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Need to revitalize grazing resource management practices for sustainable use of forage in arid Rajasthan

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ABSTRACT: Since ages, the traditional grazing grounds have been the lifeline of pastoral economy in arid region of Rajasthan. Owing to many fold increase in the human and livestock populations, these grazing grounds have been subjected to excessive pressure of grazing and utilization. As a results the area under traditional grazing resources – *gochar, oran, beers, jorh, adaw, bhelwars or choili,* etc. have declined. Due to over-grazing, most of such grazing resources are in degraded form with poor productivity. The traditional management practices of grazing resources by the community at village level with the system of *kar* and/or *go-had* (grazing boundaries) have also disappeared. The continuous decrease in grazing resources and increase in livestock population coupled with changing cropping patterns lead to conflicts between pastoral v/s herders and herders v/s farmers. The alarming situation warrants to look in to the opportunities- protection, reseeding, scientific grazing management which allows resting period to grasslands/pasture, integrating silvi-pasture systems and the issues-free grazing, herd size linked with equity on community grazing land, pastoral migration, etc. for conservation and rehabilitation of pastures and other grazing resources in arid region. Sensitization of people and capacity building at village level to ensure peoples participation, development of grazing calendar, establishment of fodder banks and formulation of a grazing policy like revenue policies both at State and National level would augment not only forage productivity of these shrinking grazing resources and enthuse their better management on sustainable basis but would also lead to better management of grazing resources with community participation.

Key words: *Gochar*, *Go-had*, grazing lands, *Orans* and Thar Desert.

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1. INTRODUCTION

Arid zone covers about 18.8% of the total land area of the world and faces most severe edapho-climatic conditions. In general arid zones are characterized by pastoralism and little farming with few exceptions (Malhotra, 1984). The major distinguishing feature of defining arid zone is low rainfall (below 500 mm or aridity index <0.20) with more than 50% inter annual variability. High wind and solar regimes further increases the effect of rainfall variability and the whole complex makes a fragile ecosystem in which small disturbances may cause great loss to the sustainability, which sometimes are irreversible (Le Houerou, 1996). Arid zones are found in almost all the continents of the world. In North America, arid zone are found in the southern US and Mexico, and in South America, they are located in Brazil, Argentina, Chile, and some other countries. In Africa, substantial parts of Saharan Africa, Ethiopia and Namibia are classed as arid region. Asia represents second largest arid zone after Africa which spreads mainly in India, Pakistan and Middle East countries.

In India, the hot arid region lies between 24^0 and 29^0 N latitude and 70^0 and 76^0 E longitudes covering an area of 31.7 mha. The arid region of Rajasthan, Gujarat, Punjab and Haryana together constitute the Great Indian Desert, better known as Thar Desert, which accounts for 89.6% of the total hot arid region of the India. The mean annual rainfall over Indian Thar desert is little less than 500 mm at the eastern margin from where it declines to less than 100 mm to west of Jaisalmer. Against this rainfall, the potential evapo-transpiration is 1650 mm in the east and it rises to over 2069 mm in the west, thus indicating very high annual moisture deficit. Severe wind erosion is caused by strong and desiccating wind regime. From the month of March wind start building up and peaks in the month of May and June. The mean wind speeds in the peak months are 20-27 kmph in the western end with tendency to decline to 10-15 kmph in the north eastern part of Thar. The strong blowing winds on one hand takes away top fertile soil thus causing irreparable loss to soil productivity, on the other hand deposition of airborne soil particles (sand, silt and clay) blocks the roads, railways, water bodies, open canals and burry

Table 1. Vegetation cover and yield in degraded and non degraded conditions.

