

Chapter 2

Range Resources of Pakistan

Rangelands in Pakistan extend from alpine pastures in the northern mountains to temperate and mediterranean ranges in the western mountains and arid and semi-arid desert ranges in the Indus Plain. Elevations range from sea level in the south to over 8800 m in the northern mountainous region of the Himalayas. Extreme climatic variations are the result of extreme elevation range and summer monsoon rainfall. About 70 per cent area of the country is arid to semi-arid. Summers are extremely hot while winters are cold. Rainfall varies from 100 mm in the south to over 1500 mm in the north. Northern snow-covered mountains of the Himalayas, Hindu Kush and Karakorum ranges are the main source of runoff for the mighty Indus River and its tributaries. Central and southern plains consist of fertile soils but annual rainfall is low, averaging less than 250 mm. As a result, water from the Indus and its tributaries is used to develop the largest canal irrigation system in the world.

Based on configuration of the land surface, relative elevation, mode of deposition of the sediments, and degree and kind of soil profile developments, Mian and Syal (1986) classified Pakistan into the following nine geomorphic units:

(i) Pleistocene river terraces, (ii) Subrecent level terraces, (iii) Flood plains, (iv) Indus Delta, (v) Loess plains, (vi) Sandy deserts, (vii) Piedmont plains, (viii) Weathered bedrock plains, and (ix) Mountains.

Recently, several attempts have been made to classify Pakistan into different agro-ecological zones. Rafiq (1976) delineated crop ecological zones on the basis of physiography and climate. Champion et al (1965) gave a comprehensive description of the forest types of Pakistan. However, range vegetation has never been given much emphasis. Pakistan Agricultural Research Council (PARC) in 1980 classified Pakistan into 10 agro-ecological zones, based on physiography alone. Agro-ecological zonation of

Pakistan by Baig and Ali (1986) has practical application in the rangeland rehabilitation and improvement operations. Khan (1971) divided northern Pakistan into alpine, sub-alpine, dry temperate, sub-tropical humid and sub-humid zones. A detailed eco-zonation of Pakistan is yet to be developed.

Due to bioclimatic variation, the range vegetation varies from one area to the other. Range condition of the areas also varies from site to site. Alpine pastures and northern mountain ranges are comparatively in fair to good condition. Forage production of desert ranges and aridlands of Baluchistan is low due to low rainfall. Estimated annual forage production of main grazing areas in the country is given in Table 1.

Table 1. Estimated annual forage production from rangelands of Pakistan

Rangeland	Area (m.ha)	Current production		Improvement potential	
		DM (t/ha)	Total DM (m.t)	DM (t/ha)	Total DM (m.t)
Alpine pastures	1.68	1.5	2.52	2.50	4.20
Trans-Himalayan grazing lands	3.50	0.6	2.10	2.00	7.00
Himalayan forest grazing lands	0.67	0.6	0.40	3.00	2.01
Pothwar scrub ranges	1.68	1.5	2.52	4.00	6.72
Desert rangelands	7.97	0.5	3.98	2.00	15.94
Kohistan ranges	2.38	0.4	0.95	2.00	4.76
Central Baluchistan ranges	8.00	0.5	4.00	1.00	8.00
Eastern Baluchistan ranges	5.00	0.4	2.00	1.50	7.50
Western Baluchis- tan ranges	18.50	0.3	5.55	0.80	14.80
Sulaiman mountain ranges	1.50	0.3	0.45	2.00	3.00
Total	50.88	0.66	24.47	20.8	73.93

Source: Mohammad (1987).

ALPINE PASTURES

The areas lying above an altitude of about 3000 and below the zone of perpetual snow constitute alpine pastures. Mohammad (1987) described in detail the alpine ecosystems. Alpine pastures are characterised by short, cool growing seasons and long, cold winters. The vegetation is mostly dominated by slow growing perennial, herbaceous and shrubby vascular plants and extensive mats of cryptogams (mosses, lichens, etc). Much of the landscape of the alpine pastures is rugged and broken with rocky, snow-capped peaks, spectacular cliffs and slopes. However, there are also many large areas, gently rolling to almost flat topography.

Khan (1971) discussed vegetation of alpine and sub-alpine zones in Hazara division. The forage production from various range types in alpine and sub-alpine zones is as follows:

<u>Range Types</u>	<u>Forage Yield (DM kg/ha)</u>
Meadows	1240
Shrub meadows	2660
Shrub	2400
Kail/fir forest range	1270
Birch range	Not sampled
Shrub-grassland	2300
Grasslands	2300

Hussain (1968) measured vegetation condition of alpine pastures in Kaghan Valley. The average plant cover, cumulative cover and soil protection percentage was 90.82, 119.25 and 97.79, respectively. Average forage production recorded was 700 kg/ha. Dry matter yield estimated during summer, 1987, in partially protected areas of Khunjerab National Park at altitudes of 3500, 4000, 4500, and 5000m was 380, 470, 585 and 370 kg/ha, respectively. Average dry matter production from Chaprot alpine pastures near Gilgit was 500 to 700 kg/ha. Champion et al. (1965) classified alpine vegetation into the following four major types:

- i. Alpine scrub type consisting of moist deciduous alpine scrub, dry zone alpine scrub, moist alpine pasture, dry alpine plateau pastures, dwarf juniper scrub, and dwarf *Rhododendron* scrub forest.
- ii. Moist alpine scrub comprises dry alpine scrub and moist alpine scrub.
- iii. Alpine forests contain alpine fir birch forest, *Rhododendron* forest and high level bluepine forests.
- iv. Sub-alpine forests consist of West Himalayan sub- alpine birch/conifer forest, sub-alpine birch forest, Hippophae - Myricaria river bed scrub, sub-alpine blue pine forest, deciduous sub-alpine scrub, sub-alpine scrub and sub-alpine pasture.

Hussain (1968) gave the following description of vegetation types in the alpine pasture in the northern mountains of Pakistan:

- i. Alpine stony deserts are found just below the zone of perpetual

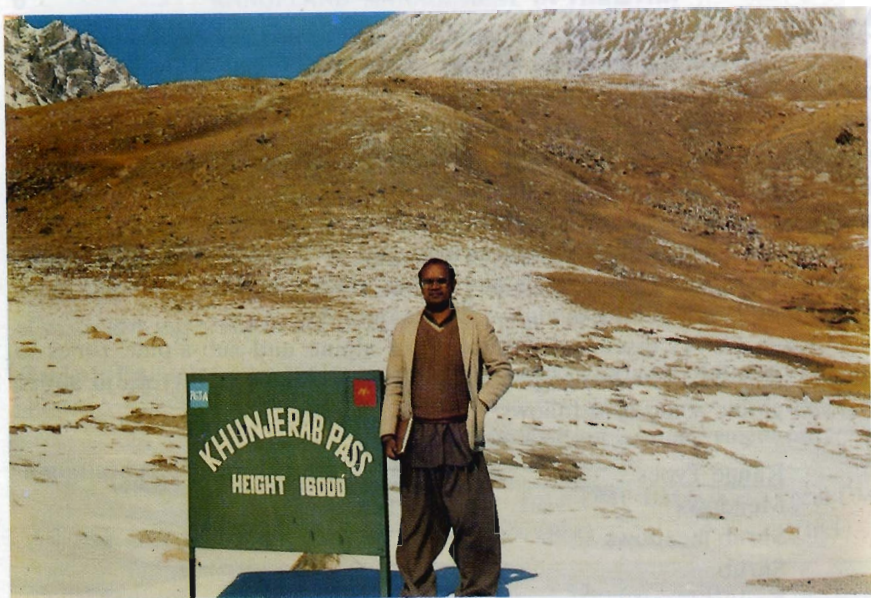


Plate 1. Alpine pastures in the Hindu Kush Range during early fall.

