

Country Pasture/Forage Resource Profiles

ALGERIA



by

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1. INTRODUCTION

The Democratic and Popular Republic of Algeria covers an area of 2 381 741 km², and is the second largest country in Africa after the Sudan, but nearly nine tenths of its land is in the six Saharan provinces. Its capital is Algiers. To the north it borders the Mediterranean Sea, to the south Mali and Niger, to the west Morocco and to the east Tunisia and Libya (see Figure 1). It is subdivided into 48 *wilayas* or provinces.

Four fifths of the population are Arabs; Berbers form the largest minority. The languages are Arabic and Berber. Almost all the population are followers of Islam.

It was a province of the Roman empire, thereafter the Vandals and Byzantines invaded. The Islamic conquest of North Africa took place in the seventh century; it became part of the Ottoman Empire in the sixteenth century and was taken by the French in the early to mid nineteenth. Algeria gained its independence from France in 1962.

Two great mountain ranges, the Sahelian Atlas in the south and the Tell Atlas in the north, divide the country into three types of landscape which are distinct in their relief and morphology, giving rise to great biological diversity. From north to south the three zones are the Tell System, the High Plains and the Sahara. Algeria's rivers are mainly seasonal. The basins of the Chelif and the Hamiz provide about a third of the country's irrigation needs.

The population at the 1998 census was 29 270 000. According to the World Factbook the estimated population in July 2006 was 32 930 091 with a growth rate of 1.22%. The previous census in 1987 recorded 22 710 000 which gives a mean annual population growth of 2.8% over the decade. People actively involved in agriculture represent 25% of the national work force, about one million people, of which 125 000 are livestock rearers.

Urban and peri-urban areas, which cover only four% of the land, are the most densely populated with about 80% of the total population. The steppes, beyond the Tell Atlas, 9% of the country, are true grazing lands and their people, essentially agropastoralists, form 12% of the population. The remainder, 8 percent, are dispersed in the Saharan regions which cover 87% of the country.

The hydrocarbons (oil and gas) sector is the backbone of the economy, accounting for roughly 52% of budget revenues, 25% of GDP, and over 95% of export earnings. Algeria has the fifth-largest reserves of natural gas in the world and is the second largest gas exporter; it ranks fourteenth for oil reserves.

Land distribution

According to the Ministry of Agriculture (Statistiques Agricoles 1999) Algeria's 2 380 000 km² are distributed as shown in Table 1.

The land used by the agricultural sector is 40 000 000 ha, 17% of the country: 31 000 000 ha are grazing, the home of Algerian pastoralism. Eight million ha are farm land of which 94% are arable and 6% under perennial crops. Farm land corresponds to 0.28 ha per inhabitant.



Figure 1. Map of Algeria

Table 1 : Land use

Land use type	Farm land	Grazing	Alfa steppe	Forest land	Barren land	Total
Area (km ²)	82 270	310 540	29 160	4 1960	1 913 310	2 381 740
Percentage of total	3.45	13.22	1.22	1.76	80.33	-

Forest land covers 4 100 000 ha (Ghazi and Lahouati, 1997), divided as follows:

- Natural forest : 1 329 000 ha (32.4%)
- Maquis and scrub: 1 844 400 ha(44.0%)
- Grassland: 800 ha (0.1%)
- Plantations: 972 800 ha (23.5%)

The main forest trees are:

- Aleppo pine *Pinus halepensis*: 800 000 ha (35.4%)
- Cork oak *Quercus suber*: 463 000 ha (20.5%)
- Holm oak *Quercus rotundifolia*: 354 000 ha (15.7%)
- Junipers *Juniperus* spp.: 217 000 ha (9.0%)

The alfa (*Stipa tenacissima*) steppe is the transition between the forests and the steppes. The area covered by alfa was 5 000 000 ha at the beginning of the twentieth century but is now reduced to 2 000 000. Its degradation is due to overexploitation since it provided an important source of paper pulp as well as being used in basketry and weaving by the traditional artisanal sector (Nedjraoui, 1990; Kadi-Hanifi, 1998).

Barren land, 80% of the country, is in the Saharan region where ergs, regs and hamadas dominate.

Livestock sector

Stock-rearing in Algeria mainly concerns sheep, goats, cattle and camels. Table 2 shows the results of livestock censuses for selected years 1990-2005. FAOSTAT (2005) also shows for 2005: 170,000 asses and 43 000 mules.

Sheep predominate with 80% of the total, over ten million ewes. Goats are in second place with 13% of which does comprise half. The cattle herd is small, 1.5–1.6 million head of which 58% are milch cows. Agro-ecological zones differ in their livestock specialization. Cattle are mainly limited to the north of the country with some enclaves elsewhere. The steppe is the favourite zone for sheep and goat raising, over ninety% of their total is there, causing serious over-exploitation of the herbage.

Table 2: Livestock numbers ('000 head)

Year	1990	1995	1999	2000	2001	2002	2003	2004	2005
Cattle	1 393	1 267	1 580	1 595	1 613	1572	1540	1560	1560
Sheep	17 697	17 302	17 989	17 616	17 299	18 738	18 700	18 700	18 700
Goats	2 472	2 780	3 062	3 027	3 129	3 187	3 200	3 200	3 200
Camels	123	126	220	235	246	245	245	245	245
Total	21 685	21 475	22 851	22 473	22 287	23 742	23 685	23 705	23 705

Source: FAO database 2006

2. SOILS AND TOPOGRAPHY

Algeria has three great structural units: the Tell, the High Plains and the Sahara.

The Tell system

This comprises a succession of mountain massifs, coastal and sub-littoral, and plains.

- The Western Tell is formed by alternating lines of massifs, of medium height, dominated by a dorsal of Jurassic and Cretaceous limestone and depressions represented by the low plains of Oran and the plain of Bas Chélif.
- The Central Tell comprises a chain of mountains prolonging the Western Tell; it includes the mountains of Zaccar, the Atlas of Blidé and the mountains of Djurdjura which rise to 2 300 m. The Cretaceous rocks are schists, marls and marly limestones. The coastal edge is dominated by a large depression which forms the rich alluvial plain of Mitidja.
- The Eastern Tell is the most mountainous part of the country and consists of parallel chains; from North to South these are:

- The chains of the coastal Tell, composed of gneiss and granite which are a prolongation of that of Djurdjura. These are the massifs of Collo, Skikda and l'Edough which border the low plain of Annaba where the two largest areas of sweet water are found: Lake Tonga and Lake Oubeïra which are on the list of nature reserves of the Convention of Ramsar.
- The Outer Tell, comprising the mountains of Babors and the massifs of Lesser Kabylie are on the basement complex of the Jurassic and Eocene.
- The chains of the Inner Tell are dominated by mounts Hodna, Belezema and the massif of Aurès (2 328 m) and the Nemenchas mountains. This belongs to the Atlas.

The High Steppic Plains

These are between the Tell Atlas to the north and the Saharan Atlas to the south, at altitudes between 900 and 1 200 m; they are dotted with saline depressions, chotts or sebkhas, which are continental lakes formed during the Pleistocene when there was torrential rainfall and heavy run-off. Two areas are recognized:

- **The Western Steppe**, which comprises the South Oranese and South Algéroise High Plains; their altitude decreases from Djebel Mzi (1 200 m) in the west to the saline depression of the Central Hodna (11 000 ha) which is occupied by detritic deposits.
- **The Eastern Steppe**, to the east of the Hodna, is formed by the High Plains of South Constantine where dolomites and limestones of the Cretaceous dominate. They are bordered by the massifs of Aurès and Némemchas.

The Sahara

The Sahara is a great barrier separating the Mediterranean from the tropical zone. It consists of plateaux (hamadas and tassili) where the volcanic Massif of Hoggar rises to 3 000 m, plains (regs and ergs) and depressions (sebkhas and gueltas).

Hamadas and tassilis are immense calcareous, table-shaped plateaux with skeletal soils dominating in the valleys and wadis. The Tassili of Ajjers covers 350 000 km². Regs are flat areas covered with stones and gravel; of varied forms, the result of serious aeolian erosion of surface soil horizons. Ergs are sandy deposits in the form of dunes. The Western Erg is 500 km long by 150 – 250 km and covers 100 000 km² and is part of the great Saharan dune complex. The depressions are either saline (chotts and sebkhas) or non-saline where run-off accumulates (dayas).

Soils

There are several soil types. (Djebaili et al, 1983 ; Halitim, 1988 ; Kadi Hanifi, 1998).

Coarse mineral soils or little evolved soils are found mainly on the summits of mountains where they are subject to intense hydraulic erosion. These soils are characteristic of forests and matorrals and include:

- lithosols on hard rocks, (sandstones and limestones)
- regosols on soft rocks (marls and marly limestones)
- undeveloped mineral soils in the beds of stony wadis.

