systems. These technologies include: drip irrigation, mulches, protective measures against frost or cold temperatures, superior and improved hybrid seeds, more adequate pest control measures, and proper use of mineral fertilizers. Use of these technologies has led to the improvement in productivity (to varying degrees) of most vegetables. In 1991, for example, the overall average productivity of vegetables was 2.8 tons per dunum compared with 1.7 in 1980. The increase in area in 1991 over 1980 was only 18 percent while the increase in total production of vegetables was more than 100 percent. In other words, the production of vegetables doubled from 1980 to 1991, but the area planted increased only by about one-fifth.

The technological advances in the productivity of vegetables has led to more market risks because of the slow development of markets, export and domestic. This eventually forced farmers either shift or choose the production of fruit trees, even though they require more investment.

1.3.4 Higher Levels of Technology Inputs, Higher Production and Productivity Levels, and Higher Market Risks of Vegetables

Improved Production Methods of Vegetables. Five different methods are used to grow vegetables in the country. The methods differ in the type and level of production inputs used, the cost of inputs used, the degree of pest and cold temperature risks, productivity levels, and distribution of area covered (Tables 7 and 8). The relationship between increased cost and higher level of technology on the one hand, and productivity level on the other, is positive (i.e., the higher the level and cost the higher the levels of productivity). The most commonly used method is the drip and mulch method with or without plastic tunnels, which covers about 70 percent of the area cropped with vegetables. Although it increases input costs by 2.8 times that of the base level, it results in an increase in productivity of 4 to 6 times that of the base level. The other methods, such as plastic tunnels and plastic house culture, also led to higher levels of input costs and productivity, but they have additional advantages such as lower risks of cold weather damage and better chances of higher market prices.

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Table 1.7. Five Production Methods Used in the Cultivation of Vegetables in Jordan

Production Method	Cropped area (% of total)	Level of tech-nology inputs[a]	Cost of production(%)[b]	Productivity level (%)[b]	Major types of crops
Open field:standard furrow or basin irrigation	14	Lowest level I	Base year = 100%	Base year = 100%	Vegt. other than cucurbits & solanaceous crops
Open field with drip irrigation	13	Level II	=125	=150-230	Vegetables other than cucurbits tomato & pepper
Open field with drip and mulch	55	Level III	=280	400-600	Vegetables other than cucurbits, tomato and pepper
Semi open field with drip, mulch and plastic tunnel	15	level III	=320	400-700	Cucurbits, pepper and tomato
Plastic house with drip and mulch	3	level IV	=900	1,000-1,400	Cucumber tomato and pepper

Source Cropped area covered: Ministry of Agriculture; Others: field survey by authors in 1992.
[a]Level I is the lowest
[b]Base level = 1-1.5 tons = 100%

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Table 1.8. Type and Level of Technology Inputs for Five Production Methods Used for Vegetable Crops in Irrigated Lands (1992–1993)

Type of input/method	Level I	Level II	Level III	Level IV	Level V
	Furrow or basin open field	Furrow drip open field	Furrow drip and mulch	Plastic tunnels drip, mulch	Plastic house drip and much
Seeds	Standard	Standard or hybrid	hybrid	hybrid	special hybrid
Seedling Production	rare	common	very common	all	all
Manure, non-treated	common	very common	common	common	rare
Manure, treated	rare	rare	partly common	partly common	very common
Fertilization mineral I[a]	common	common	common	partly common	rare
Fertilization mineral II[b]	rare	rare	partly common	common	partly common
Fertilization Mineral III[c]	none	none	rare	rare	very common
Soil fumigation	rare	rare	partly common	partly common	all
Pesticide applications per season	4	6-8	6-8	12	16
Drip system	none	yes	yes	yes	yes
Black plastic mulch	non	rare	yes	yes	yes
Clear plastic tunnel	none	none	none	yes	none
Plastic house	non	none	none	none	yes
Water (open furrow= 100%)	100 %	85	80	80	70
Labor for 4-6 months per season/dunum	0.15	0.2	0.25	0.3	0.7

source Field survey by authors in 1992.

[a]Fertilizer mineral I: One pre-planting application of diammonium phosphate (DAP) at the rate of 50 kg/dunum + urea or ammonium sulphate at the rate of 100 kg/dunum applied in 2-3 dressings.

[b]Fertilizer mineral II: Same as I but with 60-80 kg/dunum of urea (instead of 100 kg/dunum) + light application of soluble complete (NPK) fertilizer applied at the rate of 4-5 kg application in irrigation water.

[c]Fertilizer mineral III: Same as II but with 12-16 applications of soluble fertilizer plus chelates.

The share of input costs of total production costs varies from one method to another and from one crop to another. Labor costs represented the highest share of average costs. The share of labor averaged 25 percent of total cost and ranged from 18 percent in the open-field drip method to 29 percent in the plastic house method.

In this case the difference between highest and lowest share was not as pronounced as in other inputs. In the case of water, for example, the share of cost averaged only a fraction of a percent to 2 percent in all methods that use water developed by the public sector. However, when private water was used, its share of total costs ranged from 3 percent in the plastic house method to 21 percent in the open-field furrow or basin method. The share of land as another resource input is also highly variable. The share ranged from 2 percent in the plastic house method to 21 percent in the open-field furrow irrigation method. These big differences in share of resources with regard to total cost of production have significant implications for policy. Land and water are scarce resources and should not be used with inferior or low-productivity methods.

The share of seeds or seedlings of total cost averaged about 7 percent, but ranged from 5 to 14 percent. The increase in yield due to the use of improved hybrid seeds, however, outweighs the difference in price between high-yielding seeds and traditional seeds.

The share of fertilizer is the highest single input after labor. Its average share is about 19 percent, but it ranges from 8 percent in the plastic house method to 26 percent in the open-field traditional method. The share of pesticides is about half that of fertilizers on average, but can be as high as 16 percent of total cost in the plastic house culture method.

Increasing Production and Productivity of Vegetables. Total production of all vegetables in 1991 was twice that in 1980. Because the increase in area was only 17 percent, the increase in production was mainly due to increased productivity. The increase in productivity varied from one vegetable to another. Production of squash, cucumber, and eggplant, for example, fluctuated slightly, but remained about the same; tomato production, whose share of total vegetable production averaged 57 percent over 1980-1991, doubled; and production of potato, onion, watermelon, and garlic increased 4 to 6 times (Table 1.9)

Table 1.9. Increase in Vegetable Production from 1980 to 1991 and Share of Major Crops of Total Production

Crop	Production		% of Total		% Increase 1980 to 1991
	1980	1991	1980	1991	
Tomato	188	445	38	45	136
Watermelon	21	104	4	11	395
Cucumber	60	77	13	8	29
Potato	13	69	3	7	430
Eggplants	55	69	11	7	25
Squash	35	36	7	4	3
Others	116	179	24	18	55
Total	488	979	100	100	101

Increasing but Variable Levels of Vegetable Productivity. The overall average production of vegetables increased by 65 percent from 1980 to 1991 (an average increase of 6 percent per year), but the increase varied dramatically among different crops, among the same crops for different years, and among the same crops in different regions or Governorates (Table 1.10).

Cucumber showed the largest increase; productivity in 1991 was more than four times that in 1980. Cucumber production in 1991, which was 16 percent higher than in 1980, was produced from about one-fourth the area cropped in 1980. The main reason for this dramatic increase in cucumber production was that 70 percent of the area cropped with cucumber was under plastic houses, the method with the highest level of productivity. The other 30 percent was cultivated under plastic tunnels or in the open field.

Tomato production methods were more heterogenous. Only 0.3 percent was cropped under plastic houses, and 12 percent under plastic tunnels, while 88 percent was cultivated in open field with a substantial area under the drip-and-mulch method.

Reasons for variability in productivity include:

- Use of different methods of cultivation for the same crop and in the same region
- Different levels of inputs for the different methods
- Cultivation of the same crop in different regions (and therefore under different agroclimatic conditions) in the country, and in more than one season.

The analysis of productivity data for same crop shows some common trends that include:

1. Vegetable productivity in the Jordan Valley is better in dry years than in rainy years. This is caused by a wider spread of disease and colder temperatures in the rainy years.

2. Productivity in the Jordan Valley for the autumn planting is lower than that for the spring planting because high temperatures in the early months of the season promote the spread of pests and because cooler temperatures prevail over the rest of the season.

3. Productivity is higher for any one crop and in any one region whose production methods are more uniform and superior.

Table 1.10. Productivity Levels for Vegetables Grown Under Irrigation in Jordan and Variability of Productivity Among Regions.

Crop	National Average				Variation among major regions in 1991	
	1980	1991	Record Year	Year	Lowest	Highest
Cucumber	1.3	6.4	7.5	1989	2.0 Irbid	7.9 Balqa
Watermellon	2.6	4.0	4.5	1989	2.0 Amman	5.0 Mafraq
Tomato	1.6	3.9	5.6	1989	1.7 Irbid	7.1 Mafraq
Eggplants	1.7	3.4	3.5	1988	1.9 Irbid	4.0 Zarqa
Squash	1.0	2.0	2.0	1991	1.0 Zarqa	2.0 Ghors
Potato	1.2	1.8	2.9	1987	1.7 Ghors	3.3 Balqa
All Vegetables	1.7	2.8	3.1	1990	1.0	7.9

Higher Market Risks for Vegetable Growers. The increase in production and productivity was not rationalized with market demand for most vegetables. Oversupply of vegetables, especially tomato and eggplant in some months of the year, flooded the domestic market and greatly exceeded the demand of export markets. This in turn led to a large decrease in farm gate wholesale prices as well as export prices. Losses borne by farmers in many cases have outweighed their profits in other seasons or months when prices were higher. Price fluctuations of vegetables is common in the country and has become a chronic risk for vegetable farmers.

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Market risks vary from one farmer to another, from one crop to another, and from one season to another. A farmer who uses plastic houses, for example, who invests almost 1,200 JD in each dunum of plastic houses, faces more risk when prices are low than a farmer who uses less expensive methods. In other words, good farmers will be more rewarded when prices are high and more penalized when prices are low. Unfortunately, lower prices were more common in the mid-1980s, occurred less in the late 1980s, but became more prevalent in the early 1990s.

Prices of potato, onion, and garlic, are more stable than prices of tomato, eggplant, and squash. Vegetables with fluctuating prices are generally export commodities. Farmers prefer to plant tomato, cucumber, and eggplant because they have a higher production potential.

Vegetables produced from the autumn planting in the Jordan Valley and marketed from December to April command higher prices than those marketed from May to September. Winter vegetables produced in the Ghors have few competitors in the domestic market and are also of more demand in the export markets. Unfortunately, these vegetables suffer most in terms of cropped area where water shortages occur in the country. The advantages of the Ghors has always been highlighted because the winter agroclimate allows for the production of vegetables. However, when water shortages occur, the amount of water available for vegetables in September to November is minimal, and does not permit large areas to be cultivated.

1.3.5 Fruit Tree Production

Unlike seasonal or annual crops, fruit trees require a long-term commitment of water resources. For example, an olive tree in a desert or semidesert climate requires full irrigation for a few decades. A banana tree, on the other hand, requires full irrigation for only five years. Trees planted in high- or medium-rainfall regions require only supplementary irrigation. In Jordan, where water is in short supply, early policy decisions on the type, location, and amount of area to be planted with fruit trees is vitally important.

Increase of Area Planted with Fruit Trees. The area of irrigated fruit trees quadrupled from 1980 to 1991; the most dramatic increase was in the Highlands rather than in the Ghors. In 1991, 67 percent of all the fruit trees planted were planted in the Highlands, 33 percent in the Ghors.

Water resources in the Ghors are limited, and therefore tree plantings that use water developed by the public sector were also limited. In some years, banana plantations were subject to special licensing in order to control the amount of water they consumed. Sixty thousand dunums (almost 20 percent) of the Jordan Valley has remained without water rights although it was developed for irrigation. Fruit trees occupied only 22 percent of the cropped area in 1991 in the Ghors, but consumed 70 percent of the total water used for irrigation in the Valley.

Fruit tree planting in the Highlands, on the other hand, occurred with little or no followup by the authorities responsible for water development and use. It has been estimated

that, in 1991, the amount of groundwater used in the Highlands exceeded the safe yield of the aquifers by one-third. This problem will worsen as the demand for water increases, by about 50 percent, when the newly planted trees reach bearing age within the next five years.

Trees grown under irrigation in 1991 were 60 percent evergreen and 40 percent deciduous. The major fruit trees under irrigation were olive (31%), citrus (25%), and banana (6%). Deciduous fruit trees included grape (13%), apple (7%), peach (5%), and others (13%) (mainly stone fruit, fig, and pomegranate).

Irrigation Methods of Fruit Trees. Two methods are used to irrigate fruit trees: the drip method for high-density rows, and the standard surface flooding or basin method. Unfortunately, most of the large water consumers such as banana and citrus are irrigated by the inefficient basin method (Table 1.11).

Table 1.11. Distribution of Type of Fruit Trees by Method of Irrigation (1991)

Crop	Total Area	% of Trees Irrigated by:	
		Drip	Surface basin
Olives	72	50	50
Citrus	59	25	75
Grapes	31	50	50
Apples	16	88	12
Peaches	11	89	10
Bananas	13	20	80
Others	32	60	40
Total	233	55	45

Production trends. Citrus production accounts for about two-thirds of the fruit produced in irrigated areas. In 1991, total production of fruit trees was 330 thousand tons, six times the production of 1980. Except for citrus most fruit is consumed locally. Small quantities of stone fruit, grape, and pomegranate have been exported in recent years, however, and the export rate is expected to increase. Productivity levels are available for trees grown in the Jordan Valley, but not for those grown in the Highlands.

Cost of Tree Production Inputs. Production methods of fruit trees have remained conventional except for grapes, for which a trellis is used. The use of production inputs such

as improved varieties of stone fruit, pest control measures, and fertilizers has become more intensive in fruit tree orchards under irrigation than in orchards grown under rainfed conditions.

Annual production costs of trees are less than those for most vegetables, but establishment of orchards requires substantial investment for a number of years before any return is generated. The annual share of establishment cost per year in fruit tree production life varies from one type to another, but averages 16 percent in the Highlands and 23 percent in the Ghors. The establishment cost of banana is the lowest, that of grapes is the highest, primarily the result of trellising.

The most significant difference in costs of production for trees is the share of water in the total annual recurrent production costs. For trees irrigated with water developed by the public sector in the Ghors the cost comes only to 3 percent, compared with 25 percent for those irrigated with water developed by the private sector. Labor represents the highest share of annual production costs and averages 57 percent in the Ghors and 41 percent in the Highlands.

Fertilizer and pesticides each account for an average of 14 percent of total production costs, the lowest for olive, the highest for grapes. The average share of production inputs of total production costs for fruit grown in the Ghors and Highlands is summarized in Table 1.12.

Table 1.12. Average Share of Production Input Costs of Total Costs (annual costs and establishment costs) for Trees Grown in Jordan

Type of input	% Share of Annual Costs	
	Ghors	Highlands
Labor	57	40
Irrigation water	3	24
Fertilizers	15	13
Pesticides	14	13
Management	4	5
Machinery	4	3
Cultivation	3	2
Total	100	100
% share of establishment costs of total annual costs	23	16
% share annual recurrent cost of inputs	77	84
Total	100	100

1.3.6 Field Crop Production Under Irrigation

Irrigating cereals with fresh groundwater is a controversial issue in Jordan, although irrigating barley, alfalfa, and wheat with more saline water or even surface water is an accepted practice.

The total area cropped with field crops fluctuated over the years and reached a record high of 114 thousand dunums in 1991. About 40 percent of this area was cropped with wheat and barley using fresh groundwater in Disi and Mudawara in 1991. Productivity fluctuates greatly in the Jordan Valley due to the limited amounts of water used to supplement rainfall in the northern area.

1.4 Efficiency of Irrigation Water Use

Irrigation and production methods have changed substantially in the past ten years. In 1980, few farmers used drip irrigation systems or sprinklers, but by 1991, drip systems covered 62 percent and sprinkler systems covered 7 percent of the total irrigated area. Farmers thus made a substantial investment in these more efficient irrigation systems of nearly 71 million JD in current prices.

More efficient production methods have also been adopted by farmers in vegetable culture. By 1991, plastic houses, plastic tunnels, and plastic mulch, all equipped with drip irrigation systems, constituted 3, 15, and 55 percent of area cropped with vegetables, respectively. The distribution of production and irrigation methods by major crop group in 1991 is given in Table 1.13.

Table 1.13. Distribution of Irrigation Methods by Percent of Total Area and Crop

Irrigation method	Area covered (%)			
	Vegetables	Fruit trees	Field crops	Total
Plastic house (drip)	3	0	0	1
Plastic tunnel (drip)	15	0	0	8
Drip mulch	55	0	0	28
Drip open-field	14	52	0	25
Sprinkler	0	2	48	7
Surface basin or furow	13	46	52	31
Total	100	100	100	100

Source: Pride report 1992, updated by authors.

Losses of irrigation water occur in Jordan in two situations: when it is conveyed from its source to the farm gate, and when it is applied in the field.

Water is conveyed in three ways:

1. **Concrete-lined canals.** The King Abdullah Canal is the main water conveyance structure in the Jordan Valley and there is a distribution network of lateral canals. Water lost to evaporation and seepage in this conveyance and distribution system was calculated to reach 20 percent.

2. **Pressurized closed-pipe transport system.** This system, which operates in parts of the Jordan Valley and southern Ghors and is connected to open canals or open weirs, loses water to leaks and sudden breaks. Losses were calculated to reach 15 percent.

3. **Pressurized closed-pipe transport and on-farm distribution system.** This system is common in most farms irrigated by groundwater, and there is little chance of water losses. The farm irrigation system is either directly connected to the well pump or to a reservoir (open or covered) fed by a closed pipe that is connected directly to the well pump. This system loses the least amount of water, calculated to be about 5 percent.

The area covered by these systems in the Ghors and the Highlands are as follows:

System	Area covered (000 dunums)
Open canal transport and distribution (Ghors)	160
Open canal transport but closed-pipe distribution system	130
Closed-pipe transport and distribution system to farm gate	75
Closed-pipe transport within farm (i.e., groundwater wells)	326

Source: Ministry of Water and Irrigation, Jordan Valley Authority.

Water is also lost when it is applied in the field. The sources of loss are either the system used for water application or the method in which it is used. The degree of consistency between quantity of water applied and the amount required by the crop in any one situation determines the amount of water lost and the efficiency of water use. Farmers, for example, use efficient methods of water application such as the drip system. However, if the system is not calibrated to deliver the correct amount per unit time, and if the amount applied in each instance is not based on sound information generated for each production system and its environment, the efficiency of the water application system would not be fully utilized. Unfortunately, studies to measure losses of water due to misuse of the irrigation system in the country are not available.

The efficiency of different irrigation methods is shown below.

Irrigation system	Percent efficiency
Drip and plastic house	95
Drip and plastic tunnel	87
Drip under mulch	85
Drip no mulch or sprinkler	80
open surface (basin or furrow)	60

The overall efficiency of water use in Jordan in 1991 was 62 percent, which means that 38 percent of the water available was lost. The efficiency of irrigation systems throughout the world varies greatly; among the highest reported is 85 percent. If the Jordanian target is 72 percent in the next fifteen years, a total of 60 million cubic meters could be saved, to be used for irrigation or other purposes. Such a venture, however, would require substantial expenditure by both the government and the private sector. The cost of converting all areas to drip or sprinkler systems would cost about 32 million JD (current prices), and the cost of transforming the open-canal transport system into a closed-pipe system was estimated to cost 40 million JD.

The probability of achieving the transformation in irrigation systems to raise the efficiency to 72 percent requires measures that may prove more difficult. Changing basin irrigation systems to drip systems in tree orchards can take place only when replanting. On the other hand, changing the open system of transport and distribution into a closed one is achievable. In fact the government has a plan to transform the entire open system into a closed-pipe system by the year 2000.

1.5 Economic Returns on Irrigation Water

1.5.1 Variability of Irrigation Water Requirement by Region and Crop

Jordan can be divided into eight different agroclimatic regions with regard to the water required for irrigation. Almost all vegetables and field crops may be cultivated in all eight regions, but some fruit trees (e.g., citrus and banana) are restricted to the Jordan Valley and southern Ghors, while citrus may be grown in small pockets with warm winters in the side wadi's and Highlands. All deciduous trees and olives may be grown with variable degrees of success in all agroclimatic regions. The significant difference among crops is the amount of water consumed by different crops in the same agroclimatic region and by the same crop when grown in different regions. The amount of water used by the same crop may also differ if different methods of culture or irrigation are used. When a crop that consumes higher amounts of irrigation water is grown under an inefficient irrigation system the differences among crop irrigation requirements become much higher. The irrigation water requirements for major crops grown in different agroclimatic regions are given in Table 1.14. The following are examples of the most common cases of variability as they exist in Jordan:

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Example (1): Eighty percent of the banana crop is irrigated by the surface flood system and supplied by water from the open-canal system in the northern part of the Jordan Valley. The irrigation requirement for bananas is 1,235 cubic meters per dunum per year in the Jordan Valley, but the total consumption of water (diverted water) resources is 1,865 cubic meters per year due to the use of inefficient transport and application systems. On the other hand, tomatoes grown in the same area consume 470 cubic meters per dunum per year, about one-fourth the amount of water consumed by bananas.

Example (2): Potatoes grown in the Highlands consume a total of 500 cubic meters when grown in the semiarid agroclimate of the Highlands near Amman, but they require three times that amount when grown in the same season in the Disi area, which is in the southeastern corner of Jordan and has a semidesert agroclimate.

Example (3): Olives can be grown successfully when rainfall averages more than 400mm per year. When these trees receive supplemental irrigation, their production increases as water added approaches optimal levels. Optimal levels of full irrigation in the hilly areas around Amman is 700 cubic meter per year, but increases to 1,100 cubic meter per year in the arid Mafraq area.

1.5.2 Variability of Economic Returns of Irrigation Water Used by Different Crops

The economic returns derived from the use of irrigation water depend on the type of crop and the irrigation method used.

In 1990, the net return on each 1,000 cubic meters of irrigation water used for sixteen crops grown in the Jordan Valley ranged from a low of 2 JD for barley to a high of 540 JD for tomato (Table 1.15).

The three variables used to determine the net return on water are:

1. Amount of total irrigation water used per dunum. Calculated on the basis of the crop's irrigation requirement and water use efficiency in transport and distribution and on farm application.

2. Amount of crop production (kilogram per dunum as an average for the entire Jordan Valley).

3. Average farm gate prices for Jordan Valley produce for the year.

Changes in any of the three variables can alter the rank of the crops. The net return on irrigation water for crops grown in the Highlands show more extreme variation for different crops.

Example (1): Plastic house cropped with cucumber in Amman and Balqa consume 350 cubic meters per season and produce an average of twelve tons. The net returns in current prices of 1989, 1990, and 1991 equal to 2,260 JD per thousand cubic meters used.

Example (2): Tomato cultivated in Mafraq, the primary tomato-producing area in the Highlands, consume about 1,110 cubic meters per dunum per season and produce an average of eight tons, twice the productivity in the Jordan Valley.

Given the prices of Highland tomatoes in 1989, 1990, and 1991, the net return to farmers was about 270 JD per thousand cubic meters. If the prices had been similar to those of the Ghors, the net return would be three times that, 890 JD per thousand cubic meters.

Table 1.14. Irrigation Water Requirements of Major Crops Grown in Different Agroclimatic Regions

Crop	Irrigation Water Requirement (cubic meters/dunum)			
	Country		Major Production	
Vegetables: Drip	Minimum	Maximum	Minimum	Maximum
Tomato	350	1400	415	990
Cucumber (plastic house)	255	400	280	400
Watermelon	510	870	663	870
Squash	290	440	290	440
Cabbage/cauliflower	250	560	250	560
Potato	420	1286	505	1286
Onion	310	712	310	712
Fruit trees: Drip				
Citrus	881	903	881	903
Grapes	775	1420	905	1080
Pome fruit	720	1240	720	874
Olives	635	1160	635	1160
Fruit trees: Basin				
Bananas	1850	2350	1127	2350
Citrus	1175	1204	1175	1204
Field Crops: Sprinkler				
Wheat	300	1000	300	1000

Example (3): Apple trees grown in Shoubak consume about 800 cubic meters of water per dunum per year. The production level per dunum under the semiarid, but cold, conditions is three tons. The net return, based on local prices from 1989 to 1991, was 900 JD per 1,000 cubic meters of water.

Example (4): Olives are grown in arid and semidesert conditions east of Zarqa and Mafraq, consume 790 cubic meters per dunum per year, and produce an average of 1.2 tons per dunum. The net return is 180 JD per 1000 cubic meters.

Table 1.15. Net Returns on Total Irrigation Water Used for Sixteen Crops Grown in the Jordan Valley (1990)

Net Returns on Irrigation Water Used (JD/1,000 cubic meters)					
Crop	Net return	Farmgate prices (JD/ton)	Crop	Net return (JD)	Farmgate prices (JD/ton)
Tomato	540	82	Banana	175	392
Grape	515	150	Watermelon	161	73
Potato	503	147	Cauliflower	158	77
Bean	475	232	Cantaloupe	81	101
Squash	366	140	Cabbage	67	33
Pepper	291	161	B.beans	44	161
Citrus	253	143	Wheat	4	126
Eggplant	179	78	Barley	2	96

Source: Water Management Study for Jordan, 1992, Pride Technical Report 4.

In the three examples above, the net return on water under actual conditions ranges from 180 to 2,280 JD per thousand cubic meters of water. Although olives have a low rate of return, they also have a low risk; cucumber, however, with a high rate of return, have a high rate of risk when supply exceeds demand. Apples, on the other hand, have a high rate of return and enjoy a low rate of risk under the protective policy that prevails in the country.

1.5.3 Optimization of Water Use

Four factors affect the optimization of water use in Jordan:

1. The efficiency in water transport, distribution to the farm gate, and on-farm application

2. Cultivation of a crop in the most optimal agroclimatic region for the crop and for water consumption

3. Cultivation of crops using the method of production that produces the highest level of produce per cubic meter of water used for irrigation

4. Cultivation of crops that have the highest net return per cubic meter of water used for irrigation

The constraints for achieving each of these measures vary. The achievement of a high level of efficiency that is close to optimal is possible and requires investment that may become economically justifiable under Jordanian conditions. On the other hand, cultivation of crops with the highest net return per cubic meter of irrigation water requires the removal of many constraints. Among the more difficult of these is the market demand for highly profitable crops that sustains acceptable levels of price stability. Optimization of resource use is certainly a strategic option and is discussed in the next chapter.

1.6 Place of Irrigated Agriculture in the National Economy

1.6.1 Agricultural Sector

The share of irrigated agriculture of total agricultural production has increased over the years. The amounts produced were either double or more than double of the major commodities produced in 1991. On the other hand, the share of plant products of total agricultural added value has increased year after another during 1980-1985, the share of plant products from total added value was 60 percent compared to 40 percent for animal products. In 1990, the share of plant products increased to a record high of 78 percent of total added value of all agricultural products. The added value of plant products in 1990 was also a record high of 141 million JD in current prices and exchange rates.

Irrigated agriculture, which represented about one-fourth (24–27%) of the total area cultivated in Jordan (including rainfed and irrigated cultures), accounted for 82 percent in 1989, and 79 percent in 1990, of the total value of plant products in the country. Accordingly, production from each irrigated dunum, on the average, is approximately three times the value of production from each rainfed dunum. In summary, irrigated agriculture contributed 62 percent of total added value of the agricultural sector in 1990.

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1.6.2 Share of Irrigated Agriculture of Major Commodities and Its Distribution by Region and/or Governorate

The share of irrigated agriculture of the total value of national production of vegetable, fruit trees, and field corps averaged, during the period 1989–1990, 98, 76, and 32 percent, respectively. The share of rainfed areas of field crops ranged from 30 percent in 1989, a year with below-average rainfall, to about 34 percent in 1990, a good rainfall year. It must be noted that vegetable growing is becoming strictly irrigated. Areas with relatively higher rainfall that used to be cultivated with rainfed spring and summer vegetables have been either planted with fruit trees or used for housing in urban centers.

The value of commodities produced by irrigated agriculture was calculated for each Governorate or region. For 1989–1990 the Jordan Valley and southern Ghors represented 78 percent of the total value of irrigated agriculture, the Highlands represented 22 percent. The share of each major crop group in each of the two major irrigated areas for 1989–1990 is shown in the following table.

Distribution of Value of Production (%)

	Vegetables	Fruits	Field Crops	Total
Highland	26	11	68	22
Ghors	74	89	32	78
Total	100	100	100	100

The area under irrigation in the Highlands has increased steadily over the last five years and now equals the amount of area under irrigation in the Ghors. The value of the Highlands commodities has also been increasing, mainly due to the increase in the share of fruit trees. Because 60 percent of the fruit trees in the Highlands in 1991 were in the non-bearing or very early bearing stages, it is expected that the Highlands' share of total value of irrigated agriculture will increase steadily during the next ten years.

Outside the Ghors, the distribution of value of produce from irrigated areas varies greatly from one Governorate to another. Mafraq, rich in groundwater resources, had the largest share (6%) of upland Governorates during 1989–1990. Maan and Amman contributed 4 to 5 percent in the same two-year period. The expected increase in output from irrigated areas in the Highlands will affect the shares of each Governorate. This situation should be closely monitored to promote equitable and efficient resource allocation of services to the irrigated subsector as a whole and to each of the regions.

1.6.3 Share of Irrigated Agriculture of Gross Domestic Production

The share of the agricultural value added of the total GDP fluctuated from 6 to 9 percent during the 1980s. In 1990 irrigated agriculture represented 62 percent of total agricultural value, and total agricultural value represented 7.6 percent of GDP. Thus, in 1990 irrigated agriculture represented 4.7 percent of GDP. Other values and benefits—environmental, social, and political—of agriculture are important, but cannot be valued in terms of income.

1.6.4 Share of Major Crops of Total Value of Production

Vegetables continue to represent the largest share of the three major crops cultivated in irrigated areas. In 1989-1990, the share of vegetables was 57 percent of total value of irrigated agriculture output, followed by fruit trees (38%) and field crops (5%) (Table 1.16).

Table 1.16. Percent of Total Gross Value of Major Crop Groups Grown Under Irrigation (1989-1990)

Crop Group	Value (million JD)	% Share of Total Output of:	
		Irrigated	Country
Vegetables	64.4	57	46
Fruit trees	42.4	38	30
Field Crops	6.0	5	4
Total	112.8	100	80

1.6.5 Share of Irrigated Agriculture of Total Exports

Vegetables and fruits have always been among the more important exports of Jordan. The value of exports continued to increase during the 1980s and reached a record high in the late 1980s and early 1990s. The share of vegetables averaged 80 percent of total exports of fruits and vegetables in 1989-1991.

The Department of Statistics figures show that the share of fruits of total vegetables and fruits was 6,7, and 9 percent of total national exports in 1989, 1990 and 1991, respectively. However, figures of the Agricultural Marketing Organization show the share of these exports as 17, 15, and 19 percent of total exports for the years 1989, 1990, and 1991, respectively.

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1.7 Impact of Existing Policies and Government Interventions on Irrigated Agriculture

Numerous laws, bylaws, and decisions have been made to promote or regulate agricultural activities, including irrigated agriculture. These actions may be grouped into four major categories: incentives for investment, promotion of exports, protective measures for domestically produced commodities, and promotion of cereal production.

Incentives for Investment in Agriculture include:

- All revenues generated by individuals, companies and/or other institutions from agricultural production activities are exempt from income tax.
- All production inputs known to be used exclusively for agricultural production are exempt from import custom duties.
- All exports of agricultural commodities are exempt from export duties.
- Agricultural loans from the Agricultural Credit Corporation (ACC), the only public credit institution, have interest rates 30–50 percent lower than loans from commercial banks. The smaller the loan and the shorter its duration, the lower the interest rate.

All of the above had positive impacts on agriculture. The constraints or gaps with regard to investment in agriculture include the following:

- Coverage of loans is considered inadequate, and many farmers are forced to borrow capital from marketing middlemen and banks or buy inputs on credit. The ACC suffers from a lack of funds available for loans as well as from companies trading with production inputs.
- There is no insurance against any risk in agricultural activities.

