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Banni Grasslands of Kachchh- Issues and Strategies for Enhancing Productivity

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Introduction

Kachchh is the largest district (45,652 sq km) in the state of Gujarat and the second largest district after Leh in India. The significant portion of the population depends upon agriculture and animal based farming system for their livelihood. The district witnesses both intensive high input oriented irrigated agriculture and low input, subsistence rain fed agriculture. The region is located in the North-West agro-climatic zone in Gujarat and experiences arid climate frequented with droughts and erratic rainfall (Dayal *et al.*, 2010). Kachchh is known for vast stretches of saline deserts, salt marshes and grasslands. The two major unique grassland ecosystems in Kachchh are Banni and Naliya. Banni, once referred as Asia's finest grasslands cover an area of 2,617.72 km^2 constituting 51.56% grassland area in Kachchh whereas Naliya grassland is covered in 654 km^2 (12.89%) (GEER and GUIDE, 2011). Banni alone constitute 45% of the permanent pasture and 10% of the grazing land available in Gujarat state (Patel, 2013).

Banni was referred as the largest stretch of contiguous grasslands in India. However presently it is regarded as degraded remnant grassland. It occupies as a low alluvial land lying 3-10 m above the level of Great Rann. It is located in Bhuj taluka of Kachchh district (23" 19' to 23"52'N latitude and 68"56' to 70"32'E longitude). Banni is surrounded by Wagad and Beta Islands in east, Pachham Island in north, Great Rann in north-west and Little Rann and Kachchh mainland in south (Dayal et al., 2015). The name Banni thought to have its origin from local Kachchhi word *Bannai* (*Bannai hui* in Gujarati) meaning "made up" indicating the land was formed from sediments. It is believed that the formation of this alluvial land is due to deposition of detritus and sediments brought by rivers flowing towards north side of Bhuj namely Nara, Bhurud, Nirona, Kalia, Kari, Kaswati, Panjora etc. But the studies by Kadikar (1994) on sediment characteristics indicated the relationship to sediments brought by Indus, Luni, Banas and Saraswati hypothesising Banni formed out of sediments brought by those rivers. Some researchers believe that Banni is part of Ranns of Kachchh and relate its origin to upliftment from Arabian Sea theory. Fossil studies indicate that Banni has been of Jurassic period formed 101-151 million years ago (Sharma, 2013). Saucer shaped saline depressions in these regions limits infiltration of water.

Degradation of Banni grasslands

Various factors led to degradation of one of the largest stretch of Asia's finest grassland.

Soil salinity: The constructions of dams during 1960s across rivers on the northern side of Kachchh draining Banni area have arrested water flow to the area and annual fertilisation through riverine deposits of sediments. The flushing out of salts was stopped by these dams and salinity ingress by Arabian Sea persisted without check. Large amounts of nutrients were being added to the area by the rivers which provide a fertile environment for the plant and were also deprived by construction of dams (Saxena, 1993). The grasslands presently strive to thrive on limited and sporadic rainfall. Construction of Punjabi road in 1965

caused the sea water entry to the northern part of Banni from Kori creek, increasing soil salinity in the area (Patel, 2013). The salt laden winds from Great Rann and Little Rann is also responsible for increased salinity in the areas of poor land cover.

Grazing pressure: The livestock pressure on this grass land is immense. As a large population of livestock graze on finite resources more than its carrying capacity, the ecosystem did not get adequate time to rejuvenate. Due to overgrazing the rangelands get eroded and vegetation become sparse, since eating away of vegetation is more than natural regeneration of grasses. Ultimately palatable grass species vanishes and unpalatable species stay back and in due course of time dominate and proliferate in the rangeland. Coupled with poor rainfall and high temperature which are characteristics of the region, the degradation of grassland aggravates. The pastoral communities of the area are well known for their ecological awareness and their preparedness to conserve natural resources. As these lands are designated as common property resources without legal rights, herds from other areas of Gujarat and Rajasthan are sometimes brought to graze on these areas mounting grazing pressure further. It is a common practice to bring small ruminants such as sheep from Rajasthan during good rainfall years (Bharara, 1993). Over grazing by different types of cattle have serious implications. During pre-independence, goats and sheep were not allowed to graze these lands as they eat away everything leaving the land barren. The overgrazing, apart from having its effect on natural succession, has impact on soil properties due to frequent and heavy traffic of animals in the rangeland. There are always issues regarding land ownerships with claims from Forest, revenue departments and pastoralist communities and is freely used for various activities such as grazing, charcoal production etc without any control.

