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Arid rangelands in the Cholistan Desert (Pakistan)

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Abstract

The Cholistan Desert, once a prosperous, lively, and thriving jungle is now by and large a desolated piece of land. Its productivity potential is on the decline despite the fact that the number of animals in this desert is on the increase. This sandy desert is situated in the southern part of Punjab (Pakistan) with highly saline soils and a brackish subsoil aquifer. It supports a human population of 110,000 pastoral nomads depending exclusively upon livestock for their livelihood. Life sustainability in this desert revolves round annual precipitation. The summer in the desert is extremely harsh and punishing. Some xeric plant species do survive during severe droughts but undergo tremendous grazing pressure leading to partial eradication; as result, the flora and fauna have been thinning out gradually with the increasing severity of desertization. The paper highlights the range livestock production in the Cholistan Desert.

Key words: desert, desertization, pastoralism, rangelands, Pakistan.

Résumé

Les parcours arides et désertiques du Cholistan (Pakistan)

Le désert du Cholistan qui fut autrefois une jungle vivante et prospère n'est plus qu'un territoire désolé. Son potentiel de productivité est en déclin bien que le nombre d'animaux s'accroisse dans ce désert. Il s'agit d'un désert sableux situé dans le sud du Punjab, avec des sols très salés et un aquifère phréatique d'eau saumâtre dans le sous-sol. Il comprend une population de 110 000 pasteurs nomades dont la survie dépend entièrement de leur bétail. La durabilité de la vie dans ce désert tourne toujours autour du problème des précipitations annuelles. Certaines espèces végétales arrivent à survivre pendant les sécheresses sévères mais sont alors soumises à des pressions pastorales considérables conduisant à leur éradication partielle. Il s'ensuit que la flore et la faune se sont progressivement éclaircies et que la désertification s'est aggravée. Cet article souligne le déclin de la production pastorale et animale dans le désert du Cholistan.

Mots clés : désert, désertification, pastoralisme, parcours, Pakistan.

Introduction

Location

The Cholistan desert is located in southern Punjab extending through the Nara and Thar deserts of Sindh (Pakistan) between latitudes 27° 42′ and 29° 45′ N and longitudes 69° 52′ and 75° 24′ E *(figure 1)*, covering about 2.6 million hectares [1-4]. Soils are classified as either saline or saline-sodic, with pH ranging from 8.2 to 8.4 and from 8.8 to 9.6, respectively. Based on topography, parent material, soil and vegetation, the Cholistan Desert can be divided into two geomorphic regions; the northern region is called Lesser Cholistan bordering canal-irrigated areas covering about 7,770 km^2 and the southern region is called Greater Cholistan and covers about 18,130 km^2

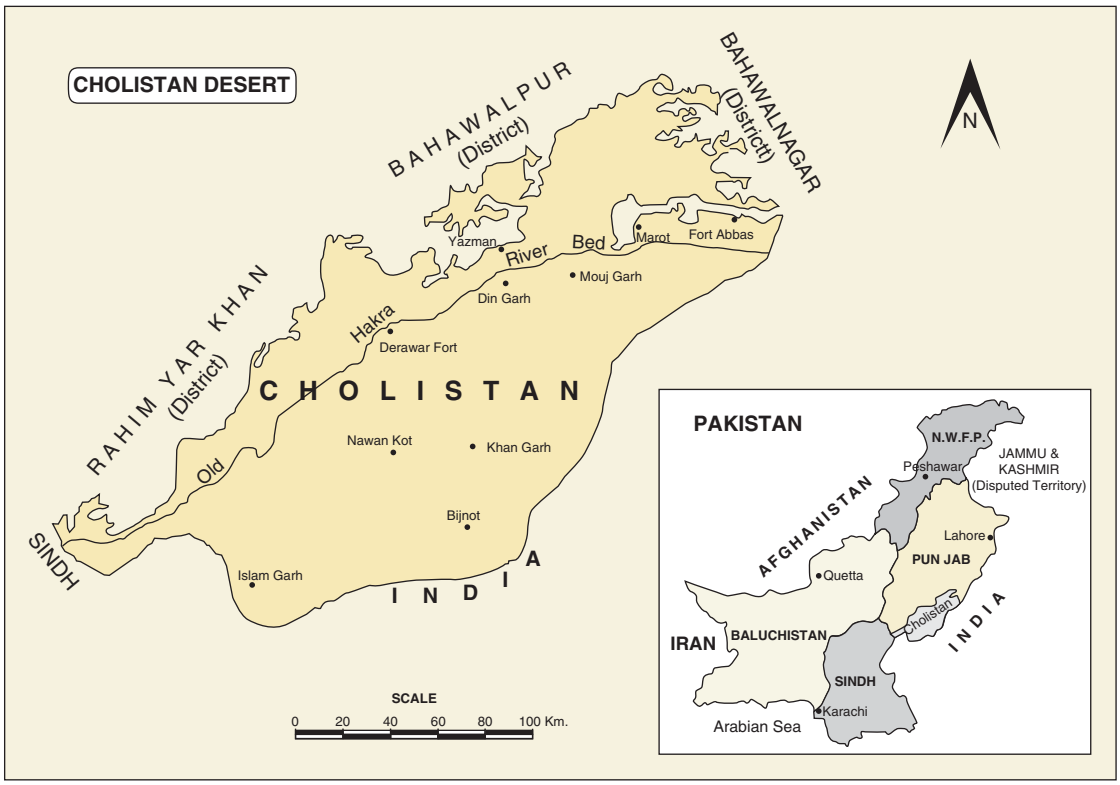

Figure 1. Location map of Cholistan.

