

# Country Pasture/Forage Resource Profiles

**IRAQ**



by  
**Tara Mohamed Anwar Omer**



The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned.

The views expressed in this information product are those of the author(s) and do not necessarily reflect the views of FAO.

All rights reserved. FAO encourages the reproduction and dissemination of material in this information product. Non-commercial uses will be authorized free of charge, upon request. Reproduction for resale or other commercial purposes, including educational purposes, may incur fees. Applications for permission to reproduce or disseminate FAO copyright materials, and all queries concerning rights and licences, should be addressed by e-mail to [copyright@fao.org](mailto:copyright@fao.org) or to the Chief, Publishing Policy and Support Branch, Office of Knowledge Exchange, Research and Extension, FAO, Viale delle Terme di Caracalla, 00153 Rome, Italy.

# CONTENTS

<b>1. INTRODUCTION</b>	<b>5</b>
<b>2. SOILS AND TOPOGRAPHY</b>	<b>6</b>
Topography	6
Terrain and land forms	6
Physiography	7
Soils	8
<b>3. CLIMATE AND AGRO-ECOLOGICAL ZONES</b>	<b>10</b>
Climate	10
Climatic regions	11
Agro-ecological zones	12
Land use and water resources	16
Land degradation	17
Cultivated area, production of major crops	18
<b>4. RUMINANT LIVESTOCK PRODUCTION SYSTEMS</b>	<b>21</b>
Production systems	24
Traditional extensive system	24
Mixed and farm marginal system	24
Semi intensive system	25
Species-specific intensive system	25
Cropping patterns/farming systems in rainfed regions	25
<b>5. THE PASTURE RESOURCE</b>	<b>28</b>
Mountain forests and herbaceous vegetation	28
Steppe region	28
Riparian vegetation	28
Al-Ahaur region	28
Desert region	28
Biodiversity	28
Rangeland and grazing resources	29
Review of previous forage programmes	30
<b>6. OPPORTUNITIES FOR IMPROVEMENT OF PASTURE RESOURCES</b>	<b>31</b>
Short-term plans	31
Medium term plans	31
Long-term plans	31
<b>7. RESEARCH AND DEVELOPMENT ORGANIZATIONS AND PERSONNEL</b>	<b>32</b>
Present status of range management and relevant institutions	32
Historical background	32
Projects and activities of the relevant units	32
The Division for Combating Desertification	33
Rangeland Division	33

The National Herbarium	33
Sand Dunes Research Station (Baiji)	33
Forest administration	33
Hamad Basin Project	33
<b>8. REFERENCES</b>	<b>34</b>
<b>9. CONTACTS</b>	<b>34</b>

## 1. INTRODUCTION

The Republic of Iraq is in southwest Asia between latitudes 29° 5' and 37° 22' N and longitudes 38° 45' and 48° 45' E; it forms the eastern frontier of the Arab countries. Turkey to the north, Iran to the east, Jordan, Syria and the Kingdom of Saudi to the west, and the Arabian Gulf, Kuwait and the Kingdom of Saudi Arabia to the south, border it (see Figure 1a). Its unique environmental, biological and social features, which are unlike anywhere else in the Arabian Peninsula, characterize the country. It has a total area of 438 317 km<sup>2</sup>.

The estimated population in July 2011 is 30 399 572 persons with a growth rate of 2.399%. The capital city is Baghdad with a population of 5.751 million persons. Population distribution/density (based on 2002 figures and estimates) is shown in Figure 1b.

Around 97% of the country is in arid lands with low and erratic rainfall. In most parts agriculture suffers from high rates of evapotranspiration that exceed rainfall. Temperature varies widely (10–40 °C) during the growing season, particularly in desert regions.

Iraq is an agricultural country. Although a considerable portion of its agricultural lands are under irrigation, it still depends highly on rainfed agriculture for grain and sheep production. Rainfed agriculture is practiced in the northern parts where the mountains, foothills, and Jazeera desert are located. These three regions depend mostly on rainfall for agricultural production and supply a substantial part of the grain (wheat and barley) consumed in the country.

Of the 120 000 km<sup>2</sup> of cultivable land, which comprise 26.4% of the total area, there are 40 000 km<sup>2</sup> in the rainfed northern region and the rest is in the irrigable areas of the Mesopotamian plains.

Rangelands cover 75% of Iraq and contribute a large share to the national wealth of the country and provide a livelihood for millions of people through grazing livestock. These lands which are unsuitable for farming because of dry climate, poor and rocky soils, rough topography and other adverse factors, make up the majority of the land in Iraq. The real contribution of the rangelands to the feeding of livestock has not been assessed, but it has been estimated that range forage makes up 90% of livestock feed (Sabah Kuwaz, 2007). It is estimated that about 7 900 000 sheep and goats are kept on the range. Rangelands in Iraq have several deficiencies for supporting grazing animals. Limited and highly variable precipitation causes wide fluctuations in forage production in terms of both quantity and quality. Recurrent droughts frequently reduce



Figure 1a. Map of Iraq

(Source: World Factbook)

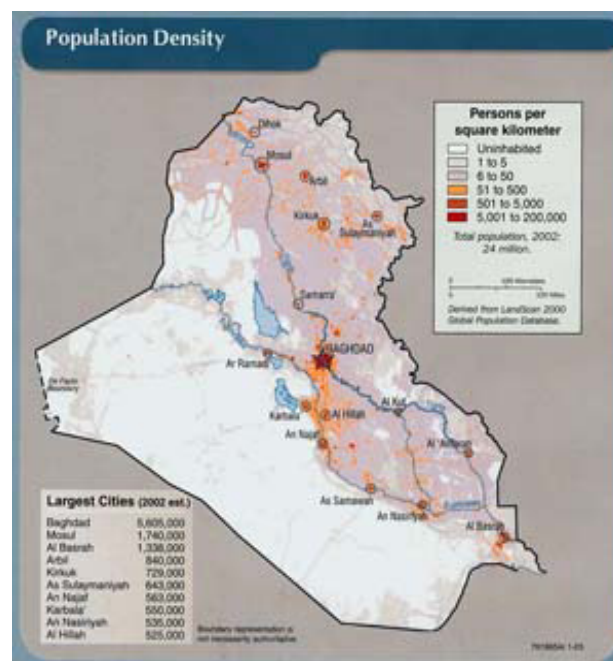


Figure 1b. Map of Iraq showing population density

(Source: 2002 data)

plant growth to zero causing heavy losses and the result of varying forage supplies is reflected in the animals' health and productivity by slow growth, delayed maturity, and reduced reproduction. On the other hand, in the northern and southern Badia (steppe) range productivity varies from 60 to 80 kg DM/ha/year. During the grazing season forage produced in these pastures sometimes exceeds the requirements of sedentary livestock by three times. There are possibilities to greatly improve vegetation resources through improved management techniques.

Overgrazing is a major problem. There are no coordinated efforts to bring about improved range management to increase livestock production while maintaining range resources. To date information on the nature, extent, present use, and production potentials of the rangelands is lacking. It is obvious that there are many and complex problems to be resolved before the continuing degradation of the rangelands can be halted and improvements can be brought about.

## 2. SOILS AND TOPOGRAPHY

### Topography

The relief in Iraq is shown in Figure 1c.

### Terrain and land forms

The details of the areas covered by the different terrains and landforms are presented in Table 1 and Figure 2a. These can be classified into the following categories:

**Sedimentary plain:** occupies a quarter of the total area of the country (about 132 500 km<sup>2</sup>). It lies as a rectangle extending from Belad on the Tigris and El-Ramadi in Tel Aswad on the Euphrates in the north, Iranian borders in the east, and desert plateau including El-Ahwar and Buhiera areas in the west.

**Desert plateau:** occupies 168 552 km<sup>2</sup> and includes the western part of the country at an altitude ranging from 100–1 000 m and the Jazeera area.

**Mountainous region:** stretches over 92 000 km<sup>2</sup> in the northern and north-eastern parts of the country extending into bordering areas of Syria, Turkey and Iran.

**Undulating terrain:** a transitional area between low plains and the mountainous region in the north and northeast. This category covers 42 000 km<sup>2</sup> and is divided into two sub-divisions one outside the mountainous region (42 000 km<sup>2</sup>) at altitudes ranging from 100–200 m, and the other within this region (25 000 km<sup>2</sup>) at an altitude varying from 200–450 m.

**Sand Dunes:** form a rectangular belt parallel to the Euphrates and covering 2 500 km<sup>2</sup>. It lies above the artesian and semi-artesian aquifer of the southern desert. There are possibilities to transform these dunes into agricultural land by utilizing the rich EI-Damam artesian aquifer.



Figure 1c. Relief map of Iraq

Table 1. Types of terrain, landforms, and rainfall (mm) in Iraq

Types of terrain/Landform	Area km <sup>2</sup>	%	Rainfall
Plains	132 500	30	50–200
Undulating/Terrain Land	42 000	10	250–450
Mountains	92 000	21	400–1 000
Deserts	168 552	39	50–200
<b>Total</b>	<b>435 052</b>	<b>100</b>	

Source: Directorate General of horticulture, forest and Rangelands (2007)

## Physiography

Iraq can be divided into the following five physiographic (see Figure 2b) zones (FAO/UNESCO/WMO, 1962).

**Zagros Mountain Region:** consists of high mountain ranges and valleys. The mountains are 1 000 to about 4 000 m high consisting of mostly limestone ridges. There are different kinds of limestones varying from very hard dolomitic limestone to soft chalk. In places shale is inter-bedded with limestone. The various layers of limestone are folded. The mountain ridges have scarp like faces on the south-western sides but gentler slopes on the northeast. In a small area in the north-eastern part there is a thrust zone in which older geological formations are resting on top of the younger. The mountains have steep slopes but the valleys are nearly level to gently sloping or undulating. Three fluvial terraces are found in valleys.

**Foothills Region:** Comprises hills at the foot of the Zagros Mountains, 500 to 1 000 m high. It consists of beds of gravel, conglomerate and sandstones. The gravel and conglomerate layers alternate with thin layers of reddish loam and clay. In some places these red loam and clay layers are at the top and are severely eroded, forming bad land and gullied land. It is an area of rolling hilly landscape with low parallel hill ridges and extensive valleys and plains. There are three distinct terraces in the valleys indicating various cycles of erosion during the Pleistocene. The vegetation consisting mostly of grasses flourishes during winter and spring giving the whole region a green look. In summer the vegetation dries up and the climate is hot and dry. The hills are generally rounded and have thin soil. The level areas of valleys commonly consist of three different terraces. The lowest terrace usually being most extensive is most important with good soil.

**Jazeera Region:** includes the remnant of an old inland sea in which mainly gypsum was deposited. It is a steppe and desert plateau. The area is relatively flat broken by some hills and low mountain ridges which are an extension of the mountain ridges to the east. The mountain ridges go in an east west direction; in between there are level to undulating and at places rolling terrain. Gypsum is the main rock but in the east and north limestone and sandstones occur. Large areas have lime and gypsum crusts exposed at the surface. The natural vegetation is of desert type in the south west and steppe in the north east. This region has been traditionally a grazing area but recently some parts in the north have been broken and ploughed to grow wheat and barley.

**Desert Region:** consists of various kinds of limestone which was deposited on the old shelf (the stable land area). This region is 200 to about 600 m above sea level. The north-western part is the highest and

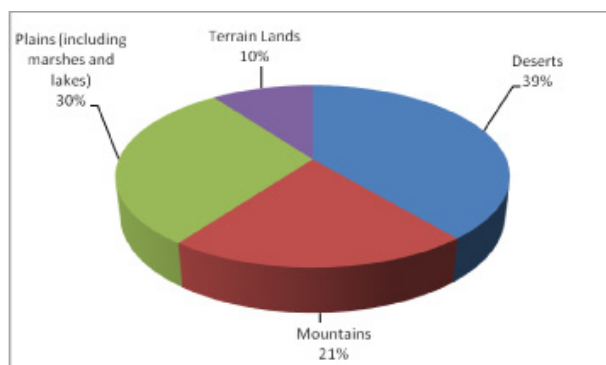


Figure 2a. Physical land division of Iraq (%)



Figure 2b. Map of physiographic units of Iraq



there is a general slope from west to east. The vegetation is of Irano-Turanian type in the northern part and of Sahara-Sindian type in the south. The whole of the northern desert and the northern part of the southern desert are rock plains developed on limestone or limestone crust (an old soil horizon). A small part in the south is a sandy desert with sandy and gravelly surface as well as sand ridges or high but stable dunes up to 35 m high. The eastern strip has gypsum crust. Wind erosion is important as high winds are very common. A layer of gravels or pebbles called desert pavement is commonly present on the surface protecting the soil from being blown away. Water erosion is also important and large parts of the desert have been affected by it during the Pleistocene and the Holocene. In some places deep gullies or wadis have been shaped by water erosion in a true desert with rainfall of about 70 mm and these wadis have some sparse vegetation. In the northern part, the rainfall is up to 150 mm and there is some vegetation especially in wadis.

**Mesopotamian Plain Region:** is a geological depression filled with river sediments which covers the central and southern parts of Iraq. It is a plain of the Tigris and Euphrates rivers. In the Bible it is referred to as “Shinar”. Later on it was called “Babylonia and As-Sawad”. In the Holy Quran, there is a reference to the city of “Baable,” the capital of the state at the time.

