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# Indian Rangeland and Grassland Conservation, Restoration and Sustenance: A Policy Perspective

भा.च.चा.अ.सं.
IGFRI

ICAR-Indian Grassland and Fodder Research Institute
Jhansi-284 003 (U.P.) India

# Towards Fodder - Plus India.....

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# Indian Rangeland and Grassland Conservation, Restoration and Sustenance: A Policy Perspective


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सत्यमेव जयते

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## MESSAGE

Grasslands are indispensable to address the fodder crisis and ongoing fodder inflation in the country. Current estimates showed that the country faces a net deficit of 11.24% green fodder, 23.4% dry crop residues and 28.9% concentrate feed ingredients. Grassland Conservation and Management is sustainable strategy for achieving the India's target of restoring 26 Mha degraded land by 2030 under United Nations Convention to combat desertification (COP 14) and land degradation neutrality.

It is indeed, heartening to note that ICAR-Indian Grassland and Fodder Research Institute, Jhansi has come up with a proposal for devising policy prospective on Indian Rangeland/Grassland Conservation, Restoration and Sustenance**.** This document aims to address the complex interplay between conservation and development, offering actionable recommendations to enhance the sustainability and resilience of Indian grassland ecosystems. In the light of upcoming International Year of Rangelands and Pastoralists 2026 declared by UNO, we need this torch bearing document to address the underlying issues and ways to tackle them. The present policy paper not only gives an insight to historical context of grasslands and associated issues but also provides the strategies to support the sustainable management, conservation of grasslands and dependent pastoralists in the 21st century.

I wish this document will the pave the way to address the long awaited issues related to Indian Grasslands and may it get implemented in letter and spirit. I appreciate the ICAR-IGFRI for taking the lead in this direction and providing the insightful document to the country.

**(Himanshu Pathak)**

**Dated the 14th August, 2024**
**New Delhi**

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# MESSAGE

India with a livestock population of 536 million is the largest milk producer in the world. The livestock sector alone contributes nearly 27% to the total value of output in agriculture and allied sector at current prices and plays a major role in the livelihood security of the rural population. Grasslands covers around 11.5 Mha area of the country in comparison to 9 Mha are under cultivated fodder crops. Grasslands are important avenue for green fodder supply and providing livelihood to dependent pastoral communities. However grasslands are confronted with substantial obstacles, despite their significance. Their ecological equilibrium and sustainability are imperiled by rapid urbanization, agricultural expansion, and climate change. To understand the issues related to grasslands and their management a policy document is required.

I am glad that ICAR-Indian Grassland and Fodder Research Institute, Jhansi has prepared a Policy perspective for Indian Rangeland/Grassland Conservation, Restoration and Sustenance to support and provide inputs to the grassland managers, scientists and policy planners for sustainable development and conservation of grasslands and dependent pastoralists.

I appreciate the efforts made by ICAR-IGFRI in bringing out this much needed document.

**(T.R. Sharma)**

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सत्यमेव जयते

आज़ादी का अमृत महोत्सव

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**Dated: 13th August, 2024**

## Message

The ever-increasing demand of milk and other animal-based products in India can only be met with increased rearing of cattle heads, which in turn necessitates higher production of feed and fodder crops. Further, since ages, the quality rearing practices for animals are associated with grazing, which provides for healthy environment for animal growth as compared to the captive rearing. The grazing based rearing practices involving vast grasslands are commonly practised in several countries, whereas, Indian grasslands, often referred to as the country's "forgotten ecosystems," still play a vital role in our ecological and cultural landscapes, even though shrinking day-by-day. These diverse landscapes, ranging from the semi-arid regions to the lush, expansive savannas, provide essential services such as carbon sequestration, soil fertility, and habitat for a multitude of species, both domesticated and wild.

In the present era of climate change, when the nation faces increasing environmental pressures and developmental challenges, the need to establish a coherent and strategic approach to grassland management has never been more crucial. The aim here should be to foster a balanced approach that respects the ecological significance of these landscapes while addressing the needs of local communities and economic development. The present document, which is based on comprehensive analysis and stakeholder engagement, focusses and outlines key strategies for conservation, management and sustainable use of the grassland ecosystem.

I sincerely hope that the 'Policy perspective on Indian Rangeland/Grassland Conservation, Restoration and Sustenance' will serve as a valuable resource for policymakers, conservationists and community leaders committed to the documentation, upheaval, conservation and responsible stewardship of Indian grasslands.

I appreciate the efforts made by ICAR-IGFRI in bringing out this much needed document.

**(P.K. Singh)**

# PREFACE

Grasslands are among the most diverse ecosystems on our earth. They span across the continents and support a rich tapestry of flora and fauna while providing essential services to human societies. Indian grasslands, spanning across diverse climatic regions from the Himalayan foothills to the Deccan Plateau, are vital to the country's ecological and economic landscape. Yet, despite their importance, grasslands face significant challenges. As policymakers, scientists, and communities grapple with these challenges, it is imperative to approach grassland with both a sense of urgency and a spirit of collaboration.

The document investigates the historical context of grassland, analysing the ways in which past practices have influenced current approaches. The effectiveness and areas for development of the current strategies and frameworks that are designed to protect and restore grasslands has also been examined. In order to address the challenges of the 21$^{st}$ century, it is imperative that India should have "National Grassland Policy" that prioritize the well-being of communities that rely on grasslands, as well as ecological resilience and sustainable development.

In summary, this publication establishes the foundation for a more in-depth examination of grassland, encouraging readers to contemplate the intricacies and prospects that await them. We can strive for a future in which these essential ecosystems coexist in harmony with human aspirations by comprehending and confronting the multifaceted nature of grassland management.

The inputs received from several experts, NGOs, civil societies and other stakeholders are thankfully acknowledged. The various ground level experts who are working closely with rangelands/grasslands and pastoralists have given valuable information and suggestions. The document has also incorporated salient views/suggestions arising in the virtual meetings, national and international seminars, personal interactions and discussions. Authors are thankful to active participation of various agencies like ATREE, SEVA, RISG-SA, Sahjeevan *etc*. Special thanks are due to experts like Dr. Arun Dixit, Mr. P. Vivekanandan, Palani Pakshirajan, Dr. Syed Naseem Geelani, Dr. Abi Vanak, Ms. Iravatee Majgaonkar for their valuable inputs and suggestions.

We put on record our gratitude to the ICAR, New Delhi, Director, IGFRI and the IGFRI fraternity for their valuable guidance and encouragement.