[1-3]. The old Hakra riverbed (dried about 600 years ago) is the dividing line between the two regions. Lesser Cholistan comprises the desert margin and includes all the area north of the Hakra, while Greater Cholistan is essentially the area south of the old Hakra riverbed. The northern part of Lesser Cholistan includes an irrigation zone of 280,000 hectares served by a canal network, where only 130,000 hectares are commandable but only a small part is actually irrigated.

Climate and soils

Cholistan is a hot hyperarid sandy desert. The mean annual rainfall varies from less than 100mm in the west to 200mm in the east, chiefly falling during monsoon (July through September). Rainfall is very inconsistent in quantity and duration and prolonged droughts are common once every 10 years. Temperatures are high in summer and mild in winter with no frost. The mean summer temperature (May-July) is 34-38°C with the highest reaching over 51.6°C [5,6] *(figure 2)*. The soils are generally saline, alkaline and gypsiferous composed of granites, schists, gneiss, and slates. The dunes reach an average height of about 100m in Greater Cholistan and about 30m in Lesser Cholistan [2-4, 7-9].

Lesser Cholistan consists of large saline alluvial flats (locally called *dahars*) alternating with low sandy ridges/dunes. The clayey flat areas in Lesser Cholistan are generally homogenous to a depth ranging from 30 to 90cm. These soils are classified as either saline or saline-sodic, with pH ranging from 8.2 to 8.4 and from 8.8 to 9.6, respectively. Greater Cholistan is a wind-resorted sandy desert and comprised of old river terraces, large sand dunes and less interdunal flat areas.

There are no permanent, natural bodies of surface water in Cholistan. Factors like low rainfall, high rate of water infiltration, and high evaporation rate prevent the natural accumulation of surface water [1]. Rainwater is collected in man-made dug-

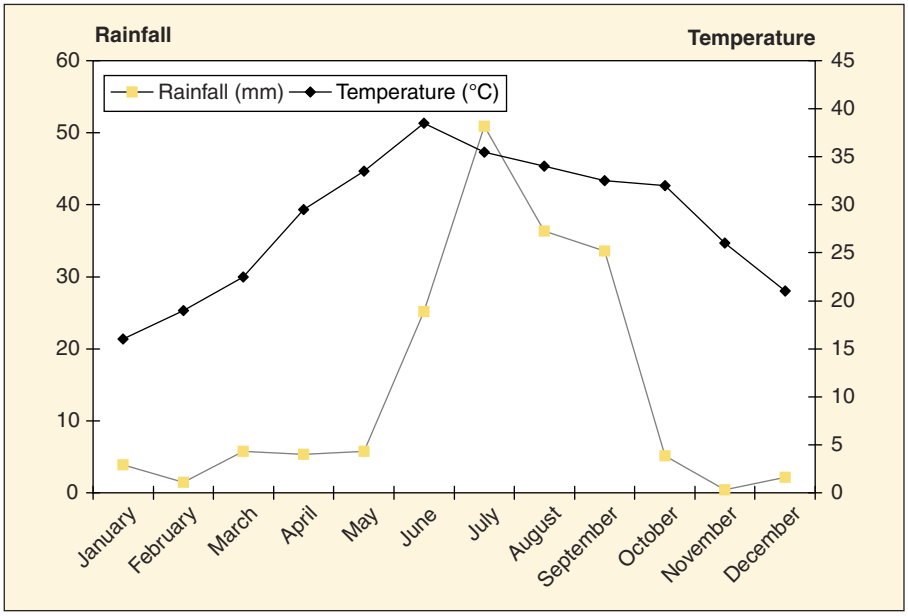

Figure 2. Ombrothermal diagram of Cholistan Desert.

out water ponds called *tobas*. *Tobas* are made in clayey flats locally called *dahars* with a large catchment area to avoid the loss of runoff and water percolation. Underground water is at a depth of 30-50m, generally brackish, containing salts 9,000-24,000 mg/L [3, 7].

Socioeconomic aspects of pastoralism

The total human population of this desert is around 110,000 nomadic pastoralists. The majority of the people live on the periphery of the desert and the interior of the desert is thinly populated. The economy of the region is predominantly pastoral and people have been practising a nomadic life style for centuries. The nomads own smaller to large herds of camels, cattle, sheep and goats. The interior desert area is not connected by a modern communication system and sandy desert tracks are used for travel by camels or jeeps. Local people use camels as a mode of transportation. Habitations are small and extremely scattered [3, 10].

