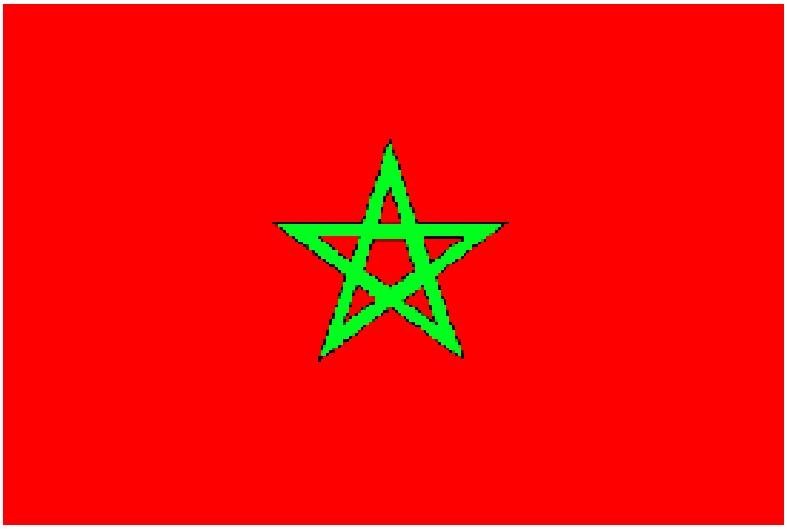
Country Pasture/Forage Resource Profiles

MOROCCO



by
O. Berkat and M. Tazi

CONTENTS

1. INTRODUCTION

The Kingdom of Morocco is situated in the north west of the continent of Africa, between latitudes 21° - 36º N and longitudes 1° –17º W. The country is bordered by the Atlantic Ocean on the West (2 934 km from Cap Spartel in the North to Lagwira in the South), the Mediterranean sea on the North (512 km from Saidia in the East to Cap Spartel in the West). It is bordered in the East and South by Algeria and Mauritania, respectively (see Figure 1). The total land area is 710 850 km^2 of which arable land is less than 12% (Ministère de l'Agriculture et du Développement Rural 2003).

[**FAO Editorial Note**: the status of Western Sahara remains unresolved and was the subject of a proposed UN Agreement on the Status of Western Sahara in 2001.]

Figure 1. Map of Morocco

According to the 1994 census, the population was 26 100 000. The population growth rate during the 1984–94 period was 2.06%, lower than the 2.6% recorded in 1974-84. Presently, the population growth rate is 1.7%. Population estimates for 2002 and 2003 were 29 630 000 and 31 600 000, respectively and according to the World Factbook the population in July 2006 was estimated at 33 241 259 with a growth rate of 1.55%.

Most of the population is concentrated in the north-western areas. Urbanization is over 50% presently, contrasting strongly with a level of 30% in 1970. Large cities include Casablanca (3.1 million) which is the largest industrial, commercial and financial centre, Rabat-Salé (1.2 million) which is the capital, Marrakech, Fès, Méknès, Tétouan, Oujda and Agadir each have hundreds of thousands of inhabitants.

The country's history is very ancient as attested by numerous prehistoric and historic monuments and artefacts. In historical time, the country has seen a number of invaders and civilizations: Phoenicians, Berber, Carthaginians, Romans, Vikings. The Arab conquest came in 681.

Morocco exists, as a state, since 788, when the Idris the First was proclaimed king. The subsequent dynasties were:

- Idrisside (788–1055, foundation of Fes which is part of the UNESCO Universal Heritage),
- Almoravide (1055–1130, foundation of Marrakech with the Place Jamaa Lafna also part of Universal Heritage),
- Almohade (1130–1258, Foundation of the Capital City of Rabat, construction of Koutoubia and its twin the Giralda of Sevillia),
- Merinide (1258–1554, construction of Chellah Necropolis in Rabat),
- Saadian (1554–1664, Saadian tombs in Marrakech, plants for processing sugar from cane and exports to Europe, end to the Portuguese occupation of some coastal places), Alaouite (1664–Present).

Morocco gained its independence from both the French (Central and Southern zones) and the Spanish (Northern zone) in 1956. At the same time the City of Tangiers, which was under International Rule, was recovered. The Southern Saharan Provinces were recovered in 1975 [although the status of Western Sahara remains unresolved and was the subject of a proposed UN Agreement on the Status of Western Sahara in 2001 – Editorial Note].

Agriculture is the backbone of the economy since it contributes 17% of the Gross Domestic Product (GDP) and provides employment to half of the active labour force. It has benefited as a priority

investment sector by the Government during the last four decades. As a result of this policy, 92 large dams have been built with a total capacity of 14 billion m^3. This and other smaller infrastructure, has allowed the irrigation of some 1 200 000 ha. Major irrigated areas are the Rharb and Loukkos in the NW, the Tadla in the centre north of the Atlas, the Haouz in the Marrakech region, the Souss-Massa in the Agadir region, the Ouarzazate and Tafilalet south of the Atlas, and the Low Moulouya in the Northeast.

However, agricultural production varies with the weather conditions and most crops are grown by subsistence farmers, but a modernized sector produces food for export. The main products include wheat, barley, pulses, vegetables, citrus fruit, olives and olive oil, figs, and dates. Agricultural exports include vegetables, citrus, olive oil and wine. Animal products are consumed locally, except for processed leather.

Table 1. Land use

	Area (million ha)
Arable and permanent crops	9.2
Forests	5.8
Alfa steppe	3.2
Range (1)	52.885
Total	71.085

(1) including low productive Saharan steppes, rocky sites and areas occupied by infrastructures as they have not been estimated separately.
Sources: Ministère de l'Agriculture et du Développement Rural (www.madrpm.gov.ma/). Stratégie de développement des terres de parcours au Maroc 1992-1995, Direction de l'Elevage, Ministère de l'Agriculture et de la Réforme Agraire, Rabat.

Fisheries is another important sector as it represents 55% of agricultural food exports and maintains some 400 000 jobs. Handicrafts contribute 10% to the GDP and offers jobs to about 1 500 000 people.

Tourism is of growing importance to the economy. With 2 500 000 tourists in 1999, it contributes 7.8% to the GDP, and helps maintain about 500 000 jobs.

Mining and energy represent 10% of the GDP. Morocco has the world's third largest deposits of phosphate, but a stagnant market and lower world prices have reduced the contribution made by this previously important export earner.

A small manufacturing sector is growing and bringing export revenues. Consumer goods and semi-finished goods now account for about half of Morocco's export earnings.

About 15% of the labour force works abroad, mainly in European countries such as Belgium and France, and the money these workers send back to Morocco helps to offset the country's large foreign debt.

In an effort to stimulate economic growth, the government is selling more than a hundred state-owned enterprises and encouraging other economic reforms.

Land Area, Arable and Pastoral Areas. Land classification in Morocco shows that 78% of the area (56,000,000 ha) is in desert and dry zones (annual average precipitation <250 mm/year), 15% (10 000 000 ha) in the semi arid zone (250 to 500 mm rainfall per annum) and 7% in the sub-humid to humid zones (> 500 mm rain per year). Arable land and permanent crops represent 12% (9 200 000 ha) of the land area, of which 1 200 000 ha are irrigated, 12.5% (5 800 000 ha) is forest, and 52 900 000 ha are rangelands and unproductive lands (Table 1).

Of the total cereal area, which covers 80% of arable land, 50% is sown to barley, 40% to bread and durum wheat and 9% to maize. Four% of the arable land is sown to pulses, mainly fava bean, chickpeas, lentils and peas. The area under weedy fallow varies between 1 600 000 and 2 600 000 ha and is more prevalent in the drier zones.

The Ruminant Sector. Generally, it is considered that only 18% of farmers gain their incomes solely from animal husbandry, but livestock constitutes a significant financial reserve for the majority of farmers, in particular for those who have difficult access to agricultural loans. It also ensures the production of manure necessary for the fertilization of the land and to yield improvement (mainly vegetables and citrus orchards). It is also used as draught power; it supplies the necessary raw materials (wool, skin, leather) to the leather and the craft industries, and plays a role in the transport of goods and of man (dromedaries in the south, mules in the mountains and horses and donkeys in the plain) It is also necessary to underline its socio-cultural role (horse and Fantasia, sheep and Eid El Adha).

There are about 2 700 000 cattle, 17 000 000 sheep and 5 300 000 goats in the country, in addition to 200 000 camels (FAO database only 36,000), 510 000 mules and 980 000 asses, producing some 300 000 tonnes of meat (with chicken and game meat the total is near to 600 000 tonnes) and more than 1.35 million metric tonnes of milk (Table 2). Up until 2000 Morocco imported more than 10–15 000

Table 2. Livestock numbers and production

Items	1973–74	1980	1982	1984	1987	1995–96	2002*	2003*	2004*	2005*
Cattle (,000,000)	3.21	3.38	2.54	2.36	3.18	2.38	2.67	2.69	2.73	2.73
Sheep (,000,000)	11.44	16.51	10.16	12.86	16.14	16.73	16.34	16.74	17.03	17.03
Goats (,000,000)	4.23	6.15	4.09	4.22	5.81	5.70	5.09	5.21	5.36	5.36
Cow milk (,000 mt)	490*	780	625	705	783	865*	1 236*	1 250	1 300	1 300
Beef (,000 mt)	91*	102	111	77	99	113*	170	150	148	148
Mutton (,000 mt)	50*	66	47	54	64	101*	110	105	103	103
Goat meat (,000 mt)	26*	16	15	16	20	20*	20	21	21	21

Sources: Recensement Général de l'Agriculture (RGA), Ministère de l'Agriculture et du Développement Rural, Guessous 1991.
**2002-2005 and others - data from FAO statistical database (2006)*

live cattle per year as well as 10 M chickens but numbers have declined as have beef and veal imports. Milk and milk product imports have increased from less than 200 000 M tonnes milk equivalents in the 1980s to nearly 400 000 tonnes in 2003/2004.

The Crop Sector. Farms are rather small (Table 3). Of the 1 500 000 holdings, the size classes are as follows: i) 4.3% are landless, very probably only keeping livestock; ii) more than 70% have less than 5 ha; iii) only 4% have more than 20 ha. The small farm size generally leads to diversified production (cereals, vegetables, livestock) but also to low income levels and high vulnerability to market forces and drought events.

In the agricultural sector, livestock production ranks second after cereals. It provides approximately 20% of the total of agricultural employment and contributes to the income of more than 80% of the rural population, especially small farmers. It also plays an important role in mitigating the impact of droughts. Of the 1.5 million farms in 1996, 1.1 million had a livestock production component (Table 4).

