

# Country Pasture/Forage Resource Profiles

## OMAN



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## 1. INTRODUCTION

The Sultanate of Oman is on the south eastern corner of the Arabian Peninsula, along the Gulf of Oman and the Arabian Sea, from the Strait of Hormuz in the North to the borders of Yemen in the South. The Sultanate shares borders with the Republic of Yemen, the United Arab Emirates (U.A.E.) and the Kingdom of Saudi Arabia (Figure 1). It covers an area of approximately 309 500 km<sup>2</sup> and includes several islands: the U.A.E separates Madha and Mussandam from the mainland. Two-thirds are desert ranging from Al-Sharkiya to A'Dhahira in the North, through Jadat Elharasees up to Dhofar in the far South.

The Sultanate comprises five administrative divisions or regions (see <<http://www.nsaom.org.om/english/omanadmin.htm>>): Al-Dakhiliya, Al-Batinah, Al-Wasta, Al-Sharkia, Al-Dhahira, and three governorates: Musandam, Dhofar and Muscat. The country is divided into 59 states.

According to the 2003 census the population is 2 340 815, of whom 76.1% are Omani citizens and 23.9% expatriates (according to the World Factbook the July 2006 estimated population was 102 229 [with 577 293 non-nationals] with a growth rate of 3.28%). Al-Batinah is the most populous area (27.9%), followed by Muscat Governorate with 27%, Al-Sharkia with 13%, Al-Dakhiliya with 11.27% and Dhofar Governorate with 9.19%. The Middle Region has a very low population density (0.98%). Overall population density in the Sultanate is estimated at 11 individuals/km<sup>2</sup>. The annual rate of population increase has reached 1.84%.

The most developed urban regions are in the south and the north due to favourable economic and environmental circumstances, especially the availability of water and job opportunities. Other factors: the existence of inhabitants along the coast, oases, valleys and nearby chains of mountains influence this situation. There are no accurate statistics about the urban and rural



Figure 1. Map of Oman



Photo 1. Dense woodland in Dhofar



Photo 2. Eillop coastal plain



Photo 3. *Ficus vasta*



Photo 4. Densely vegetated sea-facing slopes

populations but estimates in 1993 put the urban inhabitants at 40%. According to the 1997 census the category of ages under 14 years represents about 46% of the population; 25–65 years olds represent 51%, and over 65 years old 3%. This frame of age categories is expected to have an effect on the type of preferred careers: traditional ones - farming, herding and fishing are expected to decline. The huge availability of services in urban centres has motivated emigration from rural areas. The internal emigration net rate is estimated at 1.42 per 1 000 citizens. There is random rural emigration in response to drought, environmental deterioration and declining soil productivity, raising urban population density and putting more pressure on resources.

The Sultanate of Oman is arid; annual rainfall averages about 100 mm, of which 80% is lost to evaporation, 5% flows to the sea and about 15% infiltrates into the soil. There are no perennial rivers, with the exception of Dhaiga wadi (70 km south of Muscat). Seasonal watercourses (wadis) flow after heavy rains. Pools along wadis hold water for variable periods; some may last the whole year. Springs at the bottom of wadis and the edges of mountains flow into other permanent ponds.

The Sultanate depends on groundwater from springs and wells. Aquifers are replenished by occasional rainfall. Renewable groundwater supplies are estimated at about 1 239.8 million m<sup>3</sup> annually (JICA, 1990). Groundwater varies in quantity, quality and distribution. The quantity of groundwater drawn in 1990 was 850 million m<sup>3</sup>. JICA also estimated that water lost in torrential floods is about 230.5 million m<sup>3</sup>. The agricultural sector is the main user of water (94% of the total) and its demand for water has constantly increased. The increase in human and livestock populations and their rising food and feed demands, expansions in cultivated area, extensive use of the deep wells with modern pumps, and changing cropping systems from seasonal to permanent trees and perennial grasses, have led to a deficit in water balance. The result is wider gap between supply and demand for water reflected by the critical shortage in water resources in most regions of the country. The sum of adverse effects is a decrease in quantity of groundwater and deterioration of its quality, drying of many wells and springs,



Photo 5. Summit grasslands



Photo 6. Typical escarpment woodland



Photo 7. Wadi Darbat pools



Photo 8. Typical local cattle

intrusion of sea water and its mixing with groundwater in coastal sites. A study by the Ministry of Regional Municipalities, Environment and Water Resources indicated that the annual water shortage exceeds 300 million m<sup>3</sup>.

In spite of its dry climate most of the country enjoys a high degree of biodiversity, especially in less arid areas such as Dhofar Governorate, where seasonal rainfall induces diverse and dense vegetation. The biological environments (fauna and flora) in the north of the country are similar to those in Iran and Pakistan, while the African types are encountered in the south. [Typical vegetation for various regions is shown in photos 1–8.]

There is a wide range of crops, especially in Dhofar. Diversity is not confined to food crops such as sorghum, wheat and barley, but extends to horticultural products, such as bananas, citrus, mangoes, jak fruit, and native forage plants such as: *Themeda quadrivalvis*, *Ziziphus spina-christi*, *Acacia tortilis*, *Grewia* spp. and *Anogeissus dhofarica*, irrigated forage (lucerne), vegetables (cucumis) *Solanum* spp, *Corchorus olitorius*, *Basella rubra*, *Allium*, *Nannorrhops* sp. *Cassia*, *Capparis* spp, *Ocimum forskolei* and perfume sources such as *Lavandula* spp, and *Boswellia sacra*. Many other genera grow on Dhofar Mountains, such as *Tamrindus*, *Olea* sp. and *Moringa oleifera*. The flora of Oman, is estimated at 1 208 genera 87 of them endemic.

Range, forest and woodland are natural reserves and suitable habitats for many mammals, birds and other types of wildlife. Mammals include Arabian deer, wolf, striped hyena, Arabian tiger, Nubian ibex, Musairah rabbit, Arabian Oryx, Arabian ibex. There are 451 species of bird, some resident and others passage migrants. This biodiversity is being adversely affected, through human interference, over-exploitation and degradation of resources, especially over-grazing, deforestation and overall ecosystem fragmentation. The scarcity of renewable resources, which are jeopardized and deteriorating and accelerating development programmes, indicates an urgent need for an action plan not limited to protecting biodiversity, but giving attention to rehabilitating threatened ecosystems, to maintain

**Table 1. Cattle, camels, goats and sheep by region (head)**

Region	Cattle	Camels	Goats	Sheep	Total
Muscat Governorate	4 542	55	47 992	13 998	66 587
Al-Batinah Region	66 349	5 652	427 982	119 475	619 458
Musandam Governorate	325	38	68 417	5 635	74 415
Al-Dhahira Region	22 542	15 639	243 606	95 059	376 846
Al- Dakhiliya Region	19 033	6 735	200 232	42 586	268 586
Al-Sharqiya Region	14 604	12 232	312 658	58 547	398 041
Al-Wasta Region	4 543	22 987	72 601	14 897	115 028
Dhofar Governorate	171 893	57 716	170 219	7 424	407 252
Total	303 831	121 054	1 543 707	357 621	2 326 213