The pastoral system is characterized by a mass movement of animals and people throughout the year in search of water and forage within the desert. The onset and distribution of monsoon rain mainly dictate the pattern of movement of nomadic herders *(figure 3)*. Around the months of March or April, depleted feed and water resources in the interior of the desert force nomadic households and their herds to move towards nearby irrigated areas. Supplementary income is earned through unskilled labour in towns or irrigated farms. In irrigated agricultural fields the pastoralist nomads have free grazing of livestock on wheat stubbles, drinking water for humans and livestock and markets for livestock and their by-products. In return, farmers in the irrigated agricultural lands obtain sufficient labour for crop harvesting, farming operations and animal manure to enhance soil fertility through camping of livestock on fallow fields.

The nomads and their herds return to the desert around July or August with the onset of monsoon showers. Distances travelled during this movement vary from 10 to 100 km. While in the desert, the natural vegetation is the main source of fodder and *tobas* serve as a source of drinking water for both nomads and their livestock [10]. *Tobas* belonging to one clan are generally located close to each other (often within a 2-4-km radius). During October and November, when water resources dry up, each clan moves its herds to semi-permanent settlements where primitive unlined wells and *kunds* (usually lined) are available [1, 3]. Upon exhaustion of these water resources, the desert is vacated and nomads move to peripheral areas of the desert where water and fodder are available.

The economy of these nomads entirely depends on fragile and meagre natural resources associated with inconsistent rain pattern. Job opportunities are confined to labour in agricultural fields or other minor activities due to lack of education or skilled training. Most of the nomads live below poverty line in the absence of basic human needs like clean drinking water or sufficient food, health and education for their children. Livestock breeding, improvement of performance or range management is not practised scientifically.

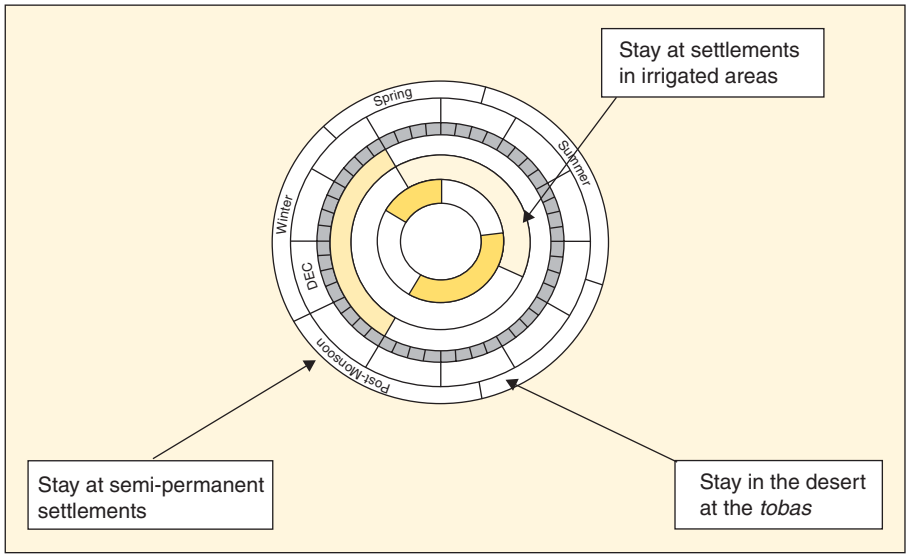

Figure 3. Yearly movement pattern of pastoralists in Cholistan.

Few nomads manage to shift milk-producing animals near the roadside to earn some living. Livestock is used for exchange of gifts in communal ceremonies like weddings, tribal celebrations, childbirth or funerals, and animals are slaughtered for feast for the guests. A nomad's status in the desert life-style is chiefly determined by the size of herd. All livestock are indigenous breeds well adapted to climatic conditions. Herd reproductive performance is generally poor with low birth rates and high mortality due to poor nutrition, lack of healthcare and climatic stresses [1, 3, 11]. Veterinary health care centres are not available to majority of livestock.

All the nomads have an unwritten code of ethics for their range territories and use of water points: *tobas*, *kunds*, or wells. Each clan has access to traditionally-defined territories to use for grazing irrespective of the condition of the range vegetation. The exhaustive use of range vegetation has resulted in the decline of palatable species especially grasses, overall vegetation cover, malnutrition of livestock and degrading wildlife habitats.

Range vegetation

Phytogeographically, the vegetation of the Cholistan desert belongs to the Nubo-Sindhian Province of the Sudanian Region and is typical of arid regions [1].

The sparse vegetation of Cholistan is dominated by bush forming perennial shrubs with scattered small trees. A large number of annual and ephemeral species appear after rains, complete their life cycle in a short span and dry up after dispersing seeds. Most of the shrubs and trees are leafless or have reduced and modified leaflike structures. Several members of Chenopodiaceae like *Haloxylon, Suaeda, Salsola* form the dominant species along with the hardy grasses of rangelands. Most of the species have a remarkable capacity to regenerate even in minimum rainfall. The seeds are also hardy enough to withstand severe high temperature, aridity and multiple years of drought. Rainfall is generally confined to few showers in the months of July to September. The rainfall ranging from 100-300 makes the desert green with vegetation cover up to 60% in some areas.