Table 3. Farm size (1996)

Size class in ha	Number of farms		Arable area	
	(thousands)	%	(thousand ha)	%
Landless	64.7	4.3	-	0.0
0-1	315.3	21.1	170.4	2.0
1-3	446.7	29.8	904.7	10.3
3-5	237.7	15.9	1 011.1	11.6
5-10	247.8	16.6	1 894.7	21.7
10-20	125.2	8.4	1 880.5	21.5
20-50	47.9	3.2	1 526.3	14.5
50-100	7.8	0.5	585.1	6.7
Over 100	3.2	0.2	759.4	11.7
Total	**1 496.3**	**100.0**	**8 732.2**	**100.0**

Table 4. Number of farms practising animal husbandry

Size class	Numbers in 1973–74		Numbers in 1995–96	
(ha)	(thousands)	(%)	(thousands)	(%)
Landless	438.8	26.9	62.5	5.7
0–1	340.0	20.8	214.4	19.5
1–3	332.0	20.4	311.3	28.5
3–5	177.3	10.9	175.2	15.9
5–10	192.1	11.8	190.2	17.3
10–20	101.8	6.2	99.2	9.0
20–50	30.7	2.5	38.9	3.3
> 50	8.7	0.5	8.5	0.8
Total	**1 630.4**	**100.0**	**1 100.1**	**100.0**

2. SOILS AND TOPOGRAPHY

Major topographic features

Morocco has the widest plains and the highest mountains in North Africa. The country has four main physiographic regions:

1. the Rif mountain range, parallel to the Mediterranean coast;
2. the Atlas Mountains (the Middle Atlas, the High Atlas, the Anti-Atlas) extending across the country, southwest to northeast, between the Atlantic Ocean and Rif, from which the Atlas is separated by the Taza Depression. The highest summit is Toubkal, which rises 4 165 m in the High Atlas range;
3. a region of broad coastal plains along the Atlantic Ocean, framed in the arc formed by Rif and the Atlas Mountains; and
4. the plains and valleys south of the Atlas Mountains, which merge with the Sahara along the south-eastern borders of the country.

The country has many rivers, mostly seasonal torrents, which, although unimportant for navigation, are used for irrigation and for generating electricity. The main rivers are the Moulouya, which drains into the Mediterranean Sea, the Sebou, the Bou Regreg, the Oum Rbia, the Tansift, and the Souss which flow into the Atlantic Ocean.

Major soil types

The major soil types include (Figure 2): i) yermosols, lithosols, regosols and sierozems which are the dominant type because of mountainous topography and the large area of the Saharan and arid zones; ii) rendzinas; iii) xerosols; iv) vertisols; v) gleysols; and vi) saline soils.

The dominant soil types in the main physiographic units are as follows (INRA 1967, Osrhiri, 1985, Berkat *et al*. 1999, MADRPM, 2000):

1. Eastern High Plateaux and Moulouya Valley: soils are mostly sierozems on a caliche layer. In addition, fluvisols (important to agricultural activities) and saline soils are also present;
2. Middle Atlas: the dominant soils are brown soils and rendzinas. However, on steep slopes, lithosols and regosols are dominant;
3. Rif: on schists and limestone, dominant soils are brown soils associated with lithosols and regosols. On marls and limestone with marls, dominant soils are brown soils and vertisols;
4. Loukkos: mostly gleysols and brunifiés;
5. Rharb plain: soils derive from the sandy-loam formations of the recent quaternary. These are mainly gleysols and vertisols;
6. Sais plateau: dominant soils are brown limestone and vertisols, associated with lithosols and regosols;
7. Mamora and Zemmour plateau: soils derive from the sandy formations of the Villafranchian. They are mostly brown washed with a textural contrast represented by sand underlain by clay;
8. Central plateau: in forested areas, soils are brown associated with lithosols and regosols. Elsewhere (Zaer), vertisols and gleysols dominate;
9. Doukkala, Chaouia and Abda plains: in areas close to the Atlantic coast, soils are mostly rendzinas associated with lithosols that have caliche layer. In the inland, soils are mostly isohumic and vertisols;
10. Plains and plateaux north of the Atlas: dominant soils are lithosols (Rehamnas, Jebilete), sierozems associated with lithosols on a caliche layer (Haouz, Chichaoua);
11. Argan zone: soils are mostly lithosols and regosols, associated with fluvisols and saline soils on lowlands;
12. High Atlas: the dominant soils are lithosols and regosols, in association with brown soils and sierozems;
13. Presaharan Zone: lithosols and regosols dominate, in association with sierozems and regs. In the valleys, saline soils are frequent;
14. Saharan zone: soils are mostly yermosols, associated with sierozems, lithosols and saline soils.

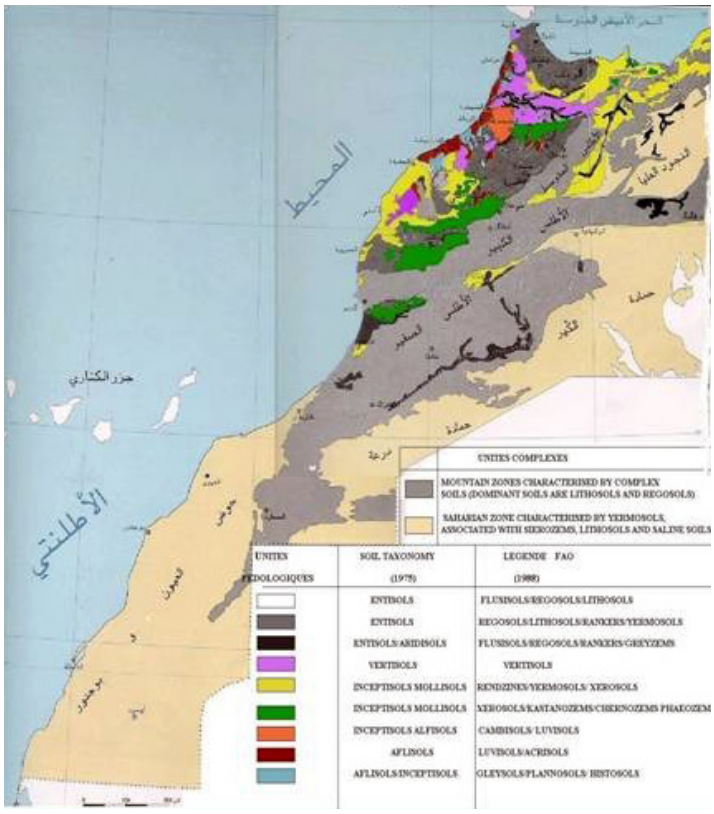


Figure 2. Soil map
Sources: MADRPM (2000)

3. CLIMATE AND AGRO-ECOLOGICAL ZONES

Climate

Morocco is dominated by the Mediterranean climate as rainfall occurs within the cool season, while the warm season is dry. However, owing to its latitudinal location, and as well as the influence of the Atlantic Ocean and the Mediterranean Sea, and that of the powerful Atlas mountain ranges between the southern Saharan and the other zones, the climatic conditions are quite diverse. In fact, this diversity made it ideally suited for the bioclimatic classification of the Mediterranean (Emberger 1955, Sauvage 1963). The main bioclimatic subdivisions are:

- Saharan or desert, with annual rainfall less than 100 mm and erratic. Winter temperatures are mild along the Atlantic coast, but become cool some 10 km inland and cold further inland;
- Arid, with annual rainfall ranging from 100 mm to 400 mm. This concerns the southern fringe of the Atlas mountains, the Moulouya Valley, the Eastern High Plateaus, the Souss plain and the plains north of the Atlas. Winter temperature subdivisions vary from warm (Atlantic and Eastern Mediterranean coast), to temperate, cool and cold. This latter situation is encountered inland in portions of the Moulouya Valley, and more extensively on the Eastern High Plateaus;
- Semi-arid, with annual rainfall ranging from 400 mm to 600 mm. This concerns the major cereal regions such as the plains of Doukkala, Chaouia, Gharb, Saiss, as well as large portions of the Anti Atlas, High Atlas, Middle Atlas, Central Plateau, the Prerif zone and the Eastern part of the Rif mountain range. This large spatial extension translates also into a large diversity of winter temperature subtypes;
- Subhumid, with annual rainfall ranging from 600 to 800 mm, encountered within the mountain ranges of the Rif, the Middle Atlas, the High Atlas and on localized coastal area (Western Mamora cork oak forest). As in the previous type, the winter subdivisions are also diverse;
- Humid, with annual rainfall greater than 800 mm within the Rif and the middle Atlas mountains.

Rainfall is variable within seasons and between years. It occurs mostly in autumn (October–November), winter (December) and spring (March–April). Mean annual rainfall ranges from less than 100 mm (Saharan bioclimate), to 1 200 mm (humid bioclimate).

Drought is the most important and dramatic manifestation of such variability. The country has witnessed the longest drought episode in its recent history (1979–1984, most of the 1990's) causing impacts on agricultural production, on farm economics and sustainability, on systems of production (for example, more concentrates are being incorporated into livestock feeding), and on natural resources and environment (acceleration of degradation and resource depletion).

Extreme temperatures are attenuated in the coastal areas along the Atlantic Ocean and the Mediterranean sea, translating into bioclimate sub-types of warm and temperate winters. By contrast, in the inland, the temperatures are more extreme and winters can be quite cold (translating into bioclimate sub-types of temperate to cold winters) and the summers very hot. In the mountain ranges temperatures can drop to 0°F and highest mountain peaks in both the Atlas and Rif mountain ranges are snow capped throughout most of the year.

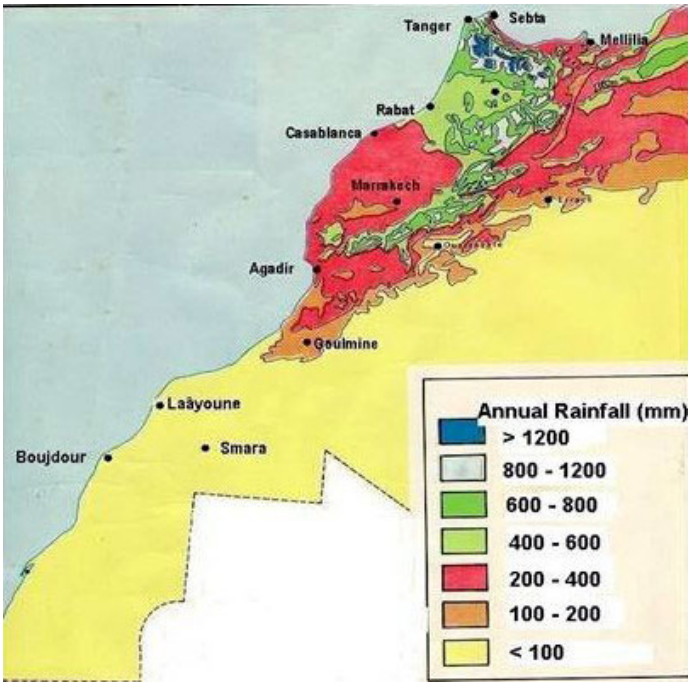


Figure 3. Rainfall map
Sources: MADRPM (2000)

Agro-ecological zones

Several agro-ecological zonings have been proposed, depending on the

objectives and the scale of approach. The fourteen physiographic units described for soils (see above) could be considered as major agro-ecological zones as they represent some homogeneity in terms of landform / substrate-soil, rainfall and the growing season (bioclimates and their thermal subdivisions).

