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Rangeland Productivity and Improvement Potential in Highlands of Balochistan, Pakistan

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1. Introduction

Pakistan has total land area of 88 million hectare (ha) and about 65% of this is rangelands. Five different types of range ecological zones (Sub-alpine and temperate, Sub-tropical humid, Sub-tropical sub-humid, Tropical arid and semi-arid deserts plains, and Mediterranean) have been described in Pakistan (Khan & Mohammad, 1987). These rangelands are the major feed source of about 97 million heads of livestock. Precipitation varies from 125 mm to over 1500 mm per annum. About 60 to 70% of monsoon rains received during the months of July to September while the winter rains occur from December to February (Khan, 1987).

Balochistan has a total area of 34 million ha of which only 4% (1.47 m ha) is under cultivation while 60% of the cultivated area is rainfed (Khan, 1987). Approximately, 93 % of this province (Fig. 1) is characterized as rangelands (FAO, 1983) Arid and semi-arid areas are falling within the rainfall zones of 50-200 mm and 250-400 mm, respectively (Kidd et al., 1988). Rainfall patterns are unpredictable with great variations. Like other arid and semiarid rangelands of the world, Balochistan ranges also provide a diversity of uses, including forage for livestock, wildlife habitat, medicinal plants, water storage and distribution, energy, minerals, fuel wood, recreational activity, wilderness and natural beauty.

Livestock rearing is the main activity of the inhabitants of Balochistan. Sheep and goats are the main livestock of the province. About 87% of the people in Balochistan directly or indirectly drive their livelihood from livestock rearing (Heymell, 1989). About 20 million sheep and goats population have been reported in Balochistan (GOB, 1996). Rangelands are the major feed source of these animals and approximately 90% of total feed requirements of sheep and goats were being met from rangelands (FAO, 1983). Overgrazing, drought, erosion, and human induced stresses caused severe degradation of rangelands in Balochistan (Islam et al., 2008; Hussain & Durrani, 2007). The degradation of rangelands includes changes in composition of desirable plant species, a decrease in rangeland diversity and productivity, reduction of perennial plant cover, and soil erosion (Milton et al., 1994).

In Balochistan, the mixed grass-shrub steppe is more common than single plant communities. The range vegetation types in Balochistan changes from south to north along the rainfall distribution. In South, shrub species *Haloxylon* species and *Artemisia* species while in north perennial grass species *Cymbopogon jwarancusa* and *Chrysopogon aucheri* are dominant. The fragile ranges of Balochistan are degrading very rapidly due to heavy

grazing pressure, aridity, and human disturbances. However, still many of these ranges have potential for improvement by using grazing management practices, natural recovery of vegetation and artificial re-vegetation at suitable sites coupled with better water harvesting and conservation practices.

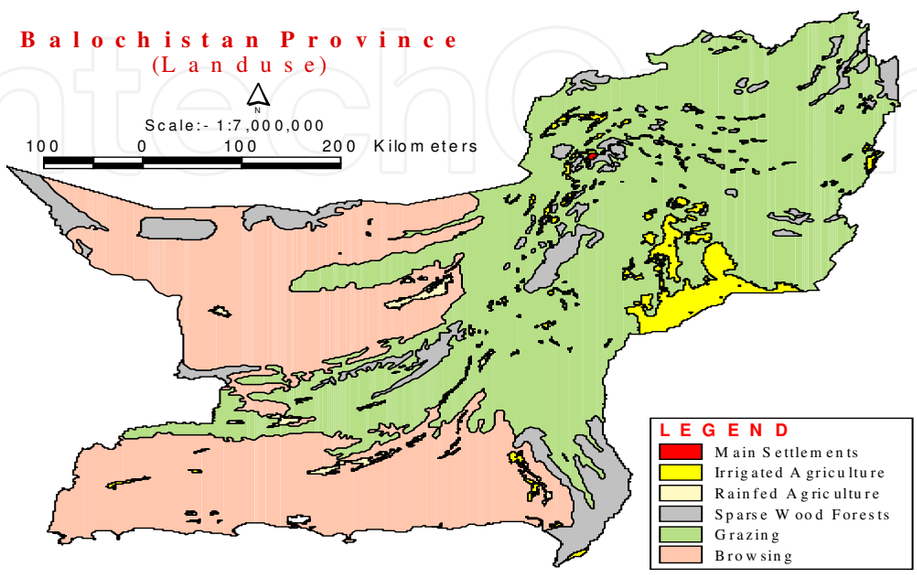


Fig. 1. Land use Patterns of Balochistan.

