

Rangeland management for livestock production

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*Rangelands are principal source of forage for livestock in arid region. The productivity of arid rangelands is low (between 300 and 400 kg/ha) and can be improved by reseeding with high yielding perennial grasses, proper soil and water conservation, and control grazing. Various silvi-pastoral models were developed by the Institute and demonstrated at farmers' field to improve rangeland productivity. The productivity of improved pastures increased 2 to 3 folds over natural grazing land. Forage yield of improved pasture under cut and carry system and protected condition was higher (1,403 to 2,900 kg/ha) than pastures under open grazing (between 360 and 900 kg/ha) at different location in Jodhpur and Nagaur district of Rajasthan. Forage yield of grasses *Cenchrus ciliaris* (0.32 kg m²) and *C. setigerus* (0.23 kg m²) grown on farm bunds was higher than grazing land and field boundary.*

Key words: Arid rangelands, Grazing, Livestock, Perennial grasses, Resources reseeding

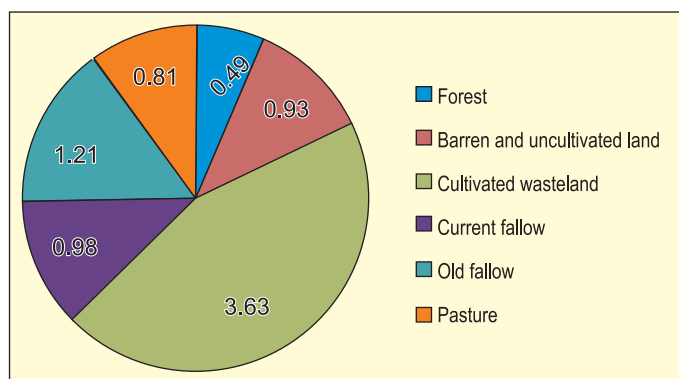
CROP cultivation alone is not profitable and livestock enterprise is more sustainable than arable crops. Therefore, livestock rearing is an integral component of farming system in arid region which provides employment to large section of rural people. There is vast area available for grazing i.e. over 40% in western Rajasthan of which pasture and waste land constitute 4 and 17%, respectively. In spite of large grazing area of western Rajasthan, fodder availability is not sufficient to meet the demand of 30.18 million livestock. The production from the available grazing lands is between 300 and 400 kg/ha. The present availability of dry fodder was worked out to be about 15 million tonne under normal rainfall condition, which is deficient to the extent of 30 to 40%. This may increase to 80 to 90% during drought years requiring large volumes of fodder from neighboring states. The production of fodder in arid zone can be increased through better management of common grazing lands. There is ample opportunity for

augmenting productivity of these rangelands by managing scientifically. Traditional grazing lands (*Orans* and *Gochars*) need to be rejuvenated and managed properly to supply fodder to the livestock. Improved rangeland management systems offers a sustainable management system which increases overall productivity of the land, conserve soil resources, improves environment, offers an efficient system for utilization of rainfall and stores soil moisture and recycling of nutrients.

Grazing resources of arid region

Grazing of livestock is a common practice in arid zone. About 41% (8.06 m ha) of total land in arid region (19.61 m ha) which includes forest, permanent pastures, cultivable and uncultivable wastes and barrens are available for grazing to livestock of arid region in Rajasthan. The area under grazing land is declining due to deterioration and overgrazing. The rangelands of arid zones have different types of grass cover such as *Sehima nervosum* on hills and

piedmonts, *Cenchrus* type on well drained sandy alluvial soils, *Lasiurus indicus* type on loose sandy soils and *Sporobolus marginatus* and *Dichanthium annulatum* type on low lying heavy saline soils. Rangelands include not only grasslands but also forest grazing areas and wastelands. Though forest area is very less in arid zone, some forests are open to the common people for grazing animal. These forests have some useful species of grasses and shrubs which provide leaves, flowers, pods and seeds as feed to livestock. *Orans* and *gochars* are traditional systems of grazing prevalent in arid western Rajasthan. These lands were attached to deities and were excellent source of biodiversity conservation. Many species of grasses, weeds, shrubs and trees from natural grazing lands/pasture provides nutritious forage to grazing/browsing animals. Green forage is available to the grazing livestock during monsoon and post-monsoon days only. During post-monsoon period some trees/shrubs having top feed value also provide



Grazing land (million ha) in arid region of Rajasthan

green fodder for browsing of goat.