Promotion of Exports. The Government's declared policy is to allow and promote exports of all agricultural commodities, especially fruits and vegetables. The implemented policy in this regard has been consistent with declared objectives since 1982. In some years, however, export of some commodities (e.g., olives and olive oil) are limited in some seasons to ensure an adequate supply of these commodities in the domestic market. In general, the stability of Government intervention in this area has had a positive impact on farmers and exporters alike.

Protective Measures for Domestically Produced Commodities. To promote the production of fruits and vegetables the Government has banned their importation. However, when some vegetables and/or fruits are in short supply in the domestic market the ban is temporarily removed. This policy does not apply to some fruits such as cherries, however,

because, according to decision makers, other stone fruit such as apricots and peaches are available and can substitute for cherries. Some tropical fruits not produced in the country can be imported, but are subject to custom duties.

The protective policies have had a positive impact and encouraged farmers to produce commodities for the domestic market. For example, since the Government banned the importation of apples in 1984, apple production has risen from 2,000 tons to 12,000 tons in 1991, and it is expected to increase further in the coming years. There have been repercussions to this policy, however; neighboring countries (e.g., Syria, Lebanon, and Iraq) have taken similar measures that may jeopardize Jordan's comparative advantage in the vegetable export market.

Promotion of Cereal Production. Due to a low supply of domestically produced wheat the Government has taken measures to expand wheat cultivation in irrigated and rainfed areas. Since the mid-1970s the Government offered promotional prices for wheat. The price per ton of wheat was gradually raised from 60 to 147 JD per ton. In the Disi area, with an aquifer that produces high-quality groundwater, substantial amounts of land were leased at a nominal price. Due to the high cost of production, however, only about 40,000 dunums (one-third of the area) was used for wheat cultivation. Considering the scarcity of good-quality water resources and the low economic return on wheat, the Government should reconsider its policy on expansion of wheat cultivation.

1.8 Impact of External Factors on the Performance of Irrigated Agriculture

1.8.1 Trade Barriers or Constraints in Regional and International Markets

The majority of the output from irrigated agriculture has been developed to meet the demand of domestic and external markets. Public policy has promoted exports of vegetables and fruits, and the export of vegetables and fruits has always constituted a substantial portion of national production. In 1990, exports of vegetables reached a record high and constituted about 50 percent of the national production, which was nearly 1 million tons. However, farmers and/or exporters have faced great risks from actions taken by other countries in the region, which constitutes Jordan's traditional markets. These actions ranged from closing their borders to Jordanian exports to imposing custom duties against imports of agricultural commodities. These actions resulted in a decrease of vegetable and fruit exports by 40 percent from 1990 to 1991.

Jordan has taken measures to diversify the export markets for vegetables and fruits within and outside the region. The barriers or constraints represented by the high cost of transport, special requirements of export markets, limitations of exports by quotas, customs, and import prohibitions will continue to cause risks and increase costs of export for Jordanian farmers. Although the political barriers against exports may not be permanent, they and other constraints require attention. Among the options are barter trade agreements with countries that have promising markets.

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1.8.2 Competitiveness of Jordanian Products

Jordanian agricultural produce, especially vegetables, can compete well in both regional and international markets, especially when the conditions of such competitions are fair. Jordan's high productivity of agricultural commodities and their availability throughout most of the year are the main reasons for this comparative advantage.

Neighboring countries (e.g., Turkey, Egypt, and Syria) may compete with Jordanian commodities in the summer months, but they do not present a serious threat to Jordanian exports.

1.9 Constraints and Risks of Production

Farmers of irrigated crops in Jordan face a number of risks and constraints that have serious impact on the performance of the irrigated subsector. Some of these risks are not specific to irrigated agriculture but face other subsectors of agriculture as well. The manner in which these risks and constraints affect the performance and, in some cases, limit production is discussed briefly below:

1.9.1 Shortage of Water

The limiting amount of water is by far the most serious and important factor that may constrain or cause great risks to investors in irrigated agriculture. Jordan already suffers from a crisis-like situation in its efforts to supply enough water to meet the demand. The amount of agricultural land in Jordan that needs irrigation exceeds the amount of water available and, in addition, there are demands from nonagricultural water users. Accordingly agriculture's share of total water resources will diminish. Another concern is the depletion of aquifers that has occurred in recent years. The main reason for depletion is the overextraction of groundwater. To manage this development, which threatens the sustainable productivity of these aquifers, water management strategy has called for a lowering of the present levels of pumping from these aquifers by 100 million cubic meters per year.

In the light of the above, Jordan must seriously weigh its options for water resource allocations for agriculture. Questions that need to be addressed include: How can Jordan maximize efficiency of water utilization? What are the priorities of water utilization in terms of types of crops to be irrigated? Should farmers be free to grow any tree any where under irrigation, or should tree planting be controlled? Should economic return per cubic meter of water used precede all other considerations, or should different criteria be used for different crops? Should water developed by the public sector be used with different economic criteria than private water? Answer to these questions must be used to develop agricultural strategy.

Water shortage problems that farmers already face, and which may increase in intensity in the future, include:

- Water resources, both in quantity and quality, are already inadequate to irrigate some orchards in the country. Many of these trees are young, and their increasing demand for irrigation water as they reach the bearing stage will exacerbate present water shortage problems. Fruit tree growers may face the risk of dried up water resources and/or may need to supply water at high costs.

- Insufficient water resources, both in quantity and quality, for vegetable growing in the fall season in the Jordan Valley, is partly due to water shortages that have developed in recent years. These shortages may be caused by weak management of the water resources available to the Jordan Valley and/or by inconsistencies between water supply and present water demand of the cropping patterns that have been increasingly dominated by fruit trees, which require water in the summer and fall months. Owners of the land without trees, therefore, face the risk of losing the advantages of the fall vegetable planting, which has the advantage of higher seasonal prices due to the high demand both in domestic and export markets.

1.9.2 Salinization of Water

Farmers must face this problem, either before or after planting. If properly advised, they may not suffer losses but rather limit their choice of crops to those that can be grown with the available water. Farmers in most locations, however, are faced with the problem of increasing salinity of groundwater resources. The risk of losses will be greater if the farmer has used the water for orchards. Most salinity problems developed because of weak monitoring of water pumping, which eventually led to depletion of fresh water in the upper parts of the aquifers. When given a license to dig and operate a groundwater well, the farmer is allowed to irrigate specified areas, which are determined by the type of crop to be cultivated and the capacity of safe discharge from the well. Unfortunately, violations of these regulatory provisions are common, and many wells are drilled and used without a license. These violations lead to discharge of quantities well beyond safe the levels of the aquifer and lead to salinization of pumped water.

Another problem of water salinity facing farmers is the use of effluents from wastewater treatment plants. The choice of farmers who may use the water along the open stream flow is limited to crops that may be consumed fresh. This limitation is sound and acceptable. However, the saline content of these waters may reach levels that threaten the quality of the soil, harm the crops, and reduce productivity. Near the King Talal Dam, where this problem is most prominent, the problem may be managed by mixing the saline effluent from the Samra plant with fresher water. However, as the volume of the effluent increases and/or in the absence of fresh water in adequate quantities to bring the mixed output to levels that are safe for irrigation, the problem requires basic reconsideration of quality improvement of this water or limitation on its usage. In view of the increasing water demand and the huge volume of water involved, the

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improvement of water quality is the better option from the standpoint of environmental considerations, sustainability, and productivity of resources.

1.9.3 Market Risks of Vegetables

One of the major risks to farmers' profits is unstable prices of vegetables due to repeated distortions between supply and demand. The variations are so high that in extreme cases farmers may lose their entire crop.

The intensity of market risk varies from one crop to another and from one season to another. It is common, for example, for vegetables from the spring plantings in both the Jordan Valley and the Highlands to be marketed in the summer months. Farmers of tomato, squash, and cucumber suffer most from such overlap.

Many farmers hold the view that it is their responsibility to produce and the Government's responsibility to ensure adequate markets. In recent years, however, more farmers have realized that they too have a responsibility to limit supply of certain vegetables, especially when the Government takes measures to help minimize market risks. The Government, for example, has encouraged export of fruits and vegetables and has built two tomato processing plants to solve the chronic problem of tomato surplus. However, when the Government enforced a program of cropping pattern to solve surpluses of some crops in the mid-1980s, the program failed to achieve its objectives because of the lack of cooperation by farmers.

Experience has shown that market risks can not be successfully managed unless all stakeholders in the marketing system cooperate. These include farmers, exporters, domestic market commission agents and public authorities. The following measures can help solve the problem.

- Strengthen farmers' organizations (e.g., Vegetable Farmers Association, Citrus and Fruit Farmers Association) so they can organize marketing activities and assume a major role in minimizing sources of risk.
- Strengthen the information system on export market opportunities and demand for Jordanian vegetables and fruits.
- Strengthen the Government's role in cooperation with farmers organizations and exporters to organize and enforce standards of output, promote contracting for selected vegetables needed for the domestic market, and strengthen storage and transport facilities for export crops.
- Minimize marketing costs, especially the cost of crates, for domestic and export markets.
- Take measures, both authorities and farmers, to streamline the production process by using the agroclimatic conditions in the country to rationalize market supply and demand

of vegetables. For example, water should be made available for fall planting of vegetables, and minimized for spring planting in the Jordan Valley, a planting that overlaps with early spring planting in the Highlands.

1.9.4 Constraints Due to Weaknesses in the Information Services of Production System

These risks include:

- Losses from serious pest outbreaks
- Losses from frost and other physical hazards due to weakness of warning services
- Higher costs of production due to the misuse of fertilizers and pesticides
- Losses due to mismanagement of orchards (e.g., pruning, thinning, watering)
- Losses due to planting the wrong varieties or species of trees
- Losses due to crop failure when soils and water resources deteriorate without farmers being warned of dangers
- Higher costs of production due to a lack of farm management services

The weakness of public institutions responsible for generation and transfer of technology (information) is a chronic problem in Jordan. Fortunately, however, private sector companies dealing with production and trade of production inputs have provided some information services in the introduction of superior and improved vegetable varieties, introduction of fruit tree varieties, use of pesticides to control important pests based on manufacturers recommendations, and packages for use of fertilizers. Information provided by this sector has had a positive impact on crop productivity. The role of the public sector institutions, however, in providing information demanded by farmers has continued to be inadequate.

The most serious lack of the public institutions is in the monitoring and evaluation and documentation of resource quality, forecasting information of frost (i.e., lack of early warning systems), agribusiness management, and optimal use of production inputs. The scarcity of documented information on all aspects of the production systems for both vegetables and crops continues to be a major constraint for farmers who seek information that they cannot obtain from other sources.

1.9.5 Gaps in Farmers' Organizations

All stakeholders in the agricultural production and marketing systems are adequately organized except farmers. Farmers in the Jordan Valley have had an association since 1974, but the Jordan Valley Farmers Association suffers from weaknesses of financial support as well as ambiguity of purpose; farmers in the uplands, who are more numerous, have never had their own organization. As result, the impact and participation of farmers in the agricultural decision-making process have always been unsatisfactory.

The areas that suffer most from the lack of farmers organizations are marketing, quality of services provided to farmers, and policy formulation. The importance of organizing farmers

in groups has gained recognition in recent years, and the Government has taken the initiative to pass a law that will allow formal organization of all farmers in the country.

1.9.6 Gaps and Weaknesses in Marketing Services

Marketing services became more important when market risks gained more recognition. Marketing services include quality control, packing materials and methods for domestic and export markets, harvesting, storage and transport methods, and consumer concerns both locally and abroad. The weakest point common to all of these services is the scarcity of information, including technology, that is available to farmers. The effects of pesticide residue in fruits and vegetables, for example, is becoming a major issue in the trade of these commodities. The services rendered to exporters and farmers in this regard are inadequate to say the least. Consumer likes or dislikes as well as other concerns are not attended to. Packing material constitutes the largest share of marketing costs and may reach 15 to 20 percent of total production costs for many vegetables. In addition, the types used have been evaluated and were found unsuitable for export market for all crops.

In view of the opportunities that exist for Jordanian vegetable and fruit exports, marketing services require immediate attention. They are important in making Jordanian produce more competitive as well as in increasing exports.

1.9.7 Distortion of Regional and Subsectoral Distribution of Resources Allocated to Services Provided by Public Institutions

The most critical distortion was found to exist in resources allocated to the generation, transfer, and dissemination of agricultural information. The share of irrigated agriculture of total agricultural added value was 62 percent in the early 1990s. The share of the Ghors, on the other hand, was 48 percent of total agricultural added value. Analysis of human resources at the Ministry of Agriculture in 1990-1991 revealed that agricultural engineers working in all services in the Ghors, for example, made up only 19 percent of all engineers working in the regions. Similar analysis of resources allocated to research and transfer of technology has shown great inconsistencies between size of resources allocated to subsectors on one hand, and the importance of each subsector on the other. In 1991, the number of researchers with advanced degrees who specialized in horticulture made up only 20 percent of the total with advanced degrees in Jordan.

On the other hand, resources allocated to research activities by the Ministry of Agriculture and national universities in the eighties never exceeded 0.8 percent of total national value added sums of agricultural sector. The share of resources coming from outside Jordan made up a large portion of total resources and reached a record high of 58 percent in 1987.

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1.9.8 Overlapping Responsibilities of Public Institutions

Among the fourteen public institutions whose responsibilities are related to agriculture, the most critical overlap is that between the Ministry of Water and Irrigation (MW&I) and Ministry of Agriculture (MOA). The two ministries provide services that are important to irrigated agriculture. However, because of the historical role of the MOA and the new laws of the authorities under the MW&I, the lines of responsibility of each institution are not clearly defined. As a result the scope, quality, and adequacy of some services provided to farmers are far from satisfactory. These services include:

- Timing of distribution of water developed by the public sector that is consistent with crop needs
- Determination of water required by each crop in each of the major agroclimatic zones of the country
- Amount of water developed by public sector allocated to each area and to each type of crop
- Information about on-farm irrigation regimes consistent with crop requirements as well as with the methods of production
- Information on quality of water and soil, especially warnings and measures to be taken by farmers to sustain the productivity of the soil and to avoid losses from the use of low-quality water
- licensing and regulation of groundwater wells as well as enforcement and monitoring of the conditions for groundwater use. These conditions include what crops to plant and on what scale, etc.
- Development of standards for the quality of irrigation water used for each crop

The resolution of these issues and the provision of these services in adequate levels is essential for the efficient use of this scarce resource. In addition the availability of information will help farmers minimize their losses.

1.9.9 Negative Impact of Regulatory Conditions Required by a Large Number of Public Institutions on some Agricultural Activities

A good illustration of this constraint is the number of conditions and permits that vegetable and fruit exporters must secure before export activity is concluded. The institutions involved include the Chamber of Commerce, the Agricultural Marketing Organization, the Ministry of Industry and Trade, the Ministry of Agriculture, the Ministry of Finance/Customs, and the transporting agency. Although the Government declares a policy to promote exports, exporters are faced with many hurdles and frustrating conditions before they are able to export. One of the main complaints is the volume of paperwork required. Another is that the paperwork and permits required for one activity (i.e., exportation of fruit or vegetable) must be obtained from many public institutions located far from each other.

Activities as crucial as exportation of agricultural produce should be served by one combined office that can provide exporters with all the necessary permits and can ensure that all conditions have been met. Management efficiency and administrative coordination must be improved to ease bureaucratic conditions for all activities related to agriculture.

1.9.10 Inconsistencies Between Demand and Supply of Labor and Science and Technology Human Resources

The rapid expansion of orchards and the use of high-technology methods (e.g., plastic houses and tunnels) in crop production have resulted in a deficiency of personnel skilled in activities related to agribusiness, agricultural water-related issues, management of irrigated agriculture, technical services such as pruning, and irrigated production systems. The above matters needs to be addressed by public institutions in cooperation with private sector organizations.

2. SUMMARY AND CONCLUSIONS

2.1 Significant Developments in Irrigated Agriculture

Under the agroclimatic conditions that prevail in Jordan, irrigated agriculture is more stable and more profitable than rainfed agriculture; it is also more risky because of the higher investment requirements.

Since 1980, both the public and private sectors have invested substantially in the development of water resources and in the infrastructure necessary for agricultural production. The significant developments during the period 1980-1991 include:

- An increase of irrigated cropped areas by about 6.4 percent per year, from 404 thousand dunums in 1980 to 699 thousand dunums in 1991.

- An increase of water resources used for irrigation by an average of 12 percent per year, from 285 million cubic meters in 1980 to 657 million cubic meters in 1991. In 1990, groundwater resources, developed mainly by the private sector, represented 51 percent of total water resources. On the other hand, the share of total water resources used for irrigation began to decrease in recent years and is expected to decrease further, from its present level of 74 percent to 53 percent by the year 2010. This will be a decrease in irrigation water of 69 million cubic meters, which equals 10 percent of present level.

- Traditionally, the Ghors (Jordan Valley and southern Ghors) was the main region for irrigated agriculture. The large increase in irrigated area in the Highlands, however, caused the share of the Ghors of total cropped area to drop to 49 percent in 1991, compared with 70 percent in 1980.

- Cropping patterns of irrigated areas have changed significantly. The share of fruit trees had increased to 34 percent (233,000 dunums) of the total by 1991, compared with 15 percent in 1980. The share of vegetables of total cropped area decreased to 50 percent (351,000 dunums) by 1991, compared with 72 percent in 1980. The share of field crops fluctuated, but reached 16 percent (114,000 dunums) in 1991, compared with 12 percent in 1980. These changes resulted in a long-term commitment of substantial amounts of water resources for irrigation of fruit trees, a group whose share of total water resources has been increasing every year.

- Total production from irrigated areas increased about two and half times from 1980 to 1991. Improvement of productivity was responsible for about 53 percent of the total increase, while 47 percent was due to an increase in the area planted. Vegetable production doubled during the period, reaching a record of 1 million tons in 1990 (979 thousand tons in 1991) compared with 489 thousand tons in 1980. Production of fruit trees increased sixfold from 1980 to 1991, reaching a record level of 331 thousand tons

in 1991, compared with 53 thousand tons in 1980. Field crop production had increased fourfold by 1991, when it reached 44 thousand tons.

- Tomato continued to represent the largest share of vegetable production, equaling 46 percent of total production in 1991. A record high of 512 thousand tons of tomatoes was produced in 1990 and 445 thousand tons in 1991. Citrus represented 61 percent of total fruit production in 1991, but the share of citrus is expected to decrease as more of the newly planted orchards of stone fruit, apple, grape, and olive reach bearing age.

2.2 Developments in Market Demand and Supply of Produce from Irrigated Areas

Both farmers and developers have always viewed the Ghors, the traditional main irrigated area in the 1970s and early 1980s, as an area of high comparative advantage. High-value fruits such as citrus and banana as well as off-season winter vegetables that have a promising market demand can be produced successfully in these areas. The export market for fruits and vegetables in the Arab region, especially in Lebanon and the Gulf States, has always been a target for both private and public sector stakeholders. With this export market in mind, farmers invested in and expanded vegetable and fruit production in the Highlands in addition to the Ghors. By 1985 one-third of the area cropped with vegetables was in the Highlands. During the mid-1980s, Jordanian farmers were able to sell all their fruit, either inside or outside Jordan, and citrus was the main fruit export. Vegetable farmers, however, faced high market risks and suffered severe losses because the domestic market was flooded, and the demand from export markets decreased. Since 1985, market risks have become the number one problem facing vegetable producers in Jordan. With the encouragement of the Government, the farmers, in response to these risks, shifted from vegetable to fruit production. Despite this shift, the total production of vegetables continued to increase because of the higher levels of productivity achieved through the use of modern and improved production inputs. The overall cropping pattern of vegetables changed during the 1980s. For example, potato, a commodity that has been in short supply in the domestic market, has increased its share of the total volume of produced vegetables. Other crops in short supply in the local market, such as garlic, onion, and watermelon, have also increased in importance, and new crops such as fennel, red cabbage, broccoli, and celery were produced on a larger scale. The market risk for most vegetables decreased in the late 1980s but an oversupply of tomato in certain seasons continues to be a chronic problem.

The year 1990 was perhaps the most normal for fruit and vegetable producers in the country. Market demand at home and abroad kept fruit prices high and export of vegetables reached an all time record of 502 thousand tons (50 percent of total vegetables produced that year). Export of fruits and vegetables decreased in 1991 due to the Gulf war, but vegetable growers suffered most because the level of production was close to that of the previous year. Therefore, exports dropped 43 percent from the 1990 level. The main reason for the decrease was the closure of Kuwaiti and Saudi markets to Jordanian exports. Exports to these two countries decreased to only 16 thousand tons in 1991, from 266 thousand tons on 1990.

With regard to field crops—cereals and green fodder—the irrigated areas produce 5 percent of the country's demand for cereals and a small portion of green feed needed by some four million head of animals. Cereals are bought by the Government at prices close to or a little higher than the international market price while green feed is produced by some farmers using low-quality water with a high content of total soluble salts.

2.3 Place of Irrigated Agriculture in the Economy

The value added of plant production has been increasing, and reached a share of 78 percent of total value added of the agricultural sector in 1990. During the same year, the share of produce from irrigated areas made up 80 percent of the total value of plant production, a figure equal to 62 percent of the total value added of all agricultural output.

The share of fruits and vegetables of total exports has increased over the years and reached a record high of 9 percent in 1990. The potential to increase the value of fruits and vegetables is promising due to the expected increase in fruit exports when Jordan's traditional markets in Lebanon, Saudi Arabia, and Kuwait are again accessible. Demand in other Gulf States is also expected to increase for both fruits and vegetables, and other opportunities exist in increasing winter vegetable exports to Europe.

2.4 Constraints to Production

Farmers in Jordan operate under a variety of serious risks and uncertainties. Most of the uncertainties stem from the changing and unclear lines of Government interventions in the agricultural sector. No formal strategy has been formulated to achieve policy objectives already declared by the Government. Risks, however, have varied origins. These risks include:

- Risks related to seasonal water shortages and depletion of local groundwater resources. The most serious risk is the loss of the comparative advantage of the fall planting of vegetables in the Jordan Valley. Another important risk is the shortage of water in some Highland areas (e.g., Amman) which requires farmers to pay high prices to have water trucked in from distant sources to irrigate their tree orchards.

- Risks related to deteriorating water quality, which has started to develop in several locations in the country.

- Market risks both domestically and abroad. The main market risk is the low prices of some vegetables (e.g., tomato) in some seasons. These losses may be exacerbated by the increased use of high-technology inputs, which increase the cost of production. The competitiveness of produce may also suffer due to the high cost of production and marketing of some commodities.

- Risks related to natural hazards such as frost and hail, which affect most crops in the Jordan Valley and Highlands.

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- Risks related to pests that are difficult to control such as viruses, white fly, stem borers, and root rots.

- Risks that export commodities may be rejected due to weak enforcement of quality control measures and standards.

In addition to these uncertainties and risks, farmers face other constraints as well. These include:

- The weakness of those farmers' organizations that do exist prevents farmers from exerting effective pressure on the government to bring about favorable changes both in policy and in services provided.

- Many farmers, especially those in the Highlands and southern Ghors, have no organization at all, and therefore, lack the means to lobby for their interests. This problem is exacerbated by the fact that all other stakeholders in the agricultural sector are organized.

- The weakness and/or absence of farmers' organizations weakens their ability to participate in the decision-making process as well as in the management of important aspects of production such as cropping patterns that are consistent with size and type of demand for various commodities. It also weakens the position of farmers to have a voice in the planning and resource allocation process for services provided to their subsector.

2.5 Efficiency of Resource Use

Most innovations introduced on the international market are being used to produce fruits and vegetables in Jordan. What is lacking, however, is the popularization of these innovations, on one hand, and the optimization of their use on the other. In vegetable production, for example, some farmers still use traditional production methods that produce 1 ton per dunum of irrigated land, while others, who have mastered sophisticated methods such as plastic house culture, produce 15 tons per dunum. There are five production methods used in Jordan. These five methods (and the percent of the total they represent), from the least to the most sophisticated, are the traditional basin or furrow method (13%), open drip (14%), drip mulch with raised bed (55%), drip mulch with plastic tunnel (15%), and plastic house (3%). If the plastic house method were used at the rate of 30 percent instead of 3 percent, then the area needed to produce the total vegetable output of 1991 would be 100 thousand dunums instead of the 343 thousand dunums actually used.

Methods of fruit production are less advanced than those of vegetables. About 45 percent of the area planted with fruit trees is irrigated by the traditional, and inefficient, surface flooding method. The majority of these areas are irrigated with water resources developed by the public sector, which is one-tenth the price of private water.

Field crops in the Highlands are irrigated on the whole with overhead sprinkler systems, those grown in the Ghors are surface irrigated. The irrigation in the Ghors is supplementary, rather than full irrigation. The supplemental amount of water fluctuates due to the low priority given to field crops in the cropping pattern of these areas.

The overall average efficiency of irrigation methods used in the country was 62 percent in 1991. Losses of irrigation water result from inefficient transport and distribution via the open cement-canal system and from inefficient on-farm surface irrigation methods. In 1991, the water transport and distribution systems, by efficiency and area covered, were:

Systems	Efficiency in percent	% Area covered
Open-canal transport and distribution	60	23
Open-canal transport but closed-pipe distribution	70	23
Closed-pipe transport and distribution to farm gate	85	11
Closed-pipe transport and distribution within farm	95	43
Total	--	100

On-farm irrigation systems have substantially improved in recent years. By 1991, 72 percent of the irrigated area was serviced with drip systems, 7 percent with sprinklers. The inefficient basin method of irrigation covered 31 percent of the irrigated area, a significant part of which is located in the Jordan Valley.

The economic returns of irrigated areas vary greatly from one crop to another and from one method of production to another. In 1990, field crops on the whole, for example, occupied about one-third the area cropped with vegetables, consumed an amount of water equal to 34 percent of that used for vegetables, but produced only 10 percent of the value of vegetable output. The prices of the output used to calculate the value of each of the two groups of commodities were the promotional prices of cereals offered by the Government, which were higher than those of the international market, and the low-priced vegetable output in the local market. Had the vegetable export prices been used to calculate the value of vegetable output (50 % of vegetables were exported in 1990), the difference in value generated between the two groups of crops would have been much greater.

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Net return for each 1 thousand cubic meters of water used to irrigate individual crops in the Jordan Valley in 1990 ranged from 3 JD for wheat to 540 for tomato. The highest returns were for vegetable crops and grapes, and ranged from 475 to 540 JD per 1 thousand cubic meters of water used. Net return for citrus was 253 JD, for banana 175 JD. The three variables used to calculate net return were the amount of water used by the crop under actual field conditions, the productivity levels per dunum, and the actual farm gate prices that prevailed in domestic markets that year. Prices of high water consuming crops like banana, for example, are quite high due to their short supply and a protective policy from imports, while prices of vegetables are lower in domestic than in export markets.

2.6 Impact of Government Policies and Interventions

Measures taken by the Government have had variable impacts. Agricultural credit has had a substantial positive effect on investments made in the irrigated areas. Tax exemptions on agricultural income and custom exempt production inputs have also been viewed favorably by all stakeholders in the performance of this subsector.

The protective policy for domestically produced commodities and the promotional policy for export of vegetables and fruits, however, appear to be contradictory. All domestically produced fruits, for example, enjoy protection from imports regardless of their production efficiency and their competitiveness with regard to prevailing prices both in the region and in international markets.

Examples of ineffective Government intervention are its failure to enforce cropping patterns to achieve the targeted objectives, pricing policies of water developed by the public sector, weaknesses in enforcing regulatory laws in the utilization of water resources, and the allocation of low levels of resources in support of some services that are vital for the successful and efficient performance of the irrigated subsector.

3. STRATEGIES TO OPTIMIZE DEVELOPMENT AND PERFORMANCE OF IRRIGATED AGRICULTURE

3.1 Assumptions

Strategies that will be suggested under this title will be based on some basic assumptions which constitute the basic elements under which strategies will be implemented. These assumptions are not theoretical, but are viewed as long-term policy elements or agreed upon by legislative and executive powers of the country. The important assumptions are:

- Infrastructure projects will continue to be formulated, financed, executed, monitored, and regulated by the public sector. These include construction of dams, conveyance and distribution networks for water developed by the public sector, farm roads, energy sources, and infrastructure of institutions that provide services.

- The private sector will share with the Government the cost of services and commodities provided to individuals. The share of the cost paid by the private sector will vary from one service to another but may reach 100 percent of operation and maintenance costs for some commodities such as water and drainage systems. The principle of service fees provided optionally to farmers and other stakeholders in the production and marketing systems is accepted.

- Private sector ownership of production resources will be recognized, as will the public sector's right to legislate and enforce laws, bylaws, and regulations to manage, monitor, and conserve production resources. Resources will be managed, monitored, and conserved to sustain the quality, the renewability, and the productivity of these resources for the welfare of present and future generations.

- Market forces, based on fair competition and equitable conditions for all concerned, will be the guiding principle in the production, internal trade, and external trade of all commodities used as inputs or produced as outputs of the production and marketing systems. Subsidies or protective measures for any input or output of the production and marketing systems should be of a temporary nature and should be designed to achieve equity for all. Subsidies or protective measures should only be implemented to create a transitional environment that is considered essential for the development of economically sound ventures that have a high probability of survival under conditions of market forces.

- Market forces, as outlined in these points, are assumed to apply also in countries with which Jordan will have trade relationships. Otherwise, trade relationships will be subject to conditions as negotiated by the two parties.

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- Market forces, in as much as they are rationalized by the parties concerned, will be the basis for integrated production and/or marketing systems with countries of the Arab region or any other country with which Jordan enters an international agreement.

- Policies and strategies of production and marketing systems will be formulated and implemented with due consideration to the interests and welfare of all stakeholders. Rewards and costs that result from these policies and strategies should be fairly distributed among all stakeholders.

3.2 Objectives, Policies, and Strategies for Irrigated Agriculture

I. The objectives of agricultural activities in irrigated areas in Jordan include:

- Development and utilization of production resources, especially land and water, with due consideration to optimal efficiency, economic return, sustainability, and the environment.

- Maximization of the net return on producers' investments.

- Production of food and agricultural commodities for which there is a demand in the mestic, regional, and international markets, and that are competitive in quality and price.

- Maximization of the ratio of value added in the gross value of commodities produced in irrigated areas.

- Maximization of the contribution of irrigated agriculture to the total value added sums of the agricultural sector and Gross Domestic Product.

- Maximization of the contribution of exports from irrigated areas to the national trade balance.

Objective (I) For the development and utilization of production resources, especially land and water, with due consideration to optimal efficiency, economic return, sustainability, and the environment. The following policies and strategies are needed:

(A) Policy: MAXIMIZING THE EFFICIENCY OF WATER STORAGE, CONVEYANCE, DISTRIBUTION, AND ON-FARM APPLICATION

Because water is the limiting resource for irrigated agriculture, the best option available for Jordan to maintain a balance between supply and demand of irrigation water is to maximize the efficiency of water storage, conveyance, distribution, and on-farm application methods. All stakeholders in irrigated agriculture will benefit from the implementation of this strategic option and when soundly implemented it will reduce shortages of water in the presently cropped areas and newly developed lands. The Government will need to appropriate funds to implement projects to decrease water losses and maximize efficiency. The costs of these projects are

reasonable when the amount of water that may be saved is taken into account. Raising the irrigation water efficiency by 10 percent (from its present level of 62%) to 72 percent will increase the resources available by about 60 million cubic meters.

Farmers in the meantime must bear the cost of installation of drip irrigation systems on farms that are presently irrigated by the surface basin or furrow methods. The change in irrigation systems on lands planted with fruit trees must take place during orchard renewal, that is, after the trees have passed their productive ages.

The priority measures to be taken and the institutions responsible for their initiation and followup are:[1]

1. Develop suitable storage structures both on-farm and outside to minimize loss of water through evaporation and seepage (MOWI, MOA, farmers).

2. Change present open-canal conveyance and distribution systems in the Jordan Valley to closed-pipe systems (MOWI).

3. Install closed-pipe systems to convey surface water in the Highlands (MOWI).

4. Increase the price of water developed by the public sector to cover part of the cost of infrastructure and all costs of operation and maintenance of water conveyance and distribution services (MOWI).

