



## **High Altitude Pasturelands of Kashmir Himalaya: Current Status, Issues and Future Strategies in a Changing Climatic Scenario**

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### **Authors' contributions**

*This work was carried out in collaboration between all authors. Authors SA and SSB analyzed the issue and designed the policy paper and wrote the first draft of the manuscript. Authors NHM and JPS made critical analysis of the subject and redesigned the improved draft. All authors managed the literature searches, read and approved the final manuscript.*

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### **ABSTRACT**

**Background:** Climate change mitigation and adaptation has become unavoidable globally and different land use management systems have to be managed accordingly on sustainable basis. In Jammu and Kashmir, livestock sector is emerging as important growth leverage to state economy and its share to gross state domestic product is also increasing. Census figures 2011 signify that about 73% of the population lives in rural areas and are associated with agriculture and allied sectors including livestock rearing as main occupation.

**Livestock Issues:** It is estimated that livestock and its derived foods and other products contributed about 6.13% to the GSDP in the year 2010-11. Grasslands produce forage for domestic livestock, which in turn support human livelihoods with meat, milk, wool, and leather products. Livestock sector engages sizeable number of working force not only in rearing of animals but also in processing, transportation and sale of the animal products. However, the productivity of livestock

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in this north western Himalayan region is low. There is no shortcut to sustain livestock husbandry, without focusing the issues related to the development of fodder and feed resources.

**Forage Factor:** Livestock production is more efficient from cultivated fodder than from the degraded grazing lands but unfortunately fodder cultivation has remained static and less than 4% arable land in J&K is devoted to fodder production. The major challenge is to bridge the gap between forage production and requirement. The state produces around 64 lakh MT of green fodder and 35 lakh MT of dry fodder. However the requirement of green is 139.13 lakh MT and dry is 58.53 lakh MT. Therefore, increased production of fodder is essential to meet the nutritional requirements of the livestock. Crop residues, tree leaf fodder and grazing from alpine and sub-alpine pastures, forests and other grazing lands form the bulk of animal feeding requirements in the state. The possibility of increased forage production by bringing additional area under fodder cultivation are limited and it is therefore, imperative that continuous efforts are made to enhance forage resource availability from high altitude pasturelands through scientific management.

**Future Strategies:** Despite having more than 75% of the total Himalayan alpine area in the state, the high grazing pressure and lack of adoption of any scientific management practices is resulting in their degradation which is adversely affecting the herbage production and in turn the livestock productivity. The production potential of these temperate grazing lands has shown a gradual decline on account of unrestricted grazing, infestation of weeds, presence of undesirable and unpalatable species and encroachment. These pastures are not at an optimum level of production. Maintaining a productive pastoral production system is dependent on sustainable and efficient management of grasslands. By sustainable practices, mitigation and adaptation of climate change can also be achieved in this sector.

*Keywords: High altitude pasturelands; Kashmir Himalaya; climate change; livestock; forage; management.*

## 1. INTRODUCTION

The Kashmir valley in the North Western Himalayan state of Jammu and Kashmir, with its serene and picturesque valleys, magnificent snow clad mountains, fresh water rivers and streams, lakes, meadows and dazzling forests, is aptly called as the paradise on earth. A unique feature of this mountainous state is the presence of alpine and sub-alpine pastures, locally known as *Margs* or *bahaks*. The term 'grassland' is synonymous with pastureland when referring to an imposed grazing-land ecosystem and is defined as, "Land (and the vegetation growing on it) devoted to the production of introduced or indigenous forage for harvest by grazing, cutting, or both". The vegetation of grassland in this context is broadly interpreted to include grasses, legumes and other forbs, and at times woody species may be present [1]. The alpine grasslands of Jammu and Kashmir account for 77% of the total alpine grassland area of 171464 km<sup>2</sup> of the Indian Himalaya [2]. These grasslands regarded as the outcome of forest regression and are characterized by a large number of herbaceous communities with varying proportions of tussock-forming grasses and sedges [3]. Besides being essential and integral to the animal husbandry sector of the state, the grasslands play a vital role as a storehouse of

various important medicinal plants. The use of the Himalayan grasslands for summer grazing by migratory and local herders and the role of pastoralism have been discussed and argued previously [4,5,6,7].

