

Country Pasture/Forage Resource Profiles

JORDAN



by

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CONTENTS

1. INTRODUCTION	5
2. SOILS AND TOPOGRAPHY	6
Major topographic features	6
Major soil types	7
3. CLIMATE AND AGRO-ECOLOGICAL ZONES	8
Climate	8
Bioclimate	8
Agro-ecological zones	9
Major agricultural enterprises in each zone	9
4. RUMINANT LIVESTOCK PRODUCTION SYSTEMS	10
Scale of enterprises	10
Small ruminant production systems	10
Sheep production systems	11
Feeding systems	12
Limitations	12
Socio-economic limitations	12
5. THE PASTURE RESOURCE	13
Description	13
Status of rangeland tenure (public versus private)	14
Settled communities in the grazing lands	15
Fodder crops	15
Feed balance	16
Forage seed production	16
Limitations	17
6. OPPORTUNITIES FOR IMPROVEMENT OF FODDER RESOURCES	18
Rangeland rehabilitation	18
Integration of livestock into farming systems	18
7. RESEARCH AND DEVELOPMENT ORGANIZATIONS AND PERSONNEL	18
Key institutions	18
Research priorities	19
Contact persons	20
8. REFERENCES	21
9. CONTACTS	22

1. INTRODUCTION

Location The hashemite Kingdom of Jordan is about 100 km from the south-eastern coast of the Mediterranean Sea, between latitudes 29°–33° N and longitudes 35°–39° E. It borders the Syrian Arab Republic to the north, Iraq to the east, Saudi Arabia on both eastern and southern borders, and Palestine to the west (see Figure 1), and has a land area of about 89 200 km², of which arable land is less than 5%. The population is 5 000 000 (the World Factbook 2006 estimate was 5 906 760), with a high annual growth rate of 3.5% (World Factbook 2006 estimate was 2.49%). About 30% of the population lives in rural areas and roughly 45% are below 15 years of age.

Land area, arable and pastoral areas. The actual cultivated area in 1997 totalled around 290 000 ha, of which 130 000 ha are planted with olives and fruit trees, 50 000 with vegetables and 110 000 with field crops. The fallow area was estimated at 90 000 ha. According to the Ministry of Agriculture survey, the number of farm holdings in 1997 was around 91 500, at an average area of 4.15 ha each, versus 57 438 holdings in 1983, at an average of 6.43 ha each.

About 90%, or 80 771 km², of the Kingdom is grazing land, 69 077 km² of which receive under 100 mm of rainfall, and 1 000 km² of marginal grazing with 100–200 mm annual rainfall. Natural and human-made forests cover 760 km², out of 1 300 km² registered as forests. There are also about 500 km² of state-owned land used for grazing in mountainous areas.

The ruminant sector. Livestock is a major component of the agricultural sector. According to 1999 statistics, it comprised 2 200 000 head of sheep and goats and 64 700 head of cattle. Table 1 indicates the evolution of livestock numbers.

In 1994 local production of red meat was 15 800 tonnes; it increased to 16 000 tonnes in 1996, then declined to 15 200 tonnes in 1997 only to rise in the succeeding year to 22 000 tonnes (Table 2). This was accompanied by a decline in meat imports, which were 33 100 tonnes in 1994, and declined to 23 700 tonnes in 1998. The Kingdom has improved its self-sufficiency in red meat. In 1994, it was 32.3%, but rose to 37.6 in 1996 and to 48.2% in 1998. The improvement was mainly due to drought, which caused a rise in number of animals slaughtered.

Farming systems. The total arable land (in 1997) was only 400 000 ha, less than a tenth of



Figure 1. Map of Jordan

Table 1. Livestock numbers in Jordan (,000 head)

Year	Sheep	Goats	Cattle	Camels
1930	229.1	289.5	n. a.	26.2
1940	265.0	506.0	n. a.	8.0
1950	267.3	325.3	n. a.	14.5
1960	608.9	513.3	n. a.	20.5
1970	664.9	350.3	37.6	10.5
1975	772.2	480.9	37.4	18.2
1980	825.0	453.0	28.0	12.3
1985	1 121.0	515.0	34.5	15.0
1990	1 556.0	479.0	37.3	21.0
1991	2 524.0	1 062.0	63.8	32.0
1992	2 524.0	1 062.0	63.8	32.0
1993	2 878.0	1 151.0	64.1	32.0
1994	2 211.0	814.0	61.2	32.0
1995	2 182.0	852.0	58.0	32.0
1996	2 375.0	807.0	61.6	25.0
1997	2 144.0	812.5	63.5	22.0
1998	1 935.0	649.6	61.2	18.0
1999	1 581.0	631.0	64.7	n. a.
2004*	1 529.1	501.1	69.3	18.0
2005*	1 671.5	444.5	69.1	18.0

Source: Animal Production Directorate Annual Reports, MOA
* 2004 and 2005 data FAOSTAT (2006)

Table 2. Production, imports and self-sufficiency of red meat (,000 tonnes)

Red meat	1994	1995	1996	1997	1998	1999
Local production	15.8	14.3	16.0	15.2	22.0	21.3
Imports	33.1	23.4	26.7	27.4	23.7	25.1
Available for consumption	48.9	37.7	42.7	42.6	45.7	46.4
Self-sufficiency (%)	32.3	37.9	37.5	35.7	48.2	44.0

a hectare per capita. This is accompanied by scarcity of renewable fresh water resources, which do not exceed 750 million m³ per year, an average of 170 m³ per capita for all uses. Around 80% of the cultivated area is rainfed.

The agricultural sector is characterized by unstable production; it depends on rain and its distribution over the cultivation season, which directly affects production of the rainfed lands, pasture, livestock and irrigated crops because of its impact on the dams, groundwater and water sources storage. In spite of the sector's low contribution to the GDP, it is still – in its economical and social dimensions – a fundamental sector of the national economy. It is the base for integrated rural development, a source of income and employment for rural and Badia (semi-desert) people and a generator of activities in the other economical sub-sectors, especially the industrial and services ones. It also plays a central role in food security and trade balance improvement.

Agriculture is the main income source of about 15% of the population and employs around 62 000 (6% of the workforce). Women constitute 6.6% of the sector's labour force and about 4% of the working women in all sectors. The agricultural sector contributed 13.7% of all exports (average 1991–95) and 15.4% in 1996.

Despite the increasing production and the constant increase of the net absolute value of agricultural production during 1993–97 from 193 300 000 Jordanian Dinars (JD 1.42 USD) at 1993 prices to 254 300 000 JD in 1997, its share in the GDP decreased from 6% in 1993 to 5.5% in 1997 prices and from 7.7% to 6.1% in fixed, 1985, prices as shown in Table 3:

If agriculture-related activities are included, then the share in GDP would increase to 28%. Jordan's dependency on agricultural imports increased with an aggravated deficit of the agricultural commodity balance (rose from 342 000 000 JD in 1993 to 543 000 JD in 1996 or about 120 JD per capita). The deficit was concentrated in basic commodities, mainly wheat and pulses at 149 000 000 JD, feed at 209 000 000 JD and red meat at 40 000 000 JD.