5. Replace surface irrigation with drip systems wherever water developed by the public sector is used. This change may be implemented over a period of time, especially in existing tree orchards (MOWI and farmers).

6. Minimize the costs of production of all water-saving technologies and exempt raw material imports from custom duty (MOWI & MOF).

7. Strengthen the capacity of manpower responsible for management of water distribution in agricultural related issues (MOWI).

8. Strengthen the national capacity in the development and application of information on crop water requirements, irrigation scheduling, and management in each of the agroclimatic regions of the country (MOWI in cooperation with NCARTT and universities).

9. Strengthen the national capacity to generate, evaluate, and disseminate information on water-saving technologies (MOWI in cooperation with NCARTT and universities).

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[1] First institution in the bracket placed after each measure is the leading (initiator) party for the implementation of that measure.

10. Resolve the issues about the overlapping of responsibility of the Ministry of Agriculture and Ministry of Water and Irrigation in the management of water resources (MOA, MOWI).

11. Assume national responsibility for supervising and approving the design and installation of introduced irrigation systems (MOA, MOWI, private sector companies, farmers organizations).

12. Strengthen the methods of dissemination of information to promote public awareness of efficient use of water, water quality, and conservation of watersheds (MOWI, MOA, nongovernmental organizations, and the private sector).

(B) Policy: MAXIMIZATION OF ECONOMIC NET RETURNS OF WATER USED IN IRRIGATION.

Due to the scarcity of water in Jordan, the logical strategic option is one that maximizes the net economic returns per cubic meter used. Planting of crops that presently consume large quantities of water developed by the public sector, and that enjoy protective measures, and which would become noncompetitive once these measures are removed, should be discouraged.

The priority measures required for the implementation of this policy include:

1. Limit the production of crops that require large amounts of water, especially those that use water developed by the public sector. Priority should also be given to limiting production of those crops that have lower net economic returns per cubic meter of water used (MOWI and MOA).

2. Remove protective measures for high water consuming crops, provided that no subsidies are provided to such crops by other countries (MOF, MOA).

3. Promote the production of crops and fruit trees that are in demand both domestically and abroad and that provide the highest net economic returns per cubic meter of water used (MOA and MOWI).

4. Develop and enforce a management plan for water developed by the public sector in the Jordan Valley. Use monthly water budgets to ensure that water is available for crops and plantings that have the comparative advantage of being winter vegetables, which have demand and high prices both in domestic markets and abroad (MOWI, MOA, farmers organizations).

5. Develop water regimes, taking into consideration quality and quantity, that will maximize the net value of output per cubic meter of water used (MOWI in cooperation with NCARTT and universities).

6. Generate, transfer, and disseminate information on the performance of different crops under the agroclimatic zones in Jordan, economic net returns on water used by different crops, economically viable water regimes, standards for water quality used for optimum irrigation of crops, and the effects of quality of water on yield and net returns of crops (NCARTT and universities in cooperation with MOA, MOWI, and farmers organizations).

7. Promote the use of technologies and practices that maintain soil fertility and acceptable standards of water quality.

8. Take measures to safeguard the soil and water quality from contamination by the surplus drainage water that contains pesticides and herbicide residues and surplus mineral fertilizer.

(C) Policy: THE CONSERVATION OF WATER AND SOIL QUALITY, AND PROPER TREATMENT OF RECYCLED WATER, ESPECIALLY EFFLUENT FROM WASTEWATER TREATMENT PLANTS, TO PRODUCE QUALITY WATER CONSISTENT WITH STANDARDS USED IN IRRIGATION

Water quality is already deteriorating in many groundwater aquifers due to overexploitation, recycled water, and in some surface waters due to the decrease in supply of fresh water in some wadis. Salinity problems are already developing in several irrigated soils throughout the country and overexploitation of some aquifers is causing their depletion.

The priority measures required for the successful implementation of this policy include:

1. Enforcement of laws and regulations to monitor pumped quantities of all groundwater wells in the country to ensure the safe water balance between recharge and discharge of water from aquifers (MOWI).

2. Preserve recharge areas of major aquifers to ensure sustainability of the quality and quantity of recharged water (MOWI, MOA).

3. Monitor the quality of all soils, surface water, and groundwater, evaluate the results, and implement actions to stop deterioration in quality, including the removal of sources of pollutants (NCARTT, RSS in cooperation with MOWI and MOA).

4. Minimize salinity levels in effluents from wastewater treatment plants by improved treatment methods, desalination of effluents, or mixing effluents with fresh water (MOWI).

5. Enforce regulations, including licensing of groundwater wells, to ensure consistency between license conditions and area and type of crops planted (MOWI and MOA).

6. Enforce environmental impact assessments of all water development projects, especially reservoirs and wastewater treatment plants (MOP, MOWI, MOA).

Objective (II) For maximization of net return on producers' investments. The following policies are needed:

(A) Policy: MINIMIZING VARIOUS RISKS FACING PRODUCERS.

Some of these risks are related to the export market and are beyond the control of any one party. These risks result from strained political relationships among the countries of the region and develop due to actions taken by countries other than Jordan.

The measures required for the successful implementation of the above policy include:

1. Organize production patterns to balance supply and demand of produced commodities and minimize losses of farmers due to market price fluctuation (Farmers Organization, AMO, MOA, and private and public sector marketing companies).

2. Strengthen information provided to producers and exporters on past and forecasted market demand and supply of commodities that may be produced by Jordanian farmers (AMO, private and public sector marketing companies).

3. Organize farmers and exporters to assume more responsibility in the improvement of marketing activities, including development of new markets and newly demanded crops (MOA, AMO, producers and/or exporters).

4. Establish a crop insurance system against natural hazards, especially frost and hail (MOA, private sector insurance and financial institutions, and farmers).

5. Strengthen the generation, transfer, and dissemination of information to minimize risks from pests (NCARTT, universities, private sector, and farmers organization).

6. Stabilize interventions of the Government to help create a healthy environment for investment in irrigated agriculture (all ministries whose responsibilities affect irrigated agriculture).

7. Strengthen post-harvest technical services for fruits and vegetables, including monitoring of pesticides, residue analysis, quality control standards, packing specifications, storage precooling treatment, and transport management of fresh commodities (AMO, MOA, NCARTT, Higher Council for Science and Technology, producers and exporters).

(B) Policy: MINIMIZING PRODUCTION AND MARKETING COSTS

Measures needed to implement this policy include:

1. Optimize the use of inputs in the production system with priority given to inputs that constitute a high share of total costs. This requires the strengthening of information output

by public institutions and the orientation of research as well as technology transfer activities to priority programs (MOF, MOP, MOA NCARTT, universities, Higher Council for Science and Technology, and farmers organizations).

2. Maximize the consistency between the amount and type of resources allocated to research, technology transfer, and information dissemination on one hand, and the importance of crops, regions, and production constraint priorities on the other (MOA, MOP, NCARTT, universities, farmers organizations, and Higher Council for Science and Technology).

3. Increase the financial resources allocated to research, technology transfer, and dissemination programs. The support to these programs must be sufficient to make them efficient and must not be less than two percent of the total value added of irrigated crops (MOA, MOF).

4. Improve and introduce marketing materials and services that are more economic and more efficient. These include crates, packing and storage facilities, export transport services, and processing facilities (AMO, NCRATT, universities, private sector companies, farmers organizations).

5. Strengthen the power and participation of farmers in the decision-making process of resource allocation of research and technology transfer institutions, identification of program priorities, and provision of financial support (MOA, MOWI, universities, and farmers organizations).

Objective (III) To produce agricultural commodities that are demanded in the domestic, regional, and international markets, and that are competitive in quality and price. The following policy is needed:

Policy: PRODUCING COMMODITIES THAT WILL BETTER UTILIZE NATIONAL RESOURCES.

Due to its mild climate, its human resources, and its geographic location, Jordan has the opportunity to produce high-value commodities such as off-season vegetables, fruits, flowers, tree seedlings, and seeds for domestic and export markets. The domestic market demand has been adequate for most of the produced commodities; some are in short supply in some seasons or months and others in oversupply in some months. Commodities in short supply include tree seedlings, nonhybrid vegetable seeds, hybrid seeds, onion, and fruit. Commodities in oversupply, which have suffered the most from low prices, include tomato, cucumber, eggplant, and squash.

In addition to providing an adequate supply to domestic markets, Jordan has become an exporter of several vegetable and fruit commodities, and there is an opportunity to export more. To optimize the supply for demanded commodities, both domestically and abroad, Jordan must be competitive, provide quality produce, and ensure fair and stable trade relations with countries of the region as well as with European countries. Jordan is in a curious situation because it can

produce commodities other than fruits and vegetables, such as cereal, oil seed, and sugar crops, which are in short supply domestically but yield much lower output both in value and quantity than fruits and vegetables. Jordan's limited irrigated resources may, if they are optimally utilized both economically and agroecologically, enable it to produce most if not all of the fruits and vegetables it needs and to export substantial amounts. Producers have already achieved an advanced and efficient level and were able to satisfy all domestic demand for most vegetables and fruits and have exported in some years almost 50 percent of total vegetable production and modest quantities of fruits.

Farmers and public authorities, therefore, have opted to promote the production of high-value crops that are demanded by both domestic and export markets. The challenge ahead for both parties, as well as other stakeholders, is to produce and market commodities that are competitive in price and quality.

To achieve this policy Jordan must:

1. Maintain its present policies of exempting all imported production inputs from custom duties in order to keep their cost low (MOF).

2. Remove protective measures, especially import bans or subsidies that may foster noncompetitiveness of domestically produced commodities or may constrain exports (AMO, MOA).

3. Improve, to the highest level possible, the quality of all services that raise the competitive capacity of producers and/or exporters (all public and private sector institutions concerned).

4. Utilize trade relations and agreements with other countries to promote the export of Jordanian products that have comparative advantages (MOIT, MOF, MOA, private sector companies dealing with export/import activities).

For the following objectives:

Objective (IV) Maximization of the ratio of value added in the gross value of commodities produced in irrigated areas.

Objective (V) Maximization of the contribution of irrigated agriculture to the total value added sums of the agricultural sector and Gross Domestic Product.

Objective (VI) Maximization of the contribution of exports from irrigated areas to make the national trade balance.

The following policy and strategies are needed:

Policy A: Promote Domestic Production of as Many of the Inputs for Irrigated Production Systems That Are Competitive With Imported Ones and of Equal Quality and Benefits.

The ratio of value added of plant commodities to total gross sum of production has been increasing. In recent years the cost of production inputs has averaged only 20 percent of gross value of plant production output, of which irrigated areas contributed 80 percent. Most fertilizers, drip systems, plastic sheets, metal frames for plastic houses, and seedlings are already produced in Jordan. Most pesticides, open pollinated improved hybrid seeds, parthenocarpic seeds, and some implements are imported. The imported inputs constitute 12–25 percent of the cost of total inputs used in the production system, but contribute significantly to the high levels of productivity achieved by producers. There are no barriers or constraints that prevent investors from producing these inputs domestically except for small market considerations. Domestic production of these inputs, if they are comparable in quality and price to imported ones, may promote exports and therefore render their domestic production feasible.

Measures that may promote the domestic production of inputs include:

1. Enforcement of international standards and specifications for produced commodities that make them competitive both domestically and abroad (MOA, MOF AND MOIT).

2. Removal of any constraints, including duty, on imported raw materials that are used in the manufacturing of production inputs (MOA, MOF, MOWI).

3. Promotion of the maximization of value added components in commodities produced domestically (MOIT, MOA, farmers).

4. Removal of any protective measures that may lead to the production of low-quality inputs and/or outputs (MOA, MOF, and MOIT).

Policy B: Present Policy of Export Promotion Should be Maintained and Strengthened.

Irrigated agriculture output has constituted about 80 percent of total plant production and 62 percent of total value added sums of the agricultural sector as a whole. The share of exports of commodities produced in irrigated areas has been increasing in recent years and has the potential to become a major component of national exports.

Measures needed to achieve maximization of exports; in addition to those outlined under other strategies; include:

1. Maintain the present policy of export promotion and reinforce confidence of producers and exporters to make long-term arrangements and/or agreements with importers from other countries (MOA, MOF, MOIT).

2. Promote and enforce, if needed, high standards of packing, quality of produce, and specifications that are consistent with those required by importing countries (AMO, MOIT, MOA).

3. Strengthen all services that lead to the expansion of export markets including studies on type and quality of demanded commodities, identification of constraints facing Jordanian products in present and potential export markets, and dissemination of international market information relevant to export and import operations (AMO).

4. Use the negotiating power of Jordan to conclude international trade agreements to promote export of food and agricultural commodities produced in irrigated areas (MOF, MOIT, MOP, MOA, AMO, and private sector companies).

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1. INTRODUCTION

This study is part of the agricultural sector review and policy implementation plan, which is intended to study the sector, its resources, present uses, and constraints, and to suggest ways to develop a policy that will result in sustainable, efficient, balanced, and competitive agricultural production systems. This system should preserve and develop resources, conserve the environment, and help attain returns for producers, investors, and laborers in the sector. Equity among the sectors and within the sectors is of equal importance.

The livestock production subsector is very diversified; it acts, reacts, and interacts with plant production, the environment, and human activities. It is related to all land classes and can have an effect on all kinds of plant production.

This study is intended to present the current production situation, policies and trends of change, constraints and suggested changes amendments, and modifications of policies, production systems, and distribution. An overview of the resources will be presented with emphasis on feed production and livestock. Following will be an analysis of the comparative advantage of production of certain commodities and suitable systems, which will influence the allocation of resources—natural, human, and financial. The disposition of resources and the optimization and suitability of their use will determine the allocation of certain resources to certain production systems and species. This leads to the importance of sheep and goats in relation to rangeland development and stubble utilization. Management systems for grazing, breeding, and growth have a high priority, and research programs should be designed to develop and improve them.

2. ASSESSMENT OF THE LIVESTOCK SUBSECTOR

2.1 Resources

2.1.1 Water Resources and Water Use

Given the scarcity of water resources in Jordan, and the complexity of the geopolitical conditions in the region, Jordan has suffered severely from water shortages. These shortages were exacerbated by the drought in the late 1980s and the hundreds of thousands of returnees from the Arabian Gulf area.

Precipitation is the main source of surface water and groundwater. Total annual precipitation is 7,200 million cubic meters (MCM), 85 percent of which evaporates. The rest is surface runoff, which is used as a supply source or which recharges groundwater supplies.

Surface water supply sources account for two-thirds of the total water supply in Jordan. The available water supply can be divided into three major resources:

1. The Jordan Valley, which encompasses the Yarmouk River, the King Talal Dam, local wadis that flow into the Jordan Valley, and groundwater wells in the area. This supply contributes 250 MCM.

2. The Dead Sea wadis, which include Waleh, Mujeb, Karak, and Hasa and other groundwater sources in Amman, Zarqa, Dhuliel, Qastal, and wells north of the Zarqa River. These sources contribute 380 MCM.

3. Other basins such as Wadi-Arabah, Jafir Basin, Disi, Azraq, the Northeastern Region, and other local sources. These sources account for 100 MCM.

There are 11 major surface basins in Jordan (Table 2.1).

Table 2.1: Major Surface Water Basins in Jordan

Basin Name (Local Name)	Base Flow MCM/Year	Flood Flow MCM/Year	Total Flow MCM/Year
Yarmouk (historic average)	167	133	300
1. Side Wadis to Jordan Valley	66	15	81
2. Zarqa River	46	46	92
3. Dead Sea Wadis	44	4	48
4. Mujib	35	32	67
5. Hassa	32	4	36
6. Wadi Arabah	28	6	34
7. Yitim	--	1	1
8. Jafir	4	10	14
9. Sarhan	--	10	10
10. Azraq	12	15	27
11. Al-Hammad	--	13	13
Subtotal	267	156	423
12. Total With 100 MCM From Yarmouk			523

Source: Al-Wishah, R.A. 1992. Jordan's Water Resources.

Groundwater can be classified into two types according to its origin and characteristics: (1) Renewable groundwater, which can be recharged, and (2) fossil water, which has collected at greater depths (> 150m) during early geologic ages, and receives no substantial recharge. The estimated groundwater supply in Jordan ranges from 223 MCM to 465 MCM, which includes both renewable and nonrenewable (Table 2.2).

Table 2.2: Total irrigated area (dunum) and water requirements (MCM) during 1989–2010

Water Resource	Location	1989		1995		2000		2005		2010	
		du.	MCM	du.	MCM	du.	MCM	du.	MCM	du	MCM
Runoff	Jordan Valley	228,280	370	288,000	338	310,000	370	350,000	419	360,000	425
	Southern Ghors	47,000	44	47,000	44	85,000	79	85,000	79	85,000	79
	Natural Wadis	15,000	10	15,000	10	20,000	12	20,000	12	25,000	15
	Subtotal	290,280	424	350,000	392	415,000	461	455,000	510	470,000	519
Groundwater	Jordan Valley	20,000	20	--	--	--	--	--	--	--	--
	Highlands	245,000	170	245,000	170	250,000	175	250,000	175	250,000	175
	Disi Aquifer	50,000	37	55,000	40	55,000	43	60,000	45	60,000	45
	Wadi Arabah	2,000	Little	5,000	5	10,000	10	10,000	10	15,000	15
	Subtotal	315,000	227	305,000	215	315,000	228	320,000	230	325,000	225
	Ground Total	605,840	651	655,000	607	730,000	689	775,000	740	795,000	754

Source: Bani Hani, M. and Balbisi, M. 1991. Water Resources and Water use in Jordan.

The amount of water available for use is about 720 MCM, divided in the following way: municipalities 172 MCM; industries 34 MCM; and irrigation 514 MCM.

2.1.2 Land Resources and Land Use

Jordan is divided into four agroclimatic zones according to total annual rainfall: arid (<200mm); marginal (200-350mm); semiarid, (350-500mm); and semihumid, (500-600mm) (see Table 2.3).

Table 2.3: Agroclimatic Zones in Jordan

Zone	Area (ha)	% of Total	Annual Rainfall (mm)
Arid Zone	8,456,900	91.37	less than 200
Marginal Zone	563,400	6.09	200-350
Semiarid Zone	135,900	1.47	350-500
Semihumid Zone	98,900	1.07	500-600

Source: FAO 1992. Regional Study on Rainfed Agriculture and Inventory of Eleven Countries in the Near East Region.

Land Use. Over 91 percent of the total area of Jordan (92,428 km^2) is rangeland; cultivated land covers less than one-half million hectares. The largest area of cultivated land is allocated to field crop production. Most of the area is in the marginal zone.

It was estimated that about 700,000 dunums are cultivated with vegetables and pulses in the semiarid and semihumid zones in rotation with wheat; fallowing in these areas is rather limited. More data on land use are shown in Table 2.4.

Table 2.4: Land use in Jordan According to Agroclimatic Zones, in hectares.

Zones	Cultivated	Field Crop	Vege-tables	Fallow	Orchards	Wood lands	Range land	Irrigated	Cropping intensity
Arid	120,400	59,632	---	60,768	---	---	8,316,253	20,247	49.53
Marginal	330,997	198,547	7,884	124,566	2,429	6,035	211,764	12,175	62.37
Semi-arid	24,975	10,621	10,963	3,391	19,096	21,375	68,014	2,440	86.42
Semi-humid	13,328	8,000	2,553	2,775	6,175	12,590	65,898	909	79.18
Total	489,700	276,800	21,400	191,500	27,700	40,000	8,661,929	35,771	60.9
% of Total	5.29	---	---	---	0.3	0.43	93.59	0.39	---
% of Cultivated area	100	56.52	4.37	39.11					

Source: FAO 1992. Regional Study on Rainfed Agriculture and Agro-Climatic Inventory of Eleven Countries in the Near East Region.

Wheat and barley occupy by far the largest area of rainfed lands in Jordan. It is interesting to note that wheat farmers delay seeding until a good part of the rainy season has passed. If sufficient rain has fallen, they proceed with their planting; if not, they do not plant. In addition to wheat and barley, farmers in Jordan plant a number of crops under rainfed conditions. These include pulses (lentils, chick peas, broad beans) and vetches, which are planted in rotation with wheat as winter annual legumes in areas of medium and high rainfall.

Land Tenure and Land Usufruct Rights

Before 1933, most state-owned land was in perpetual lease to the occupier. The settlement act, which was passed later, was intended to generalize private ownership in order to improve agricultural productivity through personal attachment of the farmer to his land. Consequently, according to the 1983 Agricultural Census, most of the cultivated land is privately owned. About 97 percent of landholdings are run by individuals or families, and about 75 percent of those are owned by the occupiers.

Individuals can claim ownership of Amiriyya-type land on the basis of historic use and under the Law of Administration of the Property of Governmental Land (No. 17/1974), according to which application can be made to lease the land for a five-year period to be developed in accordance with an agreed-upon plan. If conditions of the lease are met the lessees can apply for ownership. It has been observed that ownership based on historic use of land causes misuse of arid lands. To establish proof of use prior to future registration, the "would-be owners" plow and sow the land regardless of yield or subsequent land degradation. Uncertain land use policy actually encourages such practices.

Theoretically, government rangelands are protected under Agricultural Law No 20(1973), which authorizes the Minister of Agriculture to protect and improve conditions of the natural vegetative cover. Implementation of this legislation is extremely difficult, however, because most users consider themselves de facto owners of the land. Any attempt to protect rangelands must take into account this new legal reality. Future legislation should be tailored to include private land in any law aimed at preserving rangelands. Agricultural lands in Jordan, especially in the rainfed areas in the north, have been severely fragmented. This fragmentation is a major obstacle to agricultural development in Jordan because it leads to a reduction in the size of holdings (27.4 percent of land holdings are less than 1 hectare), which adversely affects implementation of modern techniques such as use of farm machinery and crop rotation.

2.1.3. Feed Resources and Feed Balance

The livestock feed available in Jordan can be divided into six broad categories:

1. Natural range resources in the rangelands (marginal and desert land)
2. Natural vegetation in the rainfed area

3. Tibin, straw, and stubble
4. By-products of irrigated vegetables in the Jordan Valley
5. Forage production in the rainfed and irrigated areas
6. Cereal grain and wheatbran

Rangelands. Total agricultural land in Jordan covers an area of approximately 92,428 km^2, and may be divided into: rangeland, which covers 80,590 km^2 (91 percent) of the area; forest, which covers 1,414 km^2 (1.6 percent); and agricultural land, which covers 6,520 km^2 (7.4 percent).

According to Gaddes et al. (1991) the annual production resources total 262 million Scandinavian Feed Units (SFU), which supplies at most 30 percent of the livestock requirement. The high-potential area of the range (steppe) is 12.5 percent or less of the total land area.

There are two plant association groups: the forest community and the pastoral community. The forest community covers the mountainous regions; the pastoral community covers part of the mountained and slopes of the western region, and all of the desert zones.

Rangeland is currently undergoing severe erosion. This is causing a reduction in organic matter and a consequent reduction in fertility, a decline in the efficient use of rainfall, an increase in the surface water flow, a change in the structure and composition of the vegetation, and a deterioration in range production and conditions.

Productivity ranges from 5 to 320 forage units per hectare. In the western regions the average productivity is estimated at 110 forage units/hectare, while in the eastern regions, it does not exceed 50 forage units/hectare. The carrying capacity is 3.8 hectares per sheep unit in the western range, and 8.4 hectares per sheep unit in the eastern region.

Straw and Stubble. The second most important source of feed in Jordan are the by-products and residues of field crops planted in the rainfed area. These include cereal stubble, straw and grains left in the field; straw or failing crops of lentils, chick peas, broad beans, vetch, and other leguminous crops. Barley can be a natural crop to be grazed, or can be collected as supplementary feed for the or for sale to other farmers, who pay up to 6 JD per dunum. When it fails it can be used as immature green fodder. It should be stressed that sheep use stubble after grains are harvested or the straw is baled. Baling straw is a new development in Jordan, and farmers are becoming aware of the economic value of this operation. The bales that are collected become winter feed, and the market price may reach 60-80 JD per ton at harvest time.

It has been estimated recently by Neshawat (1987) that straw and other field crop residues could supply about 164,000 tons, of feed, enough to maintain the national flock for three to four months. Residue is estimated to total 100,000 tons. In Syria this source represents up to 40 percent of the metabolizable energy consumed by sheep (ICARDA 1980).

Barley Cultivation as a Feed Crop. Barley is an ideal crop for arid areas. It is a multipurpose crop that can be used as green hay, harvested and collected as grain, and grazed as stubble. The decision on how to use it can be made at any stage of growth based on the amount of rain, without making it useless as a source of feed for ruminants. It could be grazed if there were a shortage of forage on the farm; the entire crop in the mature stage could be grazed if there were a drought. This decision depends upon the cost of a harvesting machine, the grain yield, and the price the sheepowner is willing to pay for the crop.

The versatility of barley as a crop has encouraged sheepowners to cultivate it in marginal areas (i.e., rainfall of less than 200mm), which unfortunately increases desertification of the range. Barley cultivation has also expanded in the steppe regions, because the use of tractors has made it possible to produce enough barley forage or grain for sheep.

The above ideas highlight the dominant role of barley and the declining dependence on natural vegetation in the range. This factor encouraged the government to adopt a project financed by UNDP and the Arab Development Fund--the "Mashraq Project"--which concentrates on the relationship between growing barley and the feeding of sheep.

Forage Crops Grown on Arable Land (Rainfed and Irrigated). Fodder production has been encouraged in recent years through many programs, but two programs are of importance here: the Australian Dryland Farming Program, and the Jordan University Forage Program in the Jordan Valley. The results of these two programs will be summarized here because of their importance in future development forage crops in Jordan.

The aim of the Australian Dryland Farming Project is to increase the productivity of the main rainfed (> 250mm) cereal-growing areas of Jordan through research, extension, training, and seed multiplication. The aim was refined later to integrate livestock and cereal production through the introduction of forage legumes into the farming system.

The first year's work concentrated on identification of more productive medic varieties. M. rotata was found to be the best adapted to Jordanian conditions. M. scutellata and M. rigidula are also suitable. The total productivity for three different crop rotations at Ramtha Research Station was greater than 550 kg/dunum in two good years, while it was less than 150 kg/dunum when the rainfall was only 150mm. The rotations were barley/vetch, barley/medics, and barley/fallow while it was a little bit high in Maru Research Station. In a 200-dunum trial demonstrating the productive potential of medic pastures under management conditions, the lambs that grazed upon this pasture gained 220 grams per day.

The land area planted with barley in Jordan (Table 2.5) reached 633,600 dunums in 1988, but then decreased. Although wheat is planted more widely than barley in Jordan, barley is the main feed crop. The land area planted with barley fluctuates according to variation in rainfall.

Table 2.5: Field Crop Area and Production 1987-1991 (Area = 1000 dunums, Production= 1000 Tons)

Product	1987		1988		1989		1990		1991	
	Area	Pro.	Area	Pro.	Area	Pro.	Area	Pro.	Area	Pro.
Winter Crops	2022.7	165.9	1970.7	204.7	1438.1	124.7	1158.4	135.9	711.5	53.9
Wheat	1245.4	109.3	1182.7	137.0	812.1	61.1	634.2	59.7	443.2	33.8
Barley	600.6	41.0	633.6	50.0	421.4	25.0	328.1	26.0	200.1	15.8
Lentils	112.1	7.6	103.8	9.8	58.5	4.9	80.0	6.7	34.4	1.9
Broad Beans	7.5	4.2	4.8	1.2	7.1	1.1	7.0	0.8	4.0	0.2
Vetch	57.1	3.8	45.8	6.7	29.8	1.7	31.9	4.5	28.7	2.3
Summer Crops rainfed	19.0	1.4	39.4	2.3	35.9	2.9	3[illegible].6	1.6	42.5	2.6
Chick-peas	17.1	1.0	33.6	2.1	29.8	1.8	24.6	1.4	32.6	2.2
Sesame	0.5	0.0	1.0	0.0	0.5	0.0	1.1	0.0	4.2	0.1
Maize	1.4	0.4	4.8	0.2	0.3	1.0	0.2	0.0		
Summer Crops Rainfed	39.4	10.9	80.1	30.1	105.2	28.6	75.5	39.9		
Wheat	25.8	7.1	57.2	25.7	84.8	24.8	58.3	29.0	63.2	24.0
Barley	12.2	3.4	17.0	3.2	20.4	3.7	16.3	10.4	25.6	11.0
Maize & Forage	1.4	0.4	5.9	1.2					5.4	0.3

Source: Ministry of Agriculture

Barley production ranges from 250 to 800 kg/ha. The area planted in 1990 was 34,440 dunums; in 1991, 22,570 ha. Production was 55,000 and 26,800 tons in the two years. All of this was used to feed livestock, but it was not sufficient.

Lentils and vetch are the next two most important crops for animal feed. While the crop residue of lentil is used as feed, vetch is used as a grain or as a crop residue. The crop residue of both lentil and vetch is called "Brown Tibin" in Arabic. Brown tibin has a higher nutritive value than barley or wheat straw.

A large project was initiated in Jordan in 1981 and it is working. The project is called the "Jordan Australian Dryland Farming Project." Its primary goal was to increase the productivity of the main rainfed cereal-growing areas in Jordan by improving cereal crop husbandry, and by integrating livestock and cereal production through the introduction of fodder crops into the cropping rotation. Jordan University participated fully, and high-quality research components were incorporated in this project. It proved feasible to grow raise medics as pasture. Grazing customs were the main constraint to expanding the area planted with medics, because roaming Bedouin herders view medics as legitimate forage, not as a private crop such as barley or wheat. A successful application of "Ley Farming" requires long-term planning to change grazing practices at the community level.

Grazing trials conducted by Jordan University with annual legumes mixed with cereals produced a growth rate for fattened lambs of 122-197 g/day (Harb and Al-Fawal 1981-1983). The Australian experiments performed during good years in higher rainfall areas and in fertile land produced similar results. During the drought year of 1986, however, the biomass yield varied from 30 to 300 kg per dunum, with an average of 75-100 kg per dunum

Vegetable By-Products. Another source of feed for ruminants is vegetable by-products, grasses, and weeds that grow in the Jordan Valley between vegetable land and orchards. A rough estimate of vegetable and fruit by-products in the Jordan Valley is around 30,000 tons.

Wheat By-Products and Grains. A final, but very important, source of feed in Jordan is the by-product of the domestic milling industry: wheat bran. It is estimated at about 140,000 tons and may be the most important single feed resource in Jordan. On average, wheat bran produced from the milling of wheat is estimated to be about 22 percent of the whole grain. This feed is subsidized by the government.

Barley and sorghum grains are the most important groups of domestic livestock feeds. Most of the grain available in Jordan's market is imported, subsidized by the government, and distributed to sheep and cattle owners.

The concentrates distributed by the Ministry of Supply (MOS) are crucial to the survival of the sheep and goat production subsector, because they represent 40-50 percent of the metabolizable energy offered to these animals. Use of these subsidized concentrates,

which were intended to encourage farmers to increase flock productivity, instead has caused them to increase the size of their flocks, which in turn has caused more deterioration of the rangeland. The low concentrate prices also have discouraged production of forage on the farm. Another negative effect is that health of the animals is poor, due to the low roughage content in their diets.

Table 2.6: JORDAN FEED RESOURCES

Resource	Area/ha	Production Ton DM	FU/kg	Million FU	%
A. Rangelands					
Steppe range*	1,000,000	1,000,00	0.8	40,000,000	
Desert (badia) range*	7,100,000	284,000	0.8	113,600,000	
Subtotal				153,600,000	31
B. Highlands					
Mountainous pasture	200,000	120,000	0.8	96,000,000	
Fallow and neglected lands	130,000	39,000	0.8	31,200,000	
Subtotal				127,200,000	25.7
C. Green Forage					
Clover	828	8,932	1.0	8,932,000	
Vetch	155	455	1.0	0,455,000	
Subtotal				9,387,000	1.80
D. Field Crops					
Wheat straw		55,000	0.65	35,750,000	
Barley straw		20,000	0.65	13,000,000	
Vetch straw = lentils		8,800	0.65	5,720,000	
Subtotal				54,470,000	11
E. Field Crop Grains					
Barley grains		24,000	1.0	24,000,000	
Vetch grains		3,270	1.0	3,270,000	
Maize		5,213	1.0	5,213,000	
Subtotal				32,483,000	6.55
F. Food Industry Byproducts (w. bran)		13,000	0.75	97,500,000	19.70
G. Other By-products		40,000	0.50	20,000,000	4.40
Total				494,640,000	

Source: Nabulsi, H. Mohamed, J. Nahleh. Management Systems of Sheep and Goats in Jordan, 1992.