Natural re-vegetation practices particularly grazing management may restore vigor and accelerate the spread of desirable species (Vallentine, 1980). Grazing management alone may not accelerate the succession towards desirable species in arid and semiarid rangelands due to limited precipitation where artificial re-vegetation would involve the establishment of adapted species either by seed or transplanting seedlings (Roundy & Call, 1988). Restoration and rehabilitation are the two main procedures for regeneration of a depleted rangeland. Restoration or biological recovery means to bring the ecosystem to their pristine situation and rehabilitation or artificial recovery is the artificial establishment of a new type of vegetation different from the pristine native vegetation (Le Houerou, 2000). Biological or artificial recovery may include increase in biomass, plant cover, organic matter, soil micro and macro-organisms, better water intake and turnover, lower evaporation and runoff. Biological recovery may be obtained by protecting the target area from human and livestock intrusion. The purpose of rehabilitation of rangelands may be diverse like forage production, timber production, landscaping, wind breaks, sand dune fixation, and erosion control (Le Houerou, 2000).

A major concern of arid and semiarid ranges is the progressive reduction of secondary productivity and diversity (West, 1993) and how to manage these changes (Walker, 1993). The management and improvement of arid and semi-arid ranges is always a challenging job. Different theoretical models of rangelands have been developed and few are also being tested in different rangeland ecosystems of the world. However, the arid rangeland ecosystem of Balochistan is very dynamic where major climatic and agricultural changes are occurring. Hence many range management projects were carried out with little success.

Therefore, there is a need to re-look into research, policy and management issues for better productivity of rangelands and livestock.

1.1 Rangeland types

Balochistan can be divided into two zones regarding precipitation and grazing quality of the rangelands. The northern zone comprises the best ranges of the province located in the districts of Zhob, Loralai, Sibi, Nasirababd, Kohlu, Pishin, Quetta, Kalat, and the northern 18% of Khuzdar area. This zone, equivalent to only 38% of the total province area, carried 76.5% of the provincial livestock. The southern zone comprises the poorest ranges located in the rest of Khuzdar, Chagai, Khanar, Panjgur, Turbat, Gwadar and Lasbela district, which covers 62% of the province and carries only 23.5% of the livestock population (FAO, 1983). The high stocking rate and lack of grazing management in the Northern zone is rapidly depleting these ranges. Geomorphologically, the rangelands in Balochistan can be distributed into six types of landscapes, including mountains, uplands, piedmont, desert, flood plains and coastal plains. Muhammad (1989) divided rangelands of Balochistan into three main categories: Central Balochistan ranges, Western Balochistan Ranges, Eastern Balochistan Ranges. The biomass productivity varies from 30 to 380 kg/ ha (Fig. 2.).