Source: \* 2004/2005 agricultural census, MAF; Website: [www.agricensus.gov.om](http://www.agricensus.gov.om)

**Table 2. Oman: livestock numbers ('000 head), live animal and meat and milk imports (1996–2005) according to FAO database.**

Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Cattle	244.5	258.0	271.0	285.0	299.0	313.5	319.8	326.2	330.0	335.0
Sheep	281.1	295.0	312.0	327.0	344.0	354.0	361.2	368.4	370.0	375.0
Goats	902.3	925.0	940.0	959.0	979.0	998.0	1 018.2	1 038.6	1 050.0	1 070.0
Camels	94.7	95.0	96.0	117.0	118.9	120.8	117.8	120.2	122.0	123.0
Total	1 522.6	1 573.0	1 619.0	1 688.0	1 740.9	1 786.3	1 817.0	1 853.4	1 872.0	1 903.0
Live sheep imports ('000 head)	513.9	441.6	530.9	477.9	499.4	460.8	488.6	328.6	333.0	n.r.
Live goat imports ('000 head)	644.9	926.9	886.7	851.2	750.4	1 113.8	754.6	850.3	961.8	n.r.
Total meat imports ('000 tonnes)	48.7	47.0	53.1	52.7	39.3	65.3	85.2	75.5	73.1	n.r.
Whole dried milk imports ('000 tonnes)	10.4	11.7	10.3	11.3	9.3	32.4	40.5	42.4	64.5	n.r.
Whole evaporated milk imports ('000 tonnes)	15.0	15.7	15.0	15.6	9.4	12.9	14.1	25.5	18.3	n.r.

Source: FAO database 2007; n.r. no record

**Table 3. Imports of live animals and livestock products in Omani Riyals**

Year	1968	1989	1995	1996	1997	% increase over this period
Imports						
Live animals	3.1	7.5	19	17.9	20	545.2
Meats & meat products	21.7	22.4	33.4	35.7	35.8	64.97
Total	24.8	29.9	52.4	53.6	55.8	125

Source: Annual Statistical Book (1989)- Development Council – Technical Secretariat

Annual Statistical Book (Aug. 1998) Ministry of National Economy, Vol. 26

One Omani Riyal = US\$ 2.6

resources for sustainable development to assure livelihoods and to ensure social welfare for current and future generations.

Most livestock is owned by herders and small farmers. According to the 2004/2005 agricultural survey the number of livestock reached 2.4 million (Table 1). Table 2 shows data from the FAO database which gives slightly lower livestock numbers (1.9 M in 2005, mainly due to lower goat numbers) as well as live sheep and goat imports and meat and milk imports. The value of imports of livestock and their products recorded an increase, estimated at 125% between 1968–1997 (Table 3). FAO data indicate that in 2004 the value of meat and milk imports were respectively 93.5 M US\$ and 188.3 M US\$. The system of animal rearing is related to the style of living and prevalent grazing systems. The main systems are: nomadic based on camels and goats on the dry rangelands; transhumance where cattle, camels and goats are raised under partial or full dependence on natural pastures; supplementary feed is provided by irrigated forages, concentrates, and dried sardines. The third system is sedentary, characterized by fattening livestock for the local market as well as relatively large and small scale dairy farms. Here production depends upon irrigated fodders in addition to supplementary feeding utilizing farm by-products and purchased concentrates.

Land tenure systems in the Sultanate vary from freehold to communal ownership. In centres with more enlightened groups, land tenure is based on leasehold. Holdings are small and their areas range from 2–8.5 ha.

## 2. SOILS AND TOPOGRAPHY

### Soils

The Oman Soil Atlas, prepared in 1992 by UNDP/FAO Project-OMA/87/011 Soil Survey and Land Classification, showed that 93% of land is unsuitable for cultivation; most is arid, rocky, or sandy and unproductive. Currently, a small part (about 1.4 million ha) is used for grazing. Most of the population and resources are in northern Oman. Agricultural soils are situated on flat alluvial plains, coastal and alluvial plains, watercourses and mountain terraces.

Soil surveys in 1990 indicated that 2.223 million ha of land are suitable for agriculture (MAF, 1990), of which 791 651 ha are highly suitable and 1 431 406 ha are moderately suitable. According to a JICA 1990 study based on satellite imagery (Landsat MSS) analysis in 1982, only 269 000 ha are suitable for cultivation.

### Topography

The landscape of the Sultanate is varied and has multiforms with similar soil variability [see Figures 2 and 3]. The following features are encountered:

- **Island of Mussandam** in the far north has a deeply fissured fjord-like landscape.
- **North Oman**, is surrounded by the Hajar Mountains that stretch from the northwest up to the south-east (600 km) along the northern coast. The western part of the Hajar Mountains (El-Jebel El-Akhdar 3 009 m) is higher than the eastern part. Due to the calcareous, alluvial nature of the material from which these mountains were formed, water flows freely through deep ravines to the wadis.
- **Al-Batinah coast**, which is the most important agricultural region, is characterized by relatively fertile soils. Its width ranges from 10 to 50 km, extending 400 km between the western Hajar Mountains and the Gulf of Oman. In the north and the west soils are alluvial, including sandy silt Yermosols, among the most suitable soils for agriculture.
- **Ga'alan**: south of the eastern Hajar Mountains, is the homeland of Wahiba sand which extends 200 km to the Indian Ocean. Here, the soil is basically formed as a result of alluvial cumulating processes and aeolian sand deposits. Most of the suitable agricultural lands are Yermosols. Interfluvial plains, which are covered by Arenosols have high potential agricultural productivity. (JICA, 1990).
- **Nejd**: wide flat arid plains in the middle of the country, which extend 800 km from the Hajar Mountains to the chain of Dhofar Mountains, cover the western part of the country. Yermosols in the north, which represent the agricultural soil in the area, were derived from the calcareous Hajar Mountains. Flood water moves silty materials to the wadis, forming fine textured soils.

