

Country Pasture/Forage Resource Profiles

ISLAMIC REPUBLIC OF IRAN



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1. INTRODUCTION

The Islamic Republic of Iran, with a total land area of 1 648 195 km², lies between 25° 00' and 39° 47' N and 44° 02' and 63° 20' E. Thus the southern half of the country is in the subtropical zone and the northern half of the country in the temperate zone with a desert zone in the middle of the country around 30° N. The country has, on the northeast side, the desert and steppe of Turkmenistan and on the south and southwest side, the hot and arid Saudi Arabian peninsula. It borders with Iraq and Turkey in the west; Pakistan and Afghanistan in the east; Turkmenistan in the northeast; Azerbaijan and Armenia in the northwest. Iran enjoys sea borders in the north as well as the south (Figure 1).

The mean altitude is over 1 200 m above sea level. The lowest inland point is in Chale Lut, 56 m below sea level and the highest point is Damavand Mount, 5 610 m. The coast of the Caspian Sea is 28 m below mean sea level.

Iran is divided into 28 provinces, 293 cities, 885 towns and 2 293 villages. Based on the latest national census (1996), the human population is 60 055 488 (68 688 433 according to the World Factbook 2006 July est.) of whom 30 515 159 (50.81%) are men and 29 540 329 (49.18%) women. The number of families is 12 398 235 of which 7 948 925 (64%) live in cities and 4 410 370 (36%) in rural areas. The birth rate was 6.42% in 1986 but it dropped to 3% in 1996 and the next census would suggest a lower rate. Table 1 shows the growth rate trend from 1977 to 1996. Since the climatic conditions vary considerably from harsh condition in the central arid and desert zone to very favourable conditions in the north, the population density also varies a lot.

As Iran is in the arid zone, some 65% of its territory has an arid or hyper arid climate, and approximately 85% of the country an arid, semi-arid or hyper arid environment. The peculiar features and location cause the country to receive less than a third of world average precipitation. Only the

Table 1. Human population in recent years

Year	1977	1982	1987	1992	1996	2006 est.*
Population	35 025 195	42 419 985	50 656 562	55 837 163	60 055 488	68 688 433

* World Factbook



Figure 1 Map of Iran

Caspian Plain receives more than 1 000 mm of rain annually. Two major mountain ranges affect the climate: the Zagros chains in the west and the Alborz in the north. Most humid clouds come from the west but mountains prevent clouds from reaching central, eastern and southern parts, so the central and southern lowlands and eastern parts of the country receive very little precipitation. Due to low precipitation and unevenly distributed precipitation in these areas, most rivers are seasonal and their flows depend heavily upon the amount of rainfall. If rainfall is above average, flash floods are common. The main land types are shown in Table 2.

The mean annual rainfall is about 246 mm. The total annual volume of precipitation equals 413 billion m³ of which 44.5 billion could be controlled and managed for utilization. Presently, 36.5 billion m³ of underground water (total of 81 billion m³) are utilized; this could be developed to 116 billion before 2021. Iran has six main watersheds: the Caspian Sea, the Persian Gulf, the Sea of Oman, Urumieh Lake, the central Plateau, eastern border region and Ghare-Ghoom. From the main land types shown in Table 2, it is clear that Iran is a mountainous country.

Of the total land area, some 90 million ha or 54.6% are rangeland; 12.4 million ha or 7.5% are forests; 34 million ha equal to 20.6% are deserts. Settlements, infrastructures and water bodies occupy some 10.1 million ha. Approximately 33 million ha of the land area have average to good capacity for cultivation but just 18.5 million ha are cultivated of which 8.5 million are irrigated (irrigated farming 5.2 million ha and irrigated gardens 1.1 million ha and irrigated fallows 2.2 million ha) and 10 million ha are rainfed.

In 2000 about 10.27 million ha were under annual crops, 7.011 million ha equal to 68.27% was under cereals, some 53.97% irrigated and 46.03% rainfed. Cereal production reached 12.86 million tonnes equal to 28.76% of annual crops; wheat, barley and rice are the commonest, respectively producing 62.87%, 15.32% and 13.11% of the cereals; wheat is grown on 72.75% of cereal farms. Table 3 shows the production of some of the major crops in 1999 (a drought year).

The average area of farms in 1992, shown in Table 4, indicates 60% are smaller than four ha.

All agricultural lands are owned by the people, except a very small portion which belongs to government bodies i.e. banks, the agricultural complexes of the Ministry of Jihad-e-Agriculture. Natural resources, i.e. forests, rangelands and deserts belong to the government but are exploited by people through a contract. For grazing lands, the Technical Bureau of Rangelands, through its district staff, identifies lawful livestock holders and then issues a grazing permit to the stock owner for a set period which should be extended each year. In order to have better management of rangelands, a range development plan would be formulated and based on that plan, a contract would be signed by the stock owners and the government Forest, Rangeland and Watershed management Organisation Ministry of Jihad e Agriculture (FRWO) provincial head in order to ensure the stock owner invests in development and improvement of rangeland instead of just exploitation.

Sheep and goat are the commonest livestock; cattle, buffalo, camels, asses and mules are also kept. The number of animal units (AU: a sheep of 45 kg which requires 276.5 kg TDN per year) in the country is

Table 2. Land types of Iran

No.	Type of land	Area (ha)
1	Mountains	46 036 179
2	Hills	22 027 499
3	Plateaux and Upper Terraces	23 004 259
4	Plain Mountain Slope	7 794 319
5	River Sedimentary Slope	4 022 892
6	Lower and Saline Lands	5 565 823
7	Torrential Plain	8 608 070
8	Alluvial Fan	10 568 120
9	Mixed Lands	4 978 319
10	Other Lands	5 211 466
11	Alluvium with Gravel (stone)	1 074 320
12	Sedimentary Slope	227 600
13	Total	138 130 573

The difference between the area given in this table and the total area of the country is because Sistan va Baluchistan province has not yet been studied.

Table 3. Production of major crops in 1999

Crop	Yield (1 000 tonnes)	Crop	Yield (1 000 tonnes)
Irrigated wheat	7 201	Sugar beet	5 548
Rainfed wheat	1 473	Sugar cane	2 236
Barley (irrigated and rainfed)	1 999	Oil seeds	271
Rice	2 348	Potato	3 433
Cotton	441	Onion	1 677

Table 4. Average area of farms in 1992 across the country

Farm area (ha)	Number (%)	Area (%)	Farm area (ha)	Number (%)	Area (%)
< 0.5	19.00	1.22	5 – 10	19.00	18.17
0.5 – 1	-	-	10 – 20	17.50	36.70
1 – 2	14.40	2.63	20 – 50	2.94	13.49
2 – 3	-	-	50 100	0.89	8.00
3 – 4	26.00	11.24	Over 100	0.31	8.55
4 – 5	-	-	Total	100	100

some 83 million. Range can meet the requirements of only 37 million animal units for a period of seven months, so there are some 46 million Animal Units excess on rangelands. Based on a study conducted by the Natural Resources Faculty University of Tehran, an economic size of rangeland exploitation is some 536 ha with 230 AU. It suggests that the range can meet the requirements of only 180 000 households whereas there are 916 000 households at present.

Although, many measures have been taken to develop the standard of living of livestock raisers, there is still a lot of work to do. The standard of living of most rural people is, of course, acceptable because they live in population centres and thus they enjoy the facilities provided by the government much better than do mobile pastoralists who are far from cities and villages, so access to facilities is difficult.

A major problem that pastoralists, both sedentary and mobile, face is the lack of a marketing system, thus they have problems in meeting their needs by trading their products. In some places cooperatives and companies go to the pastoralists to collect their surplus production. Sedentary pastoralists have fewer problems in selling their products and buying their requirements where mobile pastoralists often have to go to towns to buy their needs during their seasonal migration.

2. SOILS AND TOPOGRAPHY

Topography

Iran is mountainous; more than half of the country is at altitudes between 1 000–2 000 m (Table 5) and 16% is above 2 000 m with some mountains of 3 000–4 000 m. Damavand Mount at 5 670 m is the highest in west Asia and Europe. Some 11 000 km² equal to 0.9% of the land at the Caspian Sea coast is below sea level. In the Central Plateau the lowest point in the Dasht-e-Lut is 156 m. The mean altitude of the country is approximately 1 250 m and that of the Central Plateau 900 m (Figure 2).

Although Table 5 suggests that Iran is mountainous with lots of features, studies conducted on the slopes of the country indicate that the area of flat land and gentle slopes is large. Iran's topographic map at 1:250 000 consists of 134 sheets. A study on 109 sheets suggests that the area of flat and gentle slopes is greater than the steep slopes (Table 6): the mean slope on 54% of the area is between 1 and 5% which consists of coastal plains, watershed beds, inland plains etc. Some 21% of the country has slopes of 5–15%. Thus about 75% of the land area of the country has a mean slope of 0–15% (about 7°).

Topography generally affects climate and soils and plays a considerable role in the differentiation and distribution of climates and vegetation zones. For example, the Caspian zone is humid, due to the high Alborz mountain range. In the Sefid-Rud valley as a result of the low

Table 5. Altitudinal categories of the country

Altitude m	Area (km ²)	%
Over 2 000	260 000	15.7
1 000 – 2 000	879 000	53.3
500 – 1 000	154 000	9.3
0 - 500	332 000	20.0
Below sea level	11 000	0.9
Inland water bodies above sea level	14 000	0.7
Total	1 650 000	100



Figure 2. Altitude classes in Iran

Table 6. Slope classes of the country

Slope (%)	Area (km ²)	% of total land area
1	352 044.9	25
1-3	281 457.1	20
3-5	134 794.1	9
5-10	171 847.1	12
10-15	126 197.2	9
15-30	152 619	11
30-50	89 239.5	6
> 50	118 268.3	8
Total	1 426 467.2	100

altitude, dry winds from the interior move towards Guilan, creating an area of low rainfall which extends up to some 40 km from Rasht (Capital of Guilan Province). The great chain of Albers and Zagros forms a "V shaped" natural barrier which inhibits the humid winds of the southwest and prevents the majority of clouds from reaching the centre of the country, so steppes and deserts are created.

Because of their height, parts of Iran's Central Plateau have relatively high potential as regards land use. With proper treatment a large part of this plateau might be converted into relatively productive rangelands, despite the fact that their original vegetation is in a state of utter ruin caused by careless overgrazing through the ages. It is obvious that the proportion of grasses primarily confined to the *Artemisia* steppes is quite considerable.

Due to the great variations in altitude in mountainous regions, quite different types of vegetation are found over relatively short distances from one another, a factor which encourages the seasonal flock movement. The most outstanding feature in the topography of the Central Plateau is its microrelief which is the outcome of a series of geomorphologic processes, such as erosion, drainage, and peneplanization, which are still in full action. This has led to differentiation of the plateau into a series of habitats that differ from each other in the physical and chemical properties of their soils including salt-moisture relations. This series starts from the foot of each mountain ridge or block and ends in the deepest depressions of the alluvial basins. The rocky slopes of the ridges are often bare or very poorly vegetated. At the base of the hills the talus (the accumulated boulders and coarse stones) is a most promising habitat for more shrubby elements of the steppe, such as the *Artemisia - Pteropyrum* community which often grows here, and some shrubby elements including *Astragalus*, *Amygdalus*, *Lyciu* and *Ficus carica* var. *rupestris*.

North-facing slopes are moister than those facing south and their vegetation is generally denser. This is particularly evident in the high mountains because snow lies longer on north-facing slopes. Many plants and among them good forage or woody species, prefer warmth and sun. On the hills of southern Iran, most perennial grasses are found on southern slopes.

The steepest slopes will also usually be the poorest in vegetation because of more intense water run-off and erosion. Overgrazing is, however, more intense on gently sloping land and in almost any place where dry farming is possible the land has been worked as high as the slopes permit. Topography and even micro-topography play an important role in the conservation of the best species. It is often on the slopes, sometimes quite steep and much eroded, that the good forage plants and the last forest remnants of a region are present. The surviving good plants of a large flat region can often be found on one small bank. The now uncultivated flat lands are so compacted by the herds that infiltration and aeration are insufficient to allow the development of normal vegetation. This explanation is not, by itself, sufficient and vestigial perennial grasses of a region can often be found on slight slopes, often facing south, which – apart from the topography - do not differ from the surrounding flat land. The most typical case can be observed 90 km west of Kerman city where the only vestigial *Aristida plumosa* are found on a very gentle slope (hardly 10%) covering a few square m, without any particular pedological differentiation.

In dry or arid regions of the Middle East, the search for native plants is in general more fruitful on slopes than on flat land. Numerous species that could well grow on flat land are now found almost exclusively on the more or less eroded slopes. The micro-relief - i.e. difference in level of a few centim only - appears to have an influence which is progressively stronger as the micro-climates become more arid; the presence of a few small pebbles is often sufficient to prevent the destruction of seedlings.

Soils

Due to its topographical, climatic and particularly its lithologic diversity, Iran displays a rich mosaic of soils. The following is a brief geo-botanical account of the soils classified by Dewan and Famouri (1964) and Zohary (1963). It is mainly a geobotanical review and as such, it considers as soil all kinds of substrates in their relation to vegetation.

Most of the soils of the area are lithosols due to heavy erosion which does not allow profile development. Other soils are alluvial-colluvial with steady rejuvenation of the profile and which occur in a variety of forms not always well differentiated by the pedologist, but readily distinguished from one another by vegetation.