Grassland soils are a very significant store of carbon, with global carbon stocks estimated at about 343 Gt C, which is about 50 % more than the amount stored in forests globally [8]. In addition to the significant stocks of carbon, grasslands also contribute to climate change mitigation by sequestering additional carbon. It has been estimated that the soil organic carbon sequestration potential of the world's grasslands is 0.01–0.3 Gt C year<sup>-1</sup> [9]. Grazing land management and pasture improvement has been one of the options considered for global biophysical mitigation potential against climate change [10]. Of the total global mitigation potential of 5.5–6 Gt CO<sub>2</sub> equivalent per year, almost 1.5 Gt was related to grazing land management and pasture improvement.

Animal-rearing has its origin in the transition of cultures to settled farming communities from hunter-gatherer's lifestyle. Over the time, the collective behavior, life cycle, and physiology of livestock have changed radically. Livestock are domesticated animals raised in an agricultural

setting to produce commodities such as food, fiber etc. In Jammu and Kashmir livestock plays a crucial role at both at the household level as well as the state level for overall socio-economic development. This sector is emerging as important growth leverage to state economy and its share to gross state domestic product is also increasing. The economy of Jammu and Kashmir is still agriculture dependent and is the main occupation of majority of the rural people who earn their livelihood from it. Around 70 per cent of the population lives in rural areas and are associated with agriculture and its allied sectors including livestock rearing. The number of livestock units per 1000 human population in the state is 736 animals against the national average of 409 animals/1000 human population [11]. The estimated livestock population (excluding poultry) of the state is 92,00,842 which shares about 1.78 per cent of country's total livestock population. The density of livestock per sq. km of area is 98 animals against 90 animals recorded by 19<sup>th</sup> Livestock census, conducted in 2012, with sheep constituting the major share (36.84%), followed by cattle (30.41% and goat (21.93%), [12].

Beyond 3500 m altitude livestock rearing is the primary activity of sedentary and migratory populations. The livestock capital plays a crucial role, as an integral part of the age-old crop-livestock mixed farming system in the mountainous regions where livelihood options in the non-farm sectors are limited for the resource-poor hill peasantry. Pastoralists view livestock as symbols of wealth as animals provide milk, small-stock meat and wool and also provide security against unpredictable climatic conditions. They also rear indigenous animal breeds, retaining and maintaining rich genetic diversity. Besides livestock makes substantial contributions to conservation of environment by utilizing huge amount of crop residues and by-products as feed/fodder and by supplying draught power and dung. Animal husbandry, despite its much worth in the state's economic and social prosperity, has been a serious case of neglect. Although almost every aspect of livestock rearing has been experiencing inadequacies, however, feeding animals with adequate amount of quality fodder has been the immensely ignored front [13]. The main sources of herbage availability, in the state, for the livestock are the abundantly available grazing lands. Grazing lands mostly comprise sub-alpine and alpine pastures, forest openings and the demarcated forests. Agricultural crop residues

are also used extensively during winters to feed the livestock. At lower altitudes, conservation of tree leaf fodder for winters is a common practice. For centuries, pastoralists have moved their herds over the mountain passes to sub-tropical areas during the winter and to alpine pastures during the summer, in search of quality fodder for their animals [14].

There are a number of practices that could contribute to reduced greenhouse gas emissions and enhanced sinks in grazing lands. These include grazing intensity, grassland productivity improvement, proper nutrient management, checking fire hazards and fire management, and above all the management of biodiversity and species introduction.