Major agricultural enterprises in each zone

The Eastern High Plateaux and Moulouya Valley: because of limited rainfall and generally shallow soils, most of the area is used as grazing for sheep and goats. However, the Moulouya valley has a number of irrigated areas, of which the largest is the perimeter of Low Moulouya where agricultural enterprises include citrus fruits, vegetables and dairy cattle. Cultivation is actively encroaching on grazing lands. This, and increasing grazing pressure, has induced a downward spiral of pasture degradation. A number of projects, some financed by IFAD (PDPEO, PDRTT) aim at improving the living conditions of the rural population in this area while improving the management of rangeland resources.

The Middle Atlas has a relatively high rainfall, except locally. This has resulted in a well developed natural vegetation cover (grazing land and forests) accounting for more than 70% of land use. Crops represent less than 30% of the land area (mainly cereals, pulses, and fruit trees in the irrigated valleys). Most farming is of a subsistence type, based on crops and livestock (sheep, goats and some cattle).

The Rif is diverse in terms of rainfall and land forms. This translates into diversity in land use. Thus, cropland varies from 23% (Chefchaouen) to 76% (Taounate). Cereals represent more than 50% of the cropland. Fruit trees contribute 16% and are important in some areas (olives, figs, almonds). Pulses contribute 9%. Very little forage is grown. Farms are subsistence type combining crops with livestock (sheep, goats and cattle) (Berkat *et al.* 1999).

The Loukkos area possesses an irrigated perimeter where vegetables, industrial crops, oil crops, orchards, forage and cereals contribute 29%, 25%, 25%, 8%, 6%, and 7%, respectively.

The Rharb area has also an important irrigated perimeter (100 000 ha) and rainfed agriculture (some 288 000 ha). Major crops in the irrigated perimeter are cereals (32%), industrial crops (19%), vegetables (16%), forages (11%), orchards (11%), pulses and oil crops. Agricultural enterprises are a mix of subsistence and large farms. Crops are combined with livestock (mostly sheep and cattle in small herds).

The Sais plateau is mostly concerned with rainfed agriculture. Major crops are cereals, orchards (olives, vineyards), pulses, forages and oil crops. Livestock is integrated with the crops (sheep and cattle in small herds).

The Mamora and Central Plateau are characterized by a land use where cropland and forest/ rangelands represent 55% and 45%, respectively. Cereals are the dominant crop (68%), whereas forage crops, pulses and orchards contribute only 6%, 3% and 4%, respectively (Berkat et al. 1999). Farms are mostly small with less than five hectares, combining crops with livestock (cattle are well integrated with the crops, sheep on an agro-sylvo-pastoral system).

The Doukkala, Chaouia, and Abda plains are characterized by rainfall ranging from 300 to 400 mm, and by mild winters. However, the dry season is relatively long (May-October). Land use consists of some 80% cropland, and 20% forest/range. The cropping system consists of cereals (wheat, barley, maize: about 80% of the crop area), fallow (13%),vegetables, forages (3%), pulses and orchards. Vegetables, mainly tomatoes, represent an important activity, geared partly toward export. Livestock (cattle, sheep) is well integrated with crops. This zone is quite vulnerable to drought as most of the crops are rainfed. The Doukkala plain has an irrigated perimeter (some 61 000 ha) where cropping consists of cereals, industrial crops (sugar beet, cotton), forages and vegetables.

The plains and plateaux north of the Atlas are characterized by low and variable rainfall (200–350 mm). This and the fact that soils are shallow is a major constraint to agricultural productivity.

Under rainfed conditions, about half of the land is used to grow crops, and the remainder are very degraded range. The cropping system is based on cereals, particularly barley, but also wheat and maize (80%). Farms are mostly of the subsistence type (more than half have less than five hectares) combining cereals and livestock (mostly sheep). Two irrigated perimeters are in this zone: at Haouz and Tadla. The cropping system of the Haouz is based on cereals, orchards (mostly olives), forages, vegetables, and some cotton and tobacco. In the Tadla perimeter, cropping is based on cereals, forages, orchards (olive and citrus fruit trees), sugar beet and cotton, and vegetables. Dairy cattle are well developed in this perimeter.

The Argan zone is also characterized with low and variable rainfall (170 to 285 mm) and mild winter temperatures. The dry season is quite long resulting in a short growing season. Crops, forest/range represents 30% and 70% of the land area, respectively. The cropping system is based on cereals (mostly barley), fallow, and some almond orchards. Farms are of the subsistence type in 75 to 90% of the cases (less than 5 ha). They combine barley cropping, some almond trees, vegetables and livestock (mainly goats) in association with the argan tree, and beekeeping. This zone has a high frequency of drought, and the argan tree plays an important role in drought mitigation by providing forage to goats and also by producing argan oil for local consumption and for sale. The Souss-Massa irrigated perimeter is in this zone. Its major crops are citrus fruits and vegetables, partly for export.

The High Atlas is characterized, despite its high elevations, by a modest level of rainfall (400 to 800 mm on the north slopes, 200 to 500 mm on the south-facing slopes). This level of rainfall, combined with shallow soils and steep slopes, and cold temperatures, translates into a short growing season and low productivity, except locally (valley terraces, high altitude rangeland). Forests/range occupies about 76% of the land area, whereas crops are limited to about 20% (mostly in lowlands and valleys). These valleys are intensively cropped. The cropping system is based on cereals (71%), forages (11%), orchards (7%), pulses, vegetables and fallow (6%). Farms are subsistence type with less than 5 ha, combining crops on terraces, and livestock (sheep and goats grazing on range, cattle integrated with crops).

The Presaharan zone is characterized by a very low (100 to 200 mm) and variable rainfall. Crops occupy only two% of the land as they are mostly in valleys and oases. Most of the land is used for grazing sheep, goats, and some camels. Cropping is based on cereals, fallow, orchards (olive trees, date palms, fig trees, apple trees), forages and vegetables. Two irrigated perimeters are in this zone: the Ouarzazate perimeter and the Tafilalet perimeter.

The Saharan zone is characterized by a very low (less than 100 mm) and erratic rainfall. Thus, cropping is limited to irrigated areas, or areas receiving runoff. Main crops are cereals, forages and vegetables. However, the most important activity is extensive livestock production (goats, sheep, camels).

4. RUMINANT LIVESTOCK PRODUCTION SYSTEMS

In the past, extensive and range based livestock allowed the country to satisfy its needs in terms of animal protein. With the extension of crops at the expense of grazing land, the development of irrigation and the rapid demographic growth, production systems that associate crops and livestock are expanding.

Under irrigation, dairy production has been developed and cultivated forages were the only way to provide the needed quantity and quality to sustain production in high performance animals.

Feeding systems

Several factors should be considered when defining livestock production systems: the breeds raised, production type or objective, reproduction and feeding management. In Morocco the feeding aspects remain the most important criterion classifying animal production systems. Indeed, feed resources, their amount, quality, and seasonal availability determine which animal production system predominates.

Cattle production systems

The distinction of three cattle production systems is based on the parameters: 1. Feeding calendar; 2. Genetics of the herd; 3. Milk marketing options.

Dairying with irrigation. This system is found in irrigated perimeters, especially large ones managed by the Offices Régionaux de Mise en Valeur Agricole (ORMVA). Its main characteristics are (Guessous 1991):

- forage produced under irrigation covers part of the animal requirements;
- cattle are mainly Friesian or crossbreed;
- milk is systematically marketed.

The feeding calendar varies according to the main forage crop which could be either berseem (*Trifolium alexandrinum*) or lucerne (*Medicago sativa*). Berseem, which is the main forage crop in the areas of Rharb, Loukkos and to some degree in the Doukkala perimeter, is used entirely as fresh cut-and–carry, during October to March or to June (Guessous 1991). This system leaves the summer and autumn relatively forage deficient if other forages are not used (lucerne, Sudan grass, Italian ryegrass, forage beet). In the case of lucerne, which is the main forage crop in Tadla, Haouz, Souss-Massa, Low Moulouya Valley, Tafilalet and Draa, the growing season is from March to October. Even though some farmers use part of the lucerne as hay, the system is relatively deficient in autumn and winter (Guessous 1991). In order to alleviate this constraint, other forage crops are brought into the system: barley, oats/vetch, maize.

Mixed system. This system is found in the most favourable zones under rainfed agriculture, or on the periphery of irrigated perimeters (Guessous 1991). It can be characterized by the absence (or very limited contribution) of irrigated forage crops compared to the previous system. However, it shares a number of characteristics with this system, namely, the use of improved breeds and the marketing of milk produced.

The feeding system is as follows (Guessous 1991): i) stubble grazing during June to August; ii) the use of straw from September to March, sometimes coupled with the use of oat/vetch hay; iii) grazing the fallow pastures during December to March; iv) grazing barley during January to February; and v) the use of concentrates including wheat chaff, dry sugar beet pellets, molasses, barley grain, especially in autumn and winter.

Forage crops are lucerne, berseem, Sudan grass or maize when there is some water available for irrigation. However, as this is rarely the case in the production system, the forages under rainfed farming are barley (cut and fed fresh, sometimes as silage), oats/vetch, barley/peas and triticale/peas. These crops are mostly made into hay.

The contribution of forages in the feeding system is still relatively modest; it was estimated to be 28%, 21%, and 1%, in the Rharb, Tadla and Low Moulouya Valley, respectively (Guessous 1991), while the concentrates contribute 31%, 28% and 53% in the plains [straw and stubble 15, 44, 28; fallow + range 12, 3, 14].

Beef cattle. This system, based on local breeds, produces calves for fattening. Some milk, after the calf is fed, is consumed domestically, generally in small quantities, but is not sold. The system is found in areas of rainfed farming where the main crops are winter cereals or spring-sown maize (Guessous 1991). This system is at risk from drought.

Feeding is based on crop by-products, denoting a very high integration into the farming system. The feeding calendar in rainfed regions consists of (Guessous 1991): i) stubble grazing during June to October; ii) feeding hay and wheat and barley straw during the period September to March; iii) barley (light grazing of growing crop) during January and February; iv) feeding on weeds collected from the fields; v) grazing fallows during January to May. Grazing on natural pastures may also contribute up to five months in some regions.

Cultivated forages include: i) mixtures of cereals/legumes for hay; ii) barley as forage used as cut-and-carry green forage or grazed; iii) berseem in areas having relatively good rainfall (>450 mm); iv) annual medics for fallow improvement in a ley-farming system; but, this technology, which was

introduced during the early nineteen-eighties, appears to be fading away, leaving the fallows without improvement.

When used in irrigated perimeters, this system benefits from a feeding calendar and forage resources comparable to those of the dairy cattle system (Guessous 1991). The differences may be in a greater use of range and fallow. The feeding calendar consists of : i) green lucerne as cut-and-carry from March to October; ii) lucerne hay from October to February; iii) stubble grazing during the summer; iv) straw all year long; v) range and fallow during February to April; vi) concentrates during September to April.

Sheep production systems

Livestock production on extensive grazing land is by hardy local breeds of small ruminants (sheep and goats). A very small number of cattle and camels exploit these pastoral resources.