snow between 3500 and 5000 m altitude. The habitat is characterized by the presence of scree sand bits of rocks, heavily encrusted with lichens. *Saxifraga imbricata*, which is adapted to high winds, strong radiation and snow, is dominant. Alpine deserts have little value as grazinglands due to the absence of forage and difficult topography. However, the area provides excellent habitat for ibex and morcopolo sheep. Since most part of the year these areas remain under snow, they do not pose any watershed problem.

ii. Alpine meadows contain luxuriant ground flora. These alpine meadows have the greatest value as grazinglands. Trees are conspicuous by their absence in this type. Vegetation consist of perennial forbs, and grasses belonging to the genera *Poa*, *Festuca*, *Stipa* and *Agropyron*.

iii. Above 3200 m elevation, the forest is replaced by scrub consisting of *Juniperus recurva* and *Artemisia maritima* which occupy exposed slopes in the interior valleys. *Ephedra jerardiana* occurs on gravel deposits in the bottom. This type does not have much value as a grazingland. The shrubs make up a close community and do not allow forage plants to occupy site.

iv. Alpine forests are dominated by *Abies pindrow* with occasional *Pinus wallichiana*. In the second storey, *Betula utilis* and *Quercus semicarpifolia* are sometimes present with many shrubs. Above the fir zone, *Betula utilis* is the only tree species with *Pyrus foliosa* and *Rhododendron sp.* in moist habitats. Alpine forests are subjected to

heavy grazing during summer. No planned grazing system is followed. Native flora of alpine pastures is given below:-

TREES/SHRUBS: *Juniperus communis*, *Rosa webbiana*, *Berberis lycium*, *Berberis* spp, *Cotoneaster* spp.

GRASSES: *Phleum alpinum*, *Agrostis gigantea*, *Trisetum* spp., *Poa* spp. *Agropyron dentatum*, *Agropyron caninum*, *Festuca ovina*, *Alopecurus gigantea*, *Dactylis glomerata*, *Pennisetum lanatum*, *P. filaccidum*, *Clamagrostis pseudopharagmites*, *Oryzopsis* spp, *Carex* spp.

FORBS: *Plantago ovata*, *Plantago major*, *P. lanceolata*, *Trifolium pratense*. *T. repens*, *Fragaria vesca*, *Medicago* spp, *Potentilla* spp, *Rumex nepalensis*, *Polygonum alpinum*, *Anaphalis contorta*, *Thymus serpyllum*, *Astragalus* spp., *Taraxicum officinalis*, *Iris hookeriana*, *Nepata spicata*, *Saxifraga jacquemontiana*.

TRANS-HIMALAYAN GRAZINGLANDS

Landscape and Environment: Trans-Himalayan grazinglands spread over northern mountains in Dir, Chitral, Swat, Gilgit, Chilas and Skardu districts. Northern Areas became accessible by road in late 1970s following the completion of the Karakorum Highway (KKH). Most of the villages are connected with KKH by jeep. However, some are still approached by travelling on foot for several hours. Chitral and Swat valleys have an extensive road system. Gilgit, Skardu, Chitral and Swat are also linked by air with Islamabad and Peshawar.

The region constitutes a series of high mountain ranges of Karakorum, Hindu Kush and Pamir. The altitude varies from 1500 to 8600 m and includes 19 peaks over 7600 m, such as K2, Nanga Parbat, Rakaposhi and Trichmir. The area has rugged, steep and dissected slopes, and narrow valleys, subject to active geologic erosion. The terrain is naturally unstable. Landslides and rockfalls are very common. Mian (1985) recognised two main rock groups in the Northern Areas of Pakistan including i) igneous rocks consisting mainly of granites and diorites and ii) sedimentary and metamorphic rocks comprising mainly quartzite, slate, crystalline schist, marble and limestone. He further stated that most of the areas are without soil cover. They include (i) areas at high altitudes permanently covered with snow or glaciers, (ii) rock outcrops, (iii) recently deposited alluvium, scree materials and moraine, (iv) water bodies and the adjoining areas subject to periodic flooding.

The climate of the area is that of a mountain desert with bitterly cold winters and hot dry summers. The climatic variation in the area is greatly influenced by altitudinal differences. Lower altitudes (valley bottoms and hill slopes below 2300 m) experience marked diurnal as well as seasonal temperature variations and scanty precipitation. The areas between 2300 and 3300 m receive sufficient snow and enjoy a temperate climate. Areas above 3300 m are very cold with a limited growing season. Most of the area is beyond the reach of summer monsoon rainfall. Average annual rainfall (100-300 mm) in valleys is mostly received during winter and early spring.

Land Use: Crop production, livestock rearing and forestry are major land uses in the area. Maize, rice, wheat, and barley are important cereal crops. Double cropping is practised up to 2300 m while above that altitude only single, short-duration crops can be raised. Orchards of apricot, apple and mulberry are important components of the farming system. Due to low precipitation, crop cultivation is possible only in irrigated areas. Cultivation is practised on river terraces alluvial fans and scree slopes. As cultivable area is limited, considerable resources are being utilized for the reclamation of eroded lands. Mian (1985) enumerated the following steps in the reclamation of eroded lands:

- i. Collection of stones and gravel from the surface and their use in demarcation of field boundaries and erection of 50 to 100 cm high stone walls around the fields.
- ii. Minor levelling of hummocks and filling of depressions.
- iii. Sowing of alfalfa seed and occasional plantings of poplar, willow, Russian olive and mulberry.
- iv. Frequent irrigation of fields every fourth or fifth day during summer.
- v. After this, the fields are developed as irrigated pasture-cum- forest land. Fodder (alfalfa, thorny bushes) tree leaves and fuel and timber are produced.
- vi. Pastures are irrigated for five to ten years, depending on the clay content of the soil. During the reclamation period, root mass, fallen leaves, twigs and branches decay to produce organic matter, which in turn provides nutrients and humus. The humus fertility improves water-holding capacity. Addition of organic matter and root action enhance the biological processes in the soil, thereby improving the overall soil environment. Alfalfa and other leguminous plants fix the atmospheric nitrogen in the soil. Irrigation water, which carries a high amount of suspended material mainly silt and some clay, also improves the water-holding capacity of the soil.
- vii. When alfalfa begins to disappear due to competition with other vegetation and shade, the land is cleared of all vegetation. Stones and gravel are collected from the upper metre of the soil and are used for construction and strengthening the houses as well as raising the field boundary walls.
- viii. The field is levelled and made into a nearly level terrace for irrigated farming.
- ix. Farmyard manure is applied before crops are planted and land is prepared.

Marginal and newly reclaimed lands are used for fodder production. Livestock grazing is done in alpine pastures, forests and along stream channels. Forestry operations include protection of natural forests, national parks, afforestation of marginal lands and wildlife conservation.

Range Types: Vegetation of Trans-Himalayan grazinglands can be divided into the following four range types:

i) Foothill ranges ii) Dry temperate ranges iii) Valley depression grazinglands and iv) Alpine pastures.

Sheikh and Khan (1982) described the forest and range vegetation of the Northern Areas. According to them, the areas are subject to heavy pressure by livestock as well as a shortage of fuelwood. Alpine pastures are in good condition but due to environmental limitations, the growth period is short. Low-lying ranges are in fair to good condition. The present forage production varies from 0.5 to 1.5 t DM/ha. Beg and Bakhsh (1979) distinguished eight plant communities in scree slopes in Chitral. Ahmed and Qadir (1976) conducted phytosociological studies along Gilgit to Gopis. The following range plants are found in the area:



Plate 2. Dry temperate grazinglands in Hunza valley.