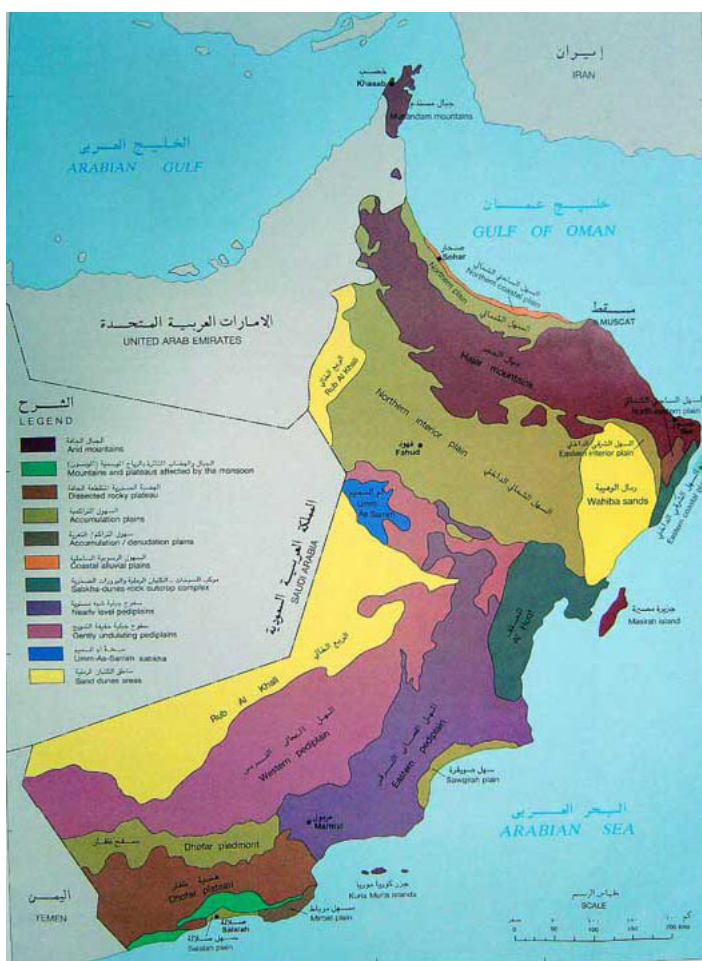
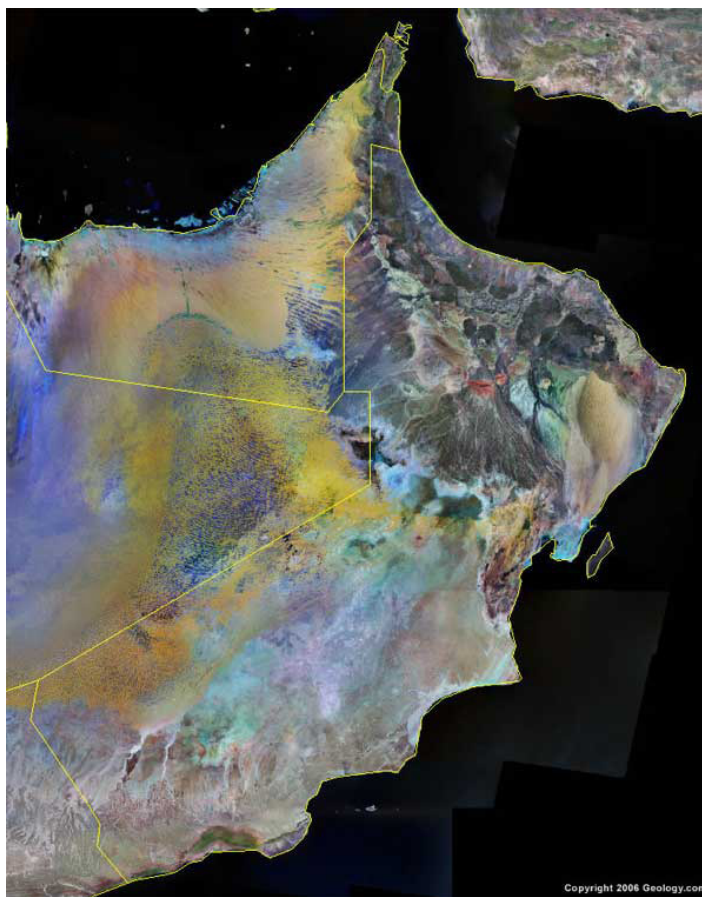


Figure 2. Physiographic regions of Oman

- **Dhofar:** the home of frankincense trees and most of the relatively productive rangelands and woodlands covers 100 000 km<sup>2</sup> of diverse land systems, which include the high sand dunes of the Empty Quarter, the dry moist plateau, the steep mountain escarpments, the deep wadis, foothills and coastal plains. Salalah coastal plain of yermosols derived from the Dhofar Mountains is the most important agricultural area in the Governorate. Silt and clay are basic elements that form mountain soil. Yermosols are the main soils in the Nejd desert.



**Figure 3. Satellite image of the main physical features of Oman**

### 3. CLIMATE AND AGRO-ECOLOGICAL ZONES

#### Climate

The climate of Oman varies according to the prevalent wind, the upwelling of coastal cold water and cyclones. The country is characterized by a desert sub-tropical climate, except in the Dhofar Mountains which enjoy an arid and semi-arid tropical climate; the area receives seasonal rainfall as a result of the monsoon winds from the Indian Ocean saturated with cool moisture and heavy fog. The monsoon season starts late June and extends to late September. It stays dry during the rest of the year, however, occasional rains fall out of season causing floods and influencing watersheds and the coastal plain. It is hot and humid in summer, but in winter it is cool in coastal areas and relatively cold on the mountains.

The interior parts (Nejd) are hot and dry in summer and relatively cool in winter. Rains along the coast and the interior plains, fluctuate between 20–150 mm/year and occur during mid and end of winter. There is more rain in mountainous areas, especially in El-Jebel El-Akhdar, where it may reach 700 mm annually. The calcareous nature of the mountains facilitates infiltration of water to form a rich aquifer that replenishes springs and supplies water to users in low areas.

In Dhofar rainfall varies from 100 mm in the coastal plain, to 200–350 mm in Dhofar Mountains; in addition to moisture derived from mist, which ranges between 50–300 mm. This latter quantity varies according to altitude, aspect, topography and woody species crown configuration.

#### Major agro-ecological zones

Most of the land is desert, arid or semi-arid plains and mountains. In addition to the mainland which is estimated at about 309 500 km<sup>2</sup>, there are many small islands, the most important of which Maseira Island, which, with the Musandam Peninsula guards the strait of Hormuz. There are three major ecological zones with profound impact on the country's agricultural and pastoral activities; the coastal zones of the north and south constitute 3% of the total area covering 9 000 km<sup>2</sup>, the mountain zones of north and south

cover 45 000 km<sup>2</sup> being 15% of the total area, and the dry lands and deserts of the centre that covers most of Oman and approximates to 246 000 km<sup>2</sup>, 82% of the country (as well as approximately 9 500 km<sup>2</sup> covering numerous islands, among which Masirah and Hallaniyat are the largest).

### Major agricultural activities

A large sector of the population depends on, and derives its living from, agriculture: irrigated farming, pastoral activities and fishing. Estimates put those involved in these activities at about 85 000, 60 000 and 18 500 households and fishermen, respectively. Much farming is at a subsistence level, the rest of Oman's inhabitants depend on imported and commercially grown foods. Although the contribution of the agriculture and fisheries sectors has increased from 14.3 million Omani Riyal in 1967 to 111.7 million in 1989, as a percentage of the National Domestic Product their contribution has dropped notably from 34.6–3.6% in the same period (JICA 1990). Nevertheless the government realizes the importance of these sectors and pays special attention to their development to improve food security and in order to check excessive emigration from rural to urban areas.