Four sheep breeds are well identified and are subject to selection programmes by the Association Nationale Ovine et Caprine (ANOC) in the so called "breed cradle zones". These are Timahdit in the Middle Atlas and neighbouring zones, the Sardi in the plains north of the Atlas, the Beni Guil in the Eastern High plateaux, and the Dman of the oases (which does not use the range) (Kabbali and Berger 1990, Boujenane 1999).

Some lesser known breeds are used in other regions: the Beni Hsen in the Gharb and Loukkos regions, the predominant Boujjad in the region of Boujjaad, the Siroua and Sargho raised in the Anti Atlas.

Compared to sheep, goat breeds are less well studied. Three types can be distinguished: the Dman dairy goat of the oases crosses with Spanish breeds in the north of the country, and the small local goat elsewhere.

There are three main systems defined according to the origin of the feed resources: i) pastoral system; ii) agro-pastoral system; iii) the oasis system.

The Pastoral System. In this system, the feeding calendar is dominated by grazing, up to 8-12 months of the year. Differences can be found according to agro-ecological zones. Thus, in the western and central plains and plateaux where the growing season ends early, range and fallows are used up to April-May, then the animals graze cereal stubble until the autumn rains. By contrast, in the Eastern High Plateaux, grazing on range dominates, with animals moving south in winter, and north in summer, or moved in the same area between alfa (*Stipa tenacissima*) (winter) to *Artemisia herba alba* and other shrub-dominated types (spring, summer and autumn). Stubble grazing takes place during July-August, but is variable because of the frequent impact of drought on cereal production. In the Atlas Mountains, range/forests are used at all seasons, although there may be some stubble used in the summer especially at altitudes below 1 500 m. Higher altitudes (above 1 500 m in the Middle Atlas, and more than 2 000 m in the High Atlas) are used in the summer by transhumant herds coming from the lower lands of the mountain itself or in the adjacent plains. In the Southwest, grazing on forest land (*Argania spinosa*, *Callitris* and Juniper) occurs at all seasons with stubble used in rare wet years during April-June.

The feeding calendar also includes: i) straw (and hay), and concentrates (mostly barley) in autumn-winter, and periods of drought; ii) barley grazing iii) cut-and-carry branches of forest trees such as *Quercus rodundifolia, Quercus suber, Juniperus* spp*., Fraxinus zanthoxyloides*; iv) cut-and-carry shrubs and grasses such as alfa (*Stipa tenacissima*) in the arid ranges.

The Agro-pastoral system. This system is found in the irrigated perimeters outside the Saharan oases and in rainfed cereal regions. Its main characteristic is the relatively large farm contribution to feed resources, attaining 50% of the animal requirements (Guessous 1991). The feeding calendar consists of: i) grazing on range and fallow January to May; ii) stubble grazing June to October; iii) feeding cereal straw September to March.

Variations around this generalized scheme include: i) moving animals outside the irrigated perimeter for grazing on forest ranges or rented private pasture on fallow; ii) grazing growing barley iii) cut-and-carry berseem (Rharb) or lucerne (Tadla).

The Oasis System. This system is specific to the oases of the Saharan zones, mainly Tafilalet in the Ziz valley, Draa in the Draâ Valley, and the Figuig area in the southeast. Its characteristics include (Guessous 1991): i) highly productive irrigated agriculture on small units, generally not exceeding 1 to 2 hectares;

ii) a sheep breed (D'man) which is very prolific, kept in small herds and penned almost all the time; iii) a feeding calendar where lucerne is the most important element.

The feeding calendar varies according to the growth of the lucerne: i) cut-and-carry lucerne during March to October, with other contributing sources including straw, barley, chaff, date by-products; ii) lucerne hay, in addition to straw and concentrates during November-February.

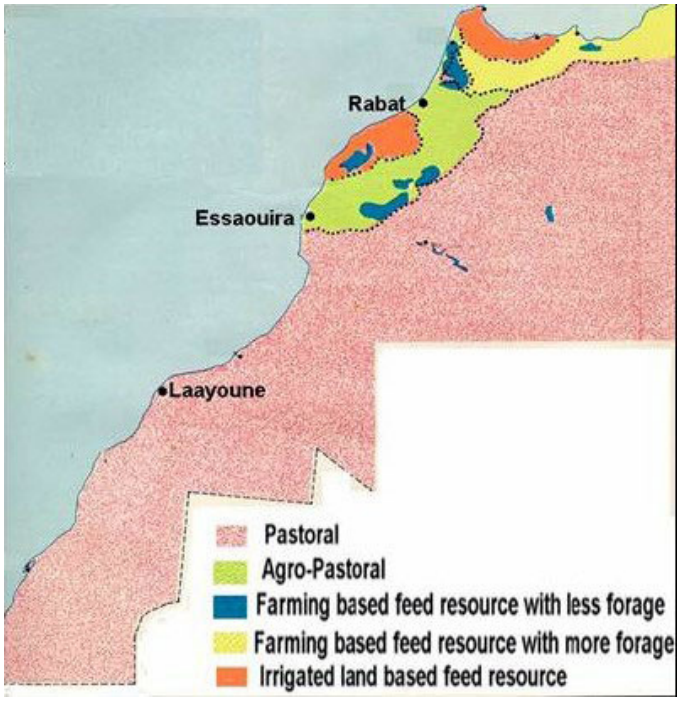


Figure 4. Map of feed resources
Sources: MARA (1986)

Constraints

The productivity and sustainability of the agricultural sector are hindered by the following: i) climatic constraints, particularly the high frequency and severity of drought; ii) land tenure not always facilitating prudent use and investments for the medium and long term; iii) resource degradation, including soil loss to water and wind erosion, loss of soil fertility, soil salinization, decrease in levels of aquifers, and degradation of range and forest resources due to overgrazing, cultivation of marginal lands, and wood and other plant harvesting for fuel and commercial purposes.

In addition to constraints to forage crops development (farm size, prices of concentrates as compared to those of forages and to animal products, research and extension limitations), other constraints have been described, particularly with respect to livestock production on rangelands (MARA, 1993):

i) inadequate feeding is the major constraint responsible for high mortality of young animals, and for growth and reproduction performances well below the genetic potential. Inadequate feeding results from low pasture productivity, inadequate use of crop residues, lack of producer knowledge of the nutritional value feed and concentrates;
ii) inadequate stock water in most range areas. Animals may have to travel long distances to water points, and some water is of poor quality;
iii) inadequate herd management practices leading to uncontrolled reproduction with no castration of inferior males, low replacement of old females. These practices translate into little genetic improvement in the herd. An increase in ANOC activity to integrate more producers would probably help alleviate some of this;
iv) health management of the herd is still insufficient, despite important efforts made by the Ministry of Agriculture in terms of prophylactic programmes and actions. Parasites are a limitation to herd productivity in many range areas.

Socio-economic constraints

Socio-economic limitations to improving the pasture and forage resources and to animal production reside in the following:

- insufficient technical packages, staffing and extension;
- vulnerability of small producers to drought impacts and vis-à-vis the buyers in the marketing system;
- meat prices to the producer not sufficient to encourage investments;
- inadequate infrastructure for processing and adding value to meat for the benefit of the producer;
- changes in production systems where more and more concentrates are being used puts extra pressure on farm financial resources and on ranges;

- land tenure characterized by collective ranges and State forests used also for grazing. In both cases, major difficulties exist in organising the users of range resources for their sustainable management. In addition, this situation is not an incentive for investments for rehabilitation of collective ranges. Moreover, collective ranges are subject to cultivation encroachment where ecological conditions are not suitable, creating conditions for desertification.

5. THE PASTURE RESOURCE

According to MARA (1986), the main forage sources in Morocco were: i) natural pastures; ii) stubble and straw; iii) sown fodder; iv) fallow; v) crop residues; vi) cereal grain; vii) industrial by-products. Their respective estimated contribution to the forage budget was 28%; 38%, 10%, 6%, 2%, 7% and 8%. However, it is important to make a few comments about these numbers: i) the trend toward a decrease in the contribution of the natural pastures over the years is due to their degradation, to the recurrent drought, and to extension of crops on marginal lands which once were used as range; ii) these numbers are averages over the entire country, reflecting the importance of forage demand of cattle production systems and which are met mostly by on farm production.

Small ruminants, on the other hand, rely more on natural pasture (more than 70% in some regions); iii) these estimated averages vary according to weather conditions in any given year. Thus, in a dry year, relatively more resources are contributed by natural pasture (which also results in increased grazing pressure and degradation) and grains (which puts increased pressure on the economics and stability of the farms, particularly the most vulnerable ones). During a wet year, important sources include increased cereal yields), fallows, and grain (due to increased barley production and thus increased availability to animal feeding).

Natural pasture and pastoral ecosystems

Natural grazing land, in varying degrees of productivity and use, extend over some fifty three million hectares. Ten pastoral zones can be distinguished according to topography, climate, vegetation and use (MARA, 1992). These are: i) Zone 1: Eastern High Plateaux and the Moulouya Valley; ii) Zone 2: the Middle Atlas; iii) Zone 3: the High Atlas; iv) Zone 4: the Rif mountain and its borders; v) Zone 5: the Mamora and Central Plateau; vi) Zone 6: the plains and plateaux north of the Atlas mountains; vii) Zone 7: the Atlantic coastal meseta; viii) Zone 8: the Argan tree area; ix) Zone 9: Presaharan ecosystems; x) Zone 10: the Saharan ecosystems.

Rangeland ecosystems have been described and mapped for each zone (Berkat *et al.* 1992). The number of such ecosystems (scale 1/ 2 500 000) is 29, 17, 13, 9, 5, 9, 1, 7, 12, 12, for the respective pastoral zones 1 to 10.