Climatically, the soils of Iran can be classed into humid, semi-humid and arid ones. From the geobotanical point of view the soils can be subdivided into regional and interregional ones. The former

comprises all soil series which are definitely confined to climatic and plant geographical regions, such as forest soils and steppe soils. Interregional soil units are such that may occur in various plant geographical regions, although slightly or markedly varying in their vegetation cover in the various regions. Such soils are not necessarily related to the climatic vegetation complexes of the region; examples are sandy soils, swamps and marshes; such soils as long as they preserve their primary pedological nature, will sharply differ in their vegetation from other soils of the region, while showing more vegetational affinity to similar soils in alien regions. Of the regional soil groups, the following should be mentioned:

Forest climax soils

a) Brown Forest Soil. This is the soil of deciduous forest of the most mesic type both in the Caspian and reportedly also in the Zagros mountains. It is sometimes mixed with podzolic soils from which it is not easily distinguished. It is confined to areas with high precipitation, part of which falls in summer. Generally, it has a well developed profile with a humiferous A- horizon, moderately acid to alkaline. Beech and Oak forests are the characteristic climax vegetation of the soil. At present, the typical brown forest soil is less extensive than its more ruined or skeletal derivative (lithosol facies), or its alluvial variety deposited in the intermountain valleys. Here it occurs as fine textured soil which is largely under cultivation.

b) Chestnut soil. It develops under humid climatic conditions from various parent materials such as limestone and igneous rocks. It is characterized by the dark brown or dark greyish-brown surface horizon. The lower subsoil is strongly calcareous. The chestnut soils, as the other soils, occur in Iran in three facies, one with a well developed profile, another lithosolic and the third as a transported colluvial fine textured soil. All occur both in the Caspian Sea and the Zagros districts, and all seem to support climax vegetation similar to that of the brown forest soil.

c) Rendzinas. True rendzinas developing from soft marly limestones are confined to humid or semi humid areas. They are generally characterized by their dark-coloured usually calcareous surface horizon which sharply contrasts with the marly or chalky white parent rock. In Iran, they are not uncommon in the forest areas of the mountains but are often intermixed with other types. This type too occurs in some varieties, according to topography and conservation of profile. Forms with mature profiles are found at present only under forest vegetation. Apart from the black rendzinas there are also light-coloured and greyish-brown ones.

Alluvial soils. These are the soils that fill the great plains and valleys. They are partly formed in situ, but largely transported from the mountains and redeposited, and thereby physically changed. There is no mature profile in these soils because of the steady rejuvenation of the upper horizons. Alluvial soils in this sense, do not include hydromorphic deposits, they are ecologically zonal soils, because they are apt to harbour plant communities of the same regional vegetation complex as the adjacent mountains that supply the soil material. Examples are alluvial soils of the intermountain valleys of the Zagros and Alborz mountains, which support the same forest type that grows in similar altitudes of adjacent mountains. Actually no natural vegetation has been left in most of these alluvial plains. In this variety, one should include the terraces of the mountain slopes which have been under cultivation since time immemorial and are inhabited by a particular weed flora. The alluvial soils in the above sense are not typological units in themselves. They are a derived form of the oropedic group just as the lithosols are another derivative of this or another regional soil group.

Steppe soil series

The bulk of Iran is occupied by steppe and desert, which are characterized by dwarf shrubs or herbaceous formations, the density of which is largely dependent upon the amount of rainfall. The soils classed under this heading include (Figure 3) sierozems, brown steppe, loess and loess-like soils, as well as hammadas.

a- Sierozems are typical steppe soils. They are mostly oropedic, shallow, with an A - C profile, almost devoid of a humiferous layer, and grey in colour. They are mostly highly calcareous, free or almost free

from injurious salts. They develop under arid conditions with rainfall not exceeding 250 mm, with cool to cold winters and hot and dry summers. Sierozems may occur in a variety of forms caused by topography and nature of the parent rock. In Iran, most of the mountain slopes facing the Central Plateau and all the elevations of the plateau itself are typical sierozems. They are characterized mainly by various plant communities of the artemisia and tragacanth formations. For rainfed farming, this soil type only offers marginal conditions.

b- Brown soils. Brown soils are formed under more favourable climatic conditions than sierozems, but are still marginal for arboreal vegetation. In Iran, brown soils are common in more humid parts of the Zagros mountains and in Khorasan (Dewan and Famouri, 1964). The surface soil is lighter in colour from greyish-brown to yellowish-brown. Brown soil is not always easily discernible from sierozems. As with other soils, lithosolic and alluvial varieties also occur in this type. The natural vegetation characterizing this soil is a kind of sparse steppe-forest.



Figure 3. Calcareous Lithosol soils in desert and sierozems soils

c-Loess and loess-like Soils. A type of soil reminiscent of loess has been observed in several localities, south of Alborz mountains and in the adjacent valleys. This aeolic soil has a yellowish-brown colour and is deposited mainly as desert dust in valleys on the outer fringe of the desert. It is no doubt confused with brown soils and sierozems. Loess is a fine-grained soil with a medium clay / silt ratio and a high proportion of fine sand. The profile shows almost no differentiation into horizons.

d-Hammadas. Most of the hammadas are confined to the intermountain valleys and drier parts of the Central Plateau. They are greyish-brown, calcareous soils with a fairly high content of silt and clay mixed with and covered by pebbles of various rock materials (desert pavement). hammadas are generally poorly vegetated because of the low rainfall. This soil could be looked upon as an alluvial phase of the sierozem, formed through the perpetual process of erosion. hammadas are generally exposed to deflation by wind so that the soil particles are blown away and deposited elsewhere, where the plant cover is more able to protect the soil. The subsoil may sometimes differ from the surface layer. It may be loessy or marly or it may be provided with a gypsic crust. Because of the low rainfall, soil moisture decreases with depth. hammadas are typically desert or steppe soils. Vegetation where existent is made up of dwarf shrubs mainly of the Artemisia class. Density of vegetation varies with moisture. In extreme cases, such as in Dasht-e-Lut, there are immense stretches of altogether bare hammadas.

Interregional soils

a) Hydromorphic soils. This type includes the soils of fresh water swamps and river banks. These soils are largely hydromorphous not only by the way of their transportation and deposition but also by their pedogenesis and physical properties. Their inclusion within the group of interregional soils is due to the fact that the high moisture content in its various manifestations affects plant life in the same way under various climatic conditions so that vegetation in such soils is largely uniform over wide areas and in several regions. In Iran this type comprises river-bank soils, swamps, alluvial soils under inundation or irrigation. The banks of greater or smaller rivers are covered by riparian forests comprising various species of Populus, Alnus, Salix, Platanus, Fraxinus, etc. There is also very rich moisture content in its various climatic lacustrine vegetation of reed and rush communities in fresh water and also particular vegetation wherever crops are irrigated.

b) halomorphic soils. This type comprises saline soils, both solonchaks and solonetz. The largest part of saline soils in Iran are solonchaks in which sodium chloride is the dominant salt; other chlorides (CaCl_2 , MgCl_2 , KCl), as well as gypsum and sodium sulphate, are also not calcareous loams, loess, marls, sands, etc. Iran has its largest concentration of salines in the Central Plateau. The salines here belong to northern continental ones of Middle and Central Asia, notably of Turan. There are also “hot” salines fringing the coasts of the Persian and Oman Gulfs.

According to their hydromorphous relations these salines may be subdivided into automorphous and hydromorphous varieties. The former are those in which salinity stems from the local parental rock or other saline deposits that had not been leached out. In hydromorphous salines, soil formation is strongly affected by the presence and movements of water, such as surface deposition of salts through capillary rise in high ground-water salines or through seasonal flooding or disappearance of ephemeral water bodies by evaporation. All these kinds of salines are richly represented in Iran. In addition, there are also man-made salines caused by irrational irrigation.

The halophytic vegetation of Iran comprises two classes each consisting of a number of communities; the commonest are those dominated by *halocnemum strobilacnemum*; others are dominated by *Salsola* spp., by *Alhagi maurorum*, *Tamarix* spp., and many others.

Solonetz soil (black alkali) are characterized by high pH values (up to 9 and 9.5); they contain exchangeable sodium in the absorption complex in an amount sufficient to interfere with plant growth. The clay in such soils is easily dispersed, and hence their puddled and sticky appearance, their low permeability, and their low air content. When dry, the soils show a prismatic, columnar structure. So far, insufficient data exists as to the distribution of this type of saline in Iran.

c) Dunes and sandy soils. Iran has considerable areas covered with sand and dunes. The largest of these is the Dasht-e-Lut, on the southern fringe of the Dasht-e-Kavir; some smaller areas are scattered in the Central Plateau and the coastal plains. Desert sand dunes and sandy soils in general, when not in excessive movement, offer more favourable conditions for plant life than fine-textured soils. This is because of their capacity to absorb rain water without run-off and their lower evaporation rate. On the other hand, rain-water accumulates here at greater depths and only deep-rooting perennials or shrubs can take foothold in this habitat. Accordingly, there are only a small number of plant communities specific to sandy ground. Generally sandy soils are less saline than others, but in the Central Plateau sand cover overlies salty subsoil. *haloxylon persicum*, *Calligonum* spp., and *Aristida pennata* are among the leading species of the psammophilous plant communities.

3. CLIMATE AND AGRO-ECOLOGICAL ZONES

Climate

Since Iran is in the arid zone, some 65% of its territory is arid or hyper arid, and approximately 85% has an arid, semi-arid or hyper arid environment (Figure 4), the specific features and location of Iran causes it to receive less than a third of the world average precipitation. Only the Caspian Plain in the north receives more than 1,000 mm of rain annually. Two major mountain ranges affect the climate: the Zagros chain in the west and the Alborz in the north. Most humid clouds enter the country from the west but the mountains prevent them from reaching the centre, east and south. Therefore, the central and southern lowlands and the east of the country receive very little precipitation. Due to shortage of precipitation and its uneven distribution in these areas, most rivers are seasonal and their flows depend heavily on the amount of rainfall: if rainfall is above average, flash floods are common.

Based on the data published by the Water Resource Management Organization, the mean annual rainfall of the country over a 35 year period is 249 mm, but as shown in Figure 5 the variation of rainfall is very high between years; thus the country sometimes experiences drought, which is when the rainfall is below 75% of the long-term mean. Rainfall varies both temporally and spatially, i.e. some places at the Caspian sea coast receive over 1 000 mm, while some have below 50 mm in central Iran. Even if the country is not experiencing drought there are three provinces, Sistan va Baluchistan, Hormozgan and

Kerman which in 2004 had a rainfall of 13%, 28% and 48% of mean annual long run, respectively. Figure 6 shows the rainfall classes of the country.

The main factors determining the broad climatic zones are:

- Abundant precipitation and high relative humidity which make the Caspian region a climatic entity entirely different from the rest of the country.
- Warm winters and high relative humidity of the areas bordering the Indian Ocean which cause a very special arid sub-tropical climate.

Between these regions, so radically different, the great mass of Iran is characterized by very dry summers (no rain and very dry atmosphere). The winters are generally cold; the range of temperature variations is much greater than in the Caspian and Baluchi Zones. The continental climate, arid in summer, somewhat resembles a Mediterranean climate, but is distinguished from it because of extreme temperatures. It extends from Syria and Anatolia to the east of Afghanistan and to Turkistan. It has sometimes been called "Syrian" climate, but it corresponds fairly well to what the geo-botanists have described as the "Irano-Turanian" zone. The accumulation of snow over several months on the highest mountains gives climates with some alpine characteristics, but with a dry summer.

Main climatic zones

The main climatic zones are considered to be:

i) Caspian Zone (Caucasian and mid-European affinities, slightly Mediterranean on the coast). Annual precipitation between 600 and 2 000 mm with a minimum in June but no real drought, maximum in autumn. Relative humidity generally above 80%. Mild or cold winters. Mean temperature in January below 8 °C. Mean temperature in July below 26 °C; annual temperature range (continental) between 16 and 19 °C. Towards the east (Gorgan) the climate is drier and a little more continental (transitional towards the Irano-Turanian climate).

ii) Baluchi Zone (Saharo-Sindian and subtropical affinities). Annual precipitation below 300 mm (generally less than 200 mm) almost entirely in winter (six to eight months without precipitation), but

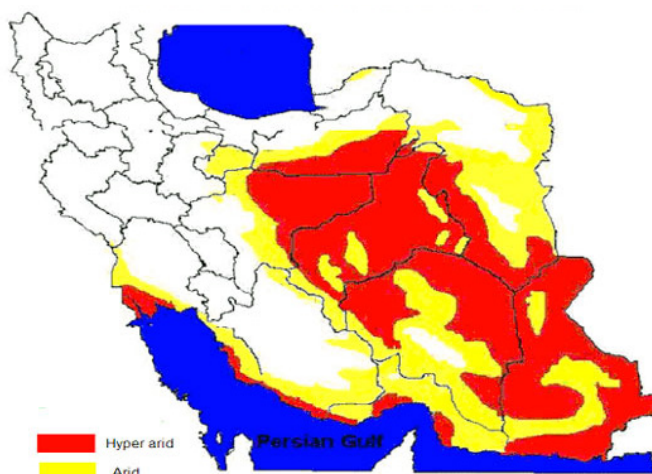


Figure 4. Distribution of arid and hyper arid areas of Iran

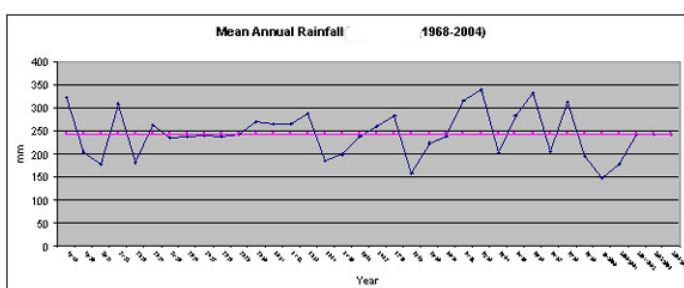


Figure 5. Mean annual rainfall of the country

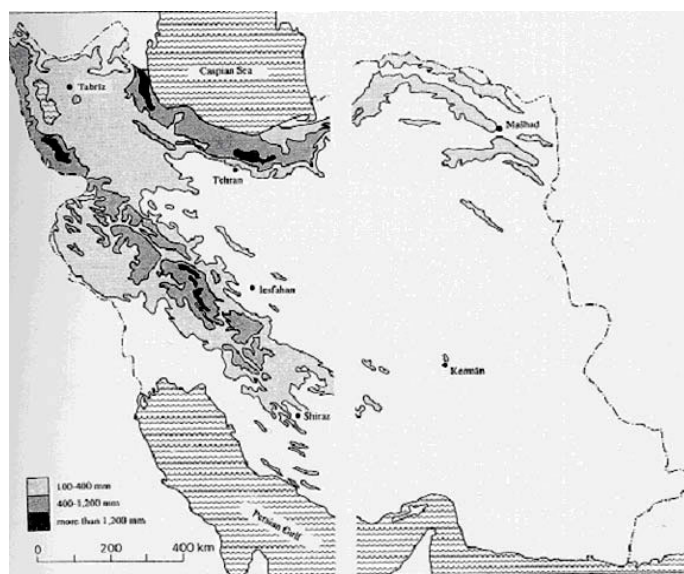


Figure 6. Map of rainfall classes of Iran

high relative humidity (60% to 80%). Fairly warm winters; mean temperature for January above 15 °C; average for July less than 34 °C; annual temperature range (continental) between 10 and 18 °C. This zone is typically east of Lengeh port - Khuzistan coast is not part of it, as Boushehr port is the western limit of the zone; in the east it forms a much larger strip.

iii) Irano-Turanian Zone (slight Mediterranean affinities). Extremely variable precipitation, generally between 100 and 500 mm; maximum in winter or spring. At least three summer months of total drought extending up to nine months in the most arid regions (Figure 6). Relative humidity in winter between 80% and 55% (central desert) falling in summer to below 40% and down to 20%. Very variable temperatures, depending on the region, but winters generally cold or very cold except in Khuzistan and in the north Baluchi zone (mild winters). Summers extremely hot in the Khuzistan plain (average in July above 36 °C), very hot in the central depression (more than 30 °C), hot or quite hot (24 to 29 °C) everywhere else, except above 2 000 to 2 500 m altitude. The average annual range of temperatures (continental) varies from 21 to 28 °C, but is generally more than 24 °C. Diurnal variations in temperature are also very large. There is a large variability in the precipitation and even winter temperatures from one year to the next.