Invasion of *Prosopis juliflora*: *Prosopis juliflora* was introduced to meet the fuel wood demand around 100 years ago, by the then King of the princely state of Radhanpur. The first large scale planting of the species in Gujarat was reported to be in 1894 (Tiwari, 1999). Forest department promoted the tree for arresting soil erosion, salinity ingress, desertification and to green the desert in the early 1960s (Anonymous, 25 June 2000). Due to very high survival ability, its unique coppicing potentials and seed dispersal rate, this tree species invaded at a faster rate and occupied the place of grasses. Due to fast growth rate, it suppresses other vegetation in the area. During 1980, about 9.85% of the Banni grasslands was covered by *P. juliflora* (Sastry *et al.*, 2003). GUIDE (1998) reported a spreading rate of 25 km^2 per year in this grassland. The over grazing animals have also increased the spread of the species by aiding dispersal of seed through their droppings.

Even with this degraded status, buffalo rearing is the primary occupation of for nearly 70% of households in Banni (CAZRI, 2015) and there is a need to address the issues to arrest further degradation and to look at the opportunities for improvement of the present situation.

Present status

Presently the grassland is in degraded condition. Singh and Kar (1996) reported that soils of Banni are of alluvial origin with sandy texture. The soil salinity varied from 1.0 to 15 dS/m. The problem of salinity in these areas have been increasing in the recent past. The salinity problem occurs due to many reasons in this region. Primary reason being the geomorphology of the region, low lying alluvial land receiving discharge of salt laden runoff brought by rivers such as Khari, Bhurud, Nara, Kaswati and Panjora. Constructions of dams have in part reduced these problems. Another inducing factor for salinity is the presence of sea which brings salts by tidal processes. The area being predominantly arid, add to the salinity problem through heavy evaporative demand bringing salts to the surface. Since majority of soil are fine

textured with high content of silt and clay, the permeability of soils are very low and as such limited salts are leached out of soil during rainfall. The degraded condition of the grassland also contributed to increasing salinity problem by letting deposition of wind laden salts in the barren lands. Major tree species are *Prosopis juliflora, Acacia nilotica, Acacia leucophloea, Acacia senegal, Salvadora persica, S. oleoides, Capparis decidua, Tamarix sp, Azadirachta indica* etc. Because of wider adaptability to harsh conditions and fast dispersal rate of seeds, *P. juliflora* is the dominant tree species and has suppressed or replaced other trees. Major grasses grown in the area include *Sporobolus marginatus, S. pallidus, S. helvolus, Dichanthium annulatum, Cenchrus ciliaris, C. setegerus* and *Desmostachya bipinnata*. These grasses grow in the low to moderate saline areas (Singh and Kar, 1996). In the highly saline areas, grasses such as *Aeluropus lagopoides* and *Urochondra setulosa* dominates. Presence of halophytic plants such as *Cressa cretica, Suaeda nudiflora, S. fruticosa* is also very common in these areas.

Strategies for future development

Stakeholder participation and institutional support: The involvement and participation of pastoral community is a pre-requisite while initiating any programmes to revitalise the grassland. Many NGOs are working in association with pastoral communities for developing this grassland. A huge investment also required for doing activities such as fencing and other field works. Adequate support must be provided to supply additional fodder demand so that over grazing is not practised allowing natural or assisted rejuvenation of grassland.

Scientific grassland restoration: For realising a succesful restoration of the degraded pasture land a scientific plan need to be developed. This should start with assessment of current situation and delineation of areas needing intervention. Being a common property resource the restoration is only possible in a phased manner. After demarcation of area, scientific protocols to be followed by the implementing agency need to be identified. This involve removal of unwanted and non palatable species, protection of the area from grazing during the period of restoration by fencing, trenching to keep wild animals away, land levelling, provision of slopes and trenches to ensure drainage to leachout excess water, additional manures and fertilisers to improve soil fertility, and sowing the seeds. Indigenous and dominant grass species of the area need to be used. The selection should be based on regional adaptability and animal preference. Choice for all types of animals needs to be included. Trees, shrubs, grasses and legumes in a mixed silvipastoral combination will serve the needs of diverse animals and ecological stability in the region. In highly saline areas palatable halophyte grasses like *Aeluropus lagopoides, Urochondra setulosa* and *Sporobolus marginatus* may be used.