**Authors**

# Indian Rangeland and Grassland Conservation, Restoration and Sustenance: A Policy Perspective

## Preamble

- Grasslands are one of the most widely distributed terrestrial biomes and are predominated by grasses or grass-like species with scattered shrubs or trees. Rangeland is a broader term than grasslands, including regions where even woody vegetation is dominant. It is a term looking at the land from the viewpoint of livestock production. The rangeland ecology is the complex interaction of biophysical components (rainfall, soil type), composition of plant species and livestock/herbivores and human activities.
- The various ecosystem services provided by grasslands include quality fodder for livestock production, other products such as wild food, plant and animal-based raw materials, fuel wood, fresh water, seeds of diverse plants, medicinal and aromatic plants, and herbs *etc.* They regulate climatic variability, help in carbon sequestration, soil and water erosion, improve air quality and oxygen supply, nutrient recycling, pollination services, and help in soil formation and stabilization. Besides, they have recreation, cultural and tourism value and heritage importance. In addition to these manifold ecosystem services, grasslands are also important for biodiversity conservation and endemism.
- Rangelands and grasslands are multifunctional and contribute to the various services to nature. They constitute the largest ecosystems in the world (26% of earth surface) and contribute to the livelihoods of >800 million people, provide forage for over 360 million cattle and 600 million sheep and goat, food for mankind, habitat for wildlife, carbon sequestration and water harvesting. Grassland soil carbon stocks amount approximated 10% of the global total. Economies of several countries depend heavily on grasslands. Owing to several socio-political reasons, the area under grassland is decreasing fast in many tropical countries including India.
- Total of 120.7 m ha in India is considered as the degraded or wastelands, which includes 25-30 m ha of degraded forest, 45-50 million ha agricultural lands unsuitable of crop production, 9-10 million ha sodic wastelands and the rest ravines, pasture lands and revenue wastelands. About 12.15 million ha of land in the country is classified as permanent pastures/grazing lands, however, grazing is estimated to occur on about 40% of the land area in the country. The distribution of pasture lands varies from 36.4% in Himachal Pradesh to only 4.5% in Gujarat. Additionally 550 tribal communities spread over 5000 forested villages derive livelihood from grazing lands. In India also decline of pasture land has been reported by several agencies.

- Agricultural scenario in the country is characterized by the traditional predominance of a mixed farming system and livestock production is an important source of income and employment in the rural sector.
- In the present scenario, the forest department is mainly interested in trees, agriculture department is interested in agricultural crops and animal husbandry and veterinary services department is concerned with the clinical aspects of livestock husbandry completely ignoring the grasslands by all these departments on which the livestock is dependent.

## Rangeland/grassland resource

- Rangeland management in the early 20$^{th}$ century was based on a particular understanding of ecology and believed that this ecosystem naturally moved through different stages to a final or stable state generally to a closed, fully developed forest. It was believed that livestock numbers need to be controlled to prevent forests from turning into grassland. The new concept of 'non-equilibrium rangeland ecology' or 'new rangeland ecology,' explains the importance of pastoralists' traditional practices, based on flexibility, adaptability, mobility and living with and from variability.
- Owing to the wide climate variation, various types of grasslands with different species composition and productivity are available in the country; such as *Sehima - Dichanthium* in Peninsular India including central India Plateau; *Dichanthium-Cenchrus-Lasiurus* type in sub-tropical and semi-arid regions of Gujarat, Rajasthan; *Phragmites–Saccharum-Imperata* type in Gangetic plain (U.P., Haryana, Bihar & West Bengal) and Brahamputra valley in N.E states; *Themeda-Arundinella* type sub-mountain tract of northern- western part of U.P., Punjab, H.P., J&K and Haryana; temperate alpine in the Hindu Kush Himalayan (HKH) region and arid and semi-arid grasslands in Rajasthan and Gujarat.
- The country has some old natural grasslands with ethnic value such as Terai-Duar Savanna and Grasslands, Rollapadu grasslands, Banni Grasslands, Kangayam grasslands, Alpine grasslands and Shola grasslands *etc.* A proper study of such grasslands can give a lot of information regarding their formation, survival and also lessons for future conservation. These pastures, with unique floristic compositions, have evolved over hundreds of years of ecological succession and it may not be possible to bring these back once these are destroyed.
- Large proportion of Indian farmers' is still dependent on grasslands and forests for their livelihood. Livestock and grazing based livestock husbandry continues to play an important role in the rural economy of the country. As per livestock census 2019, livestock population is around 536.76 million which is 4.8% more than the livestock census 2012. Livestock population is marked with increase in the number of stall feeding based bovine livestock and increase in the number of free grazing

based small ruminants like goats and sheep belonging to resource-poor landless pastoralists and marginal farmers.

- India is facing 11.24% green fodder deficit as well as 23.4% dry fodder deficit. Fodder is being cultivated only in nearly 5% of agricultural land, hence, fodder availability from non-arable lands need to be significantly increased.
- Last few decades have seen tremendous technology development in grassland science which includes ecosystems understanding, alternate systems, varieties of grasses/legumes developed and the plus trees identified, as well as information on interactions of microbes, soils, trees, grasses studied. Hence, the grasslands can be managed in more professional and scientific way to recuperate them to their natural potential.

## Degradation/conversion of rangelands and grasslands

- Pre-independence the nomadic pastoralists were sedentarized, and the grasslands they depended on were converted to agriculture leading to salinization of these soils and rendering once productive grasslands to wastelands.
- Wrong policies like converting grasslands to woodlands/ forests by plantation as well as declaring them as forests, protected areas and also use for developmental activities and industrial establishments have negatively impacted the sustainability of this ecosystem. In many states of India, true grasslands almost vanished due to plantation/cultivation. Many wildlife species have drastically reduced or threatened like Lesser flamingo, Painted Stork etc.
- Overgrazing/ early grazing, lack of feeding management, drought, improper land use and overstocking has led to denudation. Annual displacement of 6600 million tonnes of soil has also resulted in 175 m ha degraded land. Overgrazing has affected 23 of the 35 global hotspots for biodiversity loss. The grazing pressure on these low productive grazing lands is 3.42 ACU/ha, and the reason being that the grasslands are the 'common' lands of the community and are the responsibility of none. Further, due to poor management or community interest many of the grazing lands have been invaded by non-palatable invasive alien species like *Lantana, Eupatorium, Parthenium, Prosopis juliflora, Leucaena*, *etc.*, thus, severely impacting productivity.
- The present day rangelands/grasslands are no longer able to provide required forage for the livestock. The carrying capacity of Semi-arid grasslands has reduced to 1 ACU/ha against potential of 5.1 ACU/ha, whereas the same for Arid grasslands has reduced to 0.2-0.5 ACU/ha against potential of 1 to 4 ACU/ha.
- Globally, around one billion hectares of rangelands have been mistakenly earmarked for such restoration due to faulty assessment techniques. This form of 'green grabbing' is highly dangerous, undermining livelihoods and ecosystems. Bringing more area under reserve forest category and development of areas under

afforestation schemes will lead to further reduction of grazing areas. Diversion of village community lands for different purposes have already affected grazing.