The northern part extending between Samarra and Deltwa consists of three distinct river terraces which are about 5 to 15 m higher than the present river level. These old river terraces thus form high plains which are never flooded by the river. The lowest of these terraces is the most important for irrigated agriculture. It extends on both sides of Adhaim River.

In central Iraq, the plains are nearly level. Large parts of it were flooded almost every year during spring and new soil material was deposited till 1956 when the first flood control project was completed. Deposition of material by the rivers is in a levee basin pattern giving a distinct mesorelief in the nearly level landscape. In addition, the old irrigation canals have deposited irrigation silt to form narrow high strips along them.

In the southern parts the plain can be divided into delta plain, the marsh region and the estuary region. In the delta plain starting south of Kut and Hilla, the rivers split up into many branches. The land is flat, the natural drainage is poor and the ground water level is high. South of the Delta is a marsh region starting from Amra and Nasiriya. The ground water is at or near the surface and a large proportion of the area is covered by marshes which expand after river floods during winter and spring and contracts in late summer. The marshes are covered by reeds. Near the coast is the estuary region where sedimentation is in the form of extensive saline, estuary flats traversed by estuary channels. Along the river there are narrow strips of high well-drained land which are famous for date orchards.

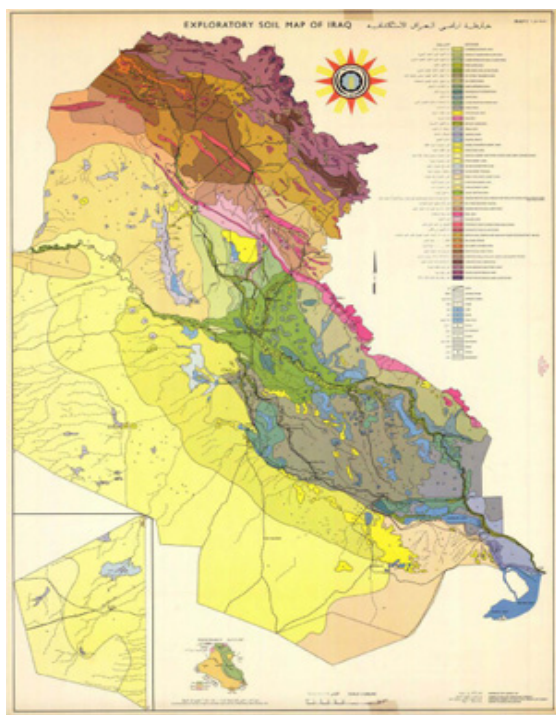
## Soils

According to the FAO/UNESCO (1962) soil classification used for the soil map of the world, the following types of soils are found in Iraq and the salient characteristics are summarized below (Buringh, 1960) [and also see Figure 3]:

**Calcario Fluvisols:** These are stratified soils of the lower Mesopotamian plain. They occur along the rivers in narrow strips; in central Iraq they cover a large contiguous area. Formed in the alluvial material deposited by the Tigris and Euphrates rivers these soils are strongly calcareous having about 20% lime. They are grayish brown in the Euphrates deposits but have reddish or pinkish tinges in the material of the Tigris. Almost invariably they contain gypsum because the catchment area of the Tigris and Euphrates has gypsum crusts and deposits. The organic matter content is low (0.3 to 0.5%) and the carbon: nitrogen ratio is narrow (4 to 8). The pH is 7.5 to 8.1. The texture ranges from silt loam to silty clay loam and silty clay.

These can be subdivided into river levee soils and river basin soils. The former are usually loamy whereas the latter are clayey. It may be mentioned that only backslope parts of the basins have fluvisols (the main basins have solonchaks). These are the most important soils in the lower Mesopotamian plain. The levee soils are well drained being 1–3 m higher than the basin soils and having loamy texture. The salinity problem is not serious on them as the salts move downward and then laterally into the basin soils. The basin soils usually have salinity problems.





**Figure 3. Soil map of Iraq**

**Orthic Solonchaks:** These are the strongly saline soils covering about 70% of the lower Mesopotamian plain. Mostly these soils contain high amounts of hygroscopic salts (calcium chloride and magnesium chloride) as well as calcium sulphate, sodium chloride and sodium sulphate. Small quantities of sodium biocarbonate and sodium nitrate may also be present locally. They are strongly calcareous. The pH of the soil generally varies from 7.5 to 8.2 and seldom more than 8.5. On leaching the soils do not develop any alkalinity or sodicity problem. Such soils are locally called “Sabakh”.

The other kind of solonchaks, occurring along with “Sabakh” soils, are what the local people call “Shura soils”. These have white salt crust or salt efflorescence on the surface, and contain higher amounts of sodium sulphate and sodium chloride than chlorides of calcium and magnesium. As they also contain gypsum no alkalinity or sodicity problem is encountered when they are leached and reclaimed. The salt efflorescence is pronounced in winter and spring but often disappears or becomes less prominent in summer.

Besides salt content and the kind of salts the drainage characteristics of the soils are very important in determining the development potential of these soils and these depend upon the physiographic position of the soil, the rate of water permeability and the depth of ground water. The loamy soils of river levees and higher parts of river basins have low potential. The organic matter content is low (0.5% or less) and the physical conditions of the surface soil is generally poor.

**Luvic Yermosols:** These are soils of the arid areas of old river terraces in the northern part of the country where the climate is transitional to semi-arid. They have reddish brown subsoils or B horizon which has higher clay content and is more red than the surface soil and the substratum. They are moderately or strongly calcareous. A zone of lime accumulation is found at about 40 cm depth. The organic matter content is 0.2 to 0.6% and the carbon: nitrogen ratio is 3 to 8.

Without irrigation they are suitable for grazing only. With irrigation they are moderately to highly productive depending mainly on effective soil depth and organic matter content.

**Calcic Yermosols and Gypsic Yermosols:** These are the soils of old river terraces and old rock plains occurring under arid and true desert climate. The calcic yermosols have a very strong zone of lime accumulation (with 40 to 60% lime) at about 30 to 40 cm depth. The gypsic yermosols have a strong zone of gypsum accumulation at 20 to 40 cm depth. Over large areas these soils have suffered from sheet erosion with the result that many patches of land have a crust of lime or gypsum at the surface. These soils have value only as grazing lands. Small areas with at least 70 cm of soil are irrigated by pumps from the Tigris River.

**Cambic Arenosols:** These are very sandy soils of stable sand dunes occurring in the northern part of the country under semi-arid climate. The sand dunes were stabilized by vegetation during the last pluvial age (the last glaciation period). The soils have subsoils which are brighter and more red than the surface soil and the substratum. They are calcareous and have low organic matter content.

**Albic Arenosols:** These are also very sandy soils which consist of light coloured sands in the surface soil and occur in the southern part of the country. They are formed in stable sand dunes or sand ridges. Except for colours they are similar to cambic arenosols.

**Calcic Xerosols:** These are the soils of the semi-arid areas where dry farming is possible. They are developed in old river terraces and are calcareous. The subsoil has a reddish brown colour and a subangular blocky or blocky structure. The organic matter content is 0.5 to 0.9% in areas under cultivation; under neutral conditions it is expected to be about 1.0% or higher. These soils are very strongly calcareous below about 40 cm depth due to the presence of a zone of lime accumulation. On account of low rainfall they form only marginal crop land. At present they are used for dry farmed wheat and barley under a system of one year wheat and one year fallow.

**Gypsic xerosols:** These soils are like the calcic xerosols but differ from them in having a strong zone of gypsum accumulation instead of lime accumulation. They are also formed in old river terraces under semi-arid climate. The subsoil is reddish brown and has sub-angular blocky or blocky structure. The zone of gypsum accumulation occurs at 20 to 80 cm depth. The thickness of the soil over the gypsum zone determines their agricultural value. Only those parts which have at least 60 cm of soil above the gypsum zone are suitable for cropping. Even they form marginal dry farmed land.

**Chromic Vertisols:** These are very clayey soils of mountain valleys and some parts of foothill plains. Having about 60 to 70% clay of montmorillonite type they develop wide deep cracks on drying. They have a meso-relief of minor highs and lows differing in level by a few centimetres. The high spots are about 15 to 30 cm in diameter. This kind of meso-relief, a characteristic feature of these soils is known as “gilgai”. These soils are mostly under cultivation and contain about 0.5 to 0.7% organic matter; under natural conditions under grass they would have slightly more. They are calcareous and the pH is about 7.8 to 8.1.

### 3. CLIMATE AND AGRO-ECOLOGICAL ZONES

#### Climate

Except for a small part in the northeast, the whole country has an arid or desert, subtropical continental climate. Summers are hot and completely dry; there are rarely any clouds during four months of summer. Winters are cool. The mean annual rainfall is less than 100 mm in the south-western half of the country increasing to about 140 mm in the centre near Baghdad and to about 200 mm along a line passing about 25 kilometres east of Sinjar in the north, about 40 kilometres west of Mandali and about 80 kilometres east of Baghdad. The 400 mm isohyet passes through Mosul, Erbil, Khanaqin and Mandali. From there to the northeast the rainfall increases gradually to about 1 000 mm in the Zagros Mountains (see Figure 4). However, there is great variation in rainfall from year to year especially in the region getting less than 400 mm of rain per year.

The temperatures are more or less similar (Figure 5) throughout the country except in the mountain areas in the northeast. The monthly mean maximum temperatures for July range from 38 °C at Rutba to 43 °C in Baghdad. The highest maxima in June, July, and August range between 43 °C and 50 °C. The monthly mean minima for January range between 1 °C in the south western desert and the north eastern foothills to 8 °C in the central part of the river plain. The lowest minimum is about –14.5 °C in the northern desert, –11 °C in the foothills and –8 °C in the central part of the river plain. Even at Basra near the coast the lowest minimum is –4.5 °C, showing the effect of cold waters.

The dominant winds are from the northwest and north in the central and northern parts of the country. In the south they are from the west and northwest, so north-westerly winds are the most dominant. Dust storms are quite common in the desert and the Mesopotamian plain, occurring mainly in the early summer months but also in midsummer as well. The wind speed (Figure 5) may reach 100 km per hour. Baghdad has on an average 23 major dust storms in a year. Sometimes the whole country is enveloped in a cloud of very fine dust. According to an estimate, 2.5 m of dust falls on the whole area of Iraq every year on the average.

As a result of high temperatures, strong winds and low rainfall, the evaporation is very high; it is 2 170 mm at Abu Dibbbis Lake in the central part of the country. During summer (June, July, and



Figure 4. Precipitation map of Iraq

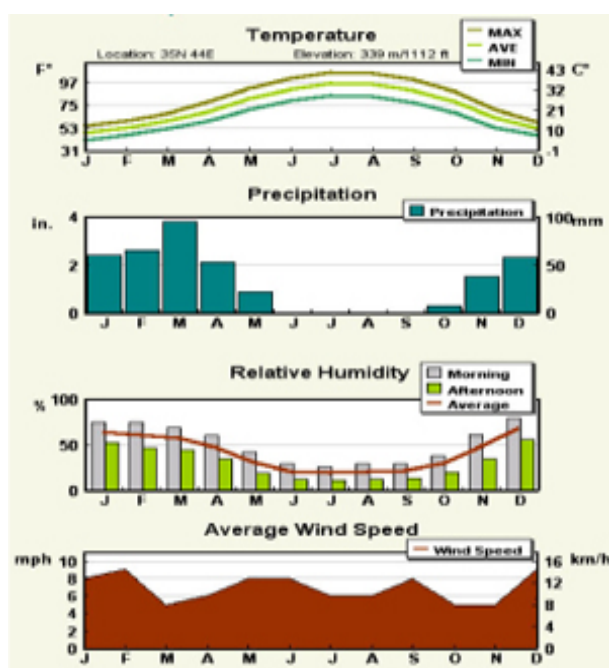


Figure 5. Weather and climate in Iraq

August) the evaporation is 250 mm to 300 mm per month or about 10 mm per day.

Rainfall and altitude are the two main factors influencing the climatic variations in Iraq. Based on these factors, the country can be divided into the following main climatic regions:

### Climatic Regions

The various climatic regions in the country are:

**Arid lowland region:** this includes areas having less than 200 mm rainfall, i.e. about 80% of the country. It is characterized by hot summers (maximum temperatures around 43 °C) and mild to cool winters (minimum temperature about 4 °C). In summer dust storm are common and there are a few heat waves which raise the temperature to 48 °C. During winter cold waves are experienced when the temperature may drop to -8 °C. Humidity is low and evaporation from free water surfaces is up to 10 mm per day. The annual evaporation is about 2 100 mm.

**Semi-arid lowland region:** includes the area bounded by the 200 mm and 400 mm isohyets covering the foothill area in the northeast. The summer is hot and dry with maximum temperature around 43 °C and humidity of 12 to 15%. The highest maximum temperature reaches 49 °C. The minimum temperature during summer remains between 30 °C and 32 °C. In summer high winds are common. The winter is mild to cool with minimum around 1 °C and maximum temperature around 14 °C. The lowest minimum in December and January is about -11 °C. The rainfall occurs during winter and spring from November to April but there are great variations. The 200 mm isohyets are the limit of dry farming. So this region is a marginal dry farming area.