This vast Irano-Turanian zone, which is shown in Figure 7, covers approximately 90% of Iran and can be subdivided; taking average precipitation as a basis for classification:

- a) **Subdesertic zone:** The most arid part of the central Iranian plateau, with annual precipitation below 100 mm. Average temperature in January between 4 °C (north) and 10 °C (south) and the average temperature in July being between 29 and 34 °C. The towns of Yazd, Bam and Zabol are in this zone.
- b) **Steppic zone:** Surrounding the subdesertic zone and reaching into the east and south of Khorasan, into the southwest half of Khuzistan and the north of the Baluchi zone; covers two-fifths of Iran. The towns of Tehran, Qom, Isfahan, Shahrud, Sabzevar, Birjand, Zahedan, Kerman, Jiroft, Lar, Ahwaz and Abadan are in this zone. Annual precipitation between 100 and 200 mm (south) or 230 mm (north). Temperatures highly variable according to altitude and latitude. This zone should be divided into sub-zones on the basis of the winter temperatures, i.e.:
 - a “warm steppic zone” (Khuzistan, the southeast of Fars province, low-lying regions between the Baluchi zone and the central desert), with mean January temperatures generally above 10 °C, thus presenting analogies with the “Saharo-Sindian” climate (irrigated date-trees);
 - a “mild steppic zone” (Qom, Kerman, Zahedan, Birjand) with January means of about 5 to 8 °C;
 - a “cold steppic zone” (Tehran, Isfahan, Sabzevar) and below 4 °C .
- c) **Substeppic zone:** This forms a continuous strip, sometimes very narrow, around the Zagros mountains to the southeast of the Alborz range and extends widely onto the Plateaux of Azerbaijan as well as to the east of Kurdistan; it also extends onto certain mountains of the east and southeast. The towns of Qazvin, Zanjan, Tabriz, Khoy, Urumieh, hamedan, Arak, Boroujerd, Golpayegan, Shahr-e-kurd, Shiraz, Mashhad, Torbat e Heydariyeh, Bojnourd, Kazeroun, Behbahan and Dezful are in this zone. Annual precipitation between 200–230 and 450 mm, depending on the region. Very variable temperatures especially in winter, depending on altitude and latitude. Here also, it is necessary to distinguish between a “warm sub-steppic zone” (north and east Khuzistan, Kazeroun); a “mild substeppic zone” (Shiraz, Ghasr e shirin, north and east of Gorgan); and a “cold substeppic zone” – by far the largest.



Figure 7. Climatic zones of the country

d) Xerophilous forest zone: This stretches along the Zagros chain, from Fars to Kurdistan, over mountains in Azerbaijan, forming a narrow strip on the slopes of Alborz and extends to the east of the chain from roughly 800 to 2 600 m in regions with annual precipitation above 400 mm. Temperatures vary much from north to south, especially according to altitude. Winters are mild on the south-western border of the Zagros and cold or very cold elsewhere.

iv) High mountain zone: It is very difficult to give details of the climates of high mountains, as these climates are probably very different according to their northern, eastern or western aspect. However, it may be assumed that the temperature drop is about one degree Celsius for each 200 m and that daily and yearly variation normally diminishes with increase in altitude. Finally, the precipitation must decrease above a certain altitude, which we may very roughly estimate at 2 000 m, but evaporation also diminishes with altitude. These climates are therefore progressively colder and drier with increasing height. Above 3 000 m in the north of Iran, climate can be qualified as "alpine-substeppic" but in high mountains of the south and especially the southeast, there should be a type of cold steppic climate.

The classification given above only partially corresponds to those used by the climatologists; it gives, however, a reasonably clear description of the great climatic divisions of the country. It has the additional advantage of corresponding reasonably well to the different types of flora and natural vegetation found in Iran.

Some remarks on the Iranian climate:

Over most of Iran the rains are often violent and occur only at long intervals; for a given amount of annual precipitation the number of rainy days is small. Much of the water streams down the slopes and the vegetation does not benefit from it. The autumn rainy season often has periods of several weeks without any precipitation, which may stop the germination process and kill most of the young seedlings. The violence of rain is equally destructive to the surface structure of fine textured soils and clay crusts are formed which impede the growth of young plants and increase evaporation.

The efficiency of rain on plants depends not only on its abundance and regularity, but also on mean daily temperatures. Below about 7 °C the photosynthesis of most species is practically nil. It is only above 10 °C that active growth can be expected, which becomes progressively more rapid with the increase in temperature. In the south and especially southeast regions with a warm winter, vegetation benefits from the entire period of humidity and annuals are very abundant, whereas in northern regions growth only starts towards the end of the humid period and annuals are generally scarcer. An annual average rainfall of 150 mm in the Baluchi zone can give a rich and fairly dense vegetation, but the same rainfall gives only a poor vegetation to the south near Tehran. Finally, in regions where the spring rains are plentiful, growth is more favoured than where the main precipitation is in winter, especially in the case of annuals and seedlings of perennials.

In regions with long, cold winters and on mountains, accumulation of snow favours perennials as they are thus protected against excessively low temperatures; in addition when slopes are gentle water from melting snow infiltrates almost completely, thus producing a good reserve of water in the subsoil which is tapped by deep-rooted plants in the dry season.

Agro-ecological zones

Rainfall is the major determining factor in defining agricultural zones and rainfall in its turn is dependant on physiographic features of the country. As mentioned earlier, there are two major mountain chains, Alborz and Zagros. Alborz stretches west to east in the north near the Caspian Sea, creating a very rainy zone where many kinds of crops, fruits and forests are produced and since crops are common extensive livestock husbandry is only practiced in the uplands where there is little or no cultivation, due to cold weather and unsuitable soils.

The Zagros mountain chain prevents rain clouds entering the country from the west, thus creating a rainy zone and many farms, orchards and forests are there. Crop production is common along with livestock - the summer grazing rangelands are in the high mountainous areas of Zagros and the lowland ranges are usually exploited in winter.

The central part of the country receives very little rainfall, thus the crop production is limited to places with adequate water from rain or groundwater. Unsuitable soil is another deterrent to agriculture; there are many areas of mobile sand dunes across central Iran where no farming or stock rearing is possible. In the central area where appropriate, farming and fruit orchards - pomegranates, nuts, pistachios, etc. are common. Although the rainfall is low and erratic, stock rearing is very common in central Iran.

Broad phytogeographic zones of Iran

The main bioclimatic zones are shown in Figure 8.

Caspian Flora:

The Caspian flora is undoubtedly the best characterized in Iran due to a climate which remains humid throughout the year. As there is no real summer drought, the Caspian flora has comparatively few affinities with the Mediterranean flora (few species with evergreen foliage). It resembles much more that of the southern Caucasus and the northeast coast of Turkey, and includes many species of the European temperate zone. It is essentially a forest flora, of which almost all the trees and bushes are deciduous. The great differences in altitude permit the distinction of at least three belts of vegetation. The approximate limits of these belts appear to increase in altitude going from west to east, partly because of the decrease of the temperatures.

(a) Lowest forest belt (reaching approximately 800 to 1 000 m). The fundamental tree is in principle *Quercus castanaefolia* and the understorey is frequently dominated by *Buxus sempervirens*. *Carpinus betulus*, *Zelkova crenata*, *Parrotia persica*, *Albizia sp.*, *Gleditsia caspica*, *Diospyros lotus*, *Ficus carica*, *Tilia rubra*, and *Acer spp.*, are generally the dominant trees. With the exception of a narrow coastal strip, supporting mostly annuals, there is practically no pasture extending over a wide area. Annual grasses (especially *Setaria spp.*) are much more abundant than the perennial grasses. Among these are *Brachypodium pinnatum*, *Dactylis glomerata*, *Andropogon ischaemum*, *Poa spp.* and on the driest slopes *Aristella bromoides*, *Festuca ovina*, *Stipa sp.*, *Melica sp.*, and *Phleum boehmeri*. Legumes are not abundant, but most noteworthy are annual or perennial *Trifolium* and several perennial *Onobrychis*.

(b) Medium forest belt (approximately 800 to 2 000 m). This belt corresponds to the zone of maximum rainfall. The famous beech forests (*Fagus orientalis*) are found in these moist and cool areas of the Caspian region, but *Carpinus betulus* is often the dominant tree. These trees are frequently associated with *Acer insigne*, *A. laetum*, *Tilia rubra*, *Ulmus glabra*, *Fraxinus excelsior*, *Taxus baccata*, *Sorbus spp.* and many bushy species. A few species of the lower belt (*Parrotia*, *Zelkova*, *Diospyros*, etc.) can be found as high as 1 400 m and even higher in the east where the beech is absent and replaced here and there by *Taxus baccata*. The driest areas are populated by *Quercus castanaefolia*, *Carpinus betulus*, *Carpinus orientalis* and several *Acer* (up to five species in the higher regions of this forest belt). Forest felling favours the multiplication of the bushy species *Ilex*, *Prunus*, *Lonicera*, *Crataegus*, *Rhamnus*, *Mespilus*, *Rosa*, etc. The herbaceous vegetation is always poor when the forest is dense but becomes very rich in the areas exposed to the sun. Perennials are largely dominant over annuals. Among perennial grasses the following should be noted: *Festuca montana*, *Aristella bromoides*, *Agropyron panormitanum*, *Brachypodium sylvaticum*, *Dactylis glomerata*, *Phleum boehmeri*, *Melica spp.*, *Bromus sp.*, *Trisetum sp.*, *Poa spp.*. The following forage legumes can be found: *Trifolium pratense*, *T. repens*, *Lotus corniculatus*, *Coronilla spp.*, *Onobrychis sp.* In the highest areas spiny *Astragalus*, an element of Irano-Turanian flora, can be found.

(c) Upper forest belt – or the “sub-alpine belt” (approximately 2 000 to 2 700 m). This belt, both drier and colder, is transitional with the steppe-like pastures of the higher regions. It is difficult to define its precise altitudinal limits because of the destruction of most of the woody flora which comprises various *Acer*, *Sorbus*, *Crataegus*, *Rhamnus*, *Prunus*, *Cotoneaster*, *Juniperus communis*, *J. sabina*, *Lonicera caucasica*, *Viburnum lantana*, *Berberis integerrima*, etc. There is even a localized colony of *Betula verrucosa*.

The herbaceous vegetation is very rich throughout but varies greatly with the degree of soil humidity and exposure. The dominant perennial grasses are *Bromus persicus*, *Dactylis glomerata*, *Trisetum sp.*,

