PROBLEMS AND PROSPECTS OF FORAGE PRODUCTION AND UTILIZATION OF INDIAN HIMALAYA

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INTRODUCTION

The Himalaya exhibit a great diversity in climate, landforms, ethnicity, resource availability and agricultural practices. The great mountain chain covers about 13% of geographical area in India. It starts from Nanga Parbat (8126 m above m.s.l) in north-west and passes through Pakistan, India (Kashmir, Himachal Pradesh, Garhwal, Kumaon, Sikkim and Arunachal Pradesh), Nepal and Bhutan and ends in Namche Barwa (7842 m) in the East (Ahluwalia and Gerner, 1985). Remunerative agriculture in the form of double cropping is practiced up to an elevation of 1000 m only; beyond this altitude, the uncertainty of climate and steep slopes have restricted the agricultural activities, mainly to livestock husbandry.

Livestock rearing plays a significant role in the economy of the Himalayan people. Grasslands are the major feed resource for this activity. Climatic, topography, physiographic factors, altitude and related aspects have influenced the distribution of various grass species, which determine the grassland production both qualitatively and quantitatively (Whyte, 1968). Except the high altitude grasslands located in the areas beyond 3000 m elevation, the grasslands in mid and low elevations represent a range of successional stages and thus can be named as sub-climax or disclimax entities (Melkania, 1995). Though livestock rearing is an important occupation of farmers in the area, the forage cultivation has remained almost neglected. Grazing in the forest areas and sub-alpine and alpine pastures is the mainstay for the animals. Fodder trees and shrubs also contribute significantly. The natural resources of the Himalaya have been exploited for centuries in an unplanned manner leading to degradation all along. Reckless cutting of trees, indiscriminate use of grazing areas and absence of rehabilitation programmes has lead to denudation of hill slopes, which has resulted in critically low biomass availability and adverse effects on livestock production. Consequently the livestock productivity is very low and all the Himalayan states have to import various livestock products from the plains. This paper describes the present status of forage production, major constraints and future strategies for the development of this resource to ensure sustainable livestock production.

PRESENT STATUS OF THE FORAGE PRODUCTION

The Himalayan forage resource base has undergone a considerable neglect at the hands of researchers, planners and the development agencies. Misri (1988) studied the biomass availability of some of the representative pastures of Kashmir Himalaya and found that green herbage availability varied from 4.7 to 29.1 t/ha. In Himachal Pradesh the green herbage availability varied from 1.5 to 1.74 t/ha in temperate pastures and 0.5 to 1.0 t/ha in alpine and sub-alpine pastures (Singh, 1995). Ram and Singh (1994) observed that biomass availability varied from 1.62 to 3.96 t/ha (green herbage) in Himalayan pasture of Uttar Pradesh).

Tincheng and Yuangang (1989) reported the stocking capacity of central Himalayan pastures between 0.4 and 13.3 sheep/ha/annum under natural vegetation in alpine steppe, meadows and alpine meadows. In cold and temperate grasslands of semi-natural grasslands the stocking capacity varied from 0.6 to 1.9 sheep/ha/annum. Melkania and Singh (1989) have estimated that net above ground biomass varied from 279 to 1568 gm^{-2} for low elevation Himalaya, 219 to 285 gm^{-2} for mid elevation Himalaya and 233-372 gm^{-2} for high elevation Himalaya.

Forage cultivation is restricted to only about one per cent of the cultivated area in the entire Himalayan region. This is basically because of the preponderance of marginal and small land holdings in the area. Besides grazing and fodder trees, the major local forage resource is the crop residue, which again is too

inadequate to sustain the livestock. In the state like Himachal Pradesh there exists a gap of about 35.0 and 57.0% from dry and green forages, respectively. Every year on an average about 7450 t of wheat straw is imported annually from the neighboring states. (Vashist *et al*., 2000).