The first step in the rangeland improvement is protection of the site from biotic factors like stray animals. Angle iron posts with barbed wire fencing were found to be most effective and economical in the long run. If properly maintained, these fencing last for more than 20 years. Other fencing includes, trench fencing, core wall thorn fencing or live hedge fencing. In trench fencing, trenches of trapezoidal shape of 1.5 m wide at the top and 1 m deep are dug around the area of grassland improvement. The protection may also be required in range lands from grazing to improve the natural regeneration of grasses. This can be carried out in a phased manner so as to ensure that the livestock in the region are not deprived of feed due to the imposition of restriction. In a highly degraded situation, the regeneration is a slow process and may require 4-6 years to obtain desired result in the hot arid regions.

Clearing of bushes: All the unwanted bushes and vegetation are to be cleared by manual, mechanical or chemical means. The efficiency of manual or mechanical methods can be enhanced by applying selective herbicides on the cut stumps to prevent bushes from coppicing. The bushes like *Ziziphus nummularia* can be retained to a medium density level for the benefit of browsing animals like goats.

Reseeding with improved grasses and legumes: For rejuvenating deteriorated rangelands, low yielding and non-palatable grasses can be removed and replaced with improved palatable grasses and perennial forage legumes. The selection of different species and varieties are to be made based on the prevailing local agro climatic conditions. The reseeding of degraded rangeland or even naturally vegetated rangeland is helpful to increase its carrying capacity and to replace the low yielding annual grasses with high yielding perennial grasses. The advantages of a reseeded pasture over natural pasture are given below. In selecting the perennial grasses for reseeding, the grasses with drought and shade tolerance, fast growing with profuse tillering/ branching, palatable and suitable to the agro climatic condition need to be selected. The reseeding with suitable perennial forage legumes like clitoria, wild groundnut provide dual advantage of supplying protein rich fodder to the livestock and improving the fertility status of rangelands.

Introduction of top feed species in rangelands in silvipastoral combination: Introduction of common top feed species in rangelands is beneficial in meeting food and fodder requirement of livestock especially in drought years. They provide fodder from leaf twigs and pods. Besides fodder, some of these species also provide fire wood, timber for building and fencing, fruits, vegetables, gums, medicines etc. They are also helpful in providing shade to the animals in the desert rangelands apart from the ecological functions on vegetation stabilization and sustainability. The common top feed species are listed below.

- ***Prosopis cineraria***: Popularly known as *khejri* and it provides fodder, timber, fuel and edible pods useful as fresh and preserved vegetables. It can sustain heavy lopping annually in winter (November to January) from the age of about 8-10 years. The leaf fodder yield ranges from 25-45 kg leaf fodder/ tree/yr.
- ***Ziziphus nummularia***: It is a multi-stemmed shrub that is extensively grazed by cattle especially goat. The bush yield vary from 23-323 kg/ha.
- ***Ailanthus excelsa***: It is a deciduous tree, growing up to 1m height. A mature tree can yield 5-7 quintals of green leaves twice a year.
- ***Moringa olifera***: It is a medium sized deciduous tree reaching up to 10 m height. For leaf fodder, the branches up to thumb thickness are cut in the post monsoon period before leaf fall.
- ***Hardwickia binata***: It is a large tree growing up to 36 m under favourable conditions.
- ***Colospermum mopane***: It is a small to medium sized tree (10-15 m). The leaves of mopane are highly palatable. The green leaves can be harvested from 7 year onwards and provides leaves at the rate of 7 kg/tree.
- ***Acacia tortilis:*** (Israeli babool): It grows very well on wastelands and provide nutritive feed for sheep and goats.
- ***Calligonum polygonoides:*** It is a good sand dune fixing plant and its tender stems provide good top feed for animals.
- ***Acacia senegal:*** It grows well on rocky sites and provides leaves and pods for sheep and goats.
- ***Prosopis juliflora:*** It performs in all types of soils and is good as live fencing of pasture lands. Since it has very high regeneration capacity, adequate care should be exercised to avoid its invasion in rangelands and subsequent degradation. It provides nutritious seed from pods for sheep and goats. It is also browsed by camel.