Table 3. Domestic product (in million JD)

Year	1993	1994	1995	1996	1997
Value of agr. domestic product in fixed prices	193.3	197.2	213.3	232.9	254.2
Share of GDP	6%	5.6%	5.5%	5.5%	5.5%
Value in fixed prices of 1985	154.3	140.4	146	150.4	153.4
Share of GDP	7.7%	6.5%	6.4%	6.3%	6.1%

Source: Annual Statistical Bulletins

2. SOILS AND TOPOGRAPHY

Major topographic features

There are four main physiographic regions (see Figure 2):

Jordan Rift Valley and Wadi Araba. The rift valley extends from Lake Tiberias in the north to the Gulf of Aqaba in the south. It is the Jordanian part of a continental shelf extending from Aqaba in the South to the Adasiyyah in the north. This zone is divided into three areas:

- **The Jordan Valley**, lies between 200–400 m below sea level, extending from Lake Tiberias in the north to the Dead Sea, with a length of 104 km and a width of between 4 and 16 km; it is surrounded in the east and west by high mountains. Rainfall decreases from approximately 300 mm in the north to 102 mm in the south.
- **The Southern Ghor**: this also lies below sea level to the south of the Dead Sea. Annual rainfall is less than 100 mm.
- **The Wadi araba**: this area extends between the Southern Ghor and Aqaba on the Red Sea. It is extremely dry, with limited cultivated areas using underground water.

The Jordan Valley and the Southern Ghor are among the most important agricultural areas, as there is a permanent source of water from the Yarmouk River and side dams for the former, and from surface water for the latter. Due to their position below sea level and high temperatures (microclimate), these two are the most important winter vegetable producing areas. Cultivable lands in Ghors total approximately 34 000 ha, all irrigated. The majority of holdings are between 3 and 4 ha. Farmers use modern agricultural

techniques in irrigation, production and marketing.

The Highlands. These extend from the Yarmouk River in the north passing through the Ajloun mountains, the hills of Ammon and Moab, and the Edom mountains. Many creeks and wadis drain from the east to the Jordan River, Dead Sea, and Wadi Araba. The average altitude ranges from 600 m in the north to 1 000 m in the middle and 1 500 m in the south. The highlands, which are a succession of catchment and sub-catchments, comprise: a semi-arid zone (350–500 mm annual rainfall) and a small sub-humid zone (over 500 mm annual rainfall).

The Arid Zone (Plains). This comprises the plains between the Badia (semi desert) and the Highlands. Rainfall ranges between 200 mm in the East and 350 mm in the West. More than 50% of the arable land is in this zone, the rainfed crops are mainly barley (areas of 200–300 mm of rainfall) wheat and fruit trees (where rainfall ranges between 300 and 350 mm).

Badia (Eastern Desert). This covers about 8 090 000 ha or 90% of the Kingdom. It is characterized by a very sparse vegetation cover and an annual rainfall of less than 200 mm. In the past it was only used for grazing. In the last two decades, however, 20 000 ha have been irrigated, using underground water, to grow vegetables (especially tomatoes, watermelon and potatoes), plus fruit trees and cereals, especially wheat.

Major soil types (see Al-Qudah, 2000)

The soils of the Rift Valley in Zor, Wadi Araba and parts of Ghor belong to the order entisols and enceptisols (ustochrepts). The other parts of the rift are covered by aridisols. In the north of the Valley, the soils are deep and of moderate to medium structure. These soils have good water holding capacity and are relatively fertile.

The soils of the Highlands are non-cracking soils (xerochrepts), cracking clayey soils (vertisols) and shallow loamy soils (xerothents). The soils are generally calcareous with fair nutrient level but suffer from nitrogen and phosphorous deficiency and occasionally iron and manganese deficiency. Their organic content is less than 1%. The texture is heavy loam to clayey with high water holding capacity.

The soils of the Steppe region are aridisols and entisols. They are deep to moderately deep, slightly gravely, with fine silty loam texture in the surface and subsoil horizons. The subsoil horizons are rich in CaCO₃ (calciorthids). The surface layer is dark, yellowish brown to brown. The high silt content of the surface soil and the absence of suitable organic content are responsible for the poor infiltration rate that leads to higher run-off and decreases the water storage capacity of the soil profile. Consequently, the vegetative growth is retarded and further soil degradation occurs. In general the soils of this region suffer from deficiencies of nitrogen and phosphorous. These soils are highly susceptible to gully and wind erosion particularly when disturbed by ploughing or subjected to over grazing.

The soils of the Desert region are aridisols and entisols. Soil depth varies considerably from one place to another. In the basalt area in the north, the deep clayey, well structured, soils occur below the

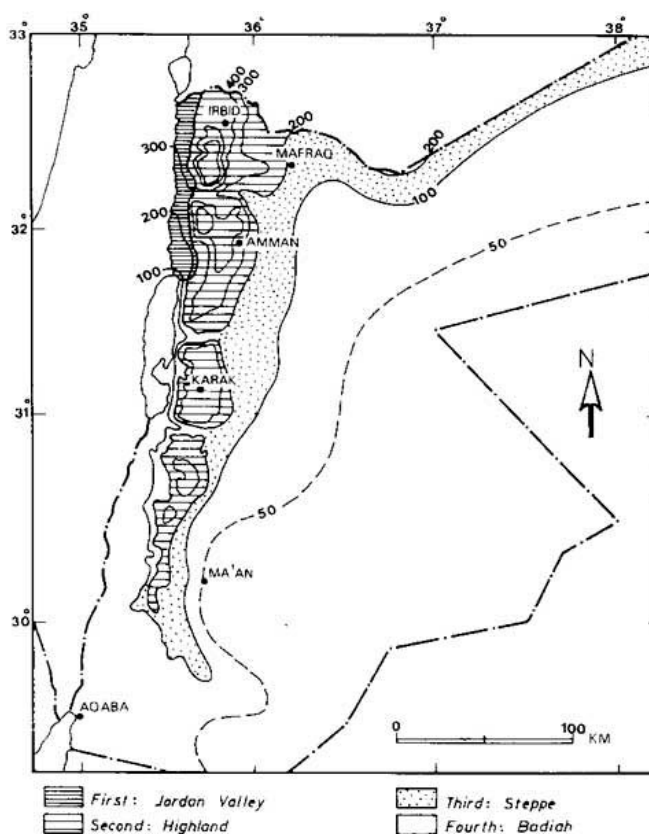


Figure 2. Physiographic regions

Source: GCEP: Jordan Country Study on Biological Diversity, 1998.

moderately weathered basalt pavement (camborthids). Recent soils are saline, rather silty due to the effect of wind sediments or are like the soils which occupy the mudflats. Older soils are clayey, deep, and contain higher amounts of CaCO_3 . In the middle of Badia and to the south of Azraq, the soils become saline and contain gypsum (gypsiorthids). In the south around Disi and Mudawwara, the weathered sandstone shale and granite have resulted in the formation of sandy soils. The soils are in general low in organic matter, sandy to sandy loam in texture, often highly saline or alkaline and are generally devoid of vegetation. Their water holding capacity and fertility status is very low.

3. CLIMATE AND AGRO-ECOLOGICAL ZONES

Climate

Jordan is on the eastern margins of the Mediterranean climatic zone of the eastern Mediterranean. This climate is characterized by hot, dry summers and cool, wet winters. More than 90% of the country receives less than 200 mm annual precipitation (see Table 4 and Figure 3).