- In such a scenario, a strong policy and institutional support is required to tackle this grave situation.

## Related policies in place and history

- The grasslands are the most neglected, abused and least protected ecosystems in India. They remain unprotected unless they are notified as Protected Areas under the Wild Life (Protection) Act, 1972 or notified as Protected or Reserve Forest under the Indian Forest Act, 1927. Most of the States have excluded the grasslands and have not identified them as "deemed forest"
- During British rule, a tripartite classification of lands was followed from a commercial point of view: agricultural lands were taxed, forestlands were managed for forest revenue, and other lands were classified as "wastelands"
- Land policy in post-Independence India has evolved through different phases. These include: two phases of land reform; attention to issues pertaining to quality of land through the Drought-Prone Area and Desert Development Programmes, Wasteland Development and Watershed Development Programmes designed to reclaim environmentally degraded land.
- National forest policy is against grazing rights and favours stall feeding which is against the interest of the pastoral community and thus impractical. As per policy, the rights and concessions should always remain related to the carrying capacity of forests which can be optimised by increased investment, silvicultural research and development of the area.
- The Forest Policy of 1894 was the most elaborate of all the policies in explaining the modalities of grazing in protected forests.
- The forest policy of 1954 is extremely critical of unrestricted and uncontrolled grazing and blamed it as contrary to scientific management of forests. It faced difficulties in implementation due to grazing pressure. It allowed limited grazing as it might actually improve the grassland/forests in some areas
- Dhebar Commission (Schedule Areas and Scheduled Tribes Commission, 1966) recommended that the Forest Department should promote growth of improved varieties of grasses in forest areas and grazing fees should be regulated.
- The National Commission on Agriculture (NCA) (1976) recommended strict control on grazing and regulation on grazing and the promulgation of grazing rules by each state specifying the grazing rates and manner in which grazing should be permitted.
- National Forest Policy 1988 and its implementation also recommended that "A National Grazing Policy should come into effect at the earliest." It stated that

grazing in forest areas should be regulated with the involvement of the local community.

- Forest Rights Act 2006 deals with certain power to the scheduled tribes and other traditional forest dwellers. It gives access to them for use of forage, access to migratory routes, usage of water bodies, use of NFTPs, MFPs etc under section 2(a), 2(c), 3(d). Section 3(i) of the act gives them the right to protect, regenerate or conserve or manage any community forest resources which they have been traditionally protecting and conserving for sustainable use.
- Draft Grazing and Livestock Management Policy (1994) emphasized to develop large blocks of grass reserves away from human habitation for higher production (in arid and semi-arid regions) and as fodder banks for drought years. The National Environment Policy 2006 (NEP) put emphasis on conservation of environmental resources but it totally misses out on the grassland ecosystems and their ecosystem service function. Many types of grassland in the country are prone to climate change, developmental pressures and invasion by alien invasive plants.
- National Wasteland Development Board was established in 1985 under the Ministry of Forests and Environment mainly to tackle the problem of degradation of lands, restoration of ecology and to meet the growing demands of fuel wood and fodder at the national level. The Government of India is taking up this task of improving wastelands through its IWDP by revitalizing and reviving village level institutions in order to harness the actual productivity of "marginal areas" and enormous potential of livestock products from these areas. However, the programme could not prove to be a game changer with regard to grasslands.
- In 2011, Hon'ble Supreme Court ruled that responsibility of maintenance of commons lies with village panchayats.

### Environment Protection Act (EPA), 1986

Under this act, Section 2A defines the environment to include "water, air and land and the inter-relationship which exist among and between water, air and land, and human beings, other living creatures, plants, microorganisms and property". Section 3 empowers the Central Government to take all measures for protecting and improving the quality of the environment. Under Section 5, the Central Government can constitute and declare Ecological Sensitive Areas or zones for the better protection of the environment and in particular with respect to the grasslands. In case such a notification is issued, there would be no need to acquire land or shift people, as has been done in the case of Matheran and Mount Abu areas. This procedure has a clear advantage over declaration of national parks and sanctuaries under the Wild Life (Protection) Act 1972. (*Report of the Task Force on Grasslands and Deserts, Government of India Planning Commission)*

## Rationale for Rangeland/grassland utilization and sustainability policy in India

Despite the fact that India has one of the largest livestock populations in the world, it does not have a grazing or grassland policy. As early as 1937, cattle conference held in Shimla passed a resolution that in all the provinces, a standing fodder and grazing committee should be established.

- Proper formulation and implementation of grazing policy is the need of hour. There is a requirement of a rational and holistic grazing policy incorporating the livelihood issues of the disadvantaged communities and the scientific consideration of vegetation recovery and ecological sustenance.
- The rights of graziers and pastoralists should be properly recognized and their rights like the right to access resources for food and livelihood security be protected while formulating such regulations. It must recognise the contributions of pastoralists and rangelands to environmental services, biodiversity conservation and climate mitigation. The policy should have provision for conflict management and dispute resolution.
- Restrictive forest policy and animal grazing should be developed/modified in a complementary mode for realizing the forage potential of forest fringe and open forests.
- Classification of pasture land, geography, species, land use type of grazing system including livestock and communities and major challenges need to be documented. Traditional management system and best practices in the management of Pastureland including the role of local institutions needs to be revisited for best management.
- Integrated Grassland-Livestock System needs to be developed, like the Integrated Farming System.
- Regulation of grazing system, carrying capacity, community forests and traditional resource rights as per Forest Rights Act 2006 and involving all stake holders in conservation of biodiversity, local livestock breeds, wild flora, medicinal plants and fauna needs to be done.
- Stipulating minimum intervention of protecting and restoring pasture land, village commons with attractive slogans *viz.* **"One Gram Panchayat, One Grazing Land"** and linking with Govt. schemes like MGNREGA
- Long term policy beyond 2026 of international year of Rangeland and pasture land policy with better coordination and financial mechanisms with state Govt. Schemes as well as eco-service monetization covering climate mitigation scheme, carbon offsets and Green credit.

Hence, there is urgent need to formulate the "National Rangeland/grassland utilization and sustainability policy". The 23$^{rd}$ IGC (International Grassland Congress)

also recommended that Savanna and old grasslands with high ethnic values are a source of subsistence to millions and need to be conserved. The congress also recommended to constitute Grassland Authority of India; record real time remote sensing data and develop subsistence to market oriented and business plans involving communities. Recommendation of Task Force for Desert and Grasslands for constituting National Grazing Policy and Sustainable Natural Resource Management committee constituted by Planning Commission of India, 2011 also need to be implemented. Thus, there is an immediate need to map the grazing lands in the country, demarcate these on the ground and initiate policy steps to maintain their land use.