TREES/SHRUBS: *Juniperus macropoda*, *Quercus ilex*, *Pinus gerardiana*, *Cedrus deodara*, *Pinus wallichiana*, *Fraxinus xanthoxyloides*, *Artemisia maritima*, *Artemisia sacrorum*, *Indigofera* spp. *Ephedra* spp, *Daphne oleoides*, *Sophora* spp., *Cotoneaster* spp, *Parrotia jacquemontiana*. *Salix* spp, *Jasminum* spp, *Sorbaria tomentosa* *Caragana* spp.

GRASSES: *Chrysopogon* spp, *Cymbopogon* spp, *Dichanthium anulatum*, *Pennisetum orientale*, *Aristida* spp, *Oryzopsis* spp. *Poa* spp, *Bromus inermis*, *Agropyron dentatum*, *Agropyron caninum*, *Agrostis* spp, *Dactylis glomerata*, *Rottboellia exaltata*, *Phacelurus speciosus*, *Eragraostis* spp.

FORBS: *Iris* spp. *Tulips* spp. *Polygonum* spp. *Astragalus* spp. *Sambucus*

ebulus, Lotus corniculatus, Medicago spp. Plantago lanceolata, Lathyrus spp. Thymus serpyllum, Nepata spicata, Viola spp. Taraxicum officinalis, ferns, etc.

HIMALAYAN FOREST GRAZINGLANDS

Landscape and Environment: Himalayan forest grazing lands cover Siran, Kaghan, Neelum and Jhelum valleys. These areas can be ecologically divided into moist temperate and sub-tropical humid zones. The wet temperate zone occurs between 2000 m to the timber line. Kail, deodar, spruce and fir forests are abundant in this zone. Jammu and Kashmir and Hazara have extensive wet temperate areas. The areas receive plenty of snow during winter. About 3-4 m of snowfall has been recorded at Kaghan, Shogran, Naran and Nathiagali. Most of the areas in this zone receive more than 1000 mm during the monsoon which creates heavy soil erosion as the topography is steep and disturbed by unscientific cropping. Summers are cool but winters are very cold.



Plate 3. Saiful Maluk lake in Kaghan valley.

The sub-tropic humid zone is represented by 'chirpine,' but 'kail' forests also occur on higher slopes. The altitude varies from 1000 to 2000 m. Rainfall is usually more than 1000 mm. Flat and plain areas are fit for the cultivation of wheat, rice and maize cultivation with occasional irrigation. Most of the areas in this zone are subjected to soil erosion.

Land Use: Forestry, cropping and livestock grazing are the major land

uses. As the area receives monsoon rainfall, plenty of soil moisture is available for crop cultivation. Maize, rice and wheat are the major crops. Apple orchards cover a large area. Bluepine and 'chirpine' forests cover an extensive area throughout the tract. Grazing is done in forests and along water channels and on cropped areas.

Range Types: Khan (1971) prepared a detailed report about range management in Hazara. He recognized the following range ecological zones:

i) Sub-tropical sub-humid zone, ii) Sub-tropical humid zone, iii) Temperate humid zone, iv) Sub-alpine zone, v) Alpine zone, and vi) Glaciers or Snowfields.



Plate 4. Moist temperate forest grazinglands near Murree.

In the sub-tropical sub-humid zone, *Acacia-Olea* and *Dodonea, Imperata* are major range types. Forage production varies between 200 and 1800 kg/ha. In the sub-tropical humid zone, 'chirpine' forests, shrub savanna and grassland types are recognized with forage yields between 200 and 2000 kg/ha. Temperate humid zone has shrub grassland, shrub savanna and grasslands along with several forest types. Forage production ranges between 200 and 3000 kg/ha. Important plants in the Himalayan forest grazinglands are listed below:

TREES: *Pinus wallichiana*, *Picea smithiana*, *Taxus baccata*, *Cedrus deodra*, *Quercus incana*, *Q. dilatata*, *Q. semicarpifolia*, *Juglans regia*, *Aesculus indica*, *Acer pictum*, *A. caesium*, *Populus alba*, *P. ciliata*, *Pyrus* sp.

SHRUBS: *Viburnum nervosum*, *Indigofera* spp. *Rosa webbiana*, *Salix* spp., *Cotoneaster* spp., *Pistacia* spp., *Berberis lycium*, *Prunus comata*, *Rhododendron arboreum*, *Sarcococca saligna*, *Rubus* spp. *Desmodium* spp. *Strobilanthus* spp.

GRASSES: *Dactylis glomerata*, *Agropyron dentatum*, *Phacelurus speciosus*, *Rottboellia exaltata*, *Alopecurus gigantea*. *Pennisetum flaccidum*, *Oryzopsis* spp. *Poa* spp. *Stipa sibirica*, *Bromus inermis*, *Bothriochloa pascuodischaemum*, *Chrysopogon echinulatus*, *Themeda anathera*.

FORBS: *Plantago ovata*, *P. major*, *P. lanceolata* *Senecio* spp. *Rumex nepalensis*, *Astragalus* spp. *Trifolium repens*, *T. pratense*, *Lotus corniculatus*, *Fragaria vesica*, *Medicago* spp. *Geranium collinum*, *G. nepalensis*, *Thymus serpyllum*, *Polygonum aviculare*, *P. parencoides*, *Phlomis bracteosa*, *Taraxicum officinalis*.

POTHWAR SCRUB RANGES

Landscape and Environment: Pothwar plateau includes Islamabad, Rawalpindi, Chakwal, Jhelum and Attock districts, an area of 1.5 million ha. The tract lies between Jhelum and Indus River. Altitude varies from 300 to 1500 m. Ecologically, it is located in the sub-tropical semi-arid to sub-humid zone. Geomorphologically, the plateau can be classified into mountains, hills, rock plains, weathered rock plains, piedmont plains, loess plains and river plains (Beg et al. 1985). The soils of the area have developed from wind and water-transported materials consisting of loess, old alluvial deposits, mountain outwash and recent stream valley deposits; some are derived from shales and sandstones.

The climate is temperate in the northeast to sub-tropical semi-arid in the southwest. Annual rainfall varies from 250 mm in the southern part of Salt Range to over 1500 mm at Islamabad. Temperatures extremes are 45°C in June and often drop below freezing during January.

Land Use: Dryland farming is the dominant land use. Wheat, maize, sorghum, millets, groundnut, gram, mustard, sunflower and soybean are major cultivated crops. Livestock rearing is an important component of the rural economy. It is the home of the famous 'Dhani' cattle breed. The tract possesses scrub forests of Kala Chitta, Margalla Hills, Pabbi Hills and Salt Range which are gradually disappearing due to excessive exploitation for firewood and grazing by livestock. The Agency for Barani Areas Development (ABAD) in 1987 prepared a master plan for the development of the barani tract. The plan contains an extensive review of the natural resources and present land uses. Beg et al. (1985) delineated the ecological zones for maize and wheat. Land suitability evaluation for other cultivated crops, range livestock production and forestry is in progress.

Most of the tract is subjected to heavy soil erosion. Several government agencies, like Soil Conservation Directorate, ABAD, Water and Power Development Authority (WAPDA) and PARC, have an elaborate research network for soil and water conservation to increase productivity per hectare.