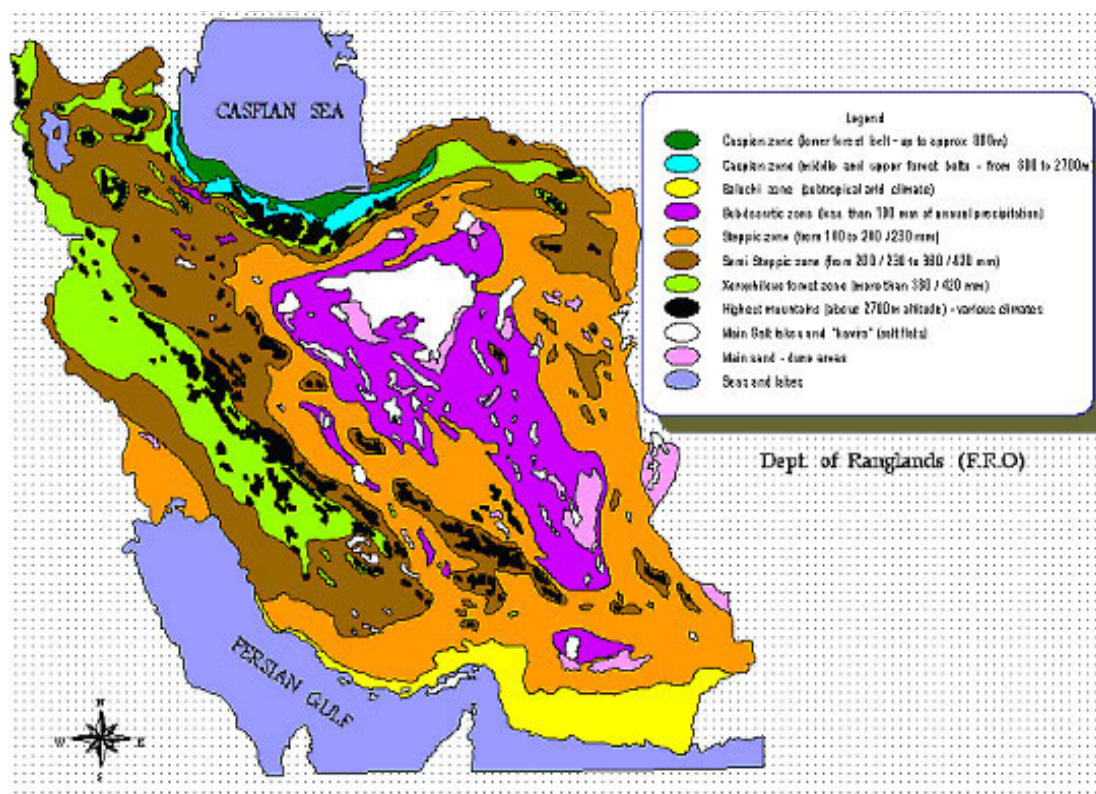


Figure 8. Bio climatic zones of Iran

Caspian zone < 800 m	<i>Quercus castanaefolia</i> , <i>Buxus sempervirens</i> , <i>Carpinus betulus</i> , <i>Paliurus spina christii</i> , <i>Rubus</i> spp., <i>Buxus sempervirens</i> , <i>Punica granatum</i> , <i>Pteris aquilina</i> , <i>Dactylis glomerata</i> , <i>Brachypodium pinnatum</i> , <i>Poa</i> spp., <i>Aristella bromoides</i> , <i>Andropogon ischaemum</i> .
Caspian Zone > 800m	<i>Fagus orientalis</i> , <i>Carpinus betulus</i> , <i>Acer insigne</i> , <i>Acer laetum</i> , <i>Tilia rubra</i> , <i>Quercus castanaefolia</i> , <i>Carpinus orientalis</i> , <i>Carpinus betulus</i> , <i>Prunus</i> , <i>Agropyron panormitanum</i> , <i>Aristella bromoides</i> , <i>Festuca montana</i> , <i>Phleum boehmeri</i> , <i>Dactylis glomerata</i> , <i>Trifolium pratense</i> , <i>Trifolium repens</i> .
Baluchi zone	<i>Avicennia officinalis</i> , <i>Rhizophora mucronata</i> , <i>Acacia arabica</i> , <i>Prosopis spicigera</i> , <i>Panicum antidotale</i> , <i>Pennisetum</i> , <i>Cenchrus ciliaris</i> , <i>Tricholaena teneriffae</i> , <i>Taverniera</i> , <i>Astragalus</i> , <i>Rhynchosia</i> , <i>Amygdalus scoparia</i> , <i>Amygdalus horrida</i> , <i>Pistacia khinjuk</i> , <i>Stocksia brahuica</i> , <i>Pteropryum aucheri</i> .
Subdesertic zone	<i>Chenopodiaceae</i> , <i>halocnemum</i> , <i>Seidlitzia rosmarinus</i> , <i>Salicornia herbacea</i> , <i>halocnemum strobilaceum</i> , <i>Tamarix</i> , <i>Noaea mucronata</i> , <i>Calligonum</i> spp., <i>Aristida plumosa</i> , <i>Stipa barbata</i> , <i>Zollikoferia</i> , <i>Stellaria</i> , <i>Echinops</i> , <i>Astragalus</i> , <i>Fagonia</i> , <i>Heliotropium</i> , <i>Reaumuaria</i> , <i>Peganum harmala</i> , <i>Carex stenophylla</i> , <i>Poa bulbosa</i> , <i>Stipa</i> spp.
Steppic zone	<i>Haloxylon</i> , <i>Salicornicum</i> , <i>Salsola rigida</i> , <i>Stellera lessertii</i> , <i>Acantholimon</i> spp., <i>Ephedra</i> spp., <i>Fagonia</i> , <i>Echinops</i> , <i>Cousinia</i> , <i>Aristida plumosa</i> , <i>Cenchrus ciliaris</i> , <i>Aeluropus</i> , <i>Poa bulbosa</i> , <i>Carex stenophylla</i> , <i>Peganum harmala</i> , <i>Schismus arabicus</i> , <i>Pistacia khinjuk</i> , <i>Pistacia atlantica</i> , <i>Calligonum</i> , <i>Pterophyllum</i> sp., <i>Pycnocycla</i> .
Semi steppic zone	<i>Labiatae</i> , <i>Compositae</i> , <i>Umbelliferae</i> , <i>Papilionaceae</i> , <i>Caryophyllaceae</i> , <i>Cruciferae</i> , <i>Boraginaceae</i> , <i>Gramineae</i> , <i>Celtis</i> , <i>Pyrus</i> , <i>Crataegus</i> , <i>Amygdalus</i> , <i>Prunus</i> , <i>Lactuca orientalis</i> , <i>Cousinia</i> , <i>Acantholimon</i> , <i>Nepeta</i> , <i>Stachys</i> , <i>Salvia</i> , <i>Phlomis</i> , <i>Teucrium</i> , <i>Onobrychis</i> , <i>Astragalus</i> , <i>Trigonella</i> .
Xerophilous forest zone	<i>Quercus persica</i> , <i>Acer cinerascens</i> , <i>Pyrus syriaca</i> , <i>Pistacia atlantica</i> , <i>Fraxinus syriaca</i> , <i>Celtis</i> spp., <i>Crataegus</i> spp, <i>Salix</i> , <i>Eleagnus angustifolia</i> , <i>Platanus orientalis</i> , <i>Hordeum bulbosum</i> , <i>Poa bulbosa</i> , <i>Dactylis glomerata</i> , <i>Oryzopsis holciformis</i> , <i>Onobrychis</i> , <i>Medicago</i> , <i>Goebelia</i> .
Highest mountains	<i>Juniperus excelsa</i> , <i>Rosa</i> , <i>Lonicera</i> , <i>Daphne</i> , <i>Prunus</i> , <i>Amygdalus</i> , <i>Onobrychis cornuta</i> , <i>Astragalus</i> , <i>Acantholimon</i> , <i>Gramineae</i> , <i>Leguminosae</i> , <i>Labiatae</i> , <i>Bromus</i> , <i>Festuca</i> , <i>Poa</i> , <i>Alopecurus</i> spp, <i>Dactylis glomerata</i> , <i>Trifolium</i> , <i>Lotus corniculatus</i> , <i>Euphorbia</i> , <i>Erysimum</i> , <i>Primula auricula</i> .
Main salt lakes and "Kavirs"	<i>Tamarix</i> spp, <i>haloxylon</i> spp, <i>Salsola longifolia</i> , <i>Limonium carnosum</i> , <i>halocnemum strobilaceum</i> , <i>Seidlitzia</i> , <i>Salsola incanescens</i> , <i>Aellenia glauca</i> , <i>Aellenia subaphylla</i> , <i>Bienertia cycloptera</i> , <i>Aeluropus repens</i> , <i>Seidlitzia rosmarinus</i> , <i>Suaeda fruticosa</i> .
Main sand dune areas	<i>Calligonum commosum</i> , <i>haloxylon ammodendron</i> , <i>Aristida plumosa</i> , <i>Heliotropium kaserunense</i> , <i>halimodendron halodendron</i> .

Poa spp., *Agropyron* spp., *Festuca* spp.. The forage legumes are more or less the same as those of the medium forest belt, but *Astragalus* are more numerous. In the drier or eroded areas the “tragacanth” vegetation of the high Irano-Turanian mountains appears (*Onobrychis cornuta*, *Astragalus* spp.). In fact, this is a much more pastoral rather than forest belt, especially in its upper regions. The rangelands above 2 700 m are of the “substeppic-alpine” type and more related to the Irano-Turanian zone.

Baluchi flora:

The Baluchi flora is probably as different from the Caspian flora as the Sahara-Sudanian flora is from the Mid-European. Unfortunately, it is practically only known from the taxonomical point of view and has not yet been analysed in its phytogeographic aspect. It is therefore difficult at present to distinguish its vegetation belts; these should be well enough characterized by their topography and their distance from the ocean. Despite low precipitation, generally under 200 mm, the Baluchi flora is very rich and the vegetation much more dense than might be thought. A number of families and a great number of genera are present in Iran only in the Baluchi zone, which is the sole region where it is possible to grow bananas and various other tropical plants.

Many tree-like and bushy species are found in this area, almost all of which are part of the “saharasindian” flora, which extends from the Sahara through Arabia to the south of Pakistan. Certain species in humid locations are typically tropical such as some evergreen *Ficus*; even mangroves *Avicennia officinalis* and *Rhizophora mucronata* at various places on the coast. The most typical and commonest trees and bushes in this zone are Mimosaceae: *Acacia arabica*, *Acacia nubica*, *A. seyal*, *Prosopis spicigera*; also the following can be mentioned: *Ziziphus spina-christi*, *Calotropis procera*, *Tamarix articulata*, *Tamarix stricta*, *Nerium indicum*, *Ochradenus baccatus*, *Nannorrhops ritchieana*, *Salvadora persica*, *Euphorbia larica*, *Periploca aphylla*, *Calligonum* sp., *Grewia* spp., *Lycium* spp., *Otostegia* spp., *haloxylon* spp. It is probably the only region in Iran where the date (*Phoenix dactylifera*) is really native.

Certain families, such as *Asclepiadaceae*, *Verbenaceae*, *Acanthaceae*, *Mimosaceae*, *Cesalpiniaceae*, *Capparidaceae*, *Tiliaceae*, are much better represented than in the other parts of Iran. On the other hand, so many species of the Irano-Turanian zone, are infrequent or absent in the Baluchi zone. The same is true for certain families: *Umbelliferae*, *Rosaceae*, *Ranunculaceae*, *Labiatae*, etc. Annuals - e. g. *Stipa capensis* - are very abundant, especially in overgrazed areas, and their development occurs essentially in winter. There are also many small woody species which remain green for a great part of the year.

Perennial grasses are almost all species of warm regions, in particular the Paniceae and Andropogoneae, such as *Panicum antidotale*, *Panicum turgidum*, *Pennisetum dichotomum*, *Cenchrus ciliaris*, *Tricholaena teneriffae*, *Imperata cylindrica*, *Saccharum benghalense*, *Tetrapogon villosus*, *Eragrostis piercii*, *Cymbopogon laniger*, *Aristida pogonoptila*, etc. *Aristida plumosa* is not rare and *Aeluropus repens* is frequent on saline soils, but these two grasses are mainly common in the Irano-Turanian zone. On the other hand, *Bromus*, *Agropyron*, *Stipa*, *Poa*, *Festuca*, are absent from the Baluchi zone.

Perennial legumes are quite common and principally represented by mostly subtropical genera: *Taverniera*, *Indigofera*, *Tephrosia*. There are a few species of *Astragalus*: *Astragalus fasciculifolius*, *Astragalus squarrosus*, etc. Many of these legumes are woody or shrub-like. In some arid sites it is possible to find in one place as many as seven or eight species of perennial grasses and four or five perennial legumes – without mentioning numerous other perennial or annual plants. It is only in the Alborz mountains that it is possible to find a vegetation as rich in grasses.

In the northern regions and in the mountains of the Baluchi zone, the climate becomes drier and more continental, making a transition to the warmest parts of the Irano-Turanian zone. Typical Baluchi plants become rare or disappear; they are replaced by *Amygdalus scoparia*, *Zygophyllum eurypterum*, *Populus euphratica*, etc.. The perennial grasses are mostly *Aristida plumosa*, *Cymbopogon laniger*, but *Stipa* seem to be absent. The *Astragalus* become numerous and a species of *Artemisia* can be abundant, as well as other woody Compositae and many spiny Convolvulus.

Irano-Turanian flora:

The Irano-Turanian flora covers more than 85% of the country. It is very well characterized by the frequency and richness in species of numerous genera, in particular the genus *Astragalus* (at

least 600 species); the genera: *Cousinia* (more than 200 species), *Silene* (more than 100), *Allium* (approximately 90), *Euphorbia*, *Nepeta*, *Acantholimon* (roughly 80 species), *Onobrychis*, *Salvia*, *Centaurea* (approximately 70 species), etc. Among other genera less rich in species, but present in the greatest part of the Irano-Turanian zone, are: *Acanthophyllum*, *Artemisia*, *Stipa*, *Phlomis*, *Stachys*, *Achillea*, *Bromus*, *Poa*, *Agropyron*, *Hordeum*, *Scrophularia*, *Eremurus*, *Echinops*, *Ephedra*, *Trigonella*, *Convolvulus*, *Alyssum*, etc.

The arborescent vegetation includes a good number of *Amygdalus*, *Prunus*, *Crataegus*, *Rhamnus*, *Pyrus*, *Celtis*. The most important native trees are *Quercus persica*, *Pistacia atlantica*, *Juniperus excelsa*, various *Tamarix* and *Salix*, *Populus euphratica* and in the warmest regions *Ziziphus spina-christi*.

In almost all the Irano-Turanian zone the depletion of rangelands has favoured the extension of *Poa bulbosa* (and related species) and more recently *Carex stenophylla* (and related species). In occasionally-cultivated lands certain perennial weeds have extended considerably, such as: *Hulthemia persica*, *Alhagi camelorum*, *Prosopis stephaniana*, *Glycyrrhizia glandulifera*, *G. glabra*, *Goebelia alopecuroides*, *Eremurus* spp., *Phlomis persica*, *Euphorbia* spp., *Peganum harmala*, *Cynodon dactylon*, numerous *Compositae*, etc..

(a) **Subdesertic flora.** In the central “deserts” of Iran a scattered vegetation is generally possible but very large areas are completely bare due to human influence, the excessive concentration of salt in the moister lowlands, or the extension of moving sand dunes. From the phytogeographic point of view there is still little reliable documentation on these areas. In this subdesert zone it is mainly edaphic and topographic factors which determine the vegetation belts. Many of the plants are halophilous *Chenopodiaceae*: *halocnemum strobilaceum*, *Salicornia herbacea*, *Seidlitzia rosmarinus*, various *Salsola*, etc. Others *Chenopodiaceae* (*Haloxylon*, *Cornulaca*, *Suaeda*, etc.) can be abundant outside the saline areas, in particular on sandy soils and on very stony and rocky slopes. Perennial grasses are generally absent, except *Aristida plumosa* in some sandy or gravelly areas and *Aeluropus repens* on moderately saline soils, with perhaps a few *Stipa barbata* still existing on the mountains. The remainder of the vegetation includes *Astragalus*, *Echinops*, *Heliotropium*, *Fagonia*, *Zollikoferia*, *Stellera*, *Reaumuria*, etc., as well as a good number of spring annuals. *Peganum harmala* is frequent around villages and camp sites. This subdesertic flora can be distinguished from the steppic flora by the absence (or extreme rarity) of *Artemisia herba-alba*, *Poa bulbosa*, *Carex stenophylla*, *Noaea mucronata*, *Stipa* spp., etc.. In the warmer southeastern region the flora is notably richer than in the north.

(b) **Steppic flora.** In the very large area where precipitation varies between 100 and 230 mm, the vegetation types are very diverse, the determining factor being primarily winter temperatures, which depend on the altitude and even longitude (at equal latitudes and altitudes the eastern areas are noticeably warmer). The flora is generally richer in the southern and eastern regions due to a greater abundance of annuals.