## Mission

- Sustainable development of rangeland/grassland resources for increased fodder availability, environmental protection and biodiversity conservation with community participation.

## Goal

- Let's green the grasslands and rangelands of the country and restore them based on sound ecological principles of sustenance in consultation with local communities.
- Constitution of a National Grassland Authority to monitor and implement the "National Rangeland/grassland utilization and sustainability policy". The authority to coordinate with various stakeholder, programmes, schemes, agencies and ministries of the state and central government.
- Improving livelihood opportunities for farmers and pastoralists and thereby contributing to the national economy through sustainable rangeland management.
- Increasing fodder availability and contribution to environmental protection and biodiversity conservation.

## Objectives

- Restoration of rangelands, grasslands and other common property resources based on sound scientific principles with involvement of all stakeholders, mainly the local communities.
- Making rangeland/grassland an economically viable option of livelihood
- Increasing cultural competence and traditional pride of the dairy farmers and pastoralists. Poverty reduction of the dairy farmers and pastoralists through sustainable development of natural resources in the rangelands, grasslands and other common property resources.
- Addressing the issue of fodder scarcity in the country without burdening the agricultural lands.
- Contributing towards global organic food supply, as well as eco-services like conserving biodiversity, renewable energy resource, sequestering carbon and reducing global warming.

## Strategy

### Developing atlas of rangelands/grasslands

- There is a need to develop an atlas of rangelands and update records of rangelands/grazing land using remote sensing and GIS data validated by ground-truthing and should be updated every 10 years. A special focus should be given to studies exploring rangeland productivity and regeneration amidst the intensive tourism impacts.
- A data base on productivity status and key social/economic/environmental issues need to be prepared for different ecosystems for identification of critical gaps and preparing a comprehensive restoration plan.
- The status of exotic plants and weeds, and eradication methods also need to be documented.

### Rejuvenating rangelands/grasslands

- Grasslands are integrated human-animal-plant-soil-climatic systems with interdependencies among them with social, legal, economic and ecological components.
- Rejuvenation of grasslands is urgently required with emphasis on developing/disseminating technologies matching to social needs.
- Sustainable development of rangeland/grassland resources for increased fodder availability, environmental protection and biodiversity conservation is a complex technology development and adoption process. The ecosystem comprises many species of flora and fauna, varied edaphic/climatic conditions, diverse social issues including pastoral community. Hence, a comprehensive grazing, CPR ownership and management policy is required. The policy needs to consider various intricacies and strategies for its implementation.
- There is a need for preservation of contiguous patches of grassland, which can be achieved by reducing vehicular movements in breeding season and adopting cropping patterns suitable for the birds/pollinators.
- There is a need to enhance functioning of panchayats and local communities, developing robust local institutions for managing natural resources and working towards restoring community assets (forests, pastures, water bodies *etc.*)

### Developing action plans

- Prepare area specific action plan involving all stakeholders with monitorable targets. Area specific rural assessment of goals, skills, resource and socio-cultural modifiers a must for formulation of local technical programmes.
- As the ownership of these areas lies primarily with the government, the implementation of policy or programmes is possible only through a mission mode programme of state/central government.

- A suitable regulatory mechanism must be in place to monitor development and sustainability of the programme. For this purpose, appropriate institutional linkage to implement the policy and the mechanism to develop real-time status of resources and needful modification in the policy is required. Establishment of National Grassland Authority at the center, followed by state level, district , block and village level authority may ensure the filling of regulatory vacuum present as of now to tackle the grassland related issues.
- Development of Gaushalas/Gram Aranya/Model grasslands to reduce pressure on grazing land especially in peri-urban and forest fringe area required to reduce grazing pressure on cropped land and forests. Dry cattle can also be housed in such gaushalas.
- Developing protected 'Gram Aranya' (5 to 50 ha size) and government owned 'Model grasslands' (5 to 10 ha size) in vicinity of the village clusters and peri-urban areas for dry cattle and other livestock.

**People's participation**

- People's participation is the crux of getting successful implementation of the programme on a huge area in a targeted time frame. Farmers access to these areas, participation in development and incentives for development and biodiversity conservation may suitably be defined.
- Farmers and pastoralists need to be educated on the importance of rotational or seasonal grazing, control on free ranging animals, grassland plots to serve as nucleus for seed banks and improvement of livestock breed. People's participation in grassland management has given encouraging experience with *Patel* in western India where shepherds herding groups negotiate access to harvested fields and sorts out disputes that arise during migration.
- Integration of farming and pastoralism is needed because of fragmentation of extensive rangelands, thus posing a negative factor as market barriers. Strong financial support mechanism, suitable market linkage for farmers and pastoralist is required to increase participation of all stakeholders. Incentives to farmers and pastoralists to continue traditional practices could be beneficial for wildlife and help in sustainable use of grasslands and deserts.
- Involving societies through formation of grass growers co-operatives and ensuring benefit to the local people by providing the fodder produced from reserved vidis (as in Gujarat) to them may prove to be successful in attracting their interest.
- The grazing land must be used for animal rearing and kept for the community use. The dependent communities must be consulted before allotting grazing lands to development purposes.
- Concern of Nomadic Gujjars and Bakarwals in Jammu and Kashmir with regard to fast shrinking pastures due its rapid conversions for different purposes is worth

mentioning here because a large number of tribal families are entirely dependent on these lands and their very livelihood is threatened.

- Pastures should be enriched as per the grazing habits and requirement of animals *viz.*, nutritionally superior shrubs for the browser species like goats, proper balances of superior quality grasses and legumes for sheep and cattle *etc.*
- Thus, there is a need for initiative from the government with involvement of all stakeholders for the improvement of this ecosystem.