Range Types: Pothwar scrub ranges contain dry sub-tropical broad leaved, thorn-mixed forests. *Acacia modesta* and *Olea ferruginea* are dominant species. *Dodonea viscosa* has invaded most of the hills. *Prosopis juliflora* is in abundance in the Pabbi Hills. Some of the main grazing blocks under the control of the Forest Department are located in Khare Murat, Mari, Gullial, Lohi Bher, Pabbi, Kala Chitta, Margalla Hills, Sohawa and Salt Range. *Heteropogon contortus* and *Desmostachya bipinnata* are encroaching rangelands as well as cultivated areas. The northern part of the tract has a diverse. The vegetative cover of the protected Margalla Hills has increased markedly. The southern part of the tract is sparsely vegetated. Flat areas consist of *Aristida depressa*, *Eleusine flagellifera*, *Cynodon dactylon*. Said (1951) divided the vegetation of Salt Range into the following types:

- i. Degraded zone includes the area with heavy soil erosion. Here, *Acacia modesta*, *Capparis aphylla*, *Salvadora oleoides*, *Cymbopogon jwarancusa* are dominant,
- ii. The hotter sandstone aspect consists of *Acacia modesta*, *Gymnospora royleana*, and *Zizyphus nummularia*. Among grasses, *Cenchrus ciliaris* and *Bothriochloa pertusa* are prevalent,
- iii. The cooler sandstone aspect has occasional trees of *Olea sp*, *Celtis sp*. *Acacia modesta* are dominant,
- iv. Limestone ridges consist of *Acacia modesta*, *Dodonea viscosa*, *Cenchrus ciliaris* and *Eulaliopsis binata*.

Ahmad (1964) also recognized the above-mentioned vegetation types. Beg et al. (1985) classified the range vegetation of Pothwar tract. Both of the workers recognized four major climatic regions, 18 bioclimatic zones and 36 ecological zones. The carrying capacity of the area was sampled by the government of Punjab (1974). Forage production varied from about 1 t/ha to 2.5 t/ha of dry matter. The tract consists of following important range plants:-

TREES/SHRUBS: *Acacia modesta*, *Olea cuspidata*, *Zizyphus mauritiana*, *Salix tetrasperma*, *Dodonea viscosa*, *Zizyphus nummularia*, *Sageretia theezans*, *Gymnospora royleana*, *Carissa spinarum*, *Adhatoda vasica*, *Pistacia integerrima*, *Nerium oleander*, *Otostegia limbata*.

GRASSES: *Chrysopogon montanus*, *Chrysopogon aucheri*, *Themeda anathera*, *Bothriochloa pertusa*, *Bothriochloa intermedia*, *Dichanthium annulatum*, *Tetrapogon villosus*, *Aristida mutabilis*, *Cenchrus ciliaris*, *Digitaria nodos*, *Desmostachya bipinnata*, *Imperata cylindrica*, *Eleusine compressa*, *Cynodon dactylon*, *Panicum antidotale*, *Pennisetum orientale*, *Polypogon monspeliensis*, *Cymbopogon jwarancusa*, *Eulaliopsis binata*.

THAL DESERT RANGES

Landscape and Environment: Thal range stretches over an area of 2.6 million ha. The tract is bound by the piedmont of the Salt Range in the north, the Indus River flood plains in the west and Jhelum and Chenab Rivers flood plains in the east. Ecologically, it is situated in the tropical

plains (sandy). The mean maximum and minimum temperatures recorded in the tract are about 44°C and less than 0°C respectively. The wind affects the amount and distribution of rainfall in the desert, most of which is received during the monsoon. It varies from 133 mm in the southern areas to 300 mm in the northeastern region of the tract (Government of Punjab 1974). The soils are alluvial with sandy textured sand dunes covering 50 to 60 percent of the area (Khan, 1966). Continued heavy grazing and ruthless cutting of trees and shrubs continue have resulted in the complete disappearance of several desirable species. The topsoil has been eroded by wind erosion and sand dunes have become unstable. The vegetative cover and forage production have declined substantially.

Accordingly to SSP (1968), the geomorphology of the area consists of the following landforms:

i. *Sand ridges*: Over the major part of the Thal Desert, the alluvium has been blown into sand ridges and hollows or valleys known as 'Pat-tis' in the local dialect. The soils of the ridges consist of very deep, structureless, fine sand of various degrees of calcareousness and colour gradations. All the sand ridge soils are excessively drained and have an average pH value of 8.3.

Fine material from the ridges has been washed into the hollows and where allowed to accumulate, has formed very deep, moderately calcareous, weakly structured soils. The soils of hollows are mainly well drained and have an average pH value of 8.4.

ii. *Abandoned channels*: The soils of the abandoned channels are water reworked and/or deposited material with a wide textural range (loamy fine sands to silty clays), usually have a 'kankor' zone and are moderately calcareous with a pH value of 8.3 to 8.8.

iii. *Flood plains*: Soils of sub-recent floodplains are moderately deep to deep dark, greyish-brown, silty clay loams and silty clays with weak to moderate structures and a weak lime profile, but no 'kankor' zone. In southern areas, reduced annual flooding, and a high water table have resulted in alkalinization. The soils are dense and strongly saline alkali, with a pH value of more than 9.

Land Use: Livestock grazing is the main occupation of the people. With the construction of Thal irrigation canal, about 1 m ha sand dunes have been converted into highly productive cultivated areas. However, about 1.6 m ha are still used as grazinglands. In a year of normal rainfall, sand dunes are cultivated. Gram, water melon, guar and millets are grown on a large scale. Persian wheel wells are quite common in the area.

Range Types: The following four major range types are recognized in Thal Desert (Government of Punjab, 1974):

i. *Dunes*: The soils of the dunes consist of coarse and loose sand. The dunes usually run in a northwest to southeast. On average, the dunes cover about 43 percent of the total area. The vegetation growing on

the dunes include (a) *Calligonum polygonoides*, (b) *Pennisetum sp.*, (c) *Aristida sp.*, and (d) *Acacia jacquemontii*

ii. *Slopes and foot of dunes*: This range type is in between the dunes and flats. There is a gradual change in soil from dune to flat. The soil is comparatively less coarse. This area occupies about 5 percent of the total area. The vegetation includes *Pennisetum sp.*, *Suaeda fruticosa* and *Aristida depressa*.

iii. *Flats*: The flats are generally sandy-loam and are ideal sites for the satisfactory growth of grasses. Artificial reseeding very successful here and this site offers great potential for range development. The flats occupy about 48 percent of the total area. In this range site, the most common flora consists of *Eleusine flagellifera*, *Suaeda fruticosa*, *Cymbopogon jwarancusa*, etc. Palatable species like *Cenchrus ciliaris* and *Lasiurus indicus* also grow in this range type.

iv. *Kankor sites*: These are devoid of any vegetation. The seed of grasses cannot germinate and become established due to compact and hard soil. Boron is reported to be present in toxic levels that inhibits growth. About four percent of the total area is in this type of range.

The following plants are found in the Thal Desert.

TREES/SHRUBS: *Acacia jacquemontii*, *A. nilotica*, *Calligonum polygonoides*, *Euphorbia caducifolia*, *Leptadenia pyrotechnica*, *Haloxylon recurvum*, *H. salicornicum*, *Kochia indica*, *Prosopis juliflora*, *P. cineraria*, *Rhazya stricta*, *Salvadora oleoides*, *Salsola foetida*, *Suaeda fruticosa*, *Tamarix aphylla*, *Zizyphus mauritiana*, *Z. nummularia*.

GRASSES: *Aristida depressa*, *Cenchrus biflorus*, *C. ciliaris*, *C. penisetiformis*, *C. setigerus*, *Cymbopogon jawarancusa*, *C. schoenanthus*, *Cynodon dactylon*, *Desmostachya bipinnata*, *Dichanthium annulatum*, *Eleusine flagellifera*, *Lasiurus indicus*, *Panicum antidotale*, *P. turgidum*, *Saccharum bengalense*, *S. munja*.

FORBS: *Aerva javanica*, *A. tomentosa*, *Crotalaria burbia*, *Indigofera cordifolia*, *I. oblongifolia*, *Tribulus terrestris*.

D.G. KHAN RANGELANDS

Landscape and Environment: D.G. Khan rangelands lie between the Sulaiman Range and the Indus River over an area of 0.5 million ha. Average slope is gentle. A few sand dunes are also found. Soils are divided into two sub-regions. The piedmont plains called 'pachar' are formed in the local alluvium derived from adjoining mountains. These soils are deep, well-drained, calcareous, medium-textured and low in organic matter. The river plains locally known as 'belas' are formed in the mixed alluvium from the Himalayas. These are sandy clay, calcareous and low in organic matter.