Grass cover	Herbage cover (%)		Dry herbage yield (t/ha)	
	Non-degraded	Degraded	Non-degraded	Degraded
Dichanthium annulatum - Desmostachya bipinnata	4-8	0.5-2	4.00	0.13-1.10
Eleusine- Dichanthium - Desmostachya bipinnata	3-9	0.5-2	1.20-1.50	0.10-.060
Sporobolus marginatus - Dichanthium annulatum	4-7	1-3	1.40-2.60	0.30-0.50
Saccharum spontaneum - Saccharum bengalense	4-7	1-3	1.40-2.60	0.30-0.50
Cenchrus ciliaris - Cenchrus setigerus	4-6	1-2	2.00-2.50	0.30-0.40
Eleusine compressa - Dactyloctenium scindicum	3-4	0.5-2	0.80-1.00	0.18-0.45
Lasiurus scindicus	5-14	2-4	4.00	0.40-0.50
Lasiurus scindicus - Panicum turgidum	5-8	2-3	1.50-2.00	0.30-0.45
Aristida-Eragrostis - Cenchrus biflorus	2-3	0.-1	0.50-0.80	0.10-0.20

agricultural fields (Gupta and Aggrawal, 1978; Mertia *et al*., 2010). The soils of arid zone are sandy, devoid of organic carbon and highly erodible. The fragile ecosystem of arid region is un-conducive for agricultural activities. The productivity remains restricted due to limited choice of crops and aberrant weather conditions (Chatarjee and Kar, 1992). The drought is a common phenomenon and all agricultural activities are at gamble. Therefore, the living in desert, calls for immense forbearance and endurance.

Vegetation in arid region is typically sparse and comprised of perennial and annual grasses, other herbaceous plants, shrubs and small trees. The native species have adaptations that enable them to reproduce, grow and survive in most inhospitable conditions. The trees are limited in numbers and are slow growing in nature. Most of the vegetation cover is in denuded condition caused by mismanagement and over exploitation. The degraded grasslands are able to produce only 10-20% herbage yield in comparison to that of non-degraded ones (Table 1).

The grasses suited for desert ecosystem have been supporting livestock population for decades to sustain pastoral economy in the arid Rajasthan. But, the increase in density of livestock population coupled with manifold increase in human population has caused reduction in grazing lands. This has increased many folds grazing pressure on grazing resources. Grazing based animal husbandry is the predominant occupation and main stay of inhabitants of arid region in Thar Desert of India. Against 0.2 to 0.5 ACU/ha, the grazing pressure ranges from 1 to 4 ACU/ha. There is a wide range in the palatability of perennial and annual component of vegetation to the livestock from area to area. As such overstocking causes severe competition between the grazing animal species and slowly leading to deterioration of more palatable grass species in the natural vegetation. In last 40 years the availability of grazing land has declined by 30-35% (Mertia and Santra, 2012). It is a matter of concern that such an important life support system is continuously degrading and warrants collective community efforts for restoring glory of dwindling traditional grazing lands. The current synthesis presents a brief description of traditional grazing resources and their management, present scenario and measures to be adopted for sustainable forage supply from grazing resources in arid region of India.

2. TRADITIONAL GRAZING RESOURCES OF ARID ZONE

2.1 *Adaw* (own grazing lands and annual grasslands)

In traditional cropping system a farmer used to divide his land holdings in to three parts *viz.* locally known as *sathaw*, *darh* and *adaw* which were respectively used in rotation for growing millet, legume and grazing. *Adaw* being fallow was used for grazing by own cattle during July to October (Bharara, 1992). Singh (2014) opined that keeping 10-15% of total land holding as fallow for 2-3 years is normal practice being followed by farmers of arid areas even today. If the area of *adaw* was more and owner was not able to use available forage by grazing own cattle, it was allowed for cattle of neighboring farmers on co-operation basis. Some time the owner used to rent out *adaw* for

a season. Essentially *adaw* helped in enriching fertility of soil as grazing cattle's urine and cattle drop added manure to soil. Farmers maintain *adaw* for years depending on the holding size, number of cattle and quality of soil. When *adaw* was used to grow leguminous crops, it was known as *darh*. Growing of legumes in *darh* further improved fertility of soil enabling it to become *sathaw*. *Sathaw* means healthy soil capable of producing cereal crops mainly millet. The millet crop exhausts soil fertility which needs to be strengthened again by keeping it fallow and growing legumes. Hence, the system of *adaw*, *darh* and *sathaw* were rotated for sustaining soil fertility and taking a dependable harvest. Most of the farmers in arid region followed system of *adaw-darh-sathaw* traditionally (Figure 1). However, with passage of time the practice has declined drastically and resultant effect is degradation of land resources in arid areas. Main advantages of *adaw-darh-sathaw* cropping system were: a) Efficient and need based land use, b) Reduced pressure on community grazing land and common grassland or permanent pastures thus allowing them to get rest time and regenerate; c) Enrichment of physical, chemical and biological characteristics of the soils, d) Existence of harmonious society with minimum conflicts, and e) Maintenance of biological diversity of the system with minimum threat of extinction or disappearance of any species.