Poorly developed soils include:

- soils of colluvial origin on the piedmonts of hills and glacis
- soils of alluvial origin in wadi beds, alluvial fans and dayas
- soils of aeolian origin with fixed sandy formations.

Calcimagnesian soils are the group of carbonate soils:

- humic rendzinas on the slopes of hills
- brown calcareous xerified soils which are widespread on glacis of various origins of the upper and middle Quaternary.
- soils with gypsum crusts which are less common, they appear as small patches in sandstone areas where they alternate with marls and versicolour clays.
- carbonate soils which are the commonest in Algeria, notably in steppic and presaharan ecosystems where they form vast, encrusted areas.

Isohumic soils are present in the erosion glacis of the recent Quaternary. They bring together soils with calcareous or gypsum crusts. They are found in arid zones with under 200 mm annual rainfall.

Halomorphic soils include saline soils (solontchak) with AC profiles and saline alkaline soils (solontchak-solonetz) with profile A (B) C. These soils are generally deep and found in chotts and sebkhas. They are low in organic matter. Their salinity is of the types chlorate, sulphate-soda and magnesian.

Algerian soils are subject to serious aeolian and hydraulic erosion due to the climate and strong anthropic pressure which has reduced the vegetation cover.

Wind erosion mainly affects the arid and semi-arid zones. Wind action removes the finer particles, clay and sand, leaving an unproductive stony soil. About 600 000 ha in the steppe zone have been totally desertified, past the stage where a recovery of vegetation can take place.

Hydraulic erosion affects 28% of northern Algeria. Soils on the steep slopes of the Tell are the most seriously affected. Erosion takes the form of rills and gullies on the whole catchment with the uncovering of the bedrock and creation of badlands (Hadjiat, 1997).

3. CLIMATE AND AGRO-ECOLOGICAL ZONES

Sources of information on Algeria's climate include: Data from 1913–1938 published in "*Le climat de l'Algérie*" by Seltzer (1946). Data from 1926–1950 for Saharan stations published in "*Le climat du Sahara*" by Dubief (1950–1963). Data from 1913–1961 published in the legend of the rainfall map of northern Algeria, by Chaumont and Paquin (1971). The rainfall map published (1993) by l'Agence Nationale des Ressources Hydriques. Up-to-date data are published by l'Office National de la Météorologie.

Algeria, influenced by the sea, topography and altitude, has a Mediterranean, subtropical, temperate climate. This is characterized by a long, dry summer of 3–4 months on the coast, which extends to 5 or 6 months on the High Plains and over 6 months in the Sahel Atlas.

Rainfall

Rainfall is very variable, monthly and especially annually. This variation is due to gradients (Djellouli, 1990). There is a longitudinal gradient: rainfall increases from west to east (450 mm annually at Oran, over 1 000 at Annaba); this gradient is due to two phenomena: to the west the Spanish Sierra Nevada and the Moroccan Atlas act as a screen, eliminating the Atlantic influence. In the east high rainfall is attributed to perturbations in northern Tunisia. There is a latitudinal gradient: mean annual precipitation varies from 50 mm at M'Zaba to 1 500 at Jijel. This decrease from the coast towards the Saharan zone is due to the great distance depressions have to cover crossing the two Atlas ranges. There is also a universal altitude gradient which varies according to the distance from the sea.

Temperatures

The mean minimum temperature of the coldest month "m" is between 0° and 9° in coastal zones and between –2° and 4° in the arid and semi-arid zones. The mean maxima of the hottest month "M" vary with the continentality : from 28 to 31 °C at the coast, between 33° and 38° on the High Steppic Plains and over 40° in the Sahara.

Bioclimate

Algeria has all the Mediterranean bioclimates from the perhumid in the north to the perarid in the south for the bioclimatic levels and from the cold to the hot for their temperature variants; see Table 3.

Depending on the climatic (National Agroclimatic Classification of the Arab League, Louay, 1978) and edaphic factors, the agro-ecological zones of Algeria can be

Table 3. Bioclimatic zones of Algeria

Bioclimatic zone	Annual precipitation mm	Area, ha	Percent of total area
Per humid	1 200 – 1 800	185 275	0.08
Humid	900 – 1 200	773 433	0.32
Sub humid	800 – 900	3 401 128	1.42
Semi-arid	600 – 300	9 814 985	4.12
Arid	300 – 100	11 232 270	4.78
Saharan	< 100	212 766 944	89.5

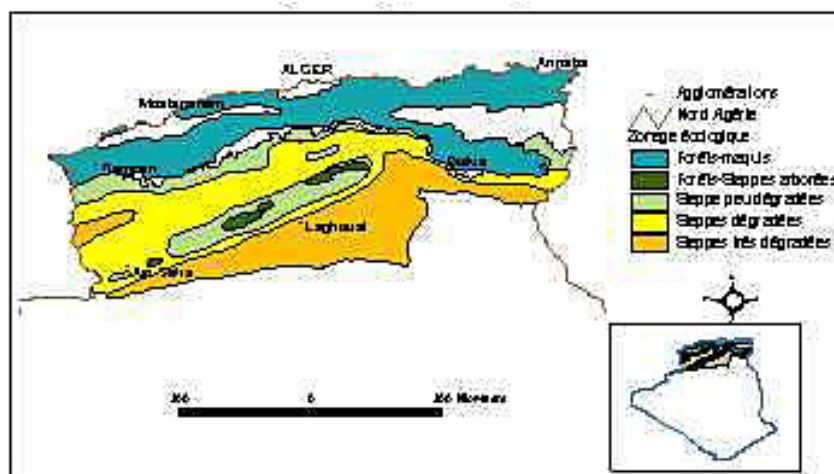


Figure 2. Agro-ecological zones of Algeria (map drafted by SALAMANI M. 2001)

defined. Soils and climate define the natural vegetation and the agricultural potential of the various zones. (Djellouli, 1990; Cadi *et al.*, 2001 and Smadhi, 2001).

Going from north to south, a range of vegetation and land types are traversed including forests, maquis and matorral, to the semi-arid steppes then to the desert ecosystems. The following zones are recognized according to rainfall ranges:

1200–1 800 mm corresponds to the perhumid level and is present in limited zones the area of which is no more than 300 ha, between 800 and 2 000 m in altitude in the Tell Atlas; here very rare endemic species like the aspen (*Populus tremula*) and the Numidian fir (*Abies numidica*) are found along with forests of cedar (*Cedrus atlantica*), cork oak (*Quercus suber*) and Aleppo pine.

900–1 200 mm is the humid level found in the north-western regions, dominated at altitude by forests of cedar and various oak woods, *Quercus faginea*, *Quercus suber* and *Quercus afares*.

600–900 mm is the subhumid level which covers the northern part of the Tell atlas from west to east and where forests of holm oak and Aleppo pine grow.

400–600 mm is the upper semi-arid level which corresponds to the more or less degraded forests, maquis and matorral on the summits and northern slopes of the Saharan Atlas, *Quercus rotundifolia*, *Callitris articulata*, olive and lentisk are the commonest woody vegetation in the north west with Aleppo pine at altitude.

In the past decade the forest sector has benefited from a Programme of “Grands Travaux” which is based on the following actions and principles:

- consolidation and extension of the Green Barrier in the context of the anti-desertification programme;
- treatment of the catchment areas of dams to protect them against silting;
- development and maintenance of national forest resources with better silviculture;
- reconstruction of degraded national forests to preserve the ecosystem: 60 000 ha are replanted annually with a success rate of 42%.

300–400 mm corresponds to the sub-steppic of the semi-arid; it is characterized by the disappearance of forest species and the appearance of steppe vegetation like *Artemisia*, alfa (*Stipa tenacissima*) and esparto (*Lygeum spartum*). These lands, considered good grazing, are in the north of the High Plains of Algiers-Oran on the south slopes of Aurès, the mountains of Ouled Nâils and Nemachas. In this bioclimatic zone there is competition between grazing and cereals in the depressions.

100–300 mm this rainfall belt corresponds to the arid southern and presaharan steppes which have a much sparser vegetation cover, giving meagre grazing on skeletal soils; they are at an advanced stage of degradation.

< 100 mm is the zone south of the Saharan Atlas. The vegetation, which is localized in the wadi beds, is hydrophilic and psammophilic, strongly adapted to very dry conditions and with a high degree of endemism. There is grazing based on the grasses *Aristida pungens* and *Panicum turgidum* and browse shrubs such as several acacias.

Agricultural areas are found in the north on the coastland sub-coastal plains and in the south, in the agropastoral zones, in wadi valleys or oases. Oasis agriculture is strongly dominated by dates, a very important crop in the Saharan regions (inventories of about fifteen Algerian palm groves have identified 400 cultivars, a hundred of which have been described in detail Hannachi S *et al.*, 1998). Agricultural land is distributed as follows:

- arable land comprises fallows (48%) and gramineous crops (47%) which are cereals (82%) and forage (18%). Seventy two% of the resting land is grazed.
- perennial crops comprise orchards (452 000 ha, 5.6% of agricultural land), vineyards (74,000 ha, 0.9%), and natural grazing (36 000 ha, 0.4%).
- irrigated areas, mainly tree crops, market gardens and cereals, cover 443,000 ha annually.