Grazing pressure in arid region

Rajasthan is one of the major states of India, having 57.733 million livestock population of which 30.18 million are in arid district. The grazing area available in arid district is 0.61 ha/ACU's with grazing pressure of 1.65 ACU/ha. During the last 50 years, the livestock population has increased about three-fold. The density (number/km²) increased from 49.7 in 1951 to 153.9 in 2012 where as, the availability of grazing land is decreasing. It increases the pressure on grazing land that lead to deterioration of existing rangelands. Thus, these arid rangelands are in poor condition due to overgrazing.

Reasons for low productivity of rangelands

Rangelands are uncultivated land that are suitable for grazing and browsing animals. Rangelands are principal source of forage for livestock in arid region. The productivity of arid rangelands is low (300 to 400 kg/ha) due to erratic rainfall, over grazing and indiscriminate use without protection. Uncontrolled and overgrazing are major factors for degradation and low productivity of grazing lands. Besides these, lack of adoption of pasture development technologies including quality seeds of improved pasture grasses, knowledge about sowing techniques that requires precision for sowing depth at proper soil moisture for germination of grass seeds, inadequate method of seed collection and harvesting of grasses are also considered as factors for low pro-

ductivity of rangelands. Further, lack of coordination among different stakeholders also lead to poor management of common grazing resources.

Rangeland husbandry for higher productivity

Rangelands are in degrading with poor quality grasses and vegetation. Rehabilitation with proper management improved the productivity and carrying capacity of these rangelands to supplement fodder requirements. Most of the grazing lands fall under the land use capability class V and are characterized by steep slopes, shallow soil depth, poor in fertility and water-holding capacity and subjected to soil erosion.

CAZRI has developed full package of management and utilization techniques of rangeland. The selection of suitable grasses and tree species and their combination is important for developing sustainable land use system for such land forms. Improved grassland technologies envisaging protection of area, reseeding with high perennial grasses, soil and water conservation, utilization of pasture, management of excess forage and scientific methods of grazing can enhance productivity of these lands manifold. Thus, suitable land use system i.e., a combination of afforestation and pasture development with proper soil and water conservation measures could be possible approaches for rehabilitation and improvement of degraded lands with sustainable use of natural resources and environment protection.

CAZRI TECHNOLOGIES

This Institute has developed following technologies:

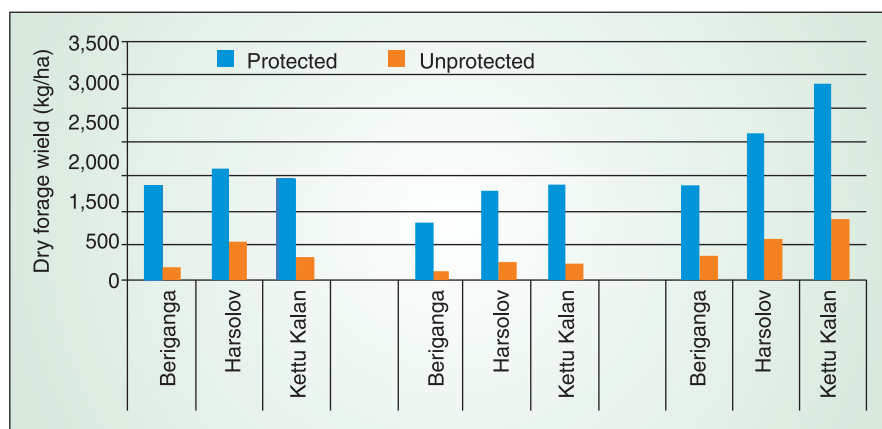
Grasses suitable for rangelands

In arid region *Cenchrus ciliaris*, *Cenchrus biflorus*, *Cenchrus setigerus*,

Lasiurus indicus *Dichanthium annulatum*, *Panicum antidotale* and *Eleusine* spp. are dominant grasses available for grazing during monsoon. *Lasiurus indicus* gives high yield (25-36 q/ha) on sandy soils with low-precipitation (200 to 250 mm and below). *Cenchrus ciliaris* and *C. setigerus* produce higher forage yield (20-30 q/ha) on well drained-soil with rainfall 300-400 mm or above, whereas *Dichanthium annulatum* gives higher yield (50-60 q/ha) in heavy soils with annual precipitation of 400-500 mm and above. High-yielding varieties of these grasses were identified after evaluation of the germplasm. CAZRI 75, CAZRI 358, CAZRI 2178 of *C. ciliaris*, CAZRI 76 of *C. setigerus*, CAZRI 30-35 of *L. indicus*, CAZRI 490 and CAZRI 491 of *D. annulatum* and CAZRI 330 of *P. antidotale* were identified by CAZRI for higher forage yield.

Fencing

Community grazing lands are subjected to heavy biotic pressure both from the human beings and animals. For protection against biotic factors, angle iron posts (6" × 1.5" × 1.25" or 180 cm × 3.75 cm × 3.13 cm) with barbed wire (4 to 5 strands) fencing of proved to be most durable and economical in the long run although the initial cost is high. The fact to be reckoned with that fencing is must before any management programme to be launched atleast in arid regions of western Rajasthan where pressure on land is the maximum both from human beings and animals as compared to other desert areas of the world. Moreover, larger the area, cheaper it is to go for fencing and as such, initial coverage of area between 100 and 1,000 ha is desirable for range management programme. Fencing cost works out to be approximately ₹ 1 to ₹ 5 lakh for 10 ha area for trenching and barbed wire fencing. Based on this principle as well as based on our research findings, pasture development programmes were taken up in various drought prone districts in Rajasthan and results so far are quite encouraging. It is interesting to note



Forage yield of pastures under protected and unprotected condition

that the forage yield on rangelands, after two years of protection, increased by 148, 92 and 116% in 'Poor', 'Fair', and 'Good' rangelands, respectively. Improved pasture of *Cenchrus ciliaris* and *Cenchrus setigerus* grasses were developed at three protected sites, viz., Beriganga Farm of CAZRI Jodhpur, grazing land of Harsolav Goshalla, Nagaur and community land of Kettu Kalla village, Jodhpur. The growth and biomass production of pasture grasses were recorded under two management practices i.e. protected and open grazing at all the sites. Forage yield of improved pasture under cut and carry system and protected condition (1,403 to 2,900 kg/ha) was higher than pastures under open grazing (360 to 900 kg/ha) at all the location.

Adoption of soil and water conservation measures: Rangeland management areas generally comprise of land falling in class IV to class VIII which were mostly highly eroded thereby exposing rocky surface, stones and boulders. As such, soil -conservation measures especially on land forms with shallow soils and rolling topography are essential. Contour furrows (60.96 cm wide and 22.86 cm deep) with a cross-section of 929 cm² at a distance of 8 to 10 m across the slope have invariably proved to be more effective than any other soil conservation measures, viz. contour bunds and staggered contour trenches. Contour furrows help in increasing the forage production from, on an average, 4 q/ha to 15-20 q/ha in 10-15 years. Inter-row water harvesting increased forage yield by

75% in *Cenchrus setigerus*, 90% in *Cenchrus ciliaris* and 30% in *Lasiurus indicus*.