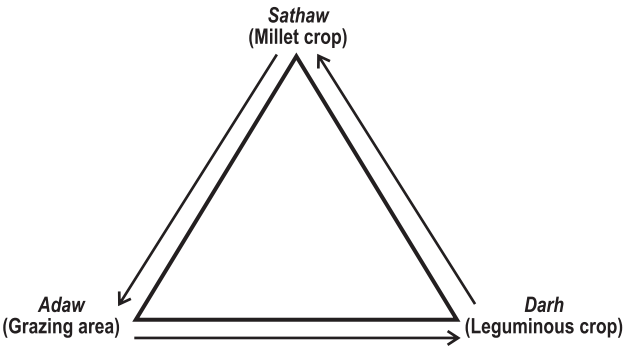

Fig. 1. Traditional farming system adopted by farmers in arid Rajasthan

2.2 *Orans* (sacred grooves or woodlands)

Orans are sacred forest having temple of local deity. Due to religious sanctity no villagers used to cut or destroy trees in *orans*. The grass stand are grazed by animals for which there were set guidelines regarding period of grazing and type of animals that were allowed to graze. Generally, there used to be one water body (*nadi* or *jorh*) near the temple in *oran*, however, existence of *nadi* or *jorh* was essential part of *oran*. The area of *orans* varies from few to thousand hectares. Among the larger *orans*, the Bhadriya *Oran* in Jaisalmer district has an area of about 15,000 hectares, the Baankal Devi ka *Oran* is spread over 4,600 hectares, and the Kundla *Oran* in the Barmer district covers about 7,500 hectares (Gokhale *et al*., 1998; Singh and Bahl, 2006; Singh, 2009). In Rajasthan, *orans* play an important role in promoting and flourishing livestock based economy and growth of livestock rearing communities. *Orans* used to be the source of natural wealth like fodder, fuel, timber, fruits, medicinal herbs etc. Many species are found both within and outside the *Orans* and traditional societies use them for a variety of livelihood needs. These sites have declined in areas due to encroachment or allotment for various purposes.

2.3 *Gochar*

The literal meaning of the *gochar* is the grazing land for the livestock. *Gochar* is the community land under the control of village panchayat. Traditionally every village used to have *gochar* where livestock of all villagers were allowed to graze freely without any distinction of caste, religion, or poor and rich. Every *gochar* had *nadi* wherein rain water was harvested for animal drinking. *Nadi* was an essential component of *gochar*. Size of *gochar* varied from few hectares to 500 ha and accordingly size of *nadi* also varied. Small water bodies or pond is referred as *nadi* whereas big water bodies referred as *jorh*. Some times a single village had 2-4 *gochar*.

2.4 *Bhelwars or Choili*

After harvest of *kharif* crop (bajra, mung, moth, til, etc.) the crop fields were allowed for grazing by all animals. This system of grazing was known as *bhelwars* or *choili*. There was no restriction of animal species. The residues of crops provided good forage to grazing animals and supported them for two months from November-December to January.

2.5 *Beers*

It refers to extensive grazing areas, which use to be maintained by local administration during the pre-independence period, and were transferred to state department of forest after independence. Their sizes use to vary from 1000 hectare to 5000-10000 hectare were located in every district. For their best utilization they were opened for grazing on nominal charges for period of 5-6 months from January-June, every year in the years of fodder scarcity; cut and carry head load fodder also. In the year of good rainfall range fodder stacking were practiced for use in draught periods. This practice of subsistence during lean period has almost diminished slowly in last 2-3 decades.