**Sub-humid upland and mountain region:** includes the Zagros mountains and valleys as well as a part of the foothills. The main annual rainfall ranges between 400 mm and 1 100 mm. The region may be subdivided into the following zones.

**Kirkuk-Erbil-Mosul plain:** The summer is hot and winter is cold. At Mosul the mean maximum temperature in July and August the hottest months is 43 °C.; the highest maximum may go up to 50 °C during heat waves. The mean minimum in July is about 22 °C. In winter the mean monthly minimum in January is 10 °C and the lowest minimum is -11 °C.

**Lower Mountain Slopes (500 to 2 000 m):** The temperatures are slightly milder in summer than the Kirkuk –Erbil-Mosul plain and slightly lower in winter.

**Higher Mountain Slopes (2 000 to 4 000 m):** The summer is warm to hot but dry and winters are cold. The precipitation occurs mostly as snowfall.

**Alpine Zone (above 4 000 m):** It has hot and dry summers but wet and cold winters. The precipitation is approximately 900 to 1 000 mm.

Papadakis (1966) has recognized and described three climatic regions in Iraq:

**Hot Subtropical desert region:** The temperature regime is hot subtropical. The winter type is Ci or Av, thus frost occurs and temperatures are sufficiently low for cryophilous crops (like wheat) and at the same time sufficiently mild for winter oats. Summers are sufficiently hot for cotton and days are very hot. The humidity regime varies from absolute desert to Mediterranean desert.

**Subtropical semi-arid Mediterranean region:** The regime is hot subtropical to semi hot subtropical. The winter has only mild frost and is sufficiently cool for cryophilous crops like wheat and for winter oats. The summer is sufficiently warm for cotton and summer days are hot to very hot. The humidity regime is semi arid Mediterranean.

**Subtropical Mediterranean region:** The temperature regime is semi hot subtropical. During winter frosts occur and temperatures are sufficiently low for cryophilous crops. The summer is sufficiently warm for cotton and days are hot but not very hot. The humidity regime is moist Mediterranean.

### Agro-ecological zones

Based on the physiography, climate, soils, and drainage, the country has been divided into seven agro-ecological zones. Suggestions are also given about the most suitable crops, cropping systems, and land use for each zone. This should help the agriculturists and planners to promote the most appropriate crops and land use systems for each zone to enhance productivity (FAO/UNESCO/WMO, 1962). Further refinement of the zones based on additional data on climatic conditions, soils, and soil-crop-climate interrelationships may also be possible. A summary of agro-ecological zones is presented below.

**Basra zone:** this consists of the marshy and estuary region of the lower Mesopotamian plain. It is bounded on the south by the Persian Gulf and the limit of the Mesopotamian plain; on the west approximately by a line connecting Nasiriyah and Amara; on the north by a line due east from Amara; and on the east by the border with Iran. The whole area is less than a few metres above sea level and most of it is flooded by the Euphrates River from March to July forming very extensive marshes; the area has a drainage problem. Only the narrow belts of river levees have well-drained soils. The climate is arid subtropical with less than 130 mm rainfall per annum only in winter. Because of extensive flooding the humidity is slightly higher (relative humidity 15%) than that in central Iraq. Winter is cool with minimum temperature in January around 6 °C but during short periods of cold waves it goes down to -6 °C. Sometimes early frost occurs and damages the millet crop. Soils can be classified into three types: Loamy and well drained soils occur on the narrow river levees (high strips of land along the river). These are non saline and mainly under date orchards. Then there are silted up marsh soils of old rice areas. These are loamy and clayey soils. The areas under cultivation are non saline but somewhat poorly drained. The areas of abandoned cultivation are strongly saline. The third kind of soils covers areas of shallow flood marshes which are covered by 1–2 m of water from March to

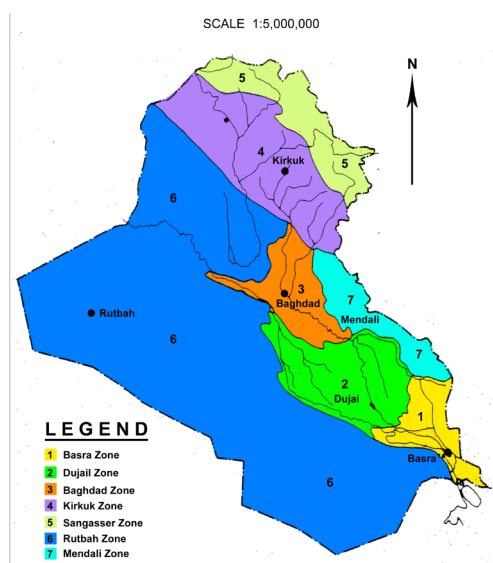


Figure 6. Agro-ecological zones in Iraq



July. They are saline and have greenish grey colour due to ponding water for a few months and nearly wet conditions during the rest of the year. The first two kinds are important for agriculture. The third kind of soils are used mainly for grazing, although a small part is used for growing millets on flood moisture in late summer. Reeds and rushes growing in marshes provide forage. The total cultivated area is only about 10% of the total.

Based on the climate, soils, drainage conditions and water supply, this area is suitable for a combination of buffalo raising and coarse rice production. Rice, especially IRRI varieties, has very good yield potential due to continuous sunshine and high temperatures. It should be followed by vetch (*Vicia sativa*), Senji (*Melilotus parviflora*), lentil or chick pea on residual moisture. Millets and sorghum are also highly suitable; these should be used mainly as fodder. At present this area depends mainly on floods but after the construction of barrages the extent of flooded area will be greatly reduced. To sustain the human and the animal populations, it would be necessary to provide an assured supply of water sufficient for the land already under cultivation. With assured supply the present millet area could be used for fodder production. The rice area should remain under rice and efforts should be made to increase production by introduction of high yielding IRRI varieties. Summer pulses are another possibility. The levee soils are suitable for dates, citrus, alfalfa, sorghum, wheat, and summer pulses (*Phaselous* spp.).

**Baghdad zone:** comprises the flood plains and the old flood plain (an old river terrace) in the lower Mesopotamian plain, lying north of Hilla and Kut and south of Adhaim River but including a small area north of this river. The climate is arid subtropical continental with very hot and completely dry summers and cold winters having some rain. The mean maximum temperature in July and August is about 43 °C but during heat waves the temperature shoots up to 49 °C. Dust storms are common in summer. High temperature and winds combine to cause very high evaporation, about 10 mm per day during June, July, and August. The winter is cool with mean minimum temperature of 4.5 °C in December and January but the minimum temperature dips down to -7 °C during cold waves which are experienced intermittently during December and January. The mean annual rainfall ranges from about 120 mm in the south to about 160 mm in the northeast, occurring in winter and spring.

The soils are mostly silty clay loams and silty clays formed in river basins. They are layered with soil materials ranging in textures from silty clay loam and silty clay to very fine sand. The surface layer 20 to 50 cm thick has usually poor physical condition with low porosity and slow permeability. Most of the area is saline with a water table of 2–3 m deep. However, some parts have only a minor salinity problem. Apart from basin soils there are loamy soils formed on river levees which are 3–4 m higher than the basins. Being well drained and non saline, these are mostly under fruit orchards (dates, oranges, pomegranate, grapes, figs etc.) and vegetables. Under irrigation, they are amongst the most productive soils in the world. Then there are basin depressions surrounded by medium level basin soils or irrigation silt deposits. These are poorly drained and have poor physical conditions. Some of them turn into marshes in winter and spring.

Along canals and irrigation ditches irrigation silt levees have formed by deposition of silt from irrigation water which is very muddy (containing 900 ppm of silt during low river flow and up to 4 000 ppm during floods). These irrigation levee deposits are 50 cm to 3 m deep. They are mostly silt loam or silty clay loam in texture and quite uniform. Generally, these soils are moderately saline. They are used for growing wheat under a system of one wheat crop and 18 months fallow.

All soils are strongly calcareous (containing about 20% lime). As the soils contain gypsum they do not develop any alkalinity or sodicity problem upon leaching. Only the depressional sites may have lost all the gypsum through leaching and have high exchangeable sodium percentages. Some small areas in the old river terrace (Mahdi Terrace) have a sodicity problem. In the south-western part of this zone there is an area of sand dunes.

Based on the climate, soil type, and drainage characteristics and seasonal patterns of water supply, the most suitable crops are wheat, berseem (*Trifolium alexandrinum*), chickpea, lentils, sugar beet, soybean and cotton for the river basin soils. It might be well to grow a crop of rice once in 3–4 years to keep salinity under control. Alternatively, wheat may be grown in rotation with berseem (two crops of wheat and one crop of berseem) under a system of winter crops and summer fallow. Under a continuous cropping system, cotton can be grown in summer in rotation with wheat and berseem. The river levee

soils are suitable for orchards and vegetables as well as soybeans, wheat and summer pulses. This is the zone that has a high proportion of good soils.

**Dujaila zone:** It includes the delta plains parts of the lower Mesopotamian plain as well as the marsh area (Figure 7) extending from Hilla and Kut in the north to Nasiriya and Amara in the south. It is bounded on the southeast by the Basra zone; on the northeast by levees of the Tigris River; on the north by the Baghdad zone; and on the southwest by the desert. The climate is arid subtropical continental with very hot summers and cool winters. The mean maximum temperature in July and August is around 43 °C. Heat waves are common during these months raising the temperature to 48 °C or even slightly higher. The mean minimum temperature in January is 4.5 °C but cold waves are experienced in December and January lowering the temperature to -7 °C. The mean annual rainfall is about 120 mm received in winter. The dominant winds are from the northwest, north and west. The humidity remains low. The sunshine is continuous in summer and almost continuous in winter.



**Figure 7. Exploitation of shrubs in the low lying areas of the marshy region in Iraq**

The soils are silty clay loams and silty clays formed in river basins. The surface soil has poor physical condition, low porosity, and slow permeability. The most part of the area is saline with the water table at 2–3 m depth but in some parts the salinity is only a minor problem. There are numerous depressions locally called “Haur” where flood water and excess irrigation water collect to form marshes. The “haur” soils are covered by irrigation sediments which are silt loam or silty clay loam. In the cultivated area the soil is usually slightly or moderately saline to a depth of 100 cm and strongly saline below. The uncultivated areas are very saline containing mainly chlorides of calcium, magnesium, and sodium. Gypsum is invariably present in saline soils. In narrow strips along the rivers there are loamy soils which are non saline and well drained. These are 3–4 m higher than basins soils. All soils are strongly calcareous and contain gypsum.

The basin clayey soils are suitable for the production of berseem, sugar beet and soybeans. A crop of rice may be grown once in three to four years to keep salinity under control. Alternatively, wheat may be grown in rotation with berseem or in a continuous cropping system. Chickpea and lentils may be grown on residual moisture after rice. Cotton can also be grown in rotation with rice to keep salinity under control. The well drained non saline levee soils are suitable for fruit orchards and vegetables as well as soybeans, wheat, and summer pulses.

**Kirkuk zone:** includes the main dry farming area of the country with 200 to 600 mm rainfall. The summer is hot and dry but the winter is cold and rainy. The soils are clayey and loamy, moderately calcareous and non saline. Some areas have calcareous clayey soils with expanding type of clay. It is bounded by the 200 mm isohyet on the southwest and by the boundary of the mountains on the north.

The climate is semi-arid subtropical. The summer is hot and dry with mean maximum temperature of 43 °C in July and August, the hottest months. Some heat waves are experienced in summer raising the temperatures to about 48 °C. The winter is cold with mean minimum temperature around 1 °C to 2 °C in January and February. During cold waves the temperature drops down to -6 °C to -10 °C. The mean annual rainfall ranges from 200 mm to 600 mm occurring in winter and spring (October to May, but mainly from November to April). The amount and time of rainfall is however, quite variable especially in the areas of less than 400 mm of mean annual rainfall.

The soils are mainly of two types in plains and valleys. They are clayey and loamy, moderately to strongly calcareous and have a zone of lime or gypsum accumulation at about 30 to 40 cm depth. They are free of salinity. The organic matter content is about 0.6 to 1.0%. The pH of the soil is about 8.0 or slightly less (Haplic xerosols and Gypsic xerosols). Some areas have clayey soils (Vertisols) with expanding type of clay. They develop wide cracks on drying. They are calcareous and usually have a zone of lime accumulation at 40 to 60 cm depth. The pH is around 8.0.



The climate and soil combinations make this zone suitable for growing wheat and barley. This is the part of the fertile crescent of the Middle East where the cultivation of crops was first started. The shallow soils are more suitable for barley than wheat which grows well in deep soils, as these soils are underlain by lime hardpan at less than 50 cm depth. At present these crops are rotated with fallow.

The Kirkuk zone can be further subdivided on the basis of variations in precipitation.

**200–350 mm rainfall zone:** Wheat and barley are the most suitable crops. Either of the crops should be grown in rotations with a self regenerating *medicago* species. Application of phosphatic fertilizer is the key to the success of the system. Wheat may be grown in deep soils and barley in shallow ones. Crop and livestock production should be properly integrated.