**Safeguarding pastoralists interest**

- Pastoralists are 'invisible livestock keepers'. Estimates put their number as 13 million belonging to over 46 communities. They are dependent on common pool resources, mobility having primary income from livestock and are associated with specific breeds with traditional knowledge systems. This form of livelihood has been an integral part of our economy and culture for centuries.
- As per estimates, 'extensive system of livestock management' produces 53% of India's milk and 74% of meat with contribution of manure and ecological services. This system is dependent on fodder from rangelands or CPRs. Pastoralism is being gradually replaced by semi-migratory and sedentary animal husbandry/ dairy enterprises.
- As a land-use system, pastoralism is found on between 25 and 50 per cent of the globe's total land area and supports hundreds of millions of people worldwide. Pastoral systems around the world are quite diverse, with a wide range of factors guiding mobility patterns including biophysical conditions, market access, resource access, access to social services and infrastructure, and socio-cultural and political factors. Pastoralists are vulnerable to resource appropriation, sedentarization and restrictions on mobility. Pastoralists are usually considered backwards looking and unproductive and have historically been undermined by adverse legislation and a lack of supportive legislation.
- Governments have sought to sedentarize pastoralists, fragmenting, enclosing and privatizing common resource lands. Resources to which pastoralists previously had access, are often appropriated for industry, mining, restrictive protected areas or crop cultivation. It is therefore imperative to consider resource access arrangements when developing policies for pastoral mobility.
- In India, pastoralism varies from camel-keeping in the deserts of Rajasthan and Gujarat to upland pastoralism in Himachal Pradesh, Assam and the Karakoram mountains. Pastoralism is being squeezed in terms of territory, political status and economic opportunity. Urbanisation, 'green revolution' agriculture and other forms of 'development' are further marginalising pastoralists. They have adapted, including by grazing along roadsides, in peri-urban and urban areas and on crop farms.

- Livelihood of a big nomadic or pastoralist population is dependent on these grasslands/rangelands. Additionally, intricacies of technology development need to be suitably addressed. By way of community participation at the planning stage and community response can be enhanced. Pastoralist in different regions have varied practices and beliefs, still there is a need to have a common and harmonized set of programmes with space for fine tuning as per local needs. Pastoral nomads in India also specialize in animal breeding. In the mountains, *Gujjar Bakarwals* , *Gaddi*, *Bhotiyas, Sherpas* and *Kinnauris* are common whereas on the Plateaus, Plains and Deserts *Dhangars, Raikas* and *Banjaras* are important pastoral communities.
- Despite massive changes to pastoral areas, pastoralism persists because they are good at adapting to change through flexible practices such as mobility, dynamic restructuring of social arrangements, labour, land, markets and other resources. Therefore, with change in land utilization pattern and social factors pastoralism will also inculcate changes, which is required to be closely monitored and needful changes be made in the programmes. Making use of a variable environment requires skilled herding and well-trained animals.
- As our institutions, policies, and practices struggle to keep up with a rapidly-changing, turbulent world, pastoralists also have much to teach us about reliability, adaptation, and flexibility in the face of uncertainty. Pastoralists could sustain and survive because the community was able of cultivating and maintaining knowledge and capacities to respond to high variability; move to respond to spatial and temporal variabilities; flexible responses to property and tenure through diverse forms of land control; real markets embedded in social relations; dynamic social formations etc.

**Steps for empowerment of pastoralists**

- Pastoral census should be initiated with a robust understanding of both pastoralists as well as livestock composition.
- Exploration, identification, and documentation of pastoral cultures and traditional knowledge regarding pastoralism-based livelihood dependency and SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis of pastoralism-based livelihood are to be considered.
- There is need for developing support system for the pastoralists, provision of a pastoralists card for identification and availing benefit of government schemes, training about animal husbandry and veterinary services as well as value added products, insurance of animal using RFID techniques, government supported processing and purchase center for their produce, information about grazing land status along the routes for availability of fodder, pastoral field schools for orientation for youths *etc.*

- Social and economic services such as mobile health and veterinary services, credits, education system, marketing, communications, Extending facilities *viz.* mobile schools, health units, drinking water provision, community halls etc. are likely to enhance their interest in participatory management of the ecosystem.
- There is a direct correlation between policies and laws on pastoralism and the level of investment that governments make to support the pastoralist system. Without legislation, governments are not obliged to commit resources to promoting pastoralism or pastoralist welfare.
- Pastoralist youth and women have to be integrated because of their increasing disinterest. Access to financial and technical resources and empowerment for women will be a basic need. For youth, vocational training, alternative income opportunities, professionalism in herd management, value addition, pride in their profession will be important. Thus, sustainable technologies and innovation can only protect the future of pastoralism.
- Land ownership, common property management, corridors for mobility, social licence to operate rights and land access are the key issues for pastoral communities. Values of diverse pastoral societies and cultures and the ITK being followed by them are to be protected in formulating programmes for these areas.

### Valuation and rewarding of eco services provided by rangelands/grasslands

This ecosystem has long been seen as a grazing resource, whereas it has to be capitalized for its significant role in environmental protection, biodiversity conservation, hydrological balance and medicinal plants. The vast grazing lands, if managed properly, can have significant positive impact in mitigating climate change adverse effects. Restoring grasslands contribute to carbon sequestration and maintaining hydrological balance.

- Rangelands can significantly contribute in mitigating climate change and biodiversity and ecosystem services. GHG emission from rangelands can be reduced to a minimum using technology. Further, the ecosystem can contribute to carbon sequestration, support renewable energy and biodiversity conservation, wild life tourism. Thus, the communities dependent on it or contributing in its development should be suitably rewarded.
- For the 'total economic valuation' of the ecosystem assigning monetary values to social, environmental, and cultural goods is important. Evaluation of a large number of goods from the ecosystem such as meat, milk, manure, wool, hides, and skins, livestock provide transport, draft power, environmental services, and cultural values, they also support livelihoods in veterinary services, trade, abattoirs, fodder production and more.
- There is a need to develop PES (Payment of Ecosystem Services) on the line of the ecological compensation policy of countries like China to encourage community participation.

- Apart from carbon sequestration, the grassland can help in achieving the Land Degradation Neutrality target as it acts as a carbon sink. Land degradation neutrality is an umbrella term that incorporates biomass production, land cover, and soil organic carbon. They are a sustainable strategy for achieving India's target of restoring 26 Mha degraded land by 2030 under United Nations Convention to Combat Desertification (COP 14).
- The agricultural areas (including grasslands and wastelands) have a potential to sequester 26-31% (FAO 2014) of the 4.5-6.5 Gt C eq/year net GHG emissions (Steinfed *et al.*, 2006). Emissions by various livestock production cycles on grasslands also come in a negative way for environmental protection although sources of GHG emission in the production cycle are 34% from deforestation for creating grasslands, 25% from enteric fermentation and 30.5% from manures as both methane and nitrous oxide. Hence, we must concentrate on limiting enteric fermentation in animals and managing manures and fertilizer. Free animal grazing on rangeland (extensive systems) and manure and fertilizer management should receive priority for GHG reduction from animal activities on grasslands. Response of grassland ecosystems to climate change is critical in grazing animal production efficiency as climate change will have an impact on forage quality (nutritive value). Foliage quality decreases at elevated $CO_2$ because of higher C:N ratios. Further, with doubling of $CO_2$ climate change a 40% increase in warm grasslands and a 50% decrease in cool grasslands are predicted (Babu *et al.*, 2015).
- It is time to concentrate and ways and means to revegetate them which needs technological input as well as strong socio-political will.
- The points for improving pasture sustainability and fodder availability to be considered are creation of nodal agencies on CPRs to coordinate and steer various research, educational and extension programs; mapping of ecologically sensitive grasslands; rehabilitation and productivity enhancement of degraded forests through silvi-pastoral practices; develop fodder blocks in Forest Fringe Villages; development of seed/germplasm banks and nurseries in every state for pasture development.
- Grasslands can prove to be the best hotspot for *in-situ* biodiversity conservation with people's participation. Community based conservation is likely to be more cost effective and sustainable when national regulatory frameworks are left flexible enough to accommodate local peculiarities. It required establishing community protocols in which communities can document their role in biodiversity conservation and articulate their demands for access and benefit-sharing.
- Modification is required in environment impact assessment guidelines by including ecologically fragile and environmentally sensitive areas. Developing a network of grassland ecologists/scientists can provide continuous technological