The number of holdings is about 1 054 000; of these 60 000 (6%) are privately owned and cover 70% of the land; 80% of holdings are under 10 ha. The state owns 94 860 holdings (9%), which cover 2 500 000 ha, 31% of all agricultural land.

4. RUMINANT LIVESTOCK PRODUCTION SYSTEMS

Table 4 shows the development of livestock numbers over the period 1987–1999 (with totals added for years 2000, 2004 and 2005; 78% are sheep, 14% goats and only 6% are bovines. The steppe and presaharan zones hold 80% of the total, mainly sheep.

The main cattle breed, the Atlas Brown, has four sub-breeds:

- the Guelmoise has a dark grey coat and is found in the forest zone,
- the Cheurfa has a whitish coat and is found in the pre-forest zone,
- the Chélifienne has a fawn coat,
- the Sétifienne has a blackish coat and is adapted to hard conditions.

Exotic breeds are represented by: the Dutch Friesian, an excellent milker, is widespread in the coastal region and constitutes 66% of improved breeds; the French Friesian is also widespread and a good milker; the Pie Rouge de l'Est and the Montbéliarde are present in small numbers. These breeds, introduced to raise production, find themselves under ecological conditions very different from those of their countries of origin. Although they are imported for their high genetic potential, their performance decreases because of the strain on their metabolism in adapting to the local environment.

Algeria's sheep herd is dominated by three breeds, well adapted to local conditions (Adem, 1986 ; Chellig, 1969 and 1992):

- the white Arab breed, Ouled Djellal, the most numerous, is adapted to steppe conditions and has exceptional qualities for meat and wool production.
- the red (hamra) Béni Ighil breed of the High Plateaux of the West, a Berber meat sheep, is very cold tolerant; it originated in North Africa.

Table 4. Evolution of livestock numbers ('000 head)

Year	1987	1989	1991	1993	1995	1997	1999	2000	2004	2005
1- Cattle	1 416	1 405	1 300	1 314	1 267	1 255	1 580	1 595	1 560	1 560
Modern milk cattle	146	173	166	188	206	208	248			
Improved milk cattle	705	705	661	724	731	720	752			
Others	565	527	473	482	330	327	650			
2- Sheep	16 148	17 316	16 891	18 665	17 302	17 387	17 989	17 616	18 700	18 700
Ewes	9 784	10 354	9 098	10 964	11500	10 000	11 000			
Others	6 364	6 962	7 793	7 701	5 801	6 755	8 203			
3- Goats	2 568	2 404	2 485	2 683	2 780	3 122	3 062	3 027	3 200	3 200
Does	1 960	1 990	1 262	1 492	1 600	1 680	1 680			
Others	608	414	1 222	1 191	1 180	1 440	1 723			
4- Camels	134	122	126	114	126	151	220	235	245	245
Total	20 266	21 247	20 802	22 776	21 475	21 915	22 851	22 473	23 705	23 705

Source: Ministère de l'Agriculture and FAOSTAT (2006)

- the Rumbi of the jebels of the Saharan Atlas has fawn head and limbs.

There are four secondary sheep breeds:

- the wool breed Zoulai de l'Atlas Tellien adapted to mountain pastures.
- the Dmen, Saharan breed of the Erg Occidental notable for its high fecundity.
- the Barbarine, Saharan breed of the Erg Oriental.
- the Targuia-Sidaou hair sheep, is a Peul (Fulani) breed, kept by Touaregs in the Central Sahara.

Some even rarer breeds are mentioned, the Taadmit, developed from the Ouled Djellal, and a few isolated herds of merinos, which correspond to attempts to intensify sheep production.

The composition of the herd is tending to change. Nowadays the hardy Beni Ighil, so well adapted to the steppe, is being replaced by the very prolific Ouled Djellal which is a more profitable meat producer. In fact a yearling Beni Ighil has the same weight as a four month Ouled Djellal lamb (Abdelguerfi and Laouar 1999).

Horse breeds are: the pure Barb, which has practically disappeared in the Maghreb except for a few specimens in Algeria; the purebred Arab and Arab-Barb crosses. Asses are the local breed and mules are also kept. Camels are the local race of Arabian camel.

Ruminant production systems in northern Algeria

Stock raising systems vary according to geographic regions:

In northern Algeria the nature of the herd depends on altitude. In the plains and valleys cattle predominate; up to 1 500 m sheep and goats are commoner, rarely cattle in winter; above 1 500 m the high pastures are only used by transhumant herds of cattle after the snow melt. Because of differences in pasture quality, cattle predominate in the east while sheep and goats are commoner in the west.

Cattle in the North

About 80% of cattle are in the North, of these 53% are to the east and 24% to the west with 23% in the centre. In general herd composition is as shown in Table 5.

Cattle are an important source of income for the agro-pastoralists of the Tell and compensate for the low income from crops due to very small areas cultivated; this encourages the increase of livestock and serious overgrazing of free communal pastures. Two types of cattle raising are distinguished:

- the extensive system uses local breeds and cross-breeds and is based on traditional transhumance between high pastures and the plains. Its main product is beef (78% of national production); it also produces 48% of the milk.
- the intensive system is based on imported "improved" breeds and is strongly oriented to dairying and based in the coastal regions. Herd size is small, 6 to 8 milch cows per holding. It accounts for 30% of the national cattle herd and provides about 20% of national beef production.

Table 5. Structure of the cattle herd

Milch cows	Young females	Young males	Breeding bulls
56%	18%	15%	11%

Source: Ministère de l'Agriculture

Sheep in the North

Sheep are relatively unimportant in the Tell in a sedentary system, with sheep housed in winter, and usually associated with goats. Flock size is small, 10 to 20 ewes according to holding size. Forage is scarce in the mountains and there is no scope for increasing production (Arbouche, 1995). Agropastoralists only devote 5% of their arable land to fodder and there is overgrazing of the maquis and the forest understorey, the degradation of which aggravates the risks of erosion. In some regions, like Kabylie, flocks are fed, in winter, on fig leaves and olive twigs and taken in spring to the fallows which provide adequate grazing; in mountainous areas the high pastures furnish summer grazing (Arbouche, 1995).

The income of agro-pastoralists varies according to holding size. Crops are the main source of income (57–60% of all income) for those under ten ha, where semi-intensive systems predominate. However livestock is the main income source (72% of all income) on holdings over 10 ha with extensive production systems. (BNEDER survey, 1996).

Livestock production systems in the High Plains steppes

In Algeria the steppes are excellent grazing lands but have real problems associated with pastoralism.

Development of sheep rearing Sheep are the main stock of the steppe (about 80%) and their number has not stopped rising since 1968 (Table 6).

The exponential growth of livestock numbers in the steppe and their concentration because of the decrease in nomadism, is due to several phenomena:

- a rapid demographic growth which has caused an increase in the consumption of animal protein has taken place in the last quarter of the twentieth century. The population in the steppe that was 925 708 in 1954 is now estimated at nearly 4 000 000 inhabitants (Kacimi, 1996). This takes into account both the sedentarized and mobile populations (Table 7).
- speculation on the mutton market (the retail price has risen from 55 DA/kg in 1977 to 500 DA/kg at present) has contributed to the development of sheep rearing.
- extensive stock-rearing has also benefited from subsidies which the state provided on concentrate feed during the 1970s and which, originally, was only to be used by the livestock cooperatives to compensate for the meagre forage available during lean seasons. Very large amounts of imported barley were distributed at low prices (1.7 DA/kg in 1985) to cover the fodder deficit. Concentrate use rose from 750–2 060 millions of fodder units between 1971 and 1985 (Le Houérou, 1985; Boutonnet, 1989). Figures for the importation of barley and maize are shown in Table 8.

The steppe production system. The population of the steppe, composed basically of pastoralists, practiced nomadism (in which the whole family moves with the herds) and transhumance (which only affects the shepherds and the livestock). These are forms of social adaptation to arid regions which permit survival under conditions of cyclic droughts and help to maintain environmental equilibrium. That system allowed rational management of space and time through two basic movements:

- “*achaba*” consists of taking the herds up into the Tell zones to graze agricultural by-products, stubbles and straw on the cereal fields during 3 or 4 months of summer;
- “*azzaba*” took the shepherds and their herds to the northern piedmont of the Saharan Atlas during the 3 winter months.