**350–600 mm rainfall subzone:** It is the major area of rainfed cereal production. Currently wheat is the dominant crop grown in rotation with 18 months fallow. It is recommended to intercrop wheat with perennial *medicago* (Lucerne) species (one or two crops of wheat and 18–30 months *medicago*). Phosphatic fertilizer application to *medicago* is the key to success of the system. Some areas are irrigated with water from springs and “Karez” (systems of underground tunnels) to grow fruit orchards (citrus, pomegranate, plums, and figs), rice, potatoes, tobacco, cotton, and vegetables. Hills and shallow soils are used for grazing. It would be economical and useful to introduce furrow systems of irrigation.

**Sungassar zone:** consists of dissected hilly areas and high mountains with 600 to 1 000 mm of rainfall per annum. The vegetation is mainly oak forest on slopes between 500 and 2 000 m altitude; mainly grasses between 2 000 to 4 000 m and alpine plants above 4 000 m. In the valleys near Sulemaniyah, Sungassar and Rania, the soils are clayey and deep in level parts. There are large valleys which have self mulching clayey soils with expanding type of clay and which develop wide cracks on drying. They are calcareous with pH 7.5 to 8.1 and have a weak zone of lime accumulation below 50 to 80 cm depth. On the higher parts of valleys there are shallow soils over gravel. On the hills there are shallow soils over limestone, mudstone, and gravel or very strongly calcareous whitish soils developed on marl.

Grazing is the dominant land use on hills and mountains as well as on shallow soils in valleys. The valleys are cultivated to grow wheat under a system of one crop of wheat in rotation with summer fallow. Some areas are irrigated with spring water to grow rice, tobacco, cotton, and vegetables.

A system for the management of grazing lands has yet to be evolved by proper integration of rainfed cropping with animal production through the introduction of alfalfa in the cropping system. At present a large number of livestock move into the area from the desert region, especially in dry years during summer, creating a problem of overgrazing.

**Rutba zone:** includes the western desert region, the southern part of the Jazeera, and the whole area west and southwest of the river plain. This zone includes more than half of the country. The area consists of level plains to undulating surfaces with limestone rocks under the ground; in places there are wadis 50 to 60 m deep. A part is gypsum rock plain. In the south is a gravel plain which is covered by sand dunes in places. Most of the area is a limestone rock plain. The soils are mainly shallow over limestone, gypsum, gravel, lime hardpan or gypsum pan. In places there are depressions which receive the run-off water of occasional rain showers. The southern part is a plain formed of sand and gravel; a part of this is covered by sand dunes which are up to 35 m high, but stable at present.

The main characteristics of its climate are: extremely low and erratic rainfall (from less than 100 mm to 150 mm for the greater part of the area). Very hot summers, cold winters, great diurnal and seasonal variations of temperatures, high wind and dust storms. The mean annual rainfall over the greater part of the area is less than 100 mm; only a small northern part gets 150 to 200 mm. The rainfall occurs in winter, the summer being completely dry, and it is very erratic. The maximum temperature in summer is around 40 °C, occasionally going up to 46 °C. However, the ground temperature is much higher than the air temperature. The minimum temperature in January is near to 1 °C but during cold waves it may go down to –14 °C. The soils are mostly shallow over limestone, gypsum, gravel, lime hardpan or gypsum hardpan (Calcic and Gypsic Yermosols). Locally there are deep sandy or loamy soils usually moderately deep and deep soils with good moisture conditions due to collection of runoff. There are strongly

saline soils (Solonchaks) in depressions which turn into marshes whenever the rain water collects in them. In sand dune areas are found sandy soils (Arenosols) which are very strongly calcareous (25 to 30% lime) and very poor in organic matter (about 0.1 to 0.2%).

The whole area has a very limited use for grazing of camels, goats, and sheep for two or three months in winter and spring because it is only after the rain that some grasses and shrubs come up and provide grazing for short periods (Figure 8). In some wadis in the north wheat and barley are grown under dry farming systems in years of above average rainfall. Little improvement is possible in the present systems of grazing, or dry farming of wheat and barley in wadis in some parts. It will be only after introducing some organized management system of grazing in the hilly areas of higher rainfall that some improvement of the grazing land may be possible in this area through delaying the grazing to allow the vegetation to develop properly.

In the dry farming areas of this zone (patches in wadis), it may be better to grow some varieties of alfalfa, annual medics or vetch instead of wheat or barley. The condition of the animals in this area can be improved only if a part of the irrigated area in the Mesopotamian plain is used to produce fodder for providing supplemental feed for them.



**Figure 8. Exploiting seasonal availability of forage in desert regions of Iraq**

**Mandali zone:** comprises a narrow strip of land along the eastern border of the country and consists of areas of piedmont basins of Iranian hills and back swamps of the Tigris River, in addition to some badly dissected upland and gravely fans and marsh soils. The climate is arid and semi-arid subtropical with mean annual rainfall ranging from 170 mm in the southwest to about 350 mm in the northeast.

The soils are mainly strongly saline and poorly drained; only the gravely soils of the fans are well drained. There are areas with depressions which turn into swamps after rain but partly dry up in summer. The soils of the depressions and marshes are clayey. The water coming from the Iranian hills is brackish and unfit for irrigation.

Only some small areas in the upper part are irrigated by wells having somewhat brackish water. The agricultural potential of this zone is low and little improvement is possible.

### Land use and water resources

The total area of Iraq is approximately 44 million ha (440 000 km<sup>2</sup>). Land potentially suitable for agricultural production however is not more than 12 million ha (120 000 km<sup>2</sup>) or 27% of the total area of the country. The rest includes deserts with extremely low rainfall and rocky/steep mountains which are the natural grazing grounds for the millions of head of sheep and goats in the country.

The total area which has been used for agricultural production is about 8 million ha (80 000 km<sup>2</sup>) which is almost 67% of the cultivable area. However, due to certain limitations such as soil salinity, drought, shortage of irrigation water in summer, fallowing and the unstable political situation it is estimated that the average area actually cropped each year ranges from 3 to 4 million ha.

Historically the most significant types of land use and food production in Iraq have been irrigated agriculture, which requires substantial investment and is an intensive form of land use, and pastoralism, which requires relatively little investment and is extensive. These have been combined with dry land farming in the semi-arid areas of northern Iraq. Although these basic types are technologically very different, they have been closely interrelated, socially and economically, for thousands of years. Environmental problems in development generally derive not from basic technologies such as types of irrigation or grazing, but from the scale of the productive activity in relation to the resource. Before the first attempt to develop irrigation in modern-day Iraq, irrigation had already served as the basis of vast agricultural projects, and had environmental effects which reduced productivity seriously. Perennial irrigation in Iraq, which requires storage and gradual release of the water through the period of minimum flow, is largely the introduction of the twentieth century. Such irrigation has allowed major increases in areas under cultivation and inten-

**Table 2. Classification of land for potential use in Iraq**

Type of land	Area (million ha)
Lands that are suitable for agricultural production	32.97
Excellent lands for irrigation by flood method	1.70
Good lands for irrigation by flood method	2.40
Moderately suitable lands for flood irrigation	1.70
Excellent lands for rainfed agriculture	0.25
Excellent lands for dryland farming and irrigated crop production if water can be provided	1.29
Good and moderately suitable lands for rainfed agriculture	1.07
Good forest and rangelands	3.07
<b>Total</b>	<b>44.45</b>

Source: Planning Authority, Central Statistic Agency, (2001–2005)

**Table 3. Area (ha) under various crops**

Crop	Area ha)
Field crops	3 727 000
Vegetables	192 000
Orchards	195 000
Woodlands	1 520 000
Grazing (uncultivated lands)	36 040 000
Forages	100 000
<b>Total</b>	<b>41 774 000</b>

The land use for the major crops in Iraq may be summarized as below – see Table 3 and Figures 9 and 10 (Nakd A. Khamis, 2005):

### Land degradation

More than 50% of Iraq's land is desert, and an increasing part of the permanent pasture is subject to erosion because of reduced vegetation cover. Additionally, much of the cropland is losing its inherent productivity due to poor agricultural practices and over exploitation. The direct loss of agricultural land is most acute around urban centres, where established agricultural land is being lost to alternative uses, including urbanization, industrialization, and transport infrastructure. To compensate for this, new land is being brought into production through reclamation. The productivity of the reclaimed land, however, is in many cases only a fraction of the old, and new land is being brought into production more slowly than old land is being lost. Overgrazing in desert areas is a major cause of plant cover loss, particularly in the semi desert regions, which have suffered a particularly severe loss of vegetation as a result of overgrazing, off-road vehicles, construction, and tourist activities.

**Soil salinity:** Salinity has always been a major issue both in old Mesopotamia and modern-day Iraq and it was already recorded as a cause of crop yield reductions some 3 800 years ago. By 1950, approximately 60% of Iraq's agricultural land was estimated to be seriously affected by salinity; and 20–30% had been abandoned with the rate of loss estimated at 1% per year. It was estimated that in 1970 half the irrigated areas in central and southern Iraq were degraded due to waterlogging and salinity. The absence of drainage facilities and, to a lesser extent, the traditional irrigation practices used (i.e. flooding) were the major causes of these problems. In 1978, a land rehabilitation programme was undertaken, comprising concrete lining for irrigation canals, installation of field drains and collector drains. By 1989, a total of 750 000 ha had been reclaimed at a cost of around USD 2 000/ha.

sification of cropping but it also magnifies the adverse effects of irrigation: soil salinity and water logging develop faster and some of the adverse effects are more difficult to reverse. Water resources in Iraq are controlled by the Twin Rivers, the Tigris and the Euphrates. Both are international rivers originating their source in Turkey. The Tigris river basin in Iraq has a total area of 253 000 km<sup>2</sup>, or 54% of the total river basin area. The history of irrigation started 7 500 years ago in the land between the Tigris and the Euphrates when the Sumerians built a canal to irrigate wheat and barley. Irrigation potential was estimated in 2006 at over 5.15 million ha, of which 60% is in the Tigris basin, 37% in the Euphrates basin, and 3% in the Shatt Al-Arab basin. Considering the soil resources, it is estimated that about 6 million ha are classified as excellent, good or moderately suitable for flood irrigation. With the development of water storage facilities, the regulated flow has increased and changed the irrigation potential significantly, since it was estimated at 4.05 million ha only in 2007. However, irrigation development depends to a large extent on the volume of water released by the upstream countries. The total area of Iraq has been divided into the following categories with regard to land use (see Table 2):



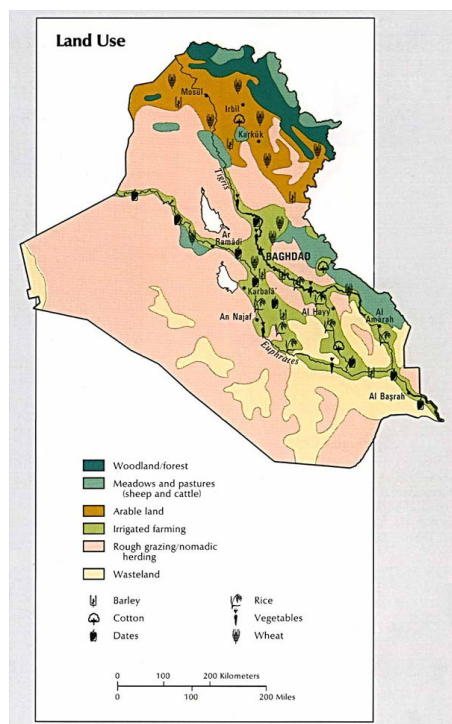


Figure 9. Land use in Iraq

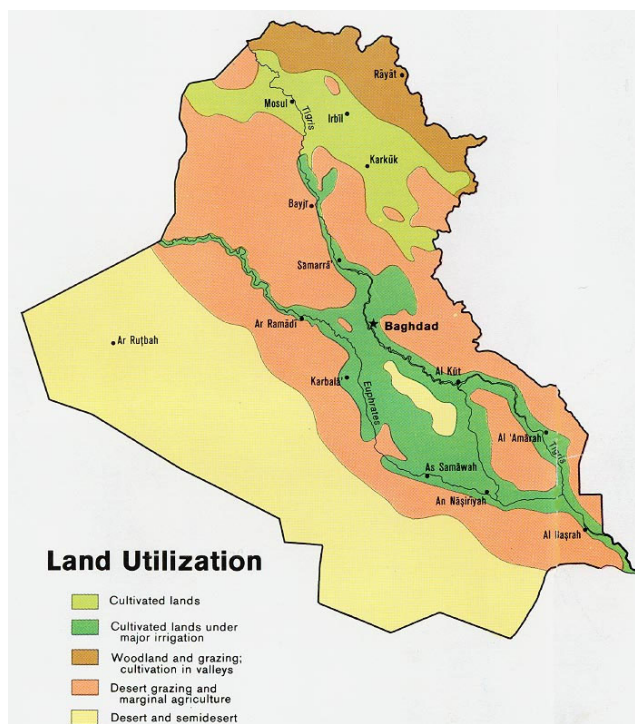


Figure 10. Land utilization in Iraq

### Cultivated area, production of major crops

Most farming in Iraq entails planting and harvesting a single crop per year. In rainfed areas the winter crop, primarily grain, is planted in the autumn and harvested in the spring. In irrigated areas of central and southern Iraq, summer crops predominate. A little multiple cropping, usually of vegetables, exists where irrigation water is available over more than one season.

Even with some double or triple cropping, the intensity of cultivation is usually of the order of 50% because of the practice of leaving about half the arable land fallow each year. In the rainfed region, land is left fallow so that it can accumulate moisture. The fertility of fallow land is also increased by ploughing under weeds and other plant material that grow during the fallow period. On irrigated land, fallow periods also contribute some humus to the soil.