Artemisia herba-alba still characterizes this flora well, but it has disappeared over wide areas as a result of uprooting, particularly in much cultivated regions such as Khuzistan. It grows at Tehran, Khorasan, Kerman and even as far south as Kuwait. It is often found with, or replaced by semi-ligneous, non-halophilous *Chenopodiaceae*: *Salsola* c.f. *rigida* in the north, *haloxylon salicornicum* in the south, *Anabasis* spp., *haloxylon* spp., *Salsola* spp., etc.. *Noaea mucronata* is present almost throughout. Among the somewhat woody species it is possible to cite: *Dendrostellera lessertii* (very common), *Ephedra* spp., numerous *Astragalus*, *Acanthophyllum*, *Acantholimon*, *Achillea* spp., etc. *Lactuca orientalis* or *Stachys inflata*, *Teucrium polium* and *Iris songarica* are often common in the less arid regions of the north and west.

Aristida plumosa is normally the dominant grass in this steppic zone, irrespective of winter temperatures, but it is never found on heavy or saline soils. In certain favoured localities (far from watering places) it is still possible to find almost pure populations of this good forage. The perennial *Stipa* (especially *Stipa barbata*), thought to be very abundant formerly, have too often disappeared from wide areas. In the south and east *Cymbopogon laniger* is not rare, nor is *Pennisetum orientale* on rocky slopes. In the warmer regions, it is still possible to find here and there *Cenchrus ciliaris* and *Hyparrhenia hirta*. In saline areas, whatever the climate, it is always possible to find *Aeluropus repens* or *Aeluropus*

littoralis, which often provide good pastures. Finally, on sands which are more or less moving, in addition to *Aristida plumosa* there is generally *Pennisetum dichotomum* (south and southeast), *Aristida pennata* (east) and *Cyperus conglomeratus*.

Perennial forage legumes are infrequent and only some species of herbaceous *Astragalus* (Cerciothrix group) are sometimes abundant. The *Onobrychis* are rather rare. On non-eroded and fairly compact soils *Poa bulbosa* (or related varieties) often covers very large areas, but it is greatly rivalled and often replaced by *Carex stenophylla*. In the steppic zone severe depletion of the rangelands tends to cause the disappearance of most perennials which are replaced by vast populations of *Peganum harmala*, or vegetation consisting essentially of the less palatable annuals, such as *Schismus arabicus* and especially *Stipa capensis*.

Areas formerly cultivated are generally infested with *Alhagi camelorum*, *Alhagi maurorum*, *Peganum harmala*, *Prosopis stephaniana*, *Hulthemia persica*, *Goebelia pachycarpa*, and numerous annuals.

(c) **Substeppic flora.** The substeppic flora is very rich in species but is probably the most difficult to define being botanically very varied and in a zone where human influences have been the strongest. As dry farming has been possible almost everywhere where the soils have not been eroded, the greatest part of the natural vegetation has been destroyed or deeply modified and replaced by weeds. Numerous species originating in the steppic zone have penetrated into this substeppic zone, frequently giving the impression that the rainfall is lower than it in fact is. The herbaceous flora is much richer than in the steppic zone. The following families are particularly well represented: *Compositae*, *Labiatae*, *Umbelliferae*, *Leguminosae*, *Caryophyllaceae*, *Cruciferae*, *Boraginaceae*, *Poaceae*. The *Artemisia* (especially *A. maritima* or related species) are often very abundant, and above 2,000 m there are sometimes populations of *Artemisia aucheri*. However, *Artemisia herba-alba* is clearly steppic and does not penetrate, except accidentally, into this zone. Spiny species: *Noaea mucronata*, *Lactuca orientalis*, *Astragalus*, *Cousinia*, *Acantholimon*, *Acanthophyllum*, *Echinops*, *Eryngium*, *Gundelia* are quite frequent.

The Chenopodiaceae are especially abundant on saline or alkaline soils and comprise many perennials belonging to the genera: *Salsola*, *Kochia*, *Atriplex*, *Camphorosma*, *halocnemum*, etc. The Labiatae are almost always abundant, particularly the genera: *Teucrium*, *Phlomis*, *Salvia*, *Stachys*, *Nepeta*, *Marrubium*, *Ajuga*, *Ziziphora*. Among the other families should be mentioned the genera: *Centaurea*, *Achillea*, *Euphorbia*, *Hypericum*, *Silene*, *Erodium*, *Onosma*, *Helichrysum*, *Alyssum*, etc.

The perennial grasses of the substeppic zone are most frequently *Stipa* (*S. barbata* and related species, *Stipa lagascae*, etc), and above 1 000 m (north) and 1 500 (southwest), *Bromus tomentellus*. On light soils there is sometimes *Aristida plumosa*, a steppic species. In the south *Cymbopogon laniger* and *Hyparrhenia hirta* reach this zone. The saline plains are often populated with *Aeluropus* and less frequently (higher altitudes) with *Puccinellia*. A particularly drought resistant variety of *Andropogon ischaemum* is quite frequent in Azerbaijan. On the stony slopes *Agropyron tauri* can be found; other *Agropyron* are frequent on the lands previously cultivated in dry-farming. *Melica* spp. are almost always found in the rocky areas. Also present are: *Bromus cappadocicus* (mostly north west), *Agropyron cristatum* (north), *Hordeum fragile*, *Pappophorum persicum* (in the south and east), *Pennisetum orientale* (scattered), *Koeleria gracilis* (quite rare). *Festuca valesiaca* (or other species of the *Festuca ovina* group) is more likely to be found in the zone mentioned below. These species have generally been eliminated over great areas, either by cultivation or by over-grazing. This has considerably favoured the extension of *Poa bulbosa* and of course, *Carex stenophylla*. On the plateaux and the mountains *Hordeum bulbosum* is often abundant in overgrazed range. *Secale montanum* is rare. Perennial forage legumes consist of: *Onobrychis*, *Astragalus*, *Trigonella* (more rarely), *Trifolium fragiferum* (moister and saline localities), and *Poterium* (Rosaceae).

(d) **Xerophilous forest flora.** Relatively dense forests, consisting essentially of oaks, certainly existed in ancient times, wherever the annual precipitation was above approximately 400 mm, but the majority of these forests have been destroyed and it is only in the Zagros range that significant remnants can be found. This zone could well be divided into various geographical provinces and into vegetation belts corresponding to altitudes. In the Zagros range the oak forest begins towards 800 m and sometimes

reaches as much as 2 600 m, which corresponds distinctly to three altitude belts of vegetation. Due to deforestation, overgrazing, the extension of farming, erosion and the profound modification of the microclimates a good part the subdesertic flora has heavily invaded this zone to such a point that in a good number of regions only some less xerophilous species, or even only the rainfall data, indicate a climate no more subdesertic.

The forests of Zagros consist mainly of: *Quercus persica*, *Quercus infectoria*, *Quercus libani*. Other trees or bushes are: *Pistacia atlantica*, *Pyrus syriaca*, *Celtis* spp., *Fraxinus syriaca*, *Prunus mahaleb*, *Amygdalus* spp., *Daphne angustifolia*, *Lonicera nummulariaefolia*, *Cotoneaster nummularia*, *Colutea persica*, *Berberis integerrima*, *Juglans regia*, *Juniperus excelsa* and tall spiny *Astragalus*.

The herbaceous flora is less rich at lower altitudes (south of the Zagros) where it consists essentially of annuals (abundance of *Aegilops*). *Hordeum bulbosum* and *Poa bulbosa* are the only really common perennial grasses. Here and there are some *Stipa* or *Agropyron*, with very few forage legumes. The general aspect of the flora tends towards the subdesertic.

Above approximately 1 500 m in the Zagros range and in the north of the country, perennials are very numerous and form the basis of the vegetation. Where the rangelands have not been destroyed the fundamental grass is *Bromus tomentellus*, often associated with *Festuca valesiaca* (or other varieties of *F. ovina* group) or with various *Stipa* (especially *S. barbata* varieties) and sometimes *Bromus cappadocicus*. Other perennial grasses of this area are: *Dactylis glomerata*, *Oryzopsis holciformis*, *Hordeum bulbosum*, *Hordeum fragile*, *Secale montanum*, *Melica* spp., *Hordeum violaceum*, *Poa* spp., and on very stony slopes *Agropyron tauri* (and related species), *Bromus persicus* and *Festuca sclerophylla* (the latter two only in the Alborz region). *Agropyron aucheri* (or related varieties) is very widespread in the areas most affected by human influence.

The best perennial forage legumes are *Onobrychis*, some *Astragalus* of the Cercidothrix group, *Trigonella elliptica* (rather rare) and *Medicago sativa* (uncommon as a native plant).

The *Labiatae* and *Compositae* often form the greatest part of the vegetation. Many species of these families are particular to this climatic zone, notably some *Thymus*. Too often overgrazing has resulted in considerable extension of unpalatable or spiny species: tall Umbelliferae, *Noae mucronata*, *Lactuca orientalis*, *Phlomis*, *Euphorbia*, *Eryngium*, *Cousinia*, *Astragalus*, *Acantholimon*, *Acanthophyllum*. The latter three are remarkable for their hemispherical or cushion-like thorny aspect ("tragacanth" vegetation) often making up a portion of the vegetation of the high semi-arid mountains. It is interesting to note that the flora and herbaceous vegetation are generally much richer in deforested regions than in the areas which still support an open forest cover.

(e) **High mountains flora.** Above 2 600 m the only tree capable of surviving is *Juniperus excelsa*; it can be found as high as approximately 3 200 m, but it seems incapable of forming woods above 3 000 m. Some bushes of *Amygdalus*, *Daphne*, *Lonicera*, and *Rosa* can ascend towards the 3 000 m mark. The upper limit of herbaceous vegetation is around 4 300 m. These altitude marks are valid for the Zagros and Alboz mountains, which are the only high mountains, but in the high mountains of the south and southeast the altitude limits should be much higher as a result of the warmer climate. The vegetation of these high regions where the growth period of plants is limited to some few months - not more than three towards the 3 500 m mark - consists essentially of perennials. It is characterized by an abundance of the spiny cushion-like "tragacanth" vegetation such as *Astragalus* spp., *Acantholimon* spp., *Onobrychis cornuta*, as well as some species with a strong woody base.

Perennial grasses comprise *Bromus* (especially *B. tomentellus*), *Agropyron*, *Poa*, *Festuca* (especially *F. ovina* group), *Stipa*, *Melica* spp. and *Sesleria phleoides*. *Oryzopsis molinioides* appears to be a truly characteristic species of the dry high mountains (Alborz, Lorestan, Fars, Kerman). The high mountains have very few forage legumes: some *Trifolium* and *Lotus corniculatus* which are restricted to relatively humid places. Among the other families should be mentioned the genera: *Thymus*, *Pyrethrum*, *Nepeta*, *Helichrysum*, *Erysimum*, *Euphorbia*, *Scutellaria*, *Silene*, *Dianthus*, *Alyssum*, *Phlomis*, *Achillea*, *Scrophularia*, *Ephedra*, *Ziziphora*, *Eryngium*, *Cousinia*, etc.

4. RUMINANT LIVESTOCK PRODUCTION SYSTEMS

There are two main groups in this sector, namely: Industrial and Extensive livestock rearing; Figure 9 shows their relative contribution to meat and milk production. Livestock numbers as of 2001 are given in Table 7. Farahpour and Marshall (2001) indicate that according to the latest reported census Iran has 133 million AU, which is close to the number mentioned in Table 7. According to FAOSTAT (2006) livestock numbers for Iran for 2005 were: buffalo 550 000; camels 146 000; cattle 8 800 000; goats 26 500 000; horses 140 000 and sheep 54 000 000.

Table 7. Livestock population (as at 2001)

Livestock	Thousand head	Coefficient to AU	Population (1 000 AU)
Sheep	54 000	1.0	54 000
Goat	25 757	0.75	19 318
Native Cattle	55 000	4.0	22 000
Hybrid Cattle	1 806	6.5	11 739
Pure Cattle	74.5	9.5	7 044
Camel	143	5.5	786.5
Buffalo	475	6.5	3 087.5
Draught	1 727	3.5	6 044.5
Total	-	-	124 000

Industrial animal husbandry

The only livestock raised in this system are cattle with a population of 741 500 head which by calculating its animal unit equivalent (9.5), would be 7 044 000 AU. The livestock of this system are not dependant on rangelands (and therefore cause no damage to the rangelands) as they are kept in industrial units and modern barns scattered across the country. The livestock raised in this system do not leave the barns yearlong and are totally fed on cultivated fodder and supplements and imported feed. The cattle are usually kept in the vicinity of cities where the veterinary, sanitation and marketing services can be easily accessed; the outputs are both dairy and meat products.

Extensive animal husbandry

Extensive livestock production systems in Iran are as follows (Farahpour, 2001):

Nomadic systems: Nomadism is defined as: a type of pastoralism in which livestock owners follow the irregularities of the weather, in search of drinking water and pastures for their herds and flocks (FAO, 1992). The vegetation density of semi-arid and arid rangelands is low, and the temporal and spatial variation in forage supply and quality is enormous. These large fluctuations, combined with periodic lack of drinking water and very high temperatures, force herdsmen to move with their herds continuously. Nomads generally, do not own any specific area, they live at subsistence level and their products are mostly absorbed by the family, so that their contribution to the supply of meat or other animal products is small. This type of animal husbandry is rare in Iran.