* 50 percent utilization from rangeland dry matter production.

Total local resources of livestock feed are 494,640,000 FU; of which 417,840,000 FU are utilizable. Total livestock feed requirements are estimated to be 1,065,000,000 FU. The balance to be provided by imports is thus about 647,160,000 M tons of feed concentrates.

2.1.4 Livestock Resources

Population, Function, and Importance. The cattle population in Jordan is approximately 64,150 head, of which 81 percent are Friesians. The average number of cattle per holder is seven, and the total number of holders is about 9,156 families. Cattle production is concentrated in northwestern Jordan.

Based on the 1991 survey, the number of small ruminants in the country was 2.6 million sheep and 1.0 million goats. They are scattered from north to south, with a higher concentration in the Mafraq area.

The amount of subsidized feed distributed to the owners of cattle and small ruminants increased from 262,000 tons in 1988 to 444,000 tons in 1989.

The nomadic system includes 10 percent of the sheep and goat production in Jordan but only 5 percent of the herders. The transhumant system includes 70 percent of the national flock and the mixed farming or integrated sheep production includes 20 percent. The latter system is comprised of landowners and their families who get milk and meat for consumption from their sheep and goats. Feeding patterns are highly integrated with crop residue and forage production. This system is performed by about 8,000 herders. The last system is the lamb fattening system, which is done commercially by investors.

Red meat production comes from cattle, sheep, goats, and camels; and the total amount is estimated at 17,217 tons. Cattle provide about 1,000 tons; sheep provide about 5,000 tons from controlled slaughter, 3,700 tons for export, and 1,800 tons for family consumption; goats provide 2,700 tons for the market and home consumption. Only about 8,300 tons are marketed through controlled abattoirs. The average carcass weight of sheep increased from 13 to 18 kg from 1979 to 1988. The same trend was apparent for goat carcasses. The trend was opposite for cattle; on average, cattle carcasses weighed 130 kg in 1979, but only 30 kg in 1988.

Industrial poultry production is operated by the private sector, but the government is increasing its control by subsidizing the feed industry. There are about 3,000 farms producing 100,000 tons of broiler meat. The total number of broilers birds is about 16.7 million. The broiler farm capacity is about 6.18 million birds per batch with an average of 2.7 batches per year.

For egg production, there are 206 farms producing 723.6 million eggs from 4.021 million laying hens. The parent stock raising was 51 units producing 154 million eggs for broiler. The hatcheries increased to 39 units in 1991, producing 150 million one-day chicks.

The annual per capita consumption of livestock is estimated to be 17.0 kg of red meat, 29.5 kg of poultry, 113 eggs, and the equivalent of 54.5 kg of dairy products. The estimated production of red meat is 16,300 tons, the net import is about 37,000 tons, and the net export is about 3,670 tons. The net meat consumed represents a self-sufficiency of about 27 percent.

During the past decade, agriculture provided 8–9 percent of nominal GDP and employed a corresponding proportion of the Jordanian labor force. An estimate of the labor force composition indicated that agricultural guest workers numbered 50,000 and that the number of Jordanian nationals engaged in agriculture was only 37,500.

Although agriculture does not contribute as much to Jordan's national income as it does to the national income of other Arab countries, it is still very important because one-fifth of the population depends upon it for their livelihood. The government has three objectives in the agriculture sector. First, to protect and conserve, both environmentally and ecologically, an important economic resource. Second, to increase the return on investment in agricultural land and generate sufficient income to discourage rural to urban migration. Third, to increase the net income and growth from agriculture.

The agricultural GDP increased from 100 million JD in 1980 to 156.7 million JD in 1985. This increase came mainly from the livestock subsector (from 31.7 percent in 1980 to 46.5 percent in 1985) and was mainly the result of increased poultry and egg production. (Between 1975 and 1988 poultry and egg production increased by threefold and fivefold, respectively.) Red meat and milk production was 25.1 million JD and reached 26.9 million JD in 1989 (Strobel 1991). No trend was apparent in meat and milk production.

Animal production, especially small ruminants, is not only important in producing 93 percent of the red meat and about 42.8 percent of the milk, but also in integration with other sources of agriculture. It is important for the following reasons:

1. The grazing area utilized by this sector may not have alternative uses. It is very arid, can be used only by sheep, and represents about 92 percent of Jordan's land areas.

2. This sector utilizes crop residues and other agricultural by-products—feeds that can only be used by small ruminants.

3. The small ruminants provide fertilizer to the soil, which adds nutrients and minerals and enhances plant production.

4. The animals are a source of wealth for the people who own them. The fattening centers for lambs provide a cash source for those who earn their living from small ruminants.

5. Animal production also provides the nation with sources of proteins, mainly meat and milk.

Herd Structure. Herd structure is affected by many factors, the most important of which are the quality and quantity of feed available. This is especially true in the rangeland where sheep and goats depend on vegetation for 3-6 months. The sizes of flocks vary with the region and the season. Harb (1981) noted an average flock size of 155 animals in a special study that covered an area from Irbid to Karak. The ACSAD study in Houd-Hammad (1983) found that flock size varied with the season. The pure flocks, which contain only Awassi sheep, averaged 566 head in autumn and 497 head in spring. The mixed flocks, containing sheep and goats in the Hammad area, ranged from 474 head in autumn to 315 head in spring. The 1991 census performed by the Department of Statistics showed the flock size and their distribution differed according to Governorate, but the number of animals with highest percentage in sheep and goats were 10-20 and 50-90.

Nabulsi (1992) calculated an average flock size of 300 for the entire country.

The ACSAD study found that productive ewes accounted for 73-75 percent of the entire flock. Yearlings and ewe lambs made up 21-30 percent of the flock and rams about 5 percent, of which 2 percent were young rams.

The ACSAD study in the Hammad area found that the number of Baladi goats averaged 75-90 per flock.

Mature does ranged from 63 to 83 percent of the flock of which productive does ranged from 61 to 79 percent, yearlings (14-18 months) and doe kids (< 14 months) were 17-37 percent of the flock. It was found in the Al-Hammad study that 58-65 percent of flocks are composed of sheep only while 35-47 percent of flocks are composed of sheep, goats, and camels. The camels are found only in nomadic herds.

The number of ewes in a flock decreases during dry years and increases during good years; the percentage of decrease and increase depends upon the season. In a dry year more female lambs are sold, indicating that farmers are selling lambs to raise cash, save feed costs, and economize on the use of milk for lambs.

The percentage of mature ewes (1-2 years) differs from year to year according to pasture conditions and supplementary feeding. The percentage of milking ewes is usually about 90 percent of the mature ewes in the flock.

The flock structure in the village areas where the production is semi-intensive was investigated by Neshwat and Muhammed (1987). Most of the sheepowners in this system also own land. The area investigated, called the "Al-Hummran," is the land between the mountainous area and the Ghor Valley. The flock structure in the village area was as follows:

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Sheep	
	%
Rams	4
Ewes	79
Ewelambs and yearlings	17
Total	100

Goats	
	%
Bucks	5
Does	77
Doe kids and yearlings	17
Total	100

The barrenness of ewes has not been studied carefully in the area, but probably the percentage of ewes that fail to conceive over the breeding cycle is no more than 5-10 percent because farmers quickly identify these ewes and cull. Barrenness is usually higher in poor and drought years.

Sexual Maturity and Mating. Under range conditions, ewe lambs reach sexual maturity at an age of 14-18 months and at a body weight of 30-37 kg (60-65 percent the body weight of mature ewes). The first lambing of an Awassi ewe occurs at the age of 2 years. Under improved conditions (especially with good feeding) ewes could reach sexual maturity at 9-10 months and could lamb at 14-15 months of age (Kabbaz 1987; Termenini 1991).

The mating time for sheep is usually from mid-June to September, although this varies with the quality and quantity of available feed. If the growing season occurred early and good pasture exists, mating occurs from May to July. If pasture conditions are good, but growing did not occur until later, mating takes place from June to August. If the growing season was poor, if there is a drought, or if the season occurred very late, then mating occurs in August and September, although fertility is very low in these months. This fluctuation in mating season does not occur in flocks near agricultural lands, because the sheep can graze on stubble if natural vegetation is not sufficient.

Goats mate from July to October, camels from December to February. Rams usually mate with 25-30 ewes, male goats (bucks) with 25 females (does), and male camels with 50-60 females. The males stay with the females year round.

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Livestock mating in Jordan is natural; artificial insemination has never been practiced.

Animal Health. Health is a vital aspect of livestock production. The Ministry of Agriculture, through its Animal Health Department, has the responsibility for vaccinations for contagious diseases, diagnosis of diseases, provision of drugs, and safeguarding the general health of the national flocks through inspections and quarantine measures on imported livestock. There are critical constraints in the field of animal health, among them shortages of specialized human resources, facilities, and finances. In addition there are control and managerial constraints.

The new systems being developed for sheep and goat production, in particular, and the imbalances in diets that result, have aggravated the livestock's health problems. This situation necessitates a special effort to cope with the constraints and fill the gaps--whether human, physical, financial, or administrative. The private sector must be encouraged to increase its participation in livestock health activities. Currently, the private presence is good in poultry, fair in cattle, and poor in sheep and goats.

Table 2.7: Infectious Disease Infestation, 1991.

	Sheep	Goats
Number inspected	623,679	230,523
% diagnosed to suffer from:		
Anthrax	0.1	less than 0.1
Pox	0.2	0.4
Clostridia	1.1	0.5
Brucellosis	0.2	0.5
Cutaneous Postular Dermatitis	less than 0.1	less than 0.1
Foot and Mouth	less than 0.1	less than 0.1
Pasteurella	less than 0.1	0.1
	1.9	1.8

Source: Ministry of Agriculture, Animal Health Department.

Table 2.8: Noninfectious Disease Infestation, 1991.

	Sheep	Goats
Number inspected	623,679	230,523
% diagnosed to suffer from:		
Diarrhea (adults)	0.5	1.1
Diarrhea (young)	0.3	0.8
Intestinal parasites	4.3	3.7
Lungworm	9.0	11.0
Respiratory infections	2.5	1.9
Impaction	0.1	0.1
Poisoning	0.2	0.1
Foot rot	less than 0.1	less than 0.1
Arthritis	less than 0.1	0.1
Mastitis	0.3	0.5
Tick fever	3.5	8.2
Tick infestation	4.1	5.2
Lice infestation	4.5	6.6
Mange	0.9	0.6
	29.4	40.0

Source: MOA, A.H.D.

2.1.5 Human Resources

Jordan has a high annual population growth rate which reached 3.9 percent during 1980-1985 and 3.5 percent during 1991-1992. The estimated population of the East Bank was 2.67 million in 1985 and 3.5 million in 1992. Age composition showed a high percentage of young people (15 years and under), who constituted 50 percent of the total population and contributed to a high dependency ratio of 1:5, and an average family size of seven persons.

Another feature is uneven demographic distribution. The Amman and Zarqa governorates, with only 20 percent of the total area of the country had 56 percent of the population; while the Ma'an governorate, with about half the land area of all of Jordan, had a mere 3.5 percent. The high population growth in Jordan, which reflects the impact of mass migrations from Palestine, has exerted great pressure on agricultural land. Population density, which was less than 10 person/km^2 in 1961, rose to 29 person/km^2 in 1985.

Employment of Hired Labor. The total labor force in Jordan has been estimated at 216,9 thousand people or about 11.5 percent of the total population. Out of this number about 95.6 thousand people are engaged in agricultural production. Thus, agriculture provides

employment to about 44 percent of the total labor force in the country. However, the agricultural labor force consists of female labor, (34.2 percent) people below 18 years of age (3 percent) and 62.8 percent men.

There are two types of labor in agriculture: family and hired labor. The former type was estimated to account for 37 percent of the labor force while the latter provides 63 percent as shown in the table below.

Table 2.9: Distribution of labor force in agriculture.

Kind of Labor	Family Labor		Hired Labor		Total Number	% of Total
	Number	%	Number	%		
Percentage	9942	21.46	63321	80.44	73263	58.6
Temporary [a]	8007	17.29	7266	9.36	15373	12.3
Short Period [b]	28373	61.65	8033	10.2	36406	29.1

[a] Work less than 66 percent of the year.
[b] Work less than 33 percent of the year.

Most agricultural laborers are hired to work on irrigated lands, although there are no records to show the proportion of hired labor on irrigated and rainfed lands separately. On rainfed lands a substantial number of hired laborers are needed for harvesting growing low crops such as lentils, vetches, and chick peas.

2.2 Production and Distribution Systems

2.2.1 Sheep and Goats: Red Meat and Milk Production and Marketing

Meat Production. The production of red meat in Jordan has risen slowly from 6,936 tons in 1990 to 10,908 tons in 1991. Domestic production was about 24 percent of total red meat consumption from 1980 to 1988. The main source of red meat in Jordan is sheep and goats.

Lamb meat is available year round. The type of meat available varies with age of the lambs and with the ways lambs are reared.

The types of lamb and ewe meat available in Jordan include:

1. *Auzi Type*: Meat from lambs and kids that are slaughtered at very light weight (12-15 kg), usually before weaning. This type is available only in February and March, and the slaughtering is done outside slaughter houses because it is against the law at this light weight. People prefer this kind of lamb and will pay high prices for it.

2. *Weaned Lambs and Kids:* Lambs that have been weaned and given concentrates to supplement the grasses available in the range. Their weight ranges from 18 to 25 kg and they are sold in March, April, and May.

3. *Veal Type:* These lambs drank their mothers milk for five months and were also given concentrates. Their weight could reach 30 kg. This type of lamb is popular in Jordan and Syria.

4. *Fattened Lambs:* Specialized merchants (and some sheepowners) buy lambs at a light weight of 16-24 kg and fatten them for 60-90 days until they reach a weight of about 40 kg

5. *Culled Ewes and Does:* Sheepowners cull females of all ages year round, but particularly in summer. The quality of this type of meat is low.

Lamb fattening could rapidly increase Jordan's red meat production. Traditionally, lambs are produced on the range and are slaughtered at ages of 60-90 days, at live weights of 18-22 kg in good rainy years and 16-20 kg in bad dry years. All of these lambs have an inadequate finish and low body weight. Fattening techniques could maximize gains in weight and efficiency of feed. Two alternatives are available to the private sector to develop fattening enterprises: fattening on high-energy concentrate diets based on barley, and fattening on mixed pasture in rainfed areas.

Milking for the use of the family is done usually in the first 15 days after lambing because the ewes produce more milk than what their lambs need.

This practice is done by 34 percent of sheepowners (ACSAD, 1983) and by 50 percent of goat owners. However commercial milking does not commence until after weaning at the end of February and later. The ewes are milked twice daily: once in the morning and once in the evening, with about 7 hours between the two milkings. This procedure is reduced to one milking at the end of the lactation period.

The length of the milking period depends upon many factors, but the main factor is the season. It may last for 2-3 months in poor seasons and it may last for 4 to 5 months in good range conditions and in ewes and does lambing early.

The Awassi ewes who are living under extensive conditions have good genetic potential to increase milk production if feeding and genetic selection are improved and practiced. The ewes are milked as a group system. The sheep are joined together into two opposite lines. A rope is placed around their necks on what is called "Shebak" in Arabic. The dry ewes are usually removed from the rope. The does and camels are usually ilked individually. The milking is done by hand and the milk is collected in cooking containers. The women usually do the milking, but they may be helped by the shepherds. Milking could be made more sanitary by cleaning the utensils and the udder before milk collection.

The amount of milk begins to decline in May or June as the grasses start to get dry. As volume falls, the milkings are reduced to one per day, and as the ewes reach 100-200 ml they are reduced to one milking every 2-3 days until they dry completely. Although this is done on most of the ewes and does, some does milk much longer—if thy are big producers.

The milk is sold fresh to cheese merchants or processed into yoghurt, ghee, and gameed. Milk sales contribute substantially toward paying the debts incurred from buying winter feed for the ewes. The selling usually starts in March for flocks which are near city centers. However, for the flocks in the Badia region and far from city centers, the milk is processed into dried yoghurt (Gameed) and ghee. Part of these processed products will be used by the family but the remainder will be sold.

Milk production. The amount of milk produced by Awassi ewes in Jordan has been estimated by Gharaibeh et al. 1974. He found that the amount of commercial milk, other than that used by the lamb, was around 57 Kg for the whole lactation period of around 114 days. Average milk production per day was around 0.53 Kg.

Marketing of Animals and Animal Products. The red meat supply in Jordan depends upon the availability of sheep and goats, which fluctuates from day to day and seasonally. The wide seasonal fluctuations result in broad variations in livestock supplies and prices.

As it begins raining, herders move to the eastern parts of the country, far from the regular markets. The regular marketing time for most lambs from the range begins in late of February and ends in July. Kids and goats are marketed throughout the year.

Most lambs are sold to roaming merchants on the range, others are sold in markets. Those sold on the range usually have a live weight of 18–22 kg, and the prices paid by the merchants depend upon the season and the age of the lambs.

Most cities in Jordan have markets with pens to hold the animals, although the buying and selling takes place in open, unfenced areas.

Amman's livestock market, located 20 km south of Amman at Sahab, is used mainly by merchants and commission agents, who must often purchase stock on a per-head basis, although they may also buy them on the basis of weight. The merchants and agents sell the animals to wholesale butchers at a price of at least 0.3 JD per head. Usually the agents and merchants are wealthy enough that they can pay the sheepowners immediately, and can also allow the butchers to pay on a 10-day credit basis.

The wholesale butchers or merchants in the city markets keep, feed, and water the animals before they slaughter them. Therefore, they effect the quality of the lambs that are sent to the slaughterhouse. Slaughtering is done by specialized slaughter men who work on a per-head basis.

All large towns in Jordan have slaughtering facilities (abattoirs). The Amman central abattoir is the largest, followed by Zarka, Karak, Irbid, Ma'an, and Jerash. The abattoirs are similar except in the number of animals they can slaughter and the facilities available.

The Amman abattoir can handle sheep, goats, cattle, and poultry. Its capacity is about 5,000 head of small ruminants and 1,800 larger animals or a combination, on a ratio of three small ruminants to one large animal. The abattoir is opens five days a week and closed for two days (Thursday and Friday). The facilities in the abattoir, which include storage and inspection of chilled meat, stay open all the time.

Inspections are carried out by veterinarians who also determine the quality of the meat before it is sent to retail butchers. All carcasses are stamped and marked and held at 0-4°C in storage for up to 12 hours. The slaughter of domestic female sheep is forbidden by law. The charges by the abattoirs are as follows:

Sheep and goats	0.6 JD per head
Cattle	3.2 JD per head
Camels	4.2 JD per head

The marketing channels for the local production of red meat are shown in Figure 2.1. Figure 2.2 shows the marketing channels for all red meat, both imported and produced locally.

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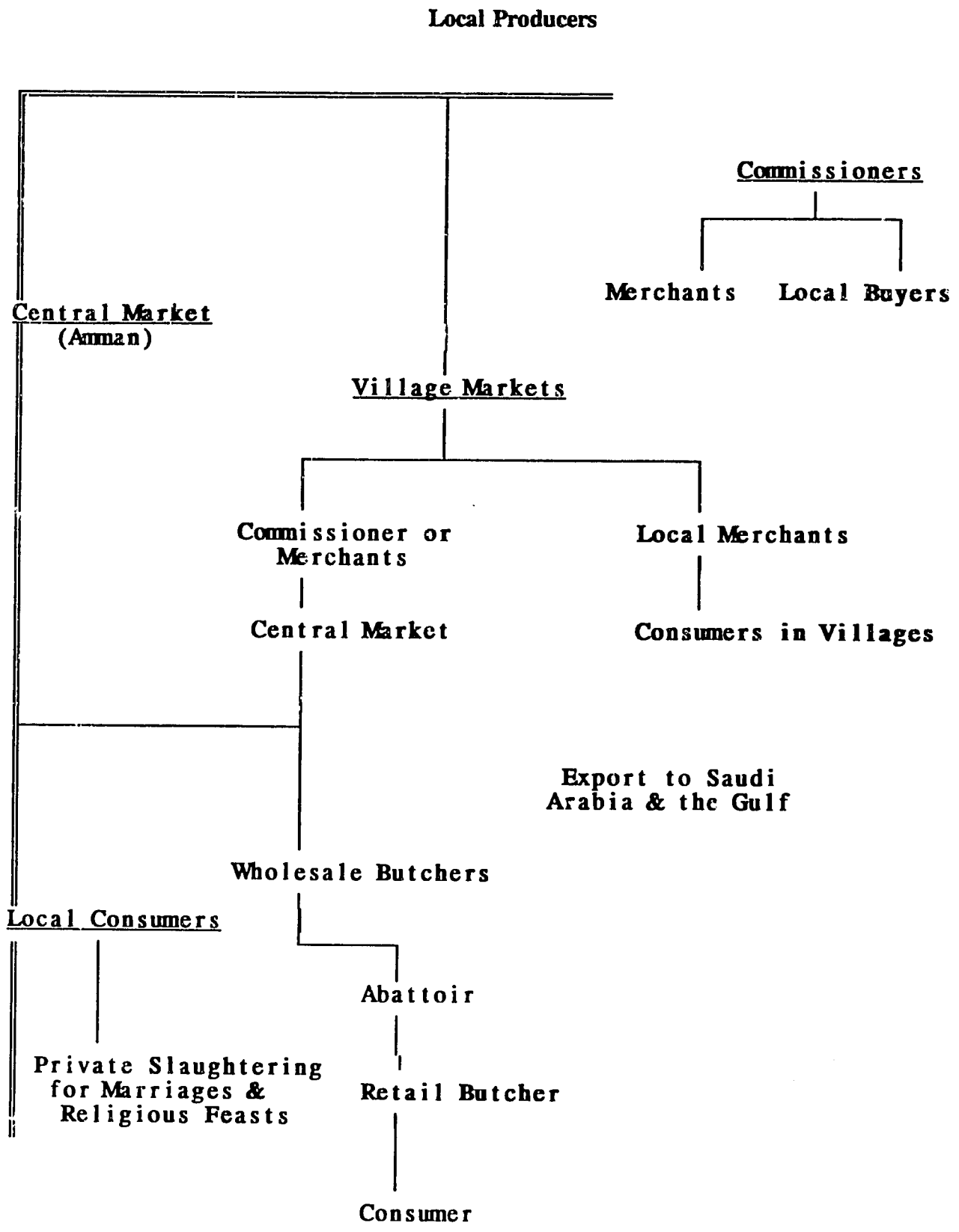

Figure 2.1: Marketing channel for local red meat production in Jordan.

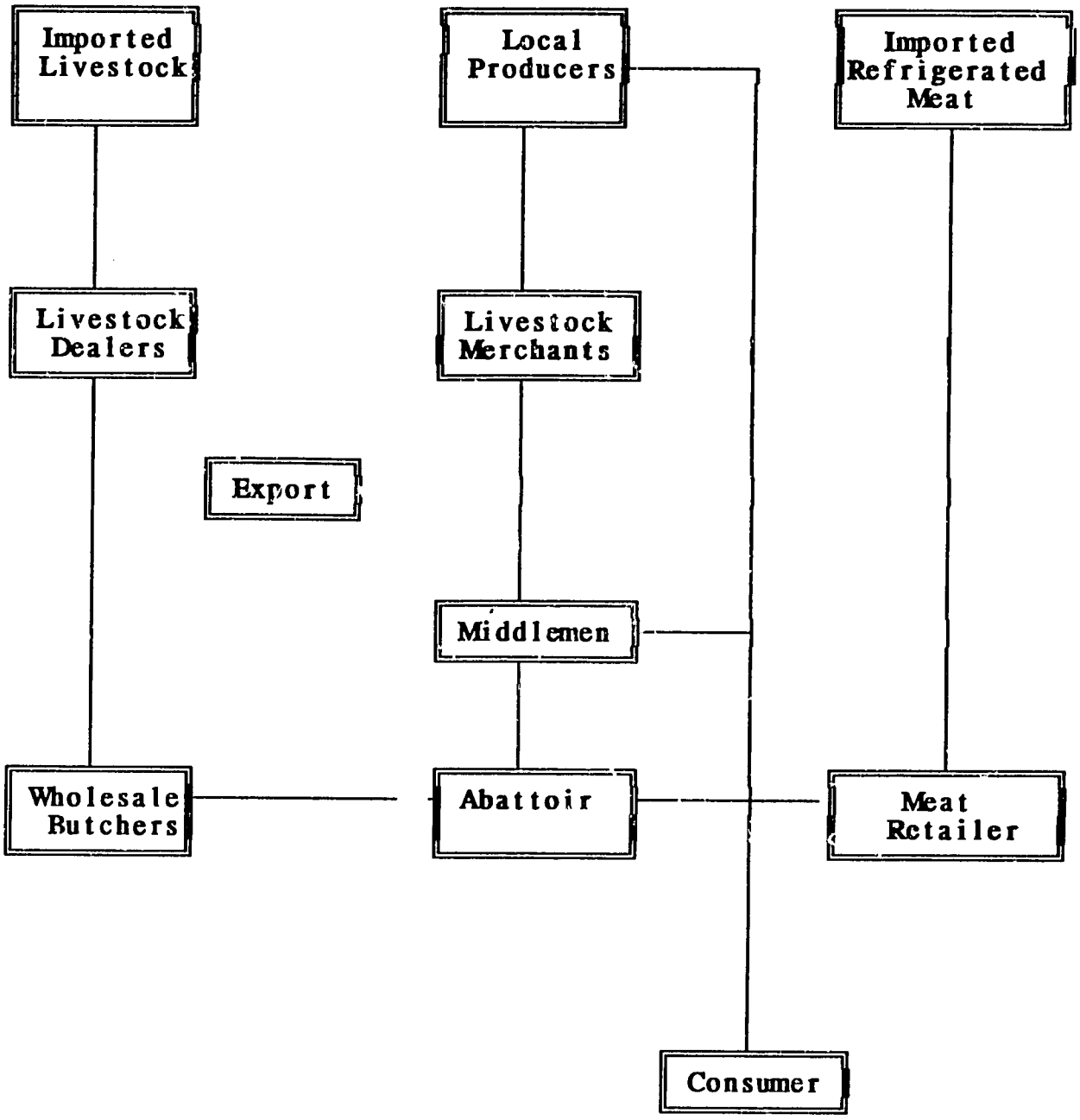

Figure 2.2: Marketing channels for local and imported red meat in Jordan

The estimates of costs and margins of marketing lamb meat were estimated by Harb and Karabliah (1990) as follows:

• The average live weight of lambs sold	22–25 kg.
• Price/kg live weight	1.6 JD/kg
• Total money paid/lamb	35.2–40 JD
• Carcass weight	50% of live weight
• Liver price/kg	2.5 JD
• Head, rumen, intestine price	1.0 JD
• Hide price	0.5 JD
• Transportation cost/head, farm to market	0.3 JD
• Feeding in abattoir (2–7 days)	0.8 JD
• Transportation cost, market to abattoir	0.3 JD
• Cost of slaughtering, municipality storing and loading	0.85 JD
• Money paid by retail butcher	35-40 Kg
• Consumer price	3.8–4.0 JD
• Weight of carcass	11-13 Kg
• Total charge paid by retail butchers	47.5 JD
• Cost/kg by retail butcher	3.1 JD
• Consumer price/kg	3.8 JD
• Percent of profit	18%

According to Nabulsi (1992) the sale of milk represents about one fourth of the total revenue from sheep flocks. The fresh milk is either sold to cheese makers or is used for manufacturing ghee and dried laban (gameed) by the sheep owners. The cheese makers take the fresh milk twice daily and process it into cheese. Every 4.5 kg of fresh milk can produce 1 kg of boiled cheese. In the range, where it is difficult for the cheese makers to reach the flocks, the sheep owners use the milk to manufacture ghee and gameed. Every 18 kg of ewe's milk can produce 1 kg of ghee and Kg of gameed. Milk and its products are sold at higher prices in drought years.

After shearing wool is sold to roaming merchants and the price is given according to each clip. The shearing happens at the beginning of summer and the wool is sold immediately. The average price per kg of greasy wool is about 0.7 JD.

2.2.2 Dairy Production and Marketing

Milk production in Jordan, using sheep (31 percent), goats (18 percent), and dairy cows (51 percent), is approximately 80,000 tons. The contribution of sheep and goats is considered low relative to their numbers, which may be due to the inadequate feeding of flocks, especially on the range. The local milk produced by Baladi cows is usually consumed at the village level; very little reaches the market. Sheep milk is used mainly for cheese, ghees, and dried laban (gameed).

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Holstein Friesian cows provide about 45 percent of all milk produced in Jordan, and this share will increase in the future. There are 561 dairy farms in Jordan (Table 2.10). One of the main centers is the Dulil area, north of Zarqa, where there is a dairy cooperative that feeds cows and markets raw milk. In this area there is an average of 46 cows per farm. In the rainfed area the average is 5–10 cows per farm. In the Ghor Valley, farmers with cows depend upon vegetable by-products as a source of forage.

Most cows in Jordan are imported from Europe at an age of 2–3 years, and they are usually pregnant. Heifers growing as replacements was not the norm in dairy production in Jordan. This will change as the price pregnant heifer is becoming around 1,000 JD/animal.

A look at the Friesian cows in Jordan showed that the Amman, Zarqa, and Irbid areas have about 90 percent of all farms. Irbid is taking the lead and about 38.5 percent of dairy cows are in that area. (Table 2.11).

Milk production in 1991 totalled 156,623 tons, while 101,957 tons were imported. Thus, self-sufficiency in milk and milk products was about 60.5 percent. Average annual per capita consumption of milk is about 69.8 kg.

The increase in milk production is coming from cows and not from ewes (Hall 1990). Dairy production is increasing, which has caused a problem, since more is produced than is needed for consumption. The dairy factories prefer using imported skimmed milk instead of fresh milk. The government enforces the use of fresh milk for the production of laban.

Imports of milk and milk products in 1988 totaled 16.32 million JD, which accounted for about 9 percent of all expenses for food and feed imported in to Jordan.

Table 2.10: Numbers of dairy farms in the Kingdom 1987-1991

Years	Licensed Farms	Non-Licensed farms
1987	78	123
1988	120	153
1989	187	158
1990	229	472
1991	209	352

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Table 2.11: Distribution of dairy cows in Jordan

Categories	Licensed Farms	% from all Licensed Farms
1 - 10	4	4.0
11 - 20	15	15.2
21 - 30	15	15.2
31 - 50	24	24.2
51 - 70	14	14.2
71 - 100	16	16.2
101 - 150	6	6.0
151 - 200	2	2.0
> 200	3	3.0

Most milk is marketed through one of four channels:

- Cooperative and private factories
- Manual factories
- Salesmen who manufacture cheese
- Selling popular products such as gameed to homes

Each channel is important. Cooperative and private factories can process about 148 tons of milk per day, but they usually operate at one-third to one-half capacity. Manual factories used to handle one-half of the milk produced, but this has decreased in recent years due to health problems and hygiene standards. Manual processors used to produce very high-quality products that were popular with consumers.

The merchants who sell cheese follow sheep flocks and buy milk from the herders to make cheese. Home selling is direct selling by the farmer to consumers. This is a common practice on dairy farms with fewer than five cows. This milk is usually turned into laban and labneh by housewives.

Transportation, Cooling, and Hygiene in Milk Production. The cows are milked semi-automatically, manually or automatically. Usually the udder is cleaned before collection. The milk is cooled in a cobbler in big farms, but this can't be done in small farms due to the lack of coolers.

Another limiting factor is the lack of an organization to collect the milk. The cooperative in Dulil area faced a lot of difficulty in collection because the farmers usually milked the cows which had been injected with antibiotics.

The milk collected from sheep should be pasteurized so that it is safe because Brucella infection is widespread among sheep.

Licensing of collection centers could promote cleanliness and hygienic handling of milk in Jordan, and cooperatives could operate these centers.