Generally rainfed agricultural lands in Iraq are limited in area. The regions that are suitable for full mechanization of crop production are the ones in the low rainfall areas (Jazeera and the foothills). On the other hand, the areas with good rainfall are the steep and rocky mountainous areas. Iraq however, has rich water resources with a potential to bring extensive areas under irrigation. Despite huge irrigation potential Iraq still depends heavily on rainfed lands to meet its grain requirements (Tully, 1986).

The major portion of the agricultural land in Iraq is cultivated with field crops. Wheat and barley are by far the most important crops and occupy most of the area in the rainfed regions (Figure 11). Data on the areas cultivated in hectares for various major crops and yields obtained in tonnes are presented in Tables 4 and 5. Other crops of significance and major importance are pulses that include lentils, chickpeas, broad beans (Tables 6 and 7), oil seed crops such as cotton, sesame, sunflower (Tables 8 and 9).

Vegetable production has also increased, particularly near urban centres, where a comparatively sophisticated marketing system had been developed. Vegetable gardening usually employs relatively modern techniques, including the use of chemical fertilizers and pesticides. Tomatoes are the most important crop, with production



Figure 11. Rainfed barley crop overtaken with weeds

**Table 4. Area (000 ha) under different crops**

Crops	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Wheat	1 200	1 220	1 649	1 714	1 540	2 550	1 514	1 570	1 435	1 262
Barley	1 110	1 200	1 300	1 063	957	1 063	1 026	1 094	1 349	704
Dates	110	102	102	102	102	50	102	105	115	120
Paddy rice	100	100	100	29	88	107	126	124	85	55
Vegetables	30	33.5	27	28	30	31.7	25	24	23.1	20.6
Tomatoes	77.3	80	84.5	23.3	66.5	67	65.8	59.5	59.6	51.9
Pulses	106	165	198	194	119	29	30	27	28	17
Orchards	192	182	181	181	174	122	176	171	201	209
Potatoes	39	38	53	61	39	51	45	33	33	20
Fibre crops	20	40	54	24	20	27	22	17	8	13
Oil seed	96	115	124	98	99	112	96	89	76	73
Sugar beet	0.330	0.330	0	0.004	0.004	0.004	1.8	1.8	1.8	1.8
Sugar cane	5	6	7	0	0	0	0	0	0.175	0.250

Source: FAO Statistics, 2011

**Table 5. Production (000 tonnes) of different crops**

Crops	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Wheat	384	903	2 589	2 329	1 832	2 228	2 086	2 203	1 255	1 700
Barley	400	550	1 032	861	805	754	919	748	404	502
Dates	932	907	866	868	875	404	432	431	476	507
Paddy rice	60	128	250	90	250	309	363	393	248	173
Vegetables	140	170	110	120	140	153	115	105	97	94
Tomatoes	989	132.1	130.9	264	988	939	1 042	955	802.4	913.5
Pulses	75	103	118	121	71	32	44	31	25	22
Orchards	11	23	32	15	12	10	9	10	4	8
Potatoes	545	623	897	812	630	808	795	598	349	223
Fibre crops	11	23	32	15	12	10	9	10	4	8
Oil seed	39	42	48	40	42	41	38	39	39	35
Sugar beet	8	8	0	0.065	0.070	0.070	19	18	17	18
Sugar cane	65	65	70	0	0	0	0	0	3.7	6.3

Source: FAO Statistics 2011

**Table 6. Area (ha) under pulses**

Crops	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Beans* dry	9 000	9 000	7 000	7 000	6 300	6 300	5 200	4 377	4 600	4 302
Broad/horse beans dry	6 500	2 250	4 000	3 250	7 250	4 500	3 000	4 750	4 250	3 150
Chick pea	85 362	149 513	180 436	180 000	100 000	11 750	10 000	11 500	10 500	935
Cowpeas dry	700	782	600	580	550	483	750	631	663	726
Lentils	2 750	2 000	4 500	1 500	3 000	4 500	9 750	2 900	5 375	5 375

Source: FAO Statistics 2011

\*Phaseolus beans

amounting to more than 600 000 tonnes in 1985 increasing to 913 493 tonnes (on 51 888 ha) in 2009. Other vegetables produced in significant quantity are beans, brinjal, okra, cucumbers, and onions. Overall vegetable production remained stable between 2008 and 2009, even though the production of legumes dropped about 60% over the same period.

Area harvested each year indicates that both wheat and barley yields and area planted fluctuate considerably from year to year (Tables 4 and 5). During 2005, the wheat area was nearly double that in any other year from 2000 to 2009 because of good rainfall, with poor rainfall in the rest of the years. Such fluctuations in area and yield are less conspicuous with regard to barley, perhaps because barley requires

**Table 7. Production (tonnes) of various pulses**

Crops	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Beans* dry	8 900	8 900	8 000	8 164	8 118	7 991	6 500	4 219	3 037	2 460
Broad/horse beans dry	14 000	3 000	9 000	5 000	9 000	6 000	4 000	15 000	12 819	10 874
Chick pea	48 890	87 197	96 776	104 000	50 000	13 000	15 000	5 000	2 000	748
Cowpeas dry	600	822	500	490	480	410	600	389	280	227
Lentils	2 000	2 000	3 000	2 000	2 700	4 000	17 000	3 368	2 000	2 000

Source:FAO Statistics 2011

\*Phaseolus beans

**Table 8. Area (ha) under various oil seeds**

Crops	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Groundnut	439	800	750	700	704	650	1 000	913	772	739
Linseed	570	550	500	470	473	537	400	365	309	296
Olives	2 000	1 700	1 832	1 250	950	1 079	923	2 800	3 400	4 050
Seed cotton	19 750	40 250	54 000	24 380	20 000	27 000	22 250	16 500	7 600	13 300
Sesame	23 000	23 000	18 000	25 250	30 250	35 500	24 250	21 750	16 300	7 500
Soybean	100	50	50	50	50	57	49	45	38	36
Sunflower	50 000	49 000	49 000	47 000	47 000	48 000	48 000	48 000	49 000	49 000

Source:FAO Statistics 2011

**Table 9. Production (tonnes) of various oil seeds**

Crops	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Groundnut	1 144	2 400	2 250	2 100	3 108	1 950	2 000	2 152	1 922	1 935
Linseed	290	250	200	180	181	168	150	161	144	145
Olives	6 000	6 000	5 500	4 000	3 000	3 000	3 000	9 052	10 840	12 992
Seed cotton	33 000	65 000	92 000	41 500	37 000	29 000	25 000	28 993	11 633	23 871
Sesame	14 000	14 000	22 000	2 0000	26 000	24 000	18 000	16 300	18 222	4 559
Soybean	100	60	50	50	50	47	43	46	51	47
Sunflower	66 000	65 000	65 000	63 000	63 000	64 000	64 000	64 000	65 000	65 000

Source:FAO Statistics 2011

less water than wheat, and it is more tolerant of soil salinity. For these reasons, Iraq started to substitute barley for wheat in the 1970s, particularly in southern regions troubled by soil salinity. However, although between 2000 and 2008, the total area under barley cultivation grew slightly, by 2009 wheat production was virtually 2–3 times higher in terms of total yield. Several types of summer/winter vegetables are also important crops in Iraq. Iraq also produces several other crops such as maize, millet, and oil seeds in smaller quantities.

Lentils and chickpeas are mainly cultivated in the northern provinces of the country under rainfed conditions. Also, over 65% of the wheat land is in the rainfed region and contributes over 50% of the wheat crop produced each year. Also 40% of barley lands are in the rainfed areas.

Cultivated area and production of sugar beet and sugar cane in Iraq is negligible; the production of sugar cane was discontinued during 2003 and 2007. Iraq may have cut back on production of sugar beet and sugar cane because of an intention to produce sugar from dates. Dates, of which Iraq produces eight distinct varieties, have long been a staple of the local diet. The most abundant date groves were along the Shatt al Arab. In the early 1960s there were more than 30 million date palms. In the mid-1970s, the Iraqi government estimated that the number of date palms had declined to about 22 million, at which time production of dates amounted to 578 000 tonnes. The devastation of the Shatt al Arab area during the Iran-Iraq War hastened the destruction of date palm groves, and in 1985 the government estimated the number of date palms at fewer than 13 million. Date production between 2005 and 2009 dropped to almost half of the total production in 2000. The government-managed Iraqi Date Administration, however, planned to increase production in an attempt to boost export revenue. The Iraqi Date Administration also devised plans to construct large facilities to extract sugar, alcohol, vinegar, and



**Table 10. Area (ha) of forages**

Crops	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Alfalfa	4 500	4 500	4 500	4 500	4 500	4 500	4 500	4 500	4 500	4 500
Forage legumes	520	520	500	500	500	500	500	400	400	400
Clovers	34 000	34 000	30 000	30 000	30 000	30 000	30 000	30 000	29 000	29 000
Maize	72 750	98 250	101 500	95 250	185 000	173 750	164 500	155 000	122 575	114 050
Millet	4 000	4 000	4 000	1 750	4 500	5 000	4 000	5 650	4 925	2 850
Oats	6 000	633	500	460	300	280	250	200	100	71
Sorghum	3 000	3 000	3 000	2 762	2 639	3 403	2 974	2 939	2 787	2 953
Vetch	1 600	1 826	1 800	1 760	1 630	1 700	1 864	1 569	1 649	1 600

Source:FAO Statistics, 2011

**Table 11. Production (tonnes) of forages**

Crops	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Alfalfa	230 000	230 000	210 000	210 000	220 000	220 000	200 000	195 000	195 000	195 000
Forage legumes	31 000	31 000	31 000	30 000	29 000	29 000	28 000	26 000	26 000	26 000
Clovers	730 000	730 000	600 000	600 000	600 000	600 000	600 000	580 000	580 000	580 000
Maize	55 000	232 000	248 000	233 000	416 000	401 000	399 000	384 000	287 955	238 113
Millet	4 000	4 000	4 000	2 000	4 000	4 000	4 000	6 471	4 470	1 954
Oats	480	616	400	341	321	450	500	700	300	215
Sorghum	1 000	1 000	1 000	852	802	896	914	905	727	761
Vetch	1 000	1 370	1 150	1 174	1 099	1 000	1 192	822	511	850

Source:FAO Statistics, 2011

concentrated protein meal from dates. Iraq produces a variety of other fruits as well, including melons, grapes, apples, apricots, and citrus. Production of such fruits decreased almost 40–50% between 2000 and 2009.

Compared to wheat and barley the areas planted to forage crops are very small. The most important among these forage crops are alfalfa (*Medicago sativa*), maize (*Zea mays L.*), sorghum (*Sorghum vulgare*), vetches (*Vicia sativa*) etc. (Tables 10 and 11). Almost all of the forage crops are planted under irrigated conditions and are fed under the cut and carry system. Most of the alfalfa is preserved as hay and surplus quantities of alfalfa are also transported and sold throughout the country for feeding during forage scarcity periods. The yields of all the forage crops are extremely low due to traditional production and management practices and unavailability of seeds of improved varieties. The forage yields can be enhanced through the use of improved seeds, suitable heat, drought, and salinity tolerant varieties and use of proper quantities and types of fertilizer.

## 4. RUMINANT LIVESTOCK PRODUCTION SYSTEMS

Livestock constitutes an integral part of farming systems. Traditionally farmers keep livestock to enhance farm incomes and satisfy their basic food requirements for milk, meat, milk by-products etc. For centuries millions of head of sheep have been roaming over the natural rangelands in the deserts, the foothills and mountain regions of Iraq. The sheep population however, was reduced when parts of the desert lands were converted into farmlands (Jazeera) and rangelands progressively became less productive as a result of uncontrolled grazing. Sheep farmers are becoming fewer because of the severe drought in recent years.

Iraq's rich and distinctive livestock population is largely a result of being in the centre of origin from which the most common farm animal species came. However, productivity and feeding conditions of these animals, naturally limited by the land's pasture potential, are not optimum. Ancient traditions in rural communities that are significantly involved in animal husbandry still survive and maintain the diversity of cattle, sheep, goats and buffaloes. However, in some cases these practices have been greatly

**Table 12. Livestock population by type (000)**

Item	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Cattle	1 350	1 458	1 500	1 425	1 516	1 648	1 130	1 145	1 552	1 600
Camels	9	8	10	7	7	30	51	51	58	58
Buffaloes	115	109	120	115	111	213	410	396	286	275
Horses	48	48	48	47	47	47	46	47	47	48
Sheep	6 900	6 045	6 100	6 255	4 473	4 449	5 200	6 800	7 722	7 800
Goats	1 300	743	740	715	549	523	645	1 078	1 475	1 550
Asses	380	385	380	380	380	380	380	380	380	380
Mules	11	11	11	11	11	11	11	11	11	11
Poultry	23 000	28 000	32 000	24 000	30 000	37 000	40 000	45 000	27 500	27 500

Source: FAO Statistics, 2011

modified, especially after the massive import and dissemination of exotic livestock and the extensive crossing with local breeds. Livestock contributed about one-third of Iraqi rural families' income prior to the 1960s. In the past, a substantial part of the rural population had been nomadic, moving animals between seasonal grazing areas.