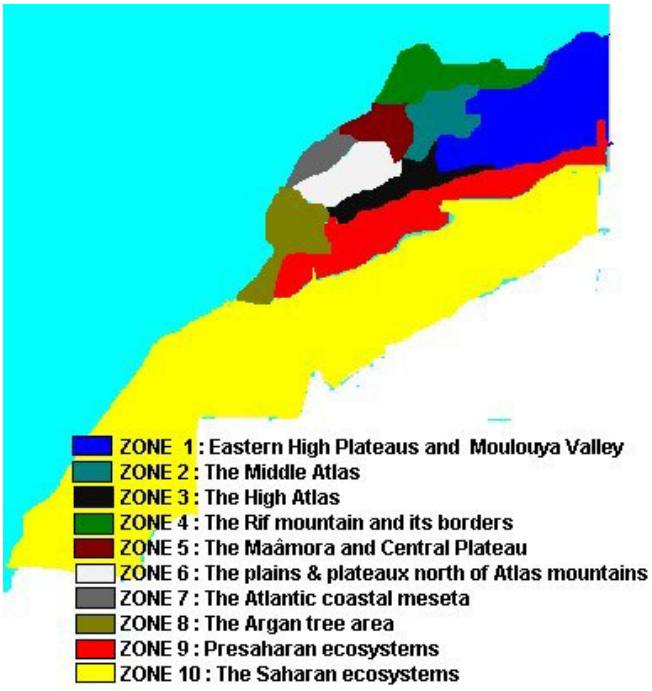


Figure 5. Pastoral zones
Sources: MADRPM (2000)

Ecosystems of the Eastern High Plateaux and the Moulouya Valley

This zone extends over more than five million hectares. Thus, it is characterized by a climatic gradient and diversity in soil and vegetation resources, even though the vegetation physionomic types are only a few: alfa steppes, low shrub

steppes, woodlands and shrublands. The bioclimatic gradient extends from subhumid in the Debdou area in the North, to Saharan in the South (Bou Arfa 160 mm) and in the Moulouya valley to the West (Outat El Haj 157 mm). However, the largest proportion of the area is the arid bioclimate with cold winters (200 to 350 mm of annual rainfall). Dominant soils in the area are lithosols and regosols, but brown steppic and halomorphs are also present. Livestock production is based primarily on sheep, and secondarily on goats. Beef cattle have increased somewhat during the last two decades, but are still of limited importance

Major range ecosystems are:

i) forest stands of the sub-humid bioclimate composed of *Quercus rotundifolia, Juniperus oxycedrus, Stipa tenacissima, Rosmarinus officinalis*. The low herbaceous strata include *Dactylis glomerata, Festuca ovina* and *Koeleria vallesiana*. This type covers about 140,000 hectares;

ii) woodlands of the semi-arid, composed of *Callitris articulata, Pistacia lentiscus, Stipa tenacissima, Rosmarinus officinalis, Cistus villosus, Lavandula multifida, Dactylis glomerata, Artemisia herba-alba,* extending over some 200 000 ha;

iii) halophytic steppes composed of *Salsola foetida, Atriplex halimus, Stipa capensis* covering some 115 000 ha;

iv) steppes of the arid bioclimate with cold winters, in fair to deteriorated condition composed of *Anabasis aphylla, Noaea mucronata, Peganum harmala, Artemisia herba-alba, Stipa capensis, Frankenia corymbosa*, covering some 880 000 ha;

v) steppes of the arid bioclimate with temperate winters, in a fair condition, composed of *Artemisia herba-alba, Frankenia corymbosa, Noaea mucronata, Teucrium polium, Stipa capensis, Stipa parviflora*. This type covers some 290 000 ha.

vi) steppes of the arid bioclimate with cold winters, in fair to good condition, composed of *Artemisia herba-alba, Stipa parviflora, Stipa barbata*, extending over some 190 000 ha;

vii) steppes of the piedmonts composed of *Stipa tenacissima, Rosmarinus officinalis, Artemisia herba-alba, Thymus* spp., *Stipa parviflora, Stipa barbata*. This type covers some 330 000 ha;

viii) alfa (*Stipa tenacissima*) steppes on varying soil types and substrates, and in varying ecological conditions, associated with species such as *Thymus* sp., *Noaea mucronata, Stipa parviflora, Atractylis seratuloides, Schismus barbatus, Artemisia herba-alba, Lygeum spartum*. This type extends over 2 500 000 ha. It provides an important forage reserve, albeit of low quality, especially in this zone characterized by long and severe drought events. It also provides invaluable soil protection when not degraded. However, the recurrence of droughts, along with maintaining too many animals by extensive use of concentrates has recently led to a large scale degradation of this resource;

ix) degraded steppes of arid to Saharan bioclimate in the middle Moulouya valley composed of *Lycium intricatum*, associated according to local ecological conditions with *Helianthemum* spp., *Halogeton alopecuroides*, *Salsola gemmascens, Noaea mucronata, Atractylis serratuloides, Aristida* spp., *Hammada scoparia*. This type covers some 420 000 ha.

The Middle Atlas

This zone has an estimated area of range extending over 1 230 000 ha. It is a mountain range in the centre of the country with a SW–NE direction. Three subdivisions can be distinguished according to topography and climate: 1) the tabular Middle Atlas, with elevations from 1 000 to 1 900 m, with high rainfall; 2) the rugged middle Atlas, ranging from the semi-arid to the sub-humid; 3) the Khénifra area in the southwest, also ranging from the semi-arid to the sub-humid. Livestock production in this zone is based mostly on small ruminants.

Major ecosystems are:

i) woodlands of the piedmonts and temperate valleys which are composed of *Callitris articulata, Juniperus phoenicea, Pistacia lentiscus, Olea europea, Phillyrea angustifolia.* Species of the lower strata include *Globularia alypum*, *Rosmarinus officinalis*, *Stipa tenacissima, S. parviflora*. They extend over an estimated area of 185 000 ha.

ii) forests of the semi-arid to subhumid zones with a cold winter composed of *Quercus rotundifolia,* generally in dense stands, but with openings having a herbaceous vegetation including

Dactylis glomerata, Bromus spp.*, Festuca* spp.*, Cynosurus elegans*. They cover an area estimated at 340 000 ha;

iii) forests of the humid zone with a cold winter, composed of *Quercus mirbeckei, Q. rotundifolia, Crataegus lacinita, Rosa* sp.*, Cynosurus elegans, Dactylis glomerata, Arrhenatherum elatius*. It extends over a relatively limited area (6 000 ha);

iv) forests of the subhumid and humid zones with a cold winter, composed of *Cedrus atlantica, Acer monspessulanum, Quercus rotundifolia,* and in the drier and colder parts *Bupleurum spinosum* and *Erinacea anthyllis*. This type covers an area of 180 000 ha;

v) forests of the sub-humid composed of *Quercus suber, Arbutus unedo, Cistus* spp.*, Halimium halimifolium, Dactylis glomerata,* covering an area of approximately 15 000 ha;

vi) low shrublands of the humid zone composed of *Adenocarpus boudyi, Genista pseudopilosa, Genista quadriflora, Festuca rubra, Hieracium pseudopilosella*, extending over some 18 000 ha;

vii) mountain grasslands or turf, composed of *Poa bulbosa, Dactylis glomerata, Stipa lagascae, Festuca rubra, Festuca ovina, Hieracium pseudopilosella, Scorzonera pygmea, Medicago suffruticosa,* covering some 50,000 hectares;

viii) mountain shrublands composed of spiny xerophytes such as *Erinacea anthyllis*, *Cytisus purgans* ssp. *Balansae, Alyssum spinosum,* associated with herbaceous species such as *Stipa lagascae, Poa bulbosa, Festuca ovina, Festuca rubra*, covering some 100,000 hectares.

The last three types are the most productive and also with the highest herbaceous plant diversity. They are grazed mostly by transhumant herds during June to October-November.

The High Atlas

This notable mountain range is composed of a series of longitudinal crests with a SW-NE direction, between which are situated large depressions. Highest points are at 4 165 m (Jebel Toubkal), 4 070 m (Mgoun), Tignousti (3 819 m), Rhat (3,781 m), El Ayachi (3 700 m) and Azourki (3 677 m). Valleys are generally of a NS direction. Annual rainfall ranges from 500 mm to 800 mm on the northern slopes, and from 200 to 600 mm on south facing slopes, the driest part being the Southeastern part of the mountain. A portion of rainfall comes in the form of snow (about 20 days above 3 200 m) and a sizable portion comes in the form of intense summer storms, representing an important cause of erosion, and an important risk to agricultural land in the valleys. Soils are relatively diversified but localized because of steep slopes: rendzinas, brown forest soils, lithosols, regosols. However, because of steep slopes, the dominant soils are lithosols. This, along with a relatively high runoff and the nature of substrates (schists, marls), makes the ecosystems of the mountain relatively dry, less diversified than in the Middle Atlas for example. Further, as pastures, they are generally less productive (owing to the previously mentioned constraints, and a short growing season at altitudes above 1 800 m). Livestock production is based on small ruminants, mostly goats on rangelands and forests, and some cattle integrated to small farms on the terraces.

Major rangeland ecosystems are:

i) woodlands of the piedmonts and valleys, with temperate winters, composed of *Callitris articulata, Pistacia lentiscus, Ceratonia siliqua*, *Olea europea, Lavandula multifida*. Variations with *Juniperus phoenicea* associated with *Callitris articulata* and *Thymus satureoides* are also found. The area is estimated at 280 000 ha;

ii) forests and woodlands at altitudes 1 400–1 800 m, semi-arid with temperate winters, composed of *Quercus rotundifolia, Juniperus phoenicea, Thymus* spp.*, Globularia alypum, Dactylis glomerata,* and locally *Callitris articulata*. The type extends over an approximate area of 370 000 ha;

iii) woodlands of the subhumid and semiarid, with cold winters, composed of *Quercus rotundifolia, Pinus halepensis*, or *Juniperus phoenicea, Globularia* spp.*, Thymus* spp.*,* covering an area over 160 000 ha;

iv) forests and woodlands of the subhumid, with cold winters, composed of *Quercus rotundifolia, Cistus* spp.*, Festuca* spp.*, Dactylis glomerata*. The area covered is estimated at 320 000 ha;

v) mountain grasslands of the high altitudes composed of *Festuca maroccana*, *F. rubra, Scorzonera pygmaea, Nardus stricta*, and *Trifolium humile*. This is a relatively productive ecosystem which extends over 85 000 ha;

vi) high altitude shrublands composed of *Vella mairei, Bupleurum spinosum, Alyssum spinosum, Festuca maroccana, Dactylis glomerata,* with locally *Juniperus thurifera*, covering approximately 770 000 ha;
vii) high altitude low shrublands composed of *Ormenis scariosa, Adenocarpus anagyrifolius, Retama dasycarpa, Alyssum spinosum, Bupleurum spinosum, Dactylis glomerata, Stipa nitens*. The area concerned is about 50 000 ha;
viii) high altitude steppes composed of *Artemisia herba-alba, Ormenis scariosa* and *Bupleurum spinosum* and covering about 93 000 ha;

The last four ecosystems are used mostly by transhumant herds from both sides of the High Atlas. Despite the relatively high animal pressures exerted on them in the summer months and the appearance of degradation indicators, these ecosystems remain relatively productive and with a good species diversity.

The Rif mountains

This range extends all along the 400 km of the Mediterranean coast and some 100 km inland, and covers, with its borders, approximately 916 000 ha. The range is characterized by a topographic dissymmetry represented by short and abrupt northern slopes (over 40 km only), and a southern slope with altitudes decreasing progressively over long distances. It is also characterized by a W-E decreasing climatic gradient (from over 1 200 mm to less than 300 mm). Three bioclimatic domains could be distinguished: 1) semi-arid in the coastal and sub-littoral areas, and also in its southern and eastern borders; 2) humid in its central zone with altitudes exceeding often 2 000 m; 3) sub-humid in the remaining areas. Soils include rendzinas over marly and limestone substrates, luvisols/acrisols (rouges) over schists and hard limestones, vertisols, and lithosols. However, due to high intensity rainfall events, degradation of the vegetation cover (mostly through inappropriate cropping on steep slopes), and the type of substrate, soil erosion is a major problem with an average of 2 000 T/sq km/year. Livestock production is based on small ruminants, mostly goats, in small-size herds.