There is a maximum annual rainfall of 600 mm in the northwest corner of the country (see Figure 3). Average temperatures show a reverse pattern; they increase rapidly from the dissected plateaus to the very low level graben, increase gradually from the dissected plateau to the eastern margins of the eastern desert, and decrease gradually from north to south in line with increasing altitude. The highest annual and monthly values for evapotranspiration are in the desert with an annual total of 2 427 mm for Ma'an and 2 325 mm for Rweishid in the northeast. In the highlands, values vary from 1 485 mm at Rabba to 1 343 mm at Shoubak:

Highest monthly values occur in July and the lowest monthly values occur in January for all the country.

Bioclimate

There are four bioclimatic subdivisions in Jordan (Long, 1957) – see Figure 4:

- **Mediterranean:** This region is restricted to the highlands extending from Irbid in the north to Ras En-Naqab in the south. The altitude ranges from 700–1 750 m above sea level. The rainfall ranges from 300–600 mm. The minimum annual temperature ranges from 5 to 10 °C. Soil type is dominated by the red Mediterranean soil (*terra rosa*) and the yellow Mediterranean soil (*rendzina*). This region comprises the most fertile part of the Kingdom and contains 90% of the population.
- **Irano-Turanian:** A narrow strip of variable width that surrounds all the Mediterranean ecozone except in the north. It is characterized by being treeless. The vegetation is mainly small shrubs and bushes such as *Artemisia herba-alba*, and *Anabasis syriaca*. Altitudes range from 500 to 700 m, and rainfall ranges from 150–300 mm. Mean annual minimum temperatures range from 5–2 °C,

Table 4. Rainfall distribution in Jordan

Rainfall range (mm)	Area (ha)	% of total area
< 50	3 679 670	41.26
50–100	2 325 260	26.07
100–200	1 986 630	22.28
200–300	435 700	4.89
300–400	216 210	2.42
400–500	118 030	1.32
> 500	104 520	1.17
Dead Sea	52 990	0.59
Total	8 919 010	100

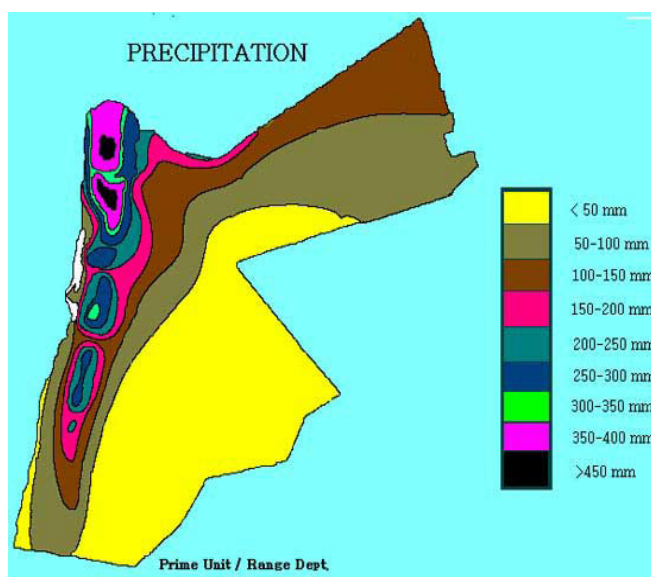


Figure 3. Rainfall distribution

and mean annual maxima range from 15–25 °C. Soils are mostly calcareous or transported by wind. The vegetation is dominated by chamaephytes.

- **Saharo-Arabian:** This is the eastern desert or Badia and comprises the largest part of Jordan encompassing almost 80% of its total area. It is flat except for a few hills or small mountains, the result of volcanic eruptions. Altitude ranges between 500–700 m. The mean annual rainfall ranges from 50–200 mm, mean annual minimum temperatures range from 15–2 °C. Soil is mostly poor, either clay, hammada, saline, sandy or calcareous. Vegetation is dominated by small shrubs and small annuals in the wadi beds.
- **Sudanian:** It starts from the northern part of the Dead Sea and ends at the tip of the Gulf of Aqaba in the south along the Dead Sea depression and Wadi Araba. The most important characteristic of this region is the altitude, considered the lowest point on earth (396 m below sea level near the Dead Sea). Rainfall ranges from 50–100 mm, the mean annual minimum temperature ranges from 10–29 °C, and mean annual maximum temperatures range from the minimal 20 to 35 °C. Soils are mostly alluvial, saline, sandy and granitic. The only inland sand dunes are in this region. The vegetation is characterized by a tropical tree element such as *Acacia* sp. and *Ziziphus spina-christi* in addition to some shrubs and annual herbs.

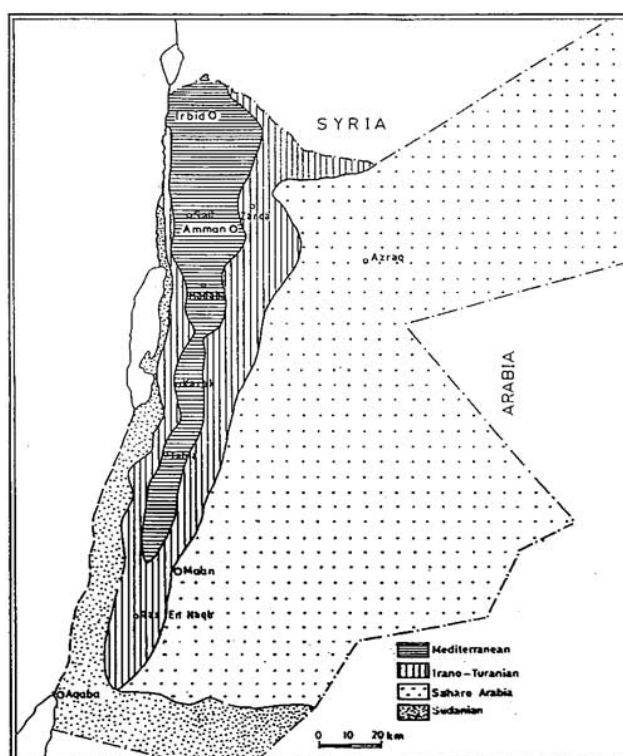


Figure 4. Bioclimatic regions of Jordan

Table 5. Agro-ecological zones in Jordan

Zone	Area (million ha)	% of total area	Average rainfall (mm)
Badia – Desert grazing	7.12	80.0	< 100
– Steppe grazing	1.00	11.2	100–200
Marginal zone	0.53	5.9	200–300
Semi-arid zone	0.17	1.9	300–500
Semi-humid zone	0.10	1.1	> 400
Total	8.92	-	

Agro-ecological zones

Four agro-ecological zones can be delineated as shown in Table 5.

Major agricultural enterprises in each zone

- **Badia (semi-desert zone):** The most significant use of this zone is pastoralism. Sheep and goats graze the forage produced on the desert range during the short time following rainfall. Steppes are used generally for grazing, but sizeable areas have now been put under cultivation. It is estimated that about 90% of the steppe areas were privatized and ploughed for barley. The cultivated area under irrigation of this zone is around 40 000 ha. Cereals, vegetables and fruit trees are usually cultivated in the irrigated Badia using underground water. Total natural forage production of these lands is estimated to be about 340 000 tonnes.
- **Marginal arid zone:** This zone is basically used for undependable barley growing. In good rainy seasons, barley is left to produce grains. Average production of barley grain, in the subzone receiving 200–250 mm of annual rainfall, ranges between 300–700 kg/ha. Sheep and goats graze most of the vegetation available in the region around the cultivated areas. After harvest flocks graze the stubble for which payment is 20–30 JD/ha. In dry years, the immature barley (green barley) is grazed at a cost of 30–50 JD/ha. The estimated production of the arid zone is 60 000 tonnes of barley grain, 80 000 tonnes of

straw, and 10 000 tonnes of dry matter of fodder barley.