Sheep, goats and cattle are the most important livestock, supplying meat, wool, milk, skins, and hair. In the 1970s, the government started to emphasize livestock and fish production in an effort to add protein to the national diet. Although cattle and sheep numbers actually declined from 1970 to 2000, production per head and overall total meat and milk production increased, but less than the potential. In 2 000 the sheep population was around 6.9 million and the goat population at some 1.3 million (see Table 12). By 2009 numbers were estimated to have increased to 7.8 and 1.55 million respectively. Sheep and goats are tended primarily by nomadic and semi-nomadic groups. The numbers of cattle were estimated at 1.35 million in 2 000, water buffalo at 115 000 (Figure 12), horses at 48 000, and camels at 9 000. According to FAO statistics (Table 12), by 2009 there were 1.6 million cattle, 7.8 million sheep, 1.55 million goats, 275 000 buffaloes, 48 000 horses and 58 000 camels.

The production of milk and meat virtually collapsed in 2003 due to the Gulf War. Although between 2003 and 2009 both meat and milk production has improved, figures have failed to reach earlier production levels. 2009 meat production was only slightly above 2000 levels and milk production in 2009 was less than half the 2000 figure (see Table 13). As well as the poor health of the dairy cows, the main factors limiting livestock and poultry production include critical shortages of feed/forages, veterinary services and drugs, machinery and equipment and lack of spare parts.

Another constraint, of growing importance, is the gradual shift in land use of pasture land for opportunistic grain production. Poultry consumption in Iraq was high because of increased individual income before 1990. This caused an increase in imported poultry and generated the need for a transport and storage system for perishable products. For these reasons, the government initiated a scheme to establish and develop large poultry projects to supply the country with sufficient poultry and poultry products. During the 1980s, there were 8 353 small and 25 large poultry projects, which provided about 1 688 million eggs, 106 million hatching eggs, and 250 000 tonnes of chicken meat, annually. However, many of these projects are either closed down or are functioning at a fraction of full capacity.

Animals in the region mainly graze on crop residues and natural pastures supplemented by imported cereals and protein. Improved forage production is neither a priority nor an important traditional part of the cropping system, both for conserved feed and fertility maintenance. The forage problem in the area is both quantity as well as quality of forage available with the digestible protein being the most important limitation. Water availability, soil fertility, use of improved production techniques, introduction of forage legumes into the present farming system and mix-planting of forage legumes with



**Figure 12. Buffaloes are mainly dominant in irrigated areas with plenty of forage**



**Figure 13. Intercropping of forage crops in orchards**



**Figure 14. Integrated farming systems are found in irrigated regions**

cereals mainly determine the quantity and quality of forage produced.

Since water is the major limiting factor throughout the country and it is mainly used for production of high value crops (vegetable and fruits), it is advisable to produce fodder in dry and semi-dry areas. It is possible to ameliorate the situation by introducing suitable forage species with heat, frost, and drought tolerance and adapted to the arid and semi-arid environment. Although soil conditions (physical and topographic) are also limiting, fodder crops can easily be initiated in the mountainous areas where there is more rain.

Due to limited per capita land holdings in the country and the very small amount of irrigated land available, the farming system consist of intensive cultivation of high value vegetable and fruit crops on irrigated land along with livestock production. Livestock are usually maintained on crop residues, limited forage production, and extensive utilisation/grazing of pastures/crop residues. The majority of the farmers who have orchards also own livestock; an integrated approach is required that complements rather than competes with the existing farming system. Forage legumes such as alfalfa (*Medicago sativa*), vetch (*Vicia sativa*), cowpeas (*Vigna sinensis*) and various types of clovers can successfully be grown in association with fruit trees (Figure 13), providing forage for livestock as well as improving soil fertility through biological nitrogen fixation.

The resources in the region are not endless (Rafiq, 1974). Lack of quality forage is one of the major factors

limiting animal production. Therefore, if the increasing living standards of the local population are to be maintained, the productivity per animal needs to be enhanced instead of increasing the number of livestock. There is a great need for feed of high quality to obtain maximum value from animals and particularly year round supplies of nutritious forage to improve both meat and milk production. Improved forage and its quality could be of immense benefit to the livestock and to the health and welfare of the rural farming communities in the country.

It is important to mention that over 36% of the sheep and 50% of the goats are raised in the rainfed provinces in northern Iraq. Most of the animals in the Northern provinces depend for their feeds on natural grazing and on crop residues. These animals are kept on the range and on wheat, barley and chickpea fields from February or March till October. Lot feeding with straw and barley is practiced for sheep during the remaining months of the year.

Although the statistics are not broken down by location of the livestock, a substantial number of sheep are found in steppe areas while most of the cattle are commonly reared in irrigated areas (Figure 14). The farmers generally tend to rear cattle in wetter zones with sheep in drier regions. Usually the numbers of livestock in the desert region are small due to limited availability of forage during summer and autumn, and the difficulty of living permanently in the desert.

Livestock play a key role in the mixed farming areas of the country, particularly for small farmers in dry zones. Also from studies in other countries it has been found that livestock contribute as much income as crops in dry areas, for example Morocco and Cyprus (Campbell *et al.*, 1977; Papachristodoulou, 1979), and this is probably typical of the region.

Livestock feeding follows a yearly pattern. The rains in the country start during October–November, and fresh forage is available in winter or early spring depending on temperatures. Therefore, usually the spring is the time of relatively abundant and surplus feed/forage for livestock. Fallow areas and

grazing lands are at their most productive, supplemented by weeds pulled from crops. Sometimes the weeding is delayed to increase the amount of forage harvested (Newberg *et al.*, 1982). Cereal crops are also usually grazed as well which some farmers perceive and claim is beneficial to the ultimate productivity of the crops. The income from the sale of livestock and dairy products is at a peak that sustains the majority of the farmers until the crops are finally harvested.

After harvesting during the months of May-June crop stubbles and residues become available (Figure 15). It consists of weeds and the left-over straw. The rest of the straw is gathered up after combine harvesting to be stored for winter use. After harvesting only weeds are left behind in the soil. There is sometimes enough stubble in some areas to sustain small livestock through the summer months. Standing grain crops with poor stands and being too short for combine harvesting supplements the stubbles in other areas. Dairy cattle usually require additional feed at this time, sometimes provided in the form of industrial by-products.

Depending on the location, irrigated or summer crop residues may be available towards the end of summer locally or at some distance. The feed tends to be fairly high in nutritive value and are the last fresh forage until the subsequent spring. Depending on temperature and the weather conditions, the winter grazing might be good but is unreliable. In colder areas animals need to be fed the conserved feeds for two to five months. The feed mainly consists of barley grain along with cereal straw wherever available. Legume straw is also highly valued. The potential of the cereal straw should not be underestimated as it provides around 45% of the metabolizable energy and 30% of crude protein to the livestock in Iraq during the winter feeding period. In irrigated areas the cotton and sugar crop by-products are also available at reasonable cost.

The policies often have been officially or practically structured to favour large farms over small, irrigated agriculture over rainfed and high rainfall areas over low rainfall (Campbell *et al.*, 1977; Hogan *et al.*, 1984). This applies to the availability of inputs, credit, and extension as well as research.

### Production systems

Livestock in Iraq are managed under four different production systems: the traditional extensive, mixed and farm marginal, semi-intensive and species- specific intensive system.

#### Traditional extensive system

Sheep and goats are the most dominant livestock under this system (see Figure 16). Local cattle are also commonly reared in some mountainous parts of the country. Most of the animals depend on free grazing in the foothill areas (Figures 17a and 17b) during the late winter and spring, on cereal stubbles and irrigated crop residues in summer and autumn, and on feed supplements in early winter. Livestock herds constantly range long distances to exploit feed resources round the year. Animal holdings fluctuate among species, season, type of rearing and owners. Sheep usually are reared alone or mixed with goats. The average herd size of cattle, goats and camel ranges from 10–120 head. In some parts of the country with good rainfall flock size ranges between 200 and 500 head. Some rich tribesmen have 1 000 or more head of sheep and goats.

#### Mixed and farm marginal system

Flocks are usually sedentary and are mainly kept in villages or around the cities year-round to exploit the communal lands, fallows, field borders, roadsides, irrigation canals, crop residues, and cereal stubbles



**Figure 15. Utilization of wheat and barley stubble for grazing**



**Figure 16. Traditional extensive livestock system with sheep and goat dominant**





**Figure 17a. Over-exploitation of pastures in northern Iraq**



**Figure 17b. Over-exploitation of natural grazing lands in northern Iraq**



**Figure 18. Subsistence farming of a small number of livestock along with crops**

(see Figure 18). Owners with access to land usually practice mixed farming and produce several different types of crops such as cereals, grain/fodder legumes, vegetables and trees. A small number of improved breeds of cattle, goats and some flocks of sheep alone or mixed with goats in addition to the indigenous poultry and rabbits are dominant in this system.

#### **Semi intensive system**

This is not very common and only practiced in cultivated areas where enough feed and forage is available. The livestock are mainly stallfed for most of the year except in spring when some grazing is available, in some

areas of the country. Only sheep flocks with 10 000–15 000 head owned by cooperative companies and Government farms or projects are included in this system. Roughages and concentrates are the major feed resources fed to the stall-fed flocks.

#### **Species-specific intensive system**

It mainly consists of hundreds of animals (sheep, goat or camels) for fattening, high milk producing imported dairy cattle (Holstein- Frisian [Friesian]) etc. Since all the livestock require nutritious, good quality, and balanced feed for optimum productivity, they are stallfed. The system is becoming extremely popular, profitable and very common in the peri-urban areas, where animals are fattened for the local market, transported to other cities, or (infrequently) exported. The usual herd size ranges between 20 and 500 head.

#### **Cropping patterns/farming systems in rainfed regions**

There are two main farming systems based on major cereal crop production (mainly wheat and barley):

- cereal –fallow
- continuous cereal

In the cereal-fallow system the fallow comprises the stubble of the previous year's crop and volunteer plants. The fallow is ploughed in March-April before the plants have produced seed and before the last spring rains. They therefore serve three purposes:

- control of weeds;
- conservation of moisture and;
- build-up and release of mineral nitrogen.

The last purpose is of rather more importance than has perhaps been realized, for two reasons; Firstly, because of the presence of several native legume species inhabiting the fallow, and secondly, because of the extremely low nitrogen requirement of the cereal varieties used in this system. Among the most important native legumes are *Hippocrepis unilguosa*, *Coronilla scorpiodes*, *Trigonella caelesyriaca*, *Scorpiurus muricatus* and a number of species of *Vicia*, *Lathyrus*, *Trifolium* and *Medicago*.

The farmers in the region cultivate a wide range of crops both under dryland and irrigated conditions. Wheat is the dominant crop and the majority of the area is under durum wheat as it is preferred for “burghul” (cracked wheat), it fetches a high price and its yield is equal to bread wheat. Chickpea is the major rotation crop in the medium to high rainfall areas. Barley is the dominant crop in the drier areas and is rotated with fallow. Vegetable crops such as tomatoes, cucumber, squash, onion, melons, brinjal, okra and fruit trees such as apricot, plums, apples, pears, peaches, grapes, pomegranate etc. are usually grown under irrigated conditions and also in the high rainfall areas near water courses. Confectionary type sunflower is widely grown under rainfed conditions but after installation of the oil factory in Arbat, the area under oilseed sunflower is steadily increasing. There is a considerable area under sesame cultivation that could be expanded to contribute to the requirement for vegetable oil. Rice is cultivated in the wet regions where water supplies are in abundance. There are also small areas with many other crops for niche markets at present (but these possibly have greater potential in future) such as walnuts, olives, cherries, peanuts, maize, sorghum, millets, vetches, alfalfa, soybeans, green beans, etc.

Livestock production plays an important role in the present farming system. In the three northern governorates (i.e. Suleymaniyah, Erbil and Dohuk), there are over 5.8 million sheep and goats in the north and also 1 million cattle, buffaloes, horses, and donkeys. All these animals require supplementary feeding during some part of the year with grains and roughages of some kind. It is estimated that about 150 000 Mt of barley grains are needed as against the total production of 100 000 Mt and about 35 000 Mt of legume grains are required annually to feed the total number of grazing animals for maintenance only. The yields of barley can be increased by 2–3 times based on the average rainfall in the non-secure rainfall areas. In addition, there is a requirement for about 60 000 Mt of cereal grains and 12 000 Mt of legume grains to feed the poultry. At the present yield levels, production of feed for animals will require about 250 000 ha of arable land. Much of the region is mountainous and perhaps half the livestock inhabit the mountains: even so the remaining 650 000 sheep are carried on something less than 250 000 ha (the amount of land cropped each year), at a rate of almost 3 sheep per ha.

Drought in this area is an annual event and a number of farming methods have evolved to deal with it in various ways such as:

- storing grain to feed animals during the dry periods;
- selling failed crops for grazing;
- using all of the crop residues for animal feed;
- using fallow;
- having more than one source of income; and
- being flexible enough to move to find employment or grazing.

The exceptions to the pattern of settled agriculture are migratory sheep and goat herders (Figure 19) who move from the plains in the centre and south of Iraq to the north according to the supply of grazing. Whenever there is a sufficient supply of feed in the south, they do not move north. There are also several farmers in the north who move down from the mountains during winter to escape the cold and feed deficiency (transhumance system). Both types of herders have to supplement the feed of their livestock with feed grains bought from local farmers.