The general climatic regime of D.G. Khan tract is typical of very arid sub-mountainous, sub-tropical areas. Ecologically, it is a tropical plain (non-sandy). Climate is broadly characterised by cold winters and very hot summers. Winter temperatures occasionally reach zero especially in

January and February, due to cold winds from the west. June and July are the hottest months with an average maximum temperature of 42°C. Average annual rainfall varies from 75 to 162 mm. Most of the rainfall storms from the high mountains (1540-3400 m) lose their moisture before reaching range areas which are at lower altitudes (150 m). Annual rainfall at D.G. Khan, Taunsa, Fort Munro, Jampur and Rajanpur is 132, 163, 202, 98 and 100 mm, respectively.

Range Types: Most of the forbs and annual plants start growing in early spring and complete their growth cycle within two to three months. *Saccharum spontaneum* and *Tamarix dioica* primarily colonise the recently formed soils along the Indus River. These are replaced by *Acacia nilotica*, *Prosopis cineraria*. *Salvadora oleoides* is probably the climax species of the area. In general, non-palatable forbs and shrubs tend to replace palatable grasses on all rangelands. Removing non-palatable plants may shift competitive advantage in favour of the palatable plants.

Forbs and secondary grasses usually increase as primary grasses decrease. Total cover may change very little, and occasionally may increase due to the invasion of non-palatable plants. In an advance stage of retrogression, growing cover is reduced and the reduction herbage yield becomes pronounced.

Deterioration of the rangelands has been associated with irregular grazing by nomadic and local livestock and illicit cutting of shrubs for fuel and fodder. Most of the rangelands are in poor shape. Estimated dry matter yields were 3 to 4 t/ha from *Lasiurus indicus* seeded areas at Rakh Choti Dalana and only about 400-500 kg/ha from non-seeded areas.

Little information about the proper grazing of rangelands in D.G. Khan tract is available concerning forage availability, quality, quantity and palatability of range plants. Some of the factors that must be considered are livestock water points, grazing habits of animals, stage of plant growth, climatic conditions and management. A management plan based on a detailed resource survey may be required to determine development options.

Shrubs, grasses and forbs are best used by different kinds of livestock. Cattle usually prefer areas with gentle terrain and where palatable grasses predominate. Areas with more rugged terrain and vegetation rich in forbs and browse are most suitable for sheep and goat. Camels relish saltish browse such as *Salsola*, sp. Except for operating and economic constraints, common use of the rangelands by sheep, goats, camels and cattle may be physically and biologically sound and effective means to maintain a desirable composition of plants.

CHOLISTAN DESERT RANGES

Landscape and Environment: The Cholistan desert is located in Bahawalpur, Rahim Yar Khan and Bahawalnagar Districts. It covers about

2.7 million ha. Its north and western boundaries are surrounded by areas irrigated by canals. On the east, it borders the Indian Rajasthan Desert. Ecologically, it is tropical arid sandy desert. The area is subject to wind erosion. Rainfall is erratic and ranges from 100 to 200 mm. Mean minimum and maximum temperatures are 20°C and 40°C, respectively. The soil survey of Cholistan has been conducted by the Soil Survey of Pakistan in 1974. The soils of the tract are saline, alkaline and gypsiferous. The area consists of shifting sand dunes. The inter-dunal valleys are locally known as 'dahrs'. The dunes reach heights of about 100 m.

The four major land forms recognised by Baig et al (1980) include: i. subrecent river plains, ii. the first sandy terrace above the Hakra River (late pleistocene) iii. the second sandy terrace above the Hakra River plain (late pleistocene), and iv. the third sandy terrace above the Hakra River plain (middle pleistocene).

The type of sandy landforms in the Cholistan is comparable to those in the Thal Desert. Mian and Sayal (1986) have distinguished three types of sand ridges. The transverse ridges occur in the western part (middle pleistocene). The longitudinal ridges spread over the northern and southern parts (the latest period of the late pleistocene) and the alveolar ridges occur in the centre (the earlier period of the late pleistocene).

Land Use: Livestock production is the major occupation. Wildlife are hunted during the winter. A shortage of drinking water is a serious problem as underground water is saline (Rasul, 1966). Aridity precludes dryland farming. The current drought is seriously affecting fauna and flora. Heavy losses of livestock are expected due to a shortage of natural browse and grasses.



Plate 5. Cholistan Desert-a natural habitat for blackbuck (*Antelope cervicapra*).

Range Types: The vegetation of Cholistan consists of xerophytic trees, shrubs and grasses. In their description of the grass cover types of Pakistan, Johnston and Hussain (1963) characterized the Cholistan vegetation as *Dichanthium-Cenchrus-Lasiurus* type. Sheikh (1986) categorized Cholistan vegetation as sand dune, desert scrub. The vegetation composition of Cholistan reported by Ahmed (1966) was *Calligonum polygonoides* (0.4%), *Haloxylon recurvum* (0.2%), *Haloxylon selicornicum* (0.7%), *Suaeda fruticosa* (0.4%), *Aristida depressa* (1.7%), *Cenchrus ciliaris* (0.7%), *Cymbopogon jwarancusa* (7.1%), *Eleusine compressa* (11.7%) and *Lasiurus indicus* (9%).

The three major range types found in Cholistan are i) *Lasiurus indicus*/*Haloxylon salicornicum*., ii) *Eleusine compressa*/*Haloxylon salicornicum*. , and iii) *Haloxylon recurvum*/*Salsola foetida* and *Suaeda fruticosa* (Government of Punjab, 1974).

THARPARKAR DESERT RANGES

Landscape and Environment: The Tharparkar desert is situated in Tharparkar, Sanghar and Mirpur Khas Districts and covers 2.65 million ha. Ecologically, the tract can be categorized as tropical thorn desert. Hussain (1966) distinguished the following four major landforms:

- i. Sand dunes are locally known as 'bits'. The sand dune ridges are from 15 to 200 m high and run parallel from northwest to southeast. The soil is sandy greyish and is derived from quartz and feldspar.
- ii. Valleys lie between parallel rows of sand dunes and constitute about 30 percent of the total area. The soils are sandy loam. In many valleys, the sub-soil water has developed into large salt lakes.
- iii. Flat alluvial plains are located in Nagarparkar. The soils are sandy loams with clay particles. Even with low rainfall the area is extensively cultivated with millets, sorghum, etc.
- iv. Rocky hills known as Karunjar are found near Nagarparkar. They may be as high as 350 m, and consist of metamorphic rocks.

The Thar desert is subjected to heavy soil erosion partly due to dry land cultivation. In the northwestern and southwestern dunes wind-blown sand is a natural phenomenon (FAO, 1975). The landforms and soils of Thar are similar to that of Cholistan. The climate is arid. Rainfall is scanty and erratic, and most is received during the monsoon. The area has experienced a severe drought for the past four years. In a normal year, rainfall varies from 150 mm in the north to 400 mm in the south near Nagarparkar. Summers are hot (45°C) and winters are mild (5°C).

Land Use: Livestock production is the major land use in the region. Dryland farming is also practised wherever rainfall is adequate. Millet, sorghum and castor crops are cultivated in the dune valleys. Forestry is limited to irrigated and riverain forests. Small villages are located wherever watering ponds are available. The ground water is 200-300 m deep and

brackish. However, sweet water is found in Nagarparkar, Mithi and Diplo near Run of Kutch.