The vegetation of Lesser Cholistan is dominated by several species of shrubs and perennial grasses dotted by few species of small trees. However, in Greater Cholistan trees are generally lacking, the shrubs are sparser and species diversity is poor. Vegetation cover is poor on sand dunes and unstable sand dunes are devoid of any vegetation. Some interdunal areas

have a better vegetation depending on the water retention capacity of the soil. Ground water table is very low and in most of the cases not fit for drinking.

Main vegetation types

It is difficult to define distinct community types associated with habitats like sand dunes, interdunal flat plains, saline plains or dry water-courses flooded periodically during rain. Some species are typically associated with a distinct habitat type. Some main vegetation types based on floristically dominant and structurally important species are described below.

• *Haloxylon-Calligonum* Community

This is a widespread community type dominated by leafless shrubs of *Haloxylon stocksii* and *Calligonum polygonoides*. Other associated species include *Lasiurus scindicus, Cymbopogon, jwarancusa, Suaeda fruticosa*, *Dipterygium glaucum*, *Crotalaria burhia*, etc. This type of communities generally covers flat plains with compact soil and saline conditions. Several species of annuals and ephemerals emerge after rains, covering the ground but contributing very little biomass.
The shrubs have strong root systems and hold the soil together protecting the soil from wind erosion. Sometimes small mounds of soil are developed around the bushes while the surrounding soil is blown away with strong winds.

• *Acacia-Tamarix* Community

The *Acacia nilotica* and *Tamarix aphylla* community is found in peripheral areas of Cholistan. *Acacia nilotica* is locally considered as poor man's teak wood for its valuable timber used for cheap furniture and agriculture implements. Leaves provide forage for livestock. *Tamarix* branches are used for thatching rooftops and fences around livestock enclosures. Trees also provide shade for resting livestock seeking shelter from strong sun. Several species of grasses and herbs are associated with these communities like *Cenchrus*, *Pennisetum*, *Eragrostis*, *Fagonia*, *Dipterygium*, *Indigofera*, etc. Large hemispherical clumps of *Heliotropium crispum* are common in the peripheral regions of the desert which hold soil from erosion and conserve water.

• *Prosopis-Salvadora* Community

The *Prosopis cineraria* and *Salvadora oleoides* community is generally found in Lesser Cholistan regions where rainfall is not less than 100mm. *Prosopis cineraria* is considered as an excellent forage species with a very deep root system, very well adapted to the desert conditions. The branches are extensively lopped for feeding young lambs and goats not able to roam around for forage. Generally the top shoots are left for future growth and lower branches are cut for livestock. It also forms excellent firewood for cooking as well as charcoal making. *Salvadora oleoides* is an evergreen tree with deformed trunk and a deep root system heavily grazed by camels and goats. It is a very slow-growing tree with poor regeneration through seeds but it profusely produces suckers forming large clumps. Sometimes only clump-forming large bushy structures are seen due to heavy browsing; tree-like shape is rare; ripe fruits are also edible.
Other associated species include *Acacia nilotica*, *Zizyphus nummularia*, *Tamarix aphylla*, grass species like *Lasiurus*, *Cymbopogon*, *Sporobolus*, *Panicum*, *Cenchrus*, *Aristida*, etc. Some annuals associated with this community include *Zygophyllum*, *Dipterygium*, *Indigofera*, *Glinus*, *Fagonia*, *Heliotropium*, etc.

• *Lasiurus-Cymbopogon* Community

Perennial species of clump forming grass species like *Lasiurus scindicus* and *Cymbopogon jwarancusa* are developed on poorer soils on flat plains with compact soil. This community type is generally poor in species diversity, having mainly annual short-lived species appearing after rains. These grass species are palatable in early stage of growth; coarse hard old leaves are not generally grazed.
Lasiurus scindicus and *Cymbopogon jwarancusa* are abundantly distributed throughout the Cholistan Desert. Scattered shrubs of *Haloxylon*, *Suaeda*, *Crotalaria*, *Aerua* are also sparsely found.

• *Acacia-Pennisetum* Community

Acacia jacquemontii and *Pennisetum divisum* are generally associated with dry water courses with better soil and moisture retention capacity. *Acacia jacquemontii* is a tall shrubby species with extensive branching from the base. It is a good forage species and a preferred firewood shrub in the desert. *Pennisetum divisum* is a tall large clump-forming grass with a good soil-binding ability preventing soil erosion from strong winds and flash floods. This is an excellent fodder grass relished by livestock producing green tender leaves in minimum moisture conditions.
Other associated species include species of *Convolvulus*, *Launnaea*, *Indigofera*, *Tribulus*, *Trianthema*, *Neurada*, etc. Several grass species include *Ochthochloa*, *Panicum*, *Aeluropus*, *Stipagrostis*, *Cenchrus*, etc.