Different aspects of grasslands and pastures of the state of Jammu and Kashmir are discussed as follows:

### **1.1 Forage Resource Availability, Utilization and Deficit**

The productivity and health of livestock mostly depends on feeding practices and the quality of feed and fodder provided to the animals. Limited land endowments make it difficult for the farmers to earmark adequate land for fodder and forage cultivation. The agro-climatic condition of the major portion of the state also warrants the need of cultivating even additional fodder that can be dried to hay or stored as silage for lean periods. The total fodder production of Jammu and Kashmir is 86.5 lakh tonnes of which green fodder contributes 61.4 and dry fodder 25.1 lakh tonnes 14. Crop residues, leaves and twigs, alpine, sub-alpine pastures and forests form the bulk of animal feeding requirements in the state. The area under fodder crops and pastures/grazing lands in the state is presented in Table 1 [15].

Despite the continued efforts of the concerned authorities to popularize and propagate high yielding fodder crops among the farmers on available arable and non-arable land. There are certain interesting features about traditional and popular feeding practices in rural Kashmir. The in-vogue feeding approaches are briefly described as follows:

1. The main cultivated fodder resource of the valley comprise cultivated oat. About 200

kg of Oat seed was introduced during Maharaja rule initially on horse farms and since then it has become the single most important fodder crop in the valley. It is grown on acreage of over 20,000 ha in the state and a wide range of varieties suitable for Kashmir Himalaya, are available now.

2. Migration of cattle is restricted to hill-slopes, grazing lands around human habitats whereas sheep and goat flocks migrate to far away distances and thrive on alpine pastures during May to September-October months. All species of livestock remain confined to basement sheds and are invariably stall-fed during severe winter months.
3. Rice straw, maize stover and grass/legume hay meets the bulk fodder requirements for stall-feeding. This is often supplemented with tree leaves. However, the approach does not take into account the nutritional quality of the residues and the same is often compromised.
4. Livestock owners face acute scarcity of feeds and fodders for their livestock, particularly during severe winter despite rich feeds and fodder resources available in the Kashmir valley.
5. Of late, the focus on horti-pastoral and silvo-pastoral systems has been gaining some momentum. These integrative systems, besides other advantages, may well augur the adequate availability of quality fodder and orchard floor management in fruit tree alleys.
6. Surplus fodders and grasses available in cultivated fields, forest lands and common property resources are harvested for hay making during summer months for feeding during lean period.
7. Concentrate feeding although limited is also in vogue and mostly well-off livestock owners' purchase wheat straw, feed pellets, bran and cakes for supplementation during lean months.
8. Fortification of fodders, silage making or feeding of mineral mixtures is not much prevalent.
9. Fodder bank establishment for fodder storage and transportation to more deficient areas during scarcity periods has not taken off substantially. Regional fodder deficits are more alarming than the overall deficit.

## 1.2 Grazing/Pasture Lands

The subalpine and alpine pastures of the Himalaya are unique biological entities utilized by sedentary and migratory graziers. These are long, flat, undulating or sloppy stretches of land covered predominantly with grasses. These pastures are utilized for the grazing of animals under various systems of animal rearing. The alpine pastures are located at higher altitudes hence their availability for grazing is limited to about 4-6 months in a year; during rest of the period these are covered with snow. Subalpine pastures, which are often surrounded by forests, are located at comparatively lower altitudes and are available for a longer time of grazing. Even approaches to the pastures pass through the forests and the herds stay and graze in these for quite some time before reaching the pastures. However, pastoralist systems in Jammu and Kashmir are under pressure. The pastures have been in an utter state of neglect and their carrying capacity has declined considerably.