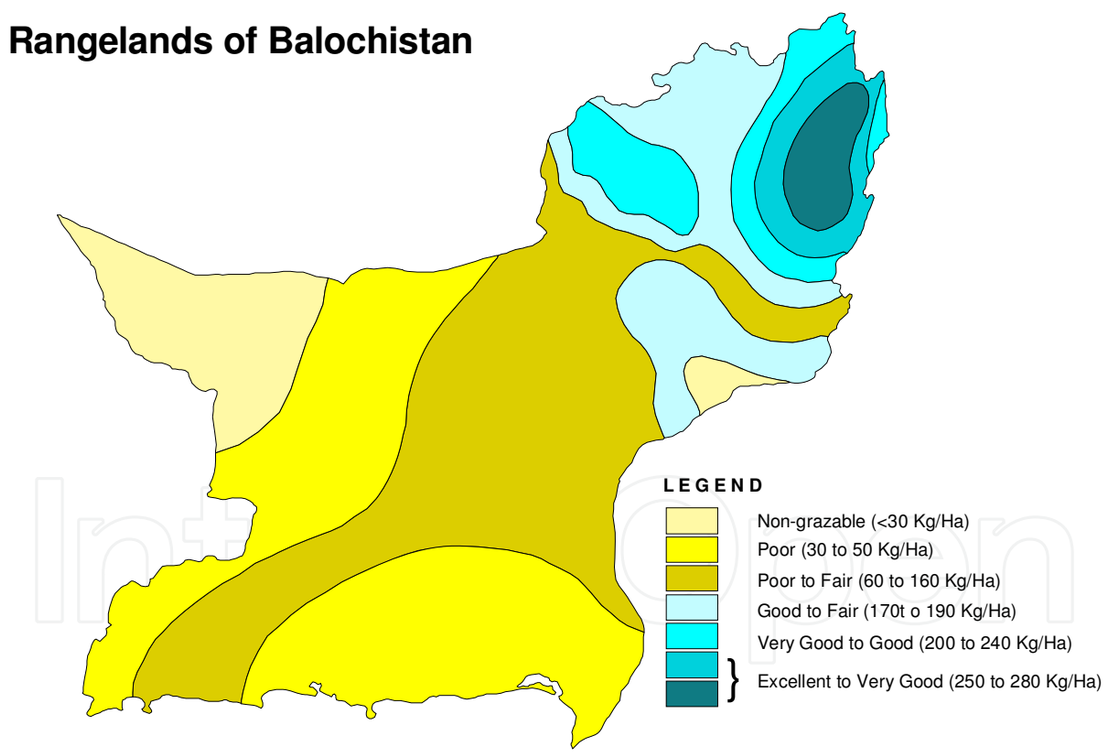


Fig. 2. Rangeland condition of Balochistan

1.2 Animal production and pastoral system

Generally three animal production systems (nomadic, transhumant, sedentary) are common in Balochistan. Most of the rangelands are used by nomadic and transhumant pastoral. According to an estimate only 30% sheep and goats are nomadic, 65% are transhumant and

5% sedentary (FAO, 1983). Nomadic flocks move continuously in search of forage. They have no agricultural land and migrate from uplands to lowlands in winter and come back again in spring to uplands. In lowlands they purchase generally sorghum crop for animal grazing. The size of a nomadic flock may vary from 200 to 700 sheep and goats. Transhumant flock owners have agricultural land and dryland agricultural activities. In winter some of them also migrate along with the families to lowlands. Sedentary flock owner raise few animals (5-20) on orchards, crop stubbles and also stale feeding. However, these systems are under transformation due to many factors like increase in livestock and human population, water mining for agriculture and orchards, changes in traditional migratory routes due to Afghan war. In a recent study, two new nomads groups (Commercial nomads and Nomad Transhumant) have been identified in Balochistan (MINFAL, 2000).

1.3 Range management issues

Range management problems in Balochistan are diverse and complex. The ranges of Balochistan are open and no one is responsible for management. Rangeland ownership is not clear or very poorly defined ownership. There are four major land ownership systems (Individual ownership, Tribal claims, Community ownership, State Ownership). Approximately 4% rangelands are under the Forest Department and the rest belongs to different groups. As a result of open grazing system the ranges are degrading very rapidly. The major range degradation factors are forage shortage, elimination of desirable range species, dominance of less preferred species, desertification, soil erosion, increased runoff and reduced infiltration (Fig. 3). Perennial grasses like *Chrysopogon aucheri* and *Cymbopogon jwarancusa* have completely eliminated in many ranges and are only found in some protected range areas. Similarly, many desirable shrub species like *Caragana ambigua*, *Stocksia brahvica*, *Berberis Balochistanica*, *Prunus eburnea* etc. have been replaced by *Haloxylon grifithii* and other unpalatable species. Limited information is available on rangeland resources, potential, and management options. Most of the Pastoral communities are in isolation especially in the mountain areas of Balochistan. Moreover, there is a transformation of these communities due to rapid extension in irrigated agriculture and changes in traditional migratory routes. From the last few years it has also been observed that to crop production on marginal lands is also increasing and resulting in conversion of rangelands into agricultural activities. Early spring migration of nomads from lowlands to highlands did not allow range plants for growth and seed production.

Generally, range management is a low priority area and lack of integrated range management approach and non-involvement of range management activities in other Natural Resource Management Projects is a common practice. Many Range Management Projects in Balochistan have adapted only technical range management approach ignoring the traditional customs, rights and local arrangements. Generally, most of the range management programs last two to three years. This duration is not sufficient to show any positive impact to communities on range management/ improvement and livestock production. Removal of range vegetation for fuel wood is a major concern all over the Province and no alternate energy sources like solar cookers and other efficient cooking and heating devices are available. Recurrence of drought is a common phenomenon in Balochistan. However, no sound viable options are available to reduce the livestock mortality and rangeland degradation under drought conditions. Some productive ranges at present are under utilization due to non-availability of stock water. Community

participation is one of the main factors for any successful range management Program. However, in Balochistan, very weak community participation in range management activities has been observed. Moreover, communities are in view that they there are no incentives for range management and they alone cannot bear the range management cost. Some other issues like limited research activities on all aspects of range management, lack of awareness, education and dissemination of knowledge, lack of trained manpower and reform in existing range management policies are also important for effective range management.