Reseeding in rangelands: Natural succession of the high-yielding perennial grasses in the arid regions is a time consuming process. Reseeding with suitable perennial grasses adapted to the specific agro-climatic conditions is the best recourse for increasing the forage as well as animal productivity. In any reseeding programme it is essential to start with removal of unwanted bushes (*Mimosa hamata*, *Balanitis aegyptica*, *Gymnosporia montana*, *Lycium barbarum*, *Acacia leucophloea* and *Indigofera suffruticosa* in saline soils) from the rangelands. Complete soil working, involving ploughing and disc-harrowing once, is essential for better establishment of perennial grasses. Sowing of grass in rows 50 to 75 cm apart is advantageous. Seed rate of 4 to 5 kg/ha for *Cenchrus ciliaris* and *C. setigerus*, 5 to 7.5 kg/ha for *Lasiurus indicus*, whereas 2 to 3 kg/ha for *Dichanthium annulatum* and *Panicum antidotale* is most appropriate. Higher seed rate may be required to achieve better establishment when grass sowings are undertaken, by seed broadcasting in dry soil just before the onset of monsoon. For large-scale development programme, placement of seed on the top (not below 1 to 2 cm) of the mound, prepared through tractor mounted disc plough, and also broadcasting just before or at the onset of first effective showers proved to be most effective. Pelleting of seed with lime, clay and farmyard manure has so far not paved to be of any

specific advantage. Thus, direct seeding preferably by mixing the seed in moist sand is advocated for achieving better establishment. Results showed that reseeding with local seed of climax species' increased the forage productivity to about 2 tonne/ha. Improved strains of grasses have the genetic potential of even higher than 4 tonne/ha and, therefore, these should be used for reseeding programme.

Fertilization: The nutrient content and production potential of forage species on the rangelands in western Rajasthan is quite low and, therefore, for optimum production, it is essential to provide adequate nutrients to the soils as these are often subjected to erosion hazards and are highly depleted. Placement of nitrogenous and phosphates fertilizers @ 40 kg N/ha+20 kg P₂O₅/ha increased forage production in the semi-arid regions receiving relatively more than 300 mm rainfall whereas the response of 20 kg N/ha appeared to be favourable in arid regions getting less than 300 mm rainfall. The fertilizer application increased the yield of crude protein in *C. setigerus*, *L. indicus*, *C. ciliaris* and *P. antidotale* by 108, 82, 58, and 26%, respectively.

Inclusion of legumes: The key role of legumes in soil enrichment in the absence of manuring needs emphasis. However, their importance is two-fold first they constitute a high protein component in Indian, dietary and secondly, they provide nutritious forage to livestock. Further, legumes constitute the cheapest way of providing nitrogen (N) to the animals and associated grasses. Owing to comparatively high costs of nitrogenous fertilizers the possible supply of nitrogen by legumes attains a place of great importance in overall improved rangeland management technology. Legumes like *Dolichos lablab*, *Atylosia scarabaeoides*, *Clitoria ternatea*, *Macroptilium atropurpureum*, *Stylosanthes* species etc. are identified for inclusion in grasslands to improve fodder quality. Performance of *Clitoria ternatea* appeared to be better, when established in the pasture by providing about 1 m space between

grass rows, it is productive for 2 to 3 years. *Dolichos lablab* also performs better but being annual it requires reseeded every year.