In the southern part of the Sultanate most livestock feed is derived from grazing lands. In the north grazing lands only yield feed immediately after the rains. Studies in 2000 indicated that the dry matter requirements of the herd in Dhofar are met by natural pastures (75%), hay and green grasses (7.5%), concentrates (15%), and sardines, crop residues, and other residues and by-products (2.5%). In the North, 40% of livestock feed is from natural pastures; concentrates provide most of the rest. Woodlands and shrubs are the only feed source during drought and times of forage scarcity. Pastoral resources support other rural income generating activities including beekeeping, ecotourism, and rural handicrafts.

The status of cultivable lands in Oman is not clear despite studies and surveys, perhaps because of the various definitions of agricultural lands and lack of comprehensive detailed surveys. The north-western coast, known as Batinah, is the most important agricultural area in the country and in the Arabian Gulf. The 2004/5 agricultural census showed that the country's agricultural area is about 84 000 hectares 47.4% in the Batinah area, 48.5% in the Northern area and about 4.2% in Dhofar Governorate. Half of the cultivated area is under date palms which number about 10 million, producing some 238 611 tonnes of dates. Fodder crops occupied 20 000 ha, with 42 000 ha of fruit, 19 000 of vegetables and field crops about 3 000 ha.

Groundwater resources in the Batinah helped to create an important agricultural area (dates, vegetables, fodders, livestock and fruit trees) irrigated from wells which supports about 28% of Oman's population.

The interior foothills of the Northern Mountains, and in Dhakilya, Sharquia and Dhahira areas are inhabited by Shawawi (a goat raising tribe) and date farmers who form together about 20% of the country's inhabitants.

In Dhofar Governorate there is irrigated farming on the coastal plains near Salalah. The total cultivable land is estimated at about 4 000 ha of which 3 482 ha are cropped annually. Coconuts, bananas, vegetables, maize, papayas, fodders [mainly Lucerne (*Medicago sativa*), and Rhodes grass (*Chloris gayana*)] are the main crops. Groups of fishermen are distributed along the coast between Mirbat and Jazir. This area is increasing in importance for the national economy. Dhofari herders, specifically cattle raising groups who occupy the flat plateau of Dhofar Mountains, practice rainfed cultivation, which used to occupy a larger area and more households; they grow cowpea, mung, sorghum, small grains, local cucumber, and recently, maize.

## 4. RUMINANT LIVESTOCK PRODUCTION SYSTEMS

Livestock production evolved under subsistence systems, which are shifting gradually and at various levels towards a market economy. Local trade varies from sales of a few small ruminants and cattle in the north, to selling at a larger scale in Dhofar Governorate. Animal production systems and livestock keeping are related to and affected by, community's ways of life and grazing opportunities. Animal production systems can broadly be divided into:

### **The nomadic system:**

In this system grazing lands are the main source of livestock feed and groups adopt a mobile strategy following availability of grazing within national borders. It prevails in the Nejd (desert) where Bedouin groups move with their livestock within their traditional tribal boundaries as well as in other sites within their region or governorate. These nomadic groups depend on camels and goats for subsistence and income.

### **The transhumance system:**

Pastoralists and agro-pastoralists' herds and flocks depend fully or partially on grazing lands. This system is adopted by semi-sedentary groups who have permanent houses but practice seasonal movement from one area to another within their home lands. Previously these groups followed an orderly movement with their animals to give the range vegetation a chance for growth and renewal. After the end of the rainy season they return to their bases in what is known as Al-Zuhair movement in Dhofar Governorate. Here herders depend on their livestock (mainly cattle but also goats and camels) beside some agricultural products from traditional cultivation plots (Mishdidas). Currently cattle herders in the Dhofar Mountains practice a semi-sedentary system of animal production which depends on grazing and crop residues (part of it produced locally) in addition to Rhodes grass hay, concentrates and sardines.

The nomadic and semi-sedentary pastoral communities are thinly spread over the entire central desert region, as well as other areas. In the north, along the Batinah coast, in the nearby valleys of the Hajar Mountains Range and El-Jebel El-Akhdar and the interior foothills are the "Shawawi" goat breeders (nearly 10 000 people). In the south, are the Dhofari livestock (cattle, camel and goats) herders. The Mahra tribe (around 6 000 individuals) in the southwestern and southeastern parts of the Nejd in Dhofar Governorate; also, the Beit Kathir tribe (around 6 000 individuals), which inhabits the central, northern and the western parts of Dhofar Governorate, raise camels and goats. The nomadic tribes which move along the northern and the southern range of mountains with herders in the Dhofar Mountains, are estimated at about 7–10% of the country's population.

The central region, stretching for more than 600 km from near Adam to Thumrait, is inhabited by close to 30 000 goat- and camel-keeping pastoralists of the main northern nomadic herder tribes, such as Duru, Wahiba, Janeba and Harasis. The total nomadic pastoral population of Oman is estimated at 60 000 to 70 000 (there are no data). Although this number represents only about 7% of the Omani population, they occupy over 80% of the country's land and hold most of the country's livestock wealth. Table 1 shows livestock numbers in the country, according to the agricultural census of 2004–2005.

### **Sedentary system:**

This production system is based on the integrated use of fodder crops and agricultural residues on farms, including processed and non-processed concentrates such as cereal and date residues. This system is used in villages, urban and sub-urban centres and includes:

- (a) Small irrigated holdings which raise commercial herds of goats, sheep and cattle with cut and carry fodder crops. Livestock are stall fed. Surplus forage produced is sold locally. Weeds that grow along irrigation channels and fields, with some grains, dates unsuitable for human consumption and concentrates are also fed to livestock.
- (b) Commercial Fattening Units: these are established near cities, they buy young stock from traditional systems, fatten and sell them. They use fodder crops and concentrates, including dry and green Rhodes grass, lucerne and Messibly (bulrush millet), cereals such as sorghum and barley, date residues, dried sardines and concentrates.

### **Nutrition**

Most livestock in the Sultanate graze on natural pastures, where forage is plentiful in the growing season, by the end of which animals are in good condition. The quantity and quality of forage begin to decrease early in the dry season and becomes insufficient to meet animals' requirements. Nutrient deficiencies and diseases associated with feed shortage adversely affect animal health and impair productivity. This is more pronounced in traditional grazing systems, in which grazing is the main source of feed. The impact is greater in settled, non-mobile herds where animals may experience a negative protein balance

due to its shortage in the dry over-mature forage. Cattle, except in the Dhofar Mountains, depend on cultivated fodders, crop and orchard residues and some concentrates such as dates unsuitable for human consumption, dried sardines and barley. Sheep, goats and camels depend on roughages from natural pasture. The cattle grazing system, which is currently adopted in Dhofar, is a semi-settled one that depends on production under full utilization of grazing lands, agricultural residues and by-products, besides baled Rhodes grass hay, concentrates and dried sardines.