- **Semi-arid zone:** The agricultural utilization of this zone is divided according to its topography as follows:

- Areas with slopes averaging below 9% are usually cultivated with wheat, other field crops and summer vegetables, within agricultural rotations.
- Areas with average slopes between 9-25% are used for tree crops, especially olives.
- Areas where the average slope exceeds 25% are used for grazing, forestry and fruit trees in some places. The estimated forage production of the mountainous grazing in this zone is about 13 500 tonnes of dry matter.

- **Semi-humid zone:** Wheat cultivation is dominant on flat areas; olives and fruit trees are cultivated on land with slope ranges between 9-25%. Forest trees are dominant in areas with slopes over 25%. The area of forest is about 40 000 ha and the estimated forage production is about 12 000 tonnes.
- **Ghor zone (the Rift Valley):** Ghor is the most important zone for vegetable, citrus and banana production, because of its tropical climate and the availability of irrigation water. Forage crops (mainly lucerne, *Medicago sativa*) are grown on a very limited scale.

Land uses by agro-ecological zone are summarized in Table 6.

Table 6. Land uses according to agro-ecological zones

Ecological zone	Uses	
Semi-desert (badiah)	pastoralism	100% in <100 mm rainfall areas
		50% in 100–200 mm rainfall areas
	Rainfed crops	40% in 100–200 mm rainfall areas
	Irrigated crops	10% in 100–200 mm rainfall areas
Arid	Barley growing	50% in 200–250 mm rainfall areas
	Cereals / fruit trees	25% in 300–350 mm rainfall areas
	Pastoralism	25% stubble grazing
Semi-arid	Cereals	40%
	Vegetables	30%
	Fruit trees	10%
	Forestry	5%
	Pastoralism	5%
Humid	Cereals (wheat)	50% (wheat)
	Fruit trees	30%
	Forestry	15%
	Pastoralism	5%
Ghor (Rift Valley)	Vegetables (irrigated)	85%
	Fruit trees (irrigated)	10%
	Forage cultivation	5%

Source: Abu-Zanat, 1995.

4. RUMINANT LIVESTOCK PRODUCTION SYSTEMS

Scale of enterprises

There are estimated to be 2 200 000 head of sheep and goats in Jordan (although Al-Qudah and Sabet (2000) suggest 2.6 M and according to FAOSTAT it was 2 030 210 in 2004 and 2 115 985 in 2005). Nomadic grazing has declined to less than 10% of the sheep and goats, which belong to less than 5% of herders. Meanwhile, the ratio of semi-settled herds has increased to more than 70% of all sheep and goats. The remaining small ruminants (about 20%) follow a system that is mixed with agriculture, especially in the west of the Kingdom.

Herd composition varies according to several factors, the most important of which is the area and productivity of the grazing and the availability of fodder. Herd size varies according to geographical zone. Herd size in the Badia and the marginal areas is larger than in the western regions. Studies have given differing figures for herd size.

Small ruminant production systems

Small ruminant production systems developed gradually in the middle of the past century as a result of the following changes:

- Increasing settlement of the nomadic Bedouin in the marginal areas.
- Change to and concentration on sheep and goat raising instead of camels.
- Deterioration of traditional grazing systems (eastward and westward trips) and spread of the use vehicles for movement of flocks and equipment.
- Increased dependency on imported feed.

Sheep: the pillar of the national livestock industry, represent about 65.6% of the animal units. They contribute 62% of red meat and 28% of locally produced milk. The main breed is Awassi, a tough wool, large tailed, triple-purpose (milk, meat and wool) sheep. They are medium sized; a male weighs 60–90 kg and a female 40–55 kg. They reach reproductive maturity young (9–12 months for females). Mating is in July–August, and lambing in December–February. Under good nutritional conditions Awassis are good milkers.

Goats: are second in quantitative and economic importance. They contribute about 23% of local red meat and 6% of fresh milk. Local (Baladi) and Shami breeds are kept. Baladi goats are the majority. They are medium- sized, rough and with medium length hair. An adult female weighs about 35 kg and adult males reach 40 kg. Baladi goats are concentrated in the mountainous areas in the northern, western and eastern regions.

Shami goats: There are about 35 000 Shami goats, about 3% of the total (1993). They are medium sized, brown, good milkers with a high twinning rate. The average weight of the adult female is 45 kg and the male 50–55 kg. Under good nutritional conditions Shami goats reach reproductive maturity at an early age and mating takes place during June–September.

An International Fund for Agricultural Development study in 1995 (IFAD, 1995), which encompassed 664 samples of sheep and goat breeders (owners of more than 50 head), showed that:

- 97% of the sample members own sheep and 82% own goats. The proportion of goats varies by geographical zone and is higher in the southern and middle regions than in the northern Badia.
- Average herd size is 296.7 head but this varies according to the rainfall. Herd size is higher in the northern Badia than in the middle and southern regions.
- 54.5% of the holdings employ shepherds, 97.7% of whom are paid in cash; the other 2.3% are paid in kind (partnerships or grants). Jordanians represented 23.7% of the shepherds and employees.
- In the mid- and northern Badia, milk is sold to cheese makers; but in the southern Badia, families make Jameed (dried yogurt) and clarified butter for sale.
- 69.9% of herders purchase crop by-products to feed their animals. Feed is their major expense; barley is top of the feed list, followed by bran.
- 70.3% of herders sell dairy products. This increases to 94.9% in the northern Badia and decreases to 80.4% in the south. Meanwhile, 12.9% of breeders' households consume their produce; 83.4% of sample members sell wool; the rest use it domestically.
- Sale of animals is the most important income source. Usually small animals, especially males, are sold even under 20 kg. 97% of the sample members sell sheep, while 84% sell goats.
- 32.5% of sample members moved with their herds according to the availability of grazing.

Sheep production systems

Sheep production systems vary from one location to another according to the availability of grazing, the breeder's financial capability and his technical knowledge. The production systems prevailing are:

- **Traditional system-nomadic mobile system.** This prevails in the eastern and southern regions, which are arid to semi-arid. It is the most extensive system as the herds move from one place to another, on foot or by truck, looking for grazing or water. The sheep depend on natural herbage as their main source of feed, in addition to the feed given in winter for a period which varies with availability of herbage.
- **Semi-nomadic system.** Sheep depend partially on natural grazing and on crop by-products. They move to land adjacent to the fields, and return to spend the winter around the houses where they survive on the feed given to them.
- **Settled (semi-extensive) system.** Stock are kept in fattening units. They graze in the morning and return to their units in the afternoon. They feed on crop by-products and the adjacent natural grazing. Supplementary feeds are fed to them as required.
- **Intensive system.** Sheep are kept in permanent farms with modern facilities and equipment. They are given balanced feeds, and health care is provided.