Governmental Policies in the Dairy Industry. Actions by the government that affect the price of milk products are concentrated in four areas:

- Cooperatives and feed industry
- Licensing dairy farms
- Pricing policy
- Importation of powder milk and cheese

The government has distributed barley and wheat bran since the early 1980s. However, this activity only became a burden when the Jordanian Dinar was devalued. The subsidy was evaluated in the cooperatives which are dealing with cows are five in Dulil, Balka, Irbid, Jerash and Maddaba. These cooperatives provide dairy mixed rations and are responsible for marketing milk. Some have factories to produce milk, homogenize milk, and process milk products. The cooperatives distribute the mixed concentrate rations, adding 3 JD/ton as profit for marketing. If the cooperative does this job, they charge the cooperative member 10 fils/kg of milk for marketing. The role of cooperatives in preparing the rations and marketing the milk is going to increase as dependence on local production increases.

The licensing of dairy farms by the government does not rely on any policy. This licensing should be encouraged, especially by investors who have land and water. They should be encouraged to produce the needed forage for dairy cows.

Pricing Policy of Milk. The pricing of milk in Jordan faces many difficulties. First, there is competition from EEC subsidized powdered milk; second, the factories of Jordan prefer powdered milk because the marginal profit is much higher than what they get from using fresh milk. The third factor which affects the price of milk are the prices of concentrates and the shortage of roughage. The Ministry of Supply is responsible for pricing milk. This ministry is very sensitive to consumers' demands and less sensitive producers' demands. The above reasons indicate that the price of milk will always remain high.

Powdered milk is taxed at 38 percent, while white cheese is taxed at about 25 percent. Any cancellation of the powdered milk import tax may cause the dairy production industry to collapse.

The factor which affects milk pricing the most is the production of the cows. It is estimated that the average cow produces about 4000 kg/year.

2.2.3 Broiler Production and Marketing

Broiler production in Jordan began around 1960, but its real development occurred in the 1970s. The broiler industry was developed by the private sector. Several factors were responsible for its development:

- Low production and high price of red meat in the market.
- The increase of consumption due to high income in the 1970s and 1980s and the increase in population.
- Good economic returns and the very high turnover of these projects.
- High technological development in this industry in the nutrition, management and health fields.
- Government assistance in providing loans for these projects.
- Small areas were needed for these projects.

White meat production total about 65,000 tons in 1988. The amount of meat depend upon the number of broiler, weight, number and cycles is around 4.2 per year in Jordan.

Average annual white meat consumption was 76,000 tons (5,000 tons from laying hens), which means that 11,000 tons were imported and kept by the Ministry of Supply in its stores, to be offered in the market when there was a shortage of domestic white meat. The average annual per capita consumption was 31.9 kg. The average consumption was higher (35 kg) for low-income people and for those spending less than 600 JD per year. The average consumption total for the coming years have been estimated in table form to facilitate planning in the veterinary and extension services. New abattoirs and cold storage facilities will be needed as consumption increases in the future.

Table 2.12: White Meat Production in Jordan

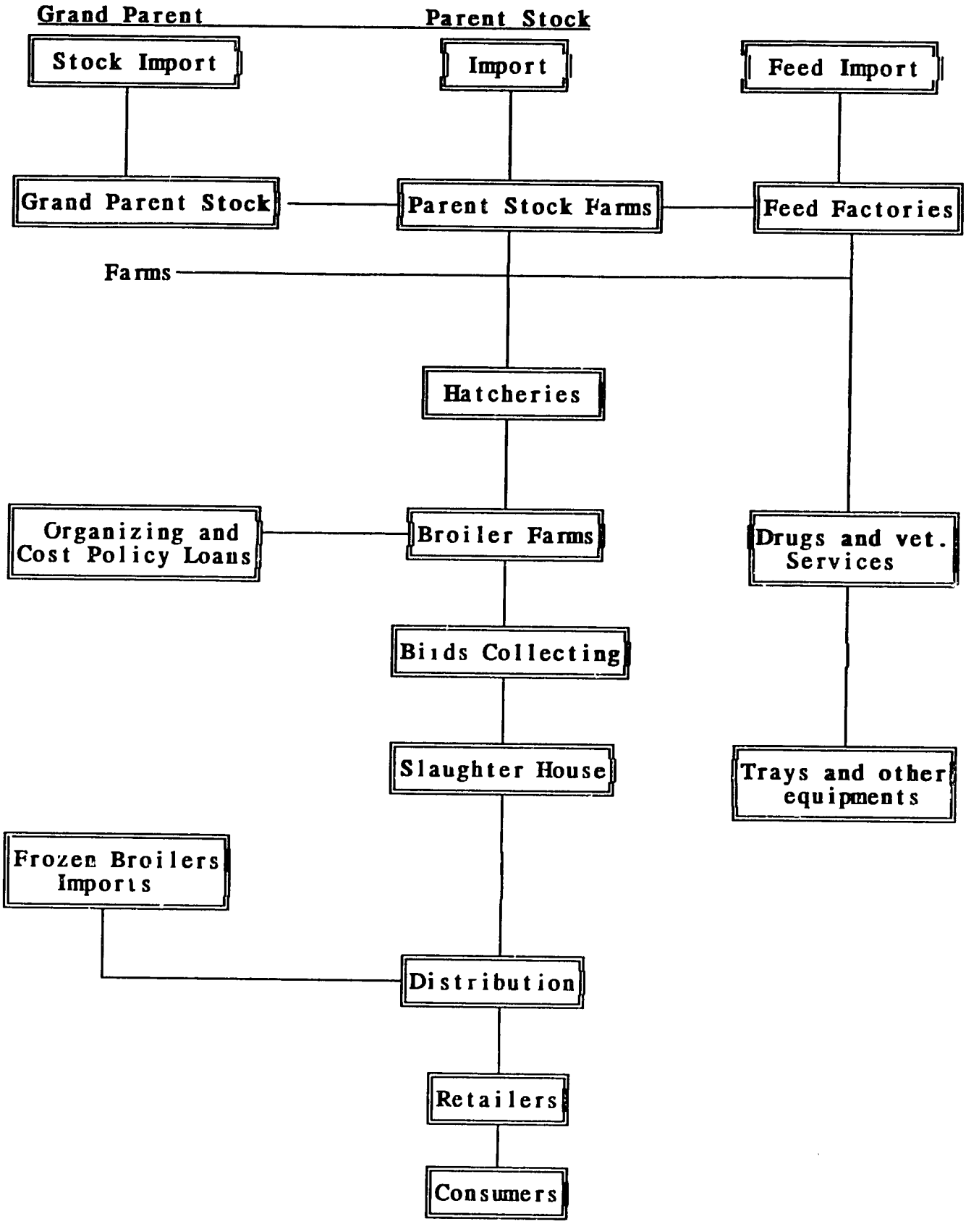
Number of broiler farms in Jordan	1360
Average size of farms	9000 birds/cycle
Total bird production per cycle	12.3 millions
Number of cycles per year	4.2 cycles
Total bird production per year	51.66 birds
Mortality rate (%)	8 %
Average number of broilers living	47.52 millions
Average weight of animals	1.6 kg/bird
Carcass white meat (%)	75 %
White meat production (tons)	64,160

Source: MOA. Animal Production and Health Directorate Statistical year book 1988

Production System. The broiler houses are open. They are 50-100 meters long, 12 meters or less in width, and 2.75-3.25 meters high. The poultry is raised on the floor, and sawdust is used as bedding. Ventilation is controlled by closing or opening the windows.

Chicks are fed and managed for 50-55, days when they reach a live weight of 1.5-1.75 kg. This permits about 5.5 cycles per year. The system of broiler meat production is detailed in Table 2.15. The poultry production scheme is shown in Figure 2.3.

Figure 2.3: Poultry Production Scheme

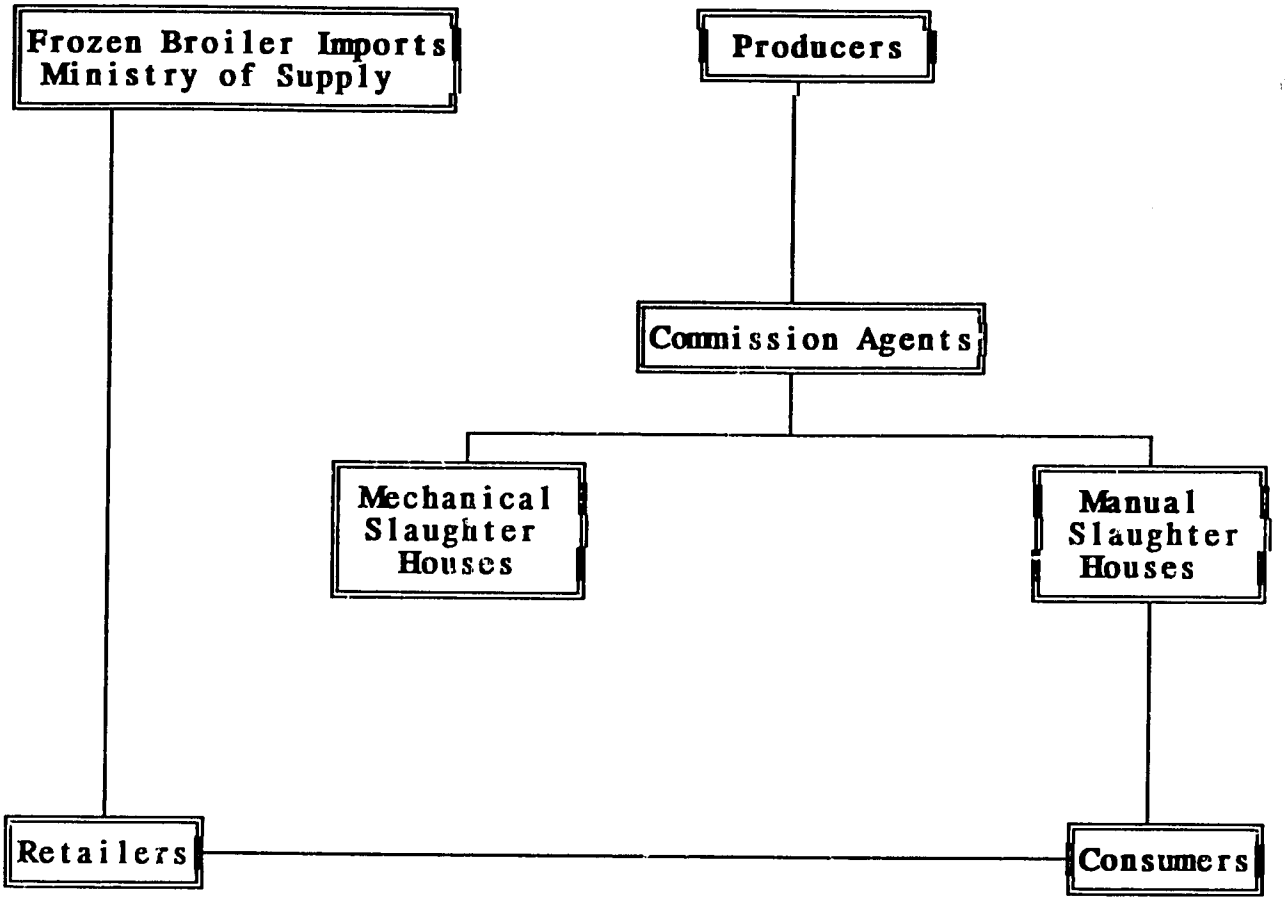


Marketing of Broiler Meat. When broiler chicks reach a weight of 1.5–1.75 kg (about 50–60 days old) they are sold to middlemen, who work independently or as agents for wholesale merchants. The birds are then sent to abattoirs, distributed to retailers, and then are available to consumers. In some cases the middlemen will sell to owners of defeathering machines who in turn sell directly to consumers. Defeathering shops are considered unhygienic.

Frozen broiler meat is also imported by the government. The Ministry of Supply is responsible for importing white meat. It has coolers and freezers with a capacity of 11,000 tons, and generally it keeps this amount in its stores. Figure 2.4 shows the marketing channels for broilers in Jordan.

There are about 100 middlemen in Jordan, who are also sometimes be responsible for the feed and chicks given to the farmer. Farmers (producers) may have little influence in the decision-making processes, and the middlemen can thus reap significantly higher profits than the farmers.

Figure 2.4: Marketing Channels of Broilers



Farmers suffer significant losses from weighing of poultry by middlemen, especially since 85 percent of the farmers' products go through middlemen.

The abattoir, the next stage in the marketing channel, is the most important because this is where the broilers are slaughtered, processed, and cooled or frozen. One of the major problems facing the poultry industry in Jordan is that the abattoirs cannot satisfy the market. This inadequacy, plus the lack of freezer space to keep extra meat (to be used when supply is low) has led to the establishment of defeathering shops in towns and villages.

The abattoirs in Jordan are government-owned, but there is talk of privatizing them and having government agencies be responsible for their hygienic operation. The two largest abattoirs are in Amman and Dulil; there is one small abattoir in Irbid but it is not operating. The Amman and Dulil facilities can handle 8.1 million birds per year, but only the Dulil abattoir can freeze the products. The abattoirs charge about 40 fils per bird for slaughtering, cooling, and storing for 12--24 hours.

The quality of the products in the Dulil abattoir is high, while that in Amman is medium, and the processing, chilling, transportation, and packing are not up to international standards.

The marketing channel lacks the necessary chilling and freezing space. The freezer capacity of the Ministry of Supply is 11,000 tons (7,500 tons in Amman, 1,500 tons in Aqaba, and 2,000 tons in Irbid) (Hall 1990).

Retail shops are the last step in the marketing channel. The broilers are sold to grocery shops and supermarkets whether they come from abattoirs or from defeathering machine shops.

Marketing Margins in Broiler Production. The marginal costs and marketing costs has been estimated recently. The data show that:

- The farmer receives about 0.69 JD for each JD the consumer spends on 1 kg of white meat.
- The loss due to feather and blood removal is estimated to be about 15 percent of the money paid by the consumer.
- The marginal cost for the retailer is not as high as the marginal cost for the wholesaler.
- The cost of transportation, and storage is considered high when compared to other if we consider that most middlemen have their own transportation.

The government's policy in the broiler industry is to:

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- Help the industry produce enough white meat to have self-sufficiency in both of these two products (boilers and eggs).

- Apply the latest new technology in the broiler and laying hen industry to increase protein sources and thus reduce demand for red meat.

- Raise the standard of living for the people working in this industry.

- Provide poor people with a cheap source of protein by producing enough white meat and eggs at reasonable prices to the consumer.

- Protect the poultry industry from imported frozen broiler meat.

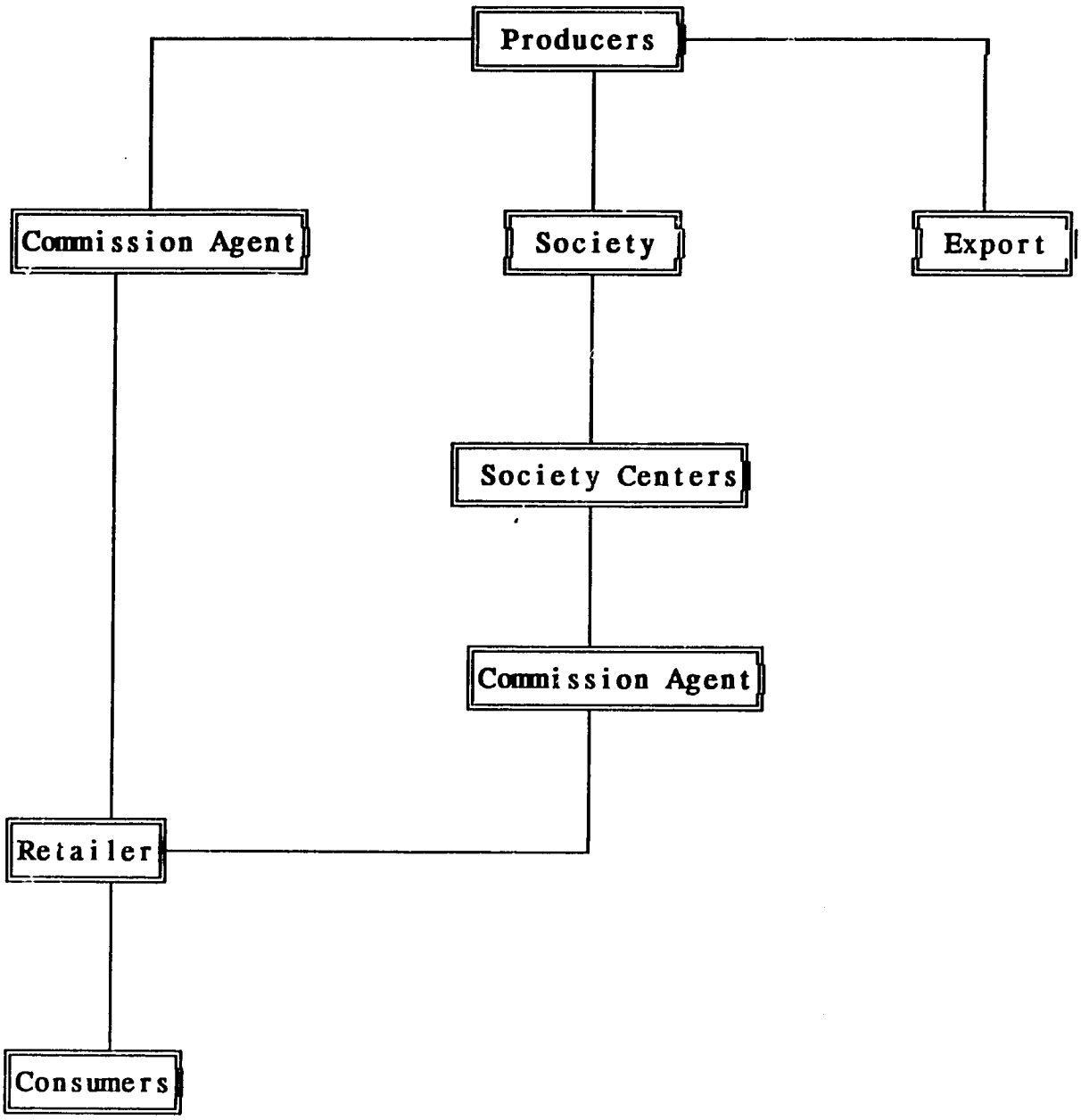
2.2.4 Egg Production and Marketing

Two methods are used to produce eggs in Jordan: in one, the birds live in the litter houses; in the other; the birds are raised in cages. The second method is highly technical. There are 206 farms producing about 323.6 million eggs in Jordan.

The export of eggs should not be a policy aim, because Jordanian eggs cannot compete at world market prices because all the ingredients in the poultry rations are imported.

The marketing channel is shown in Figure 2.5. Marketing of eggs is controlled by the Jordanian Cooperative. The problem facing egg production and marketing is the over production of eggs, which reached around 95 million in 1987.

Figure 2.5: Egg Marketing Channels



2.3 Institutional Framework

2.3.1 Organizations Involved in Agriculture

The roles of the numerous institutions and agencies involved in agriculture and agricultural development in Jordan are not well defined, which leads to overlapping areas of responsibility and inconsistent decisions. The absence of a documented agricultural policy exacerbates this situation.

Ministry of Agriculture: Responsible for the agriculture sector according to Law No. 20, which was enacted in 1973.

Ministry of Supply: Responsible for provision and pricing of foodstuffs. Also involved with import of feed and feed concentrates for livestock and with import of wheat, red meat, broiler meat, olive oil, rice, and sugar. Sets the prices for agricultural products such as cereal grains, legume grains, milk, some dairy products, imported olive oil, and imported meat.

Ministry of Water and Irrigation: Sets water policy and issues licenses for development and use of groundwater resources for all purposes, including agriculture. Responsible for construction and administration of dams. Sets prices for drinking water and administers its supply and distribution.

Ministry of Industry and Trade: Issues licenses for import and export of agricultural products (of plant or animal origin), and agricultural machinery and equipment.

Ministry of Planning: Responsible for the study and design of development plans and financing and agreements with other governments for projects and loans.

Ministry of Finance: Involved with the agricultural budget. Sets taxes on imports of agricultural inputs and administers the Department of Land and Survey.

Agricultural Credit Corporation (ACC): An autonomous governmental agency with the Minister of Agriculture presiding on its board. Through ACC the government assists in providing soft loans from foreign governments and agencies and from the Central Bank of Jordan.

Agricultural Marketing Organization (AMO): A governmental organization with the Minister of Agriculture presiding on its board. Responsible for development and control of marketing activities, including packaging and specification.

Agricultural Marketing and Processing Company (AMPCO): A governmental organization which evolved from a mixed company. Has commercial activities in agricultural commodities, some of which are monopolistic in nature. Responsible for processing agricultural products, but currently restricted to tomato processing.

Farmer's Union in the Jordan Valley: Established in 1974, this union is restricted to the Jordan Valley. Active in the provision of inputs and seasonal credit.

Many farmers in Jordan favor a national farmers' union. Meetings on this issue took place with the Minister of Agriculture and the Prime Minister, and a law is purportedly being drafted.

Jordan Valley Authority (JVA): Strong organization with great influence and importance in agricultural development in the Jordan Valley, the area that was given the highest priority in agricultural development. Has power over land use, water use, water projects, social and economic development, as well as infrastructure control.

The Jordan Cooperative Organization (JCO): National-level coordinating organization that represents cooperative societies, both agricultural and nonagricultural. Although nongovernmental by law, it is highly influenced by the government, because five of the eleven board members are government officials and the government makes decisions on credit matters.

Has its own bank and training institute. Administers seed multiplication for cereals and legumes, and machinery stations for dry farming. Provides agricultural inputs for its member societies. Also rehabilitates rangeland reserve, with assistance from the World Food Programme (WFP).

Educational and Training Organizations: There are three colleges of agriculture in Jordan.

- University of Jordan (established in 1973) qualifies students for a B.S. or M.S. in agriculture.
- Jordan University of Science and Technology (JUST) for agriculture and veterinary medicine. Its first graduates will graduate in 1993.
- Muta University in Karak Governorate in Southern Jordan will be the site of another agriculture college.
- There are two high-school-level vocational agricultural schools. Graduates receive a high school diploma certificate.

Royal Society for Environmental Protection: Concerned with wildlife and administers natural reserves, which serve as examples of what can result if rangeland is protected and allowed to "rest."

Private Sector Bodies: There are many private sector bodies that have input into agricultural development and production (e.g., Farmers Union). Many guilds and companies have members that work in agricultural inputs, trade, seeds, pesticides, herbicides, medicines, marketing, etc.

Other private sector inputs come from chambers of commerce, industries, agricultural engineers, and veterinarians.

High Council for Science & Technology (HCST): Responsible for the general policy on science and technology, one of its sectors is agriculture. It has a sectoral technical committee for agriculture, and agricultural research is supposed to come under its umbrella.

All of the above organizations have input or interest in the agricultural sector, but the Ministry of Agriculture has primary responsibility for developing and leading the agricultural sector in the country. The MOA is headed by the minister, who has a secretary general and assistants to help him. There are 13 central directorates and 19 directorates outside the center that cover all parts of the country. NCARTT is also an agency of the MOA.

The real problem is the question related of the role of the Ministry of Agriculture. The multiplicity of organizations in the agricultural sector leads to duality, waste, overlapping responsibilities, and contradictory policies and activities The cause of the problem is the absence of clear goals, coordinated policies and strategies, and well-defined roles and responsibilities. Once clear roles and functions of different institutions have been defined coordination procedures have been implemented to guarantee the harmony of work and compatibility of results, the above-mentioned shortcomings should disappear. This leads to the relevant question of the role of the Ministry. Is it service or production or policy making including planning, control, monitoring, and evaluation? If the answer is the first or the second or both, with or without the third, the problem will not be solved.

The second point concerns consolidation of the agricultural sector under the leadership of the Ministry of Agriculture. The MOA should have complete responsibility and authority over all agricultural matters, nonurban land, and irrigation water. It should also have a say in matters that affect agriculture but that fall under the jurisdiction of other ministries and institutions. These include customs, imports, exports, licenses, specifications related to agriculture or agricultural materials, and commodities.

In addition to the government's impact on agricultural development, private sector participation must also be considered when making important decisions and implementing them. The Farmer's Union is at the top of the list; others include traders of commodities and materials related to agriculture, consumers, and environmentalists.

2.3.2 Legal Framework and Regulations

The Ministry of Agriculture is authorized by the extensive statute Agriculture Law No. 20 of 1973, but none of the law's provisions convey comprehensive authority to allocate land for priority uses.[1]

The Ministry of Agriculture is responsible for the administration of rangelands, or grazing lands, which are defined by statute as those that receive less than 200mm of rainfall per year. The Minister of Agriculture has the right to issue regulations to develop and protect grazing lands, to specify the number and type of animals allowed to graze, and to protect the natural environment.[2]

Analysis of the laws that have implications for livestock subsector development policy formulation suggest that:

1. The legislation that defines the role, responsibility, authority, and mandate of the Ministry of Agriculture exists, but the law needs to be clarified.

2. The Ministry of Agriculture may lack authority to enforce a land use policy stating that land resources will be developed and utilized for the most economically productive integrated crop-livestock, crop-forestry-livestock, and forestry-livestock production systems.

3. The Ministry of Agriculture may lack authority to enforce a land use policy stating that dryland resources will be used with farming systems that conserve and improve these land, vegetation cover, water, and human resources.

4. The Ministry of Agriculture has the authority to implement a policy stating that natural grazing resources will be rehabilitated and managed to achieve a high level of sustainable livestock production and productivity within the potential capacity of those feed resources.

The Water Authority of Jordan (WAJ), within the Ministry of Water and Irrigation, operates under its mandate in Water Law No. 18 of 1988. It controls the allocation of all water outside the Jordan Valley, and the drilling, extraction, and use of ground water in Jordan. The

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[1] Trick, P.B. April 27, 1992. analysis of Jordanian Laws and Institutions. Project in Development and the Environment (PRIDE) Technical Report #2. USAID, Amman, Jordan, 59 + 2 pp. Page 18. Section 2.b: Legal Authority for Land Use Management.

[2] Trick, P.B., 1992, p.18.

WAJ drills, operates, and maintains wells that supply public drinking water, and distributes the water throughout Jordan.[3]

2.3.3 Structural Adjustment Program Requirements

In April 1989 the Government of Jordan concluded a five-year structural readjustment package with the IMF. The timing of this package was undermined by the Gulf war, however, and a second agreement was reached in October 1991. The aim of this agreement was to reduce public expenditure in seven years from 44.4 percent of gross domestic product (GDP) to 30 percent. The structural adjustment prescription aims to cut foreign and domestic borrowing from 10.6 percent of GDP to 3.5 percent in 1989.[4]

Implications for the livestock subsector development policy analysis and formulation are the following:

1. The government will be more selective in the agreements it makes with foreign donors for assistance in new livestock development projects and the associated covenants committing public sector funds. This means fewer new projects, and smaller projects.

2. To increase self-sufficiency in milk and milk products, the export-import trade policy for dairy products must support this objective, and the tariffs on milk powder and white cheese must remain.

   The International Monetary Fund/World Bank structural adjustment program, however, requires an open trade policy to support the strategy of market-led growth and modernization. Trade policy for dairy products, therefore, and indeed for other livestock and poultry products, is a key issue.

3. The Government of Jordan has agreed under the IMF Standby Arrangement program to phase out producer and input subsidies on cereals over the 1993-1995 period. The continued action on phasing out producer and input subsidies on cereals may be a component of the pipeline project Agriculture Sector Adjustment Loan from the World Bank.

   The government's importation and distribution of feed concentrates (barley, sorghum, wheat bran) at a subsidized price is a key issue.

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[3] Trick, P.B., 1992 pp. 15-16.

[4] Economist Intelligence Unit. 1992. Jordan Country profile 1992-1993. Annual Survey of Political and Economic Background. Page 12. Business International Ltd.

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4. A national water resources policy is needed to guide strategy development and research in agriculture. The preparation of such a water policy may be a component of the pipeline project Agriculture Sector Adjustment Loan from the World Bank.

The water resources policy recommended in this report for the integrated livestock production subsector is the following: The equitable allocation of water resources for irrigated agriculture shall include the requirements of livestock agriculture.

5. An objective of the Agriculture Sector Adjustment Loan from the World Bank may be to reduce government intervention in the agricultural sector to the minimum level necessary to ensure efficient essential services.

This objective would be complementary to a livestock development policy stating that the role of the private sector in providing livestock production, processing, and marketing support services will be increased relative to the role of government.

There are preliminary positive indications that a livestock extension service, together with the necessary linked livestock research program, may have been assessed and ranked as an essential public sector service.[5] The details of how to transform donor willingness to support such a project into an efficient, cost-effective, and thriving extension service have yet to be worked out. Nevertheless, the prospect is encouraging for livestock subsector development.

A component of the pipelines project may be an assessment of the cooperative movement and system, and preparation of a restructuring plan.

2.4 National and Regional Roles

2.4.1 Economic Role of the Livestock Subsector

The contribution of the agricultural sector to the national economy was about 5-6 percent of gross domestic product over the period 1985-1989.[6] The ratio of the contribution of livestock relative to crops over the same period was about 52 percent: 48 percent of value of production intermediate consumption.[7]

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[5] World Bank. March 1993. Preparation Mission for Proposed Agricultural Sector Adjustment Loan.

[6] Ministry of Agriculture, Agricultural Policy Department. 1992. The Agricultural Sector in Jordan Figures and Facts. By Majed Zakaria & Eman Hwaiadi.

[7] Ministry of Agriculture, Agricultural Policy Department. 1992. The Agricultural Sector in Jordan Figures and Facts. By Majed Zakaria & Eman Hwaiadi.

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2.4.2 Supply of and Demand for Livestock Products

Red Meat Supply: The average annual red meat supply in Jordan during 1990 and 1991 is shown in Table 2.13. It includes production from imported live sheep and goats that were slaughtered.

Table 2.13: Red Meat Supply in Jordan (1990-1991)

		Domestic production 1990+1991 Average (mtons)		Imported 1990+1991 Average (mtons)	Exported 1990+1991 Average (mtons)	Total Supply 1990+1991 Average (mtons)	
Sheep	meat	8,500	59%	(29,400)	NA	(37,900)	93%
Goat	meat	2,700	19%	( )	NA	( )	
Cattle	meat	2,800	19%	NA [a]	NA	2,800	6%
Camel	meat	400	3%	NA [b]	NA	400	1%
Total	meat	14,400	100%	29,400	NA(2)	43,800	100%
Proportions		33%		67%	0%	100%	

[a] No information on beef available
[b] Not available but assumed negligible

Source: Wattenbach, H. & H. Strobel. October 1992. Macro-Economic Aspects of Small Ruminant Production in Jordan. Veterinary Epidemiology project. Deutsche Gesellschaft fur Technische Zusammenarbeit GTZ. Tables 3-L, 5-G, 5-C& 5-F.

The production estimates for 1990 and 1991 were combined to calculate an average annual production because there was an usually large (and unlikely) increase of approximately 1.4 times from 1990 to 1991.

One source of error may have been introduced by using livestock populations to estimate domestic red meat production. The population figures show a large and unlikely increase in livestock populations from 1990 to 1991, an increase that may be the result of exaggeration by the owners because their feed entitlement is based on their number of livestock.

Imports of red meat more than doubled, from 18,200 to 40,600 mtons between 1990 and 1991. Jordan imports about two-thirds of its red meat supply.

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Of the red meat produced in Jordan, about 78 percent is from small ruminants (sheep and goats), about 19 percent is from cattle, and about 3 percent is from camels.

Of the total red meat supply (domestic production plus imports) about 93 percent is sheep and goat meat.

The annual growth of red meat imports from 1980 to 1991 is presented below under section 2.4.3: Imports and Exports, section 2.4.3.2: Imports of Red Meat from 1980-1991[8].

Implications: The implications for livestock subsector development policy analysis and formulation of the trends and changes in the red meat supply are the following:

1. The supply of red meat is becoming increasingly dependent upon imports, with the associated demands on the government's and nation's financial resources.

2. There is plenty of scope for implementing complementary policies of import substitution and providing incentives for domestic production and commercial offtake of red meat.

   These policies have associated social benefits for rural incomes and rural employment within Jordan because of the spatial distribution of sheep and goats, the main sources of red meat.

3. Implementing a policy to increase domestic production and commercial offtake of red meat will require simultaneous investment in additional slaughtering and processing facilities.