Camels herders have to move at the beginning of the monsoon, out of the mountains south to the plains and to the north of the Qatan. This movement is triggered by the fear that their animals would slip on mud during the rainy season. Recent years witnessed increasing use of different materials as supplementary dry season feed including native grass stored as hay, crop residues, by-products of food processing such as dates, and green forages. Browse is an important source of feed during the dry season; halophytic shrubs contribute browse in appreciable quantities in coastal areas, *Acacia tortilis* and *Prosopis cineraria* in the interior plains and wadis, *Anogeissus dhofarica* and *Acacia senegal* in the Dhofar Mountains and *Olea europaea* in the El-Jebel El-Akhdar area.

Small producers, who keep commercial herds of goats, sheep and cattle, use a cut and carry system for feeding irrigated fodders (Rhodes, lucerne and bulrush millet). Weeds are also collected and fed to livestock with some concentrates (grains, dates and processed feeds). Large-scale commercial farms depend on irrigated fodders including Rhodes and buffel grasses (*Cenchrus ciliaris*), which are harvested mechanically. Part of the forage is fed green, and the rest is made into hay. Maize and sorghum silage is used to feed fattening animals and dairy cattle, while locally formulated or processed concentrates, unmarketable dates, grains such as sorghum and barley are used to feed dairy cows.

Appreciable quantities of crop and horticultural residues are available and are a strategic source of livestock feed during the dry season. They include tree leaves, fruit remains, crop residues, such as wheat and barley straw, and vegetable crop residues. Usually, some of these residues are utilized in the field, while the rest are collected, transported and stored for later use or sale.

### Constraints and threats

There are many informational, biological, climatic or economic threats and limitations, which halt the development of animal production in the Sultanate; some of these are listed in the following points:

- The absence of precise, up-to-date data and statistics, for planning, monitoring and development.
- The current systems of livestock management and production are inefficient, uneconomic, and unsustainable.
- Grazing and animal resources have been subjected to major changes through attempts to restructure the sector. These changes were coupled with a weakening role, reduced efficiency and limited budgets devoted to the sector. Legislation pertinent to protection, management and development of rangeland resources has not been implemented.
- Nutrition is the most important constraint to increasing livestock production, especially during the dry season, when both quality and quantity of natural forage are reduced; the seasonality of natural forage production.
- The difficulty of using some good grazing areas due to limited accessibility, as in El-Jebel El-Akhdar in northern Oman or Jebel Al-Qamar in Dhofar Governorate.
- The occurrence of successive long periods of drought in some important grazing areas.
- The lack of additional feeds at suitable prices to meet the demand during the dry season.
- Expansion of fodder production would require use of irrigation on fertile land and would have to compete economically with cash crops. The high returns per unit area of vegetables in some areas such as Dhofar Governorate makes this activity more competitive than fodder crop based animal production.
- Scarcity and high cost of labour requires a high degree of mechanization. This is likely to increase the capital investments to any production project.
- Predators (wolves, foxes, stray dogs, mongooses) which attack livestock in farms and mountainous areas cause large losses. There are many insects which may cause health problems and bother livestock affecting their efficiency and production. These include scorpions, red hornets, ants and biting flies (*Stomoxys*). They are serious in mountainous areas like El-Jebel El-Akhdar, the Eastern Region and the Dhofar Mountains.

- Several diseases (foot and mouth, CBPP, brucellosis) of economic importance affect livestock. Internal and external parasites have adverse effects on performance and productivity. Some diseases result from malnutrition and nutrient deficiencies.
- The problem of animal diseases is getting more complicated due to imports of live animals for local consumption. The Sultanate shares borders with three countries; the region has been invaded by epidemic diseases, hence the possibility of animals transferring diseases to others inside the country exists. To safeguard the country's livestock, quarantines were established in strategic border sites, along with enforcing laws and regulations to control introduction of livestock into the country. These steps are supported by special measures undertaken during times of epidemic disease outbreak.
- Formerly animal health services were fully supported by the government and used to meet the national herd requirements. In the mid nineteen-nineties free veterinary services ceased to be provided and these services became private, provided at market price.
- Drinking water is a problem for man and livestock during the dry season, especially in areas with a scarcity of groundwater, as in the western region of Dhofar Governorate. Water supplies depend on winter rains in the north and summer rains in the south. Areas characterized by water scarcity are important grazing sites. Herders transport water from other areas. The government has drilled deep boreholes and established a system of pipes to meet the needs of human and animals in rural areas suffering from water shortage.
- Among limitations to animal production are: the absence of credit facilities, low productivity of animal breeds, limited research in the fields of animal production, nutrition and housing. Artificial insemination services associated with dairy cattle and other livestock are limited.

### **Socio-economic constraints**

- Many of the basic services provided to herders, including research, extension, supplies of water, veterinary drugs and marketing are insufficient and are not of the quality needed. Stopping subsidized veterinary services and drugs increased the burden on herders and livestock owners.
- The diminishing role of traditional institutions and the abolition of their role in regulating and controlling the utilization of local resources (water, range and forests) has had a negative impact resulting in their open use, increased grazing pressure and accelerated the rate of resources degradation and desertification.
- An increasing number of herders have low incomes and can hardly meet their basic needs.
- Absence of marketing specialists and insufficient marketing infrastructure and surveillance of livestock marketing. This is coupled with a lack of ability to cope with the internal and external socio-economic changes.

## **5. THE PASTURE RESOURCE**

### **Grazing lands**

Grazing lands are a major source of animal feed, especially on some plains, in wadis, Dhofar Mountains and El-Jebel El-Akhdar. The main objective of grazing management in the country is to provide grazing during the dry season. Beekeeping and checking land degradation are also valid goals. In the Dhofar Mountains *Ziziphus spina-christi* and *Anogeissus dhofarica*, and areas in the north *Ziziphus* and *Prosopis cineraria* are important to achieve these goals. In Dhofar some *Boswellia* tree stands are managed for Frankincense production, but the decline of the Luban trade has changed the situation. Environmental benefits (soil improvement, water resources conservation, fog water collection, recharge of groundwater aquifers, desertification control, provision of wildlife habitats, conservation of biodiversity, ecotourism encouragement) are considered as integral parts of the management strategy. The Sultanate grazing lands are estimated at about 1.4 million ha, 0.9 million ha in the north and 0.5 million in Dhofar Governorate. In this latter region grasslands cover about 400 000 ha, and woodlands and shrub lands 100 000 ha.

Three areas of rangelands of the Sultanate of Oman and are described briefly below.

### The Batinah rangelands

Agricultural land occupies a large proportion of the narrow flat coastal strip of the Al-Batinah plain. Desert and semi-desert rangelands with low rainfall (not exceeding 100–150 mm/annum) cover most of the unused area. On coastal sand dunes many halophytic bushes such as *Calligonum comosum* and other species of *Zygophyllum* spp., *Aeluropus littoralis* and *Sporobolus arabicus* are found. On less saline soils and along watercourses leguminous herbs such as *Indigofera* spp. and grasses such as *Cenchrus ciliaris*, *Cenchrus pennisetiformis* and *Pennisetum dichotomum* are encountered. Open woodlands with *Acacia tortilis*, *Prosopis cineraria* and *Salvadora persica* occur in the interior.