support. Further, grasslands and desert ecosystems need to be included in protected area system along with the parks such as of Jaisalmer and Barmer be declared as a Biosphere Reserve.

### Potential, value addition and market linkage of rangelands product

- The ecosystem can be converted to sustainable livestock production and consumption system. The production from this area will be having additional value as organic production. However, this requires suitable certification and market linkage. In order to fight malnutrition products from this area such as nature based animal protein, novelty foods, medicinal plants products both for human and animal welfare will be a good resource. For sustainability combining high-tech with ITKs, innovation in processing and marketing, risk, decentralized renewable energy, IT will play a key role.
- The sheep and goat meat has been produced practically in its entirety in India's marginal rain-fed areas. Even under degraded conditions, the livestock production from these lands by poor farmers is quite significant, well evidenced with the fact that India is one among the largest exporters of sheep and goat meat in the world. However, this production is much behind its potential. Quality of meat and ghee produced from animals raised in the *Thar* desert has also been found to be superior. Thus, the potential of grasslands for production of superior quality animal products can be exploited.

### Addressing social issues

- Degradation of Indian grasslands is a serious concern in multiplicity such as low fodder availability, environmental degradation (soil erosion, increased water runoff, poor carbon sequestration), decreased livestock production and diminishing livelihood for poor people. Social, legal and climatic factor are affecting these grasslands in different ways.
- Post independence focus on agricultural productivity and land reform was one of the factors for encroaching pastoral land which further compounded with industrialization. Social issues do come in the way of implementing programmes. For example, in a livelihood improvement programme in semi-arid India, due to misunderstanding following bans on grazing, the commons migrated out of watershed areas although this ban was suggested in the initial establishment year only.

### Policy issues for protection of grasslands

- It is thought that the whole of the subcontinent was formerly wooded; in reality, up to half the land classified as 'forest' may be grasslands.
- Some of the factors which affected growth of grazing lands are: absence of any nodal agency to coordinate and steer grassland and fodder development program; gradual erosion of the traditional agro-forestry/silvi-pastoral systems; lack of

fodder banks and value addition facilities; lack of field level research on management protocols in respect of ecologically sensitive grasslands; un-organized use of grazing lands and lack of inter-sectoral dialogue between the key departments.

- It is well agreed that lack of comprehensive grazing-cum-fodder and pasture management policies at national and state levels is the major cause of degradation and diversion of grazing lands. Enacting elaborate legal systems such as "The Jammu and Kashmir Kahcharai Act, 2011" should be in place.
- Scanty age old regulations like "The Cattle Trespassers Act' formulated in 1871 are the only Act applicable to regulate grazing in public and forest land. Most of the States have not identified grasslands "deemed forest", hence, there is urgent need to be notify grasslands as Protected Areas under the Wild Life (Protection) Act, 1972 or notified as Protected or Reserve Forest under the Indian Forest Act, 1927. Although not covered in the National Environment Policy 2006 (NEP) many of the grasslands in the country, which are sensitive to climate change, developmental pressures and invasion by alien invasive plants, need due attention. Traditional rights to grazing have to be recognized to those who primarily reside in a forest or on forest lands and are dependent for 75 years through Forest Rights Act 2006.
- Experience shows that the unrestricted and uncontrolled grazing faces difficulties in implementation due to grazing pressure. Improving grazing resources in the forest area can be achieved through promotion of growth of improved varieties of grasses in forest areas and controlled grazing only.
- Many of the ecologically sensitive pasture lands *viz.* Shola grasslands of Nilgiris; Sewan grasslands of Bikaner, Jodhpur and Jaisalmer; semi-arid grasslands of Deccan; Rollapadu grasslands in the semi-arid tracts of Andhra Pradesh; Banni grasslands of Gujarat and Alpine grasslands of Sikkim and Western Himalaya are already on the verge of no return. Recognition of these grasslands as ecologically sensitive ecosystems and proper maintenance and steps for scientific rejuvenation is needed.
- Implementing recommendation of Draft Grazing and Livestock Management Policy (1994)', and 'Draft National Policy for Common Property Resource Lands (CPRLs)' for developing large blocks of grass reserves away from human habitation.
- Policy initiatives need to be developed if pasturelands are diverted to non-pasture uses on the lines of CAMPA. There has to be provision of a Compensatory Pasture Management Authority.
- A multi-stakeholder board needs to be framed for Pastoralists and Rangelands involving representatives from all the stakeholders *i.e.*, forest department, sheep husbandry, agriculture, animal husbandry, tribal affairs, universities, IGFRI, pastoralists *etc.*

### Introducing tree component in tropical and sub-tropical grasslands

- Significant technological developments in grassland science are the strength to redevelop grasslands. Technologies such as horti/silvi/agro-forestry systems and agri-horti-silvicultural need to be popularized, as these systems have proved to be better productive and sustainable in tropical environments particularly arid and semi-arid environments. Additionally, considerable success has been achieved in cultivating halophytic forages such as chenopods, especially *Atriplex* in areas subject to total summer drought or on badly salt-affected lands.
- Generally, about 5% to 10% of the land area in a village should be reserved for community pastures. Even after encroachment or diversion for other purposes, a significant portion is still available for common grazing which can be brought under silvipasture development involving local people.
- **Vegetating ravines and mining area:** Considerable areas in the country are ravines, which are unstable, facing heavy soil erosion and degradation in addition to social problems. Steady disappearance of grazing land due to mining and agriculture in the arid ecosystem wherein about two third rural families keep livestock and largely dependent on dairy and animal husbandry need to be stopped immediately. This huge area under mining needs to be vegetated. Thus, ravines and mining areas both need to be revegetated and made productive and ecologically stable. Cactus can prove to be a good option as fodder in such areas.