CONSTRAINTS

The Himalayan region of India is presently under heavy stress on account of a large-scale exploitation for fuelwood, timber and fodder, mismanagement of forest resources and frequent fires (Khosla and Toky, 1985). There is acute shortage of fodder especially green nutritious fodder, which is the major cause of low productivity of the livestock, especially in hilly area (Deb Roy *et al*., 1989). The main reasons for low productivity is insufficient and low quality fodder and feed including grazing facilities (Deb Roy, 1993). The shortage of fodder supply in the Himalayan region is attributed to some of the following reasons.

i) Less area under fodder crops

In Himalaya, all the available cultivated land has come into being after massive deforestation and creation of terraces. The division of the families has further fragmented the land. At present land holdings are very small and the farmer is always biased in the choice of the crops. Due to these reasons agricultural land ratio does not permit diversion of land from food production to cultivated fodder. Thus the area under fodder crops is meager and is not more than one per cent of the total cultivated land.

ii) Uncontrolled grazing

Grazing pattern of Himalayan tract clearly indicates a heavy grazing pressure on pasture. This has led to a decline in biomass availability. The grazing pattern has created manifold problems in these pastures. All the three vertical divisions of the Himalaya are under heavy and indiscriminate grazing. The outer hills are used for the grazing of local livestock and migratory livestock graze here for about six months. The mid-hill grasslands are protected only for about two to three months during monsoon and are grazed during rest of the year. Sub-alpine and alpine pastures of higher Himalaya are grazed from April to October, which is the active period for growth of vegetation; during rest of the year these are covered with snow. The edible species do not get time to grow, set seed and proliferate. Obnoxious weeds have invaded the pastures. Excessive and continuous grazing has severely damaged these lands. The herbage species found in these lands represent the third or fourth stage of degradation.

iii) Poor Management Practices

The management practices play an important role in determining the productivity of grasslands, yet this has been the last priority of the farmers in the Himalayan region. Presence of inferior and unproductive grass species, lack of fertilization, absence of legume component, improper cutting and indiscriminate grazing are some of the factors responsible for poor productivity of the grasslands. There exists a wealth of indigenous knowledge for the proper utilization and management of the natural resource base but the farmers because of increasing population pressure and declining land productivity are not using it.

iv) Heavy livestock population

Livestock is the integral component of Indian agriculture, since time immemorial and its contribution to national economy through milk, meat, wool as well as farmyard manure (FYM) is enormous. We have approximately 20% of world's cattle, 50% of buffaloes, more than 120 million goats and 60 million sheep (Deb Roy, 1993). Due to religious belief the population of unproductive cattle is increasing. This huge population and poor fodder availability has widened the gap between demand and supply of forage crops. Moore (1974) maintained that considerable fodder resources were wasted on the maintenance of an excessive number of poorly fed and low yielding animals, which contributed to the process of pasture destruction.

v) Fodder tree use

Tree flora of Indian sub-continent is one of the richest on this globe. The Himalaya support about 84 trees and 40 shrubs of fodder value, yet not more than 20 trees are extensively used by the farmers (Misri,

1997). Tree leaf fodder is the major feed resource during lean periods, particularly the winters. The tree leaf fodder provides 50-90% of the forage demand during lean periods (Negi, 1977). The over exploitation and unscientific management of fodder trees has depleted this resource at huge environmental cost.

STRATEGIES

Keeping in view the constraints in fodder production and in order to overcome the gap between demand and supply, the emphasis need to be given on several steps for augmenting the fodder production. Existing resource utilization pattern needs to be studied in totality according to a system approach. Fodder production is a component of the farming system and efforts need to be made for increasing the forage production in a farming system approach. The holistic approach of integrated resource management will be based on maintaining the fragile balance between productivity functions and conservation practices for ecological sustainability. The strategies for improvement and conservation of Himalayan resources particularly the forage resources will have to be dictated by actual customers-the native inhabitants of the region. Some of the scientific interventions, which could help in improving the productivity of forages, are described here.