• *Aerua-Crotalaria* Community

This community is common on poor saline soils. Usually, large shrubs and trees are absent. Grasses like *Sporobolus*, *Ochthochloa*, *Desmostachya* species are found having stiff leaves, grazed when young. They are usually found in interdunal saline sandy soils.

• *Capparis-Suaeda* Community

Capparis aphylla and *Suaeda fruticosa* are also widespread in poor soils with inadequate moisture contents. *Capparis aphylla*, a leafless shrub, sometimes attains tree-like form; its branches are used for thatching roof tops. *Suaeda fruticosa* forms evergreen large-sized bushy dome-like clumps; leaves are reduced to scales. Vegetation is very sparse, poor in species diversity; short-lived annual plants appear after rains for a short period.

• *Leptadenia-Calotropis* Community

The *Leptadenia pyrotechnica* and *Calotropis procera* community develops in poor sandy soils; not palatable for livestock, it spreads in areas with heavy grazing pressure. *Leptadenia pyrotechnica* is a much branched leafless shrub not grazed by livestock but the branches are used for thatching roofs and fencing. *Cyperus conglomerates* is a compact clump-forming sedge with roots having good sand-binding ability, found frequently on sand dunes under poor moisture conditions, grazed when young.

Grazing potential of ranges

The vegetation in Cholistan is typical of arid and semiarid climate consisting of xerophytic species adapted to high seasonal temperatures, low humidity, moisture fluctuations and wide variety of edaphic conditions [12]. Compared to the hyper-arid southern region, the vegetation cover is relatively better in Eastern Cholistan (200mm rainfall zone). A wide range of nutritious and drought-tolerant plant species (128 species belonging to 33 families) of grasses, herbs, shrubs and trees occupy this desert [9]. Hardy species adapted to high temperature and low soil moisture include *Lasiurus scindicus, Sporobolus iocladus, Aeluropus lagopoides* and *Cyperus conglomerates*.
Major forage plants and corresponding characteristics, use and grazing animals in the Cholistan Desert are listed in *table 1*.

Pastoralism in Cholistan

Pastoral

The livestock depend entirely on self-regenerating and self-maintaining range resources throughout the year or resort to canal and riverain areas for grazing with

Table I. Major forage plants of the Cholistan Desert and corresponding characteristics, use, and grazing animals.

Plant Species	Parts used	Palatability	Season	Frequency	Grazing animals
Perennial Grasses					
Stipagrostis plumosa	Lv, Sh	HP	Monsoon, Spring	V. Common	Cattle, sheep, goat
Cenchrus ciliaris	Lv, Sh	HP	Monsoon, Spring	Rare	Cattle, Sheep Goat
Cymbopogon jwarancusa	Lv, Sh	LP	Monsoon, Spring	V. Common	Sheep, Cattle
Ochthochloa compressa	Lv, Sh	HP	Monsoon, Spring	V. Common	Cattle, Sheep Goat
Lasiurus scindicus	Lv, Sh	HP	Monsoon, Spring	V. Common	Cattle, Sheep Goat
Panicum antidotale	Lv	MP	Monsoon, Spring	Rare	Cattle, Sheep Goat, Camel
Panicum turgidum	Lv	HP	Monsoon, Spring	Common	Cattle, Sheep Goat, Camel
Sporobolus iocladus	Lv	MP	Monsoon, Spring	Common	Cattle, Sheep Goat, Camel
Aeluropus lagopoides	Lv, Sh	H.P	Monsoon, Spring	Common	Cattle, Sheep Goat, Camel
Sedge					
Cyperus conglomeratus	Sh, Lv	HP	Monsoon, Spring, Winter	Common	Cattle, Sheep Goat, Camel
Annual Grasses					
Aristida adscensionis	Sh, Lv	MP	Monsoon	Common	Sheep, Goat
Aristida mutabilis	Sh, Lv	MP	Monsoon	Common	Sheep, Goat
Aristida funiculata	Sh, Lv	MP	Monsoon	Common	Sheep, Goat
Aristida hystricula	Sh	LP	Monsoon	Common	Sheep, Goat
Cenchrus biflorus	Sh, Lv	MP	Monsoon	Common	Cattle, Sheep, Goat
Cenchrus prieurii	Sh, Lv	HP	Monsoon	Common	Cattle, Sheep, Goat
Enneapogon desvauxii	Lv, Sh	HP	Monsoon	Rare	Sheep, Goat
Eragrostis barrelieri	Lv, Sh	HP	Monsoon	Common	Sheep, Goat
Leptothrium senegalense	Lv, Sh	MP	Monsoon	Common	Cattle, Sheep, Goat
Tragus racemosus	Lv, Sh	MP	Monsoon	Common	Cattle, Sheep, Goat
Forbs					
Tribulus longipetalus	Sh, Lv, Fl	HP	Monsoon	Common	Cattle, Sheep Goat, Camel
Tribulus terrestris	Sh, Lv, Fl	HP	Monsoon, Winter, Spring	Rare	Cattle, Sheep Goat, Camel
Fagonia cretica	Lv	LP	Monsoon, Winter, Spring	Common	Sheep
Anticharis linearis	Lv, Sh	LP	Monsoon	Common	Sheep, Goat
Indigofera sessiliflora	Lv, Sh, Fl	MP	Monsoon	Rare	Sheep, Goat
Indigofera argentea	Lv, Sh, Fl	MP	Monsoon	Common	Sheep, Goat
Indigofera hochstetri	Lv, Sh, Fl	MP	Monsoon	Common	Sheep, Goat
Neurada procumbense	Lv, Fl	MP	Winter	Rare	Sheep, Goat
Glinus lotoides	Lv, Sh, Fl	LP	Monsoon, Spring	Common	Cattle, Sheep Goat, Camel
Euphorbia prostrata	Lv	LP	Monsoon, Spring	Common	Sheep, Goat
Mukia madraspatana	Lv	HP	Monsoon	Common	Sheep, Goat
Cressa cretica	Lv, Sh	MP	Monsoon, Spring	Common	Cattle, Sheep, Goat
Convolvulus microphyllus	Lv, Sh	MP	Monsoon, Spring	Common	Sheep, Goat, Camel
Launea residifolia	Lv, Sh	LP	Winter	Common	Sheep, Goat, Camel
Launea nudicaulis	Lv, Sh	LP	Winter	Common	Sheep, Goat, Camel
Dipterygium glaucum	Sh	LP	Monsoon, Spring	V. Common	Camel
Cleome brachycarpa	Sh	LP	Monsoon, Spring	Common	Camel
Farsetia hamiltonii	Sh	LP	Monsoon, Spring	V. Common	Sheep, Goat
Heliotropium strigosum	Lv, Sh	MP	Monsoon, Spring	Common	Sheep, Goat, Camel
Heliotropium crispum	Lv, Sh	LP	Throughout the year	Common	Camel, Sheep
Trianthema portulacastrum	Sh	MP	Monsoon	Common	Camel, Sheep
Zaleya pentendra	Sh	MP	Monsoon	Common	Camel, Sheep
Sesuvium sesuvioides	Sh	MP	Monsoon	Common	Camel, Sheep
Limeum indicum	Sh	MP	Monsoon	V. Common	Camel, Sheep
Shrubs					
Crotalaria burhia	Lv	LP	Throughout the year	Common	Camel
Aerva persica	Lv	LP	Throughout the year	Common	Camel
Calotropis procera	Lv	LP	Throughout the year	Common	Cattle, Sheep, Goat
Pulicaria rajputanae	Lv	LP	Throughout the year	Common	Camel