Introduction of fodder trees/ shrubs: During post-monsoon sparsely scattered trees/shrubs having top feed value also provides green fodder for browsers. A large number of exotic and indigenous trees including fodder trees/shrubs were identified for introduction by this Institute. Introduction of suitable tree species will not only provide better nutritional quality fodder during the lean period, but will also be useful in nitrogen (N) build up in the soil and serve as shade tree for grazing animals. Besides, fodder trees and shrubs will ameliorate the micro-climatic conditions and thereby improve conditions for better regeneration of grasses. The adaptive fodder tree/shrub species are *Ziziphus nummularia*, *Prosopis cineraria*, *Ailanthus excelsa*, *Hardwickia binata*, *Acacia tortilis*, *Dichrostachys nutans*, *Albizia lebbek*, *Acacia nilotica* etc. which help in increasing fodder availability in arid zone. Some of these trees were successfully propagated in silvipastoral system and suitable model were developed. The silvipasture system involving fodder value trees; *H. binata*, *C. mopane*, local grasses, *C. ciliaris*, *L. indicus* and legumes like cowpea, *Lablab purpureus* were developed for arid zone situation. Grasses and legumes were grown in strip in between rows of trees. This system provides 4,500 kg/ha green fodder per year or 2,000 kg/ha dry fodder, leaf fodder 100 kg/ha and fuel wood 200 to 400 kg/ha. This increases the fodder production by 15 to 20% with enhancement in yield between 500 and 800 kg/ha. Benefit: cost ratio is 1.5 with IRR ranging 10 to 15%. The total production from the systems varied in different years due to variation in rainfall distribution. Silvi-pastoral models, developed at CAZRI farm, also revealed that total biomass production was higher with improved silvi- and horti-pastoral systems (drymatter yield 3.4 tonne/ha) than sole pasture and natural grasses (Table 1). In arid and semi-arid regions there are many natural



Silvi-pasture model with *Hardwickia binata* and *Cenchrus ciliaris* grass

growing bushes *Ziziphus nummularia* (*Zar beri*) surviving even after intense grazing pressure. *Ziziphus rotundifolia* and *Cenchrus ciliaris* are also ideal species for horti-pasture system. Improved varieties like *Gola*, *Seb*, *Umran* etc. also performed well under horti-pastoral system and produces green forage as well as fuel wood through regular annual pruning.

Table 1. Fodder productions under different pasture system

Cropping system	Dry matter yield (kg/ha)		
	Fodder	Leaf	Total
Silvi-pasture	1,488	716	2,204
Horti-pasture	1,702	601	2,303
Sole pasture	1,825	-	1,825
Natural pasture	675	-	675

Grazing management in arid rangeland: Judicious utilization of forage from the managed rangeland is essential for sustainable livestock productivity. Rangeland herbage should be used carefully. Rangelands re-seeded with perennial species should not be grazed for the first year. Grazing might be permitted after seed dispersal in the second year it should not exceed the carrying capacity of the grassland in subsequent years. In general continuous, rotational, deferred, cut and carry systems were used for utilization of these lands. Each system was its pros and cons. Continuous grazing leads to selective grazing of palatable species and in long-term the palatable species gradually replaced by the biotic composition, which are not liked by animals. Therefore, continuous type grazing system cannot sustain the livestock productivity round the year. Deferred grazing means frequently keeping the livestock away from the range until major grasses will produce



Mixed grazing in improved pasture

the seed. Under this system range lands are underutilized. Rotational grazing is one of the improved techniques of grazing management by which livestock owners can sustain the productivity of their livestock for longer period in a year. Deferred rotational grazing is an improved grazing management system in which part of the pasture land is protected from livestock grazing for a specific period and the area is then made open for grazing in the subsequent years. The pasture from the protected area harvested during appropriate time and stage of maturity and conserved for the feeding of livestock during lean period. Under such type of grazing management livestock productivity can be sustained round the year with little to no supplementation of the top feed/ concentrate feed during lean period. Under judicious use of this system is cost effective as well as sustainable for pasture and livestock production over the other grazing management systems.

The herbage production of the entire grassland and the intake of herbage by the animal together determine the capacity of grassland. Mixed herd grazing is advocated for utilization of all the rangeland herbages. An area containing both grasses and shrubs may be best used by a combination of different ruminant species with diverse grazing habits. The consumption of forage differs from animal to animal. The feeding habit of buffalo, cattle, sheep and goat, is quite different from each other. So the type of animals in the stock will be helpful to regulate the pasture in efficient manner.