(A) Agronomic management

The herbage production from grasslands and meadows can be enhanced with the adoption of improved technology. Important components of this technology are:

(a) Control of bushes and weeds
(b) Pasture establishment
(c) Introduction of legumes/grasses
(d) Fertilizer application
(e) Cutting and grazing management

(a) Control of bushes and weeds

The bushes and noxious weeds and poor quality grasses may offer severe competition for light and nutrients. The most common obnoxious weeds of the Himalayan grasslands are *Lantana, Ageratum, Eupatorium etc*. These weeds can be controlled by cutting and stems treated with herbicides to prevent regrowth. The herbicides like Weedon 64, Picloram, Paraquat and Glyphosate *etc* @ 1.0-2.0 Kg/ha could be applied around the bush. Sood and Singh (1986) have found that paraquat spray in the 15 cm band @ 0.6 lt./ha reduced the weed incidence in the grasslands and the fresh herbage yield increased by 26.8%.

(b) Pasture establishment

The successful establishment of a pasture requires more skill and care, as compared to other crops. The method of introduction of improved grasses and legumes in the natural grasslands should be cost effective with minimum soil working. The following methods of establishment could be considered.

(i) Scratching or pitting

Singh (1995) found that planting Nandi grass and Guinea grass in circular pits was superior over local practice. Similarly Sood and Kumar (1995) has found that pit method of introduction is superior to scrapping.

(ii) Hoof and teeth method

The pasture could be heavily grazed; followed by throwing seeds, then allowing the animals to trample the area when soil is wet.

(c) Introduction of legumes/grasses

Forage legumes are important because they enrich the N content of the soil and have a high nutritive value. Legumes can be grown in mixtures with grasses in grasslands. They supply associated grasses with nitrogen and thereby contribute to the conservation of energy by reducing the need for N fertilization. By

introduction of legumes the quantity as well as quality of herbage production can be substantially increased. Among the legumes, Siratro (*Macroptelium atropurpureum*), *Stylosanthes hamata, S. scabra, Glycine javanica, Dolichos auxilaris, Desmodium spp and Centrosema pubescens etc*. have shown good performance (Melkania, 1995). Indigenous legumes such as clovers (*Trfolium pratens, T. repens)*, *Medicago denticulata*, *Melilotus alba*, white clover var. Ladino and Lousiana and red clover var. Montgomery have proved successful in Kashmir valley apart from Lucerne (*Medicago sativa* cv. T- 9, and Hunter river) and berseem (Gupta, 1977). Legumes and grass species can be introduced during July by seeding and tussock planting, respectively. A combination of *Siratro* has been found quite successful for the mid altitude region (Melkania, 1987). The herbage yield and nutritive value of the hay from grasses-legume mixtures were found five and two times higher, respectively than the hay of local species. It is essential that during the first year of seeding/tussock planting, grazing is restricted in treated sites and the grass cutting is done carefully to help the establishment of introduced fodder species.

Some of the grasses; *Cenchrus ciliaris, Dactylis glomerata, Dicanthium annulatum, Festuca sp., Lolium sp., Pennisetum pedicellatum, etc.* and legumes; *Desmodium intortum*, *Dolichos lablab, Phaseolus artopurpureus, Stylosanthes humilis, Trifolium sp. etc.* have been found adapted to different agro-climatic regions of Indian Himalaya (Shastry and Patnaik, 1990).

Legumes introduced in the pastures generally do not establish well due to ineffective nodulation. Hazra (1998) observed that the *Rhizobium* inoculation of the pasture legumes provides synergistic effect for better establishment and obtained 59% and 72% higher green and dry herbage yield as compared to control.