Feeding systems

In the past, local livestock depended totally on natural grazing. Their number did not exceed 500 000 head, pasture productivity was much more (at least twice) than at present and the area available was much more than it is now.

Existing statistics indicate that there are 2 200 000 small ruminants, which depend for half their food requirements on imported feed. Natural grazing supplies only 25–30% of their requirements, as its productivity has declined to half of its potential and the area has decreased. In the past, the availability of fodder and water, and the search for them, were the limiting factors for movement of herds. Nowadays food and water are transported to herds wherever they are, and it is possible to quickly transport the herds themselves.

Limitations

The major limitations of the sector can be grouped as follows:

- Lack of well defined policy: existing policies are not comprehensive and are incompatible with national needs and development plans. Feed subsidy policies from the 1980s until 1997 brought about the unusual increase in sheep and goats numbers and the deterioration in local production of feed. Also allocation of wide tracts of the best range to private ownership caused their deterioration and desertification.
- Pastoral communities continue informally to claim common tribal rights and enjoy free access and use of natural resources in their rangelands. However, these community claims are only recognized in settled areas. In all the unsettled areas the state asserts ownership regardless of customary tribal claims. State claims over grazing lands changed the traditional welfare system, caused the breakdown of resource allocation mechanisms and transformed secured-access rights into secured-tenure rights. Consequently, customary management rules are often no longer being enforced. State appropriation did not deny local communities access to their traditional pasture but, favoured a situation of open-access to grazing and expansion of barley cultivation.
- With removal of feed subsidies the profit margin before finance cost per ewe has declined from about 14 JD to 3 JD, with the assumption that levels of grain feeding are unchanged. Lifting of subsidies created serious financial problems for herd owners and forced a considerable portion of them to get rid of their flocks or to reduce their numbers in order to be able to feed the rest.
- Shortage of feed: local feed resources are limited. There is a big gap between the potentially available resources and the requirements of livestock in general. The local production of conventional and non-conventional feed resources can cover about only 50–60% of the needs of the local herd. The rest has to be imported.
- Unbalanced rations: farmers still use unbalanced rations for ruminants. These rations should be optimized in order to attain increase in output, to decrease the cost, reduce animal diseases, improve fertility, and consequently increase farmer's income.
- Animal health: animal disease is a major cost to livestock owners. Peste des petits ruminants (PPR), foot and mouth disease and blue tongue are endemic, causing debility rather than death. Internal parasites, external parasites, including lice and keds, together with nasal bots are significant problems. The effectiveness of government vaccination programmes is low. The imports of live animals and animal by-products from different parts of the world, and mobility of livestock within and across the borders, increase the potential of infection of animals with epizootic diseases. The losses through disease are reduced fertility and prolificacy, reduced growth rates, extended age at first lambing, mortality, and loss of quality of meat and products.
- Extension and farmer training are generally weak. Training in health care, nutrition and feeding, natural resource management, and animal management is needed.

Socio-economic limitations

- Lack of infrastructure for processing and marketing: due to the extensive production system and scattered nature of the stockowners, the transport of animal products to marketing outlets is not feasible or practical for small farmers.
- Land tenure: the absence of effective land user rights and rules, together with the passive attitude of users to this issue, represent the major constraint to change towards improved management.

Common use of the rangelands which gives an opportunity for any person to graze anywhere and with any number of animals at any time, due to lack of fixed utilization rights for specific people to graze at certain locations, is behind the present negative situation.

- Vague land ownership as grazing lands are still exempted from surveyed lands and subject to the state property law.
- Poor environmental awareness due to lack of education at all levels, and considering government lands as resources that are open for everybody with utilization constraints.
- Non-participation of range users, particularly farmers and rural women, in decision-making.

5. THE PASTURE RESOURCE

Description

Natural grazing land can be classified into three ecological zones:

Desert (Badia): The approximate area of these lands is 7 000 000 ha, which are concentrated in the area that receives less than 100 mm/year rainfall, which falls off towards the east and the south till it reaches 50 mm/year or even less. Most of these are state lands. Rainfall fluctuates from one year to another, in addition to bad distribution throughout the season; it comes as short thundershowers; and some places receive no rain at all for several successive years. Rain is the limiting factor for plant growth. Much of this area is covered with chert and an underlying thin layer of fine textured soil. *Artemisia herba-alba*, *Retama raetam*, *Achillea fragrantissima* and *Poa bulbosa* are common in the wadi beds, while the unpalatable *Anabasis* is present in most locations (see Table 7). Despite its deterioration (see Al-Qudah and Sabet, 2000), this region is the main grazing land of Jordan. The average annual dry matter production is 40 kg/ha in normal years (see Table 8); this can rise to 150 kg/ha in protected areas and range reserves.

There are some Bedouin communities in this region who live by livestock raising. The area suffers from a declining carrying capacity due to overgrazing and water and wind erosion. To develop this region, it is necessary to protect it to allow regeneration of the vegetation cover, reduce the stocking rate and specify the grazing season.

Steppe (marginal) grazing: The area is estimated at about 1 000 000 ha of which 90% is in private ownership. The average area of a holding is 23.6 ha in the northern Badia, 19.8 ha in the middle Badia and 9.1 ha in the southern Badia. The remaining 10% is state-owned. It receives 100–200 mm annual rainfall. According to its vegetation the steppe is divided into two regions:

- **Shrub region:** this is between Ras El-Naqab in the south and Mafraq in the north. The region is considered the best grazing in the Kingdom. *Artemisia herba-alba* associated with *Poa* and *Carex* are the prevailing plants. Its area is estimated at about 600 000 ha. It is considered to have a good potential for

Table 7. Palatability of desert plants

Highly palatable	Moderately palatable	Barely or not palatable
<i>Salsola vermiculata</i>	<i>Poa siniaca</i>	<i>Anabasis syriaca</i>
<i>Atriplex leucoclada</i>	<i>Poa bulbosa</i>	<i>Peganum harmala</i>
<i>Atriplex halimus</i>	<i>Artemisia herba alba</i>	<i>Noaea mucronata</i>
<i>Achillea fragrantissima</i>	<i>Haloxylon articulatum</i>	<i>Anabasis articulata</i>
<i>Erodium glaucophyllum</i>	<i>Haloxylon persicum</i>	
<i>Colutea istiria</i>	<i>Astragalus spinosus</i>	
<i>Stipa barbata</i>		
<i>Aristida plumosa</i>		
<i>Plantago albicans</i>		
<i>Reseda</i> spp.		
<i>Bromus scopiarius</i>		
<i>Erodium cicutarium</i>		
<i>Helianthemum salicifolium</i>		
<i>Medicago radiata</i>		
<i>Trifolium stellatum</i>		

Table 8. Vegetation production of rangelands

Range type	Rainfall (mm)	Area (ha)	Productivity kg/ha	Production tonnes dry weight
Desert range	<100	7 100 000	40	284 000
Steppe range	100–200	1 000 000	100	100 000
Mountain range	>200	45 000	300	13 500
Forests	>200	40 000	300	12 500
Total		8 185 000		410 000

improvement but needs protection against random grazing, restoration of vegetation cover, conservative stocking rates, conservation of the soil, and re-seeding or planting with plants suitable for its climatic conditions.