These two transhumant movements allow the steppe to be used for 3 or 4 months in spring, which is the season of maximum herbage production; that is to say the growth of annuals on the spring rain with their high nutritive value largely compensate the poor forage quality of the perennial herbage. That intelligent combination gave an optimum utilization of natural resources and, since the steppe grazing was only used for one third of the year, the vegetation had time to regenerate. The management of the grazing lands by the population was based on tacit agreements based on ancestral traditions. That grazing land comprised **public land** which regrouped the forests, the expanses of alfa and the vast grazing lands, **arch lands** held as collective property by the tribes and **melk lands** which are privately owned. (Bouhkobza, 1982; Berchiche *et al.*, 1993; Bedrani, 1996).

Table 6. Livestock numbers in the steppe ('000 head)

Year	1968	1978	1988	1998
Sheep	5 600	8 500	12 000	16 320
Goats	300	560	1 000	1 400
Cattle	120	120	200	280
Camels	100	175	100	135
Equines	250	450	530	750
TOTAL	6 370	9 805	13 830	18 885

Sources Ministère de l'Agriculture, HCDS.

Table 7. Evolution of the human population of the steppe

Year	1954	1968	1978	1988
Total population	925 700	1 255 480	1 700 000	2 500 000
Nomads	595 420	545 250	500 000	625 000
Percentage of nomads	52	43	29	25

Sources *stat.agr.* and ONS

Table 8. Evolution of imports of coarse cereals (in '000 of tonnes)

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Barley	482	614	338	0	157	848	259	307	37	103	549
Maize	383	615	605	998	874	1 209	1 066	1 198	1 099	939	1 300

Source OAIC in Bedrani, 1995

Nowadays the pastoral society has undergone great socio-economic changes. There has been a great reduction in nomadism which subsists sporadically. Long distance movements only concern 5% of the steppe population. Former nomads are not totally sedentarised as one might think but have become semi-sedentary. Movements are more limited (10 to 50 km). Pastoralists have modified their system by combining cereal growing with stock rearing. Herd size is small – about 80% of owners have fewer than 100 head and 90% of the sheep are privately owned. The types of owner are:

- the small owner-farmer who has fewer than 100 ewes and less than 10 ha to grow cereals for domestic use. He is a semi-nomad but only moves within a radius of a few kilometres. He covers the fodder deficit with crop residues and by-products. (Khalidoun, 1995).
- the medium owner (15% of stock-owners) who owns 100 to 300 ewes and several tens of ha of *arch* land. This kind of farmer, agro-pastoralist, lives off the proceeds of his herd and his crops. He only practices nomadism in bad years.
- the big owner (5% of stock-owners) who has over 300 ewes and several hundred ha of tribal land. He makes long distance movements, *azzaba* and *achaba* and is well equipped, (tractors, lorries etc.).

Livestock in the Central Sahara

An analysis of the situation in the parks of Tassili and Ahaggar gives an overall idea of pastoral management in the Central Sahara (stock numbers are shown in Table 9).

There are several types of stock-owner in these regions:

- agropastoralists who own small areas (13 ha maximum) of family land (several brothers in association), on which they grow subsistence crops, cereals and vegetables. They have small flocks of 10 to 50 head of which 80% are goats. There are three kinds of goat: the local long haired breed, used for meat; the northern breed (Nailia) for milk, and breeds from Mali and Niger introduced to improve productivity. Animals are either placed with shepherds or looked after by women and grazed in a radius of one or two kilometres. Garden residues supplement grazing.
- semi-nomadic pastoralists have small herds (less than 50 head), mainly goats (70%) and sheep (20%, local Dmen or Longipes from Mali). The proportion of camels is low (5–10% according to families). Campments “zeribas” have been fixed for some time, between 5 and 20 years. To provide for the families’ needs women cultivate kitchen gardens, the men work as tourist guides or as seasonal labour in neighbouring areas. Livestock produce, milk, butter and cheese is consumed domestically; goat hair is used by the women to make artisanal objects for sale to passing tourists.
- nomadic herders have bigger flocks, over 100 head, mostly camels with some zebu from Mali and Niger. They practice a transhumance of 2 to 4 months which may cross frontiers. Wells on the grazing lands are built by the communes and their siting is according to the nomads’ choice. Flocks are tended by shepherds paid monthly, all found (food and clothing). The closest transhumance zones are wadi valleys. When at the campments flocks are fed, either barley, which is dear (3,000 DA per quintal), when the herders can afford it, or simply acacia *Acacia raddiana* and *Acacia seyal* pods which are brought down from the trees by beating the branches with sticks.

Table 9. Stock numbers in the Sahara Central (head)

1997	Ahaggar	Tassili	Total
Sheep	65 010	11 850	76 850
Goats	52 280	20 350	72 360
Camels	29 540	12 649	42 189
Cattle	2 020	-	2 020
Total	147 850	44 849	

Sources: *Statistiques Agricoles*

Livestock production parameters and the system of integration

See Table 10.

The dairy industry

Average annual milk production during the past decade has been about a billion litres (see Table 10) of which 60% are from cows, 26% from ewes and 13% from goats. Camel milk is not taken into account. A study of zootechnical performances undertaken in 2000, on 80 holdings, by l’Observatoire des Filières Lait et Viande rouge of l’Institut Technique des Elevages (ITELV) gave the following results:

- an average production of 12.22 kg per cow milked per day.

Table 10. Evolution of livestock production parameters in Algeria

Year	1987	1990	1995	1997	1999	2000	2001	2002	2003	2004	2005
1-Milk (10⁹l)	927	977	1 168	1 186	1 411	1 511	1 658	1 488	1 508	1 688	1 688
Cows	590	630	830	850	1 040	1 170	1 310	1 135	1 150	1 300	1 300
Ewes	201	213	192	175	220	180	185	190	190	200	200
Does	131	129	140	155	143	153	155	155	160	160	160
Collected, cows' milk	81	n.r.	12.5	11.3	9.3	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Percentage	10.5	n.r.	15.4	13.4	7.5	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
Degree of integration	10	4.89	10.52	10.89	10	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
2-Meat (10³t)	370.5	436	497	511	539	565	537	550	556	581	581
Beef	74	90	101	102	117	133	105	116	121	125	125
Mutton	106	134	170	167	163	164	165	165	165	165	165
Goat	8.7	8.4	8.5	11.9	12.3	12.3	12.4	12.4	12.4	12.4	12.4
Camel	1.6	2	2	2.2	3.1	3.2	3.4	3.4	3.4	3.4	3.4
Horses	0.8	0.7	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4
Other meat*	179.4	200.9	214.9	227.4	243.1	252.1	250.8	252.8	254.6	253.8+	253+

* mainly chicken meat, data from Ministère de l'Agriculture and FAOSTAT (2006)

Table 11a. Average milk production by agro-ecological zone.

Agro-ecological zone	littoral Tell	plaine Tell	mountain
kg of milk/cow/day	14.08	9.28	11.77

Source: Observatoire des filières lait et viande rouge (OFLIVE), December, 2002

Table 11b. Average milk production by bovine race and by agro-ecological zone.

Agro-ecological zone	littoral Tell		plaine Tell		mountain	
Race	Pie Noire	Pie Rouge	Pie Noire	Pie Rouge	Pie Noire	Pie Rouge
kg of milk/cow/day	13.87	13.01	9.04	11.47	11.89	12.97

Source: Observatoire des filières lait et viande rouge (OFLIVE), December, 2002

- recorded milkings: maximum = 14.97 kg/cow/day, minimal=9.82 kg/cow/day,
- the calving rate is 34%, the highest rate being found in the agro-ecological zone of the coastal Tell and in the hills.

Data for average milk production by agro-ecological zone and by breed for December 2002 are given in Tables 11a and 11b.

The weak production on the level of the plains (9.38 kg/vt/j) is explained by the extensive agricultural vocation of these zones. Generally, the bovine race Pie Rouge presents better performances than the Pie Noire.

The annual growth of milk production is very low. It barely covers 40% of national consumption which is 110 litres per inhabitant annually, the deficit being met by imports. The global allowance for imports of milk and milk products is US \$ 490 000 000.

The level of collection of raw milk by public dairy units varies between 5 and 15%, between 50 000 000 and 150 000 000 litres. The degree of industrial integration is 4 to 10%.

There are many constraints connected with milk production; they are linked to the development of cattle keeping:

- low productivity of dairy cattle
- insufficient fodder resources and high costs of livestock feed; the forage availability of dairy enterprises is 27% of their needs;
- production costs too high and the pricing systems applied to milk, considered “a product of primary necessity”, give little encouragement to improve production. The mean production cost is 25 DA/litre, price to the consumer is 20 DA/litre (25 DA/litre from February 2001);
- the infrastructure of the collection networks is inadequate and disorganized.