### Forest grazing resource

- Grazing and browsing in forest areas should be regulated with the involvement of the community. Special conservation areas, young plantations and regeneration areas should be fully protected. The forest reserves may be allowed for regulated and controlled grazing. The requirements of the community should be met by development of social forestry outside the reserved forests with joint management by forest officers and the local *panchayat*.
- Because the forest and the forest fringe area are potential grazing resource for marginal farmers as well as a poor nomadic population, the conflicts between grazing lands and forests also a need to be suitably resolved. The Wildlife Protection Act of 1972 and Project Tiger placed the need for conservation of India's wildlife. Forests where animals used to graze were closed to grazing. In India, there are nearly 95 national parks and 500 wildlife sanctuaries. According to the report of the Forestry Commission (2006), nearly 40% of these Protected areas (PAs) suffer from livestock grazing and fodder extraction. There are only a handful of PAs having grasslands. Hence, there is a need to bring grasslands under a protected area network.
- Development of watersheds is needed to get the immediate impact on the regeneration of various native grass species on field bunds and borders which can improve fodder availability. In an estimate, even if 75% area under *Sehima-*

*Dichanthium* cover is improved in terms of productivity increase from present 0.65 t/ ha to 1.75 t/ha, the fodder availability is likely to increase from present 83 Mt to 224 Mt.

- Identification of bio-physical indicators for different grasslands can help in monitoring the status of those grasslands. For example, the very presence of Bustard species can be considered as indicators of grassland ecosystems and by conserving the bustards and their habitats, a very large number of species dependent on the healthy grasslands will also be protected.

## Constraints and pathways for rejuvenating tropical grasslands/rangelands

- Beyond doubt and delay, there is an urgent need to revegetate vast Indian grazing lands. However, several factors pose as constraints towards restoration. The most important constraint is availability of funds. This is a huge area and mostly as a common property resource. Hence, funds need to be allocated by the government and used with peoples' participation. The social values and peoples participation both in planning and implementation of these schemes is also of great importance. The environment is to be created in such a way that the communities feel responsible for restoration of these grasslands. Further, the grassland resources and its beneficiaries make up a complex environmental and institutional context in terms of varying agro-ecological conditions, rampant poverty among pastoralists, high altitude climatic harness, environmental fragility, inaccessibility, conflicts on tenure issues of common pool resources, and accelerated climate change in recent time. Specifically, the high altitude grasslands and people dependent on them deserve more investments and regional cooperation for their continued ecosystem services for humankind.
- Even if, there is a plan/scheme for restoration of these grasslands, the availability of large quantity of seeds of range grasses and legumes is likely to come in the way because of it being of low priority and low cost seed at the moment. Participatory seed production and recent grass seed related technologies such as innovative defluffing technique, *in vitro* maturation of panicles and *in vitro* rooting of stem cuttings for rapid multiplication may be utilized.

## Global initiative needed

- Rangelands and grasslands do not stop at national borders, nor do the animals that exploit them recognise political boundaries. Hence, transnational consultations are also required in border areas.
- There is a need for mission mode projects to revegetate the denuded grazing land. This will have a long term positive environmental impact also. Considering these vast lands as global resource the programme should have backup support of international agencies. More to mention that internationally it may be realized that tropical grasses which are $C_4$ or intermediate have greater potential of C sequestration. Programmes to be implemented, need careful planning through involving communities and taking lesson from other such programmes attempted

in various parts of the country over the last few decades. Thoughtful interaction between the researcher and the developmental agencies is required as voluminous work on ecology of grasslands can be a key to success of revegetating projects. It is important to know whether the grassland ecosystems are in equilibrium systems and whether they will return if stresses are removed.

**Human resource development**

- Master trainers training at IGFRI/SAUs/KVKs on grassland management for application of advanced science at farm level requiring skill, knowledge, investments and improvement in human capital.
- There is also a need for grassland science at post graduate degree level.

Thus, in order to manage these grasslands for multiple use we need to develop a comprehensive and integrated plan. A systematic approach following GIS based inventory development of degraded rangelands, policy support for grazing and utilization of CPRs, incorporation of suitable recently developed technologies, community awakening and education, involvement of Shepherds and landless, rejuvenation of water bodies, quality seeds availability and market linkage for sustainability is likely to show positive results. Since there are interactions between different CPRs, and between CPRs and farmland, development of one CPR alone is not enough. Thus, a livelihood approach to work in a more integrated way is to be followed. Further, one of the important outputs of grasslands is round the year fodder; the availability of fodder from various sources should also be looked into. A large area in the country is characterized by a tropical monsoon climate and active growth in grazing lands occurs during monsoon months and deficits of various levels in other months.

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**Stakeholders**

Department of Agricultural Research and Development
Department of Animal Husbandry and Fisheries
Ministry of Agriculture and Farmer's Development
Ministry of Forest and Environment
Ministry of Rural Development
National Rainfed Authority of India
Various NGO and social organization
Pastoralists and livestock keepers as well as farmers and nomads
Ministry of Tribal Affairs
Wasteland Development Board

# Annexure I

## Notable ethnic grasslands

**Banni Grasslands:** Made up land formed by the detritus brought down and deposited predominantly by the Indus River, which was reported to flow through the Great Rann in the past. The great and the little ranns of Kachchh were the old arms of the sea in the old geological period. Due to the eruption and formation of the Allah Bund near the Kori Creek, the lands got blocked up and were filled up by the deposits brought down by the Indus river. Banni once considered the largest grassland in Asia, has drastically degraded due to salinity ingress, lack of knowledge, increased human and livestock population and invasion of *Prosopis juliflora*.

**Banni region** has a very fascinating history, geography, diversity of flora and fauna, highly nutritive grasses; rich cultural heritage of Maldhari (Cattle breeders) communities, unrivalled embroidery work and other handicrafts, soul-touching folk and Sufi music, earthquake resistant mud houses Bhunga, traditional fresh water reservoirs Virda, traditional knowledge of medicinal plants and animal breeding and last but never the least, drought tolerant highly productive livestock - the very base of survival of Maldharis. The word 'Banni' is derived from Kachchhi dialect, 'Bannai', which means freshly made, signifying the land that has been formed by detritus and sediments brought down by the rivers such as Indus, Luni, Banas and Saraswati, which in recent geological past, flowed through this area from the north and the east. Livestock is the mainstay of inhabitants of Banni, constituting a major bulk of their assets. Despite tough survival conditions, Banni buffaloes are the most productive cattle in India and are recently recognised by 'National bureau of Animal Genetic Resources' as 11$^{th}$ distinct breed of the nation. During princely rule, the Maharao of Kachchh declared Banni as a Rakhal (reserve grassland), where only milching cattle were allowed to graze. In spite of all its significance, Banni grassland is now facing severe degradation. Unfortunately, Banni is gradually losing capacity to sustain human and livestock populations. Main reasons for the degradation include increasing soil salinity, invasion of *Prosopis juliflora*, grazing pressures, water scarcity, climate change and desertification. The grassland belongs to all and responsibility of none. Bannis represent the largest stretches of contiguous grasslands in India.