- **Grass region:** This extends from Mafraq in the west to the Iraqi border in the east, along the Syrian borders and covers an area of 400 000 ha. Vegetation includes *Poa* sp., *Carex* sp., *Stipa* sp., and *Salsola vermiculata*. The grass region is one of the areas that requires more attention. Productivity of steppe areas could be raised from 100 kg/ha dry matter to 450 kg/ha (in normal year) with application of proper range management and improvement practices.

Grazing vegetation of this area mainly consists of:

Highly palatable	Moderately palatable	Low or not palatable
<i>Salsola vermiculata</i>	<i>Poa siniaca</i>	<i>Anabasis syriaca</i>
<i>Atriplex leucoclada</i>	<i>Poa bulbosa</i>	<i>Peganum harmala</i>
<i>Atriplex halimus</i>	<i>Artemisia herba alba</i>	<i>Noaea mucronata</i>
<i>Achillea membranacea</i>	<i>Haloxylon articulata</i>	
<i>Astragalus platyrhaphis</i>	<i>Haloxylon persicum</i>	
<i>Erodium glaucophyllum</i>		
<i>Colutea istiria</i>		
<i>Stipa barbata</i>		
<i>Aristida plumosa</i>		
<i>Plantago albicans</i>		
<i>Avena sativa</i>		
<i>Trifolium</i> sp.		
<i>Ephedra alata</i>		

Mountain grazing The area of this zone is about 45 000 ha. It receives an annual rainfall of more than 200 mm. It is composed of small plots scattered around villages and between orchards, cropland and forests.

Grazing vegetation of this area mainly consists of:

Highly palatable	Moderately palatable	Low or not palatable
<i>Oryzopsis miliacea</i>	<i>Hordeum bulbosum</i>	<i>Poterium spinosum</i>
<i>Phalaris tuberosa</i>	<i>Cynodon dactylon</i>	<i>Asphodelus microcarpus</i>
<i>Festuca arundiacea</i>		<i>Centaurea palleescens</i>
<i>Lolium perenne</i>		<i>Phlomis syriaca</i>
<i>Dactylis glomerata</i>		<i>Ononis natrix</i>
<i>Trifolium fragiferum</i>		

Status of rangeland tenure (public versus private)

For a long period in the past, Jordan's grazing lands were characterized by effective traditional land tenure systems and grazing rights which were associated with tribal institutions. This protected the resources in these lands and organized their use in a way that assisted in their conservation and continued productivity under the prevailing environmental and social conditions. With the elimination of these systems and rights and declaration of grazing lands as state-owned land, open for everybody, new land uses encroached. Many of these areas were over-used without consideration to their resource requirements or their productivity. The above change in land tenure, also led to a lack of the incentives that encourage pastoralists and Bedouins to maintain and conserve their resources and lands and control their grazing. Therefore, the identification and definition of the ownership of these lands would greatly assist in setting plans for their development and improvement. According to the Agriculture Law No. (20) of 1973, all natural grazing lands are owned by the state; but in practice and reality, the case is the opposite. The area of these lands is about 8 000 000 ha, or 90% of the Kingdom's total area.

The number of livestock is totally out of balance with the available grazing, which has suffered serious mismanagement. The impact of overgrazing on the vegetation is evident from the excessive uprooting of the green matter (grass and bushes), leading to reduced seeding, reduced regeneration,

and the consequent loss of plant production in the next year. Also, there is a change in the floristic composition, a decline in volume and frequency of plants. Despite the increasing numbers of the animals, the poor herders' incomes and prosperity are declining. The causes include lack of sown fodder, decline in traditional management, extending the lambing season to unsuitable months and dependence on complementary feeds.

Settled communities in the grazing lands

There were no settled communities in the grazing areas until the middle of the twentieth century. Nomadic groups lived in wool tents and used to move according to the availability of forage and water. This included the eastward (Al-tashreeq) and westward (Al-taghreeb) trips to the eastern grazing regions in winter and spring, and return to western farming and mountainous regions to graze on grass and crop by-products in the summer and autumn.

Pastoral communities began to plough marginal land at the borders of the Badia to grow cereals in order to confirm property rights, when the survey and registration of lands started in the forties. Settlement of people and building started soon afterwards. Land survey and property registration were resumed in the eighties. Most of the marginal grazing and some deep-desert lands were registered. Estimates indicate that at least 1 500 000 ha (or 15–20% of the traditional grazing land) where the vegetation cover was damaged, were registered to pastoralists.

Stability and urban expansion accelerated on the marginal lands near the main cities from Ma'an to Mafraq and eastwards along the Syrian border. Large settlements grew deep in the Badia such as Safawi, Rowaishid, Reeshah etc. Government agencies came to provide these communities with services, including education, health, water, electricity, communications etc.

The main feature of this change is demographic. Communities tend to change from nomadic Bedouin to settled ones that are eager to urbanize and reduce dependency on grazing and livestock. They have become increasingly dependent on alternate income sources, such as employment in government institutions.

Statistics indicate that the population of the Badia is around 185 000 who live in 170 communities. There are 25 594 households, 12 242 (or 48%) of which own livestock. The prevailing grazing system in the Badia is semi-fixed nomadic grazing. Only 2% of livestock raisers are full-time nomads, the rest are semi-nomadic and live in houses, although their stocks move according to the availability of forage. Usually flocks are transported in trucks, as are water and feed.

Socially, the tribe played a distinguished role in pastoral communities as settlement takes place on a tribal basis. The tribe is the basis for distribution of lands according to tribal frontage.

Fodder crops

Feed crop resources in Jordan are: natural grazing resources; natural vegetation in rainfed arable areas; tbn, straw, and stubble; by-products of vegetables in the irrigated areas; sown forage production in the rainfed areas and irrigated areas; cereal grain and wheat-bran.

Estimates of fodder production vary according to the researcher. According to Harb and Karabelliah (1990) quoted by FAO (1994), feed production was 252 000 000 fodder units (FUs – equivalent to one kilogram of barley) or 597 071 tonnes. Neshewat (1990) quoted by FAO (1994) estimated the production as 765 634 tonnes. According to Gaddes *et al.* (1991), the annual fodder production is 262 000 000 SFU, which covers about 30% of local livestock requirements. Table 9 shows Jordanian feed resources according to Nabulsi *et al.* (1992).

Straw and stubble are an important feed source. These include cereal stubble, straw and grains left in the field, straw or standing hay of lentils, chickpeas, broad beans, vetch and other leguminous crops. Failed barley (due to lack of rainfall in dry years) is used as green fodder.

Fallows are also an important source of fodder. Fodder production on such lands has been encouraged through many programmes and projects using sown forages in agricultural rotations in the rainfed areas. Research results using several species of *Vicia*, *Lathyrus* and *Medicago* proved that the most promising for the higher potential parts of the country appear to be *Vicia sativa*, *Medicago sativa* and *M. rotata*. The use of a seed mixture of three parts of legume to one of cereal appeared to optimize production.

Barley is the main fodder grown in rainfed land since it is well suited to dry areas. It can be used as green hay, and can be harvested and collected as grain and straw, or is grazed stubble (according to the

rainfall amounts). The areas planted to barley show great variation according to the annual precipitation. Yields range between 250–800 kg/ha.