The meat industry

Red meat is mainly produced by extensive sheep (56%) and cattle (34%) raising. Goat meat (8%) and camel (2%) are marginal, such meat is only eaten in the south of the country. It is difficult to estimate the balance between production and consumption because of non-controlled slaughtering. Published surveys

reveal an annual consumption of 4 kg of mutton and 3.5 kg of beef. Population growth and erosion of purchasing power has led to a reduction in meat consumption by 40% in the past decade, especially for those social strata on fixed incomes. Nevertheless, the strong demand generated by the social categories with high incomes who have improved their consumption model by increasing their intake of animal protein, has allowed meat prices to remain high (the retail price of red meat has increased by ten times in twenty years). To satisfy the demand for meat and dairy products Algeria imports considerable quantities of beef and veal (73 719 M tonnes in 2004) and butter, ghee, dry skim milk and cheese (2004 total milk equivalent imports 2 137 657 M tonnes with the range from 1995–2004 of 1.1 to 2.1 Million M tonnes). The value of beef and veal and dairy product imports in 2004 were 142.1 US\$ million and 818.8US\$ million respectively.

5. THE PASTURE RESOURCE

Land dedicated to fodder production and grazing cover 33 000 000 ha: extensive grazing (87.7%), fallows (10.6%), sown fodder (1.6%) and natural pasture (0.1%) .

Sown fodder (see Table 12)

Sown fodder is basically oat-vetch mixture which accounts for 70% of the area grown; 10% of the area is sown to cereals (barley, oats and rye). Lucerne and sorghum are rare, 1 to 5% of the area. During the 1998–1999 campaign the quantity of fodder seed delivered to growers was about 20 000 quintals, of which oat-vetch accounted for 68% (Abdelguerfi, 1987). Sown fodder provides 577 000 000 UFL (the UFL is a unit expressing the annual energy needs of a ewe for maintenance and supplying milk to her lamb).

These fodders represent 90% of the energy supplied by sown fodder and concern essentially oat-vetch mixtures, fodder oats and oat-pea mixtures. Fodder consumed green supplies 43 000 000 UFL (Houmani, 1999). There is also fodder barley, berseem (*Trifolium alexandrinum*) and lucerne.

Natural fodder (see Table 13)

Land dedicated to natural forage production comprises those fallows which are mown (80%) with over 130 000 ha and natural meadows (20%) with about 35 000 ha. Natural meadows are basically found in the humid and sub-humid bioclimatic zones. Yields are of the order of 8.4 quintals per hectare for natural meadows and 4.8 quintals for mown fallows. The total fodder is 1 443 000 000 UFL from the meadows and 73 000 000 UFL from the fallows.

Many studies and trials on methods of increasing cereal production and diversifying fodder resources have been undertaken in the past 30 years (Le Houérou 1971, Project FAO-UNDP-SAIDA, Project ACSAD-Tiaret, and the Ministry of Agriculture's dossier on the better use of fallows). These activities aimed at reducing the fallow area through the use of alternative crops. Thus the introduction of medics (annual *Medicago*) in rotation with wheat was intended to improve the structure and fertility of the soil and thereby improve both crop and livestock production. According to Hamadache (2001), fallow replacement crops include :

- Green fodders, (clover, sorghum, lucerne *M. sativa*) and pulses (faba bean, chickpea, haricots) in rotation with durum wheat or intercropped in citrus in the sub-humid bioclimate.

Table 12. Production of sown fodder

Year		1990	1992	1994	1996	1998-99
Sown fodder	Area (ha)	439 970	417 340	389 980	311 240	368 130
Used dry	Production (qx)	4 257 760	8 315 070	3 915 340	9 349 000	6 292 230
Sown fodder used green	Area (ha)	67 120	112 340	104 870	100 910	-

Sources Statistiques Agricoles

Table 13. Productivity of natural forage

Year		1990	1992	1994	1996	1998-99
Natural forage	Natural meadows					
	Area (ha)	26 060	32 050	36 940	40 440	35 210
	Production (qx)	318 140	450 870	567 080	941 370	679 470
	Mown fallows					
	Area (ha)	71 280	113 220	78 510	128 720	134 640
	Production (qx)	612 050	1 952 380	984 110	2 309 630	1 848 770

Sources Statistiques Agricoles

- Fodder cereals used green (barley, oats, triticale) ; cereal legume mixtures on sloping soils and intercropped in hardy fruit trees (figs, almonds and olives) in the upper semi-arid bioclimate.
- Introduction of barley-fallow; fodder vetch or medic with barley in the lower semi-arid bioclimate.
- Tree crops and vines in hilly terrain

These activities form a principal part of the aims of the PNDA and benefit from subsidies.

The fodder resources of North Algeria

The pasture resources of the North are not large; they have been evaluated in a study in the mountains of Béni Chougrane (FAO/FIDA, 1993) :

- forests : 150 UF/ha
- pastures : 100 UF/ha
- cereal straw : 320 UF/ha
- fallows : 250 UF/ha
- fodder crops : 1065 UF/ha
- barren land : 50 UF/ha

Fodder resources of the grazing lands of the steppes and the presaharan zone

Numerous vegetation studies have elucidated the pastoral potential of the steppes which are dominated by four great vegetation formations (Djebaili, 1978; URBT, 1974–1991; Nedjraoui, 1981; Aidoud, 1989; Le Houérou, 1998, 2000, 2001) :

The alfa (*Stipa tenacissima*) steppes of which the potential area is 4 000 000 ha have a wide ecological range. They are found, in fact, in the semi-arid bioclimates with cool or cold winter and the upper arid zone with cold winters. These steppes colonize all geological substrates between 400 and 1 800 m. The yield of alfa can reach 10 tonnes/ha of dry matter but the useable green part produces 1 000 to 1 500 kg/ha of dry matter. The nutritive value of alfa is low, 0.3 to 0.5 UF/kg of dry matter although the inflorescences are very palatable (0.7 UF/kg DM). The grazing production of this type of steppe varies between 60 and 150 UF/ha according to the degree of cover and its floristic composition (Aidoud and Nedjraoui, 1992).

The Artemisia (*Artemisia herba-alba*) steppes cover 3 000 000 ha in the upper and middle arid zone with cool and cold winters with precipitation between 100 and 300 mm. This type of steppe occurs in zones which receive run-off, in depressions and on encrusted glaciis with a glazed film on the surface. Primary production varies from 500 to 4 500 kg/ha of dry matter with an annual production of 1 000 kg/ha of dry matter. The annual grazeable yield is 500 kg/ha, that is 150 to 200 UF/ha. Artemisia has a feeding value of 0.65 UF/kg dry matter, these steppes are often thought to be the best grazing lands to use throughout the year, especially in bad seasons, in summer and winter when they provide important reserves. Their degraded facies corresponds to that of *Peganum harmala* around campments and water points.

The esparto (*Lygeum spartum*) steppes occupy 2 000 000 ha, rarely homogeneous, on encrusted erosion glaciis covered by a film of aeolian deposits over brown, halomorphic soils in the zone of the chotts. These formations are the upper and middle arid zone with cool and cold winters. *Lygeum spartum* has little interest as grazing, 0.3–0.4 UF/kg dry matter. These steppes are not very productive with a yield of 300 to 500 kg/ha dry matter, but they are, nevertheless good enough pastures. Their interest comes from their floristic diversity and their relatively high productivity of annuals and small perennials, about 110 UF/ha.

The “remt” (*Arthrophytum scoparium*) steppes form chamaephytic, bushy steppes with a ground cover below 12.5%. The harsh conditions of their environment, extremely arid (20–200 mm/year), high temperatures, variants hot to cool, poor soils, brown calcareous with hardpans or encrusted sierozems make these steppes rather uninteresting from the grazing point of view. The energy value of the plant is about 0.2 UF/kg dry matter. The mean annual production is 40 to 80 kg/ha dry matter, between 20 and 50 UF/ha/year. This kind of steppe is mainly used by camels.

The psammophitic steppes are connected with the sandy texture of the surface horizons of aeolian origin. These formations are unevenly distributed and their area is estimated at 200 000 ha. They follow the corridors of sand deposition in the depressions of the chotts. They are commonest in the arid and presaharan zones. These psammophitic formations are mainly grassy steppe with *Aristida pungens* and *Thymellaea microphylla* or shrubby steppes with *Retama raetam* and their grazing value varies between 200 to 500 UF/ha.

The halophyte steppes. These cover about 1 000 000 ha. The nature of salts, their concentration and their spatial variation has brought about a particular zonation of highly palatable halophytic vegetation around saline depressions. The commonest plants in these formations are: *Atriplex halimus*, *Atriplex glauca*, *Suaeda fruticosa*, *Frankenia thymifolia*, *Salsola sieberi* and *Salsola vermiculata*. This kind of steppe is much sought after by the herders and its grazing value is about 300 UF/ha.

Details of the floristic composition of typical pasture types are given in Annex tables 1–4.

Constraints to pastoral production

Climatic constraints

Yields of cultivated fodder vary with the vagaries of the weather. In 1996 the yield was 28 quintals/ha against 9.8 quintals in 1997 for oat-vetch and 31 quintals against 5.5 for the other forages during the same periods, 1997 was a drought year.