Transhumant systems. Transhumance is defined as: “a type of pastoralism in which pastoralists regularly graze their herds in two or more geographically separated grazing orbits within a year” (FAO 1992). This animal husbandry system takes advantage of the temporal and spatial variability associated with typically altering rainy and dry seasons. In Iran, annual migrations take place from mountainous cold rangelands towards the warmer plains at the beginning of autumn, with the reverse movement in spring, when temperature increases. In the Iranian system of transhumant animal husbandry, two range sites are allocated to a family, one in the cold and the other in the warmer region, the route between the

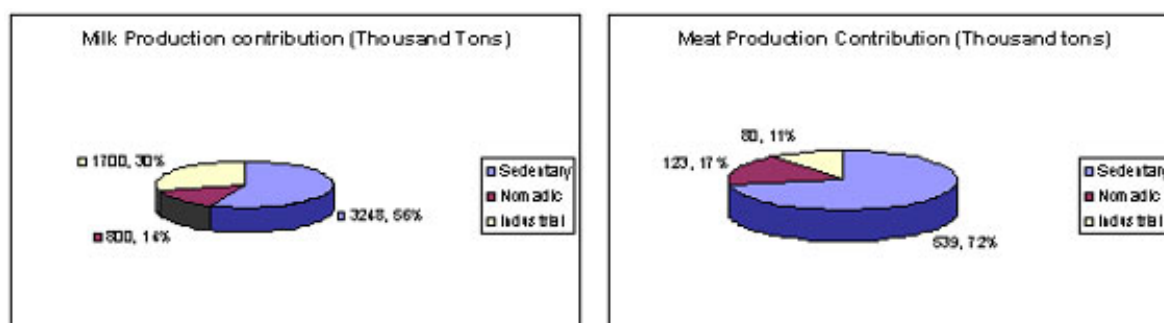


Figure 9. Production of milk and meat by the different systems

sites is fixed, and the right of grazing of available forage along this route is recognized by local farmers and tribes. Transhumant animal husbandry is practiced in Iran predominantly in the Zagros Mountains. Pastoral households of several tribes, e.g. “*Chahar Lang e Bakhtiyari*” or “*Haft Lang e Bakhtiyari*” move between the cold regions of the East and Northeast of the mountains and the warmer region in the South and Southwest. Most commonly, households move with their herd, but settled families might hire a herdsman or entrust their animals to other members of the tribe. For security reasons, members of a tribe used to move together, however, with the improvement in infrastructure and means of transport, single family migration is developing. Research in the Zagros region has shown that 84% of households migrate in family groups consisting of 45 members at maximum. The government owns the land, the pastoralists however, are granted the usufructuary grazing rights on both sides of the mountains. To avoid conflicts, a grazing usufruct (or grazing permit) is usually issued for the same land that was used by the family’s ancestors. In this system of animal husbandry, the total stock comprises on average 48% sheep, 47% goats, 3% cattle and 2% draught animals, such as donkeys and horses .

Sedentary systems

Sedentary animal husbandry, a common system in Iran, is mostly practised by farmers in a system of mixed farming, with animals in support of crop production. Herds are taken out from the village to adjacent communal ranges in the summer grazing season. Crop residues, weeds, wheat and barley stubble are other sources of animal feed. A herd usually comprises goats and sheep, while the system as a whole consists of sheep, goats, cattle, donkeys and horses. Cattle, when present, are rather kept on the farms or graze on the plains adjacent to the village, as they cannot move very far from the village, due to the topography of the rangelands. Meat is the main output of the system and milk, directly or in processed forms, is mainly consumed by the households. Herds graze on range in one of the following forms:

Small numbers of animals of various households are combined to form a herd kept by a herdsman. Each household contributes to the salary of the herdsman in proportion to the number of animals. There is no individual grazing right for the households. For bigger herds that should graze individually, the size of the herd is used as criterion for identification of the grazing right period of a household.

Based on the census, the livestock breeder households in rural and mobile pastoralists number some 1 653 260 while 916 000 households are dependent on rangelands. The number of households in mobile pastoralism is some 180 000 and 1 473 260 households are rural livestock breeders which some 736 000 households are semi mobile while they have homes in the village and live there for a while and sometime they move to rangelands far from their village to graze their livestock; the rest are the households which are sedentary and live in the village yearlong number some 737 260 households. It should be noted that some 78.41% of the pastoralists equal to 718 236 households possess less than 50 AU. Distribution of herd sizes is shown in Figure 10.

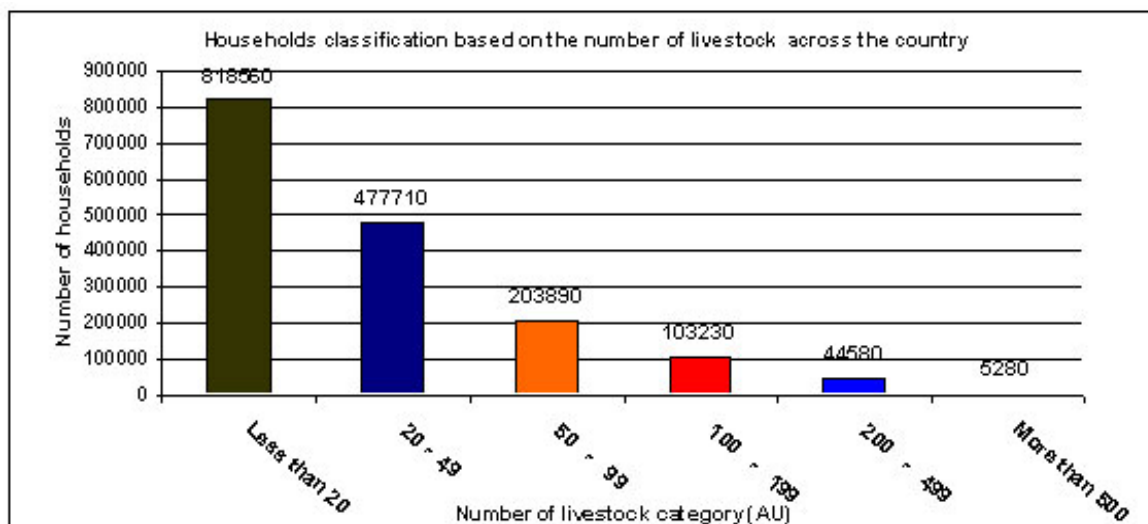


Figure 10. Flock size and number of households

Table 8. Dependent livestock population on rangeland during seven months

Livestock	Dependant on range (1000 AU)	Dependency on range yearlong (%)	Feed requirements during dependency on range (1000 tonnes TDN)	Dependent population on rangeland during seven months based on feed requirements (1000 AU)
Rural sheep	41 000	54	6 121.71	38 360
Mobile sheep	13 000	70	2 516.15	15 760
Rural goat	12 877.5	65	2 314.41	14 500
Mobile goat	6 440	80	1 424.53	8 930
Rural native cattle	12 588	10	348.06	2 180
Rural and mobile pastoral camel	786.5	90	195.72	1 230
Rural and mobile pastoral equines	6 044.5	20	334.26	2 090
Total	92 736.5	-	13 254.84	83 050

Taking into account the economic size of the rangelands (536 ha of rangeland and 230 AU), suggests that just 180,000 livestock breeder household requirements can be met by rangelands during seven months. Based on the published information by the Technical Bureau of Rangelands – FRWO, currently each household has 81 ha of rangeland and 80 AU. The same reference indicates that (Table 8) currently more than 5.7 times more than the carrying capacity is living on rangelands.

Only lawful livestock holders who have been issued a grazing permit are allowed to graze the range. They have been granted a grazing permit which should be extended each year after paying the grazing fee, which now is 400 Rials (1 US\$ is 8 700 rials). Unfortunately, due to the lack of adequate supervision, most of the grazing permits are not extended and many livestock are on the range without grazing permits. As mentioned in this section, the main problem in livestock raising is the excessive number of households and their livestock.

Needless to say that, due to the large number of livestock, there is no ungrazed land with even the forests being grazed by livestock; the government has therefore adopted policies to end the grazing of forests and expel the rural people settled in the forests after compensation of their rights. Livestock graze wherever they can reach, so mention of limitations is far from the situation faced in the field. Since the rangelands are common, conflict resolution is part of the work of natural resource management specialists, often rather than focussing on technical issues.

Most range users are illiterate or poorly educated, so resource management specialists have many problems in convincing them to take measures first to stop the rangeland degradation by grazing management and then to develop their rangelands. Due to previous experience of other policies implemented by government, users do not necessarily accept recent policies; i.e. policies providing services and facilities such as insurance and facilities are not accepted as they should be.

A previous policy that raised problems for grassland management was the nationalisation of natural resources in 1963. Prior to that act rangelands belonged to the lords and they leased their asset to the herders who could exploit the rangeland carefully in order not to damage it. The livestock owner knew that if he exploited carelessly, he would be punished and even he could not lease any range next year.

After this act come into force, the government was to play the role of the lord and the government started to identify the lawful livestock breeders to issue grazing permits for a certain time and definite place. The whole idea of identifying the lawful livestock holders was good but it had some deficiencies i.e. the grazing permits were not transferable, so nobody left the range since if he left there then he would lose his right for ever. Recently, the Technical Bureau of Rangeland has made some corrections on policy so that everyone who wants to leave the range and livestock can transfer his right to others who are usually from the same or adjacent rangeland; thus they will move towards an economic size of herd.

Poor marketing is a problem that the stock raisers especially, mobile pastoralists, face; because they often go to the cities on their seasonal movement just to procure their needs and they have problems in trading their products while they are on the outskirts. So in other times people come to them to buy their products but at low prices. The education system is good in the villages but the situation is very bad for mobile pastoralists while they are moving around; of course there are some boarding schools for their children and some mobile schools but these have their own problems.

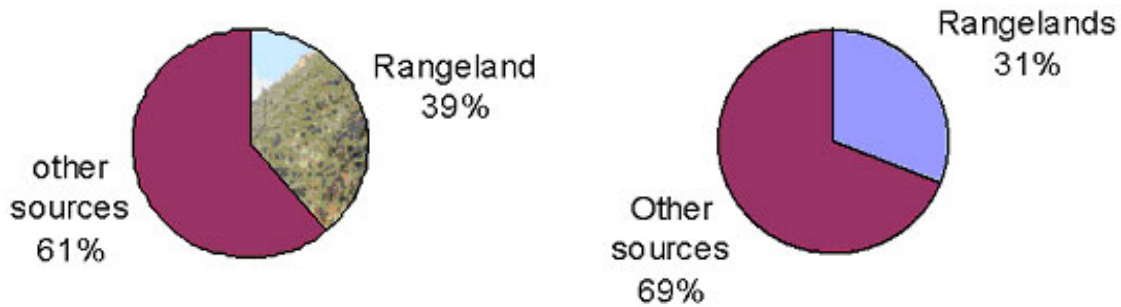


Figure 11. Contribution of rangelands to feed supply (left) and meat production (right)

The extension service is good for the villages but is not so good for mobile pastoralists when they are far from settlements, although extension service workers try to provide services.

Contribution of range to forage supply and meat production is shown in Figure 11.

Range forage is less nutritious and animals on range thus use more energy than stall-fed livestock or those in industrial systems.

The relative contribution of range to livestock feeding is shown in Figure 11 and the area of range by province is given in Table 9.

Table 9. Area of rangelands by province

Province	Range (ha)	Province	Range (ha)
Khorasan	12 800 000	Eastern Azerbaijan	2 274 370
Kerman	8 864 967	Ardabil	1 234 158
Sistan va Baluchistan	11 800 000	Western Azerbaijan	2 516 584
Semnan	5 500 000	Zanjan	1 076 210
Isfahan	6 564 353	Tehran	925 000
Yazd	3 878 000	Hamadan	1 351 483
Qom	870 000	Central	1 980 000
Fars	8 500 000	Ghazvin	950 000
Kohkiloye and Boirahmad	724 300	Golestan	1 331 675
Chaharmahal and Bakhtiari	1 093 000	Mazandaran	908 602
Hormozgan	3 800 000	Gilan	467 167
Boushehr	1 600 000	Kermanshah	736 435
Khozestan	3 874 260	Lorestan	1 261 151
Kordistan	1 934 406	Ilam	1 201 879
Total country			90 000 000

5. THE PASTURE RESOURCE

Definition of Rangelands: Rangeland has been defined as “a tract of land that is used for grazing by livestock or wildlife, where natural vegetation is the main forage resource” (FAO, 1992). Rangeland as defined in Iran is “land consisting of mountains, hillsides and flat plains covered by native vegetation and providing food for animals at least on one grazing season and commonly known as rangelands”. Fallows are not included in this definition.

Rangeland types and vegetation have been described in detail in Section 3 and also here in section 5.

Range area and condition

Estimates of the total rangeland area are not consistent, e.g. there is a very wide gap between the 10 million ha of Bavari (1980) and the 106 million ha of Sheidaei & Nemati (1978). This difference, by an order of magnitude, is most likely due to inconsistent and vague definition of the term rangeland. Probably, the first reliable estimate of the area of rangelands (100 million ha) is the work of Niknam (cited by Sheidaei & Nemati, 1970), in which a map of Iran’s rangelands was prepared on the basis of the definition given in the forest and rangeland exploitation law.

For the first time in 1974, satellite images were used by an American company, FMC, leading to an estimate of Iran’s rangelands of 90 million ha (Fazilati & Hosseini Eraghi, 1984). Aside from fallows, rangelands include lands located on mountains, hillsides or plains covered by natural vegetation during the grazing season and traditionally recognized as range (Technical Bureau of Rangeland, 2000). According to this definition, Iran’s rangelands cover 90 million ha, which have been classified as being in poor, fair and good condition (Tables 10 and 11). More recently, Farahpour and Marshall (2001) suggested that only 10.3% (9.3 million ha) of rangelands could be classified as in good condition, 41.4% (37.3 million ha) in fair condition and 48.3% (43.4 million ha) in poor condition.

Table 10. Qualitatively classified rangelands

Condition	Area (million ha)	Mean DM (kg/ha)	Usable DM (million tonnes)
Good	19	450	8.55
Fair	25	150	3.75
Very Poor – Poor	56	30	1.68
Total	100		13.98

DM: Dry Matter

(Niknam, cited by Sheidaei & Nemat, 1970)

Table 11. Rangeland major vegetation types and their attributes

Type	Area (million ha)	Mean DM (kg/ha)	Usable DM (million tonnes)
Fair - Good	14	290	4
Poor - Fair	60	92	5.5
Very poor - Poor	16	26	0.5
Total	90		10

(Source: Taeb, 1995)

According to its vegetation types, it is put into three classes: grasslands; shrub lands; and desert, which embraces both, but is low density.

Despite the forage produced by rangelands, many farms grow fodders. In 1999, the amount of sown fodder was 4 155 thousand tonnes of TDN. Plants such as lucerne (both rainfed and irrigated), maize for grazing, clover and sainfoin and others. Table 12 shows the total amount of sown fodder produced. Other sources of feed are: crop residues, concentrates and agro-industrial by-products shown in Tables 13 and 14 and Figure 12.

The total amount of produced fodder in Iran from different sources was 23 756 thousand tonnes of TDN and their contribution is shown in Table 13 and Figure 12.

Table 14 shows the area under the cultivation of fodder in different provinces and production levels.

Table 15 shows the production of various by-products and crop residues from farms and orchards and Table 16 the production of concentrates, residues and wastes and by-products from food industries.