Water is a serious limiting factor hindering cultivation of irrigated forage. In high potential areas, the use of scarce water for cash crops give a better return than forage production. At present, substantial amounts of lucerne hay are imported. Under rainfed conditions, in areas of more than 300 mm rainfall, forage crops can be grown in association with cereals, in rotation with cereals, or replacing the fallow year between cereal crops with a forage legume. Vegetable residues, by-products, grasses and weeds are fed to livestock in irrigated areas. The amount of feed so produced is roughly estimated at 30 000 tonnes.

Wheat by-products, wheat bran and barley are a very important source of feed. Wheat bran and barley are the most important. The annual production from wheat bran (from both imported and locally grown grain) is around 140 000 tonnes.

Feed balance

The total feed units (FU) required by the animal sector was estimated to be 1 200–1 300 million in 1999. However, local production for the same year covered only 25–30% of requirements. Table 10 shows the imported feeds during the period 1992–

1999, and Table 11 shows the locally produced feed for the same period. Table 12 shows the feed requirements of the major animal sectors in 1999.

Forage seed production

The Ministry of Agriculture, through the Seed Centre in the Directorate of Forests, and under the technical direction of the Directorate of Range, has an annual programme for collecting forage shrub seeds for reseeded or production of seedlings. The most collected species are: *Atriplex halimus*, *A.*

Table 9. Total feed production in Jordan

Resource	Area/ha	Production tonnes DM	FU/kg	Million FU*	%
a. Range steppe rangelands**	1 000 000	100.000	0.8	40.000.000	31
desert rangelands**	7.100.000	284.000	0.8	113.600.000	
subtotal				153.600.000	
b. Highlands mountainous	200.000	120.000	0.8	96.000.000	25.7
fallow and neglected lands	130.000	39.000	0.8	31.200.000	
subtotal				127.200.000	
c. Green forage clover	828	89.932	1.0	8.932.000	1.8
vetch	155	455	1.0	455.000	
subtotal				0.387.000	
d. Field crops wheat straw		55.000	0.65	35.750.000	11
barley straw		20.000	0.65	13.000.000	
vetch straw		8.800	0.65	5.720.000	
subtotal				54.470.000	
e. Field crop grain barley		24.000	1.0	24.000.000	6.55
vetch		3.270	1.0	3270.000	
maize		5.213	1.0	5.213.000	
subtotal				32.483.000	
f. Food industry/ by-products (wheat bran)		13.000	0.75	97,500.000	19.7
g. Other by-products		40.000	0.5	20.000.000	4.4
Total				494.640.000	

NB: * One Feed Unit (FU) = 1 kg of barley ;

** Desert vegetation assumed 50% utilization

Source: Nabulsi et al. (1992)

Table 10. Imported feeds during the period 1992-1999 (,000 tonnes)

Year	Barley	Maize*	Cake*	Concentrates*	Ready feeds*	Straw & vetch	Milk substitutes*
1992	293.5	576.6	116.4	37.3	0.43	3.1	-
1993	483	349.9	89.5	43.8	0.7	6.7	-
1994	471.9	298.9	117.3	30.7	2.6	11.1	181.6
1995	487.9	348.3	140.4	37.4	0.8	19.5	156
1996	732.9	442.2	94.8	32.6	3.2	28.3	166.1
1997	507.9	236.6	131.2	30.3	1.3	20.1	252.4
1998	505.7	447.3	144.6	37.3	13.2	32.5	60
1999	707.6	436.7	189.5	28.8			0.14

* mostly used for poultry feeding

Table 11. Locally produced feeds during the period 1992-1999 (,000 tonnes)

Year	Barley	Stubble & hay	W. bran	Vetch	Green forage
1992	103.2	110	151.9	2.2	2.4
1993	44.2	90	165.4	1.6	6.8
1994	34.2	92	127.2	3.2	17.5
1995	57.7	85	94	5.4	34.2
1996	45	58	143	3.6	48
1997	42.8	60	188.9	4.1	27.3
1998	44.5	82	168	2.2	24
1999	6.1	14	165	3.8	20

leuococlada, *A. nummularia*, *Salsola vermiculata*, *Acacia saligna*, *A. arabica*, *A. farnesiana*, *Prosopis juliflora*, *P. tamarugo*, *Colutea*, *Ceratonia siliqua*, *Ziziphus spina-christii* which are, thereafter raised in nurseries and planted out. *Atriplex leuococlada*, *A. halimus* and *Salsola vermiculata* are used for direct reseeding of grazing land.

In the hope of encouraging fodder production in rainfed areas in a frame of integrated livestock and cereal production, some programmes worked on introduction of forage legumes into farming systems. Seed multiplication of *Medicago rotata*, *M. sativa*, *M. scutellata*, *M. rigidula*, *Vicia sativa* and other forages was subject to research, trials and demonstrations. A plant genetics unit, established in 1995 in the National Centre for Agricultural Research and Technology Transfer (NCARTT), and ICARDA has collected at 113 sites throughout the country to explore indigenous pasture and forage with potential to improve livestock feed. Seeds collected for research, or to be stored, included: *Salsola*, *Acacia*, *Ephedra*, *Tamarix*, *Aegilops*, *Astragalus*, *Bromus*, *Colutea istria*, *Dactylis*, *Hordeum*, *Lathyrus*, *Lolium*, *Medicago*, *Onobrychis*, *Phalaris*, *Poa*, *Trifolium*, *Trigonella*, *Triticum* and *Vicia*.

Limitations

Jordan's grazing lands have suffered continuous deterioration due to elimination of their vegetative cover as a result to the following factors:

- Overgrazing and too early grazing.
- Encroachment of barley cultivation into grazing lands leading to soil erosion and loss of indigenous plant resources and consequently loss of land fertility, productivity of forage and biological diversity.
- Uprooting of bushes for firewood by pastoral communities.
- Uncontrolled arbitrary movement of vehicles in grazing lands and availability of modern low-cost transportation.
- Increasing livestock densities leading to overgrazing and degradation of grazing land with loss of an important source of feed.
- Loss of traditional grazing practices depending on availability of natural forage (eastward and westward flock movements, Hema etc.) mainly due to demographic and agricultural development in higher rainfall areas which caused elimination of grazing in these areas and forced the livestock to stay all the time in the eastern range lands causing early and over grazing.
- Ploughing of marginal lands to ensure property rights over the land.
- Lack of regulations for rangeland use. Large areas are allocated for mining, military training and other uses.
- Lack of legislation that is sufficient to protect and manage the ranges, and failure to enforce existing legislation.
- Tribal land problems.
- Insufficient institutional environment for range management.
- Lack of staff specialized in range development and management.
- Lack of reliable information on the condition, dynamics and trend of rangelands.
- Poor coordination between institutions and projects working in the field of range, and scattered efforts among the various institutions.

The direct result of these practices is deterioration of the vegetative cover and opening the door wide for aeolian erosion of the soil. The consequences of such activities were loss of productivity and accelerated desertification.

Al-Qudah and Sabet (2000) summarize various institutional, legal, technical, infrastructural, economic and marketing constraints to rangeland development and factors in their depletion.