3. PRESENT SCENARIO

Due to enormous increase in livestock population the gap in demand and supply of forage is continuously widening. The deficit in forage supply is further accelerated by sinking grazing lands or resources. The increase in human population and development of irrigation facilities (Indira Gandhi canal) has caused conversion of grass lands towards agricultural lands. Almost all the grasslands or grazing lands have become extremely degraded. The study on comparative re-generation potential and fodder productivity of *Lasiurus sindicus* (Sewan) pastures in Jaisalmer district of Western Rajasthan by Mertia *et al*. (2006) revealed that uncontrolled grazing had significantly reduced stand density of grass tussocks (5700 tussocks/ha) and their re-generation in openly grazed pasture in comparison to those pastures which were subjected to controlled grazing (8300 tussocks/ha) and no grazing (9200 tussocks/ha). However, the tussocks size remained unaffected with grazing intensities. The pasture with no grazing had shown maximum fodder productivity 175.8 g/tussocks (1617 kg/ha) followed by pasture with controlled grazing 105.6 g/tussocks (877kg/ha), while it was least 61.9 g/tussocks (353kg/ha) in pasture subjected to uncontrolled grazing. Linear regression of soil moisture at different soil depths on yield attributes and yield of sewan revealed that root-zone moisture at 0-30 cm and 30-60 cm depths controlled sprouting of new shoots whereas moisture at 60-90 cm depth had greatest impact on growth of shoots and fodder yield. The study suggested that sufficient quantity of rain received in single rain event which is capable of charging root-zone soil profile is pre-requisite to spark sprouting of new shoots and their subsequent growth. Further, it is essential to avoid overgrazing of pastures and grasslands should be managed on principle of controlled grazing, thus allowing rest period, if the sewan pastures are to be maintained on sustainable basis.

As per the livestock census of 2012, arid Rajasthan harbours 30.18 million livestock comprising of 20.5% cattle, 13.1% buffalo, 22.8% sheep, 42.4% goat, 0.9% camel and others such as equines (CAZRI Vision 2050) .This region has recorded 125.2% increase in livestock population within a span of 56 years (1956-2012). During this period population of cattle and sheep increased by 57.7 and 44.8%, respectively while very high increase was registered in the number of goat (266.4%) and buffalo (412.5%). Buffalo population has increased mainly due to increase in irrigated area and preference towards stall feeding. Share of buffalo in livestock population is only 11.8%, but it contributes 45.2% of total milk production in arid region. Arid Gujarat has 1.13 m livestock population, and the share of sheep, goat, cattle and buffalo is 31.6, 26.6, 25.3 and 8.5%, respectively. Availability of area per livestock cattle has sharply declined in the arid part from 0.86 ha to 0.31 ha. Fodder scarcity remains the main problem in the arid region. In normal rainfall years, dry fodder and green forage availability is 82.1 and 31.6% of demand, respectively. This situation is further aggravated during drought years.

Continuous heavy grazing modifies the botanical composition of the grasslands. Palatable perennial with high forage potential like *Cenchrus ciliaris, Cenchrus setigerus, Lasiurus sindicus, Dichanthium annulatum,* etc. are the first victim of overgrazing and some times results in their complete extermination. At present the village common grazing lands *oran* and *beers* have become devoid of these productive species (Saxena and Singh, 1997). The pioneer species like *Aristida funiculata, Aristida mutabilis, Cenchrus biflorus, Eragrostis poaeoides and Indigofera cordifolia* seen in these grazing lands are indicators of overexploitation (Gupta and Saxena, 1972). The top feeds are very important in vegetation stabilization and sustained productivity of *oran*, *gochar* and other grazing lands. The importance of main top feeds species like *Prosopis cineraria*, *Acacia* spp., *Salvadora oleoides*, *S. persica*, *Tecomella undulata*, *Albizia lebbeck*, *Leucaena leucocephala*, *Dalbergia sissoo*, *Ailanthus excelsa*, *Azadirachta indica*, *Acacia leucophloea* etc. increases with the severity of drought and progression of drought season. The species such as *Aegle marmelos, Albizzia amara*, *Bauhinia* spp., *Butea monosperma*, *Cordia dichotoma* (syn. *C. myxa*), *Ficus spp., Hardwickia binnata*, *Holoeptelia integrifolia*, *Pithecellobium dulce* (syn. *Inga dulce*), *Morus alba* and *Moringa oleifera* have also been found to be useful as top feeds for livestock. The over grazing of grazing grounds have caused significant deterioration in most of the top feed species in respect to tree density and foliage availability. The changing cropping pattern is leading to conflicts of pastoral v/s herders and herder's v/s farmers (Mertia, 1997).