**Table 1. Area (thousand ha) under fodder crops and pastures/grazing lands in J&K**

Year	Fodder crops	Permanent pastures and other grazing lands
2005-06	53	128
2007-08	61	126
2008-09	54	128
2009-10	52	120
2010-11	53	119

Limited agricultural land, severe climatic conditions and seasonal availability of resources have been the main reasons for migration of pastoral communities from one place to another [16]. From June to September, the pastoralists use the resources of the alpine pastures and in October they start their return journey to areas that are located at comparatively lower altitudes (1800 m). Their movement patterns from one place to another are guided by their traditional practices and local knowledge. At times they have to brave the vagaries of inclement weather. Five types of grasslands in the Himalaya have been identified [17], which are as as: warm temperate grasslands (1500-2500 m); cool temperate grassy slopes (2600-3300 m); sub-alpine meadows (3300-3700 m); alpine meadows (3700-4500 m); and steppe formations of trans-Himalaya (>4500 m).

### 1.3 Distinct Grazing Systems

The pastures and forests are utilized for grazing under following pasture production systems:

- I. Sedentary
- II. Semi migratory
- III. Migratory

The sedentary system of livestock rearing is practiced by the farmers living between an altitude of 1500 and 2500 m. In this zone all the cultivable land is utilized for cereal cultivation while the livestock is let loose in the forests and subalpine pastures for grazing. The grazing continues for about 8-10 months in a year. During peak winter months of December and January crop residues and conserved tree leaf fodder are fed to the livestock.

Semi migratory system of livestock rearing is practiced by the farmers living below 1500 m altitude. The farmers of this zone generally hire professional graziers who collect the livestock and take these to pastures and forests in sub-alpine and alpine zones during summer. The livestock is brought back during autumn and is stall fed on crop residues, grass/legume hay and tree leaf fodder during winter.

Migratory system is a typical example of transhumance. Under this system the livestock migrates continuously from one place to another in search of herbage and moderate climate. The migratory routes are well defined and also the grazing areas are demarcated for different groups of nomads. In Kashmir the nomads like Gujjars and Bakarwals have attained legal rights over these areas by way of usage. In Nepal the migration is in vertical succession according to different seasons and the upper limit of migration is 5000 m altitude [18]. In Kashmir, the migratory graziers stay in Jammu and in the plains of Punjab during winter and migrate to these alpine pastures and forests during summer. The upper most limit for migration is 4500 m.

## 2. PRESENT STATUS OF THE GRAZING LANDS

An area of 127,000 ha falls under alpine and sub alpine pastures in Kashmir Himalaya having a dominant grass cover. These permanent pastures are connected to lower altitudes by well-established paths known as migratory routes. The most common grasses found are *Agrostis spp.*, *Bothriochloa pertusa*,

*Chrysopogon gryllus*, *Cymbopogon spp.*, *Cynodon dactylon*, *Digitaria spp.*, *Festuca spp.*, *Poa spp.*, *Potentilla spp.*, *Dactylis glomerata*, *Lolium perenne*, *Bromus spp.* Besides, some legumes like *Trifolium pratense*, *T.repens*, *Lespedeza sericea*, *Medicago spp.* are also found in these permanent pastures. Vegetation studies undertaken reveal that biomass production of the pastures is much below than optimum potential. On an average biomass of pastures of chandanwari and Bari Bahak is 6.5 and 14.0 q per ha, respectively [19]. The sub-alpine and alpine pastures are available for about six months in a year for grazing. Soon after melting of snow, migratory flocks reach these pastures and graze the pioneer species which have not yet attained height of few centimeters. The downward movement of migratory flock starts in September and during this period the edible pasture grasses do not get time to thrive, set seeds and dispose. The undesired species which are not grazed get conducive conditions to thrive and set seeds. The high grazing pressure and lack of adoption of scientific management practices is resulting in their degradation which is adversely affecting the herbage production and in turn the livestock production. Maintaining a productive agro-pastoral system is dependent on sustainable and efficient management of grasslands. The production potential of these temperate grazing lands has shown a gradual decline on account of unrestricted grazing, infestation of weeds, undesirable and unpalatable species. These pastures are not at an optimum level of production. Lack of plant cover, steep slope, poor soil condition, low proportion of legumes, and presence of weeds, high grazing pressure and short growing season limit optimum herbage production. The continuous and heavy grazing of the pastures and forest-areas has lead to their deterioration to critical levels. Overgrazing has resulted in a depleted vegetation cover. Edible species of grasses and legumes have vanished and most of the pastures are predominantly covered with noxious weeds like *Stipa*, *Sambucus*, *Aconitum*, *Cincifuga*, *Adonis*, *Sibbaldia* etc. [20]. Besides grazing, other pressures like tourism, defense, biosphere and wildlife reserves, etc., have reduced the net pasture area considerably. In Kashmir Himalaya, pasture area of 0.143 and 0.064 ha per capita of livestock was available during 1972 in Kashmir and Jammu divisions respectively. This area got reduced to 0.103 and 0.034 ha per capita of livestock in Kashmir and Jammu respectively during 1982 [21]. Green herbage yield (Table 2) of 4.73 to 29.0 t/ha has