Table 12. Feed requirements of major animal sectors for 1999

	Unit	Poultry	Cattle	Sheep/goats	Total
No. animals	Million	129.1	0.065	2.21	
Barley	1 000 tonnes	4.5	139.2	294	437.7
W. bran	1 000 tonnes	17.5	43.6	103	164.1
Straw & hay	1 000 tonnes	-	112.7	108	220.7
Maize	1 000 tonnes	477	19.2	-	496.2
Soya cake	1 000 tonnes	152.5	36.3	-	188.8
Concentrates	1 000 tonnes	68.6	-	-	68.6
Vetch	1 000 tonnes	-	47.2	-	47.2

6. OPPORTUNITIES FOR IMPROVEMENT OF FODDER RESOURCES

The improvement of Jordan's grazing lands depends on the improvement and rationalization of their management. All other interventions are secondary.

Rangeland rehabilitation

Several institutions are involved in grazing management and rehabilitation. The Ministry of Agriculture is in overall charge. Early on, the Ministry of Agriculture started range development projects. It established 29 reserves totalling 84 400 ha in all regions; work in these reserves was confined to protection, water harvesting, re-planting/re-seeding and grazing control. The Ministry also carried out projects for the development of specific areas. Among those was the hamad Basin Development project, which aimed at comprehensive socio-economic development of the target area. Among the programmes dealt with by this project are: underground and surface water development for livestock, animal production and health, range development and management, and socio-cultural development (schools, health centres, etc.).

It is acknowledged that lack of involvement of local pastoral communities is a serious obstacle hindering land management; the Ministry of Agriculture has realized the importance of participation of beneficiaries in management issues. Participation of stake holders and beneficiaries is a major concern of the newly proposed national rangeland strategy, and MOA is now implementing the national rangeland rehabilitation programme that is using participatory methodology in planning and executing range development and management. The range directorate, with modest finance from international donors, implements participatory small range-related micro projects aiming at encouraging private rangeland development, water harvesting, lamb fattening, fodder production, intensive raising, dairy manufacture, and small income generation enterprises. The Jordan Cooperative Organization, with assistance provided through the World Food Programme (WFP), is, since 1981, implementing a programme in which range cooperative members plant fodder shrubs and improve grazing in communal lands allocated to those cooperatives by the Ministry of Agriculture.

Integration of livestock into farming systems

This is taking place in high rainfall areas (semi-arid and semi-humid agro-climatic zones) producing cereals and legumes for human and animal consumption. Small ruminants remain near communities or cultivated areas most of the year. The feed resources that are usually available to animals are barley grain, vetches, stubble, wheat bran, crop residues, agro-industrial by-products (olive cake, tomato pomace). Olive prunings and residues of vegetables in irrigated areas and residues of summer vegetables in rainfed areas play a considerable role during late summer and autumn in feeding animals. Grazing land provides 0–20% of fodder needs, depending on the proximity of mountain grazing. This agropastoral system represents 25% of national sheep and goats (Abu Zanat, 1995). Goats predominate in areas with hard topography or rich in woody plants. The two major constraints to this system are urbanization and land fragmentation.

7. RESEARCH AND DEVELOPMENT ORGANIZATIONS AND PERSONNEL

Key institutions

The Ministry of Agriculture: Through its Rangeland, Animal Production, Animal Health, and other Directorates, the MOA carries out the following tasks in relation to Rangelands and Livestock:

- Preparation and implement of rangeland annual development, improvement, protection, utilization and grazing plans and projects.

- Documentation of statistical data on sheep and camels in the Badia, their locations, movements, health care and control of diseases.
- Participation in providing extension services to sheep breeders.
- Participation in preparation of studies and projects related to vegetation and control of desertification.
- Setting regulations for protection of rangelands and the wildlife therein and monitoring their enforcement.
- Proposing the grazing and protection policies that regulate rangelands and grazing, in cooperation with concerned parties.
- Provision of Veterinary services to the livestock and supervision of all issues related to livestock and its imports, exports and feeds.

National Centre for Agricultural Research and Technology Transfer (NCARTT): Planning and conducting research activities in relation to range, fodder, livestock and other agricultural sectors.

The Cooperative Corporation: Planning and supervision of range development and management by the range cooperatives reserves.

The Higher Council for Science and Technology/ Badia Research and Development Programme: Conducting environmental and socio-economic studies in Safawi region.

Jordanian Universities: Carrying out studies and research concerning ranges, and teaching and training in the subject.

Land and Survey Department: Management of all issues related to property and land tenure issues.

The Royal Jordanian Geographical Centre: Preparation of maps, aerial photographs and images.

Environment Protection Corporation: Coordination of environment related issues.

Jordan Water Authority: Management of water resources

NGOs: There are different NGOs dealing with the technical, environmental, and social aspects related to Rangeland and Livestock related issues. These include:

- a. Royal Society for Conservation of Nature
- b. Hashemite Fund for Human Development
- c. Care International
- d. Jordanian Society for Environment Protection and Control of Desertification.
- e. Jordan Environment Society

Research priorities

The National Centre for Agricultural Research and Technology Transfer (NCARTT) is the government institution responsible for planning and coordination of implementation of agricultural research activities. Universities and some other institutions and projects are also doing research activities. The national agricultural research strategy, programmes and activities are shown in Table 13. NCARTT's main objectives for the Low Rainfall Areas Research Programme are:

- To reduce degradation of rangelands.
- To increase productivity of rangelands.
- To suggest proper utilization methods for sustainable production.
- To improve the socio-economic conditions of range users.

Research priorities for rangeland include:

- Improvement of vegetation cover
- Rangeland rehabilitation

- Water harvesting techniques
- Monitoring and evaluation of climatic information and soil types
- Grazing systems
- Economic aspects

The integrated livestock programme of NCARTT aims to improving animal production, especially of sheep and goats through the following research activities:

- Improvement of the local races through selection and breeding.
- Improvement of the management of sheep and goat farms.
- Improvement of the quality of animal feed.
- Examination of the possibility of using agro by-products in animal feeding.

Through its rainfed and irrigated agriculture research programmes, NCARTT aims to promote integrated farming systems and to improve quantitative and qualitative feed production.

For University of Jordan (UOJ), the objectives of rangeland research are:

- Developing indices for evaluating rangeland degradation and estimating the seed bank in the soil.
- Developing techniques for establishing fodder shrubs and trees by transplanting and direct seeding.
- Re-introducing fodder shrubs to cultivated grazing land.
- Developing sound management practices for fodder shrubs and trees.

Table 13. NCARTT's research programmes and distribution of activities

Programmes		Activities	%	
1	Rainfed Agriculture	Land resources	2.5	17.0
		Plant protection	3.4	
		Vegetables	0.9	
		Field crops	5.0	
		Medical/ aromatic plants	0.9	
		Fruit trees	4.3	
2	Irrigated Agriculture	Land resources	3.5	25.0
		Plant protection	5.0	
		Vegetables	7.5	
		Field crops	2.5	
		Fruit trees	4.0	
		Medical/ aromatic plants	2.5	
3	Integrated Livestock	Sheep	9.9	22.0
		Bee keeping	1.1	
		Cattle	5.5	
		Camel	1.1	
		Poultry	4.4	
4	Low Rainfall Areas	Rangelands	9.0	17.0
		Natural resources	5.0	
		Desertification	3.0	
5	Genetic Resources	Seed bank	1.0	8.0
		Field crops	1.0	
		Fruit trees	2.0	
		Vegetables	1.0	
		Wild plants	2.0	
		Medical plants	1.0	
6	Water & Environment	Water management	7.0	11.0
		Environment	4.0	
Total			100.0	

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Webpage of Interest: <http://www.nis.gov.jo/>

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