The cereal–fallow system has been employed for millennia. In contrast, the system of continuous wheat is a recent innovation. The impetus for its introduction has apparently come from Iraq’s increasing need to import cereals for its rapidly expanding population. In this system only the stubble is grazed by livestock – for the remainder of the year, livestock are fed only on barley grains along with wheat/barley straw.

The stubble is ploughed, worked dry and the crop sown either dry (the preferred time) or as soon as possible after the first autumn rains. In order to work, this system requires large inputs of nitrogenous



**Figure 19. Migratory livestock exploiting forage along road and field sides in spring**



fertilizer: in the region the amounts of urea applied exceed 100–150 kg per ha and the crop still appears patchy.

It is important to realize that of these two systems (continuous cropping and cereal–fallow) the cereal–fallow system is of far greater stability. While data on soil fertility within the two systems are not available, it seems likely that under the cereal–fallow system yields are either declining or the requirement for nitrogenous fertilizer is increasing. The cereal–fallow system requires only minor modifications to become a cereal–pasture system in which soil fertility levels will increase. In contrast to both continuous cereal and cereal–pasture, however, weed control in a cereal–fallow system does not require the widespread use of chemicals.

The change from cereal–fallow to continuous cereal has been accompanied by change in cultivation techniques. As pointed out earlier cultivation of the fallow in late spring was successful in controlling most weeds: When the system of continuous cereal is used the weed problem becomes more serious. The three strategies employed to control weeds are:

- deep ploughing in summer to bury weed seeds;
- the postponement of sowing until after the autumn rains to control newly germinating weeds and;
- the use of chemical sprays.

These strategies have become possible because of availability of more powerful tractors and their associated implements: for example it is necessary to use tractors of 220 horsepower to pull an eight-share mouldboard plough for the original summer ploughing. It is interesting to note that deep cultivation has resulted in a second serious problem - uneven land surface.

To sum up, the cereal–fallow system has achieved stability at a low level of productivity. It is the system which is used on the majority of farms in the rainfed areas of the region. The continuous wheat system is more productive but unstable in that it has:

- an increasing weed problem;
- an increasing dependence on nitrogenous fertilizers, uses inappropriate machinery and;
- probably has decreasing soil fertility.

If the demands of rapidly increasing population for cereals, vegetables, fruits, forage, oil seeds crops etc. as well as for meat, milk and milk by-products are to be effectively addressed, then modifications in the present farming systems are of utmost importance. Some of most important weaknesses of the traditional farming system observed and that need immediate attention are summarized below as:

- low crop yields;
- poor/depleted soil fertility;
- unfavourable pricing policies;
- limited land holdings;
- inadequate research and extension facilities/capacity;
- poor machinery maintenance;
- unavailability of improved seeds and fertilizers;
- inadequate marketing facilities;
- low appreciation of the importance of quality;
- uncertain size of the water resources.

It is recommended to introduce mixed farming systems through forage legumes, intercropping of legumes with cereal crops and orchards, ley farming, conservation of barley as hay and urea treatment of wheat/ barley straw to improve the feed quality.

## 5. THE PASTURE RESOURCE

### Mountain forests and herbaceous vegetation

Forests cover high mountains within the boundaries of areas characterized by Mediterranean climate. These mountains are considered the most densely vegetated areas of Iraq because of sufficient rainfall and moderate temperature. The forests cover 70% while grasses and shrubs cover the remaining 30% of the region. Prominent species belong to the genera *Quercus* and *Pinus*. This region forms reserved grazing for livestock from other regions during periods of scarcity and during summer.

### Steppe region

Steppes cover undulating lands and the eastern parts of the sedimentary plain. They are characterized by the presence of grasses, bulbs and thorny species:

### Riparian vegetation

This type of vegetation covers riverbanks and is characterized by the presence of trees, shrubs and grasses. They include species such as *Tamarix*, *Salix* sp., *Alhagi maurorum*, and *Prosopis farcata*. Riverbanks also host citrus trees and date plantations,

### Al-Ahaur region

These swamps (wetlands) are found in the southern part of the sedimentary plain. They form a triangle with its peaks at Al-Amara, Al-Nasirya and Al-Qarnah. It encompasses the most important Ahaur in the country as for instance Haur Al-Hueiza and Haur Al-Hammar. Its natural vegetation is mainly *Phragmites communis* and *Typha angustata*.

### Desert region

This region comprises the desert plateau and sedimentary plain with the exception of its northern and eastern fringes. Due to wide variation between day and night as well as between summer and winter temperature coupled with low and erratic rainfall this region has sparse vegetation adapted to the prevailing harsh environment. Prominent species are *Tamarix*, *Achillea fragrantissima*, *Ziziphus* and other desert plants (Sabah El-Kuwaz, 2005). Desert areas are characterized by harsh environment and the problem of salinity in some locations, particularly in depressions. Hence most of the plant species growing naturally in this region have become adapted to this harsh environment as well as tolerance to both salinity and drought. There are about 500 plant species in the desert region out of which 110 species are shrubs while the rest comprises annual and perennial herbs. These species vary in their tolerance to drought and salinity as well as in their grazing value. There are also variations regarding season of growth and duration for which the plant remains green (Sabah El-Kuwaz, 1984). The relevant information about some of these species is presented in Table 14. Some of these species could be one of the best sources for range improvement. In Iraq the establishment of forests and protected range sites, was initially started as wildlife reserves and to improve their condition. Since 1974 large areas were selected and fenced to protect natural vegetation and wildlife. The main objective behind such intervention was to conduct research on regeneration of trees and other plants as well as to monitor impact on wildlife in order to replicate the results in other regions with similar climatic conditions. However, only a few of these reserves were actually established, because of the unstable conditions in the country since 1980.

### Biodiversity

Four vegetation zones are recognized in Iraq: the desert, the steppe, the mountain forest, and the Alpine regions. However, desert and steppe regions are not readily discernible. Low rainfall plays a dominant role in the formation of the short-lived herbaceous plants in the last two zones. Arboreal types are practically absent in the steppe and deserts of Iraq. The northern part of the country, with its mountains and available rainfall, sustains virgin forests, man-made forests, and a large number of crop plants and their wild relatives. Over cutting and overgrazing in the Zagros Mountains have reduced some of Iraq's oak forests to scrublands. Stands of other trees, for example maple, hawthorn, and pistachio, remain

**Table 14. Some fodder shrubs commonly growing in Jazeera, Northern and Southern Deserts**

Plant	Palatability			Area of existence, salinity and/or drought tolerance
	Sheep	Goats	Camels	
<i>Artemisia herba-alba</i>	1	2	2	North and southern deserts
<i>Haloxylon salicornicum</i>	1	2	3	Southern desert and sand dunes
<i>Haloxylon articulatum</i>	1	2	3	Northern and southern desert
<i>Haloxylon persicum</i>	1	2	3	Northern and southern desert tolerates drought & salinity
<i>Rhanterium epapposum</i>	1	2	3	Northern and southern desert tolerates drought
<i>El-Rawtha*</i>	1	2	3	Northern and southern desert tolerates drought
<i>Atriplex</i> spp.	2	2	2	Southern desert and sand dunes
<i>Traganum nudatum</i>	1	2	2	Northern and southern desert & parts of Jazeera desert tolerates salinity
<i>Salsola vermiculata</i>	1	2	3	Limited parts of Jazeera, northern and southern desert, tolerates salinity & drought
<i>Tribulus terrestris</i>				
<i>Stipa</i> sp.	1	2	3	Found in three deserts & tolerates salinity
<i>Elsalmasa*</i>	1	2	J	Found in three deserts & tolerates drought
<i>Seidlitzia rosmarinus**</i>	-	-	3	Southern desert & tolerates salinity
<i>Prosopis farcata</i>	3	3	3	Grows in ares <50 mm/year, tolerates drought
<i>Alhagi maurorum</i>	-	1	2	Limited population in desert, tolerated drought
<i>Elsunut*</i>	-	2	2	Southern desert, tolerates drought
<i>Halogeton alopecuroides</i>		2	3	Northern and southern desert, tolerates drought & salinity
<i>Tamarix</i>	-	1	1	Northern and southern desert, tolerates drought & salinity
<i>Elathima*</i>	1	1	2	Jazeera and southern desert, highly tolerant to salinity

NB: - non-palatable, <sup>1</sup> low palatability, <sup>2</sup> good palatability, <sup>3</sup> highly palatable; \*local name, species not known; \*\*species by this name not identifiable; possibly could be *Seidlitzia rosmarinus*??

however. Alpine plants that can survive harsh weather appear at higher elevations. Indigenous plant and animal life in Iraq is under increasing threat due to the impact of development. Overgrazing and mismanagement of rangelands have led to the loss of natural plant cover. Deforestation is now a major concern in the northern highlands and mountains. The northern part of Iraq is a rich centre of diversity for a number of stone fruit trees, both wild and domesticated. Evergreen fruit trees, including date palm, predominate in central and southern Iraq. The date palm enjoys a favourable status in Iraq. In the early 1980s, an estimated 30 million date palm trees were growing in Iraq, but the number has declined dramatically since then. Major efforts have been initiated for the proper conservation and propagation of more than 700 varieties of date palm in Iraq. Traditional (offshoots) and modern propagation methods, including tissue culture, have been utilized to maintain and to enhance the genetic diversity and promote the cultivation of this ancient tree.

### Rangeland and grazing resources

Rangelands cover about 75% of the area in Iraq and are found mainly in Jazeera Badia as well as the northern and southern Badia. Rangelands, due to their contribution to livestock feed, play a vital role in determining the size of the national herd. In the past these rangelands were one of the major sources of the livestock feed requirements. Also livestock used to contribute an appreciable proportion of the total earnings of the farming communities. Unfortunately the majority of the rangelands have been degraded and productivity sharply reduced mainly due to overgrazing, uprooting of shrubs for fuel wood and charcoal making, lack of management of grazing resources, expansion of cultivation at the expense of rangelands, ploughing of some sites, and due to the migration of large numbers of livestock from neighbouring countries to exploit available forage during the grazing season. Consequently, and especially during dry periods, the country faces critical shortages of livestock feed (Figure 20) and animal products. The majority of the rangelands have been extremely degraded both in the northern and southern Badia. The recent data on productivity ranged from 60 to 80 kg DM/ha/year.

Draz (1969) regarded instability of herder lives and lack of property rights as the major reasons for overgrazing and misuse of rangelands. He therefore emphasized the importance of studying the human factor in relation to land use, land tenure, and number of grazing animals to determine the actual reasons

for range degradation. Considerable improvement can be achieved through controlling the number of livestock. The improvement could also be enhanced by delaying or discontinuing grazing/resting pastures for reasonable periods for plant reproduction, establishment of new plants, and/or restoration of vigour and size of existing plants. However, it is extremely difficult to practically implement the system as millions of livestock move between dry and wet zones, from winter to summer, and from southern to northern grazing regions throughout Iraq. Pabot (1967) characterized the whole middle east region in terms of long periods of drought, overgrazing of natural lands, deforestation and uprooting of combustible species, uncontrolled dry farming to the detriment of rangelands, rapid exhaustion of cultivated lands, seasonal starvation of animals, soil erosion, loss of water either through runoff or evaporation, and extension of desert or semi desert areas.

Rangelands can be made more productive through following proper grazing management practices. Pearce (1970) stressed that one of the major problems in development of rangelands stems from incorrect land use through ploughing marginal lands or through overstocking. Le Houerou (1971) has demonstrated that dry forage yields per hectare in average rainfall areas of between 75 mm to 400 mm can be four to five times higher, with better quality, under proper management. While the rangelands in Iraq are highly degraded due to overgrazing, most of them have not yet reached the point of no return with regards to forage yields and quality through natural plant succession.

Therefore development of an integrated land use system for the whole country is necessary to maximize production from rangelands, crops, and livestock. Alternative sources of forage production in irrigated areas and supplementation with concentrates to remedy the deficiencies of rangeland diets would be needed to enhance livestock productivity.

Some studies conducted in selected deteriorated range sites have indicated that rehabilitation of such sites can result in a reasonable increase in forage production. In the northern Badia productivity of a site protected for four years was 1 890 kg green forage production/ha as compared to 46 kg/ha in adjacent open grazing sites. Rangelands and forests in Kurdistan Province stretch over 17 million ha. A small area of about 5 000 ha of cultivated pasture has been established. It was accompanied by developing three nurseries for forage species seed, fodder trees and shrub seedling production.

### Review of previous forage programmes

An Australian Project in Suleymaniyah Governorate (Dost, 2003) did some work on forages, especially medics, during the 1980s. *Medicago polymorpha* had greater potential than the other medics. In particular its winter growth was greatly superior to all others and there appeared to be no nodulation problem. Regeneration, however, was unsatisfactory. Establishment of *M. truncatula* was superior to that of *M. scutellata* but this may have been due to a higher level of hard-seededness in the latter.

The recommendation that medic should be sown dry has strong support, for two reasons: sowing wet would involve intense competition for labour between the cereal and medic programmes. Also the earlier sowing gives the population of rhizobia a far greater chance to increase before the soil temperature drop in winter. If medics are sown dry there will be a period when the rhizobia have to survive on the surface of the seed. Rhizobia have a limited life-span after inoculation, usually reckoned to be no more than four weeks. Medics should, therefore, be sown dry and the seed lime pelleted to provide maximum protection to the rhizobia.