been observed in different alpine and sub-alpine pastures of Kashmir [20]. It has been reported that dry matter herbage yield ranged from 1.41 to 6.23 t/ha from temperate pastures of north-western Himalayas [22], while as the crude protein varying from 8.3 to 17.8% in different grasses of temperate and alpine region of Kashmir [23]. Himalayan alpine vegetation communities retain high ecological significance, because they control soil stability of their catchment areas, play a major role in ecosystem functioning, and are vital in cultural, ethical and aesthetic aspects [24]. The alpiners are characterized by low productivity, high intensity of solar radiation, and high degree of resource seasonality because of high ultraviolet (UV) radiation, high wind velocity, blizzards, low temperature and snowstorms [25]. Himalayan pastures have been grazed intensely for centuries [26]. Available grazing area in subalpine and alpine pastures of Kashmir decreased from 0.15 ha/animal in 1977 to 0.10 ha/ animal in 1982 [27] and continued to decrease thereafter [28]. Similarly in the north western Himalayan state of Himachal Pradesh, the average grazing pressure and grazing intensity in the state were 1.26 ACU/ha and 0.79 ha/ACU respectively [29].

The area under permanent pastures and other grazing lands has remained stagnant over the years, which is a cause of concern to planners due to increasing demand for grasses and fodder

for livestock. In the area under miscellaneous tree crops, the compound growth rates (1.55) have revealed a significant declining trend. This decline might be due to a shift of this land towards non-agricultural uses. The land under permanent pastures and miscellaneous tree crops significantly contribute to the village economy and ecology and is quite vulnerable to demand for non agricultural uses. Hence, the declining trends in both these land-use classes need to be checked [30]. The productivity and stocking capacity of Himalayan meadows and grasslands have been presented in Table 2.

The present stocking capacity ranges between 0.6 and 13.3 sheep/ha/year. The grazing pressure on forests has also increased and it has resulted in large scale destruction of vegetation and the forest cover. The agricultural activities like shifting cultivation, etc., have also reduced the forest cover considerably. According to a survey conducted by the Forest Survey of India during 1993 forest areas measuring 257, 75, 603, 75 and 29 2sq.km were lost in the states of Assam, Arunachal Pradesh, Manipur, Meghalaya and Mizoram, respectively [31]. The Productivity and stocking capacity of certain cold climate grasslands and meadows of central Himalaya is presented in Table 3. The uncontrolled heavy seasonal grazing is one of the major causes of degradation and retrogression of these pastures. The pasture deterioration is proceeding unchecked as

**Table 2. Peak Biomass availability from sub-alpine and alpine pastures of Kashmir Himalaya [20,32]**

Site	Altitude(m)	Green herbage(t/ha)
Daksum	2,500	29.1
Drobmarg	3,200	10.8
Dachigam	1,900	20.5
Dagwan	3,400	14.0
Gaobal	2,000	10.3
Gaomarg	3,000	14.7
Kralpathri	2,500	14.6