4. OPPORTUNITIES FOR SUSTAINABLE SUPPLY OF FODDER

4.1 Enhancing biomass and productivity

To cope up with the uncertainty of agricultural productivity, desert dwellers have evolved and adapted several strategies/ mechanism through their wisdom and experience over the generations. The most striking feature is the agroforestry i.e. tree based farming. Farmers grow arable crops in association with trees. The farming system of integrating woody perennials with arable crops is a unique multifunctional (productive and protective) system that works on the principles of ecology, productivity, economics and sustainability.

Based on dominance of the components, the traditional multifunctional tree based farming systems have been classified as agri-silvi, silvi-pasture, agri-horti, windbreaks/ shelterbelts etc to make scientific advancements. Agri-silviculture remains the most popular system in the areas receiving rainfall between 200-400 mm. In this system, naturally germinated seedlings of *P. cineraria, Ziziphus nummularia, Tecomella undulata* etc. trees are protected by farmers and retained in crop fields. In association of these trees, pearl millet, cluster bean, moth bean, and sesame crops are gown. These trees provide fuel, leaf fodder, fruits etc, and provide insurance against failure of crops during drought years. The *P. cineraria* – pearl millet based agroforestry system is well known all around the world. Almost all the agricultural fields in the 300-450 mm rainfall tract have 30 to 50 full grown Khejri (*Prosopis cineraria*) trees each of which provides 15-25 kg of dry foliage even during drought (Dhir, 2003). Khejri (*P. cineraria)* is unique tree that besides providing fodder enriches soil fertility and does not compete for moisture with crops grown in its association. The silvipastural system develops by coming up of tree species like *P. cineraria* and *Z. nummularia* in pastures/ rangelands of grasses like *C. ciliaris, C. setigerus, L. scindicus* etc. are well adapted to arid climate. Silvipasture system has been found as an ideal alternative for cevelopment of degraded land and restoring productivity of grazing grounds (Bhati *et al*., 1986; Rai, 2008). Shankar (1980) opined that silvipasture systems are more remunerative as compared to rainfed farming in arid and semi-arid regions. However, knowledge of species, planting techniques, fertilizer application and harvesting schedule is of paramount importance for getting optimum production from silvipasture system (Shankar, 1995). Silvipastoral system with *Acacia tortilis* and *Cenchrus ciliaris* yielded more biomass than a pure pasture (Muthana *et al*., 1985). Similarly, the carrying capacity of a pure pasture was recorded to be 3.9 sheep/ha after nine years of establishment, whereas a silvipastoral system showed carrying capacity of 8.5 sheep/ha after seven years (Tewari and Harsh, 1998). Integration of *Zizyphus nummularia* with *C. ciliaris* strips in 1:2 ratio reportedly yielded higher live weight (33 kg/ha/year) and wood production (5.65 kg/ha/year) over sole pasture thereby high return of Rs. 1326/ha/year from grazing of mixed flock of sheep and goat (Bhati *et al*., 1986). Narain and Bhati (2004) reported that silvipasture of *Z. rotundifolia* and *C. ciliaris* could sustain 554 tharparkar cattle days/ha with 60% pasture utilization. Integration of gum arabic (*Acacia senegal*) as a component of silvipastoral system has been advocated to increase economic viability of grassland and grazing grounds (Prasad *et al*., 2017). These systems play direct role in sustaining animal husbandry which is the lifeline of desert dwellers.

In Indian arid zone, productivity of grazing lands can be enhanced manifolds. Presently these grazing lands are producing a very small fraction of their potential. The main reason for poor productivity is highly depleted cover resulting from overgrazing. Due to downsizing of grazing grounds and declining forage availability, the herders are facing great difficulties in maintaining their herds. Moreover, cropping pattern has also been changing in Indira Gandhi Nahar Pariyojna (IGNP) Command area command, which has further aggregated the problems of graziers.