(d) Fertilizer management

The present poor production potential of pastures could also be attributed to poor fertility of soils. To raise the fertility status and rectify the deficiencies, soil testing coupled with field trials need to be conducted to work out the fertilizer requirement of different pastures. Generally, no fertilizer is added to rangelands except the dropped excreta by animals. Judicious use of fertilizer for pasture can boost the vegetative growth and is also economically feasible. Application of nitrogen fertilizer must be given in split doses for better utilization, whereas phosphorus and potash should be supplied as basal dose in case of grasses. In legumes the full dose of nitrogen, phosphorus and potash should be given as a basal dose in furrows or by broadcasting at the time of sowing. Dogra *et al.* (1997) found 120 Kg N/ha and 40 Kg P/ha as the most economical dose. Herbage yield increased significantly with the application of nitrogen @ 60 Kg/ha and phosphorus @30 Kg/ha (Sood and Sharma, 1996). Nitrogen @ 40 kg/ha and Phosphorus @ 30 Kg/ha applied as basal and two splits (onset of Monsoon and 45 days after first application) in natural grassland increased the forage yield significantly. Two splits were significantly superior to single application (Singh, 1995). The experiments on N and P requirement in Himachal Pradesh reveal that application of 80 Kg/ha each of nitrogen and phosphorus was found to be the best (Sood and Bhandari, 1992).

(e) Cutting and grazing management

The response to cutting of a forage plant depends upon its seasonal yield of carbohydrate storage, its growth habit and extent of inflorescence development. Frequency of cutting also significantly influences the yield and quality of herbage produced. The areas with high temperatures may require larger interval and low intensity of cutting to build up sufficient carbohydrate storage for regrowth. Singh *et al*. (1993_b) concluded that tall fescue (*Festuca arundinacea*) produced highest dry matter, when it was cut at 30 days interval during second year. Cutting grasses twice from natural grasslands recorded higher fresh forage yield (14.54 t/ha)than one cut (12.08 t/ha) and three cuts(13.30 t/ha). The crude protein content was higher with two cuts compared to one cut (Kaul and Sood, 1986). Studies undertaken by Singh (1995) on cutting management of grasslands suggest that the herbage biomass yields can be doubled if harvested twice during July – October.

The Himalayan grasslands experience intense grazing pressure on account of being the prime source of forage. Grazing contributes more than 50% of the herbage requirement for sedentary and semi-migratory flocks,

while for migratory flocks 100% herbage is provided by grazing. Controlling the time, duration and intensity of grazing appears to be the key factors in grazing management. Periods of rest allow grazed perennials to replenish leaf area, seed set and store food reserves in their roots (Merrill, 1983; Adams *et al*., 1991). Continuous or too frequent access by large numbers of cattle to the same range impedes the ability of new growth to store food. The grazing can lead to the disappearance of nutritive species and infestation by less palatable species and weeds. Deferred rotational grazing system was found superior in *Sehima* dominated grasslands (Upadhyaya *et al*., 1971), resulting in greater number of animal days as compared to continuous approach. Rotational grazing has steadily gained the popularity in last two decades, because it offers better control over livestock distribution and feeding pattern with goals of periodically resting vegetation (Adams *et al*., 1991).

(B) Growing of fodder crops and fodder trees

For augmenting fodder availability, emphasis needs to be given to cultivated fodder crops on large area. Important fodder crops of temperate region are; *Avena sativa, Brassica sp., Medicago sativa, Pisum sativum etc*. (Singh, 1987).

Foliage of fodder trees could be fed to the livestock in mixture with crop residues and hay. Mixing of tree foliage with dry roughage improves their palatability and nutritive value. Shankar and Singh (1997) and Singh (1982) have suggested the different fodder trees for sub-tropical Himalaya and sub-temperate Himalaya.

(C) Silvipastoral System

Silvipasture implies sustained and combined management of the same land for herbaceous fodder, top feeds and fuelwood, thereby leading to optimization of production. The Himalayan rangelands exhibited enormous gain in forage production over existing situation due to multi-tier silvipasture techniques amalgamated with an adaptable complementary plant species. Silvipastoral systems are the most important for increasing fodder production from the marginal, sub-marginal and other wastelands, which comprise about 50% of the total land area. It involves planting of multipurpose trees in the existing pastures/grazing lands or planting such trees on wasteland/denuded lands followed by sowing /planting of grasses and or legumes in between the inter-spaces of trees. Atul (1996) obtained 5-7 t/ha green fodder under silvipastoral system, where as it was only 3-4 t/ha with out a tree component. Sharma and Koranne (1988) found that maximum production of 300 g/m^2/annum under the existing grasslands, while under modified network of silvipastoral system of *Digitaria decumbens* + *Bauhinia pupurea/Quercus incana/Grewia optiva/Celtis australis* the production varied from 1800-2450 g/m^2/annum.