**Table 3. Productivity and stocking capacity of certain cold climate grasslands and meadows of central Himalaya [33]**

Grassland/Meadow	Productivity (t/yr/ha)	Stocking capacity (sheep/ha/yr)
Alpine steppe	0.7-1.0	0.4-0.6
Meadows	1.0-4.0	1.0-2.0
Alpine meadows	2.4-5.3	7.0-13.3
Cold grasslands	0.7-1.5	1.3-1.9
Temperate grasslands	0.5-3.0	0.6-2.0

no technical inputs are being provided by any agency. There is need to reverse the degradation processes and to improve these pastures according to their potential productivity.

## 2.1 Issues Faced by Pastoralists

1. The main constraint of pastoralists is the lack of land for pasture, which is related to their restrictions and in some cases legal exemption from land ownership. Exclusion from the use of scarce common property resource owing to increased competition.
2. Deterioration of natural pastures due to no protection and hence easy access leading to continuous misuse, indiscriminate cutting and grazing, overstocking, proliferation of noxious and poisonous weeds.
3. Shrinkage of village pastures previously ear-marked for grazing of livestock locally known as "Gass charai" due to population pressure through constructions viz; illegal encroachments. Shrinkage of cultivable land under fodders due to pressure on agricultural land for food and cash crops.
4. Failure to produce fodder crop seeds by private/ public agencies. Lack of large-scale dissemination of improved fodder production technology.
5. The continuing decline of water and pasture resources and increasing human population and livestock have led to strong pressure on natural resources gradually destroying the complementarity and coexistence between agricultural activities and livestock.
6. In summer when pastoralists move to alpine pastures, conflicts arise as they move through protected/reserved forests and National Parks/wildlife sanctuaries prohibited for grazing.
7. Lack of organization between pastoral communities on account of transhumance which limits their ability to bargain or negotiate with other institutions and their involvement in the policy process.
8. Pastoralists have received much less attention in comparison with other social groups from the governments and other institutions. There is a lack of any specific national or state policy for the sustainable development of pastoral communities.
9. Pastoralists still rely on age old traditional medical means for treatment of livestock. There are no satisfactory facilities available

in the far off villages let alone high altitude pastures.

## 2.2 Strategies for Future Development

1. Fodder development: There is an urgent need to explore opportunities for adoption of cultivated fodder crops. The fact that efficient livestock production is possible with cultivated fodders can never be undermined. Cultivation of fodder crops ensures availability of adequate quantities of good quality fodder to supplement and compliment the feeding strategies already in practice. The cultivation of annual/perennial grasses and legumes that can prove to be remunerative in the region include *Avena sativa*, *Vigna spp.*, *Medicago sativa*, *Trifolium alexandrinum*, *Dactylis glomerata*, *Festuca arundinacea*, *Phalaris aquatica*, *Phalaris tuberosa*, *Phleum pratense*, *Bromus unioloides*, *Festuca rubra*, *Lolium perenne*, *Trifolium repens*, *Trifolium pratense*, *Onobrychis viciifolia* etc.
2. Scientifically organized grassland restoration: Scientific intervention is a must for the sustainability of grazing lands. The scientific plan should start with an assessment of current situation and delineation of areas needing intervention. The different interventions involved may be removal of unwanted and non-palatable species, protection of the area from grazing during restoration period, reseeding of the pastures and establishment of silvopastoral systems. The average dry matter yield of both native and exotic grasses varies considerably from 2.5 t/ha in *Agrostis* spp. to 10.0 t/ha in *Dactylis glomerata* [34]. The grasses, legumes and tree species best suited to the location need to be identified and incorporated. The selection of the species should be based on regional adaptability and animal preference.
3. Grazing management: there is an urgent need for scientific management of grasslands and establishment of locality specific grassland management practices involving pastorals in a participatory mode. The grazing and rangelands in India are largely maintained as common property resources. Over grazing and higher grazing pressure owing to free access have resulted in the detrimental changes to the botanical composition of the pasture