2. Materials and methods

2.1 Study sites

The experiments were conducted in three districts (Mastung: Siddiqabad, Loralai: Aghbar, Ziarat: Tomagh) of highlands of Balochistan. The research was conducted on degraded community rangelands. The selection of research sites were based on the availability of community rangelands, small ruminants and willingness of the communities for active participation in different range management activities. The Mastung district lies between 29° 03' and 30° 13' north and 66° 25' and 7° 29' east. The general topography of the district is mountainous, consisting of a series of parallel ranges running in a north-south direction. The district is severely cold during winter and hot during summer. Mean maximum and mean minimum temperatures of 36 °C and -3°C have been reported. Rains mostly occur during winter months. Loralai district lies between 29° 54' to 30° 39' north and 67° 44' to 69° 40' east. Topography of the district is mountains and hilly. Mean maximum and mean minimum temperatures of 38°C and 4°C. Rain occurs both during winter and summer months. Ziarat, Tomagh site located 15 km southwest of Sanjawi in Ziarat district. The mean annual precipitation at Tomagh is recorded 300 mm, which is distributed approximately 60% and 40% between winter and summer periods, respectively.

2.2 Traditional range management and knowledge

Information was collected in three districts. Data collection procedures include interviews, focused group discussion, and transect walk in the range areas. Fifty to sixty key informants from each site were involved on broad issues like traditional knowledge of range management. Dialogues with the communities were made to assess the existing range-livestock system, grazing patterns, and related information. Main focused areas were pastoralist knowledge on plants, grazing patterns, and migration patterns, collection of plants for winter season, communal grazing, and livestock management. Range productivity was also measured on the community lands.

2.3 Recovery of vegetation

Twelve parallel transects of 35 meter each were established at each site at a distance of 15 m apart each other. Three transects were used at each site for determination of forage production. Biomass estimates were made during the months of May/ June (at optimal vegetation growth) to document the range productivity. At each transect four 1 x 5 m^2 subplots were established on alternate site of the transect line. The vegetation inside the 1 x 5 m^2 subplot was clipped at ground level, separated into leaves and wood, and oven dried. The dry matter forage production was converted into kg/ ha. Descriptive analysis was used for calculation of dry forage production. Monthly, rainfall data were recorded from a rain

gauge installed at Ziarat:Tomagh site while the rainfall data from Quetta site is used because due to non-availability of meteorological data of Mastung site.

2.4 Fodder shrubs plantations

Seedlings of *Atriplex canescens* and *Salsola vermiculata* were planted on degraded community rangeland during 2007. Initially, the seedlings of these species were raised in polythene bags at Arid Zone Research Centre, Quetta. Six to nine months old seedlings were transplanted on the community rangelands during late winter or early spring months. Micro-catchment water harvesting (MCWH) structures were developed on sloping lands. Contour-bunds were made by a tractor-mounted plough. Spacing between ridged was maintained at 15 m and two shrubs (Atriplex canescens and Salsola vermiculata) were planted in each micro-catchment basin with 2 m spacing. The number of shrubs in each strip ranged from 40-80. Shrub survival rate and shrub biomass was monitored. Shrub biomass production data were recorded during June 2010. Fifty shrubs from each species were randomly picked for recoding forage production. Harvested shrubs were separated into leaves and wood and oven dried for calculation of dry matter forage production. Descriptive analysis was used for calculation of average forage production of both species