### Oman Interior and El- Jebel El-Akhdar rangelands

#### (A) Oman Interior Rangelands:

They include mountains, plateaux and foothills which expand from south to north in the Batinah area, beside the lower elevation areas at Dhahira, Sharquia and Dakhylia. These receive more rainfall, in their higher parts, than is encountered along the coast and less amounts towards the south. In view of the rocky nature of the plateaux in most of the interior areas, rainfall causes torrential floods that run as sporadic wadi flows, to low lying areas, where agricultural lands concentrate. Due to moisture limitations the dominant natural vegetation consists of some shrubs and perennial herbaceous species of low density, especially on the slopes. Some important species in this area are: *Acacia tortilis*, *Tamarix aphylla*, *Panicum turgidum* and *Dactyloctenium aegyptium*.

#### (B) El-Jebel El-Akhdar rangelands:

The El-Jebel El-Akhdar is estimated to cover some 312 500 ha of undulating rocky and stony rugged topography. The nature of their vegetation indicates that the rainfall is not less than 200–300 mm annually, which gives a vegetation cover with a higher proportion of grasses compared to that in other Northern areas. Also the growth season is longer than that in neighbouring hills. The tree cover in El-Jebel El-Akhdar is open forest of *Reptonia* and *Reptonia-Olea europea* Association and Shiraz shrubs (*Dodonea viscosa*), with understorey cover dominated by annual grasses such as *Eragrostis barrelieri* and *Tetrapogon spathaceus*, and perennials such as *Hyparrhenia hirta*.

### Rangelands of Dhofar Governorate and the Nejd

Dhofar Mountains grasslands and woodlands cover about 500 000 ha. Flora wise they are one of richest areas of the Sultanate. They receive annual precipitation of 500 to 700 mm as rainfall and fog due to monsoon winds that blow from the end of June to the end of September.

The natural vegetation of the grasslands comprises mainly annual grasses with few perennials which become scarce in over-grazed sites near dwellings and perennial watering stations. Broadleaf and undesirable annual herbaceous species such as *Impatiens* sp. increase as an indicator of range deterioration. The period of vegetation growth is limited to the monsoon season, after which annual grasses dry out and few perennial grasses remain green into early dry season.

Mountain grasslands are grazed by cattle. Camels and goats utilize a wider range of habitats varying from the coast, the foothills, slopes, wadis and the dry plateau north of the grasslands proper. Some important annual grasses characteristic of the Mountain area are: *Themeda quadrivalvis*, *Apluda mutica*, *Aristida* spp. and *Setaria*, while the perennials are mainly species of *Dichanthium*. Trees and shrubs include *Ficus sycomorus*, *F. vasta* and *F. lutea*, *Acacia tortilis*, *Tamarix aphylla*, *Cadaba* spp., *Commiphora* spp., *Blepharispermum hirtum*, *Jatropha dhofarcia*, *Croton confertus*, *Grewia* spp., and *Ziziphus spina-christi*.

In the Nejd (beginning of the true desert) the dominant trees are the Frankincense tree and *Acacia etbaica*. A vast area of the Nejd is absolutely devoid of vegetation, but some low areas contain a few hard Orph trees and some shrubs such as *Euphorbia schimperi*, in addition to some herbaceous woody species along the edges of wadis. Ghaf (*Prosopis cineraria*) exists as isolated trees in some wadis. In the vicinity of mountains Samor (*Acacia tortilis*) and Thor (*A. senegal*) trees can be encountered. Types of Thamreet (*Acacia laeta*), Hidid (*Ziziphus leucodermis*), Ihrik (*Salvadora persica*) and Arak (*Salvadora* spp.) are observed sporadically, and are utilized by camels and goats.

### Problems of rangelands

- The scarcity of perennial grasses, herbaceous and tree forage legumes and insufficiency of protein for animals, which negatively affects animal growth and fertility.
- The seasonality of forage production where growth season and forage availability period extend from May to the end of September, after which feeding is dependent on dry vegetation of low nutritive value, as for instance in the case of the Dhofar rangelands.
- The high cost of supplementary feed used to bridge the gap between animal requirements and available grazing during the dry season and before and after calving.
- Inaccessibility of some good pastures such as the case of El-Jebel El-Akhdar.
- Shortage in stock water.
- Limited veterinary services especially for nomadic herds.

### Roughage availability from natural pastures

Most livestock in the northern parts of the Sultanate depend on green or irrigated fodders or field and horticultural crop residues, in addition to some concentrates such as dates, dried sardines and barley. Rangelands in the northern and central regions are very poor and are of very low productivity, except after rains. In the south most of the feed comes from range. This resource has reached a critical status due to both low quantity and quality of the produced forage, as a result of increased animal numbers and the lack of suitable grazing management. Table 4 shows that natural pastures in the north provide only 4.4% of animal feeding requirements, while in the south this contribution approaches 53% of animal feed requirements. This figure has been based on estimation of available roughage from range resources as compared to the feed requirements of the existing animal units according to the 2004/2005 agricultural census. In the north the deficit is met by irrigated fodder from private farms in addition to purchased concentrates. In Dhofar Governorate herders provide supplementary feed as irrigated fodder and baled hay, concentrates and dried sardines from the local market, to meet nutritional requirements.

### Fodder crops

In view of the mostly arid climate and low productivity of grazing lands of the Sultanate livestock owners have to use additional sources, basically baled hay and irrigated fodder, crop residues, concentrates and dried sardines.

Fodder crops in Dhofar Governorate occupy 1 183 ha. Most of the land devoted to fodder crops is under perennial and annual grasses, which include Rhodes grass, sorghum and some perennial legumes such as lucerne. The forage is used for feeding dairy cattle and on fattening farms, and cattle, sheep, camels and goats on grazing. Much of the production is sold in local markets and neighbouring cities as hay and green forage. Some small-scale farms also grow fodders between date palms, coconut palms and citrus trees. Dhofar Governorate produces 33 000 tonnes of forage dry matter annually, to which are added 26 900 tonnes imported from outside the Governorate.

### Crop residues

Appreciable quantities of field crops and horticultural residues are available and are important during the dry season. They include: tree leaves, discarded fruits, particularly dates, field crop (such as wheat, barley) straws and stubbles and vegetable residues. Usually, part of the residues is grazed and the rest is collected, transported and stored for latter use or for sale. About 0.5, 0.2 and 1.0 tonnes residues are produced by one feddan (1 feddan = 0.42 ha) of vegetables, fruits or wheat and barley, respectively.

**Table 4. Roughage from natural pastures**

Area	Total livestock units* (000)	Roughage from natural pastures (000 tonnes DM)	Feeding Requirements*** (000 tonnes DM)	Annual deficit (000 tons DM)	Annual deficit as a percentage of demand
North Oman**	453.6	44	997.9	953.9	95.6%
South Oman (Dhofar)	207.8	244.2	457.2	213	46.6%

Source: *Alhag Bakhit Ahmed, 2006*

\* According to 2004/2005 census

\*\* Including South and North of Al-Batinah, Al-Dakhiliya as well as Al-Wosta, Al-Sharkya and Al-Dhahira

\*\*\* Animal unit demand in tropical areas (TLU) 2.2 tonnes of DM for maintenance.