**Sewan grasslands of Thar**: Smallest desert in the world - Besides over-grazing, expansion of agriculture, salinization due to wrong irrigation practices, the desert ecosystem is also being altered due to invasive species such as *Prosopis chilensis*. Tremendous changes in the avifaunal structure of the Thar desert are taking place due to the canal. Hence, scientific approach with community participation for rejuvenation needed now.

**Amrit Mahal Kavals** are livelihood-supporting, biodiversity-rich and ecologically-sensitive semi-arid grassland ecosystems of Karnataka which are dedicated for conservation of Amrit Mahal cattle. Amrit Mahal cattle are famous among world's heaviest breeds, resemble like gambling horses and have performed extreme hard work. Kavals were an extraordinarily well protected grassland ecosystem through the appointment of a Kavalgara (Kaval in Kannada means Kaval protector). Amrit Mahal Kavals are deeply connected with pastoral communities' culture and livelihood as well as it is habitat for flora, fauna including many endangered wild species. In all these Kavals, more importance has been given for the breed maintenance rather than improvement of grasslands. *Prosopis julifera* and other thorny plants have become invasive where livestock can't even enter and graze.

"***SHOLA***", an endemic and unique ecosystem, thrives at an elevation exceeding 1600 meters above mean sea level within the Western Ghats of India. This distinctive ecological system is confined to the southern regions of the Western Ghats, specifically inhabiting the high altitude mountain ranges of Kerala and Tamil Nadu. The term 'shola' is thought to originate from the Tamil word "solai," signifying 'thicket' or patches as these Shola ecosystems are dispersed in pockets across the Western Ghats. the Shola grasslands consist of different species of grass and mostly the following species are seen widely, *Chrysopogon zeylanicus, Cymbopogon flexuosus, Arundinella ciliata, Arundinella mesophylla, Arundinella tuberculata, Themeda tremula, Themeda triandra, Heteropogon spp., Garnotia elata, Ischaemum ciliare, Sehima nervosum etc.* Many endemic and threatened grass species like *Anthoxanthum borii*, *Tripogon pungens etc.* are found in these grasslands. The Shola ecosystem shows high endemism of flora and fauna and is one of the global biodiversity hotspots. The ecology of the Shola-grassland mosaic is remarkably species-rich, hosting an impressive diversity of over 1,200 plant species and a wide array of animal species. In shola ecosystem of Nilgiri hills, indigenous Toda buffalo rearing nomadic tribe Toda and other farming tribes like Bagada graze their cattle to sustain their livelihood. Toda tribals used to conserve and manage grassland using controlled fire to stimulate grassland biomass and by controlled grazing of buffalo. They used to worship and pray to sustain this vital ecosystem to sustain their livelihood. The Toda community is known for maintaining cleanliness around their hamlets. This practice reflects their deep respect for the environment and the belief that a clean and well-maintained habitat is essential for their well-being. The plantation of non-native species such as *Eucalyptus globulus* (blue gum), *Acacia mearnsii* (black wattle), tropical pines *etc.* and cash crops like tea, originally introduced during the British colonial period, has disrupted the ecosystem and displaced the native sholas and grasslands.

**Alpine and sub-alpine pastures in the North western Himalayan region;** This region is particularly endowed with rich grassland resources that are hugely vital in preserving fragile mountain ecosystems. Locally called as "Margs", "Bahks", "Neur",

and "Nyai", "Bugyals", these grasslands are diversified ecological systems that represent climatic climax vegetation that largely involves preponderance of herbaceous elements with varying proportions of tussock-forming grasses and sedges. Coinciding with the altitudinal location of grasslands, different livestock rearing systems aimed at utilizing grassland resources to fullest are prevalent in Kashmir valley. The most important include:

- **Sedentary systems**: Prevalent at lower altitudes (<2,000 m), the system involves flexible use of grasslands in and around village commons, low-land non-cultivable slopes, cultivable wasteland, and forest under canopy. However, with shrinking of common grazing grounds and disintegration of traditional institutions, the practice is now less common.
- **Semi-migratory systems**: This system involves hiring professional grazers (locally known as "pohul"/chopan) that collect livestock from low lying villages and drive them to sub-alpine and alpine grasslands during summer months and bring them back in autumn. Unlike the sedentary system, this is still common and aids greatly to economic and ecological stability of agro-pastoralists.
- **Migratory system**: Under this system, the people (mostly the nomads) who specialize in livestock production move from one area to another, along traditionally assigned routes and treks with well defined and fixed halts. This process is called as transhumance, and it is undertaken chiefly by Chopans, Gujjars, Gaddies, Changpas and Bakerwals. The process starts in early spring when these people move along with their herds across Himalayan region to high altitude pastures in Greater Himalayas and stay there till summer ends. Afterwards, they start moving back to lower foothills and stay in winter habitats on southern valleys and plains of Shiwalik hills.

**Korangadu**: Korangadu is a traditional heritage rich grazing land lying under the western agroclimatic zone of Tamil Nadu in the rain shadow of the Western Ghats. The Korangadu grasslands of the Kangayam region are spread over four districts *viz.*, Erode, Karur, Tiruppur and Coimbatore districts of Tamil Nadu state in south India, covering an area of approximately 3,841 sq km. The grassland is located between 77° 17" E and 77° 55" E longitude and 10° 44" N and 11° 03" N latitude. It exists in 500 villages over 50,000 ha. It is recognized by the Globally Important Agricultural Heritage System (GIAHS) as one of the agriculture heritage site. Erratic annual rainfall compels the rural population to solely depend on livestock for their livelihood sustenance. A literal translation of the term "Korangadu" from the local Tamil language is "left out uncultivated land that allows natural vegetation". The "Korangadu" which is a unique silvipasture grazing system is considered as the breeding tract of Kangayam cattle. The predominant vegetation grown in the grass land pasture is Kolukkattai grass

(*Cenchrus setigerus* and *Cenchrus ciliaris)* and Seppunerinji *(Indigofera enneaphylla)*. Apart from these grasses and weeds, common trees noticed are Velvel (*Acacia leucophloea*) Drumstick tree (*Moringa oleifera*), neem (*Azadirachta indica*) and palmyra (*Borassus flabellifer*).

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