3. Results and discussion

3.1 Traditional range management and knowledge

The communities were not observing any range management practices like resting the range area or rotational grazing. The rangelands are open and can also be used by the migratory nomads. In Tomagh, Ziarat, the livestock depends on grazing from April to November and the main vegetation is *Cymbopogon jwarancusa*, *Chrysopogon aucheri*, and *Saccharum grifthii*. From December to mid March the livestock owners also used dry Saccharum grass, dry maize, dry orchard leaves, green barley, and dry Alfalfa for livestock feeding. Pregnant herds and weak animals are also provided barley grains for two months. In case of severe drought or non-availability of forage the communities migrat the livestock to the nearby rangelands. Grazing is mostly carried out by young boys and girls and no shepherd hiring on monthly cost basis is common. Rangeland productivity in open areas is very low and ranges from 40-60 kg/ ha. At Mastung, the common range vegetation is *Artemisia* species, *Haloxylon grifthii* and forbs. Generally, both annual and perennial grasses are missing in this range ecosystem. The communities utilize the range areas throughout the years both for grazing and fuel wood collection. The other feed resources include residuals of wheat, barley, and vegetables, dry orchard leaves, and dry sorghum or Alfalfa. Farmers also collect *Alhagi Camelorum* (dwarf shrub) either from fallow agricultural fields or range areas during summer months and store as a winter feed. Majority of the farmers stay throughout the year in same villages. However, some of them also migrate along with livestock towards lowlands of Balochistan during winter months. Rangeland productivity is very low and ranged from 40-70 kg/ ha at various grazing areas. Shepherd hiring is common and mostly grazing is carried out by this method. The grazing price per animal ranged from Rs. 30-35 per month.

At Loralai, the range vegetation is dominated by perennial grasses like *Cymbopogon jwarancusa*, *Chrysopogon aucheri*, *Tetrapogon villosa*, and many annual grasses and forbs. The communities utilize the ranges throughout the year. This site has better range potential due

to occurrence of monsoon rains. In case of monsoon rains, the grazing opportunities extended up to end of November. The nomads coming from Afghanistan are also passing through this site without any restriction on grazing. The other feed resources include residuals of wheat, barley, vegetables, and orchards. Rangeland productivity ranges from 70-100 kg/ ha. Grazing is carried out on Shepherd labor sharing basis. The owner and shepherd make a contract for four years. The initial number of animals provided to the shepherd will remain the property of the owner. The agreement is made verbally and has binding on both the parties. The agreement generally consists of: shepherd will graze the animals for four years around village surroundings and/ or long distances considering availability of forage and rangeland condition. The shepherd will get half of the male off-springs and 1/ 3 of the female young stock. The owner will provide 100 kg of wheat bag per month to the shepherd. The owner will provide two pairs of clothes and one pair of shoes per annum. After the expiry of the contract, the owner has the right to get initial number of animals from the herd and the remaining flock will be divided as per agreement i.e., male half and female 2/ 3 share. The expenditure made on medication of livestock rest with the owner.

Many pastoralists are willing to shift from pastoralists to crop cultivation and urban wages. Traditional knowledge is being gradually declining due to more attraction of the new generation in urban areas. Pastoralists at Tomagh try to maintain a diverse herd like both sheep and goats. Large animals (cattle) are very rare and one to two with few families for milk purposes. Large sheep and goat herds are considered as a prestige irrespective the quality of the herd. Sheep and goats are considered as a deposit in Bank account and can be cashed when required to meet the family requirements. The use of other animal products like hairs/ wools are used to some extent at home for carpet making but the trend is decreasing due to easy availability of synthetic carpets at lower prices. Herd splitting, the practice of dividing the sheep/ goats into separate herds depending on age is common at all three sites. Young sheep/ goats after weaning separated and commonly grazed by young boys or girls.

Pastoralists at all sites pointed out that availability of experienced skilled person for grazing is also a major problem. They believe that herding is a specialized job and not everyone has the same aptitude and skills in herding. Mostly, the old men are involved on payment for this job but they cannot graze more distant pastures. The art of herding is disappearing very fast as more and more young people leave the remote range areas and prefer urban wages. Herding practices include night grazing, watering at morning and evening, camping at suitable sites to avoid predator danger, quick migration for opportunistic grazing, specialized sounds and cries needed to talk with sheep and goats.

Young boys and girls are responsible for herding sheep and goats while women are responsible for milking and making milk by-products. Pastoralists during migration consider quality, quantity of forage, water availability, household labor availability, cultural gatherings, tribal boundaries, disputes, and safe camp sites. Mobility is the best adapted and effective means of obtaining what livestock needed in an ever variable environment. In traditional content, the mobility is linked with traditional routes, tribal and social interactions and alliances with neighbors. Ethno-veterinary knowledge including management strategies to reduce reproductive wastage, use of medicinal plants in animal diseases are common at all the three sites. Pastoralists use local plants like the roots of *Berberis* species are boiled in water and given to sheep and goats for internal injuries.