lands. Due to continuous and over grazing, the most relished and palatable species are continuously grazed leaving behind non-palatable species like *Anthemis cotula*, *Xanthium spinosum*, *Cirsium arvense*, *Conium maculatum*, *Carduus nutans* etc. Four types of grazing are practiced namely continuous grazing, deferred grazing, rotational grazing and deferred rotational grazing. In the continuous, pasture area is grazed continuously and animals wander through whole area. Long continuous grazing ultimately leads to the depletion and disappearance of highly palatable species. 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 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 seed formation and these un-grazed paddocks are changed every year to allow good seed bank in the soil in the entire area. There is 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.

4. Stakeholder participation and institutional support: The involvement and participation of pastoral community is a pre-requisite while initiating any programmes to revitalize the grasslands. Adequate institutional and individual support is needed and must be provided for the protection and rejuvenation of the grazing areas. There must be consolidation of a sustainable social peace through the joint management of pasture resources based on local agreements known and respected by all.
5. A secure movement of herds during their seasonal migration through a participatory approach of management of pastures. Reduced risk of conflicts linked to the transhumance of herds and their sojourn at the alpine pastures. Pasture development along nomadic routes may also be encouraged.
6. Feed and fodder availability can be increased by utilizing improved varieties, development of common property

resources (CPRs) and barren lands and better knowhow regarding fodder production and their preservation. The scarcity of fodders can also be taken care of by providing effective fodder banks, utilization of non-conventional feed resources and feed and mineral block technologies and make the nutritious fodder available during the lean period.

7. Besides these, the wastage of fodder has to be reduced to bridge the gap between the demand and supply of fodder for the livestock. Strategies have to be developed to preserve fodder for up to 1-2 years to save the livestock from any natural disaster.

### 3. CONCLUSIONS

The livelihood of the pastorals depends on livestock farming. The acute shortage of pasturing are compelling the pastoralists to abandon the traditional systems of agriculture and forced to engage on alternative options of livelihoods such as tourism and work as a seasonal labourers and/or migrate to other areas. The deteriorating situations of the high altitude pastures have created depletion of environment conservation, loss of biodiversity, threat to the rare wildlife and affect on major watershed areas of the state. The absence of pasture management and grazing policy at national/ state level have rendered the pasture lands, including village commons and unculturable wastes, open to developmental, societal and grazing pressures. Immediate attention is needed to improve the pasture production, productivity and conservation of native animals in the Himalayan region of Jammu and Kashmir with strong people's participation. Global warming is a major concern and is predicted to affect all ecosystems and human livelihoods, particularly in the developing world. In the grasslands, this may change the length and timing of the growing season and the amount and seasonal pattern of precipitation. Although pastoral societies have made a minimal contribution to the global warming process, they are likely to be seriously affected by it. Mitigation and adaptation to Climate change in the state can be well contributed through sustainable management of the grasslands. Else, the traditional practices would lead to unsustainable livestock rearing and degradation of grasslands and pastures and emission of more and more greenhouse gases. There are substantial and diverse opportunities that arise with management



practices that lead to carbon sequestration in grasslands. In addition to enhancing forage production and food security, many land management practices that sequester carbon prompt other changes in environmental processes that are beneficial for other reasons. Practices that increase vegetation cover will increase inputs of organic matter into grassland soils, and reduce soil respiration, thus sequestering carbon in the soil. With the growing appreciation about the role of local communities in the management of natural resources, the grazing land management also needs to be undertaken in collaboration with the local communities. Presently research has been mainly conducted on cultivation of green fodder in irrigated areas but focus has to be given to management of pasturelands as well through participatory approach (involving pastorals). There is a need to evolve area specific grazing plans in a participatory manner involving the local and migratory graziers, animal husbandry department, tourism department, forest department, agriculture department, sheep husbandry so that some of the heavily degraded grazing lands could be brought under a recovery plan.

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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