   This investment will be needed to achieve better public health and meat quality standards. In other words, if the increased production is to be processed in hygienic slaughterhouses rather than on butchers' slabs, the existing slaughterhouses will have to be upgraded and enlarged or new slaughterhouses will have to be built to cope with the expected increase in throughput.

Milk Supply: The average annual milk supply from cattle, sheep, and goats in Jordan during 1990 and 1991 is shown in Table 2.14. Milk production includes both commercial production and home consumption.

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[8] Source: Wattenbach & Strobel, 1992, Table 5-G.

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Table 2.14: Milk Supply in Jordan During 1990 and 1991

		Domestic production 1990+1991 Average (mtons)		Imported Milk equiv. 1990+1991 Average (mtons)	Exported 1990+1991 Average (mtons)	Total Supply 1990+1991 Average (mtons)
Sheep	milk	33,800	26%	NA	NA	33,800
Goat	milk	20,000	16%	NA	NA	20,000
Cattle	milk	74,500	58%	90,100 (1)	NA	164,600
Camel	milk	NA	NA	NA	NA	NA
					Exports	(30,900)
Total	milk	128300	100%	90,100	30,900[9]	187,500
Proportions		52%(3)		48%		100%

NA = Not Available
(1) Imported Milk Equivalent for 1990 only.
(2) Ghee-Butter, White Cheese
(3) Domestic Production minus Exported
Sources: Wattenbach & Strobel, 1992, Tables 3-I, 5-C & 5-F; Ministry of Agriculture, Annual Agricultural Statistics, 1988; Mueller, P. 1991.[10]

Of the milk produced in Jordan, 42 percent is from sheep and goats and 58 percent is from cattle. This shows the importance of small ruminants for the supply of milk and milk products.

Of the milk produced in Jordan, 24 percent is expected as milk products (e.g., ghee and white cheese).

Of the total milk supply available for consumption in Jordan, i.e. after taking exports into account, about half (52%) is produced in Jordan and the other half (48%) comes from imports. This shows the substantial dependence on imports for the total milk supply.

N.B. The sheep and goats in Jordan supply about 80% of the domestic production of red meat, and about 40% of the domestic production of milk and milk products. Livestock

[9] Exported dairy products converted into fresh milk equivalent at the following rates: ghee-butter 12.0, white cheese 6.0.

[10] Mueller, P. 1991. Memorandum to Dr. Sami Sunna, Secretary General, Ministry of Agriculture, from P. Mueller, 13 August 1991, Ref: Economic Assessment of Milk Production in Jordan. 7pp. Agricultural Policy Department, Ministry of Agriculture.

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subsector development policies should take the importance of small ruminants into account.

Implications: The implications of the relative importance of the sources of the total milk supply for livestock subsector development policy analysis and formulation are as follows:

1. Policymakers must consider dairy development programs for small ruminants, and not limit their thinking to ways of improving large-scale (i.e., more than 20 cows) specialized farms with Holstein Friesian dairy cattle on drylots and irrigated forage.

   Moreover, dairy cattle development policy must accommodate the structure of dairy farming in Jordan, where 45 percent[11] of all Holstein Friesian (HF) cows are on farms with less than six cows per farm unit. Dairy development policy must take this structure into account to make more efficient use of HF cattle resources and to increase the productivity of these resources.

2. As with the supply of red meat, the supply of milk is dependent upon imports, which places demands on the government's and nation's financial resources.

3. Imports represent such a large proportion of the total milk supply that to become self-reliant and self-sufficient in milk and milk products will require both a long-term effort and substantial financial investment.

4. To increase self-sufficiency in milk and milk products export-import trade policy for dairy products must support this objective and the tariffs on milk powder and white cheese must remain. The international Monetary Fund/World Bank structural adjustment program, however, requires an open trade policy to support the strategy of market-led growth and modernization.

   Trade policy for dairy and for other livestock and poultry products, is therefore a key issue.

5. As with the supply of red meat, there is plenty of scope for implementing complementary policies of import substitution and providing incentives for domestic production and commercial offtake of milk and milk products.

   These policies have associated social benefits for rural incomes and rural employment. They also have a positive impact on regional development within Jordan because of the spatial distribution of sheep and goats, a significant source of commercial milk products.

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[11] Mueller, P. 1991. Memorandum to Dr. Sami Sunna, Secretary General, Ministry of Agriculture, from P. Mueller, 13 August 1991, Ref: Economic Assessment of Milk Production in Jordan. 7pp. Agricultural Policy Department, Ministry of Agriculture.

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6. Implementing the policy to increase domestic production and commercial offtake of milk and milk products will require simultaneous investment in additional facilities for collection/reception, transport, cooling, quality control, processing, marketing, and distribution. Substantial efforts and large investments will be needed from both the public and private sectors to implement this policy.

Poultry Broiler (White Meat) and Other Poultry Meat Supply: Poultry meat supply is derived from broilers, culled layers (spent hens), culled broiler parents, culled layer parents, and imports. Poultry broiler production in Jordan in 1988 was approximately 75,300 mtons from 1,360 farm units with a total capacity of 122,500 birds.[12]

The table below shows figures for 1988 only, but the relative importance of the various sources of the total poultry meat supply was similar during the previous seven-year period (1981-1987).

Table 2.15: Poultry Broiler (White Meat) and Other Poultry Meat Supply in Jordan

	Domestic production 1988 mtons)		Imported 1988 (mtons)	Exported 1988 (mtons)	Total Supply 1988 (mtons)	
Broiler meat	75,300 [a]	92%59%	2,500 [b]	NA	77,800	92%
Cull Layers	5,000 [c]	6%	0	NA	5,000	6%
Broiler parent	2,000 [d]	2%%	0	NA	2,000	2%
Layer parent	NA [e]		0	NA	NA	0%
Total Poultry	82,300	100%	2,500	NA [e]	84,800	100%
Proportions	97%		3%	0%	100%	

Sources:

[a] Ministry of Agriculture, Animal Production and Health Directorate, Statistical Yearbook, 1988;

[b] World Bank. March 1990. Livestock Subsector Survey. Agricultural Sector Adjustment Loan. Kingdom of Jordan. J.M. Hall. Date revised May 9, 1990. Draft. Table 26. Imputed figure based on average for 1985-1987 of ratio: (domestic production: imports) of 30:1).

[c] Ministry of Agriculture, Annual Agricultural Statistics 1988. Livestock RPG Estimate 3.0 million x 1.6 kg (Table 10, p. 48 & Section 3.6, p. 90 of First Draft Report, both soured from Directorate of Animal Production & Health Statistical yearbook 1988 (Arabic)

[d] Ministry of Agriculture, Annual Agricultural Statistics 1988. Livestock RPG Estimate 1.113 million x 1.6 kg (Table 9, p. 47 of First Draft Report, source Directorate of Animal Production & Health Statistical 1988 (Arabic).

[e] Not available but assumed negligible.

[12] Ministry of Agriculture, Animal Production and Health Directorate, Statistical yearbook, 1988.

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Jordan is largely self-reliant and self-sufficient in its supply of poultry meat. Of the total poultry meat supply, 97 percent is produced in Jordan and about 3 percent comes from imports.

Of the total supply of poultry meat about 92 percent is from broilers and about 8 percent is from culled birds (i.e., culled layers and culled broiler parent stock).

Implications: The implications of the relative importance of the various sources of the total poultry meat supply for livestock subsector development policy analysis and formulation are the following:

1. Poultry broiler development policy should concentrate on improving the marketing system for live birds, the processing facilities, and the marketing of poultry meat and poultry meat products. This means that the policy should address the following points:

2. The problem of insufficient number and capacity of poultry slaughterhouses.

3. Inadequate representation of producers' and processors' interests in relation to pricing policy and export-import trade policy.

4. The problem of balancing supply of and demand for poultry products through the market mechanism to eliminate large fluctuations in prices and quantities traded.

5. How to improve the marketing systems for unprocessed poultry products (i.e., live birds and eggs), so that the producers, middlemen, and processors all receive appropriate rewards for their parts in the production, processing, and marketing activities.

Poultry Chicken Egg Supply. Jordan is self-sufficient in poultry egg supply. Chicken table egg production in Jordan during 1988 totaled approximately 542 million eggs from 160 farm units with a total capacity of 3.0 million layers. The broiler hatching egg production in Jordan during 1988 was approximately 131.0 million eggs from 40 farm units.[13]

The table shows figures for 1988 only, but the pattern of the total poultry egg supply was similar during the previous seven-year period (1981-1987). There was a surplus exported every year.

[13] Ministry of Agriculture, Animal Production and Health Directorate, Statistical yearbook, 1988.

Table 2.16: Poultry Chicken Egg Supply in Jordan

	Domestic production 1988 (million)		Imported 1988 (million)	Exported 1988 (million)	Total Supply 1988 (million)
Table eggs	542 [a]	80%	NA	(108)[b]	(781)
Broiler hatching eggs	131 [a]	20%	NA	( )	( )
Layer hatching eggs	NA [c]		NA	NA [c]	NA [c]
Total eggs	673	100%	NA [c]	108	781
Proportions	86%		0%	14%	100%

Sources:

[a] Ministry of Agriculture, Animal Production and Health Directorate, Statistical yearbook, 1988.

[b] World Bank. March 1990. Livestock Subsector Survey. Agricultural Sector Adjustment Loan. Kingdom of Jordan. J.M. Hall. Date revised May 9, 1990. Draft. Table 26. Imputed figure based on average for 1985-1987 of ratio: (domestic production: exports) of 5:1).

[c] Not available but assumed negligible.

Implications: The implications of self-sufficiency in poultry chicken eggs for livestock subsector development policy analysis and formulation are as follows:

1. Poultry chicken egg development policy should concentrate on improving the marketing system; the handling, grading, and other processing facilities for eggs, and on the marketing of eggs and egg products. This means that:

2. The policy should address the present problem of balancing supply of and demand for eggs through the market mechanism to eliminate large fluctuations in prices and quantities traded.

   Each year from 1981 to 1987 there was a surplus of eggs that was exported, but at a loss to the Cooperative Society. During this period the ratio of surplus to domestic consumption averaged 22:100[14] (range from 10:100 to 24:100), that is, on average, 22 percent more eggs were produced than could be consumed in Jordan.

[14] World Bank. March 1990. Livestock Subsector Survey. Agricultural Sector Adjustment Loan. Kingdom of Jordan. J.M. Hall. Date revised May 9, 1990. Draft. Table 26.

Another way to achieve a balance of supply and demand for eggs through the market mechanism is to establish a poultry marketing board that, in addition to other duties, could carry out market intelligence and disseminate price information in an attempt to stabilize the balance between egg production and egg consumption.

2.4.3 Imports and Exports

The main items of livestock and poultry products which are imported and exported are as follows:

- Red Meat Supply in Jordan During 1990 and 1991.
- Red Meat Imports from 1980 to 1991.
- Live Sheep and Live Goats.
- Feed Imports from 1981 to 1991.
- Breeding Dairy Cattle (Imports only).
- Milk and Milk Products.
- Poultry Chicken products (Meat and Eggs).
- Wool.
- Wheat, Wheat Flour, Millet, and Cereal Straw.

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Red Meat Imports and Exports: See Table 2.17: Red Meat Supply in Jordan During 1990 and 1991.

Table 2.17: Imports of Red Meat from 1980 to 1991

Year	All Meat Frozen tons	Beef Refriger-ated tons	Mutton Refriger-ated tons	Live sheep/ Live goat tons	Total Imports tons	
1980	NA	NA	NA	NA	10802	100%
1981	NA	NA	NA	NA	27500	255
1982	NA	NA	NA	NA	29927	277
1983	2600	11681	11066	7291	32638	302
1984	588	13800	12700	4344	31432	291
1985	416	13400	16314	4029	34159	316
1986	2100	9749	13420	9592	34861	323
1987	9910	8550	14739	4362	37561	348
1988						
1989						
1990		NA	8882	9313	18195	168
1991		NA	14387	26245	40632	376%

Source: Wattenbach & Strobel, 1992, Table 5-G.

N.B. The table shows that total imports of red meat have increased almost four-fold (376% in table) between 1980 and 1991.

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Live Sheep and Live Goats Imports and Exports:

Table 2.18: Imports and Exports of Live Sheep and Live Goats During 1990 and 1991

Year	Item	Imports Quantity mtons	Imports Quantity number	Exports quantity mtons	Exports Quantity number
1990	sheep	9,100	271,000	2,100	60,000
1991	sheep	23,900	740,000	10,100	279,000
Total	sheep	33,000	1,011,000	12,200	339,000
1990	goats	246	8,000	25	800
1991	goats	2,304	60,000	35	1,200
Total	goats	2,550	68,000	60	2,000

Source: Wattenbach & Strobel, 1992, Tables 5-B & 5-E.

The exports for 1990 are low compared with 1991 because the exports for 1990 are for part of a year only. The export of sheep and goats was banned from April 1988 until mid-1990, which caused heavy losses of income to sheep and goat owners.

From 1990 to 1991 about 1.0 million sheep and 68,000 goats were imported, and about 340,000 sheep and 2,000 goats were exported. The main destinations for exports were Qatar, Saudi Arabia, United Arab Emirates, and Bahrain, in that order by number of head. The main sources of imports were Australia (311,000), Romania (305,000), Bulgaria (109,000), Poland, and New Zealand.

Table 2.18 shows figures for 1990 and 1991 only, but the pattern of imports and exports was similar during the previous six-year period (1982-1987). Figures for 1988 and 1989 were not used because the export ban was in effect. The average number of sheep exported from 1982 to 1987 was 209,000 per year (range 106,000-307,000).[15] During the five-year period (1982-1986; no information was available for 1987) the average number of goats exported was 9,200 per year (range 700-17,300).[16]

[15] Source: Wattenbach & Strobel, 1992, Table 5-H.

[16] Source: Wattenbach & Strobel, 1992, Table 5-H.

Feed Imports from 1981 to 1991.

Table 2.19: Imports of Feed from 1981 to 1991

Year	Barley A 1000 tons	Sorghum B 1000 tons	Total C=A+B 1000 tons	Wheat Bran D 1000 tons	Corn (maize) E 1000 tons	Total Imported F=A+B+D=E 1000 tons	
1981	9.8	0.0	9.8	0.4	135.1	145.3	100%
1982	69.3	0.0	69.3	7.9	151.5	228.7	157
1983	17.4	0.0	17.4	39.5	132.1	351.4	242
1984	179.8	0.0	179.8	39.5	132.1	351.4	242
1985	74.9	0.0	74.9	0.0	205.4	280.3	193
1986	143.5	0.0	143.5	2.5	233.5	383.2	264
1987	114.8	0.0	114.8	2.5	182.8	300.1	207
1988	98.0	0.0	98.0	5.3	270.3	373.6	257
1989	233.0	236.0	469.0	???	???	469.0	323
1990	209.0	405.8	614.8	0.0	???	614.8	423
1991	304.0	241.0	545.0	1.3		546.3	376
1992	???	70.0	70.0	???		?????	???

Information about exports of barley, sorghum, wheat bran, and corn (maize) was not available but these numbers were assumed to be negligible.

Source: Wattenbach & Strobel, 1992, Table 5-1.

N.B. The table shows that imports of feed increased fourfold from 1981 to 1990-1991.

2.4.4 Comparative Advantage

Comparative advantage is the ability of a country to produce a given good at a lower cost than another country relative to other goods that both produce, or (loosely) the ability to produce and export a given good at a price below the border price.

During its fieldwork, the Livestock RPG did not discover any studies of comparative advantage or domestic resource costs of livestock and poultry products of Jordanian origin.

The information needed to calculate the comparative advantage of livestock and poultry products is incomplete; some is available from the work carried out by the current GTZ-assisted Advisory Services to Ministry of Agriculture Project.

In a later section of this report, the Livestock RPG has proposed a study project to produce financial and economic information that could be used to determine comparative advantage of livestock and poultry products, viz. the Livestock Policy Development Project, and the Farming Systems Research Project.

Comparative advantage is included with zero weighting in the set of criteria used to assess the impact of the proposed integrated livestock production subsector development policies because no information about the comparative advantage of livestock and poultry products was available to the Livestock RPG.

2.5 Existing Policies and Practices

There is an urgent need for a documented agricultural policy. There have been several attempts since 1980. The last attempt was in 1991 by collaborative work between the Ministry of Agriculture and FAO. Many scientists and consultants contributed papers in different fields of the study. They also participated with others from Jordan and from abroad in the seminar which was held in Amman 3-6/12 1991. A set of recommendations came out of that seminar, and they were discussed in the Agricultural Council and sent to many ministries and related agencies for comments. Our present work in this subsector group and other groups is a follow up of these recommendations.

But even if there is no written policy, a policy is practiced through the laws, by-laws, programs, projects, decisions, agreements, and development plans.

The importance of agriculture. Agriculture lost its relative importance in the economy following the 1973 war. The changes which affected the area, including Jordan, had their effect in this respect. This is not a hidden situation but is felt and expressed everywhere. In the third five-year plan, there are many statements to this effect:

> The agricultural sector has not been able to meet this increasing demand especially for meat and dairy products . . . . During the last decade, most government investments in the agricultural projects were geared towards the irrigation sector . . . in the Jordan Valley . . . . Most private sector investments were in high return activities . . . . Livestock, especially sheep and cattle and crop farming, received less attention.

Furthermore, the policy stated in the plan voices clearly the weight and importance of the agricultural sector by stating that the agricultural sector remained relatively in developed in the absence of integrated development and support policies.

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The goals cited are very general, such as increasing returns on agricultural investments and improving farmers' incomes. No real effort was made to fulfill the goals; there were no detailed objectives or instruments proposed. Furthermore, there were no serious attempts to implement the projects in the development plans. Even the law is not respected. For example, Agriculture Law No. 20 of 1973 prohibits plowing rangeland in order to protect plant cover, yet rangelands are plowed and misused every year and very little, if anything, is done to enforce the law.

Policy instruments. Many policy instruments were included in the development plan. Among them were those related to allocating land and water resources to raise local feed products, such as the following:

> "Planning under irrigation 200,000 dunums in the eastern and southern areas of the Kingdom and allocating them for the planting of cereal and forage crops and for sheep breeding". And by; "Planting an additional 60,000 dunums with forage crops ...".

It also stated a policy of open export and restricted import of agricultural products in principle, to favor domestic production. This was a important prospect, but implementation was minimal. The area put into forage production in 1990-1991 was slightly more than 1,000 dunums in the rented government lands. The import-export criteria were violated many times, and on April 17, 1988 the cabinet banned exports of sheep (including lambs) and left the door open for imports. This resulted in huge losses for herders and fatteners.

Instruments. Many projects were listed to develop livestock production, some related to feed production and others to increasing meat production through fattening. The implementation and results vary. They include:

1. Jordan Australian Dry Farming Project 1980-1991. The aim was to introduce the Australian ley farming system into Jordan. The project intended to introduce medic into the system and rotate it with cereals, and if practiced an implementation activity with the World Food Program of introducing legumes as forage crops in the rotation, enter as pure stand and as mixtures with cereals. In addition, it did a good job in demonstrating the use of seed drills to mowers and herders in cereal and forage production.

2. Forage Livestock and Rangeland project (2422) 1981-1987. A WFP project, it used food materials to encourage production of feedstuffs through shrub plantation and forage production. It included components of lamb fattening activity by establishing a revolving fund of $1.2 million to provide soft loans to sheep farmers to fatten their lambs. The number of fattened lambs was 25,000 in the years 1983-1987.

3. Lamb Fattening Units with EIB. Five fattening units were built (each with a capacity of 3,600) providing the potential (assuming four patches per year) of 72,000 lambs/year. The total potential increase in live weight, assuming an increase of 15 kg (from 20 to 35

kg) for each lamb, would be 1,080 tons. The occupancy rate of the fattening units, however, was far below potential.

4. Mashraq Project, sponsored by UNDP and AFESD and managed by ICARDA. This is a regional project in Jordan, Syria, and Iraq to improve the production of barley, forage, and sheep. Its approach is integrated and it stresses farmer participation.

Credit. There are policy instruments which give indication of the weight given to this subsector. The following loans were dispensed in the year 1992 out of a total of JD 23,293,000:

	Jordan Dinar	% of total
Sheep and Goats	3,690,000	5.84
Cattle	1,454,000	6.07
Poultry	1,429,000	6.13
	6,573,000	28.20

These figures are clear indications.

Pricing. Prices are set for some livestock commodities, but not for all. The Ministry of Supply sets prices of cow milk, eggs, and broiler meat. Other products are not officially priced and are affected by the market forces of supply and demand. These include sheep and goat milk, cheese, wool, and local red meat. These commodities are also affected by imported equivalents or substitutes—chilled and frozen meat, and powdered milk and cheeses—which are much cheaper than those produced locally.

Subsidies. Some concentrate feedstuffs are subsidized. Barley-sorghum mixture is subsidized. The barley is imported by the Ministry of Supply and the sorghum is donated to the government. Wheat bran, which is a by-product of milling wheat grain, is sold at a low price which is considered to be subsidized. Corn grain was subsidized in the past but is no more.

The subsidy figure is said to be approaching 15 million JD. Sheep, goats, cattle, and poultry benefit from subsidies, with a higher share going to sheep and goats.

People disagrees on the question of subsidies. Are they good or bad? Should they continue or should they be phased out? In any case the question is not as easy as it seems, and it should be looked at from more than one angle. The criteria are integrated production, impact on production of feeds, impact on the resources and environment. All these are to be considered, in addition to the political and social criteria and their pressures.

Subsidizing feed concentrates causes an increase in the number of livestock, which has a negative effect on forage and feed grain production, and puts more pressure on pastures and rangeland, which results in deterioration of these resources. The issue of the black market should not be ignored. The problem should be tackled as a package, and if subsidies on these inputs are

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to be phased out, we should substitute a return on the production outputs which the subsidy on the inputs is phased out. Grain feed, hay, and fattened lambs are examples of such output subsidies.

Marketing. Marketing is a weak link in agricultural development. With respect to marketing, irrigated horticultural products receive the most attention, livestock receive the least. Cereals and legumes are no problem because the government receives them at a suitable price. Livestock production remains at the bottom, and is given low priority and effort. Market information needs to be collected and disseminated, and advice needs to be developed if real progress is to be achieved in this subsector.

Export-Import. Jordan is self-sufficient only in the production of eggs. It has produced a surplus of eggs since 1980, most of which has been exported to Iraq. Production of other livestock commodities, however is not sufficient to meet the consumption demand, and so the balance is imported. In the case of red meat, much is imported and yet lambs are exported. The reason for this is that Awassi lambs command a high price in Saudi Arabia and the Gulf states, and so bring hard currency into the country in addition to benefiting the farmers. The meat that is imported is cheaper than the Awassi: lamb meat, and therefore there is a net increase in the balance of trade for Jordan.

Research and Extension. Research policy, which is supposed to be part of the comprehensive agricultural policy, is not clear and, as in other aspects of investment, programs, and marketing, livestock research is at the bottom of the list.

The main problem is that there is no national plan to coordinate research efforts by the numerous research organizations. These organizations include, among others, universities and the National Center for Agricultural Research and Technology Transfer (NCARTT), which was established in 1985 under the Project Department of the Ministry of Agriculture. NCARTT is not autonomous, however, and does not have the mechanism needed to move toward its perceived goals.

There is an effort under way to formulate the strategy of agricultural research. The Ministry of Agriculture, NCARTT, TASO, ICARDA, and ISNAR are cooperating in this effort, and there are five task groups to deal with the different fields of the issue including organization. This effort is expected to be completed during this year.

Overall Assessment & Opportunities. The present agricultural situation is on the decline with regard to resource conservation and use. A vast area of the rangeland is deteriorated and still deteriorating. The limited resources in cultivable land also misused in that this land is utilized in less profitable commodities. Desertification, salination, and erosion are on the rise.

These are the results of unsuitable policies and practices. Low productivity is an issue in some production systems. This applies especially to sheep and goat production.

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The future opportunities and potential improvements are many. Our ambitions must be limited to our resource capabilities.

2.6 Constraints and Issues

2.6.1 Key Constraints

A constraint is a straightforward difficulty or problem (e.g., animal health status), and there is usually less controversy and more agreement about constraints than about issues.

Constraints to agriculture in Jordan are numerous and have different origins and importance (e.g., physical-climatic, economic, financial, production or technical, marketing, institutional, regulatory, environmental, sociocultural). The following constraints are important to Jordan:[17] feed, livestock disease, low productivity, seasonality of supply of red meat and fluctuations in supply of white (poultry broiler) meat, processing and marketing, and lack of mechanization for forage harvesting and handling.

No. 1. Feed

Feed resources of the rangelands are deteriorating because of destructive grazing management and tillage practices. The annual production of feed from rangeland is directly related to the annual rainfall pattern, which varies in total quantity, in seasonal distribution pattern through the year, and in geographical distribution. The annual production of feed from rangeland makes up the following proportions of the feed resources produced domestically and available for ruminants: about 10-20 percent in a low rainfall year 30-40 percent in a moderate rainfall year, and 50-60 percent[18] in a high[19] rainfall year. The declining trend in annual forage production from rangeland therefore has serious implications for the future productivity of the national livestock resources.

Under present land use and water use policies and practices, domestically produced feed resources are not sufficient to meet livestock and poultry feed requirements. The shortage is made up by imports, which places increasing demands on the national supply of foreign exchange.

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[17] Further details are given in an Appendix, of constraints on: rangeland flocks of sheep and goats, including the rangeland itself and animal diseases; dairy production; broiler production; egg production; and land resources.

[18] Livestock RPG estimates based on various sources.

[19] Low rainfall - less than or equal to one standard deviation from the average rainfall; Moderate - average rainfall; high rainfall - more than or equal to one standard deviation from the average rainfall.

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The import and distribution of subsidized concentrate feed (barley, sorghum, wheat bran) for ruminants has several negative consequences; six mentioned are discussed below.

1. Availability of additional feed resources has encouraged livestock owners to keep more animals. This has increased grazing pressure on the rangeland, during the annual grazing cycle and by nomadic and transhumant herdsmen, which has aggravated the rate of deterioration of the rangeland feed resources.

2. The subsidized feed distributed to cattle, sheep, and goat owners is based on the number of livestock owned, as declared by the owner and as recorded by the November 1991 livestock census on a particular date. This limits the quantity distributed to the entitlement for that number on that date. There is no provision in the scheme for entitlement for animals acquired since the census date, and no provision for persons who have become livestock owners since the census date. These factors discourage investment in livestock breeding and livestock fattening enterprises, particularly of sheep and goats. There is an unofficial market for the cards that entitle the cardholder to purchase subsidized feed.

3. The availability of subsidized concentrate feed (barley, sorghum, wheat bran) encourages owners to feed their livestock diets excessively high in concentrates relative to the proportion of roughage, particularly during periods when roughage is scarce (and consequently expensive). The owners buy the subsidized concentrate feed rather than roughage, which discourages crop farmers from investing in the production of forage to sell.

4. Diets excessively high in feed concentrates depress animal performance and offtake (i.e., it lowers the productivity of the national livestock resource).

5. There is not a sufficient quantity of subsidized feed, at the price at which it is sold, to meet the demand from livestock producers, and therefore a black market has developed.

No. 2. Livestock Disease

Existing veterinary services cannot achieve an adequate level of prevention and control of animal diseases. The resulting morbidity and mortality cause losses to farmers and to the national economy.

No. 3. Low Productivity

The generally low productivity of livestock production systems has a negative impact on rural household incomes and the rural economy.

The low efficiency of production of many livestock enterprises is caused by a combination of factors, including output and input prices, marketing systems, and husbandry (health, feeding, watering, breeding, management skills). The result is a depression of rural household incomes below the innate productive potential of the livestock resources. This

discourages investment in livestock enterprises, which in turn has a negative effect on the level of rural employment.

No. 4. Seasonality of Supply of Red Meat and Fluctuations in Supply of White (Poultry Broiler) Meat

The supply of red meat is seasonal, with related effects on prices. The availability of feed, of natural grazing and agricultural crop residues (e.g., stubble and straw) is directly related to the seasonal weather pattern in Jordan, particularly rainfall and temperature. Consequently most animals are sold for fattening or slaughter during the late spring and summer and before the onset of the dry season and cold season and ensuing feed scarcity. The availability of lambs for fattening is seasonal.

Commercial fattening enterprises are profitable at present prices (May 1993), but the profitability is not sufficient incentive to encourage lamb fattening at unaccustomed or unusual times of the year. Fatteners are unwilling to risk investing in out-of-season fattening enterprises. Thus the profitability of fattening is not sufficient to even out the supply of red meat during the year. The livestock extension service needs to take the risk and demonstrate to lamb fatteners the profitability (or otherwise) of out-of-season lamb fattening.

The availability of broilers, and the related unofficial retail price, rise and fall in cycles for several reasons: 1) the retail price of broiler meat is regulated; 2) the Ministry of Supply imports and sells frozen broilers; 3) poultry processing plants in Jordan do not have sufficient frozen storage capacity to store birds during times of abundance and to release them during times of scarcity; 4) most broilers are slaughtered and sold fresh in manual defeathering machine shops with little or no capacity for storage; 5) the approximately 100[20] middlemen in the trade affect supplies and prices; and 6) the behavior of farmers to start broiler production during scarcity and to stop in policy for the poultry sector.

No. 5. Processing and Marketing

There are various constraints in the processing and marketing of livestock and poultry products. These products include cow and sheep milk and dairy products; ruminants and red meat; and poultry birds and eggs.

The constraints include difficulties in balancing supply with demand through the market mechanism. The problems are complicated by the government's policy of importing milk powder, white cheese, frozen red meat, and frozen broilers, which compete with products produced domestically; and the government's policy of price regulation for cow milk, broilers, and eggs.

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[20] Agriconsult. 1984. Jordan: Poultry Development Master Plan Study. Final Report. Ministry of Agriculture. The Hashemite Kingdom of Jordan.

No. 6. Lack of Mechanization for Forage Harvesting and Handling

The straws of legumes grown for human food (e.g., lentils, broad beans, and chickpeas) and legumes grown for animal feed (e.g., vetch [grain and straw], alfalfa, clover, and berseem) are important feed resources for ruminant livestock. Wheat and barley straw are also an important feed resource.

These resources would be utilized more fully and productively if machines (especially balers) were used for harvesting, processing, and handling. Baling forage would facilitate its harvesting, handling, transportation, trade, and distribution from areas of surplus to areas of shortage. The use of balers is insufficient in the rainfed agricultural areas of Jordan.

2.6.2 Key Issues

An issue is a policy difficulty or problem that is not straightforward and requires policy decisions for resolution (e.g., pricing, subsidies). There is usually more controversy and less agreement about issues than about constraints.

There are various policy issues that affect the livestock sector, and decisions need to be made to change the existing policies and practices in order to resolve the issues. The following issues are among the most important:

- Optimal allocation of resources
- Comprehensive outlook needed for resolving policy issues
- Low productivity of some sheep and goat production systems
- Importance of research and extension services
- Roles of government and other agencies in agricultural development
- Financial policies such as pricing, subsidy, credit, investment projects, and customs (export-import trade policy).

Issue No. 1: Optimal Allocation of Resources

The efficient allocation and use of resources; particularly water, land, and investment; is an important issue. Its resolution depends upon reaching agreements on national and sectoral goals, objectives, priorities, and plans for the utilization of those resources.

For example, the cost-effectiveness of investing in conservation and improvement of rangeland resources is controversial.

Another example is that the production of forage could be increased by allocating land, water, and finances under the Southern Leased Lands Project, but allocation of these resources needs to be justified on an economic basis.

Also, wastewater resources could be used to increase forage production. Wastewater is not considered suitable, for health reasons, for irrigating vegetables and human food crops.

Issue No. 2: Comprehensive Outlook Needed to Resolve Policy Issues

To resolve issues that concern allocation of scarce resources, particularly water, policymakers and decision makers need to have a comprehensive view of the agricultural sector. They need to be aware of the linkages and complementarily between technical efficiency and prudent or rational management of resources; between macroeconomic policy and the investment decisions of the livestock producer; and between agronomy and animal husbandry within farming systems.