Knowledge of local plants is more refined at all the sites. Pastoralist knew the local names of nearly all the plants of their areas. Communities were able to identify the preferred forage species and season of use. They distinguish between those that fatten livestock and improve their health. *Chrysopogon aucheri* is more preferred grass than *Cymbopogon jwarancusa*, wild olive leaves/ fruits and *Alhagi Camelorum* are good for fattening of sheep and goats. The pastoralists were also able to identify the poisonous plants of their areas. The communities were also agreed that there is a shift in species composition like from preferred/ palatable grasses to less preferred/ un-palatable grasses and shrubs. The majority of the pastoralist was also in agreement that the changes in species composition is due to over grazing, removal of vegetation for fuel wood and Afghan nomadic flux during war. The animal health and productivity is an indirect method of rangeland assessment by the pastoralists. Pastoralists evaluate the range condition on the basis of animal performance like rumen fill, milk production and animal health.

3.2 Recovery of natural vegetation

Monthly rainfall from 2006 to 2010 of Quetta and Tomagh is presented in Table 1. Total annual rainfall at Quetta ranged from 105.8 to 247 mm while at Tomagh the total annual rainfall ranged from 214 to 462.6 mm. The dry matter forage production of different sites and years is presented in Table 2. The initial dry matter forage production during 2007 was 80, 60 and 184 kg/ ha, respectively at Mastung, Ziarat and Loralai. Each year there were increasing trend of dry forage production and during 2010 the dry matter forage production was recorded 230, 485 and 864 kg/ ha at Mastung, Zirata and Loralai, respectively (Table 2). Rainfall and its distribution during winter and spring, 2007 was comparatively better than 2006. The community degraded rangelands showed recovery potential at all sites. At Mastung the dominated range vegetation is Artemisia and *Haloxylon* species while at Loralai and Tomagh site perennial grasses (*Cymbopogon jwarancusa, Chrysopogon aucheri*) are dominated. The range recovery depends on the distribution of rainfall and management practices. The Loralai and Tomagh sites have better recovery potential of range vegetation due to occurrence of both winter and monsoon rains (Fig. 4).

	2006		2007		2008		2009		2010	
Months	Quetta	Ziarat (Tomagh)	Quetta	Ziarat (Tomagh)	Quetta	Ziarat (Tomagh)	Quetta	Ziarat (Tomagh)	Quetta	Ziarat (Tomagh)
January	22.2	0.0	13.0	6.4	117.6	0.0	59.2	56.0	29.8	2.0
February	7.8	34.4	105.2	148.0	10.2	0.0	45.4	49.2	45.2	0.0
March	32.4	68.6	28.3	86.8	0.0	3.2	31.4	118.2	9.6	25.6
April	7.4	20.2	14.8	0.0	9.6	30.4	30.7	50.8	9.0	1.6
May	5.9	0.0	0.0	0.0	0.0	20.0	11.4	0.0	10.2	43.4
June	0.0	4.96	42.5	116.3	5.6	0.0	0.0	94.0	2.0	36.6
July	3.6	22.4	12.2	0.0	0.0	20.8	0.0	44.0	0.0	104.0
August	69.1	88.8	0.0	0.0	14.0	95.2	0.0	0.0	0.0	162.4
September	0.0	37.2	0.0	0.0	0.0	0.0	0.0	2.4	0.0	14.4
October	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0
November	44.8	114.8	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
December	54.6	71.2	17.0	0.0	12.1	45.2	45.4	15.7	0.0	0.0
Total	247.8	462.6	238.8	357.3	169.1	214.8	223.5	430.3	103.2	390.0

Table 1. Monthly Rainfall (mm) at Quetta and Tomagh

Districts	Dry Forage production (kg/ ha)			
	2007	2008	2009	2010
Mastung	80 ± 5.10	171.91 ± 14.29	188.46 ± 11.07	230.0 ± 15.06
Ziarat	60 ± 11.76	133.48 ± 8.84	255.8 ± 12.57	484.8 ± 20.37
Loralai	184 ± 13.90	205.0 ± 22.36	630.0 ± 30.71	864.50 ± 47.71

Table 2. Improvement of Natural Vegetation and Increase in Forage Production as aresult of protection.