Improvements of these grazing lands can go a long way in augmenting biomass resource of arid region. The research innovations of CAZRI, Jodhpur have proved that productivity of grazing resources can be increased substantially (forage yield up to 200%) only by providing protection. Through reseeding techniques and silvi-pastoral land use, 600 to 800% increase in forage yield can be obtained. If scientific grazing is followed aiming at 70% utilization of forage, productivity can be maintained around 2-3 t/ha on yearly basis as compared to 0.5 ton/ha at present.

4.2 Modernizing animal component of animal husbandry

Besides making efforts to enhance biomass production, there is an urgent need to give a fresh look to the animal component of the farming sustenance. In arid zone animals provide much needed diversity and stability to the economy by supplementing income,

providing gainful employment, particularly to women groups and acting as source of ready cash. Because of dwindling grazable material, as discussed in above section and shortage of fodder, the animal husbandry has come under severe strain. Growth in mechanized farm operations (tractorization) has eroded sale value of male calf leaving another blow on cattle economy. Even if the productivity of grazing land and arable land is increased; the supply of forage may still remain short of requirements due to growing number of livestock. To counter this problem, launching of breed improvement programs, veterinary care, and processing and marketing of animal products needs priority. The native breeds of animals are highly tolerant to adverse conditions and well adapted to arid climates. The western arid region of Rajasthan is a repository of best breeds of the cattle (Tharparkar and Rathi), Sheep (Marwari, Jaisalmeri, Magra, Punjal, Nali and Sonadi) and goats (Marwari and Parvatsari).These breeds are highly productive and drought tolerant too. But, in absence of timely breeding services and genetic mixing due to uncontrolled breeding with any available male causes deterioration in genetic purity and productivity of livestock. It is essential to conserve native breed of different species and extend help services to harness maximum benefits (Prasad and Dhyani, 2010).

4.3 Exploiting lesser known but potential indigenous forage/fodder species

Domestication and improvement of indigenous plants species provide great opportunities and open new vistas in tree based farming. This has more relevance for lesser known but potential indigenous species that are used traditionally for various purposes. The trees like *P. cineraria, T. undulata, Salvadora oleoides and Acacia senegal* have been the lifeline of Indian desert (Narain and Kar, 2005) but potential of many species like *Capparis decidua, Commiphora wightii, Acacia jacquemontii, Calligonum polygonoides, Haloxylon salicornicum, Citrullus colocynthis* etc., are not yet fully exploited. Besides, there are many other un-researched species which have potential for producing fodder, fruits, fibres and medicines need research attention. Many of these species, in lack of scientific efforts, are losing grounds and are at the verge of disappearance. For such unexploited species priority setting exercise is needed to identify those which are most worthy for conservation and commercial exploitation.

5. MEASURES FOR ADOPTION

5.1 *Go-had* (grazing limit)

Go-had is a restriction line for allowing cattle to graze. At times of lord Krishna it was known as *kar*. It was followed very strictly in the communities at village level. Now it has disappeared in practice. This was used for delineation of grazing boundaries at village level. It helped in resolving conflicts arising due to non-adherence of *kar* thus maintaining a harmonious society. This historical practice of *kar* needs to be revived. However, it would require awareness sensitization and capacity building at village level to revoke old practices (Prasad and Mertia, 2009).

5.2 Peoples' participation

For revitalization of degraded and ever declining traditional grazing resources, collective action of the society is essentially required. Individually selfish attitude has to be dismissed. The women folk need to be sensitized as they are more cooperative than men. Women have better potential and their Self Help Groups (SHG) can be effective as they posses inherent character of sharing with each other. In *gochar*, *oran* and other grazing lands, cut & carry system can be tried as demonstrative work. Formation of SHGs based on their preference and interest would help better management as scientific reasons but have traditional wisdom of managing grasslands along with pastoral practices. The programmes need to be equity oriented for grazing resources, fuel, water and other resources from the grazing lands.

5.3 Development of grazing calendar

Local people with their collective wisdom and responsibility may formulate a grazing calendar (Table 2) which is to be followed for sustainable supply of fodder for their cattle all around year. By this way more judicious use of stubbles and crop residues can be planned. It would also help in avoiding conflicts between pastorals and farmers if mutually agreed by both groups. Grazing schedule will also take in to account the present cropping systems and interest of the farmers and pastoralists (Prasad and Mertia, 2009).