Table I (*cont'd*). Major forage plants of the Cholistan Desert and corresponding characteristics, use, and grazing animals.

Plant Species	Parts used	Palatability	Season	Frequency	Grazing animals
Calligonum polygonoides	Sh, Fl	MP	Throughout the year	V. Common	Camel, Cattle, Goat
Acacia jacquemontii	Lv, Sh, Fl	HP	Throughout the year	Common	Sheep, Goat, Camel
Haloxylon recurvum	Sh	MP	Throughout the, year	V. Common	Camel
Haloxylon salicornicum	Sh	LP	Throughout the year	V. Common	Camel
Salsola baryosma	Sh	MP	Throughout the year	V. Common	Camel
Suaeda fruticosa	Sh, Lv	MP	Throughout the Year	V. Common	Camel
Capparis decidua	Sh	MP	Throughout the Year	V. Common	Camel, Cow
Zizyphus nummularia	Lv	HP	Throughout the Year	Common	Sheep, Goat, Cow, Camel
Leptadenia pyrotechnica	Sh	NP	Throughout the Year	Common	Camel
Trees					
Prosopis cineraria	Lv, Sh, Fl, Fr	HP	Throughout the year	V. Common	Sheep, Goat, Cow, Camel
Acacia nilotica	Lv, Sh, Fl, Fr	HP	Throughout the year	Common	Sheep, Goat, Cow, Camel
Prosopis juliflora	Lv, Fr	MP	Throughout the year	Rare	Sheep, Goat, Camel
Zizyphus spina christi	Lv	HP	Throughout the year	Rare	Sheep, Goat, Cow, Camel
Tamarix aphylla	Sh	MP	Throughout the year	Common	Camel
Salvadora oleoides	Lv, Sh	HP	Throughout the year	Rare	Sheep, Goat, Cow, Camel

Lv = leaves; Sh = shoot/stem; Fl = flower; Fr. = fruit; HP = highly palatable; MP = moderately palatable; LP = less palatable; NP = non palatable.

or without purchased fodder for supplementation in the pre-monsoon period.

Agropastoral

Along with range resources, the livestock also utilize fodder crops from agricultural farms owned by the pastoralists or by tenant farmers in the irrigated tract. The croplands provide food security for both the livestock and their owners. The importance of crops varies according to the status of small owner-pastoralists depending mainly on free grazing along the canals or roadsides or on additional purchased fodder to support livestock in the pre-monsoon period. After the monsoon, when sufficient forage is available, the livestock move to desert rangelands for grazing.