(D) Agrisilvipastoral system

Under the agrisilvicultural system multipurpose trees (MPTs) including fodder cum fuel trees can be grown in association with crops. Trees are pruned annually, yielding fodder as well as fuelwood. In addition to annual pruning, few trees are also cut down in order to allow light penetration and minimization of competition with the crops. Under alley cropping system MPTs like *Leucaena leucocephala* and even perennial pigeon pea *etc*. are pruned frequently to provide leaf fodder to get better crop production.

(E) Agrighorti-silvicultural system

Under this system besides growing fruit trees and fodder crops, fast growing NFTs like *Leucaena leucocephala* can be lopped two to three times in a year to provide fodder (2.5-3.0 t/ha) and fuelwood (1.8-2.5 t/ha). These fodder trees also provide some protection to the fruit trees during summer and cold winters.

(F) Hortipastoral system

In this system forage are grown in wide inter-row spaces of fruit trees for economic utilization of orchard lands. Hortipasture up to an elevation of 2000 m is catching up with the orchadist. Forage from hortipasture is consumed fresh and is also conserved as hay for winters. Sharma and Jindal (1989) found that the introduction of *Fescue* in apple orchard gave 83.5% higher fodder yield over local grasses in Shimla hills of

Himachal Pradesh.

There is considerable area under orchards in temperate regions. Inter spaces between fruit trees could be utilized for the production of fodder by growing perennial grasses and legumes. In U.P hills (Singh, 1995) reported that rye grass and orchard grass are the best perennial grasses for introduction in apple orchards. Soil N build up was maximum with white clover introduction.

(G) Forage production in various land use systems

Singh *et al*. (1193_a) has recommended various interventions that may find place under different land use systems and has also reported their potential to produce green forage from experimental findings.

(H) Forage production on terrace risers or bunds

A non- competitive land use systems for forage production in the hills is to grow forage on terrace bunds and risers (Singh *et al*., 1993_a). Forage grasses/legumes/fodder trees grown on terrrace risers and bunds arrest the nutrient loss in run off water under high rainfall conditions of this region. This gives an added advantage to produce forage with out any fertilizer or manure.

FUTURE THRUST

- Forage production must be taken up as a first management goal and 25% of the forest area should be put under trees with regulated accessibility to the farmers.
- Growing forage grasses and fodder trees along village roads and panchayat lands
- Growing forage grasses and fodder trees on terrace risers/bunds- a non competitive land use system
- Conservation of native biodiversity for future improvement
- Breeding biotic, abiotic, stress tolerant cultivars of forage species suitable for area not used under arable agriculture
- Participatory techniques to be adopted to identify the problems and to carry out the improvement programme
- In-depth studies on migratory graziers
- Forage based agroforestry systems
- Controlled grazing to maintain the productivity of pasture (grazing should be allowed as per carrying capacity)

CONCLUSIONS

It may be concluded that the forage production situation in the region is very alarming and corrective measures have to be taken to improve the same. Delineation of the area for various agricultural activities should be created and adhered under legislation. A comprehensive grazing policy needs to be formulated for the entire zone. Both grazing and forage cultivation has to be considered complementary to each other and simultaneous efforts are required to improve the both. Fodder tree improvement programmes for higher leaf fodder have to be initiated. In order to improve the grasslands, the grassland management needs to be considered holistically promoting the interaction between grassland, livestock and the grazing communities, so that this vast natural resource can serve human society substantially, more particularly grazing communities of the region.

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