Total amount of fodder produced through other sources except rangelands was 17,871 thousand tonnes of TDN. The contribution of different sources of fodder production apart from rangelands is shown in Tables 15, 16 and 17.

Pastoral output

Unfortunately, the condition of the rangelands has deteriorated drastically. The results of a recent census show that the area of good range has come down to 9.3 million ha, fair to good 37.3 while

Table 12. Total production of sown forage

Fodder	Production	Equivalent TDN
	Thousand tonnes	
Lucerne	4 029	2 619
Other forages	5 119	1 536
Total	9 148	4 155

Source: Bureau of fodder plants – Ministry of Jihad e Agriculture

Table 13. Contribution of different sources of fodder production in Iran, in 1999

Source of fodder	Production (1 000 tonnes TDN)	Contribution %
Fodder plants	4 155	17.5
Crop residues	7 322	30.8
Agro-industrial by-products	6 394	26.9
Range forage	5 885	24.8
Total		100

Table 14 Area and yield of fodder by province

Province	Yield (tonnes)	%	Rank	Cultivated area (ha)	%	Rank
Eastern Azerbaijan	547 930	6.38	7	103 968	13.17	1
Western Azerbaijan	443 259	5.16	9	93 467	11.84	2
Ardabil	130 267	1.52	18	39 651	5.02	9
Isfahan	634 497	7.39	4	40 513	5.13	8
Ilam	2 026	0.02	26	834	0.11	25
Bousheshr	2 076	0.02	27	233	0.03	28
Tehran	845 071	9.84	2	26 311	3.33	13
Chahrmahal va Bakhtiari	146 994	1.71	17	24 606	3.12	15
Khorasan	682 165	7.94	3	59 002	7.47	3
Khuzistan	228 401	2.66	14	11 270	1.43	18
Zanjan	249 227	2.9	12	48 692	6.11	4
Semnan	51 199	0.6	22	4 470	0.57	22
Sistan va Baluchistan	615 663	7.17	5	2 3604	2.99	17
Fars	604 058	7.03	6	23 956	3.03	16
Qazvin	399 318	4.65	11	28 017	3.55	12
Qom	96 957	1.13	20	8 554	1.08	20
Kurdestan	203 662	2.37	15	38 874	4.92	10
Kerman	495 890	5.77	8	40 937	5.19	7
Kohkiloye va Buyer Ahmad	24 975	0.29	23	3 798	0.48	23
Golestan	60 890	0.71	21	2 687	0.34	24
Gilan	1 120	0.01	28	311	0.04	27
Lorestan	115 475	1.34	19	33 100	4.19	11
Mazandaran	1 150 331	13.39	1	44 736	5.67	6
Markazi	236891	2.76	13	25 587	3.24	14
Hormozgan	2292	0.03	25	391	0.05	26
Hamedan	439 942	5.12	10	45 745	5.80	5
Yazd	15 8671	1.85	16	9 259	1.17	19
Total	8 590 263			789 347		

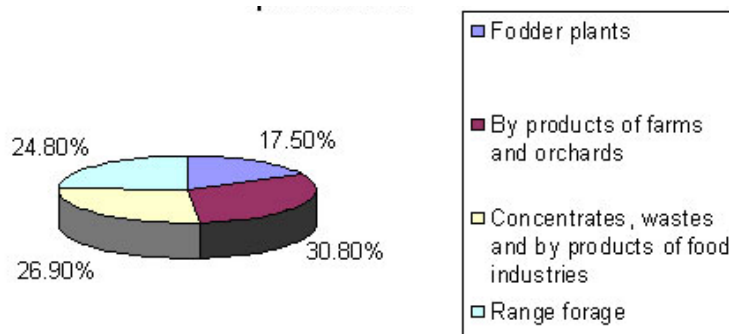


Figure 12. Contribution of different sources of fodder production in Iran, in 1999

poor ranges have increased up to 43.4 million ha (Technical Bureau of Rangeland, 2000). In Iran, as in other parts of the world, animal husbandry is the most productive use of the semi-arid zones bordering the desert. It is calculated that 31% of the meat production of Iran, 218 000 tonnes per year, is associated with range. Annual dry matter production of rangeland is estimated at more than 10 million tonnes (Fazilati and Eraghi, 1984). In addition to forage production, mining, fuel wood, industrial use of rangeland products e.g. medicinal plants and recreation are other benefits of the rangelands in Iran (Kardavani, 1995).

Harvesting medicinal plants dates back to past centuries. According to current information the amount harvested was some 39 000 tonnes (valued at 77.7 million US\$) in 1989–1993. Considering the land area of the country, harvested products should be much more. *Ferula gummosa*, a plant widespread over 700 000 ha, has a juice called galbanum which is used in different industries e.g. medicine. In 1996 and 1998, 15 and 27 tonnes of galbanum were exported, respectively. The income through the export of galbanum in 1998 alone was some 180 000 US \$. There are lots of range plants with medicinal and industrial value. Nowadays, some companies cultivate such plants.

Range and livestock contribute an estimated 1.25 billion US\$ to the non-oil GDP (or 6% of the total GDP) and the sector provides livelihood for some three million families of whom it is estimated that 180 000 are nomadic. Based on the available data, the number of people working in the range sector are: Permanent occupation: 452 173; Temporary occupation: 2 122; Dependant occupation: 2 500.

Unfortunately, since most rural people are remarkably dependant on rangeland which is a resource that provides for the essential needs of families, degradation of the range is inevitable. Based on

Table 15. By-product and crop residue production from farms and orchards, in 1999

Source of fodder	Production (1 000 tonnes TDN)	Coefficient conversion to TDN	Production (1 000 tonnes TDN)
Wheat Straw	6 500	0.4	2 600
Barley Straw	1 500	0.4	600
Rice Straw	1 174	0.4	470
Bean haulms	523	0.5	261
Oil seeds straw	300	0.47	141
Stubble grazing - irrigated	4 000	0.45	1 800
Stubble grazing rain fed	500	0.4	200
Fallow lands grazing	1 000	0.4	400
Fodder of orchards	1 600	0.5	800
Green fodder	100	0.5	50
Total	17 197	-	7 322

Table 16. Production of concentrates, waste and by products of food industries in 1999

Source	Production (1 000 tonnes)	Conversion to TDN	Production (1 000 tonnes TDN)
Barley	1 999	0.76	1 519
Maize for silage	1 155	0.8	924
Wheat bran and waste	1 686	0.65	1 096
Rice bran and waste	493	0.65	320
Bread waste	1 150	0.8	920
Sugar scum and molasses	832	0.62	515
Oil cakes	300	0.7	210
Molasses	80	0.55	44
Peat	840	0.4	336
Waste of fruits	1 400	0.3	420
Industrial by-products	140	0.64	90
Total	10 075	-	6 394

Table 17. Contribution of different sources of fodder production except rangelands

Sources of fodder except rangelands	Production (1 000 tonnes)	Contribution of each source
Forages	4 155	23.2
Crop residues	7 322	41
Agro-industrial by-products	6 394	35.8
Total	17 871	100

information published by the Technical Bureau of Rangeland within the Forest, Rangeland, Watershed Management Organization, approximately 5.4 million m³ of range shrubs are cut-off or uprooted annually just to provide fuel for rural people.

Some of the major factors contributing to the degradation of rangelands are summarized as follows:

- overgrazing;
- untimely grazing (early or late grazing);
- inefficient management of range and livestock in transhumance;
- competitive utilization of range among transhumant groups;
- collecting fuel;
- ploughing rangelands and expansion of the area of low yield rainfed farms on slopes;
- overpopulation.

At present social evolution among the transhumants due to the lack of efficient management and collapse of tribal leadership lead to degradation of natural resources. Collapse of traditional management and inefficiency of current management of state systems over the rangelands lead to overgrazing and improper exploitation.

Fodder crops

Some 7.69% of the land under annual crops was allocated to the production of fodder in 2000 out of which about 86.1% was irrigated and the balance (13.9%) was rainfed; 70.47% of the land area under the fodder production was under the production of lucerne. The other fodder crops are: sainfoin, maize, beet, turnip, sorghum, etc. In 2000, the total amount of fodder crops was 8.59 million tonnes – 19.21% of the total annual crops of the country. Fodder areas by province are given in Table 18.

There is a project conducted by both the Department of Agronomy – Ministry of Jihad e Agriculture and Technical Bureau of Rangelands (FRWO) under which the farmers are given, free of charge, some perennial range fodder seeds and chemical fertilizers to cultivate their low yielding farmlands, which are usually located on hillsides. By this means, first of all the degradation of the land is stopped and second some forage is produced for the livestock. The seeds are *Medicago sativa* and *Onobrychis viciifolia*. From its start in 1986, by 2001 some 1.4 million ha of range and farmland had thus been cultivated. These lands would produce 1 500 kg of fodder for harvest and 300 kg/ha for grazing.

Haymaking

There are some traditional methods of haymaking and stocking in the rural areas as shown below:

- Accumulation: In this method, the livestock breeder harvests the fodder of the farms or rangelands and then takes them to his/her house and keeps them on the roof. In some areas the fodder is kept on the ground but

Table 18. Fodder areas by province

Province	Lucerne		Other fodders	
	Area (irrigated & rainfed) ha.	Yield (tonnes)	Area (irrigated & rainfed) ha.	Yield (tonnes)
Eastern Azerbaijan	95 894	515 390	8 074	32 540
Western Azerbaijan	88 823	427 860	4 644	15 399
Ardabil	25 808	88 081	13 843	42 186
Isfahan	21 113	173 547	19 390	460 947
Ilam	385	1 781	449	245
Boushehr	227	2 038	6	37
Tehran	10 799	96 033	15 512	749 038
Chahrmahal va Bakhtiyari	13 949	103 484	10 657	43 510
Khorasan	39 975	251 846	19 027	430 319
Khuzistan	2 333	22 619	8 937	205 782
Zanjan	47 299	234 487	1 393	14 741
Semnan	3 357	22 071	1 113	29 128
Sistan va Baluchistan	16 976	245 706	6 628	369 957
Fars	11 812	93 985	12 144	510 072
Qazvin	21 780	205 382	6 237	193 936
Qom	8 437	92 683	117	4 274
Kurdestan	27 335	159 378	11 539	44 284
Kerman	34 098	341 343	6 839	154 548
Kermanshah	3 113	11 803	3 661	9 217
Kohkiloye va Buyer Ahmad	2 265	19 687	1 533	5 287
Golestan	49	223	2 638	60 668
Gilan	261	767	50	352
Lorestan	13 225	73 012	19 875	42 463
Mazandaran	3 340	17 904	41 396	1 132 426
Markazi	18 907	152 305	6 680	84 586
Hormozgan	358	874	33	1 418
Hamedan	37 171	424 933	8 574	15 009
Yazd	7 131	79 904	2 128	78 767
Total	556 229	3 859 126	233 116	4 731 137

it is usually kept on the roof of the houses. This method is usually applied in the mountainous areas;

- Stocking: In this method, the livestock holder stocks the grains such as barley. Some time ago, the grains were kept in big clay pots or in barns and stocks but now the grains are put in bags and stored in the stocks, silage or barns.

The amount of the stored grains depends on the season, herd size and economic condition of the herder. This method is usually done in the arid areas.

- Straw barn: In this method, the collected straw is kept in a certain room. In some areas where fodder cultivation is common, herders harvest the fodder crops including *Medicago*, *Onobrychis* and *Trifolium* and keep them in a store for the winter. This method is specially applied in the plains and lowlands.
- Storing fodder in the trunk of trees. In some rural areas of Zagros Mountains especially in Kurdistan province, oat hay is stored on the trunk and branches of trees to be consumed during the cold season.

There are also some 452 active silage stocks across the country almost all of which belong to the government.

6. OPPORTUNITIES FOR IMPROVEMENT OF FODDER RESOURCES

Effect of nationalization of natural resources

Prior to the enforcement of the law on nationalization (1963) of natural resources, the people had cadastral documents. The rangelands were their own asset and they behaved well with their asset in its utilization and conservation. Landlords even used to lease rangeland to the livestock holders for a given period and a certain number of livestock. The lord knew quite well that if his rangeland would be degraded then he would gain less money next year. So he would never let anyone degrade his rangeland and used to check the rangeland periodically. But the aforementioned law cut their authority over this valuable resource and the competition to exploit rangelands started while there were no strict control over the range utilization.

After the enforcement of the nationalization law, all natural resources including rangelands were state owned. Government decided to take measures to recognize the lawful and authorized users to issue a grazing permit in order to enable the experts and staff to control rangelands. Some four years later (1967), the government decided to start introducing range management plans like the ones implemented in the west. Range management plans included some instructions to push the exploiters toward conserving the range resources while taking the maximum benefit possible without any damage to the range. This plan or instruction is the basis on which the Forest, Range and Watershed Management Organization (FRWO) of Iran and the specified household would make a contract. This contract is valid for 30 years and if the instruction is followed properly, it will be extended for another term. None of the early plans were implemented even though they were scientifically well developed. They were a failure because they had never considered socio-economic matters. The other reason for their failure was their large area (e.g. 70 000 ha).

Pastoral planning

Then the Technical Bureau of Rangeland which is in charge of the conservation, rehabilitation and development of rangelands of the country, decided to work a little bit more on socio-economic matters and they planned the range management plans for small areas limited to the traditional boundaries of rangelands. The implemented plans have shown a great success in the sustainable management of rangelands along with the improvement and development.

Advantages of the contracts

- Legalizing the grazing right of the land utilization which is a sort of land ownership;

- Encouraging participation of the households in range improvement programs;
- Increasing investment in land;
- Encouraging range and livestock balance;
- Facilitating bank loan;
- Facilitating insurance of the households.

Rangelands are being utilized by 916 000 households. Grazing permits have been issued for 689 000 households for nearly 55 million Animal Units (AU) to be grazed on 56 million ha of rangelands. On the basis of analysis of recent data, the area of a grazing enterprise is 81 ha and mean herd size of households is 80 AU. This is at odd with households requirement as it is revealed by the Faculty of Natural Resources of Tehran University. It has been concluded that running a normal life on the basis of extensive grazing animal husbandry needs 530 ha of land to be grazed by 229 AU for a period of 8 months. According to this calculation grazing usufruct could be granted to 18 000 households. This means that over-population is still one of the most important problems of the rangelands.