On the High steppic Plains weather perturbations, especially rainfall (see Table 14) are a major cause of the fragility of these environments, already very sensitive, and provoke ecological crises which have repercussions on the primary production of ecosystems and on changes in their floristic composition. The availability of forage on natural grazing is variable (Table 15). Studies have shown a loss of pastoral production equivalent to 236 UF/ha from a reduction of 104 mm/year in the steppes of south Algeria. This is a good illustration of the situation throughout the steppe, whatever the facies. In fact the same evolution has been demonstrated for the *Artemisia* and esparto steppes.

Table 14. Reduction of precipitation (mm/year) on the High steppic plains

Station	1913–1930	1952–1975	1975–1990	Reduction (%)
Saida	430	419	320	25
El Khreider	208	184	166	18
Mecheria	293	310	213	27
Ain sefra	192	194	156	20

Source : Djellouli and Nedjraoui, 1995

Overgrazing

The severity of overgrazing has been evaluated from the potential carrying capacity and the present stocking rate.

In 1968 the classic steppe pasture fed 7 890 000 sheep units (see Table 16), which gives a stocking rate of 1.9 ha per sheep unit and the steppe had on offer 1 600 000 000 UF, enough for one sheep per four ha. At that time the steppe was already overgrazed and the stocking rate was twice the potential one. Despite the alarm bells rung by the pastoralists of that time, the situation has deteriorated. In fact in 1996 the grazing lands are seriously degraded and their forage production is 533 000 000 UF, that estimate

Table 15. Evolution of the production of alfa (kg dm/ha) according to grazing pressure and rainfall

Year	1976	1980	1983	1987	1990
Rainfall mm	-	252	176	253	270
Ungrazed	1 080	2 070	1 340	1 700	780
Moderate grazing	1 467	1 269	1 029	600	420
Free grazing	1 470	1 270	700	55	25

Source Aidoud, 1993

Table 16. Stock numbers in sheep units ('000) and stocking rates (ha/sheep unit)

Year	1968	1996
Sheep units	7,890	19,170
Production UF/ha	1600 10 ⁶	533 10 ⁶
Potential stocking rate	1 to 4 ha	1 to 8 ha
Real stocking rate	1 to 1.9 ha	1 to 0.78 ha

Source Nedjraoui 1997

is an average which takes into account annual species and variations in rainfall. The potential stocking rate would be about 8 ha per sheep unit. Now the total livestock correspond to 19 170 000 sheep units and the actual stocking rate is 0.78 ha per sheep unit. The number of livestock is, therefore, ten times greater than that which the pasture should carry; this is only possible because of the high level of concentrate feeding.

Too many sheep on the best grazing and around water points causes trampling and soil compaction which leads to soil denudation, lower soil permeability and moisture reserves and increased run-off. These increase the risk of erosion considerably. Micro-dunes form giving rise to pre-desert landscapes. This overgrazing, which takes no account of ecological conditions, arises from keeping the herd too long on the grazed areas, thus removing a quantity of vegetation largely greater than the annual production. The impact on the vegetation is enormous both qualitatively and quantitatively.

On the qualitative side good grazing species, with a palatability index of above 6, are eaten before they have time to set seed or form regrowth for the coming season. (The palatability index, on a scale 0–10 also takes into account chemical composition, speed of growth, palatability, digestibility and resistance to grazing). The indices of Algerian plants have been determined (URBT, 1978) through discussions with herders and field studies. Their root system dies and they disappear totally from the facies leaving the unpalatable species such as *Atractylis serratuloides*, *Peganum harmala*, etc. which are characteristic indicators of pasture degradation. The result of this regressive transition is a reduction in floristic richness and biodiversity. On the quantitative side, overgrazing causes a decrease in the cover of perennials and of the phytomass, and thus a degradation of plant formations.

Many studies of the steppes by academics since the 1970s show a serious regression of plant cover, of over 50%, and a serious diminution of the production of steppe ecosystems which has fallen from 120 to 150 UF per year in 1978 to 30 UF at present, for degraded grazing and 60–100 for palatable grazing. (Aidoud and Nedjraoui, 1992 ; Zegrar *et al.*, 1997).

Land tenure problems in relation to degradation of natural resources

In 1975, when the pastoral code was promulgated, all the steppes and presaharan grazing lands between the isohyets of 100 and 400 mm became state property and their management the responsibility of the communes (a commune is the local administrative unit headed by an elected mayor and council). The law on ownership of agricultural land of 1983 was applied to grazing land and “anyone who develops pasture land can claim its ownership”. The law of 1990 concerning land tenure policy reduced the area of land “with a vocation for grazing” to the steppes between the isohyets of 100 and 300 mm, allowing clearing in the 300 – 400 mm band. Because of these changes and in order to respond to the food needs caused by demographic growth, land use in the pastoral zones is now in anarchy with an extension of cereal growing, with very low yields (2–5 quintals per hectare) on fragile soils.

Land preparation with offset discs, as practiced by the agropastoralists, is very erosive, causes deterioration of the surface horizon and usually sterilizes it permanently. This destroys perennial vegetation and reduces annuals severely. Grazing is being lost to land cleared, ploughed and very often abandoned thereafter. It is estimated that, to date, 2 000 000 ha of steppe have been ploughed.

6. OPPORTUNITIES FOR IMPROVEMENT OF PASTURE RESOURCES

After 1945, and the consequences of the second world war, the colonial authorities initiated a series of activities as solutions to the crisis in the pastoral economy and advocated closing areas for resting, sedentarization of the population and control of epizootic disease. Since independence pastoral policy has concentrated on the steppe and sheep husbandry. The same actions continued with an intensification of social production links; the means of production, stock and equipment, became collective property. There have been many attempts to organize the steppe and very few have produced positive results insofar as improving the grazing land is concerned.

Evolution of policies for organizing grazing land

In 1968 livestock cooperatives were installed, under the l'Association pour le Développement de l'Élevage Pastoral (ADEP) set up in 1969. These cooperatives received the best grazing land and enjoyed much logistic support from the state. They were dissolved in 1979 without having responded to their objective of improving pastoral production and better grazing management.

In 1972–1973 the Pastoral Code was promulgated in the context of the Agricultural Reform. Its principal objective was to safeguard the grazing lands by limiting stock numbers, closing areas, banning ploughing in pastoral zones and the uprooting and sale of woody plants. Conflicts of interest appeared once the Code was put into operation and these measures have not been applied. The first and second phases of the Agricultural Revolution brought about the setting up of Coopératives Agricoles Polyvalentes Communales de Service (CAPCS) to supply farmers with food and domestic goods. The third phase was reduced to the creation of 200 cooperatives for pastoral stock-rearing and 49 (ADEP) and the transfer of land to the Front National de la Révolution Agraire.

During 1974–1979 the item “pastoralism” represented only 0.5% of the funds given to the Ministry of Agriculture. Special programmes of grazing land development and improvement of sheep production were begun, mobilizing important resources for agropastoral development in about ten wilayas.

The eighties were characterized by a new orientation of agricultural policy which brought about the dissolution of the pastoral cooperatives, the abandoning of the Pastoral Code in 1982 and the adoption of the steppe dossier in 1985 which brought about the creation of the Haut Commissariat au Développement de la Steppe (HCDS). That body is responsible for putting in place an integrated development policy for the steppe taking into account all economic and social aspects. Since 1992 it has favoured a new “participative” approach to steppe development, based on involving the pastoral population in a relation of partnership with the steppe communes.

In 1990 a law concerning land ownership was adopted; its goal was to return the land expropriated during the Agricultural Revolution. An institution in charge of land control “l'Office National des Terres Agricoles” was set up in 1996.

Projects and achievements in improving grazing resources

There have been numerous projects since independence aimed at improving the management of grazing lands and slowing down their degradation.

The Hodna project in 1968 and the projects Algeria 16, 22 and 30 (1969–1970) with UNDP participation, had as their objective the improvement of pastoral resources (fodder crops and sheep husbandry) with an aim to integrated planning and management of grazing land through agronomic experiments and phytoecological studies. The application of these projects was not worth the investments which were put into them. The technical documents prepared by the experts (reports and maps) are still referred to by present day pastoral specialists.

The principal studies and achievements of the nineteen eighties were generally under the HCDS. The steppe as a whole has benefited from 165 projects in the pastoral programme between 1985 and 1992. They involved improving grazing lands and infrastructure by construction of boreholes, pastoral wells, irrigation canals (séguías), opening tracks, improvement of land tenure, creation of “pastoral units” (60 units of which 47 were in Ouled Touil). These are homogeneous units taking social as well as technical factors into account and follow tribal or sub-tribal divisions.