Sedentary pastoralists

Livestock owners living in permanent settlements working as tenant farmers or small farmers generally use nearby grazing areas. The livestock comprising mainly buffaloes, cattle, some sheep and goats confined to the irrigated fields are mainly stall-fed or use surrounding areas for grazing and come back in the evening. The feed resources comprise a variable proportion of crop residues, fodders and peri-irrigation grazing areas. Due to the competition from the transhumant livestock, feed supply during the pre-monsoon period may be constrained.

Transhumant

The majority of livestock and people seasonally move to the desert and subsequently again towards irrigated margins. The point of origin is irrigated areas, and in the desert they have fairly well-defined range territory for various clans; however, variation in the route and the sequence of use of *tobas* are governed by the water and forage quantity available in the range.

The livestock start moving to the desert at the onset of monsoons in July/August when the *tobas* are filled with water. They stay around the tobas as long as water is available, and move to the wells or *kunds* when the *tobas* can no longer support the livestock or people. The salinity in the wells rises with the advancement of dry season. The accessible forage is exhausted till March/April and the salinity in the wells renders the water unsuitable for cattle. Livestock start to return towards the irrigated margins. Only camels and goats are left to survive on evergreen browse.

The precise times of movements depend on the rains and the resulting availability of water and forage in the desert; in good years water may be available in *tobas* until January or February, and in normal years it may dry out before that.

Desert nomads

The livestock remain all the year in the desert and are dependent upon the range resources for fodder and water. Almost all the camels, about 50% goats and a small number of cattle are represented in the system. The animals move with the transhumant livestock from one *toba* to the next and subsequently to the wells and/or *kunds*. However, they remain at the wells or *kunds* when the transhumant livestock retreat to the irrigated margins. Generally, each clan/group tends to remain at a particular well or *kund* until the *tobas* are filled again.

Livestock

Breeds

Camels, cattle, sheep and goats are the predominant types of livestock. Cattle are the most precious livestock species of pastoral lifestyle followed by sheep, goats and camels. The productivity (birth rates) among cattle is the lowest. Lambing occurs mainly during the months of January/ebruary. Goats are kept in smaller numbers due to: i) lack of browse when animals are taken to irrigated areas during droughts; ii) to avoid predation by jackals; and iii) because of difficulties encountered in controlled grazing in irrigated areas. Camels are also owned mainly for transportation purposes. Notable breeds of livestock in Cholistan are as follows:

Cattle: Cholistani and Hasari
Goat: Jattal (Cholistan goat)
Sheep: Buchi, khadali, sipli
Camel: Marecha and Brella

Generally, split-herding prevails in cattle and small ruminants. Small calves in the case of cows and lambs and kids in case of sheep and goats are kept at pens near the *tobas*, while the adults are allowed to roam around for grazing in the open range areas of the desert. Most cattle and camel are not herded. In the case of the cattle, the animals are driven out of the house to graze freely and they return home by themselves in the evening. The camels, however, remain in the desert unherded

Table II. Livestock population and forage demand in the Cholistan Desert (census 1996).

Animal type	Population	Animal Unit (AU)	Dry matter intake per day (kg)	Annual forage demand (tons)
Cattle	73,048	7,3048	7	186,638
Sheep	14,7429	21,061	1	53,812
Goats	53,680	7,669	1	19,593
Camels	16,510	33,020	14	84,366
Total	**290,667**	**134,798**	**10**	**344,409**

for months. Small ruminants (sheep and goats) are attended by herdsman mainly to avoid predation by jackals.
Mortality rate is high among cattle alone ranges from 5 to 60 percent [1]. The main causes of mortality are related to droughts, poor nutrition due to shortage of feed and water and diseases caused by nutrition stress. No livestock health facilities are available in the desert, only limited health services are available in peripheral small towns and vaccination of livestock is not practised regularly.

Livestock production and availability of feed

The rangelands in Cholistan desert are monsoonal and forage production in these rangelands depends heavily on monsoon rains (amount, time, and frequency). The health of the animals, their production, birth and mortality rate relates directly to the availability of vegetation. During normal rainfall years (100–200mm) green herbaceous production remains critically low, particularly for cattle and sheep and animals remain unnourished. Once or twice in ten years forage production is sufficient for year-round grazing of the livestock. During good years the production of livestock and by-products is sufficient enough when owners have some earnings. After successive drought years the forage production declines drastically and vegetation growth is practically nil. The grazing period starts from August till February during good rainy years.
Both the composition and production of browse and herbaceous forage vary with the range types given the same amount of rainfall. In the best ranges, herbaceous forage yields 60-70% whereas browse yields 30-40% of the total forage production. In moderate ranges, herbage production varies from 35 to 45% and browse from 55 to 65%. In poor ranges, herbage yields less than 20% and browse more than 80% [1]. Almost all the herbaceous forage is utilized during monsoon and post-monsoon season, while green browse is available in the area throughout the year. The herbaceous vegetation is very short-lived and it dries up when the soil moisture is no longer available. The feed requirements of camels and goats, in the winter and pre-monsoon are provided by green browse (*Calligonum* and *Haloxylon*), while cattle and sheep suffer severe nutritional deficiencies. The winter rains are very scarce so spring vegetation is generally poor, represented by few annual species of grasses and forbs providing very little biomass for grazing.