Pasture development on community lands

Participation of all stake-holders is



Cenchrusciliaris pasture at grazing land
Harsolav, Nagaur



Development of *Cenchrus ciliaris* at field
bunds



Pasture developed at the community land of
village Ajeet Nagar, Jodhpur

essential to disseminate improved pasture development and management technology for rangelands in larger areas. This helps in increasing the fodder availability to the livestock and sustainability of rangeland for longer duration. A participatory pasture development programme were initiated at farmers' field and community land of different villages by CAZRI, Jodhpur.

Model of improved pasture at village Harsolav: A model of improved pasture (2 ha) and silvi-pasture (10 ha) was developed at *Bhuria Baba Goshala* village Harsolav, Nagaur district of Rajasthan. The model was developed in collaboration with *Gramin Vikas Trust* and *Goshala Samitee* in 2011 and this developed silvi-pasture system that *cattle for grazing* was utilized for *Goshalla* and cut carry systems that managed by *Goshalla Samitee*. This systems provided 2 to 3 -fold higher forage than natural pasture (0.65 tonne/ha). The main user of the pasture was *Goshalla*. So, development and protection of pasture did not affect the people nearby. The developed model is being used as a demonstration unit for training the farmers and up-scaling the technology in the surrounding area. Also, there was a good amount of private pasture lands available in the village. The pastures on 97 farmers' field covering 44 ha were also developed near by villages of *Goshalla*. The grasses were sown at the farmers' field as pure pasture, at field boundary and at field bunds. Moisture conservation practice like bunding and ridge furrows enhances productivity of pasture grasses. Bunding was done around the fields

and pasture grasses were sown on slope of these bunds. These grasses help in reducing soil erosion and strengthened the bunds that helps in moisture conservation. Forage yields of grasses *C. ciliaris* (0.32 kg/m²) and *C. setigerus* (0.23 kg/m²) grown on farm bunds was higher than grazing land and field boundary.

Improved pasture model at village Kettu Kalla: Another participatory pasture model was developed on *Panchayat* land (about 10 ha) at village Kettu Kalla district Jodhpur in collaboration with KVK, CAZRI Jodhpur and NGO, GRAVIS. Improved pasture of *Cenchrus ciliaris* and *Cenchrus setigerus* grasses were developed at protected sites, *Lasurus indicus* grass was also grown along with above two grasses. The growth and yield of grasses from the pasture under protected condition was higher than pastures that were utilized through open grazing. The average production was recorded to the tune of 1.9 tonne/ha dry fodder. The primary responsibility of the pastures' development and management including pasture protection was with the project implementing NGO with technical guidance of KVK, Jodhpur. After the completion of the project, the NGO handed over the developed pasture to village Pasture Development Committee for management. Before the harvest season, the village Pasture Development Committee auctioned the grass to the highest bidder who took care of harvesting activities. The committee had fixed a rule for selling grass that the first priority would be given to the members of village Pasture Development Committee and then villagers. The price of grass for the villagers was fixed between 15

and 20% lower than the prevailing market rate.

Improved pasture model at village Ajeet Nagar, Jodhpur: The 10 ha community land of village Ajeet Nagar, Jodhpur was owned by the community and it was open for grazing of animals. The technical interventions such as reseeding and protection help in conversion of the grazing land into a well developed pasture of *Cenchrus ciliaris* that supported about 9 adult cattle unit round the year. The fodder from developed pasture (1,645 kg/ha) was three-fold more than the open pasture (591 kg /ha) which was grazed uncontrolled. The soil and water conservation measures adopted in the area enhanced establishment of perennial shrubs, *Mimosa hamata* and *Grewia tenax* which are being utilized by the browse animals during the lean period.

SUMMARY

Rangelands in arid areas are important source of grazing for livestock. The livestock keepers have no control over the climate and overgrazing may lead to deterioration and degradation of the pasturelands. Protection and reseeding along with regular monitoring of changes in range quality and productivity is essential to maintain primary and secondary productivity. Carrying capacity analysis also helps as management guide for sustaining the productivity and improving these lands. Thus developed grazing lands must be utilized as per the carrying capacity.

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