Whether or not to sow a cover crop is contentious. In favour is the possibility that winter production can be greatly increased by the inclusion of a cereal. Against: the cereal requires high levels of nitrogen to achieve significant production, that it is a strong competitor for nitrogen, and if successful, will tend to shade the medics. The cereal used should be local black barley, *Hordeum sativum*.

If extra hay is required black barley (10 kg/ha), Maral shaftal clover (*Trifolium resupinatum* - which is native to the area) (2.5 kg/ha) and *Medicago scutellata* (7.5 kg/ha) should constitute the mixture.



**Figure 20. Not enough grazing available during dry years in Iraq**

## 6. OPPORTUNITIES FOR IMPROVEMENT OF PASTURE RESOURCES

Proper rangeland management requires long term investment in conservation and development of the basic natural resources such as natural vegetation, water, soil, conservation of biodiversity, and wildlife. For effective implementation, it would require short, medium, and long-term plans.

### Short-term plans

The important actions in management of desert rangelands are summarized below:

- Establishment of new oases in desert rangelands as well as rehabilitation of degraded ones that have formerly been either privatized or rented. These oases would not only provide services such as water supply to sheep owners but also act as a source for plant genetic resources. Being protected would also improve plant distribution and the restoration of vegetation cover.
- Control/monitor livestock grazing and its implementation according to a well-prepared plan formulated by relevant technical authorities. The plan should aim at maintaining optimum vegetation cover following the utilization of a site by grazing animals and ensuring persistence of palatable species.
- Ensure that strict prohibition of cultivating lands in areas with rainfall below 250 mm/annum is rigidly observed. The same rule should hold true for sloping lands in mountainous regions. Cultivation of such lands is uneconomical in most years and the returns obtained do not cover even the cost of production. Cultivation would also result in soil erosion and its subsequent washing by runoff into wadis and rivers. Dust storms may also blow away the soil into urban centres and other establishments.
- Prohibit the cutting and uprooting of shrubs for fuel purposes, charcoal making and providing alternative sources of energy and feed for their livestock.

### Medium term plans

- Construct roads to connect range stations and oases in Jazeera as well as northern and southern Badia. The vehicles, water tankers and trucks can use the roads to avoid destruction of vegetation caused by off-road driving of vehicles. Unfortunately large areas supporting important fodder shrubs have already been destroyed.
- Establish plant genetic reserves in desert and mountainous regions to conserve germplasm of important and highly palatable forage species. In addition an arboretum for forage species should be established and the activities of the National Herbarium expanded with respect to rangelands species to include information on environment, palatability, and locations etc..
- Ensure availability of concentrates to release current pressure on the range so that it can restore its vegetation and normal condition.
- Establish national parks, protected area/nature reserves in different ecological zones to protect the ecosystem and to facilitate the work of range ecologists for collecting data that can be employed in rangeland improvement and development.
- To avoid overgrazing and deterioration of vegetation cover due to concentration of livestock in specific areas, establish wells in the Jazeera, northern and southern Badia as well as in the eastern region to ensure proper distribution of grazing animals.
- Employ proper water harvesting techniques to collect water and enhance infiltration to increase soil moisture for plant growth.
- Provide range extension services through local media and organize meetings under the umbrella of provinces neighbouring the desert and Jazeera regions.
- Establish small dams across wadis, and other suitable places to store water that can be used for domestic purposes as well as for replenishing groundwater aquifers.

### Long-term plans

Long-term plans would include research and studies in the following areas:

- Prepare detailed topographic and vegetation maps to delineate the degraded rangelands and prepare inventories of feed resources in the different grazing areas.



- Delineation of degraded rangelands using available maps, aerial photographs and ground truth as a measure to rehabilitate some degraded sites by reseeding.
- Conduct studies and research on the role of wildlife in rangelands and determine their impacts on plant cover.
- Introduce, collect, identify, and evaluate suitable plants adapted to desert environments.
- Evaluate and assess suitable methods of water conservation for improving vegetation cover in the desert regions.
- Selection of some pilot sites in the Jazeera, northern and southern Badia for participatory range improvement. These approaches can be adopted as pilot interventions that can be applied in other parts of the country.
- A continuous on-farm introduction, identification, collection, evaluation, and selection programme for salt and drought tolerant forage plants adapted to different ecological zones.
- Establish an information unit to document data, programmes and activities related to rangelands.

## 7. RESEARCH AND DEVELOPMENT ORGANIZATIONS AND PERSONNEL

### **Present Status of Range Management and Relevant Institutions Historical Background**

The variability in ecological zones and environmental conditions in Iraq has resulted in diverse vegetation resources that have attracted many Arab and foreign researchers. Agricultural Departments in collaboration with foreign experts have also initiated several studies. As a result of these efforts a national plants museum (Iraq Plants Museum) has been established. Later the museum formed the nucleus for the present National Herbarium. Various state universities are also playing a leading role in vegetation resources research particularly in the areas of ecology and plant taxonomy. The 1960s witnessed an important development in range research that culminated in the establishment of the Dry Lands Research Centre affiliated to the Scientific Research Council. The Centre in collaboration with the relevant UN organizations carried out research and studies in the areas of ecology and rangelands. In 1967 the Centre was further strengthened with the required manpower and facilities. The Range Division in the Centre played a leading role in efforts to study grazing resources and several studies and research results were published. Later the Centre was transferred to the Ministry of Agriculture as a further upgrading step. The establishment in 1974 of the Directorate General of Range Management subsequently followed this favourable change. The responsibilities and mandate of this Directorate were further expanded when it was upgraded to the General Authority of Rangelands. Unfortunately this Authority was later downgraded to a small branch within the General Authority of Agricultural Services. The Ministry of Irrigation established the General Authority for Oases responsible for environmental issues that have strategic dimensions. Later the Authority was abolished and most of the oases have been privatized. Presently the government units engaged in rangelands development and combating desertification include the following:

- The Division for Combating Desertification (Ministry of Agriculture)
- Sand Dune Research Station in Baiji
- The National Herbarium of the General Authority for Agricultural Research.

All these units have limited facilities and resources including manpower and hence, their activities are also not well coordinated. The present institutional set up and activities do not match the seriousness of the problems being faced. The Kurdistan region has its independent range management unit.

### **Projects and activities of the relevant units Ministry of Agriculture and Irrigation**

A map delineating areas for investment in agriculture and grazing was prepared in 1990 by the Ministry of Agriculture and Irrigation, building on earlier work carried out in the 1970s.



### **The Division for Combating Desertification**

It implements important activities on sand dune fixation that have negative impacts on the environment and other strategic projects. Projects implemented by this Division include:

**Sand dune stabilization:** El-Masab El-A'am. About 30 000 ha of sand dunes were transformed into forests and rangelands to protect El-Masab El-A'am from encroaching sand. Currently about 62 500 ha on both sides of El-Masab El-A'am covered with sand are being stabilized by planting various species such as *Prosopis farcata*, *Atriplex*, *Ziziphus*, and *Tamarix*. All these species have reasonable tolerance to drought and salinity. The intervention has also provided environment friendly conditions that enhanced the regeneration of other plant species growing naturally in the area, which are of reasonable forage value.

**Protection of the railway between Nasirya and Basra:** Sand dunes on both sides of the railway line (40 km) have been stabilized to check sand encroachment that hinders traffic. The same species used in the previous project were established exploiting locally available groundwater.

**Establishment of forage trees and shrubs:** The Division has also engaged in establishing suitable fodder trees and shrubs in fenced sites in the western desert with the objective of propagating these species. This activity will be extended to other selected oases in the region. In addition several oases have been developed in five locations of the desert for securing scarce plant genetic material, providing water for livestock, and creating favourable conditions in the desert to encourage livestock owners to stay.

### **Rangeland Division**

It provides technical advice and follow-up of plans implemented by the relevant agricultural units in the different provinces. Several range stations and fenced sites have been established in several regions and provinces for grazing land development and providing services to livestock.

### **The National Herbarium**

Its main activities focus on collection, classification, and preservation of plant species and recording relevant information. It is also engaged in the conservation of agricultural crop genetic resources.

### **Sand Dunes Research Station (Baiji)**

Its role is to conduct research on fixation and stabilization of sand dunes in Baiji area and utilization of stabilized areas for agricultural purposes.

### **Forest Administration**

The major responsibilities of the Administration include the conservation and protection of natural and planted forests, reforestation and afforestation of areas being developed into productive, protective and recreation forests. The Administration has also been engaged in planting trees along roadsides, establishing/managing forest nurseries for production of tree seedlings and management of grazing within forested areas.

### **Hamad Basin Project**

Sabah El-Kuwaz (2007) reported on studies to utilize the upper Euphrates region and the western desert. The total area of the basin included in this project is 166 000 km<sup>2</sup> of which 32 000 km<sup>2</sup> are in Iraq while 32 000, 37 000, and 65 000 km<sup>2</sup> are in Syria, Jordan, and Saudi Arabia respectively. The report by ACSAD indicated the possibility of utilizing available resources and increasing both grazing and livestock in the basin and proposed implementation of a pilot development project in the Iraqi part of the basin covering an area of about 60 000 ha. The project would comprise several components covering surface and groundwater resources for pasture establishment and improvement as well as its rational management, livestock development and provision of social, health, and cultural services.

## 8. REFERENCES

- Buringh, P.** 1960. *Soils and soil conditions in Iraq*. Ministry of Agriculture, Baghdad, Iraq.
- Campbell, R.R., R.H. Follett, H.B. Howeli, R. Riddle, J.T. Stubbendieck, and D.G. Hanway.** 1977. *Applied agronomic research program for dryland farming in 200–400 mm rainfall zone of Morocco*. USAID PN-AAF-329. Washington, DC.
- Directorate General of Horticulture, Forests and Rangelands.** 2007. Conference on the Strategic Plan for the Ministry of Agriculture.
- Dost, M.** 2003. End of Assignment Report, FAO Iraq.
- Draz, O.** 1969. The “Hema” system of Range Reserves in the Arabian Peninsula, its possibilities in Range Improvement and Conservation Projects in the East. FAO /PL-PFC/13.
- FAO/UNESCO/WMO.** 1962. A study of agro-climatology in semi-arid and arid zones of the Near East. Inter-agency project on agro-climatology. By C.C. Wallen, WMO Meteorologist and G. Perrin de Brichambaut, FAO Agronomist.
- Hogan, E.B., W.R. Furtick, and J.A. Grayzel.** 1984. *Morocco increase in cereal production project*. USAID, Washington, DC.
- Le Houerou, N. H.** 1971. An Assessment of the Primary and Secondary Production of the Arid Grazing Lands Ecosystems of North Africa. Int. Symp. On the Eco-physiological Basis of Arid Zones Ecosystems Productivity, Leningrad. FAO/AGOC:Misc/5.
- Nakd A. Khamis** 2005. *Agriculture in Iraq*.
- Newberg, R., J. Sleeper, T. Eighmy, M. Hanafi, H. Ream, J. Segal, and J. Hyslop.** 1982. Rain-fed Agriculture Sub-sector Strategy, technical appendices. USAID, Morocco CDSS, Washington, D.C.
- Papachristodoulou, S.** 1979. *Socioeconomic aspects of rainfed Agriculture in Cyprus*. FAO Regional Seminar on Rain-fed Agriculture in the Near East, Amman, 5-10 May 1979. FAO. Rome, Italy.
- Papadakis, J.** 1966. *Climates of the world and their agricultural potentialities*. Av. Cordoba 4564, Buenos Aires, Argentina (published by the author).
- Pearce, C. K.** 1970. Grazing in the Middle East, Past, Present, and Future. J. Range Management. 24: 13–16.
- Planning Authority, Central Statistics Agency.** 2001–2005. Annual Statistics Report.
- Rafiq, M.** 1974. Technical and economic considerations for the utilization of rainfed areas in the Near East. *Proceedings of the Fourth FAO/Rockefeller Foundation Wheat Seminar*. FAO United Nations, Rome.
- Tully, D.** 1986. Rain-fed Farming Systems of the Near East Region. Proceedings of the workshop. USDA/USAID and Jordan Ministry of Agriculture, Amman, January 18-23, 1986.
- Sabah Salim El-Kuwaz.** 1984. Technical and Economic Feasibility Study for Growing Cereals and Fodder Shrubs on Marginal Lands in Iraq. Arab Organization for Agricultural Development, Arab League.
- Sabah Salim El-Kuwaz,** 2005. Preliminary/Reconnaissance Study of Iraqi Forests.
- Sabah. Salim El-Kuwaz.** 2007. Rangelands Management and Development in Iraq. Proceedings of the expert consultation on range monitoring including under forest systems in the Near East, pp.177–188. FAO, Rome.

## 9. CONTACTS

This profile was prepared in April 2011 by Tara Mohamed Anwar Omer (BSc. Crop Production, 1995, University of Sulaimaniyah)

Address: 218-53-1 Sulaimaniyah-Iraq

Tel: +9647701525432

E-mail: taraqaradaghi@yahoo.com

[The profile was edited in May/June 2011 by Dost Muhammad, J.M. Suttie and S.G. Reynolds.]