- *Acacia nilotica:* It grows well in medium to heavy textured soils and provides nutritive top feed through its leaves and pods.
- The other tree species are Neem (*Azadirachta indica*), Su-babool (*Leucaena leucocephala*).

Soil and water conservation: The measure of soil and water conservation when introduced into the rangelands will be very useful in hastening the regeneration of different species of grasses and shrubs. Contour and peripheral bunding, mulching, wind breaks and shelter belts, water storage streams and pitting have been found suitable as soil and water conservation practices.

Fertiliser application: The natural grasslands can be fast rejuvenated by application of inorganic fertilizers and it enhances both production and quality of grasses. The natural grasslands dominated by grasses can be supplied with 40-60 kg N / ha. When grasslands contain large amount of legumes, the dose can be reduced to 20 kg N/ ha and additionally P_2O_5 can be added @30 kg/ha.

Fire management: Controlled burning of rangeland is advisable for rejuvenation of old rangelands. It is helpful in destruction of old and dead clumps of grasses. But it is to be done with due care so as to avoid complete burning of clumps (Roy and Singh, 2013.

Restricted and scientific grazing: The grazing and rangelands in India is largely maintained as common property resources and faces heavy grazing pressure of herds of cattle, sheep and goats. The overgrazing results in detrimental changes to the botanical composition of rangelands. Overgrazing triggers off succession and it may lead to dominance of less palatable perennials and annuals such as *Oropetium sp*, *Aristida sp* and *Eragrostis sp*. The over grazing damage to the rangelands can be attributed to destruction of shoot apex, decrease in root number and root biomass of different grass species, apart from their adverse effect on fertility and productivity of soil due to trampling by the hooves of livestock (Shankarnarayan, 1977). But the controlled and improved grazing provide the advantage of breaking the top crust of soil, by working through the hooves of livestock and thereby encourage better percolation of water for plant use and better yield of pasture (Roy, 2009).

Four types of grazing is practiced namely continuous grazing, deferred grazing, rotational grazing and deferred rotational grazing. In the continuous system, the grasslands are not divided into compartments and the animals wander through whole area. Long continuous grazing ultimately leads to degradation of rangelands by allowing dominating non palatable grasses. In the deferred system, the grasslands are divided into different compartments and one or more compartments are left without grazing until seed setting. In the rotational type, no compartmentalization is made; instead the rangelands are grazed in rotation of specific duration. Here grazing area is divided into 4-6 paddocks and livestock are allowed to graze in rotation for 7-15 days. The deferred rotational system is a mix of both types and is superior one owing to increased grazing periods available, maintenance of proper grass species through self-seeding and maintenance of soil fertility. In this system, some of the rotational paddocks are left ungrazed for proper seed formation and these ungrazed paddocks are changed every year to allow good seed bank in the soil in the entire area. There are yet another system of cut and carry, where livestock are not allowed to graze, instead the grass is harvested and stall fed to the animals.

The studies conducted at CAZRI, Jodhpur indicated that forage production is increased when the forage was utilized through deferred rotational system compared to continuous system of grazing, however continuous controlled grazing is beneficial for highest livestock returns (Roy, 2009). Grassland management by putting more than one kind of animals have been found to be beneficial as it allows utilization of diversified forage species more effectively. Adequate grazing scheme is to be practiced depending on the local conditions like, availability of pasture species, type of livestock to be grazed etc.

Conclusions

The grasslands at Banni is in extreme degradation state and is being further degraded at faster rate. Uncontrolled grazing, increasing salinity and invasion of *P. juliflora* are the major factors causing accelerated degradation. Steps need to be taken for controlling the indiscriminate grazing and adequate control/ monitoring with local participation is necessary to give enough time for the pasture to develop. The system of deferred controlled grazing can be advocated. Ways are to be sorted out to meet additional fodder requirement by measures such as preservation and storage of fodder for lean periods. The crops like fodder sorghum/cactus can be cultivated in wastelands and can be preserved to meet the fodder requirements. Adoption of scientific management practices with active involvement of stake holders and policy makers can only come to the rescue of the precious resources.

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