In Dhofar Governorate annual production of agricultural residues from farms and horticultural plots is estimated at a thousand tons of dry matter. The residues provide the equivalent of 330 tons of energy and 16.7 tonnes of crude digestible protein.

### Concentrates

These comprise processed and non-processed concentrates of plant origin such as discarded dates, sorghum, barley and dried sardines. Statistics of locally produced and imported concentrated feeds: quantities and types, their distribution among the governorates and districts are not available. But the total of both local and imported concentrates to Dhofar Governorate in 2001 is estimated at 86 000 tonnes, which provides 54 600 tonnes of total digestible nutrients and 9 360 tonnes of digestible crude protein. Cattle in Dhofar consume an estimated 9 730 tonnes of dried sardines of which 670 tonnes are brought from the north of Oman (particularly from the Batinah coast), and 4 000 tonnes are imported from Yemen, while the rest (equivalent to 5 060 tonnes) are dried local sardines caught in Dhofar Governorate; this is equivalent to 38% of fresh weight and contains 78% of dry matter. This quantity is equivalent to 8 470 tonnes of DM that produces 6 350 tons of energy and 3 800 tonnes of digestible crude protein (using values of 75% energy and 45% digestible crude protein).

### Forage seed production

Some farmers produce their own seed requirements and the surplus is sold locally; there are no specialized seed-producers. No institution is devoted to seed control and certification. There is no private or governmental institution designated for commercial production of forage seeds. Demands are met through agricultural import and export companies. There are no precise statistics of the types and quantities of seed imported. Local seed production is very limited; it is practiced to meet the demand of some private farms which specialize in fodder crop production. As seed yields are very low prices are very high (5–10 fold) when compared to prices of imported seeds. The government is involved in fodder seed production through the activities of research centres in the major agricultural zones e.g. Rumais and Salalah.

Rumais centre is engaged in pasture and forage research. Seed of some fodders is produced for experimental and demonstration purposes and distribution to some farmers.

The former Range and Forestry Department in Dhofar Governorate was involved in collection, multiplication and dissemination of natural pastures seeds and targeted the rehabilitation of deteriorated areas, by producing seed and vegetative materials of herbaceous and woody species for range reseeding and establishment of multipurpose trees and shrubs; and for distribution to local institutions.

### Constraints and threats

There is a wide variability in statistical data related to livestock production and reproduction parameters, imports of livestock and their products and feeds provided by different sources.

- Information and data about forage resources are rare, and in many instances out of date. Essential data: the distribution and characteristics of natural pastures, fodder trees and shrubs and the areas they cover, estimation of available biomass, browse volume stock, annually produced fodder crops in various parts of the Sultanate is lacking. This is also true about imported feeds.
- The shift in plant and land cover following pastoral deterioration, forest clearance, allocation of rangelands and forestland to other land uses is difficult to estimate as supporting data is lacking.
- Land use maps and areas cultivated with forages and the other thematic maps rarely exist or are out of date. The slow development of the digital geo-spatial databases is due to the lack of developing the ability to perform comprehensive surveys. This partially explains the lack of facilities and training opportunities in this field.
- There is no recent comprehensive survey to document rangeland condition except for the descriptive studies carried out in Al-Sharkiya Region and Dhofar Governorate.
- Settlement, establishment of new watering points, provision of veterinary services and the fast increase in livestock population coupled with abolition of tribal control and management of rangeland resources has led to the rapid deterioration of rangelands. Free grazing and uncontrolled utilization of range and woodlands triggered their degradation at an alarming rate. Some areas

(such the coastal plain in Dhofar Governorate) are suffering from scarcity of tree cover. In the Batinah area woodlands and natural tree cover has declined due to urban and agricultural expansion. The Dhofar Mountains range, which was covered with dense woodlands and large trees two decades ago, is not an exception. Presently, stunted isolated trees cover many sites e.g. *Ficus* spp, *Anogeissus dhofarica* and *Olea europaea*.

- In other areas of Dhofar Mountains, deteriorated range and woodlands have been invaded by undesirable plants such as *Dodonea viscosa*, *Calotropis procera* and *Solanum* spp. Regeneration of desirable trees is rare, due to consumption and trampling of young seedlings by an increasing livestock population, and because of interruption of seed production capacity. The density of *Boswellia sacra* trees, which characterize Dhofar deserts and dry wadis, has decreased to 0.01%.
- The scarcity and high price of seed of high productivity and quality fodder crops is a major constraint of increasing forage production from this source.
- Lack of proper understanding of the economical value of forage resources, insufficient budgets, variable and unpredictable climate, and the instability of the institutional framework through which forage resources are managed are considered the main limitations that retard the development of these resources and increasing livestock production. Despite the humble efforts made to improve the institutional framework and programmes the chances to bring about a favourable change exist.

## 6. OPPORTUNITIES FOR IMPROVEMENT OF PASTURE RESOURCES

### Grazing control

Grazing control is the most important measure for the management and improvement of grazing lands and watershed conservation. Vegetation should be allowed periodic rest by closing some sites for grazing. This will improve growth and vigour and will enhance spread of desirable forage species. Such measures and effects cannot be achieved under open grazing conditions. Trials of deferred grazing and resting of the range vegetation during the monsoon season in collaboration with herders communities (713 households owning 31 000 head of cattle) in Dhofar Mountains have been successful. As a result of deferment, forage from the site continued to provide livestock with roughage for six months compared to three months in open grazing areas.

### Local communities participation

Local community participation in planning and implementation of activities on the rehabilitation and development of grazing resources is vital for the success of any intervention in this area. The presence of local communities, including pastoral women, and their contribution to the identification of constraints and choosing solutions and participation in implementation, management and monitoring and evaluation is essential. Local communities can provide and employ their traditional knowledge and accumulated conservation and management experience to the benefit of such interventions.

### Range rehabilitation

Techniques are known for the treatment of deteriorated range by control of undesirable plants and increasing the proportion of the vegetation cover made of desirable forage species. This could be achieved through: reseedling, periodic resting to assist regeneration, watershed management and conservation of plant genetic resources.

The Ministry of Agriculture and Fisheries Resources established forest nurseries in different governorates and regions. The Forest Nursery in Dhofar Governorate is capable of producing half a million seedlings per year which have been used to rehabilitate 22 sites, after fencing then planting them with seedlings of local trees. An arboretum with 58 species and 928 trees was established in the area to conserve the genetic resources of local trees and shrubs.