Major rangeland ecosystems are:

i) tall shrublands (matorral) in semi-arid areas with temperate winters (mostly along the Mediterranean coast, composed of *Pistacia lentiscus, Phillyrea angustifolia, Olea europea* and *locally Juniperus phoenicea, Callitris articulata, Lavandula* spp.*, Piptatherum miliaceum*. The area of interest is about 83 000 ha;
ii) tall shrublands along the Mediterranean coast and in the Eastern part of the range, composed of *Callitris articulata, Cistus villosus, Lavandula multifida, Teucrium fruticans, Hyparrhenia hirta, Piptatherum miliaceum*. The area covered is 140 000 ha;
iii) forests and brushlands of the semi-arid and sub-humid with cold winters, composed of *Quercus rotundifolia, Thymus* spp.*, Cistus* spp.*, Genista* sp.*, Festuca rubra, Dactylis glomerata.* The area is estimated at 160 000 ha;
iv) herbaceous vegetation of the sub-humid western part of the zone, composed of *Urginea maritima, Asphodelus microcarpus, Cynodon dactylon, Chamaerops humilis, Plantago* spp.*, Rumex* sp.. Locally, remnants of perennial grasses such as *Dactylis glomerata, Hyparrhenia hirta, Piptatherum miliaceum*. This type is found as part of a mosaic with cropland and fallows. The area covered is approximately 20 000 ha;
v) woodlands and forests in the sub-humid with temperate to cool winters composed of *Quercus suber, Erica arborea, Cistus* spp. In the temperate area, other species such as *Callitris articulata, Pistacia lentiscus, Arbutus unedo, Hyparrhenia hirta, Piptatherum miliaceum*. The area covered is 288 000 ha;
vi) brushlands resulting from the degradation of forests in the humid with temperate to cool winters, composed of *Chamaerops humilis, Cistus spp, Erica arborea, Arbutus unedo.* Locally, *Ampelodesma mauritanica* stands can be found. The area covered is 160 000 ha;
vii) forests in the humid with cool to cold winters, composed of *Cedrus atlantica, Acer monspessulanum, Quercus* spp. A small forest of *Abies maroccana* is found in this type.

The Zone of Mamora-Zaers

This zone of approximately 800 000 ha is situated on a series of plateaux extending from the Atlantic ocean between the cities of Salé and Kenitra to the west, to the Middle Atlas to the East and the Phosphate

plateau to the South. These plateaux are: 1) Mamora plateau between 30 m of elevation to 350 m; 2) the Central plateau between altitudes of 300 m to over 1 000 m. The climate can be characterized by a number of gradients: 1) N-S: Kenitra 600 mm (sub-humid), Rabat 520 mm (sub-humid), Casablanca 440 mm (semi-arid); 2) W-E: Rabat 520 mm, Tiflet 450 mm (semi-arid); 3) altitudinal gradient: Rabat (coastal city) 520 mm; Oulmès at 1 260 m 784 mm (sub-humid). Soils resources include sandy soils, gleysols (hydromorphes), vertisols, and lithosols. Livestock production is based mostly on sheep and cattle.

Major rangeland ecosystems are:

i) the Mamora cork oak (*Quercus suber*) forest on sands of variable depths, interrupted with cropped areas and commercial plantations of *Eucalyptus* spp. and *Acacia cyanophylla*. Associated species include: 1) shrubs such as *Teline linifolia, Thymelaea lythroides, Cistus salviaefolius, Lavandula stoechas, Ulex boivini*; 2) herbaceous species such as the perennials *Dactylis glomerata, Festuca caerulescens, Aristida tunetana, Holcus lanatus, Stipa gigantea, Hyparrhenia hirta, Cynodon dactylon, Sanguisorba minor* and the annuals *Vulpia alopecura, Anthoxanthum odoratum, Lolium multiflorum, Brachypodium distachyum, Bromus sterilis, Briza* spp*., Ormenis mixta, Helianthemum guttatum, Sonchus oleraceus, Tolpis barbata, Ornithopus isthmocarpus, Trifolium* spp; Area 140 000 ha;

ii) forests and woodlands of the semi-arid temperate to warm winters, composed of *Callitris articulata, Pistacia lentiscus, Phillyrea angustifolia, Olea europea, Rhus pentaphylla, Cistus villosus, Lavandula multifida, Dactylis glomerata, Hyparrhenia hirta, Asphodelus microcarpus, Bromus* spp. *Brachypodium distachyum*. The area is about 280 000 ha

iii) forests of inner lands under sub-humid bioclimate and cool winters, composed of *Quercus rotundifolia, Cistus* spp*.; Lavandula stoechas, Thymus* spp*., Dactylis glomerata, Festuca caerulescens, Cynosurus* sp*., Bromus* spp*., Brachypodium* spp. The area covered is about 87 000 ha;

The Plains and Plateaux North of the Atlas

This zone extends over an estimated area of 1 275 000 ha. It is composed of the following physiographic units: 1) the phosphates plateau (300–400 mm of rainfall); 2) the Rhamna range (250 mm of rainfall); 3) the Jbilete range (250–300 mm); 4) the Bahira plain (250 mm); 5) the Haouz plain (250 mm); 6) the Chichaoua plateau (200 mm). Soil resources include lithosols with caliche layers, rendzinas, xerosols (steppic isohumic). Livestock production is based on sheep and cattle.

Major rangeland ecosystems are:

i) degraded herbaceous vegetation on lithosols with caliche, composed of *Asphodelus microcarpus, Chamaerops humilis, Stipa capensis, Macolmia patula, Medicago* spp*., Ziziphus lotus*. The area concerned is about 280 000 ha;

ii) degraded steppes composed of *Stipa capensis, Calendula bicolor, Medicago* spp*., Notoceras bicorne, Eruca vesicaria* extend over 250 000 ha in a mosaic with croplands;

iii) degraded steppes situated in the driest parts and shallow soils, composed of *Hammada scoparia, Eruca vesicaria, Notoceras bicorne*, covering an area of 126 000 ha;

iv) degraded steppes composed of *Salsola vermiculata* with *Aizoon hispanicum*, or with *Atriplex halimus, Anacyclus radiatus, Diplotaxis tenuisiliqua*, covering a total area of about 100 000 ha in a mosaic with crops;

v) degraded steppes of the Rhamna and Jbilete ranges with lithosols, composed of *Stipa capensis, Asphodelus tenuifolius, Notoceras bicorne, Diplotaxis* spp*., Peganum harmala.* Desirable species such as *Hyparrhenia hirta, Cenchrus ciliaris, Lavandula dentata* are minor elements or only as traces like *Artemisia herba-alba*. This type covers about 328 000 ha;

vi) degraded steppes composed of *Lycium intricatum, Plantago ovata*, *Peganum harmala, Ferula communis*, covering some 96 000 ha.

The Coastal Meseta

This zone is mostly cropland. However, the land closest to the Atlantic ocean, or what is called the Sahel, over a width of 30 km, is in the form of consolidated dunes with exposed limestone and dolomite on the surface and so is mostly covered by natural vegetation used for grazing in autumn, winter and early spring. Animals move to arable plains inland in summer for stubble grazing.

Vegetation is basically composed of herbaceous species such as *Asphodelus microcarpus, Rumex bucephalophorus, Plantago coronopus, Spergularia fimbriata, Lotus maroccanus, Vulpia myuros, Bromus rigidus* and *Paronychia argentea*. However, desirable perennials, including woody species, may regenerate with protection from grazing: *Chamaecytisus albidus, Retama monosperma, Sanguisorba minor, Dactylis glomerata* and *Piptatherum miliaceum*.

The Argan zone

This zone extends over an estimated area of 1.5 million ha. Consequently, it is quite diverse in terms of physiographic and climatic conditions: 1) coastal plains of Abda and Chiadma; 2) the Essaouira region; 3) the western area of the High Atlas; 4) the Souss plain; 5) the western Anti-Atlas. Rainfall gradients are: 1) decreasing N-S: Oualidia 392 mm, Safi 327 mm, Essaouira 278 mm, Agadir 250 mm, Anti-Atlas 200–250 mm; 2) increasing with altitude in the western High Atlas; 3) decreasing from W to E in the Souss plain south of the High Atlas. Soil resources are mostly lithosols. Fluvisols are found in lowlands. Livestock production under rainfed conditions is mainly goats on rangelands (particularly browsing on tops of the argan tree). Under irrigated systems, cattle and sheep are dominant.

Major rangeland ecosystems consist of

i) coastal or sub-coastal steppes of the Saharan bioclimate with warm to temperate winter, composed of either: 1) *Euphorbia echinus, Euphorbia regis-jubae, Helianthemum confertum, Retama monosperma*; or 2) *Argania spinosa, Artemisia herba-alba, Euphorbia echinus*; and covering 40 000 ha;
ii) wooded steppes of the arid bioclimate with cool to warm winters, composed of *Argania spinosa, Artemisia herba-alba, Ziziphus lotus, Stipa capensis* and *Asphodelus fistulosus;* and covering 680 000 ha;
iii) argan forests in the semi-arid with temperate winters, associated with *Olea europea, Pistacia lentiscus, Genista* sp.*, Chamaerops humilis;* and covering 235 000 ha;
iv) forests and woodlands composed of *Callitris articulata*, *Olea europea, Phillyrea angustifolia, Ceratonia siliqua, Pistacia lentiscus, Cistus villosus, Lavandula multifida, Thymus* sp*; Teucrium fruticans*; and covering 225 000 ha;
v) oak forest of the sub-humid with cool winters, composed of *Quercus rotundifolia, Callitris articulata, Pistacia lentiscus, Arbutus unedo, Juniperus phoenicea;* and covering 76 000 ha;

The Presaharan zone

This zone extends over 5.7 million ha. It is bound by the 100 mm and the 200 mm isohyets, respectively to the South and the North. As such, it comprises the Southern slopes of both the High Atlas and the Anti-Atlas.

Major rangeland ecosystems are:

i) relatively degraded steppes of the arid bioclimate with cold winters, composed of *Artemisia herba-alba, Thymus* spp.*, Anvillea radiata, Launaea acanthoclada, Stipa parviflora*. This type is nevertheless relatively productive (about 400 kg DM/ha/year) and covers approximately 2 200 000 ha;
ii) alfa steppes at their southern limit composed of *Stipa tenacissima, Stipa parviflora, Thymus* spp., extending over an estimated area of 300 000 ha;
iii) steppes of the South eastern plain of Tamlelt, composed of *Hammada scoparia, Atractylis serratuloides, Farsetia hamiltoni* and *Aristida obtusa.* Stands of *Artemisia herba-alba, Atractylis serratuloides* and *Stipa parviflora* can also be found. This is an ecosystem of relatively high potential, despite the climatic constraints and the impact of past use on vegetation and soil. This covers around 350 000 ha;
iv) degraded steppes of the Saharan bioclimate composed of *Fredolia aretioides, Hammada scoparia* and *Cymbopogon schoenanthus*, covering 350 000 ha;
v) degraded steppes of the Saharan bioclimate on regs, composed of *Fredolia aretiodes, Launaea arborescens, Limoniastrum fei* and *Gymnocarpos decandrum*. Area 570 000 ha;
vi) degraded steppes of the Saharan bioclimate on regs/hamadas, composed of *Hammada scoparia, Atractylis serratuloides, Farsetia* spp. and *Limonium* sp. The area covered is about 1 000 000 ha;
vii) degraded steppes of the Saharan bioclimate on regs, composed of *Zilla macroptera, Launaea arborescens, Hammada scoparia* and *Farsetia* spp. The estimated area is 750 000 ha;

The Saharan zone

This zone extends over a considerable area of 46 500 000 ha. However, forage productivity is generally low and variable because of low and variable rainfall (less than 100 mm). Nevertheless, the zone possesses a relatively high ecosystem diversity due to the extensive area, and to spatial variability (wadis, regs, hamadas, sebkhas, dunes). This diversity is at the base of livestock activities, particularly camels adapted to make good use of diversity over long distances.