Arid rangelands of Balochistan characterized by highly unpredictable and variable rainfall events, behave as non-equilibrium system. This means that both climatic and grazing factors are important in any range management and improvement interventions. There are no universally accepted grazing strategies due to specific conditions of rangelands. However, resting, restricted grazing has proved for the recovery of natural range vegetation and forage improvement in many arid and semi-arid regions. The range vegetation of Balochistan has low reproductive potential due to the adaptive strategies of the plants for survival under extreme climatic conditions. The recovery potential is also very site specific like in case of Loralai, the grasses were heavily grazed but have shown good recovery potential under favourable conditions. The optimal growth time of grasses in Balochistan is from March to June, may be extended up to October in case of monsoon rains. Therefore, resting of vegetation during this time period is very essential for recovery and forage improvement. However, if the objectives were for seed production and re-generation than at least two to three years rest period must be provided (Ahmad et al., 2010; Ahmad et al., 2007; Ahmad et al., 2000 a,b,c). Accumulated dead material of perennial grasses can decline both productivity and nutritive value (Ahmad et al., 2009; Bano et al., 2009) therefore, a rotation grazing may yield better results than long term protection. Enhanced growth rate of grasses in response to grazing, fire and disturbance under favourable environments have been observed (Chapin & McNaughton, 1989).



Fig. 3. A degraded Rangeland



Fig. 4. Recovery potential of perennial grasses

Many rangeland areas in Balochistan still have potential of natural recovery if properly grazed. As a result of protection from grazing, it is evident from the results that the community rangelands are resilient and have potential of biological recovery subject to rainfall distribution and management practices. Range productivity is greatly influenced by fluctuations in rainfall, grazing pressure and nutrients (Olson & Richard, 1989; Scoones, 1995). Above ground net primary production can be used as an integrative attribute of ecosystem function (McNaughton et al., 1989). Above ground net primary production is an important variable in natural resource management because it determines forage availability for both wild and domestic herbivores. Oesterheld et al., (1992) found a strong connection between stocking density and above ground primary production for South American Rangelands. The rate of biological recovery might be slow as expected in the arid and semiarid climatic zones. The rate of vegetation recovery is also related with the rainfall distribution during the optimal growing period rather than total rainfall distribution. Strong vegetation recovery response has been reported even under desert conditions with mean annual rainfall as 60-80 mm under deep and permeable soils (Le Houerou, 1992a). From Morocco to Iran the perennial ground cover and primary productivity were enhanced by a factor of 2-5 and in most cases, 3-4 within a few years either by total or partial protection (Le Houerou, 1992a). In West Asia and North Africa range exclosures from 11 countries showed that productivity in exclosures enhanced averaged by 2.8 times than the adjacent grazed areas (Le Houerou, 1998). However, very long-term protection may not yield better results due to accumulation of dead old material that may reduce the new fresh growth. Controlled grazing may produce similar or better results than exclosures in some cases (Le Houerou, 2000). The recruitment rate of grasses may not be achieved within two to three-year protection. The changes in species composition are very slow processes in arid and semiarid areas (West et al., 1984). Limited spring season rainfall (the optimal time of seedling recruitment) in Balochistan is the main factor for low seedling recruitment even under complete protection from grazing. According to long-term meteorological data analysis in Balochistan, it is observed that above-normal rainfall amounts that promoted

spring seedling emergence occur with about 10% and less than 10% probability (Keatinge and Rees, 1988).

3.3 Fodder shrub plantation

Survival percentage of shrubs ranged from to 80 to 89% (Table 3). Average dry forage production of Atriplex canescens ranged from 349 to 670 kg/ plant. Salsola vermiculata average dry forage production ranged from 112 to 225 kg/ plant (Table 3).

Districts	Seedlings Planted		Survival %		Average Dry Forage Production/ Plant	
	Atriplex canescens	Salsola vermiculta	Atriplex canescens	Salsola vermiculta	Atriplex canescens	Salsoal vermiculta
Mastung	6000	4000	80	85	350.20 ± 34.33	112.0 ± 15.37
Loralai	11000	5000	80	87	670.0 ± 63.13	225 ± 38.78
Ziarat	8000	5000	85	89	348.50 ± 22.09	205 ± 23.64

Table 3. Plantation of Fodder Shrubs on Community Rangelands, Survival % and dry matter forage production.