At present, the total livestock population in Cholistan is around 134,798 animal units (AU) (*table 2*). The animal unit is considered as an adult cow weighing 350 kg (400 kg at international level) and consuming 7 kg dry matter forage per day in Cholistani conditions. The total annual dry matter forage demand in Cholistan is .34 million tons while the available dry matter forage is .12 million tons. Thus there is an annual shortage of 0.22 million tons dry matter forage (*table 3*). It has been noticed that at the moment, some 88,655 AU are in excess of the present carrying capacity [13]. The rangelands of Cholistan are under severe threat of degradation because of overgrazing and harsh climatic conditions. Due to continuous grazing, the desirable palatable species are vanishing at an alarming rate and relatively unpalatable species are spreading and dominating the landscape. The severity of the problem can be seen from the fact that such highly desirable grass species as *Pennisetum divisum* and *Cenchrus setigerus* have disappeared from most part of the Cholistan desert rangelands.

Livestock production and health management

Three inter-related aspects of animal health *i.e.*, feed, water and disease have been encountered in Cholistan desert. Deficiencies in the availability of forage (quantity and quality), drinking water (saline or polluted) and free mixing of diseased animals with healthy ones during grazing expose livestock to various types of diseases. Veterinary health centres or hospitals are not available towards the interior of the desert and very few poorly-equipped small units are available in peripheral cities. Livestock owners often become distressed and helpless when their livestock, particularly cattle fall seriously ill. Some traditional homemade herbal preparations are used to treat sick animals. The mortality rate is very high and drought conditions increase stress due to malnutrition and lack of water causing various diseases. The most common diseases occurring in various livestock species are as follows:
– large ruminants: haemorrhagic septicaemia, black quarter, foot and mouth disease, anthrax, mange, surra, camel pox, endo- and ectoparasites, etc.;
– small ruminants: enterotoxemia, pleuropneumonia, sheep and goat pox, anthrax, liver fluke, endo- and ectoparasites, etc.
The amount of livestock population that have died and suffered from various diseases in Cholistan desert is given in *table 4*. Traditionally, reasonable disease diagnostic know-how is available at the *toba* level. However, disease treatment capabilities of the herders are very limited and medicines are available at places that are far away from their *tobas*. Therefore, a large number of

Table III. Annual demand and supply of dry matter forage in Lesser and Greater Cholistan.

Livestock population (AU)	Annual forage demand (tons)	Forage available tons			Deficit (tons)
		Lesser (1,237,000 ha)	Greater (1,369,000 ha)	Total (tons) (2,606,000 ha)	
134,798	344,409	55,962	61,934	117,896	226,513

Table IV. Death and disease incidence among livestock population.

Items	Cattle	Camel	Sheep	Goat
Farms reported disease incidence	49.69	5.45	59.02	34.12
Population suffered	5.64	1.65	12.19	19.37
Mortality	2.72	0.55	9.31	7.78

Source: [14].

the animals infected with disease were either not provided any treatment or were given indigenous treatment.

Livestock marketing

The pastoral nomads in Cholistan desert are living very much below the poverty line due to the lack of education or of skilled labour and to their entire dependence on meagre natural resources. The quantity and quality of livestock is not good enough to support a family. Marketing is generally practised through a middleman (locally called *Beoparí*) who collects animals from various nomads camping sites near *tobas* on the outskirts of small towns. Seasonal, monthly, and weekly livestock markets operate at various levels depending on the availability of animals for sale. Livestock by-products including homemade mats prepared from raw wool are also brought to the markets. Camel bone and camel skin products prepared with primitive skills are also prepared on a small scale. But due to the lack of training or of refined skills, the market is very limited. The money earned through sale of livestock is not enough to meet the requirements for food or for animal feed and fodder.

Constraints

The major constraint in livestock production in Cholistan Desert is the shortage of sweet water. This is compounded by the prolonged droughts of many years when *toba* water dried out completely.
In Greater Cholistan, feed for livestock is still available, but the *toba* water is depleted and the thirsty herds are forced to migrate towards semi-permanent settlements where well water is adequate but of poor and saline quality not fit for drinking. The wells are unlined and must be re-dug each season. On the other hand in the western part (Lesser Cholistan) the quantities of both water and feed are inadequate.
Landless pastoralists suffer due to the scarcity of rangelands for grazing in the irrigated fringes where they work as poorly-paid labour or as tenant farmers on farmlands generally used for agricultural crops.
The combination of long distances travelled by the livestock in search of forage, harsh temperature rising above 50°C, inadequacy of feed, undernourishment and highly saline drinking water from wells, all contribute to high mortality rates.

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