Major rangeland ecosystems are:

i) steppes of the regs and hamadas, composed of *Hammada scoparia, Aristida* spp. This is the most extensive type with over 34 500 000 million ha;
ii) steppes of the consolidated dunes, composed of *Aristida pungens, Calligonum comosum*, covering about 2 600 000 million ha;
iii) coastal steppes composed of *Euphorbia regis-jubae, Euphorbia echinus, Euphorbia balsamifera* and *Senecio anteuphorbium*, relatively productive (200 kg DM/ha) 1 200 000 ha;
iv) coastal steppes composed of *Salsola tetrandra, Zygophyllum waterlottii, Launaea arborescens* and *Lycium intricatum*. Area concerned: approximately 1 300 000 ha;
v) steppes of the wadis (Draâ valley) composed of *Atriplex halimus, Retama retam, Tamarix* sp., *Limoniastrum ifniense* and *Nitraria retusa*. These steppes are among the most productive in the Saharan zone. Area 2 400 000 ha;
vi) wooded steppes composed of *Acacia raddiana, Withania adpressa* and *Cymbopogon schoenanthus*. Area 440 000 ha;
vii) halophytic steppes of the sebkhas, composed of *Zygophyllum waterlotii, Zygophyllum gaetulum, Suaeda mollis* and *Suaeda monodiana*. These steppes are the most productive (800 kg DM/ha). Area 1 700 000 ha;
viii) steppes of the rocky plateaux and mountains, composed of *Nucularia perrini, Traganum nudatum, Salsola* spp. and *Hammada scoparia*. Area 1 700 000 ha.

Fallows, stubbles and crop residues

Fallow land. Each year, more than 2 000 000 ha are under fallow which is used for seasonal grazing. The flora is dominated by weedy species and varies according to agro-climatic conditions: i) in the Southwest (Souss), where precipitation is less than 250 mm and the temperatures relatively warm, fallows are poor in terms of floristic composition and productivity. Species include *Stipa capensis, Medicago minima, Eryngium tricuspidatum, Diplotaxis* spp.; ii) in the Atlantic plains and plateaux with less than 350 mm rainfall, and temperate winters, species include: *Malcolmia sp., Notoceras bicorne, Diplotaxis* spp., *Eryngium* sp., *Medicago* spp. iii) in the Atlantic plains and plateaux with rainfall greater than 350 mm, *Malva hispanica, Calendula bicolor, Papaver* sp., *Sinapis* sp., *Avena sterilis, Medicago* spp., *Bromus* spp., iv) inland plains and plateaux: *Avena sterilis, Bromus* spp., *Phalaris minor, Papaver* sp., *Medicago* spp., *Hordeum murinum, Lolium rigidum*; v) in the mountains: *Avena* sp., *Papaver* sp, *Trifolium* spp., *Hordeum murinum, Vicia* sp.; vi) in the Eastern Region: *Bromus* spp., *Eruca vesicaria, Stipa capensis, Medicago* spp.

Stubbles. Stubbles are used from harvest (May-June) to September-October. Their quality is relatively good during the first four weeks (Kabbali and Berger 1990) due to a high grain content and a high leaf/stem ratio. Later on, supplements are necessary, especially for pregnant sheep and after September.

Crop residues and by-products. These include wheat chaff, pelleted sugar beet meal, molasses, sunflower and cottonseed meal. The quantities utilized in 1989 were 1, 138, 159, 185, and 48 KT, respectively (Guessous 1991). In the recent past, increases in availability have been greater for wheat chaff, and the sunflower and cottonseed meal.

Fodder crops

Fodder crops are grown on approximately 386 000 ha. This includes annuals such as oats, fodder barley, berseem and fodder maize; lucerne as a perennial.

Oats: or the oats/vetch mixture were grown in 1994 on approximately 70 000 ha and 50 000 ha, respectively (Amine and El Baghati 1997). Mixtures are used in Sais and pure oats in Khemisset, Tangiers, Khenifra, Ifrane. The contribution of oats to the forage resource is 10%, corresponding to an average yield of only 1 500 FU/ha (MAMVA 1994–95): Fodder unit (FU) is defined as the equivalent to the net energy content of 1 kg of standard barley grain.

Fodder Barley: occupies the second rank in fodder acreage, after lucerne. It is cultivated on about 82 000 ha or 20% of the fodder acreage and contributes 9% to the total fodder units (FU) produced by all sown fodder in the country (Amine and El Baghati 1997).It is mixed with a legume, generally peas, on about one sixth of its area (Ouknider 1997). Most fodder barley (90%) is gown under rainfed conditions, particularly in the plains of Chaouia, Doukkala, Abda, Tadla, and the Khemisset area (Amri and El Mzouri 1997). Under irrigation, it is grown in the Tadla, Doukkala and Tafilalet perimeters. Yields are relatively low on the average, attaining 1 500 FU/ha and 3 000 FU/ha, under rainfed and irrigation, respectively (Amri and El Mzouri 1997).

Lucerne: occupies the largest area of sown fodder in the country, 85 000 ha or about 22% (Birouk *et al*. 1997). Owing to its high productivity, it contributes about 50% of the total FU of the sown fodder. It is used as cut and carry fed fresh, to make hay, silage, and pellets. Most of the lucerne is grown in three major areas: i) the oasis systems of the valleys of Ziz, Draa and Dades south of the Atlas mountains; ii) the terraces in the valleys of the Atlas mountains; iii) the irrigated perimeters north of the Atlas, such as Tadla, Doukkala, Haouz, Moulouya and Souss-Massa. Average yield is 53 tonnes fu/ha (Birouk *et al*. 1997).

Berseem: is grown on approximately 50 000 ha annually. The area continues to extend (20% increase in the last decade) (Bounejmate 1997a). Its production attains 250 million FU (about 20% of the FU produced by sown fodder) (Bounejmate 1997a). Berseem is grown mainly in the irrigated perimeters of the Rharb, Doukkala, Haouz, and Tadla (Bounejmate 1997a). It is not grown in the southern perimeters of the oases because of the cold, and lucerne is better adapted. Berseem is grown under rainfed conditions in the Rharb and Loukkos plains and in the North (Chefchaouen, Tetouan, Sidi Kacem). Average production attains 8 to 10 t DM/ha (Ameziane 1987), well below the potential of 16 tonnes DM/ha.

Fodder maize: is grown on approximately 15 000 ha, corresponding to 4% of the sown fodder (total maize area is 375 000 ha mostly for grain). It contributes some 116.6 million FU, corresponding to 11.5% of the sown fodder production (MAMVA 1994-95). The major areas of fodder maize under irrigation are the Rharb, Sous-Massa, Chefchaouen, Tetouan, and Doukkala. Under rainfed conditions, it is mainly grown in the northern parts of the country.

Forage seed production

Forage and pasture seed production is less developed compared to other crops. This is due probably to the fact that forage seeds are considered by all stakeholders and mainly by farmers as a by-product to forage production. Therefore, most seeds are produced and distributed through the informal sector.

The most important forage crops are lucerne, berseem clover, barley and maize under irrigation; oat, vetch, barley, ryegrass, fodder peas, and annual medic in the rainfed zones. For range improvement plants used are perennial grasses (*Dactylis, Festuca, Agropyron*, etc.), annual medics, clovers and fodder shrubs (*Atriplex, Acacia*, and native shrubs).

Although, efforts have been made to develop new forage crop cultivars

Table 5. Forage and pasture varieties

Crop	Variety	Country
Lucerne	African, Moapa, Sonora	Morocco
Annual medics	Bariya (CPSP00097), Haouzia (CPSP00097), Mettouh (CPSP0148), Jabilia (INDAI), Badrya (V124), Karama (V384)	Morocco
Oat	Karia, Taza (320), Tedders (412), Zhiliga (095), Paras (Cokfr79-17), Ghali (Il 3411), Soualem (Mo 06423), Rahma (C7512cpx), Tislit (83 Ab3101), Zahri (72 Ab3082), Tissir (87wiqr157-5), Amlal (87 Wi 8202-03), Nasr (88 M 1420)	Morocco
Fodder peas	Alfia5 (F305), Alfia17 (F317), Alfia21 (F321)	Morocco
Vetch	Ghazza (6194), Guich1 (6242), Hallaba (6238), Nawal (6235), Nora (6194), Salholtma (1812), Hesba (Acc573), Marhaba (Acc577), Yamama (Acc7o9)	Morocco

Source: Tazi (1998)

(Table 5), forage and pasture seed production in the country is less developed compared to other crops.

In general, the assessment of forage and pasture seed needs is very difficult due to the fluctuation of the amount of informal seed used by farmers and to the lack of precise information related to the subject. Table 6 gives areas cultivated with forage crops, seed requirement, production and importation.

Seed production in the country is highly dependent on the amount and the distribution of rainfall in the year. Therefore, seed needs are covered either through national production or through imports. In general seed import constitutes the rescue solution for forage and pasture seeds particularly in dry years.

In Morocco forage seed marketing and distribution are carried out by the National Society for Seed Commercialisation (SONACOS). Some pasture seeds are also distributed to range projects by the Pastoral Seed Production Centre (CPSP at El Jadida) (Tazi, 1998).

Table 6. Forage areas, seed requirements and seed production (1990–1994)

Crops	Forage areas	Seed needs	Certified seed needs
	ha	tonnes	tonnes
Oats	121 500	9 010	2 793
Barley	90 700	8 544	171
Lucerne	19 600	587	270
Vetch	52 400	4 189	1 424
Berseem	50 800	2 030	325
Maize	14 000	351	211
Fodder Peas	13 200	396	198
Peas	8 700	695	348
Lupin	4 200	506	506
Annual medics	3 500	69	69
Sudan grass	1 600	31	32
Rye	1 800	246	246
Triticale	800	116	116
Others	12 200	891	446
Total	395 000	27 661	7 155

Source: Tahiri et al *(1997)*

It should be emphasized that Morocco began range seed production during the 1980s. This is undertaken by public institutions such as the Centre de Production des Semences Pastorales at El Jadida and the Forestry Department. However the quantities produced do not exceed 50 tonnes/year (Tazi, 1995). Range seed production is undertaken for: (a) rehabilitation of degraded rangeland, (b) improvement of fallow land, and (c) improving fodder crop production.