Atriplex canescens (Fourwing slatbush) has potential in highland areas of Balochistan due to cold and drought tolerant characteristics (Fig. 5). The biomass and productivity of Atriplex canescens is highly variable, depending upon the ecological condition of the soil and climate as well as the management applied. Artificial plantation of fourwing slat bush under rainfed conditions can yield up to 2000-4000 kg dry matter/ ha/ year in areas with mean annual rainfall of 200-400 mm under proper management (Le Houreou, 1992b). Average dry mass production of Atriplex canescens planataion in highlands of Balochistan after three years has been reported 1600 kg/ ha (Afzal et al., 1992). The ratio between forage and wood in Atriplex species is about 50% which can be improved by appropriate management like pruning (Le Houreou, 1986). Young leaves and twigs show a much better forage quality, with higher nitrogen content and a lower amount of ashes and salts. The crude protein content in leaves of Atriplex canescens ranged 12-15% during mid winter (Thomson et al., 1987). One acre of fourwing slatbush might provide the supplemental protein requirements for 0.5 to 1 animal unit during a 90-day period (Ueckert, 1985). Like other halophytes, Atriplex canescens have low energy values because of high ash contents. Grazing of Atriplex canescens with wheat/ Barley straw could lead to a well balance ration and fulfill the nutritional requirements of small ruminants (Mirza et al., 2004; Thomson et.al., 1997). *Salsoal vermiculata* commonly called saltwort is an exotic Mediterranean arid zone fodder species. This species belongs to the Chenopodiaceae family. S. vermiculata has the potential of self-regeneration and establishment under good rainfall years (Murad, 2000). *S. vermiculata* initiate new growth in late winter or early spring (depends on rainfall distribution) and provides a considerable amount of palatable forage for small ruminants. It is not an ever-green species, however, if sufficient rains occur during winter months it retains new vegetative growth. Maximum growth has been observed from April to May. Its height ranges between 35 and 110 cm. Crown cover ranges from 45 to 57 cm^2. Forage production ranged from 250-650 kg/ ha with an equal amount of wood production (Ahmad et al., 2006). Crude protein content ranged from 15-18% (Ahmad and Islam , 2005).



Fig. 5. Atriplex canescens plantation



Fig. 6. Winter grazing of Atriplex Plantation

Artificial plantation is very costly interventions and must be carried out by considering the water availability for initial shrub survival, water harvesting techniques and availability of suitable seedlings. Plantation should be carried on highly degraded sites where no recovery chances of natural vegetation and non-availability of soil seed bank. Management of plantation is the critical aspect of success and failure (Fig. 6). Generally, any range plantation needs two to three years before grazing. The grazing period, intensity of grazing, and rest-period for recovery of biomass should also be given considerations for successful range improvement interventions. In Balochistan, the best utilization time of planted shrubs is the winter months along with dry ranges or wheat, barley stubbles.

4. Conclusions

The rangelands of Balochistan need an urgent and well-planned program in management and utilization to halt the degradation process leading towards desertification. Range management should also be based on knowledge of Pastoral communities, traditions, and local arrangements. Communities should be involved in range management planning and implementation processes. Formation of Pastoral communities or associations in major range areas may help in taking care of herd mobility, marketing of livestock, and maintenance of rangelands. Forage reserve block establishment on marginal lands with some Government incentives may ensure forage supply in winter or drought years. Supply of high production drought and cold tolerant fodder shrubs on minimum price should be introduced to complement native rangelands. These pastures may be used during the critical forage deficit period (winter months) and at the same time may allow some rest to the rangelands. Communities alone cannot bear the range management and improvement expenses. Therefore, some incentives may be provided for sustainable range management program.

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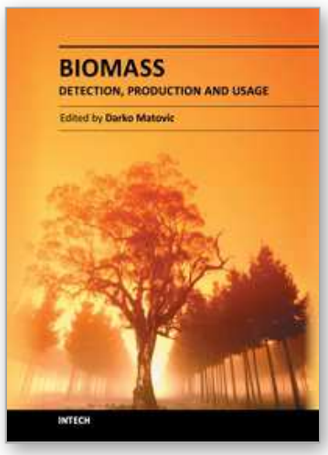
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Biomass has been an intimate companion of humans from the dawn of civilization to the present. Its use as food, energy source, body cover and as construction material established the key areas of biomass usage that extend to this day. Given the complexities of biomass as a source of multiple end products, this volume sheds new light to the whole spectrum of biomass related topics by highlighting the new and reviewing the existing methods of its detection, production and usage. We hope that the readers will find valuable information and exciting new material in its chapters.

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