5.4 Fodder bank

To supplement stall feeding, fodder banks need to be established for storing millet and sorghum straw and leaves of *Prosopis cineraria* and *Ziziphus numularia. Bagars, Kallars, Dhugari, Chhiwara* are synonyms of fodder storage of millet, sorghum and grasses, which were used to feed in dry season or in droughts. Excess

Table 2. Traditional grazing calendar adopted by graziers in arid Rajasthan

Grazing land	January	February	March	April	May	June	July	August	September	October	November	December
Adaw							×	×	×	×		
Bhelwar	×										×	×
Beer	×	×	×	×	×		◄	─	─	►		
Gochar	×	×	×	×	×	×	×	×	×	×	×	×
Oran	×	×	×	×	×	×	×	×	×	×	×	×

◄► Rest period
× Available for grazing

fodder produced in good monsoon years can be safely banked for use in drought years. Normally 3-4 years in 10 years are heavy rainfall or above average rainfall years and yields surplus forage. There is a need to make effort on large scale to develop fodder banks in these years of surplus forage. Alternative methods like grass bricks etc can also be tested for their acceptance and socio-economic viability as it is prevalent in few states in India and has also been attempted by CAZRI, Jodhpur.

6. RESEARCHABLE ISSUES

The most important issue is the free grazing of traditional grazing grounds. In old days a system of taxation for use of the *orans*/*gochars* and punishment for wrongful use, as also a monitoring mechanism, was followed scrupulously. This system of monitoring and taxation helped in maintenance and efficient use of traditional resources of grasses and fodder supply, although sometimes this was misused by ruling class to exploit villagers (Jodha, 1985). With passage of time, this historical management system has disappeared and the traditional grazing grounds, now referred as Common Property Resources (CPRs) are subjected to collective action dilemma of the society. The old mechanism of monitoring needs to be revoked in modified form that suits to present social orders and fulfils equity obligation if, the traditional grazing grounds are to be conserved and maintained on sustainable basis. The system of zero cost supply has to be stopped. After free grazing, paramount importance is attached to the issue of land degradation. Land degradation has recently been exacerbated in rangelands of arid Rajasthan by heavy grazing pressures. In terms of adult cattle units (ACU), grazing pressures are surpassing the recommended stocking rates of the rangelands at an enormous pace. The pressure was 0.87 ACU ha^{-1} in 1981 which increased to 1.02 ACU ha^{-1} ha in 2001 against the optimum desirable density of 0.2 ACU ha^{-1}. Excellent, good, fair, poor and very poor condition rangelands (having approximate productivity of 2.0, 1.5, 1.0, 0.75, and 0.5 Mg ha^{-1}, respectively) can safely provide year long grazing to 0.25–0.30, 0.20, 0.17, 0.13, and 0.01–0.06 ACU ha^{-1}, respectively, during normal years. The carrying capacities of the rangelands were estimated several decades ago and there is need to revisit these grazing grounds for their carrying capacity. A flexible stocking rate, dependent on seasonal and annual variation in feed availability, is suggested as a key element in any improved range and livestock management strategy. Also simulation of grazing with different animal species and sequentially generate data on interaction between tree-shrub-grass-grazing animal is required. So far the focus has been on dominant grass and tree species. There is need to explore role and contribution of non conventional species of both components which, perhaps contribute significantly in over all grazing and browse biomass. In addition to focus on biomass productivity fortification of fodder with mineral nutrients to be accorded priority for better health of animals. Transfer of technologies to end user needs strengthening. Large yield gaps exist between the experimental yields and those obtained at farm level. Concerted efforts are required to bridge this gap and the potential of the region needs to be carefully exploited through crop-livestock-horticulture-silvi-pasture based farming systems for a sustainable future.

Another issue is conflict between large herders and

small pastorals. Large size herders share more resources and benefits. Small size pastorals have maximum disadvantages due to none sharing of equal equity on common grazing lands. Poor pastorals are becoming poorer and moving towards cities. In last but not the least, we need to have a grazing policy at State or National level, which should be equity oriented at community level. Framing of a grazing and rangeland management policy will benefit pastoral economy.

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