Forage germplasm conservation and utilization

Morocco is an important centre of diversity for several forage species. Germplasm collecting has been undertaken by international scientists and institutions since the beginning of the century. During the last decade, national institutions and programmes have paid great attention to collecting forage plant genetic resources (Table 7). Special emphasis was put on forage legumes particularly the genus *Medicago* in the arid and Saharan zones by the Livestock Department and the IAV Hassan II (Birouk *et al*., 1991).

Table 7. Principal forage and pastoral collecting expeditions in the past decade in Morocco

Year, Participants	Species collected (number of populations)	Site of conservation
1990- M. Tazi (CPSP), A. Birouk & J. Lewall (IAV Hassan II) & H. Prendergast (KG)	Legumes (188), Grasses (85), Shrubs (73)	CPSP Kew
1990- B. Buirchell (WADA) & INRA	*Lupinus* spp. (48), *Medicago* spp. (24), *Trifolium* spp. (3), *Vicia* (2), *Pisum* (2)	SCPF
1992- C.P. West (UA) & INRA	*Acremonium coenophialum* (51)	
1993- L. Robertson (ICARDA) C.M. Francis (WADA) & INRA	*Vicia, Lathyrus* (450)	ICARDA SCPF
1994- L. Robertson (ICARDA) C.M. Francis (WADA) & INRA	*Vicia, Lathyrus* (209)	ICARDA; SCPF
1994- P.J. Cunningham (DAV), W. Graves (UC) & INRA	*Lolium, Festuca, Dactylis, Phalaris, Trifolium* (226)	SCPP CPSP
1995- A. Birouk (IAV), M. Tazi (CPSP) & M. Van Slageren (KG)	Pastoral species (73) Medicinal & others (129)	Kew CPSP
1995- S. Saidi, C. Al Faiz & M. Taoufiq (INRA)	*Avena* (17), *Aegilops* (19), Grasses (18), Others (28)	SCPF
1997- A. Birouk (IAV), M. Tazi (CPSP) & M. Van Slageren (KG)	Pastoral species & others (35)	Kew; CPSP
1998 A. Birouk(IAV) and K. Mokhtari	*Medicago sativa* from saline areas (32)	IAV
1999 A. Birouk (IAV), M. Tazi (CPSP) & M. Van Slageren (KG)	Pastoral and wild species	Kew; CPSP

CPSP: Centre de Production de Semences Pastorales, Direction de l'Elevage, El Jadida, Morocco
ICARDA: International Center for Agricultural Research in Dry Areas, Aleppo, Syria
IAV Hassan II: Institut Agronomique et Vétérinaire Hassan II, Morocco
KNAES: Kyushu National Agricultural Experiment Station, Nishigoshi, Kumamoto, Japan
SCPF: Station Centrale des plantes Fourragères, INRA, Morocco

Forage germplasm from Morocco has been widely used in breeding programmes around the world. Several traits and characters including high yielding, disease and insect resistance and cold or drought tolerance serve as the basis of crop improvement in these programmes. Local ecotypes have been used at an international level to produce commercial cultivars such as Berber, Kasba of *Dactylis glomerata*; El Golea and Sirocco of *Phalaris aquatica*; Maris Jebel and Maris Kasba of *Festuca arundinacea*, Demnat of *Medicago sativa*, Rivoli of *Medicago tornata,* El Gara of *Ornithopus compressus* and Jebala of *Ornithopus pinnatus* (Bounejemate, 1997b).

The demographic pressure that different countries in the region have experienced has engendered a high population demand for agricultural and livestock products. This has pushed farmers to overexploit the pastoral resources, leading to overgrazing, and to convert productive range to marginal croplands. These effects have became aggravated by:

- absence of private investment in range infrastructure and management;
- recurrent drought common to the region;
- maladjustment of the legislation to the range management activities;
- weakness and/or the lack of forage reserves for feed shortage and drought periods;
- insufficiency of technical support to livestock holders in the pastoral regions;
- insufficiency of research in range management fields.

This series of constraints obviously has repercussions, direct or indirect, on the development of pastoral seed demand. Although the range reseeding has allowed a mastery of techniques and has given positive results in some countries, it has remained very limited. This low rate of realization can be explained by:

- low level of involvement of populations in the carrying out of seeding activities notably because all these programmes are wholly government funded;
- insufficiency of funds allocated to the range rehabilitation programmes;
- insufficiency of extension activities concerning range improvement.

6. OPPORTUNITIES FOR IMPROVEMENT OF FODDER RESOURCES

In order to overcome some of the limitations stated above, the Ministry of Agriculture has developed a strategy for range development. The main objectives of this strategy aim to:

- create an economical environment compatible with the objective above, allowing the adhesion of the producers and the sustainability of animal production systems;
- satisfy the demand for red meat by the year 2020;
- create a facilitating economic environment for the long term participation of producers and for the sustainability of animal production systems;
- organize stakeholders and facilitate the modernization of pastoral activity;
- conserve natural resources and improve livestock productivity.

The following actions are being taken at different levels in order to achieve the stated objectives:

Policies and legislation

- Strengthen management capacity to make better economic use of investments and for the integration of livestock into farming systems. This would be a prerequisite to improving livestock productivity on rangelands;
- Improve marketing channels to benefit herders, particularly the large number of small-scale operators, by providing them access to agricultural credit and markets.

Land tenure

- Promote community-based organization(s) to ensure active and continued participation of all members of the community in the management of grazing land, to establish and/or clarify by

delimitation and registration the status of collective pastoral lands, and especially to put restrictions on land sub-division and shifting agriculture;
- It must be made clear that range management is not simply a technical issue because it also translates land policy into economic use/conservation of basic resources, and the type of development provided to producers without adversely affecting the interest of their heirs or of the nation;
- The selection of interlocutors is crucial to the success of the endeavour, given the nature of the activities to be undertaken. Consequently the beneficiaries must all have similar needs and aspirations in order to minimize conflict. The group leaders must also be clearly identified.

Conservation and sustainability. One of the main objectives of the strategy for rangeland development relates to the sustainable use of the resources. Protection of the environment is central to this strategy (combating desertification, conservation of biodiversity and agro-biodiversity).

Range rehabilitation

Strengthening the base for initiating rangeland management initiatives through surveying the use of pastoral resources, to be undertaken on twenty million hectares over twenty years, and the registration of communal lands in order to clarify the status of the area to be managed. Undertaking range improvement and rehabilitation, and taking action, both in time and space, which allows for the generation of credible production and conservation statistics. These actions will involve the rehabilitation of severely degraded rangelands (8.3 million ha over 20 years at a rate of 200 000 ha/year), the improvement of the productivity of rangelands with high potential (50 000 ha/year over 20 years) and the improvement and management of rangelands that are presently still considered to be in satisfactory condition.

Grazing land improvement. Results achieved during the phase 1969–1980 made it possible to draw the main lines for rangeland development. These, which are supported by the organization of beneficiaries, the range studies and the rational exploitation of the rangeland, have formed the basis for development of several range projects such the Middle Atlas project, the FAO-UNDP project and the USAID Range improvement project under which capacity building has been reinforced.

During the period 1980–1990 efforts were concentrated on:
- the establishment of the rangeland service in the Ministry of Agriculture;
- the training of engineers specialized in range management;
- the delimitation of eleven range improvement areas;
- the organization of the stockbreeders in pastoral cooperatives;
- the launching of the "ley farming" programme in the dryland zones (use of annual medics and clovers on traditional fallow "*bour*");
- the planting of fodder shrubs on 17 000 ha; mainly *Atriplex nummularia* and *Opuntia inermis*
- the installation of protected areas on 28 000 ha in the High Atlas and Tafrata zones;
- the establishment of the El Jadida seed production centre (Centre de Production des Semences Pastorales);
- the execution of several studies relating to rangeland use;
- the execution of a large programme related to the basic infrastructures concerning water, wells, pastoral roads and dipping tanks.

However, the actions undertaken were not sufficient enough to achieve the defined development objectives. This has pushed the Ministry to develop the livestock strategy described above.

Integration of forages into farming systems

The most important action to integrate forages into the farming systems was the ley farming operation. Other actions include promotion of the new feed production techniques such as fodder conservation, valorization of straw, and utilization of agro-industry by-products.

The ley farming operation was launched in 1986 aiming at the integration of sheep and cereal production by cultivating the 1 600 000 to 2 600 000 ha that have been fallow each year. Despite the real advantages that this operation represents in the semi-arid regions of Morocco, the substitution of the rotation cereal-annual medics or cereal-subterranean clover was only done on about 5 200 ha/year. The

main reason for the limited adoption of this system is related to the size of the farms. In fact, most of the farms are very small and scattered which makes movement of the herd and grazing difficult.

7. RESEARCH AND DEVELOPMENT ORGANIZATIONS AND PERSONNEL

The following institutions are involved in forage research and development:

- **Direction de l'Elevage** (Livestock Directorate); its main focus areas include: planning conservation and development programmes, rangelands management, rehabilitation of degraded rangelands and execution of national and internationally assisted projects. All these programmes are conducted in collaboration with the Provincial Directorate and Regional Offices of Agriculture which are the implementing agencies.
- **Ministère des Eaux et Forêts** (Ministry of Forestry).
- **Institut National de Recherche Agronomique** (National Agricultural Research Institute) – the emphasis of its forage research programme is on the introduction of fodder crops in rotations on irrigated agricultural schemes and broadening the base of fodder crops utilized in different agricultural systems.
- **Institut Agronomique et Vétérinaire Hassan II** (Agronomic and Veterinary Institute Hassan II) at Rabat – which is, through the rangeland, Animal Science, Agronomy and Plant Breeding, and Social Science Departments, involved in teaching, practical training and research on rangelands and fodder crops. Many of the M.Sc. and Ph.D. research projects focus on forage resource problems from an ecological, agronomic, nutritional or economic angle.
- **Ecole Nationale d'Agriculture** (National Agricultural School) at Meknes which, like the previous institute, is involved in teaching, practical training and research on rangelands and fodder crops. Many of the M.Sc. and Ph.D. research projects focus on forage and pasture resource problems.
- **Ecole Nationale Forestière d'Ingénieurs at Salé** – which has a training and research programme on forestry and natural resources, including range resources.
- **Centre de Production des Semences Pastorales** (Pasture Seed Production Center) at El Jadida –is involved the collection, conservation and evaluation of plant genetic resources and in forage and range seed production.

The Regional Directorates of the Ministry of Agriculture (Offices de Mise en Valeur Agricole and Directions Provinciales de l'Agriculture) are the main actors in implementing Ministry policy and programmes. They also play an important role in extension.

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9. CONTACTS

The profile was prepared by:

Omar Berkat, Institut Agronomique et Vétérinaire Hassan II, B.P. 6202, Rabat-Instituts, Rabat, Morocco. Tel. (212) 37 771758; (212) 68 493066. E-Mail: oberkat@hotmail.com
and,
Mohammed Tazi, Chef du Centre de Production des Semences Pastorales, BP 79, El Jadida, Morocco. Tel. (212) 23 344350. E-Mail : m.tazi@menara.ma

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