Current situation of the rangelands

Current census of the range production shows that proper usable forage of the rangelands touches 10.7 million tonnes DM equal to 5.9 million tonnes of TDN. having conversion coefficients of 55%, 43% and 36% for conservation of range forage to TDN it is calculated that 38.5, 30 and 25 millions of animal units could be supported by the rangelands respectively for a grazing period of 8 months.

On the basis of grazing season, rangelands could be put into two categories: mountainous, uplands characterized by their cool summers; and plains, lowlands characterized by their warm winters. The area of summer grazing rangelands is estimated to be 23 million ha producing 6.21 million tonnes equal to 3.415 million tonnes of usable TDN. Grazing on these rangelands starts from early spring and continues until late summer. It is calculated that 54 million animal units could be grazed on these rangelands for a period of 100 days. Winter and fall grazing rangelands located on lowlands are 67 million ha and are mostly used in winter. They produce 4.5 million tonnes of forage or 2.47 million tonnes of usable TDN.

The production figures cited here are just for the normal years from the rainfall point of view and occurrence of drought is a normal feature with 13 drought years during the past two decades. Iran along with some of her neighbours suffered a very prolonged drought. Drought has many negative effects on the environment and the rangeland is no exception. Based on a report by the UN, the total losses of crop and livestock due to drought in year 2001 in the agriculture and livestock sector is estimated at 2.6 billion US\$. It was estimated that 75 million heads of livestock were being affected and 900 million US\$ of damage was being inflicted. The striking drought of 1999–2000 caused a 41% reduction in the total forage of the rangelands, equal to 4.4 million tonnes.

The basic project which is conducted at the Technical Bureau of Rangeland and the district offices is the “Range Inventory and cadastral survey” through which the lawful range exploiters can be identified. As mentioned earlier, prior to the nationalization of the natural resources including rangelands, there were some lords everywhere across the country who possessed the rangelands and they let the livestock breeders to graze on their rangelands and pay some money based on the quality and grazing duration of the certain rangeland but after Natural Resources Nationalization was put into force in 1963, government tried to play the landlords’ role in this regard. At that time, the lord was a real manager and the rangeland was his asset so he tried his best in order not to lose. One of his main measures was to inventory his rangelands based on his indigenous know how. So he would be aware of the grazing capacity of rangeland and lease the rangeland accordingly to someone who was able to exploit its forage and restore the rangeland condition.

Table 19. Range improvement projects of FRWO (by 2001)

Activities	Extent
Hand planting	1 495 000 ha
Seed production	10 300 tonnes
Re-conversion of abandoned rainfed farms to pastures	1 119 000 ha
Development of range management plans	16 420 000 ha
Range Inventory and land tenure assessment	56 400 000 ha
Shrub transplanting	380 000 ha
Fertilizing	1,037 000
Water conservation project	1 824 000 ha
Construction of water troughs	19 753
Wind pumps	236 sets
Wells	4 260
Exclosures	6 128 000 ha

The lord usually assessed the condition of his rangelands yearlong so he could prevent the degradation of his rangeland in time and if he noticed any degradation then the livestock holder would have been punished and perhaps lose the chance to extend the lease for another year.

Now that the former system of range management, by lords, has been fragmented and government bodies have substituted, the new system is to develop strategies to manage rangelands. Through “Range inventory and cadastral survey” the lawful livestock breeders would be identified on certain area of rangelands. While implementing this project, the carrying capacity of rangeland would also be assessed then a grazing permit would be granted to the lawful livestock breeder to graze for a certain period on a definite rangeland. This is the first step to manage the rangelands.

Vast area of rangeland scattered across the country, coupled with lack of technical expertise at the natural resources management directorates lead to inappropriate supervision over the rangelands. Thus the exploiters feel free to overgraze rangelands because of poor supervision condition compared with the former system.

Of course, since the grazing permit holder had no right over the rangeland except the utilization, so he didn't invest to improve the rangeland. These issues push the government to think of ways to convince the people first not to deplete rangelands by overgrazing and second to invest in the improvement and development of the rangelands.

Development of “Range Management Plans” was the next step to manage rangelands and at first they developed some plans in areas of some 60 000 ha. For the development of these plans, they had just followed the technical points without taking into consideration the socio-economic aspects, so these plans failed. Finally they decided to develop small plans considering both technical and socio-economic aspects. These plans were developed for each traditional boundary of rangelands and their ownership was transferred to the people to convince them to restore it and invest in it for a 30 year period; of course the period is extendable.

Range improvement projects of FRWO included a number of activities (see Table 19).

Direct seeding and hoeing-sowing of quality range plants

The plant density of the palatable and valuable range species has decreased, consequently the range condition has declined. Therefore sowing the seeds of adaptable range species will be an integral part of many range programmes.

On the flat plains and areas with very gentle slopes direct seeding with tillage is an appropriate method. On steeper slopes and mountainous land, minimal disturbance of the soil surface is important, hence seeds are drilled or hoeing and sowing is used.

Water harvesting

Degraded rangelands with low vegetation cover have high surface runoff which leads to floods causing loss of human life, plantations, livestock and crops. This runoff could have been well utilized for the development of plantations and forage, if there had been adequate surface cover with appropriate engineering treatments e.g. contour furrows, ditches and pitting along with seeding.

Water facilities for livestock

Supplying potable water to livestock is important to reduce mortality rates and increase the production. In addition, it results in a more even distribution of livestock on the rangeland and hence reduces overall grazing pressure. Improvement of water supplies is carried out by making storage tanks, improving springs, providing troughs, drilling shallow wells and installing wind mills.

Restoration of pasture on degraded marginal lands (conversion of low-yield rainfed cereal farms to pasture)

Over a long period of time, shifting cultivation within the rangelands has exacerbated soil erosion by decreasing the perennial components of the vegetation. This has occurred without obtaining viable crop yields and forcing the farmers to abandon the area due to lack of vegetation cover, thus exposing to erosion causing irreversible loss to the national economy.

Transplanting seedlings

In some areas of low rainfall, there may be very poor germination of direct sown range seeds. It is therefore advisable to raise the appropriate seedlings for the rangelands in a nursery and to transplant them prior to seasonal rains.

Pasture seeds

Some range development and improvement projects need seeds, thus government (Forest and Range Organisation) decided to establish some seed production stations across the country in various climatic zones to produce for different ecological regions. The number of seed sites was 16 by 1980 covering 4 414 ha; some have since gone out of production. Then the Ministry of Agriculture decided to produce some fodder at the seed sites, so their number rose suddenly to 58 covering an area of 19 789 ha. The ownership of some of these orchards was gradually transferred to the private sector where nowadays some no longer produce seed or fodder.

At the moment, there are 21 active state seed farms across the country producing seeds of: *Agropyron elongatum*, *Festuca arundinacea*, *Medicago sativa*, *Agropyron desertorum*, *Secale montanum*, *Bromus tomentellus*, *Sanguisorba minor* and *Bromus inermis*. Each seed site has its own plan and the staff work in collaboration with those experts of the range technical units. The suggested plants for seed multiplication are *Kochia prostrata*, *Festuca ovina*, *Cymbopogon olivieri*, *Eurotia curvala*, *Panicum*, *Dactylis glomerata*, *Lotus corniculatus*, and *Phleum*. Some 713.2 tonnes of range seed have been sown in range development and improvement projects in 2002. The total planted seeds were provided by both private and state sector (16 seed orchards); the state contribution was 388.7 tonnes or 54.5% of the total and the balance amounting to 324.7 tonnes equal to 45.5% have been provided by the private sector. Some 187.5 tonnes (26.2% of total seed consumption) of *Medicago sativa* has been planted or oversown on ranges. The second most common is *Onobrychis viciifolia* with 69.2 tonnes equal to 9.7% of the total seed consumption of 24 range seeds applied in the range projects; 9 seed types are just produced by the private sector and 7 types both by private and state sectors. Table 20 shows the amount of range seeds used in 2002.

Another source of seed is collecting from the natural range; some 34.8 tonnes were gathered in 2003. These were in descending order: *Artemisia* spp., *Bromus tomentellus*, *Dorema aucheri*, *Astragalus* sp., *Prangos ferulaceae*, *Seidlitzia rosmarinus*.

Balancing the livestock with the carrying capacity of rangeland

For some time range scientists have believed that the rangelands of Iran are deteriorating due to the excessive number of livestock. As mentioned earlier, the country's rangelands can support just 37 million AU for a period of 7 months while at the moment there are some 83 million AU. Thus after long negotiations and meetings, a national plan was formulated which for the first time activated all concerning departments of the Ministry of Jihad e Agriculture: Forest, Range and Watershed Management Organization, Department of Livestock Affairs, Department of Agronomy, Nomadic Affairs Organization, Research Institute of Forests and Rangeland (RIFR), Department of Extension and Public Participation. The plan would last for 10 years and is now in its third year. In this plan the following is envisaged:

Table 20. Range seed provided by private and state orchards in 2002 in tonnes

Range seed	State sector	Private sector	Total
<i>Agropyron elongatum</i>	117	0	117
<i>Agropyron desertorum</i>	102.7	0	102.7
<i>Bromus inermis</i>	12.7	0	12.7
<i>Bromus tomentellus</i>	3	12.7	15.7
<i>Festuca arundinacea</i>	19	8	27
<i>Festuca ovina</i>	0.56	0	0.56
<i>Secale montanum</i>	25.4	0	25.4
<i>Secale cereal</i>	29.6	0	29.6
<i>Medicago sativa</i>	7	180.5	187.5
<i>Medicagoo scutellata</i>	0.3	70.9	71.2
<i>Sanguisorba minor</i>	1.2	0.4	1.6
<i>Ferula gummosa</i>	0	2.93	2.93
<i>Ferula assa-foetida</i>	0.35	0	0.35
<i>Onobrychis</i>	0	69.2	69.2
<i>Eurotica ceratoides</i>	0	4.87	4.87
<i>Atriplex canescens</i>	1.1	0.8	1.9
<i>Puccinellia distans</i>	0.7	0	0.7
<i>Haloxylon</i>	0	5.01	5.01
<i>Vicia villosa</i>	0	18.54	18.54
<i>Zygophyllum</i>	4.1	1.1	5.2
<i>Artemisia</i>	0	8.2	8.2
<i>Kochia prostrate</i>	0	0.05	0.05
<i>Seidlitzia rosmarinus</i>	0	2.5	2.5
Total	324.71	388.69	713.4

Livestock number reduction

- Early elimination (reduction) of 12.8 million AU equivalent of excess lamb numbers;
- Elimination of 8.5 million AU of old livestock within summer rural pasture and transhumant rangelands;
- Elimination of 20 million AU of small livestock (goats and sheep);
- Substitution of 1.5 million head of native cattle with hybrid cattle;

Increase in forage production and supply;

- Allocation of fertile agricultural land for irrigated farming in association with the cultivation of *Trifolium alexandrinum* that would increase the current forage production by 4 million tonnes TDN;
- Supplying and marketing an additional four million tonnes of hay;

Promoting extension and participation in range rehabilitation and management;

Promoting research on range management improvement.

Despite these issues, it is planned to facilitate the transfer of grazing rights to other lawful livestock holders to reduce the number of rangeland exploiters. In this regard, some strategies have been developed to compensate the rights of lawful rangeland exploiters to leave the rangeland. i.e. allocating farmland, settlement of nomads, etc.

Policies of Technical Bureau of Rangelands.

1. Establish a balance between livestock and carrying capacity of rangelands;
2. Stabilizing the rights of rangeland holders;
3. Control the grazing permits;
4. Enabling rangeland holders;
5. Formulation and implementation of the range development plans;
6. Making economic range development plans;
7. Implementing the formulated plans;
8. Supervision over the formulation and implementation of the range development plans;
9. Highlighting the ecological and environmental values of rangelands;
10. Promotion of rangeland insurance schemes;
11. Promotion of range management groups both from the quality and quantity point of view;
12. Facilitating the transfer of rangeland ownership;
13. Providing banking facilities for the implementation of the range development plans;
14. Systemizing the land use changes for the rangelands;
15. Supporting the fuel distribution in rural and nomad areas;
16. Supporting the settlement of nomads in order to free the rangelands;
17. Facilitating the involvement of capable managers with sufficient knowledge and investment in the management of rangelands;
18. Implementing the range suitability program on rangelands;
19. Supporting the culling policy of small livestock dependant on rangelands during droughts;
20. Conversion of low yield rainfed farms to cultivated pastures.

7. RESEARCH AND DEVELOPMENT ORGANIZATIONS AND PERSONNEL

Range research began in 1959. The first work was focused on botany and ecology and FAO experts with the collaboration of the Iranian experts conducted the researches at that time. Khuzestan province, locating in south western Iran, was the first place to start the study. During seven years, bioclimatic studies were accomplished and finally a valuable map was released.

The Natural Resources Research Institute founded in 1968 gradually changed its name to Research Institute of Forests and Rangelands (RIFR). The institute works under the department of Training and

Research of the Ministry of Agriculture (Ministry of Jihad e Agriculture). It has nine research divisions at a headquarters in Tehran and 28 provincial offices and a number of research stations across the country. The research divisions are namely: Botany, Desert, Forest, Forest and Range Protection, Genetics, Gene Bank, Mechanisation, Medicinal Plants, Poplar and Fast Growing Trees, Rangeland, Wood and Paper.

Initially the institute focused on: Identification of plant resources; Adaptation and introduction of range plants; Ecology and range management; Agronomy and range seeding. In the 1990's, the range research division had these projects: Ecological zones of the country; Autecology of the most important range plants of the country; Study on the adaptation of range plants to different ecological zones; Exclosure effects on condition and trend of natural rangelands in different ecological zones; Scientific Methodologies for Proper Range Management.

Current projects of the range research division are:

- Autecology of the most important range plants in rangeland ecosystems of Iran;
- The effect of ending grazing (exclosure) on range trend and condition;
- Effects of planting distance and pruning intensities on quality and quantity of forage, and longevity of three species of *atriplex*;
- The short-term effects of grazing systems at different intensities on sheep weight, plant and soil of *bromus tomentellus* pasture;
- Scientific methodologies for proper range management;
- Investigation of *capparis decidua*'s seedling problems;
- Preparation of national range vegetation map;
- Range assessment programme in different climatic zones of Iran.

Of course, there are a number of natural resources faculties across the country which offer graduate studies in range science of which three also offer Ph.D courses in range science. Thus each year many university thesis studies are being conducted at university level some of which are being supported by universities or RIFR.

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