Range Types: Champion et al., (1965) described the vegetation of southern Sind, but did not describe the range vegetation of Thar Desert. Chaudri and Chuttar (1966) gave a brief summary of the vegetation and range flora of Thar. Hussain (1966) distinguished four vegetation types in this area: i. *Cenchrus-Panicum* dune type, ii. *Eleusine-Cenchrus* stands in valleys, iii. *Eleusine-Aristida* on flat alluvial plains, and iv. sparse desert thorn vegetation on hills. Vegetation is essentially dictated by the formation of sand dunes. The important range types found in Tharparkar are given in Table 2.

Table 2 Vegetation composition and dominant species at various range sites in Tharparkar desert.

Range sites	Grasses %	Forbs %	Litter %	Bare soil %	Dominant species
Malheojotar Khanore	22 23	11 6	21 19	46 52	<i>Euphorbia caducifolia</i> , <i>A. Senegal</i> , <i>Calligonum</i> <i>Polygonoides</i>
Pabuhar	14	—	14	72	<i>Panicum</i> sp, <i>Cenchrus</i> <i>biflorus</i>
Chilhar	21	5	13	61	<i>Prosopis cineraria</i> , <i>Lasiurus indicus</i> ,
Cabul-Jotar	16	4	7	73	<i>Panicum</i> sp,
Neplo	22	5	9	64	
Pathrio	25	6	10	59	<i>Prosopis cineraria</i> . <i>Eleusine flagellifera</i> ,
Janhero	20	2	10	68	<i>Aristida</i> sp,
Adhigham	18	4	14	64	<i>Euphorbia caducifolia</i> ,
Khipuri	17	6	19	58	<i>Acacia senegal</i> , <i>Zizyphus</i> sp. <i>Aristida</i> sp <i>Cenchrus biflorus</i> .
Loohior	23	9	22	46	<i>Tecoma undulata</i> , <i>Cenchrus ciliaris</i> ,
Vakerio	20	4	16	60	<i>Panicum</i> sp. <i>Eleusine</i> <i>flagellifera</i> .
Bhalva	16	5	12	67	
Vingi	14	8	12	66	<i>Sporobolus</i> sp, <i>Aelu-</i>

(continued)

Table 2 continued

Jattari	10	6	10	74	<i>pus villosus</i> , <i>Desmostachya bipinnata</i> .
Khambrro	13	4	7	76	<i>Prosopis cineraria</i> ,
Hathango	13	5	11	71	<i>Cenchrus sp.</i> , <i>Panicum sp.</i> ,
Rar	11	2	9	78	<i>Lasiurus sindicus</i> .

Source : Khan and Baluch (1972)

Rangeland in Tharparkar desert ranges are in poor to fair condition. Desirable grasses have disappeared. However, shrubs still produce good browse. During winter, the desert does not support grazing, and most of the livestock migrate to irrigated areas.

KOHISTAN RANGES

Landscape and Environment: Kohistan ranges are situated in Karachi, Thatta, Dadu Districts and parts of Lasbela District. They cover about 2.3 million ha. Ecologically, the tract can be categorized as a tropical, arid thorn submountain zone. The following three land systems have been distinguished by FAO (1975):

i. *Kirthar Range:* A large uniform hill range culminating on the Kuttiyo-kabbar (2170 m), called the Kirthar Range, run north-south and forms the provincial boundary. It alternatively consists of smooth domes of Kirthar limestone, without any soil cover, and steep, broken outcrops of Nari shales and sandstone. At the foot of the mountain is a system of long, parallel outcrops of Munchhar and Nari limestones and shales that form a typical stone-desert landscape. Seasonal rivers descending from Kirthar (Khenji, Mazrani, Unnahar, Buri, Gaj, Nali, Angai and Bandni; some tend to be perennial) have deposited vast colluvial fans and silt flats, about 10 km wide, between the hills and the Indus Plain. Dunes have formed in some areas.

ii. *Central Kohistan:* South of Manohhar Lake, the Kirthar Range splits and tapers southward in a system of parallel ridges 500 to 1000 m high, of similar geological structure. The colluvial foot slopes of the ridges adjoin each other in a continuous piedmont system, almost as if there were no alluvial plains in-between. The most important of the well developed drainage systems is the Baran nulla and its tributaries, which join into a vast drainage zone around Thano Bula Khan.

iii. *Southeastern Shield:* Towards Karachi, Thatta and Kotri, Kohistan gently slopes down from 50 to 500 m in a system of stony plateaus

capped with Ranikot, Laki and Gaj limestones, which are occasionally dissected by Gaj sandstones and shales. The Mol, Khadeji, Malir, Ran Pathani and Liari rivers drain the area seasonally into the coastal plain.

Extremes of temperature of up to 45°C in summer and 3°C in winter. Mean annual rainfall varies from 150 to 200 mm, most of which is received during summer. Strong winds blow from the southwest to northeast during summer at 60km/hour. Relative humidity is fairly high and exceeds 80 per cent during the monsoon. Due to severe wind erosion the top soil is thin. Most of the rocks contain limestone. Areas in the valley contain silt to loamy silt with a thick layer of sand.

Land Use: Land in Kohistan is used for livestock grazing, dryland farming and wildlife habitat. Dryland farming is done wherever adequate perched water is available. Small dams have also been constructed at a few sites. Plains, depressions and valley bottoms are cultivated with millets, sorghum and castor even when rainfall is moderate. Forestry is limited to testing of arid and salt tolerant plants such as mesquite, spineless cactus, *Zizyphus nummularia* and *Atriplex nummularia*.

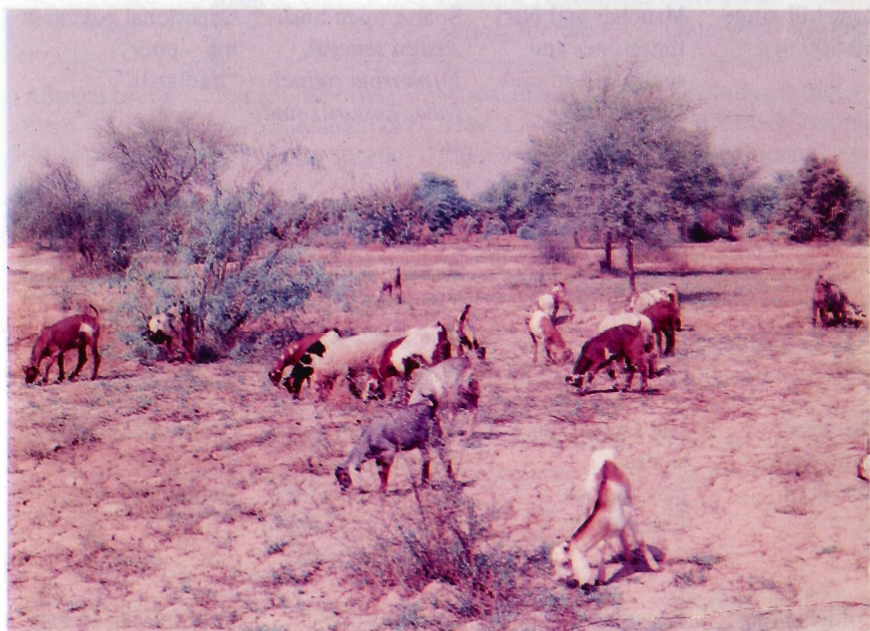


Plate 6. Depleted rangelands in Kohistan near Dhabeji, Sind.

Range Types: The vegetation of Kohistan is dictated by topography, soil type and relief. Hills contain open bushlands, footslopes have thickets of shrubs and trees, while plains are usually devoid of natural vegetation as

a result of dryland farming. A brief description of range types of Kohistan is given in Table 3.