Issue No. 3: Low Productivity of Some Sheep and Goat Production Systems

Policy instruments to improve the productivity of sheep and goat production systems warrant special consideration by policymakers. Sheep and goats are particularly important, relative to other livestock species, in utilizing Jordan's natural plant cover resources, including the more than 90 percent of land area in Jordan that receives less than 200mm of rainfall per year. Sheep and goat products are also more valuable than the production of other ruminant species.

Sheep and goat husbandry based on the exploitation of the rangeland's natural grazing feed resources through increased use of vehicles to move animals quickly around the range, and to transport drinking water to them so they can graze waterless areas is inefficient with respect to the plant cover resources. This practice accelerates the deterioration of the feed value of the plant cover, because overgrazing causes desertification and displacement of nutritious plant species by less nutritious ones.

Issue No. 4: Importance of Research and Extension Services

The importance of research and extension services, relative to the allocation of limited resources for alternative and competing uses, cannot be overemphasized. In Jordan, research and extension are not being given the attention and funding they deserve (e.g., there is no national plan for agricultural research).

Research must be carried out to optimize the allocation of resources and to determine the most efficient ways to use water, land, plant cover, livestock, and human and financial resources upon which the production systems are based. Extension services must then transfer the knowledge and improved technology to the farmers.

This research and the education and training of farmers, are absolutely necessary to successfully implement policy reforms. These reforms include changing cropping programs on dryland to introduce legumes during the fallow period; establishing herder groups to manage grazing on rangeland; persuading livestock owners to buy private veterinary services; and

supporting quality control of commercial compound feeds by making the livestock and poultry keepers better informed and better able to demand adherence to feed quality standards.

Human resource development in the livestock sector means more than just training farmers and livestock owners. It also means investment in educational and training institutions to provide courses to upgrade the occupational skills of all categories of persons employed in the livestock subsector.

Issue No. 5: Roles of Government and Other Agencies in Agricultural Development

The roles, responsibilities, and authority of the institutions involved in the agricultural sector, especially the Ministry of Agriculture, need to be defined and clarified.

The role of the private sector relative to that of the public sector in providing production, processing, and marketing support services is also an issue.

Issue No. 6: Financial Policies

Financial policies include pricing, subsidies, credit, investment projects, and customs (export-import trade policy).

Issue No. 6.1: Pricing

The pricing issue concerns price regulation for cow milk, broilers, and eggs. Farm gate prices are affected also by the government's importation and distribution of milk powder, white cheese, frozen red meat, and frozen broilers.

Issue No.6.2: Subsidies

The subsidy issue concerns the government's importation and distribution of feed concentrates (barley, sorghum, wheat bran, and formerly maize corn) at subsidized prices.

Issue No. 6.3: Credit

The main credit issue is the fact that total disbursements to the livestock and poultry subsector, relative to total agricultural disbursements, are too small. Moreover the disbursements for livestock are inconsistent with the value of the livestock sector relative to the crop sector, and inconsistent with the potential improvement in productivity of the livestock subsector that could be achieved with more credit.

In 1992, out of 23.3 million JD in agricultural credit, 28 percent was disbursed for livestock enterprises (sheep and goats 16%, cattle 6%, poultry 6%),[21] and the balance (72%) was disbursed for crop enterprises. In 1989, livestock contributed 53 percent and crops 47 percent to the value of production and intermediate consumption at current prices.[22]

Issue No. 6.4 Investment Projects

The investment projects issue involves concerns that:

- The value of the public sector investment program for livestock development is too small relative to the livestock subsector's contribution to agricultural gross domestic product.
- The value of the public sector investment program for livestock development is inconsistent with the potential improvement in productivity of the livestock subsector that could be achieved with more public investment.
- The public financial resources allocated to the feed subsidy policy would be more productively used in capital investment projects.

Issue No. 6.5: Customs (Export-Import Trade Policy Issue)

Present trade policy for livestock products is an open export, limited restricted import trade policy. This policy must be continued to protect and promote livestock subsector development.

- If the tax on imported milk powder (38%) were abolished, the domestic production of cow's milk would collapse because processors would switch to recombining imported skim milk powder and butter oil to supply the demand for processed liquid milk (e.g., flavored UHT milk).
- If the tax on imported cheese (25%) were abolished, it would be cheaper than domestic white cheese; livestock owners would not be able to sell their white cheese, a very important source of their annual income, and they would be impoverished.
- Trade policy should also be designed to prevent situations such as that which occurred in 1988, when the government prohibited export of sheep while at the same time allowing import and sale of sheep meat. This resulted in heavy losses of income to domestic sheep producers and lamb fatteners, and destroyed farmers' confidence in the trustworthiness of government policy.

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[21] Livestock RPG Estimate, First Draft Report, p. 120.

[22] Ministry of Agriculture, Agricultural Policy Department. 1992. The Agricultural Sector in Jordan Figures and Facts, by Majed Zakaria & Eman Hwaiadi.

- In the years prior to 1988 government policy promoted increased domestic red meat production by slaughtering at heavier live weights. Research and demonstrations were carried out to persuade butchers not to slaughter lambs straight off the rangeland, but to wait until they had been fattened for 60-90 days to increase their live weight from about 20 kg to about 35 kg. Lamb fatteners were encouraged to buy lambs off the range, fatten them, and not to sell them until they reached the target weight.

- When the lamb fatteners made the decision to invest in the new enterprise, they had the option of selling for export or selling to local butchers. The government's decision to ban the export of lambs (April 17, 1988) came after the lamb fatteners had already invested in the new enterprise in good faith. The government's ban destroyed that faith. The local market was flooded with fattened lambs, the farm gate price fell, and lamb fatteners lost much of their investment money.

Fragmentation and Size of Holding. According to the records of the Land and Survey Department, the total land area in Jordan is 91,945,371 dunum. The area of surveyed land (private and governmental) was 12,070,309 dunum in 1975, 14,408,748 in 1984, and 15,234,152 1990.

According to the same records, the number of registered parcels in 1975 was 392,273, increasing to 631,555 at the end of 1989. This represents an increase of 61.7%. On the national scale the average size of registered parcels (private and government) was 30.77 dunum in 1975 and fell to 24.1 dunum in 1990, which represents a reduction of 27.7% (viz 1.8% annual reduction).

These changes represent the changes in private and governmental land. The small holding area was increased accompanied with a reduction in large parcels (due to fragmentation problem).

In Jordan Valley, most of the holds are less than 40 dunums. However, shows sample of size of holding for various uses for different governorates. Land used as permanent field crops showed maximum fragmentation, with an average size of 5.8 , 8.1 , 14.5 , 15.2 and 17.6 dunums for Ma'an, Karak, Balqa, Irbid, and Amman respectively.

2.7 Overall Assessment and Opportunities

2.7.1 Potential and Opportunities (Outlook and Prospects)

The present agricultural situation is in decline with regard to resource conservation and use.

The vast area of rangeland has deteriorated and is still deteriorating. The limited resources of cultivable land are misused and under utilized. Misuse of water has resulted in

salinization of the land. Using the land for the production of less rewarding commodities than the land is capable of represents under utilization. Desertification and erosion are Increasing in the arid and marginal agro-climatic zones. This declining situation is the result of unsuitable agricultural policies and practices.

Nevertheless, there are many future opportunities and great potential. But we limit our ambitions to the capabilities and potential are many. We should be realistic in our expectations.

2.7.2 Tentative Solutions to Problems Identified

In the next section, Section 3: Policy Objectives, Strategies, and Instruments for Livestock Subsector Development, some tentative solutions are discussed for alleviating the key constraints and resolving the key issues noted above.

These solutions are presented first as 21 Proposed Integrated Livestock Production Subsector Development Policies (in Section 3.6), and then as Proposed Livestock Development Programs and Projects, (in Section 4.1.3).

3. POLICY OBJECTIVES, STRATEGIES, AND INSTRUMENTS FOR LIVESTOCK SUBSECTOR DEVELOPMENT

Definitions

Agricultural policy systems are a combination of objective and strategy and instrument.

Policy formulation includes: objectives, and strategies, and instruments, and institutional and legal basis, and evaluation of the economic and social effects on society and government.

3.1 Review External, Sectoral, and Subsectoral Policy Assumptions

The livestock policy objectives are presented in compliance with the fundamental national goals of:

- Conservation and development of the nation's natural resources of water, land, plant cover, livestock, human and financial resources
- Economic efficiency, which in turn promotes food security, improves farmers' incomes, and enhances social equity;
- Agricultural self-reliance through selection of commodities with comparative advantage and highest rewards; and
- Regional cooperation among neighboring Arab countries for integration of agricultural production, processing, and marketing systems.

3.2 Review Proposed Development Objectives

The two major livestock policy objectives are optimization of livestock production, processing, and marketing; and optimization of feed production.

Optimization includes efficient use and allocation of resources and implies improvements in productivity of resources and livestock production, processing, and marketing cycles and systems.

Productivity in Jordan can be improved by meeting the following specific objectives:

1. Increase the feed productivity of the main sources of edible biomass or dry matter. The main sources are natural vegetation of the rangeland; agricultural by-products, including by-products of irrigated vegetables in the Jordan Valley and Highlands, and animal and poultry slaughterhouse by-products; roughage (i.e., straws and stubble); feed grains;

natural vegetation in uncultivable areas in rainfed agricultural areas; and forage crops in rainfed and irrigated areas.

2. Improve feeding and husbandry management systems with special attention to balanced rations and production cycles.

3. Improve preventive and curative health care of livestock with special emphasis on diseases common to humans and livestock.

4. Improve the efficiency of processing and marketing of livestock products to reduce losses, increase producers' profits, and safeguard human health.

3.3 Review Proposed Development Strategies

The strategies to be followed should be geared toward achieving livestock policy objectives in which the efficient employment of inputs will result in the highest returns at the lowest costs. The strategies must be economically viable, and the benefits to the national economy must be maximized relative to the costs to the national economy.

To achieve the specific objectives mentioned above, the following development strategies are in order:

1. Institutional and Policy Changes

- Clarify the roles, responsibilities, and authorities of the institutions involved in the agricultural sector, especially the Ministry of Agriculture.

- Define and document agricultural sector development policies.

2. Optimal Utilization of Natural Resources

Rehabilitate and manage the rangeland to achieve a high level of sustainable production and productivity, and yet remain within the potential capacity of the rangeland resources. This could be achieved by encouraging the formation of small ruminants cooperatives or associations for communal management of communal grazing lands. Camels would also be included under these cooperative activities.

The control of grazing pressure on communal lands is possible only where there is a body with authority over the management of the land, the number of animals allowed on it, and when they are allowed on it.

This strategy also means implementing a similar strategy for the management of the natural vegetation on uncultivable places in rainfed agricultural areas.

The environmental impact of implementing this strategy for the rangelands would be very positive.

Implementing this strategy for the rangelands would also have a very positive impact on regional development within Jordan.

This strategy will entail investigating the economic feasibility of irrigated forage production within the framework of crop rotation and water resource allocation, including sewage water.

This strategy could also mean utilizing rainfed forage legumes and barley within dryland farming systems; and investigating the economic feasibility of fish production.

3. Application of Technologies to Increase Livestock Production through Research, Extension, and Education and Training of Livestock Owners.

Livestock management systems are in a state of rapid change. The traditional pastoral system for sheep, goats, and cattle (and to a lesser extent camels) has shifted away from the traditional extensive pastoral ruminant system to semiextensive, semiintensive, and intensive production systems. In parallel, the feeding systems, along with the annual feed cycle and balance between feed availability and feed requirements, have been changing.

Consequently there is a need to establish new feeding regimes to make better use of feed resources and to improve the balance between feed requirements and feed availability.

This strategy includes the better utilization of the feed resources of roughage (i.e., straws and stubble); agricultural by-products, including by-products of irrigated vegetables in the Jordan Valley and Highlands, and animal and poultry slaughterhouse by-products; and feed grains.

4. Strengthening Production Support Services

This strategy would include increasing the role of the private sector, relative to the role of the government, in providing support services.

It would also include applying the principle of cost recovery for inputs and services. The government would continue to pay where the benefit of the service is national, but the livestock owner would pay where the benefit is individual.

This strategy includes improving livestock health care services, both preventive and curative. Improved animal health is of vital importance, since it plays a pivotal role in raising production efficiency. By investing only a small amount of effort and money, substantial payoffs can be realized. Apart from the vaccination services provided by the Veterinary Department of the Ministry of Agriculture, there is a need for the private sector to become increasingly involved in providing animal health care services.

This strategy means upgrading local ruminant breeds through selection, and carrying out research on the commercial feasibility of crossbreeding the local acclimatized breeds with imported exotic breeds. The improved breeding has to be accompanied by improved feeding, health, and husbandry practices in order to bring about the genetic improvement.

This strategy would entail phasing out the import of improved dairy cattle (i.e., pregnant Holstein Friesian heifers). This action would be taken in order to utilize more productively the livestock resource comprising the offspring and descendants of the 28,828 heifers imported already during the period 1983-1991. Private importation of selected breeding animals would continue to be permitted.

5. Strengthening Processing and Marketing Systems and Support Services

The processing and marketing of livestock products needs improvement. Some products like laban (yoghurt) and labaneh (thickened yoghurt) are produced and marketed better than others such as cheese, chicken, eggs, and red meat.

Substantial efforts and large investments will be needed from both the public and private sectors to implement this strategy.

3.4 Review Proposed Instruments

Livestock policy instruments to implement the above-mentioned strategies are listed below in priority order. They have been ranked according to impact on natural resource allocation, productivity, and sustainability:

1. Financial instruments should be modified, including price regulation, subsidies, export-import trade policy, incentives to investors, investment (government budget and private capital), credit, price support, and physical infrastructure development.

   Price regulation and feed subsidies are key policy issues. The phasing out of price regulations on cow milk, eggs, and broiler meat, and the phasing out of feed subsidies should be done carefully to maximize the positive benefits and to minimize any negative effects.

2. Processing and marketing systems and support services need to be strengthened. This requires the resources and components of a livestock marketing project.

3. Legislation must define and clarify the roles and mandates of the ministries and other institutions dealing with agriculture.

   The Ministry of Agriculture should have the overall mandate for agricultural matters, including allocation of irrigation water. It should also have input in matters that affect agriculture but that fall under the jurisdiction of other institutions. These matters include

customs, imports, exports, licenses, specifications related to agriculture and agricultural materials, and commodities.

The role of the Ministry of Agriculture should include policy formulation and planning, policy implementation and follow-up monitoring and evaluation, policy enforcement, and control of agricultural specifications.

The formal procedures for coordinating the activities of all institutions involved in agricultural development need to be improved; and this may be achieved partly through legislation.

A law is needed to establish a national farmers' union. The Farmers' Union in the Jordan Valley was established in 1974, but its activities are restricted to the Jordan Valley.

4. Human resource development requires increased investment in education and training courses and in related institutions. Human resources relevant to the livestock subsector include farmers, laborers, input salesmen, extension service personnel, researchers, and private entrepreneurs such as merchants and investors.

5. Production support services need to be activated. This means developing adaptive research and extension services for the transfer of improved technologies to livestock owners. Veterinary services for contagious diseases should be encouraged, particularly services for ruminants. Animal breeding services should be improved.

3.5 Evaluation of Impacts of 21 Proposed Development Policies (Objectives + Strategies + Instruments)

3.5.1 Evaluation Criteria

The impacts of proposed development policies may be evaluated on the basis of several criteria. These criteria include:

- Optimal use of resources and factor inputs
- Efficient use and allocation of resources
- Within the resources potential
- Sustainability of production
- Comparative advantage (market forces)
- Economic benefits and costs (both macro and microeconomic)
- Impact on regional development in Jordan
- Social impact (costs and welfare benefits)
- Environmental impact (positive and negative)
- Change in requirements for energy
- Risks

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- Practical to implement
- Easy transition and implementation (socioeconomic consideration)
- Balance between future supply of and demand for livestock products, livestock populations, and feed resources, and implications for the national economy

Both the selection of the set of criteria, and the weighting of the criteria within the set selected, are important in evaluating impact.

3.5.2 Evaluation of Impacts of 21 Proposed Integrated Livestock Production Subsector Development Policies

Twenty-one proposed livestock development policies (which are listed in the next section) have been assessed and evaluated according to their impact, effects, and implications in relation to the following questions and criteria.

Questions: What problem will the proposed policy solve?
What are the major assumptions and risks associated with the proposed policy?

Criteria for the first question:

- Natural resource allocation and efficiency
- Productivity
- Subsidies
- Technology transfer

Criteria for the second question::

- Optimality (can be both over and under utilization of factor inputs)
- Comparative advantage[23]
- Sustainability
- Economic viability

Criterion:

- Practicability of implementation of policies

[23] Comparative advantage: The ability of a country to produce a given good at a lower cost than another country relative to other goods that both produce, or (loosely) the ability to produce and export a given good at a price below the border price.

Grouping of Policies under Strategies

The recommended policies have been grouped according to the strategies upon which they are based in order to simplify the assessment and avoid repetition.

Underlying Assumption for Policy Analysis

The underlying assumption for this policy analysis is that better resource allocation leads to improved productivity and savings, which is a justification for reducing subsidies. Technology transfer is a way to improve productivity.

Financial and Economic Information

In carrying out the policy analysis for the integrated livestock production subsector, the agricultural scientists comprising the RPG Livestock have reached their time nd resource limits. They produced the quantitative financial and economic information required by economists to carry out the pooling and integration of all five subsector recommendations into an agricultural sector policy implementation plan. The RPG Livestock has now proposed a study project to produce this financial and economic information, viz. the Livestock Policy Development Project, and the Farming Systems Research Project.

The information needed to calculate the comparative advantage of livestock and poultry products is incomplete, although some data is available from the work done by the current GTZ-assisted Veterinary Epidemiology Project and GTZ-assisted Advisory Services to Ministry of Agriculture Project.

Approach to the Assessment of Impacts of Proposed Policies

The approach of the RPG Livestock to assessing the impacts of the proposed livestock development policies has been to examine impacts, effects, and implications in the context of trends and changes in the livestock subsector, mainly in terms of biology, agrology, ecology, and politics as far as practicable and relevant.

3.6 Priority Ranking of 21 Proposed Integrated Livestock Production Subsector Development Policies

The proposed livestock development policies listed below have been ranked according to the following criteria:

- Impact on natural resource allocation
- Impact on productivity
- Sustainability
- Practicability of implementation

The policies have been divided into two categories: first priority and second priority. The first-priority group has been numbered according to priority, the second-priority group has been numbered for convenience and identification only. In addition, for the first-priority group, the implementing institutions have been identified.

Both the first- and second-priority groups are important; all 21 policies are required for the comprehensive development of the integrated livestock production subsector.

First-Priority Policies

Recommended Policy

1. Natural resources will be conserved and improved through establishing livestock and poultry production, processing, and marketing systems which conserve and do not damage the environment.

   Primary implementing institution: No one main institution exists.

   Other implementing institutions: Ministries of Agriculture; Water & Irrigation; Industry; Municipalities & Environment; Health (for pollution, agrochemical residues).

Recommended Policy

2. The equitable allocation of water resources for irrigated agriculture shall include the requirements of livestock agriculture.

   Primary implementing institution: Ministry of Agriculture.

   Other implementing institutions: Ministry of Finance (e.g., for support pricing of outputs to provide incentives to produce high-quality forage hay); proposed National Farmers' Union.

Recommended Policy

3. Land resources of all land use capability classes will be developed and utilized for the most economically productive integrated plant-animal production systems.

   Primary implementing institution: Ministry of Agriculture.

   Other implementing institutions: Jordan Cooperative Organization.

Recommended Policy

4. Dryland resources will be utilized with farming systems which conserve and improve water, land, plant cover, livestock, and human resources.

   Primary implementing institution: Ministry of Agriculture.

   Other implementing institutions: Ministry of Municipalities and Environment (because of the human communities involved); Ministry of Interior (for enforcement of the provisions in Agriculture Law No. 20 of 1973 that prohibit the plowing or tillage of land that receives less than or equal to 200mm average annual rainfall); Department of Land & Survey, Ministry of Finance (with respect to customary right of access to and use of land); Proposed Red Meat Development Board (for support of improved marketing services); Proposed National Farmers' Union (for participation by farmers and livestock owners in the design of the implementation mechanism which all parties could respect).

Recommended Policy

5. Natural grazing resources will be rehabilitated and managed to achieve a high level of sustainable livestock production and productivity within the potential capacity of those feed resources.

   Primary implementing institution: Jordan Cooperative Organization.

   Other implementing institutions: Ministry of Agriculture (for technical matters); Ministry of Interior (for enforcement, if needed).

Recommended Policy

6. Animal genetic resources will be conserved and improved by carrying out livestock breeding programs, including but not limited to selection and crossbreeding and related applied research.

   Primary implementing institution: Ministry of Agriculture, National Center for Agricultural Research and Technology Transfer (NCARTT).

   Other implementing institutions: Jordan Cooperative Organization; Jordan University of Science and Technology (JUST), Faculty of Agriculture and Veterinary Medicine.

Recommended Policy

7. Animal health care services for livestock and poultry will be improved both by strengthening government services and by supporting private veterinary practices. The

system of public quality standards control of commercial veterinary products will be improved.

Primary implementing institution: Ministry of Agriculture, Directorate of Animal Production and Health, Veterinary Department.

Other implementing institutions: Jordan Veterinary Association; Jordan Center for Veterinary Vaccines; Jordan University of Science and Technology (JUST), Faculty of Agriculture and Veterinary medicine; Chamber of Commerce (representing manufacturers of veterinary products); Chamber of Industry (representing manufacturers of veterinary products).

Recommended Policy

8. Research, extension education, and farmer training will be carried out to establish economically feasible and no justifiable livestock management systems and husbandry practices to utilize national feed resources more productively and efficiently.

   Primary implementing institution: Ministry of Agriculture, National Center for Agricultural Research and Technology Transfer (NCARTT).

   Other implementing institutions: Ministry of Agriculture, Department of Extension; Jordan Cooperative Organization; University of Jordan, Faculty of Agriculture; Jordan University of Science and Technology (JUST), Faculty of Agriculture and Veterinary Medicine.

Second-Priority Policies (Note: Policy numbers are for identification purposes, and do not indicate ranking)

9. The roles, responsibilities, and authorities of the institutions involved in agricultural sector development will be clarified to improve their effectiveness.

10. The role of the private sector in providing livestock production, processing, and marketing support services will be increased relative to the role of the government.

11. A national farmers' union will be established to strengthen the representation and participation of farmers and livestock producers in the formulation and implementation of agricultural sector development policy.

12. The systems of milk processing and marketing will be improved through the establishment of a national dairy development board.

13. The systems of live animal marketing, slaughtering and processing, and meat marketing will be improved through the establishment of a national red meat development board. This will include meat, hides and skins, fiber, by-products, horses, mules, and donkeys.

14. The systems of processing and marketing poultry products will be improved through the establishment of a national poultry development board.

15. Price regulation of livestock and poultry products will be phased out gradually to maximize the positive benefits of the transition and to minimize any negative effects of the change.

16. Feed subsidies will be phased out gradually to maximize the positive benefits of the transition and to minimize any negative effects of the change. A compensatory support price will be adopted on forage and red meat production to compensate for the change during the transition period.

17. An open export, limited restricted import policy will be followed, such that any support of livestock subsector development policy instruments and projects will be maximized and any hindrance will be minimized.

    The implications are that the export and import of red meat will be based on: 1) the actual domestic production of red meat and white meat (poultry broilers); 2) not allowing red meat to be imported in excessive quantities at dumping prices; 3) prevention of smuggling; and 4) open-door export of lambs.

    The implications include preventing the dumping of powdered milk, and discouraging the import of white cheese.

18. The participation of men, women, and children in livestock husbandry practices; the actual tasks they carry out; and the role of each in improving livestock productivity will be taken into account in providing of extension education and training services. The implications of this policy include but are not limited to employing female extension officers to deliver extension services to female livestock farmers.

19. The government will apply progressively the principle of cost recovery for supplying inputs and services.

20. The provision of credit for livestock and poultry production, processing, and marketing enterprises will be supported, commensurate with their contribution to the national economy and potential increase in productivity.

21. The provision of livestock and poultry compound feed and feedstuffs by the private sector will be supported. The system of public quality standards control of commercial feed and feed products will be improved.

4. RECOMMENDATIONS

4.1 Conclusions and Recommendations

For Proposed Integrated Livestock Production Subsector Development Policies (comprising Objectives + Strategies + Instruments)

4.1.2 Identification of Institutions Involved in Implementing Proposed Policies

For further details see Action Program for Implementing Recommended Policies for Integrated Livestock Production Subsector Development.

4.1.3 Identification and Priority Ranking of Proposed Programs and Projects

The livestock development policies can be incorporated as components of projects and programs. (In this context a project is defined as a narrow range of specific related actions or activities, and a program as a broad range of related actions or activities.)

The proposed livestock development projects are listed below in order of priority for implementation. The numbers of the related policies (from the list in section 3.6) are listed alongside. The projects are ranked according to the following criteria:

- impact on natural resource allocation
- impact on productivity
- sustainability
- practicability to implement

1. Livestock Policy Development Project (Policy nos. 1, 2, 3, 15, 16, 17).
2. Integrated Crop Livestock Dryland Farming Systems Extension Project (Policy nos. 4, 8, 19)
3. Grazing Resources Management Project (Policy nos. 5, 19, 20).
4. Animal Breeding Development Project (Policy nos. 6, 19, 20).
5. Animal Health Development Project (Policy nos. 7, 19, 20).
6. Farming Systems Research Project (Policy nos. 8, 18).

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7. Livestock Education and Training Project (Policy nos. 8, 19).

8. Livestock Nutrition Research Project (Policy nos. 9, 10, 11).

9. Agricultural Institutions Development Project (Policy nos. 9, 10, 11).

10. Dairy, Red Meat, and Poultry Marketing Project (Policy nos. 12, 13, 14, 19, 20).

1. Livestock Policy Development Project

This project would provide technical assistance to examine resource allocation issues according to comparative advantage and other economic criteria such as impact on input use, production, farmer income, and government expenditures.

The economic justification and feasibility of the following would be examined:

- Allocation of irrigation water for forage crops, including recycling sewage water.
- Fish production.
- Establishment of a feed reserve.

This project would build on the work carried out under the current German GTZ-assisted Veterinary Epidemiology Project on the economic cost of the subsidy system.

Executing institution: Ministry of Agriculture. Other institutions involved.

2. Integrated Crop Livestock Dryland Farming Systems Extension Project

The technical and financial feasibility of increasing the productivity of the typical dryland farming system cropping program by growing legumes during the fallow period has been demonstrated under the recent Jordan Australian Dryland Farming project (1980-1991), but adoption of the technology by farmers has been slow.

This project would as the following:

- Help transfer the technology to farmers by carrying out a social analysis that identifies the reasons for the slow adoption and determines ways to improve the adoption rate and repeat adoption rate.
- Include a component for developing the use of mechanization in forage production and conservation.

- Extend to farmers the conclusions from the current ICARDA-managed Mashraq Project in Jordan regarding increased productivity of barley, pasture, and sheep production on drylands.

  Executing institution: Ministry of Agriculture.

3. **Grazing Resources Management Project**

   This project would include but would not be limited to:

- Rehabilitation of rangeland;
- Rehabilitation of rocky and shallow land in arable areas;
- Utilization of forage in forest areas;
- Identification of the composition, social structure, role, responsibility, and authority of the institution to manage the communal grazing land and the number of animals allowed on it and when;
- Formation and operation of grazing management bodies, groups, associations, or cooperatives of livestock owners;
- Assessment of land tenure, land use, and related legislation and its effectiveness;
- Assessment of the social dynamics, trends, and changes in land use practices;
- Assessment of the lessons learned from settlement schemes and grazing management schemes in Jordan;
- Political analysis and assessment of political will to conserve and improve natural resources;
- Application of water harvesting and desert dams;
- Digging wells to increase the utilization of rangeland plant cover without damage; Research; and
- Training of forage production and range management specialists.

  Executing institution: Jordan Cooperative Organization.

  Other institutions involved: Ministry of Agriculture; Ministry of Interior.

Pipeline project: The Government of Jordan has requested that the International Fund for Agricultural Development (IFAD) design a range development and management project with a view toward providing financial assistance. IFAD has proposed holding a three-to-four day forum in Amman in May 1993 to identify the details of the project.

4. **Animal Breeding Development Project**

This project would include components for:

- Upgrading local breeds of sheep and other ruminants through selection.
- Carrying out research on the commercial feasibility of crossbreeding the local acclimatized breeds of sheep with imported exotic breeds.

Executing institution: National Centre for Agricultural Research and Technology Transfer (NCARTT), of the Ministry of Agriculture.

Other institutions involved: Jordan Cooperative Organization; University of Jordan, Faculty of Agriculture; Jordan University of Science and Technology (JUST), Faculty of Agriculture and Veterinary Medicine.

5. **Animal Health Development Project**

This project would include components to strengthen the Veterinary Department within the Ministry of Agriculture and to establish private veterinary services.

This project would include but would not be limited to provision of medicines, mobile clinics and other transport facilities, and diagnostic facilities for the prevention and control of livestock and poultry diseases.

Executing institution: Ministry of Agriculture.

Other institutions involved: Jordan Veterinary Association; Jordan Center for Veterinary Vaccines; Jordan University of Science and Technology (JUST), Faculty of Agriculture and Veterinary Medicine; Chamber of Commerce (representing traders in veterinary products); Chamber of Industry (representing manufacturers of veterinary products).

6. **Farming Systems Research Project**

Livestock are integrated with crops, rangelands, and forests in land use farming systems with three types of access to water (the main natural resource limiting agricultural production): (1) rainfall and perennial irrigation water, (2) rainfall and supplementary nonperennial irrigation, and (3) all rainfall.

Research would attempt to determine the optimum land use farming systems for each of the three categories of access to water.

The place of forage crops within the cropping program and rotation on irrigated lands would be investigated.

This project would build on the work carried out under the current German GTZ-assisted Veterinary Epidemiology Project on the economics of four typical livestock farming systems, the economics of optimal livestock farming systems, and the economic implications of agricultural livestock policy instruments.

Executing institution: Ministry of Agriculture, National Center for Agricultural Research and Technology Transfer (NCARTT).

Other institutions involved: Ministry of Agriculture, Department of Extension; Jordan Cooperative Organization; University of Jordan, Faculty of Agriculture; Jordan University of Science and Technology (JUST), Faculty of Agriculture and Veterinary Medicine.

7. **Livestock Education and Training Project**

This project would strengthen the educational and training institutions and enable them to provide courses to upgrade the skills of people employed in the livestock sector. This includes but is not limited to training livestock owners in animal health care practices, sheep and dairy cattle production; and in-service training of field veterinarians.

Executing institution: Ministry of Agriculture.

Other institutions involved: Ministry of Agriculture, Department of Extension; Jordan Cooperative Organization; University of Jordan, Faculty of Agriculture; Jordan University of Science and Technology (JUST), Faculty of Agriculture and Veterinary Medicine.

8 **Livestock Nutrition Research Project**

The objective of this project would be to identify technically and financially feasible feeding systems for ruminant livestock and poultry that would increase the productivity and utilization of domestic feed resources.

Executing institution: Ministry of Agriculture, National Center for Agricultural Research and Technology Transfer (NCARTT).

Other institutions involved: Ministry of Agriculture, Department of Extension; Jordan Cooperative Organization; University of Jordan, Faculty of Agriculture; Jordan University of Science and Technology (JUST), Faculty of Agriculture and Veterinary Medicine.

9. **Agricultural Institutions Development Project**

This project would include technical assistance to draft legislation to:

- Define more clearly the functions of the institutions with activities that affect the agricultural sector
- Develop formal procedures to improve coordination among institutions
- Establish a national farmers' union.

This project would also include a component to review the institutional effectiveness of agricultural cooperatives and related producers' marketing groups and propose ways to strengthen them.

Executing institution: Ministry of Agriculture.

Other institutions involved: Prime Ministry Legislative Bureau.

10. **Dairy, Red Meat, and Poultry Marketing Project**

This project would include components to increase the productivity of the marketing systems for unprocessed livestock and poultry products, processing systems, and marketing of processed livestock and poultry products. The project would include but would not be limited to the establishment of marketing boards for the main products—dairy, red meat, and poultry—which would represent producers' and processors' interests.