Since 1992 programmes on the steppe are executed through a participative approach which involves a close collaboration between the agropastoralists and the organizations responsible for executing the programmes, in this case the HCDS. Thus in the framework of the policy of Grands Travaux there are foreseen, among others:

- 1 500 000 ha: pastoral development
- 700 000 ha: closure to grazing
- 100 000 ha: plantation of fodder shrubs
- 1 200 km: of windbreaks
- 400 000 m³ : of structures
- 3 000 km: of construction of tracks
- 2 300 units: water points

- 4 800 ha: land improvement

Grazing developments are consolidated by a programme of water supply. The HCDS has opted for the collection of surface water and spring capture.

The achievements of these Grands Travaux have attracted the adhesion of the pastoral populations which have been involved. The closure of degraded areas is desired by the herders; it is the same for plantation on the grazing lands which should rehabilitate degraded ecosystems. The beneficiaries who participate in a project are aware of the interest of these plantations and are ready to protect them and multiply them. All these actions have been developed in partnership with the steppe communes and this has permitted the introduction of a new type of exploitation of grazing land institutionalized in 1997 which concerns the letting of areas improved or closed by the communes. In the context of these Grands Travaux, projects are initiated and developed by the HCDS with academics in pastoral matters, knowledge of the steppe environment through the identification and mapping of potential areas for cereal growing, identification and mapping of potential zones for the use of sheep herds during their winter migrations.

Closure and resting has allowed forage production to rise from 40 UF/ha to over 250 UF/ha, an increase of 525%. The introduction of fodder shrubs (15 000 ha of plantations) such as *Atriplex nummularia*, *Atriplex vesicaria*, *Medicago arborea*, and *Opuntia ficus indica* has allowed the improvement of degraded grazing lands by a production of 500 to 800 UF/ha, it has also allowed the stabilizing of dunes and patches of sand. *Atriplex vesicaria* produces 4 tonnes of green matter per ha under rainfed conditions and when irrigated can yield 10–20 tonnes of dry matter per ha.

Le Plan National de Développement Agricole (PNDA)

This National Agricultural Development Plan, adopted in 2000, has as its objective “improvement of the level of food security”. It is linked to the encouragement and support of farmers for:

- developing products which are suited to natural zones and land types
- adapting the soil management systems for arid and semi-arid regions

These activities, based on agro-climatic constraints converge “towards objectives of reconstruction of the agricultural territory and conservation of natural resources (water and soil) capable of favouring sustainable development”. The putting into operation of programmes is supported by the Fonds National de Régulation et Développement Agricole (FNRDA).

For fodder crops activities supported concern improving production and productivity through supply of agricultural inputs (seeds, agronomic operations) and specialized equipment (mowers, silage-harvesters, silos). To be eligible for such assistance farmers must integrate fodder crops into their production system.

For animal husbandry, activities supported concern the protection and development of genetic resources by giving bonuses for the birth of females, especially camels. It also concerns rehabilitation of water points in collaboration with the HCDS and support for emergency feeding of sheep in drought conditions or for loss of forage due to pasture closure or transformation of production systems. Only farmers having herds of over 100 head can claim such support.

For dairy production the actions supported aim to increase production and productivity. They concern acquisition of specialized equipment (drinking systems, milking parlours), the setting up of collection centres, encouragement of milk production and delivery to processing plants through bonuses. Support for artificial insemination and supply of breeding stock is proposed to protect the genetic patrimony and also for the encouragement of small and medium exploitations specialized in fattening, slaughter, storage and transformation of meat products. Any farmer with some cattle, including 6 dairy cows can participate.

7. RESEARCH AND DEVELOPMENT ORGANIZATIONS AND PERSONNEL

The role of research in improving grazing land

The Ministry of Higher Education and Scientific Research has, in June 1995, brought out National Research Priority Programmes (PNR) in the context of improving grazing lands (Nedjdraoui, 1999). Tenders by the Ministry have allowed numerous researchers to enrol in these programmes and receive subsidies for carrying out the work. This new policy has made it possible to bring out the scientific and technical potential of workers in this field of research. **The Centre de Recherches Scientifique et Technique sur les Région Arides (C.R.S.T.R.A)** was put in charge of coordinating and leading these research activities through a thematic, intersectorial network. Several fundamental lines and themes were retained, including:

I. The possibility of improving the productivity of agricultural systems

1. Developing forage systems for different pedo-climatic zones
2. Possibilities of using saline soils
3. Regeneration and improvement of the steppe ecosystem
4. Regeneration of the alfa lands and procedures for their exploitation
5. Development and management of the steppe
6. Influence of agro-systems on the growth and development of the date palm
7. Sustainable systems of agriculture

II. Technical and economic studies on animal husbandry

1. Cattle, sheep and goats
2. Camels and equines
3. Small stock
4. Saharan animal husbandry

III. Management of natural resources

1. Participative approach to resource management
2. Pastoral nurseries in arid zones
3. Pastoral production systems (socio-economic aspects of nomadism)
4. Industrialization of the steppe and Saharan zones.
5. Evaluation, study of cultivation systems and soil management.

IV. Qualitative and quantitative analyses of livestock resources

1. Livestock census, health and breed improvement
2. Ecophysiology and hormonal regulation of reproduction and water and mineral metabolism of mammals in arid and semi-arid zones.

Organizations involved in pastoral development

La Direction Générale des Forêts (DGF), as the national coordinating organization is responsible for applying the policy of combating desertification. It is involved in research programmes on rational grazing management to slow down land degradation processes and pastoral plantation programmes in the mountain zones.

Contacts : Mr .A. GHEBALLOU, Directeur Général., Mme F. DJEHICHE, Sous-Directrice chargée de l'application de la CCD

D.G.F. Chemin Doudou Mokhtar, Ben Aknoun, Alger Tel- Fax : 21 9153 14

Le Haut Commissariat au Développement de la Steppe (HCDS) is in charge of integrated development of steppe regions. It initiates the policy for management of these regions at the level of land tenure,

for the improvement of grazing land by planting fodder shrubs and the encouragement of the pastoral population to integrate into development processes.

Contacts : Mr. B. KACIMI, Directeur Général., Mr. L. BROURI, Ingénieur spécialiste des plantations pastorales. Mr. M. SMAIL, Pastoraliste.

HCDS, BP381, 17000 Djelfa Algérie. Tel : 27 873166 Fax : 27 875161

L'Agence Nationale de l'Aménagement du Territoire participates in studies and programmes of development of pastoral areas, especially in the steppe zone

Contacts : Mr A. Khaldoun , chercheur.

ANAT, Lotissement Mesli, Bd Mohamed V, 13000, Tlemcen. Tel : 43 41 63 93

Research institutions

Le Centre de Recherches Scientifique et Technique sur les Régions Arides has as its main mission, research on arid regions or areas in danger of drought and desertification.

Contact: Dr A. Gaouar, CRSTRA BP 1682 RP Biskra 07000 Tel/Fax : 33 734214

L'Unité de Recherches sur les Zones Arides (U.R.Z.A.) concentrates on studies on oases systems and the physiological behaviour of ruminants

Contacts: Drs Z.Amirat; N. Bouguedoura; F. Khamar; F. Rahmania.

URZA, 2 rue Didouche Mourad Alger 16000 Tel/Fax: 21 649283 3

Le Centre de Recherche en Economie appliquée (C.R.E.A.D.) is interested in socio-economic problems, in agropastoral systems in the various steppe zones and rural development.

Contact Dr S. Bédrani , CREAD , 20 rue Chahid M Khaled, Ben Aknoun Alger, 16000

Tel/Fax: 213 21 524917

L'Unité de Recherche sur les Ressources Biologiques Terrestres (U.R.B.T.) focuses on phyto-ecological evaluation and evaluation and mapping of the main steppic and presaharan grazing lands in the context of regional development projects. It has seven experimental and observation stations sited in the different ecosystems. Observations began in 1974 and continue today, permitting a study of pasture evolution according to environmental parameters. These studies are part of the Réseau d'Observations et de Suivi Ecologique à Long Terme (ROSELT) programme.

Contacts: Drs D. Nedjraoui; H. Kadi-Hanifi; A. Bouzenoune; A. Boughani; A. Hirche; M. Salamani; H. Slimani. **URBT BP 295 Alger-Gare Alger 16000 Tel: 213 21 646122**

L'Institut National de Recherches Agronomiques (INRA) through its various stations develops research themes on livestock and crop production to study the mechanisms of degradation of steppic grazing lands.

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9. CONTACTS

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The English translation was undertaken by J.M. Suttie in April, 2001 who also made a number of amendments. Table 2 was updated by S.G. Reynolds in November 2002 and Tables 11a and 11b were forwarded by Dr. Nedjraoui and added in October 2003. In September 2006 some of the livestock data were amended by S.G. Reynolds.