Table 3. Ecological characteristics of various land forms in Kohistan ranges

Land form	Geology and soil	Vegetation	Present land use-range condition
High mountain range 500-2170 m	Brahui, Borage and Kirthar limestone; silt in rock fissures only.	Open bushland <i>Acacia senegal</i> , <i>Zizyphus nummularia</i> , <i>Chrysopogon aucheri</i> , <i>Grewia sp</i>	Emergency goat grazing firewood -good, stationary
High mountain range 500-2000 m	Nari shales and sandstone; clay in rock fissures only.	Sparse open bush- <i>Acacia senegal</i> , <i>Commiphora wightii</i> , <i>Cordia gharaf</i> , <i>Grewia sp</i>	Emergency goat grazing, firewood fair, stationary
Low hill range 50-500 m	Manchar and Nari limestones and shales; silt in rock fissures only.	Sparse open bush- <i>Acaica senegal</i> , <i>Euphorbia caducifolia</i> , <i>Lasiurus sindicus</i>	Occasional goat grazing - poor, "badlands"
Stony plateau 50-500 m	Ranikot Laki limestones, Gaj limestones, very shallow film of silt.	Sparse open dwarf shrubland <i>Barleria acanthoides</i> , <i>Zizyphus nummularia</i> , <i>Lasiurus sindicus</i> , <i>Aristida sp</i>	Regular sheep and goat grazing, scattered fields in depressions poor, overgrazed
Dissected outcrops 50-100 m	Gaj sandstones and shales; clay in rock fissures only	Sparse open dwarf <i>Acacia senegal</i> , <i>Euphorbia caducifolia</i> , <i>Cordia gharaf</i> , <i>Lasiurus sindicus</i>	Occasional goat grazing - poor, "badlands"
Colluvial fans 100-200 m	Recent deposits unclassified boulders, gravel, sand and silt.	Open bushland <i>Saccharum spontaneum</i> , <i>Pterophyllum oliveri</i> , <i>Nerium indicum</i> , <i>Rhazya stricta</i>	Intensive sheep and goat grazing, firewood - fair, overgrazed

(continued)

Table 3 continued

Upper foot-slopes 200-500 m	Subrecent deposits and Manchar conglomerates; shallow, stony sandy loam.	Bushland <i>Aristida</i> sp, <i>Lasiurus indicus</i> , <i>Cymbopogon jwarancusa</i> , <i>Zizyphus nummularia</i>	Regular sheep and goat grazing - poor, overgrazed
Lower foot slopes 100-200 m	Recent deposits deep, well-structured sandy loam or loamy sand.	Wooded bushland thickets <i>Prosopis cineraria</i> , <i>Cenchrus ciliaris</i> , <i>Indigofera oblongifolia</i> , <i>Cassia holosericea</i>	Yearlong grazing, all livestock; lopping widespread shifting cultivation - fair, wind erosion
Sedimentary Plain 50-100 m	Recent deposits deep, well-structured loam or clay loam	Woodland <i>Acacia nilotica</i> , <i>Prosopis cineraria</i> , <i>Eleusine flagellifera</i> , <i>Salsola foetida</i>	Yearlong grazing all livestock; lopping; widespread rainfed cultivation - fair, wind erosion
Alluvial Indus Plain 20-5- m	Recent deposits deep clay-loam or heavy clay-locally alkaline	Woodland <i>Salsola vermiculata</i> , <i>Capparis aphylla</i> , <i>Alhagi maurorum</i> , <i>Cynodon dactylon</i>	Yearlong grazing, all livestock; lopping; fodder cutting, marginal irrigated cultivation - no rangelands
Riverbeds and drainage zones 50-100 m	Recent deposits very heterogeneous gravel-sand to heavy clay; locally small dunes, locally alkaline	Riverine thickets and woodlands <i>Tamarix aphylla</i> , <i>Tecoma undulata</i> , <i>Acacia jacquemontii</i> , <i>Saccharum spontaneum</i>	Yearlong grazing all livestock; lopping, firewood, intensive rainfed cultivation - fair but heavily used
Recent sand dunes 50-100 m	Recent deposits wind-blown sand, not consolidated	Bushed grassland <i>Leptadenia pyrotechnica</i> , <i>Cenchrus pennisetiformis</i> , <i>Panicum turgidum</i> , <i>Calligonum polygonoides</i>	Yearlong grazing, all livestock; firewood - fair, but heavily used

Important range plants are given below:

TREES/SHRUBS: *Acacia nilotica*, *A. senegal*, *Barleria acanthoides*, *Calotropis procera*, *Capparis aphylla*, *Commiphora wrightii*, *C. stocksiana*, *Cordia gharaf*, *Euphorbia caducifolia*, *Grewia villosa*, *Leptadenia pyrotechnica*, *Lycium depressum*, *Pterophyllum oliveri*, *Prosopis cineraria*, *Rhazya stricta*, *Salvadora oleoides*, *Tamarix dioca*, *Tecoma undulata*.

GRASSES: *Aristida adscensionis*, *A. mutabilis*, *Cenchrus ciliaris*, *C. biflorus*, *C. pennisetiformis*, *Cynodon dactylon*, *Cymbopogon jwarancusa*, *Digitaria sp.*, *Eleusine flagellifera*, *Lasiurus indicus*, *Saccharum spontaneum*, *Sporobolus marginatus*.

FORBS: *Aerva tomentosa*, *Cassia holosericea*, *Convolvulus glomeratus*, *Crotolaria bifolia*, *Fagonia critica*, *Heliotropium ophioglossum*, *Indigofera oblongifolia*, *Rhyncosia minima*.

BALUCHISTAN INTERMOUNTAIN RANGES

Baluchistan province has a total geographic area of 34.73 million ha. Although about 93 percent of the area is classified as rangelands, about 10 million ha are unproductive, 12 million ha produce little grazing, and about 1.6 million ha are undergrazed due to the inaccessibility of the hills and lack of water. Fair to good producing ranges are limited to about 9 to 10 million ha (FAO, 1983).

The climate of the province is arid to semi-arid with annual rainfall increasing from 50 mm in the west to over 400 mm in the east. Precipitation distribution is very erratic and irregular. Most of the rainfall is received during the winter. The temperatures are highly variable. The temperature in the Sibi plain can reach 50°C in summer and drop to 1 to 3°C in Kalat, Quetta and Muslimbagh, during the winter. About 80 percent of the area can be classified as intermountainous. The remaining 20 percent consists of flood plains and alluvial deposits with a high potential for cultivation. Geomorphologically, the rangelands in Baluchistan can be distributed into six types of landscape, including mountains, uplands, piedmont, desert, flood plain and coastal plains. Some of the important mountain ranges in the province are Sulaiman, Toba-Kakar, Central Brahui, Kirthar, Chagai and Raskoh Hills, Siahan, Pab, Central Makran and Makran Coast.

Vegetation composition, carrying capacity, and production potential of Baluchistan intermountain rangelands varies among areas. Precipitation, altitude and soil formation affect forage production. Dry matter forage yield of a few protected mountain ranges is given in Table 4.

Rangelands of Baluchistan can be divided primarily into the following three main categories:

Central Baluchistan Ranges: These ranges spread over Quetta and Kalat Divisions, a region with a mediterranean climate where annual precipitation varies from 100 to 400 mm, most of which is received during winter or early spring. Altitude ranges from 1000 to over 3000 m. The famous Maslakh Range Project, which was the first scientifically managed

Table 4. Gross dry matter production (herbage and forage) of the ungrazed mountain rangelands in Baluchistan.