Dairy marketing board functions would include the following:

- Policy issues of cow milk price regulation, and import of milk powder and white cheese;
- Development of dairy cattle industry;
- Development of forage production, including forage seed multiplication and distribution;
- Consumer nutrition education.
- Promoting consumption of fresh milk and dairy products;
- Hygienic milk production, processing, and marketing practices, including the dairy cooperatives;
- Use of milk cooling tanks on farms;

- Prevention of spread of Brucella by heat treatment of sheep's milk;
- Milk quality control laboratory services;
- Making renewal of farm license conditional upon the farms' maintaining milk quality up to the agreed standards; and
- Providing incentives for private sector investment.

Red meat marketing board functions would include:

- Development of sheep and goat production, including small-scale (5–10 animals per family) production, and private investment in fattening lambs and kids; and
- Development of forage production, including forage seed multiplication and distribution.

Poultry marketing board functions would include:

- Policy issues of price regulation of eggs and broiler meat, and import of frozen broilers.
- Assessment of and justification for privatizing the government-owned and-operated poultry broiler slaughter and processing facilities;
- Assessment of and justification for providing incentives for private investment in hygienic poultry processing plants, including freezing and cold storage facilities;
- Market intelligence and dissemination of price information (e.g., to stabilize the balance between egg production and egg consumption).

The majority of the board members would be from the private sector. The board would facilitate:

- Improvements in meat quality control and safeguards to public health;
- Improvements in the system of public quality standards control of commercial feed and feed products for poultry; and
- Improvements in the system of public quality standards control of commercial veterinary products for poultry.

Executing institution: Ministry of Agriculture.

Other institutions involved: Jordan Cooperative Organization.

4.2 Institutional Constraints on Implementing Policies

(i.e. institutional constraints on applying instruments through programs and projects to implement strategies to achieve objectives)

4.3 Key Issues (for resolution and decision)

Key Issue No. 1: Subsidized Concentrate Feeds

Subsidized concentrate feeds of barley and sorghum mixture and wheat bran are sold by the Ministry of Supply. The cost of the feed subsidy is approximately 15 million JD per year, and this cost is increasing annually. Sheep, goat, cattle, and poultry farmers benefit from the subsidy, with those who own sheep and goats benefiting the most. People differ on the question of subsidies. Are they good or bad? Should subsidies be phased out? The question is not as simple as it seems at first.

The question should be addressed carefully, taking into consideration the impact of subsidized feed on the sustainability of livestock production and production systems; on the production of feed grains and forages; on livestock numbers and productivity; and on the environment, especially the rangelands.

The positive effects are: encouragement of livestock production; and stability and certainty of feed provision in time and place.

The negative effects are: higher numbers of ruminant livestock; overgrazing and increased pressure on rangeland and natural pastures, which result in land deterioration; discouragement of feed and forage production and marketing; and creation of a black market.

The phasing out transition has begun already: the Government of Jordan has agreed under the International Monetary Fund (IMF) Standby program to gradually phase out producer and input subsidies on cereals over the 1993-1995 period. The solution should give some benefits to farmers for the production of forage and for the production of lambs and kids for meat.

Key Issue No. 2: Political Will and Serious Intent to Implement the Policy Reforms

This review of the integrated livestock production subsector has shown that existing policies and plans need to be changed. The political will to accept these changes must be sufficient to carry through the reforms. This means that the changes must be made with due seriousness to implement the new policies properly. The persons involved must be resolute.

Key Issue No. 3: Lack of Respect for Existing Laws

Even the existing laws are not respected. For example, Agriculture Law No. 20 of 1973 prohibits plowing of rangeland as a protection for plant cover, but rangelands are plowed and misused every year and very little, if anything, is done to prevent and control this practice.

Key Issue No. 4: Human Resource Development

The development of human resources, as an instrument of agricultural policy reform, warrants serious consideration. The human resource factor is pivotal from the point of view of training and increasing qualifications and occupational skills. It is also important from the point of view of financial rewards for those who are employed in the livestock subsector and for those who invest in the livestock subsector.

Key Issue No. 5: Capability of the Agricultural Sector Institutions

The capacity, competence, and effectiveness of the agricultural sector institutions to implement the recommended policy reforms and measures is an issue.

Implementing the recommendation in this report to clarify and define the roles, responsibilities, and authorities of the institutions involved in the agricultural sector, especially the Ministry of Agriculture, will have the added benefit of identifying those areas that should be strengthened institutionally. Taking remedial actions will be simplified.

Key Issue No. 6: Rangeland Conservation and Development

The method used to assess the cost-effectiveness or economic justification for carrying out conservation and improvement measures on rangelands is an issue, because different methods lead to different conclusions. While the controversy about methodology continues, however, inexpensive and affordable measures could be taken immediately, such as water-harvesting, contour strips, and use of shrubs.

4.4 Action Program

4.4.1 Plan of Steps Necessary for Alleviating Constraints and Resolving Issues.

For details, see Action Program for Implementing Recommended Policies for Integrated Livestock Production Subsector Development.

4.4.2 Action Plan of Follow-Up Actions by Main Institutions Specifically Responsible for Implementing Policies, i.e. the Executing Agencies of Proposed Programs and Projects.

For details, see Action Program for Implementing Recommended Policies for Integrated Livestock Production Subsector Development.

4.4.3 Action plan of Follow-Up Actions by Other Institutions Involved in Implementing Policies.

For details, see Action Program for Implementing Recommended Policies for Integrated Livestock Production Subsector Development.

4.5 Draft Mandate for Each Institution

Plan for each institution involved in implementing recommended livestock subsector development policies.

For details, see Action Program for Implementing Recommended Policies for Integrated Livestock Production Subsector Development.

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IMPORTS AND EXPORTS

See Section in Main Text on Imports and Exports.

The main items of livestock and poultry products which are imported and exported are as follows:

In main Text:

- Red Meat Supply in Jordan During 1990 and 1991.
- Red Meat Imports from 1980 to 1991.
- Live Sheep and Live Goats.
- Feed Imports from 1981 to 1991.

In an Appendix:

- Breeding Dairy Cattle (Imports only).
- Milk and Milk Products.
- Poultry Chicken Products (Meat and Eggs).
- Wool.
- Wheat, Wheat Flour, Millet and Cereal Straw.

1. Breeding Dairy Cattle Imports:

Table 2.4. XXXXX: Imports of Breeding Dairy Cattle (Pregnant Heifers) from 1983 to 1991

Item: Breeding Dairy Cattle (Pregnant Heifers)

Year	Imports Quantity number
1983	5020
1984	2645
1985	2000
1986	1461
1987	3188
1988	600
1989	990
1990	2772
1991	10152
Total	28828

Source: Directorate of Animal Production and Health Statistical Yearbooks 1979 - 1991 (Arabic).

2. Milk and Milk Products Imports and Exports

See Table 2.4.2.2: Milk Supply in Jordan During 1990 and 1991.

3. **Poultry Chicken Products Imports and Exports**

See Table 2.4.2.3: Poultry Broiler (White Meat) and Other Poultry Meat Supply in Jordan During 1988.

See also Table 2.4.2.4: Poultry Chicken Eggs Supply in Jordan During 1988.

4. **Wool Imports and Exports:**

Ap.1.1: Imports and Exports of Wool During 1990 and 1991

Year	Item (1)	Imports Quantity mtons	Exports Quantity mtons
1990	wool	520	2400
1991	wool	755	730
Total wool		1275	3130

(1) Wool (Greasy or Fleece Washed)
Source: Wattenbach & Strobel, 1992, Tables 5-C & 5-F.

5. **Imports and Exports of Wheat, Wheat Flour, Millet and Cereal Straw During 1990 and 1991**

Ap.1.3: Imports and Exports of Wheat, Wheat Flour, Millet and Cereal Straw During 1990 and 1991

Year	Item	Imports Quantity mtons	Exports Quantity mtons
1990	Wheat	611000	--------
1991	Wheat	759000	--------
1990	Wheat flour	9300	26500
1991	Wheat flour	NA	NA
1990	Millet	95	--------
1991	Millet	NA	NA
1990	Cereal straw	3400	--------
1991	Cereal straw	NA	NA

Source: Wattenbach & Strobel, 1992, Tables 5-A & 5-D.

APPENDIX II

ACTION PROGRAM FOR IMPLEMENTING RECOMMENDED POLICIES FOR INTEGRATED LIVESTOCK PRODUCTION SUBSECTOR DEVELOPMENT

First Priority Policies:

1. Environment policy. Natural resources will be conserved and improved through establishing livestock and poultry production, processing and marketing systems which conserve and do not damage the environment.

2. The equitable allocation of water resources for irrigated agriculture shall include the requirements of livestock agriculture.

3. Land use policy: Land resources of all land use capability classes will be developed and utilized for the most economically productive integrated plant-animal production systems.

4. Dryland resources will be utilized with farming systems which conserve and improve those water, land, plant cover, livestock and human resources.

5. Natural grazing resources will be rehabilitated and managed to achieve a high level of sustainable livestock production and productivity within the potential capacity of those feed resources.

6. Animal genetic resources will be conserved and improved by carrying out livestock breeding programmes, including but not limited to selection and crossbreeding and related applied research.

7. Animal health care services for livestock and poultry will be improved both by strengthening government services and by supporting private veterinary practices. The system of public quality standards control of commercial veterinary products will be improved.

8. Research, extension education and farmer training will be carried to establish economically feasible and economically justifiable livestock management systems and husbandry practices to utilize national feed resources more productively and efficiently.

P R O F O R M A

Action Program for Implementing Recommended Policies for Integrated Livestock Production Subsector Development

Priority Ranking of Recommended Policy: No. One.

Statement of the Policy:

1. Environment policy. Natural resources will be conserved and improved through establishing livestock and poultry production, processing and marketing systems which conserve and do not damage the environment.

Main institution which would be involved in implementing this policy:

- No one main institution exists.

Other institutions which would be involved in implementing this policy:

- Ministries of: Agriculture; Water & Irrigation; Industry; Municipalities & Environment; Health (for pollution agrochemical residues).

Institutional constraints on implementing this policy:

- No single institution is totally responsible.
- No clarity of roles of institutions involved, or clear procedure for coordination amongst them.

Key Issues relating to implementing this policy:

- Political pressure from beneficiary groups, i.e. the institutions carrying out activities which inevitably have an effect on the environment may have sufficient political influence to enable them to avoid having to comply strictly with the full requirements and implications of the policy.

Steps and decisions necessary for alleviating the constraints and resolving the issues relating to implementing this policy:

- Establish a Committee of the Council of Ministers to execute the policy.
- Draft and enact necessary legislation.
- Enforce the legislation.
- Gain public support for implementing the policy through sustained publicity.

- With respect to the institutional constraints being experienced by the Ministry of Agriculture, this report has recommended a policy that the roles of the agricultural institutions should be clarified to improve their effectiveness. This report has proposed also the related Agricultural Institutions Project which includes components for drafting legislation to: defining more clearly the functions of the agricultural institutions; and developing formal procedures for improving coordination between them.

Action plan of follow up actions by the main institution specifically responsible for implementing this policy, i.e. the executing agency of the related proposed project:

- Establish a Committee of the Council of Ministers to execute the policy.

- Committee of the Council of Ministers assesses the implications of the policy, i.e. what specific actions and activities the Committee itself, and the other institutions which would be involved in implementing this policy, are obliged to carry out to comply fully with the requirements of the policy.

Action plan of follow up actions by other institutions involved in implementing this policy:

- Ministry of Agriculture fits this responsibility for the environment, and these activities and actions into its organization structure.

- Ministry of Agriculture complies with the requirements and implications of the policy.

Draft mandate for each institution involved in implementing this policy:

- With respect to the environment, the Ministry of Agriculture is mandated or authorized by the new legislation to allocate agricultural resources and to control their use with safety and without damage to the environment.

- This mandate applies in principle to all other institutions involved in implementing this policy.

P R O F O R M A

Action Program for Implementing Recommended Policies for Integrated Livestock Production Subsector Development

Priority Ranking of Recommended Policy: No. Two

Statement of the Policy:

2. The equitable allocation of water resources for irrigated agriculture shall include the requirements of livestock agriculture.

Main institution which would be involved in implementing this policy:

- Ministry of Agriculture.

Other institutions which would be involved in implementing this policy:

- Ministry of Finance (for support pricing of outputs, e.g. incentives to produce good quality forage hay).
- Proposed National Farmers' Union.

Institutional constrains on implementing this policy:

- Quality control of water input is difficult now in practice.
- Achieving effective quality control on outputs, i.e . quality of hay, will be difficult. Will need mobile trained field staff inspectors, backed by laboratory facilities for proximate analysis of forage samples, to judge forage quality and to make certifications entitling the farmer to claim and to receive incentive payments.

Key Issues relating to implementing this policy:

Unseen and unknown future sustainable benefits compared with present visible and known returns, i.e. farmers unwilling to allocate scarce water for forage with present prices and profitability (or unprofitability); and government reluctant to commit public financial resources.

Steps and decisions necessary for alleviating the constraints and resolving the issues relating to implementing this policy:

The optimization of the use of the soil resource, by changing and intensifying cropping programmes, will require research into rotations, preservation of soil fertility, economics and what level of incentive payments are needed and justified.

Action plan of follow up actions by the main institution specifically responsible for implementing this policy, i.e. the executing agency of the related proposed project:

- Department of Planning & Economics, Ministry of Agriculture, initiates and coordinates activities.

Action plan of follow up actions by other institutions involved in implementing this policy:

- National Center for Agricultural Research and Technology Transfer (NCARTT) within Ministry of Agriculture, carries out research.

- Department of Extension, Ministry of Agriculture, carries out extension work with farmers and coordinates with proposed National Farmers' Union.

- Ministry of Finance prepares financing for incentive scheme.

Draft mandate for each institution involved in implementing this policy:

- Department of Planning & Economics, Ministry of Agriculture is authorized to execute this policy.

- NCARTT carries out research.

- Extension Department transfers the results of research and studies to farmers, and carries out field inspections for output quality control and certification.

- Department of Planning & Economics arranges incentives and enforcements to follow the recommendations.

- Ministry of Finance finances incentive scheme.

P R O F O R M A

Action Program for Implementing Recommended Policies for Integrated Livestock Production Subsector Development

Priority Ranking of Recommended Policy: No. Three

Statement of the Policy:

3. Land use policy: Land resources of all land use capability classes will be developed and utilized for the most economically productive integrated plant-animal production systems.

Main institution which would be involved in implementing this policy:

- Ministry of Agriculture.

Other institutions which would be involved in implementing this policy:

- Jordan Cooperative Organization.

Institutional constraints on implementing this policy:

- The correct identification of the most economically productive systems for each land use capability class will be a constraint because the necessary research is apt to be incomplete or not comprehensive enough because of financial constraints.

- Mis-use of forest is difficult to prevent and control, whether or not the most economically productive system has been identified, i.e. despite specifying the optimum stocking rate, the shepherd cannot be controlled.

Key issues relating to implementing this policy:

- Free choice systems versus imposed systems, i.e. two kinds of instruments to convince farmers to follow the recommendations of the technical advisory service.

Steps and decisions necessary for alleviating the constraints and resolving the issues relating to implementing this policy:

- Carry out research to identify the most economically productive integrated plant-animal production systems.

- Carry out research and development to identify constraints and to solve identified problems.

- Put research findings into practice with extension.

- Strengthen legislation.

- Strengthen the extension services.

Action plan of follow up actions by the main institution specifically responsible for implementing this policy, i.e. the executing agency of the related proposed project:

- Department of Planning & Economics, Ministry of Agriculture, initiates and coordinates activities.

- Strengthen the Department of Extension.

Action plan of follow up actions by other institutions involved in implementing this policy:

- National Center for Agricultural Research & Technology Transfer (NCARTT) of Ministry of Agriculture prepares research plan.

- Jordan Cooperative Organization prepares plan of activities in coordination with Ministry of Agriculture.

Draft mandate for each institution involved in implementing this policy:

- Department of Planning & Economics is authorized to enforce the policy.

- NCARTT is authorized to execute research plan.

- Department of Extension is authorized and financed to transfer results of research to farmers nd livestock owners.

- Jordan Cooperative Organization strengthens cooperative societies, extension service, and contract grower scheme for hay production.

P R O F O R M A

Action Program for Implementing Recommended Policies for Integrated Livestock Production Subsector Development

Priority Ranking of Recommended Policy: No. Four

Statement of the Policy:

4. Dryland resources will be utilized with farming systems which conserve and improve those water, land, plant cover, livestock and human resources.

Main institution which would be involved in implementing this policy:

- Ministry of Agriculture.

Other institutions which would be involved in implementing this policy:

- Ministry of Municipalities and Environment (because human communities involved)
- Ministry of Interior (for enforcement of the provisions in Agriculture Law No. 20 of year 1973 prohibiting the ploughing or tillage of land receiving less than or equal to 200 millimeters of rainfall annually on average.
- Department of Land & Survey, Ministry of Finance (with respect to customary right of access to and use of the land).
- Proposed Red Meat Development Board (for the support of improved marketing services).
- Proposed National Farmers' Union (for participation by the involved farmers and livestock owners in the design of the mechanism of implementation which all parties could respect).

Institutional constraints on implementing this policy :

- Actually utilizing the dryland resources with suitable farming systems, through a combination of incentives and enforcement.

Key issues relating to implementing this policy :

- Land rights, i.e. recognition and respect for customary rights of access and usage antedating 1921, land tenure, land usufruct, land ownership, crown land.
- Agreement (instead of controversy) on what are suitable farming systems for the dryland resources.

Steps and decisions necessary for alleviating the constraints and resolving the issues relating to implementing this policy:

- Carry out research to determine the most suitable farming systems in the different agro-climatic areas (distinguished mainly by differences in annual rainfall) within the dryland resources.

- Design an effective mechanism for implementation of the policy.

- Department of Lands & Survey, Ministry of Finance, issues a statement, or communicates effectively in other ways, that the presumed ability to acquire the right of ownership of crown land through occupation, cultivation and crop husbandry will be cancelled and no longer recognized officially.

Action plan of follow up actions by the main institution specifically responsible for implementing this policy, i.e. the executing agency of the related proposed project:

- Department of Planning & Economics, Ministry of Agriculture initiates and coordinates activities.

Action plan of follow up actions by other institutions involved in implementing this policy:

- Ministry of Municipalities and Environment prepares to cooperate.

- Ministry of Interior prepares to cooperate.

- Department of Land & Survey, Ministry of Finance, prepares to cooperate,

- Especially in what way the incentive for ploughing up marginal dry lands in order to acquire ownership through demonstrating and proving continuous occupation, cultivation and cropping can be eliminated effectively; and

- By reviewing the customary rights of access to natural resources of land and water based on survival needs in relation to rights based on the legislation of the modern state, with a view to identifying what rights and procedures of resource management can be respected both by the nomadic, transhumant and sedentary peoples who depend upon the dryland resources for survival and livelihood, and by the modern nation state.

- Proposed Red Meat Development Board prepares to cooperate through providing improved services for marketing and offtake of live animals, mainly sheep and goats but also camels.

- Proposed National Farmers' Union prepares to cooperate as representing livestock owners' and farmers' interests.

Draft mandate for each institution involved in implementing the this policy:

- Strengthen existing mandate of Ministry of Agriculture, i.e. Agriculture Law No. 20 of year 1973 with more specific mandate for dryland resources utilization.

- Ministry of Municipalities and Environment: existing mandate is adequate to authorize necessary cooperation.

- Ministry of Interior: existing mandate is adequate to authorize necessary cooperation.

- Department of Land & Survey, Ministry of Finance: strengthen mandate to authorize and facilitate resolution of land rights issues.

- Proposed Red Meat Development Board: expected mandate for marketing activities would be adequate to authorize necessary cooperation.

- Proposed National Farmers' Union: expected mandate for representation and participation would be adequate to authorize necessary cooperation.

P R O F O R M A

Action Program for Implementing Recommended Policies for Integrated Livestock Production Subsector Development

Priority Ranking of Recommended Policy: No. Five

Statement of the Policy:

5. Natural grazing resources will be rehabilitated and managed to achieve a high level of sustainable livestock production and productivity within the potential capacity of those feed resources.

Main institution which would be involved in implementing this policy:

- Jordan Cooperative Organization.

Other institution which would be involved in implementing this policy:

- Ministry of Agriculture (for technical matters).
- Ministry of Interior (for enforcement, if needed).

Institutional constraints on implementing this policy:

- Weak financial status of the Jordan Cooperative Organization.
- Lack of practicable plan of action.
- Lack of staff qualified in rangeland rehabilitation and grazing management.

Key issues relating to implementing this policy:

- Ownership of the rangeland.
- Land tenure and usufruct (grazing rights).

Steps and decisions necessary for alleviating the constraints and resolving the issues relating to implementing this policy:

- (1) Proposed Agricultural Institutions Project includes a component for reviewing the effectiveness institutionally of agricultural cooperatives and related producers' marketing groups and ways of strengthening them.

The cooperative movement in Jordan has reached a particular stage of development and evolution. In this report there is a policy recommendation to clarify the roles, responsibilities, authorities and mandates of agricultural institutions to make

them more effective, and a policy recommendation to increase the role of the private sector relative to the public sector in providing support services.

In this context, the Jordan Cooperative Organization needs to sort out what its role for the future should be, and to distinguish clearly between, its future development function and activities, and its future commercial functions and activities which have financed its development activities in the past.

- (2) Strong confirmation and enforcement of the ownership of rangeland by the State.

- (3) Allocate rangeland to groups of livestock owners.

The land is owned by the State and shall be allocated to groups and shall not be allocated to individuals in order to preserve yet adapt the customary and traditional communal rights of access to and use of the communal natural resources of water, land and plant cover. These customs and traditions include mechanisms for protecting all members of the community, including the rights of its poorest members, providing dignified employment, and saving the poorest from starvation.

- (4) Establish cooperative societies of sheep and goat owners.

Action plan of follow up actions by the main institution specifically responsible for implementing this policy, i.e. the executing agency of the related proposed project:

- Department of Projects, Jordan Cooperative Organization, initiates and coordinates activities.

Action plan of follow up actions by other institutions involved in implementing this policy:

- Ministry of Agriculture, National Centre for Agricultural Research & Technology Transfer (NCARTT) identifies research and grazing management studies needed.

- Ministry of Agriculture, Forestry & Range Department prepares to provide inputs such as seedlings and seeds of forage and browse species.

- Ministry of Interior, Badia police prepares to cooperate to minimize conflicts between adjacent and neighbouring groups of livestock owners, and to minimize counterproductive behavior within the groups such as an individual refusing to accept the group's management recommendation that no one shall graze his animals on that particular area on that day.

Draft mandate for each institution involved in implementing this policy:

- Department of Projects, Jordan Cooperative Organization: existing mandate is adequate to authorize necessary cooperation.

- Ministry of Agriculture, National Centre for Agricultural Research & Technology Transfer (NCARTT): existing mandate is adequate to authorize necessary cooperation.

- Ministry of Agriculture, Forestry & Range Department: existing mandate is adequate to authorize necessary cooperation.

- Ministry of Interior, Badia' police: existing mandate is adequate to authorize necessary cooperation.

P R O F O R M A

Action Program for Implementing Recommended Policies for Integrated Livestock Production Subsector Development

Priority Ranking of Recommended Policy: No. Six

Statement of the Policy:

6. Animal genetic resources will be conserved and improved by carrying out livestock breeding programmes, including but not limited to selection and crossbreeding and related applied research.

Main institution which would be involved in implementing this policy:

- Ministry of Agriculture, National Center for Agricultural research & Technology Transfer (NCARTT).

Other institutions which would be involved in implementing this policy:

- Jordan Cooperative Organization.
- University of Jordan, Faculty of Agriculture.
- Jordan University of Science and Technology (JUST), Faculty of Agriculture and Veterinary Medicine.

Institutional constraints on implementing this policy:

- NCARTT does not have an autonomous status to enable it to move freely and to act quickly and decisively. It does not have the institutional mechanism to move towards its perceived goals.
- Shortage of specialists in animal genetics and reproductive physiology.
- Lack of institutional framework for carrying out coordinated collaborative research.

Key issues relating to implementing this policy:

- Controversy over the balance between two ways of making economically productive way, viz. the conservation of indigenous germ plasm and its improvement of through selection; and the upgrading of local acclimatized breeds by crossbreeding with imported exotic breeds, followed by selection of the crossbred populations.
- Long term perspective needed for making genetic progress.

Steps and decisions necessary for alleviating the constraints and resolving the issues relating to implementing

this policy:

- Strengthen NCARTT and NCARTT Council.

- Prepare and implement animal breeding project, including research and training components (fellowships).

- Develop procedures for strict project progress monitoring and effective coordination which will be needed if more than one institution will carry out the research.

- Develop breeding policies and plans for each species consistent with the policy recommended in this report for animal genetic resources.

Action plan of follow up actions by the main institution specifically responsible for implementing this policy, i.e. the execution agency of the related proposed project:

- National Center for Agricultural Research & Technology Transfer (NCARTT) of Ministry of Agriculture prepares and carries out livestock breeding program, project and plans.

Action plan of follow up actions by other institutions involved in implementing this policy:

- Jordan Cooperative Organization collaborates with NCARTT to prepare and carry out assigned program.

- University of Jordan, Faculty of Agriculture collaborates with NCARTT to prepare and carry out assigned program.

- Jordan University of Science and Technology (JUST), Faculty of Agriculture and Veterinary Medicine collaborates with NCARTT to prepare and carry out assigned program.

Draft mandate for each institution involved in implementing this policy:

- National Center for Agricultural Research & Technology Transfer (NCARTT) of Ministry of Agriculture: strengthen existing mandate in order to make NCARTT more effective.

- Jordan Cooperative Organization: existing mandate is adequate to authorize necessary cooperation.

- University of Jordan, Faculty of Agriculture: existing mandate is adequate to authorize necessary cooperation.

- Jordan University of Science and Technology (JUST), Faculty of Agriculture and Veterinary Medicine: existing mandate is adequate to authorize necessary cooperation.

P R O F O R M A

Action Program for Implementing Recommended Policies for Integrated Livestock Production Subsector Development

Priority Ranking of Recommended Policy: No. Seven

Statement of the Policy:

7. Animal health care services for livestock and poultry will be improved both by strengthening government services and by supporting private veterinary practices. The system of public quality standards control of commercial veterinary products will be improved.

Main institution which would involved in implementing this policy:

- Ministry of Agriculture, Directorate of Animal Production and Health, Veterinary Department.

Other institutions which would be involved in implementing this policy:

- Jordan Veterinary Association.
- Jordan Center for Veterinary Vaccines.
- Jordan University of Science and Technology (JUST), Faculty of Agriculture and Veterinary Medicine.
- Chamber of Commerce (representing traders in veterinary products).
- Chamber of Industry (representing manufacturers of veterinary products).

Institutional constraints on implementing this policy:

- The division of the responsibility for providing animal health care services between the private veterinary sector and the public veterinary sector, has not been defined.

- Lack of qualified staff.

- Lack of equipment, drugs and medicines, other veterinary facilities and transport.

- The belief by many livestock owners that the provision of veterinary services is a public sector service duty and that the services should be free or nearly so.

Key issues relating to implementing this policy:

- Whether commercial veterinary products should become subject to price regulation similar to the price control on commercial human drugs and medicines. At present there is no price regulation on veterinary products.

Steps and decisions necessary for alleviating the constraints and

resolving the issues relating to implementing this policy:

- Prepare memorandum of understanding between government and Jordan Veterinary Association for provision of animal health care services. The Jordan Veterinary Association would represent private veterinarians working within the cooperative movement.

- Implement project with components for training and supply of equipment, drugs and medicines, other veterinary facilities and transport.

- Implement extension education and training program of livestock owners, including but not limited to preparing them for the progressive application of the principle of cost recovery for supplying inputs and services.

Action plan of follow up actions by the main institution specifically responsible for implementing this policy, i.e. the executing agency of the related proposed project:

- Ministry of Agriculture, Directorate of Animal Production and Health, Veterinary Department: Prepare memorandum of understanding between government and Jordan Veterinary Association for provision of animal health care services.

Action plan of follow up actions by other institutions involved in implementing this policy:

- Jordan Veterinary Association: Prepare memorandum of understanding between Jordan Veterinary Association and government for provision of animal health care service.

- Jordan Center for Veterinary Vaccines: collaborate with other institutions in making the change in delivery of veterinary services.

- Jordan University of Science and Technology (JUST), Faculty of Agriculture and Veterinary Medicine: prepare and deliver training courses to upgrade the skills of government veterinarians and to prepare them for increased private work, e.g. running a commercial practice.

- Chamber of Commerce (representing traders in veterinary products): cooperate in improving both the system of public quality standards control of commercial veterinary products, and the delivery system to retail outlets for veterinary products.

- Chamber of Industry (representing manufacturers of veterinary products): cooperate in improving system of public quality standards control of commercial veterinary products.

Draft mandate for each institution involved in implementing this policy:

- Ministry of Agriculture, Directorate of Animal Production and Health, Veterinary Department: strengthen mandate if necessary to enable Minister of Agriculture to sign the memorandum of understanding.

- Jordan Veterinary Association: strengthen mandate to authorize increased responsibility for providing animal health care services.

- Jordan Center for Veterinary Vaccines: existing mandate is adequate to authorize necessary cooperation.

- Jordan University of Science and Technology (JUST), Faculty of Agriculture and Veterinary Medicine: existing mandate is adequate to authorize necessary cooperation.

- Chamber of Commerce (representing traders in veterinary products): existing mandate is adequate to authorize necessary cooperation.

- Chamber of industry (representing manufacturers of veterinary products): existing mandate is adequate to authorize necessary cooperation.

P R O F O R M A

Action Program for Implementing Recommended Policies for Integrated Livestock Production Subsector Development

Priority Ranking of Recommended Policy: No. Eight

Statement of the Policy:

8. Research, extension education and farmer training will be carried out to establish economically feasible and economically justifiable livestock management systems and husbandry practices to utilize national feed resources more productively and efficiently.

Main institution which would be involved in implementing this policy:

- Ministry of Agriculture, National Center for Agricultural Research & Technology Transfer (NCARTT).

Other institutions which would be involved in implementing this policy:

- Ministry of Agriculture, Department of Extension.
- Jordan Cooperative Organization.
- University of Jordan, Faculty of Agriculture.
- Jordan University of Science and Technology (JUST), Faculty of Agriculture and Veterinary Medicine.

Institutional constraints on implementing this policy:

- NCARTT does not have an autonomous status to enable it to move freely and to act quickly and decisively. It does not have the institutional mechanism to move towards its perceived goals.
- Lack of national strategy and plans for agricultural and livestock research.

Key issues relating to implementing this policy:

- Priorities for research, i.e. what research topics should take precedence.

Steps and decisions necessary for alleviating the constraints and resolving the issues relating to implementing this policy:

- Strengthen NCARTT and NCARTT Council.
- Prepare national strategy and plans for agricultural and livestock research.

- Share the research work among participating institutions.

Action plan of follow up actions by the main institution specifically responsible for implementing this policy, i.e. the executing agency of the related proposed project:

- Ministry of Agriculture, National Center for Agricultural Research & Technology Transfer (NCARTT): Prepare program and plans for research, extension education and farmer training.

Action plan of follow up actions by other institutions involved in implementing this policy:

- Ministry of Agriculture, Department of Extension: Cooperate with NCARTT, and carry out assigned extension work.

- Jordan Cooperative Organization: Cooperate with NCARTT, and carry out assigned on farm research, extension work and field days.

- University of Jordan, Faculty of Agriculture: Cooperate with NCARTT, and carry out assigned research work and training.

- Jordan University of Science and Technology (JUST), Faculty of Agriculture and Veterinary Medicine: Cooperate with NCARTT, and carry out assigned research work and training.

Draft mandate for each institution involved in implementing this policy:

- National Center for Agricultural Research & Technology Transfer (NCARTT) of Ministry of Agriculture: strengthen existing mandate in order to make NCARTT more effective.

- Ministry of Agriculture, Department of Extension:

- Jordan Cooperative Organization: existing mandate is adequate to authorize necessary cooperation.

- University of jordan, Faculty of Agriculture: existing mandate is adequate to authorize necessary cooperation.

- Jordan University of Science and Technology (JUST), Faculty of Agriculture and Veterinary Medicine: existing mandate is adequate to authorize necessary cooperation.