Various techniques have been tried to rehabilitate deteriorated natural pastures, but they met limited success due to lack of sufficient knowledge and experience about the natural environment, biological and climatic conditions of the targeted range ecosystems. The techniques applied in the eighties to improve rangelands in the region, included the following:

- a) Broadcasting tropical pasture perennial grass and legumes seed on 180 000 ha in Dhofar Mountains. Some multipurpose shrubs were also planted. This intervention failed due to soil compaction, high competition from local plants, seed of the broadcast species collected by black ants and a late start of the monsoon rains.
- b) Fencing of selected sites with a total area of 190 ha on the mountain, near dwellings to be used for demonstration of range improvement to herders. Also to be used as a source of forage in cases of emergencies. Tree planting was attempted as a measure to intensify fog water collection.
- c) A site of 100 km<sup>2</sup> was selected on Salalah plain, between Rizat and Taqa, to be planted with different types of fodder shrubs, to combat desertification, and specifically, to provide camels with additional browse. This project concentrated on planting *Prosopis juliflora* which proved to be a big problem since it threatens to invade the Mountains grasslands and woodlands and destroy their unique plant diversity.

These interventions clearly demonstrate the need to understand local environmental conditions, socio-economic factors and potentials of resources prior to embarking on expensive time and effort consuming interventions.

Efforts should be made to establish shelterbelts and windbreaks around agricultural lands and on strategic sites on rangelands. This is especially important for lands reclaimed for agricultural activities in the desert areas. Use should be made of trees proven successful in one of these areas (Hailat Al-Rakah) which include *Ziziphus* sp. and *Prosopis cineraria*, with the possibility of using *Phoenix dactylifera* in shelterbelts as well as a cash crop.

Foreign assistance and international co-operation have played a considerable role in developing range and forest resources in some areas of the Sultanate. The UNDP/FAO Range Management Project (OMA/87/013) launched in 1988 in Dhofar Governorate assisted in creating a Department for Range and Forestry in Dhofar. This project focused on training of national cadres, range monitoring, techniques of range improvement, nursery techniques, local tree planting and extension and training programmes.

An agreement for technical co-operation with FAO through Project: Range Resource Information Monitoring and Evaluation in Dhofar Region (TCP/OMA/3001) is still continuing.

## **Forage resource development**

### ***Fodder crop development in Nejd***

Confronting the current deficit in irrigated fodder and expansion of livestock production in the foreseeable future is dependent on the development of new irrigated sites equivalent to the current areas under fodder crops which are intended to be cut out from Salalah and Al-Batinah plains, in accordance with the ministerial Decree No. (35\2005). This requires approving a plan to produce fodder in these areas according to type of crop preferred and irrigation water requirements. Irrigation cost is estimated to be about 40–50% of the total cost of production. Therefore reducing water use means reducing the per unit price of the produced forage. Studies, carried out by foreign consultant firms and the specialized U.N. agencies (FAO), in collaboration with the Ministry of Agriculture and Fisheries Resources in 1990, have drawn attention to the possibilities of agricultural expansion in Nejd area. This is conditioned by the safe regular pumping from groundwater. These studies also indicated the existence of limited areas of land with medium suitability for agriculture expansion.

### ***Seed technology development***

Opportunities and conditions conducive to developing seed technology, including the establishment of a specialized institution to be in charge, exist for performing the following:

- maintaining purity and uniformity of original seed, ensuring stability of hybrids with high performance,
- propagating seed of species produced in research stations,
- carrying out seed certification and activate seed legislation to control their quality,

- developing techniques for seed processing, handling and storage,
- enhancing partnership with small-scale seed producers.

### **Planting leguminous and fodder trees**

Fodder trees and shrubs, such as *Anogeissus dhofarica*, *Acacia senegal* and *Prosopis cineraria*, provide a large part of goat and camel feed especially during the dry season. These trees have been subjected to overgrazing and irrational use during the past three decades. A programme, utilizing non-traditional sources of water should be launched to establish stands of these species.

The former Range and Forestry Department, in collaboration with local communities, assisted the production and distribution of seedlings of multi-purpose trees to rehabilitate deteriorated range and woodlands sites, provide shade trees and establish windbreaks.

Any tree-planting project could include the planting of *Boswellia sacra* and tree planting for fog water collection. A study conducted by the Planning Committee for Development and Environment in 1992 indicated that a tree with a 12 m<sup>2</sup> crown and vertical to the wind direction can collect from 50 000 to 70 000 litres of water during the monsoon season.

## **7. RESEARCH AND DEVELOPMENT ORGANIZATIONS AND PERSONNEL**

The Sultanate of Oman Government recognizes the importance of agricultural research to meet National Food Policy Objectives, which, at a minimum, aim at self-sufficiency in food production. Agricultural Research Stations were established in different areas of the Sultanate with a specific mission and objectives.

The Directorate General of Agricultural Research (DGAR), under the Ministry of Agriculture and Fisheries, has its headquarters in Muscat and several Research Stations or Farms (RSF). DGAR addresses research problems of commodities or factors of production, while the sub RSF focus on identification and diagnosis of production problems in various agro-ecological zones and adapt technologies for increased production at the farm level.

Pasture and animal production research is carried out at several RSFs including those dealing specifically with range research and arid land improvement. While most pasture research is undertaken by DGAR, some limited work is carried out collaboratively with international and regional organizations, the universities and NGOs interested in pastures and livestock development. Donors and technical agencies, such as FAO, UNDP, World Bank and ACSA, fund research and development programmes targeting improvement of Oman's pasture resources.

MAF is responsible for transfer of technologies to the farmers. Oman has a well-organized agricultural extension system that operates at national, provincial, area, Wilayat, Neiabat, and farm level. There are many Agricultural Development Centres (ADC) throughout Oman, where farmers are trained on various aspects of farming, including improvement of forage resources. There are agricultural colleges and specialized agricultural cadres working on technologies related to forage production. Most research and extension personnel have been exposed to the Farming Systems Approach adopted by MAF.

All collaborators (donors) supporting research programmes are in agreement with MAF regarding the need to improve research activities and methodologies. Al-Rumais Agricultural Research Station is well connected with a number of regional and international research organizations as shown by the large number of collaborative research activities, including seed technology and biodiversity of pasture plants.

Technologies for the improvement of pasture resources have been developed and are available for small-scale farmers. Promising pasture grasses, legumes and fodder seeds are available for intensive and extensive pasture improvement in various agro-ecological zones. Various management and utilization packages have been developed. Notable break throughs have also been made in the fields of animal nutrition, livestock management, disease control, artificial insemination practices and animal breeding. A large number of pasture grasses, legumes and fodders have been collected in Oman and stored in the National Gene Bank at Al-Rumais Agricultural Research Station.

Oman has keen and receptive farmers demanding new ideas and technology. The willingness of farmers to participate in on-farm trials and to learn, demonstrates their interest to contribute to the development and dissemination of new technologies on pasture. There is opportunity to further improve forage species seed production technologies.

Some pasture research work is being undertaken by the technical staff of the Seeds and Genetic Resources Laboratory in Oman in collaboration with ICARDA. The Union of Agricultural Research Institutions in the Near East and North Africa (ARINENA) has participated in printing and distribution of research results.

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