Range	gms Wr/X	DM Kg/ha	Veg. Cover %	Plants
Shangaloona	9.8	49	10	<i>Cymbopogon</i>
Shangaloona	56.8	284	15	<i>Cymbopogon</i>
Dumas Kach	43.5	217	8	<i>Chrysopogon with Aristida spp.</i>
Tomagh Forest	28.0	140	25	<i>Cymbopogon Chrysopogon</i>
Harnai to Ashgara	51.1	250	20	<i>Cymbopogon</i>
Gok Mt, Sharan	120.0	600	13	<i>Aristida</i>
Gok Mt, Sharan	73.0	370	15	<i>Chrysopogon</i>
Lakabad, Zhob	75.0	370	15	<i>Chrysopogon</i>
Malvi, Sliaz	99.9	500	15	<i>Chrysopogon</i>
River, Zhob				
Rigora Range,	16.4	82	5	<i>Cymbopogon</i>
Chauter				
Sulaiman, Mehtra	4.0	220	20	<i>Chrysopogon</i>
Sparangha	71.9	505	15	<i>Artemisia</i>
Ziarat Range	140.5	983	36	<i>Artemisia</i>
Killi Umarbad	40.0	218	15	<i>Haloxylon</i>
Kach	12.3	76	5	<i>Artemisia</i>

Source: FAO, (1983).

range project in Pakistan during 1954, is situated in this region. Most of the area contain mountains with interspersed with flat valleys. Wheat and orchards are cultivated wherever irrigation facilities are available. The 'karez' system of irrigation is prominent in the valleys.

A detailed soil and vegetation survey of the area was conducted by Pakistan Forest Institute, Peshawar and Soil Survey of Pakistan (1981). The following four plant associations were dominant:-

i. A high to moderate density of dwarf shrubland characterized by *Cymbopogon schoenanthus* and *Chrysopogon montanus*. This community is associated with the Juniper zone of the Toba Kakar and Central Brahui mountains and includes a tree layer of *Juniperus macrocarpa*, *Pistacia sp.* and *Fraxinus xanthoxyloides*, a shrub layer of *Caragana ambigua*, *Prunus eburnea*, *Othonnopsis intermedia*, low shrub layer of *Artemisia scoparia*, *Haloxylon griffithii*, and a layer of annual grasses and forbs.

ii. On the piedmont slopes, the vegetation is characterized by *Cousinia sp.* and *Haloxylon griffithii*.

iii. A loess rocky hill complex characterized by *Iris* and *Cousinia*.

iv. A salinas associated with *Salsola* and *Tamarix spp.* Vegetation of Kalat Division can be divided into following two range types:

a. Plant communities on the piedmont, bajada and flood plains on

large areas, particularly on the flood plains and bajada, have been intermittently cultivated and fallowed; areas are very sparsely colonized by *Alhagi camelorum*, *Acanthophyllum squarrosum*. South of Mastung, on the piedmont, there is a 5-10 percent cover formed by *Peganum harmala*, *Othonnopsis intermedia* and *Haloxylon griffithii*.

a. As one proceeds south, the vegetation of the piedmont slopes varying from 5 to 15 percent of low shrubs is dominated by *Artemisia scoparia* and *Othonnopsis intermedia*. In the southern part of Kalat, grassland becomes more frequent with a vegetative cover of 15-20 percent, dominated by *Cymbopogon schoenanthus*, *Withania coagulans*, *Acanthophyllum squarrosum*, *Calotropis procera* with scattered *Caragana ulcinia*.

b. The central core of the Brahui mountains consists of widely scattered *Juniperus macropoda*, some *Pistachia* sp. with *Olea Perruginea* and a 10-20 percent cover of *Artemisia scoparia*, *Perowskia abrotanoides*, *Nepto* spp and scattered *Caragana ulcinia*. As one proceeds south, the grasses become more dominant and the following genera are common: *Cymbopogon*, *Aristida*, *Pennisetum* with annual grasses of *Bromus tectorum*, *Bromus mollis*, *Agropyron squarrosum* and *Aristida depressa*.

Range in the area is depleted due to heavy influx of livestock of Afghan refugees and 'pawindas'. A shortage of winter feed and watering points are main problems.

Western Baluchistan Ranges: These ranges cover the desert areas of Chagai, Kharan, Panjgur, Makran, Turbat, Gwadar and Lasbela Districts. Rainfall is erratic and scanty (50-200 mm). As a whole, the tract has low potential to sustain economical ranching. In Chagai District, vegetation on the piedmont slopes consist of *Cousinia alepidea*, *Haloxylon griffithii*, *Alhagi camelorum* with *Saccharum ravannae* in the nullah. In dune and sandy bajada, where livestock grazing has been excluded by the Forestry Department, there is a 1-5 percent plant cover with *Stipa plumosa*, *Aheagi camelorum*, *Tamarix* sp. and *Zygophyllum atriplicoides*. The extensive salinas have vast areas of sparse plant cover, interspersed with plant communities, which include species of *Suaeda fruticosa*, *Salsola* sp, *Panicum antidotale*, *Aeluropus repens* and *A. macrostachyus*.

In the Rakhshan Valley of Kharan District, sheep rearing is dominant. Here, the Afghan 'pawindas' have less influence. The grazing potential in Panjgur, Turbat and Gwadar is limited. Forage quality depends on rainfall.

On the piedmont, *Prosopis cineraria*, *Salvadora oleoides*, *Capparis aphylla*, *Zizyphus* sp. occur; *Tamarix aphylla* occurs in the core saline areas with *Suaeda fruticosa*. One important introduction to the Lasbela District is *Prosopis juliflora*, which has successfully colonized arid terrain, but has the potential of spreading into cultivated areas.

The main forage grasses, are *Cenchrus ciliaris*, *Eleusine flagellifera*, *Pennisetum orientale*, *Aristida adscensionis*.

Eastern Baluchistan Ranges: These are located in Zhob and Loralai Districts of Baluchistan. The bioclimate is influenced by summer monsoon rainfall.

Zhob and Loralai ranges have a high potential for range development. These are grass-dominated. However, the influence of Afghan 'pawindas' are very influential here. The protected areas support *Chrysopogon* grass communities. The area also has adequate watering points. Dryland farming is also practised at few locations. Vegetation is similar to that in the Sulaiman Mountain Ranges.



Plate 7. *Cymbopogon* dominated ranges in eastern Baluchistan.

SULAIMAN MOUNTAIN RANGES

Sulaiman mountain ranges cover about 1.5 million ha. The elongated area extends along Afghanistan border. The elevation of the Sulaiman Range is between 1540 and 3,400 m above sea level (SSP, 1976). Steep ridges of exposed bedrock with a relief of more than 150 m contain little soil material. The rocks exhibit characteristics of north-south trend. The younger rock formations occur in the eastern parts while the older rocks progress from the interior to the western side of the range. All of them represent a huge easterly dipping anticlock, the axis of which corresponds to the ridge of highest peaks culminating in the Takhti-Sulaiman.

The climate of the tract is arid mountainous, sub-tropical continental. Annual rainfall is low and ranges from 200 to 250 mm. About 50 percent of the total rainfall is received during July and August. May, June and July are the hottest months (mean maximum temperature of about 40°C) while

January is the coldest month (mean minimum temperature of about 3°C).

Livestock rearing is the major occupation of the tribal residents. Dryland farming is done in the piedmont plain and valleys of Sulaiman mountains whose water from flash floods is conserved and utilized (the 'Road-kohi' system of irrigation).

Natural vegetation consists of following species:-

TREES/SHRUBS: *Acacia modesta*, *Acanthophyllum squarrosum*, *Berberis lycium*, *Caragana ambigua*, *C. ulcinia*, *Daphne oleoides*, *Olea ferruginea*, *Perowskia obrotonoides*, *Zygophyllum atriplicoides*.

GRASSES: *Aristida funiculata*, *A. adscensionis*, *Chrysopogon montanus*, *Cymbopogon schoenanthus*, *Dactylactenium scindicum*, *Desmostachya bipinnata*, *Dichanthium annulatum*, *Pennisetum orientale*, *Saccharum ravannae*, *Stipa arabica*.

FORBS: *Ebenus stellatus*, *Cassia holosericea*, *Indigofera oblongifolia*.