10. ANNEX

Table 1. Typical inventory of a mountain pasture (Atlas Blidéen)

1 Ecological characteristics :

Altitude : 1350m

Bioclimate : subhumid

Aspect SE

Drainage straight

Slope 15%

Erosion : medium

Degraded grassland with *Poa bulbosa*

Vegetation cover 64%

Floristic composition

Species	Species	Species
1 <i>Thymus algeriensis</i>	15 <i>Aegilops triuncialis</i>	29 <i>Geranium molle</i>
2 <i>Bromus tectorum</i>	16 <i>Alyssum parviflorum</i>	30 <i>Anthemis</i> sp
3 <i>Silene gallica</i>	17 <i>Helianthemum croceum</i>	31 <i>Alchemilla arvensis</i>
4 <i>Scleropoa rigida</i>	18 <i>Romulea bulbocodium</i>	32 <i>Paronychia argentea</i>
5 <i>Trifolium scabrum</i>	19 <i>Xeranthemum inapertum</i>	33 <i>Dactylis glomerata</i>
6 <i>Erysimum bocconi</i>	20 <i>Tuberaria guttosa</i>	34 <i>Trifolium stellatum</i>
7 <i>Trifolium glomeratum</i>	21 <i>Leontodon tuberosus</i>	35 <i>Convolvulus</i> sp
8 <i>Silene imbricata</i>	22 <i>Plantago bellardii</i>	36 <i>Bromus rubens</i>
9 <i>Evax pygmaea</i>	23 <i>Filago spathulata</i>	37 <i>Alyssum granatense</i>
10 <i>Hypochoeris achyrophorus</i>	24 <i>Sanguisorba minor</i>	38 <i>Erysimum bocconeii</i>
11 <i>Poa bulbosa</i>	25 <i>Lagurus ovatus</i>	39 <i>Scolymus hispanicus</i>
12 <i>Hedypnois cretica</i>	26 <i>Minuartia tenuifolia</i>	40 <i>Crupina vulgaris</i>
13 <i>Trifolium cherleri</i>	27 <i>Erodium bipinnatum</i>	41 <i>Silene gallica</i>
14 <i>Anagallis arvensis</i>	28 <i>Biscutella didyma</i>	

Source Bernoussi et al., 1992

Table 2. Pasture types of the massifs constantinois (massifs de Ben Badis)

Pasture with <i>Ampelodesma mauritanica</i>	Cover %	Isi	Pasture with <i>Asphodelus microcarpus</i>	Cover %	Isi
<i>Atractylis cancellata</i>	7	1	<i>Plantago coronopus</i>	14	1
<i>Lolium perenne</i>	1	5	<i>Asphodelus microcarpus</i>	27	5
<i>Sinapis arvensis</i>	5	4	<i>Daucus carota</i>	23	5
<i>Convolvulus arvensis</i>	5	1	<i>Dactylis glomerata</i>	6	5
<i>Daphne gnidium</i>	13	5	<i>Cirsium arvense</i>	4	1
<i>Ampelodesma mauritanica</i>	11	4	<i>Atractylis cancellata</i>	11	1
<i>Thymus officinalis</i>	11	1	<i>Thymus officinalis</i>	6	1
<i>Plantago coronopus</i>	6	1	<i>Scabiosa stellata</i>	6	5
<i>Asphodelus microcarpus</i>	8	5	<i>Avena sterilis</i>	2	6
<i>Astragalus armatus</i>	4	3	<i>Phlomis criniata</i>	1	1
Soil cover			Soil cover		
Vegetation	71%		Vegetation	73%	
Litter	13%		Litter	27%	
Bare soil	16%		Bare soil	0	
Grazing value	10		Grazing value	12	

Source BNEDEP, 1993.

Table 3. Grazing values of steppe species

Species index Isi	Species	Energy UF/kg DM	Species index Isi	Species	Energy UF/kg DM
8	<i>Lolium rigidum</i>	0,70	4	<i>Marrubium desertii</i>	0,61
8	<i>Thymus ciliatus</i>	0,61	4	<i>Noaea mucronata</i>	0,93
7	<i>Artemisia herba alba</i>	0,65	4	<i>Retama raetam</i>	0,89
7	<i>Atriplex halimus</i>	0,85	4	<i>Suaeda fruticosa</i>	0,89
7	<i>Cutandia divaricata</i>	0,69	3	<i>Aristida pungens</i>	0,31
7	<i>Launaea resedifolia</i>	0,85	3	<i>Artemisia campestris</i>	0,42
7	<i>Plantago albicans</i>	0,70	3	<i>Atractylis serratuloides</i>	0,51
7	<i>Plantago ovata</i>	0,88	3	<i>Evax +micropus</i>	0,78
7	<i>Poa bulbosa</i>	0,77	3	<i>Herniaria hirsuta</i>	0,51
7	<i>Stipa parviflora</i>	0,77	3	<i>Launaea acanthoclada</i>	0,33
7	<i>Stipa barbata</i>	0,69	3	<i>Lygeum spartum</i>	0,30
6	<i>Helianthemum apertum</i>	0,52	3	<i>Peganum harmala</i>	0,45
				<i>Stipa tenacissima</i>	0,30
6	<i>Helianthemum virgatum</i>	0,59	2	<i>Bupleurum semicompositum</i>	0,57
6	<i>Scorzonera undulata</i>	0,87	2	<i>Frankenia thymifolia</i>	0,68
6	<i>Salsola vermiculata</i>	0,58	2	<i>Paronychia argentea</i>	0,36
5	<i>Xeranthemum inapertum</i>	0,66	2	<i>Thymelaea hirsuta</i>	0,69
5	<i>Centaurea incana</i>	0,70	2	<i>Arthrophytum scoparium</i>	0,49
5	<i>Ctenopsis pectinella</i>	0,64			
5	<i>Eruca versicaria</i>	0,88			
5	<i>Erodium bipinnatum</i>	0,86			
5	<i>Malva aegyptiaca</i>	0,78			
5	<i>Teuchrium polium</i>	0,68			

Source Nedjraoui, 1981

Table 4. Characterisation of different types of steppe pastures

Pasture type Faciès with:	Cover of perennials %	Phyto-mass above ground kg DM/ha	Forage production UF/ha/year	Forage value/100
<i>Stipa tenacissima</i>	60	2 000	130	20
“ with <i>Launaea acanthoclada</i>	34	1 150	100	14
“ with <i>Launaea acanthoclada</i>	17	600	70	7
“ with <i>Launaea acanthoclada</i>	17	650	70	8
“ with <i>Arthrophytum scoparium</i>	23	850	60	9
“ with <i>Artemisia herba-alba</i>	42	1 450	130	17
“ with <i>Artemisia herba-alba</i>	21	700	80	10
“ with <i>Lygeum spartum</i>	42	1 400	140	19
“ with <i>Lygeum spartum</i>	25	950	100	12
“ with <i>Helianthemum hirtum</i>	45	1 500	140	21
“ with <i>Atractylis serratuloides</i>	19	700	80	10
“ with <i>Artemisia herba-alba-Lygeum spartum</i>	28	960	150	19
“ with <i>Artemisia campestris</i>				
“ and <i>Thymelaea microphylla</i>	23	950	140	16
“ and <i>Aristida pungens</i>				
<i>Artemisia herba-alba</i>	27	850	190	24
“ with <i>Helianthemum hirtum</i>	27	700	180	24
“ and <i>Stipa parviflora</i>				
“ with <i>Stipa tenacissima</i>	36	1 100	160	20
“ with <i>Stipa parviflora</i>	20	600	140	17
“ with <i>Lygeum spartum</i>	22	750	120	15
“ with <i>Atractylis serratuloides</i>	19	650	110	12
“ and <i>Noaea mucronata</i>				
“ with <i>Peganum harmala</i>	10	400	70	7
<i>Lygeum spartum</i>	24	850	190	25
“ with <i>Stipa tenacissima</i>	21	550	90	13
“ with <i>Stipa parviflora</i>	26	800	120	16
“ with <i>Artemisia herba-alba</i>	30	700	120	18
“ with <i>Atractylis serratuloides</i>	16	460	80	11
“ with <i>Noaea mucronata</i>	20	620	100	13
“ with <i>Thymelaea microphylla</i>	20	550	90	13
“ with <i>Artemisia campestris</i>	22	900	160	20
“ with <i>Aristida pungens</i>	25	980	170	23
“ with <i>Frankenia thymifolia</i>	31	1 150	200	24
“ and <i>Halocnemum strobilaceum</i>	28	850	90	14
<i>Arthrophytum scoparium</i>	15	950	60	6
“ with <i>Stipa tenacissima</i>	19	1 050	60	8
“ with <i>Artemisia herba-alba</i>	18	820	90	9
“ with <i>Lygeum spartum</i>	17	670	80	9
“ with <i>Thymelaea microphylla</i>	21	800	60	10
“ with <i>Rantherium suaveolens</i>	13	800	90	6
<i>Artemisia campestris</i>	24	1 250	130	19
“ and <i>Lygeum spartum</i>				

Source URBT, 1974–1978 ; 1982–1987 ; 1988–1991