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Review

Sustaining life and livelihood: A case study of Askote conservation landscape, Central Himalaya

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The Askote conservation landscape, located in eastern Kumaun, State of Uttarakhand, represents an enlarged version of the Askote Wildlife Sanctuary, encompassing within, minor landscape, which is part of the adjoining Nanda Devi Biosphere Reserve. Of a total land area of 4,463 km^2, about 103 km^2 or just 2.31% of the area is cultivated land. The present study however, confines itself to the summer habitations of the Bhotiya community lying within the valleys-Darma, Vyas and Johaar, and delves into the factors that sustain the very livelihood of the stakeholders. Trade with Tibet was the prime occupation of Joharis and Darmis until 1962, when the Sino-Indian war brought an immediate end to this thriving lifeline. The concomitant loss of trade brought about drastic changes in the transhumant lifestyle- (i) fewer households arriving at their summer homes, (ii) a smaller livestock population, (iii) disappearance of traditional handicrafts, and (iv) increased exploitation of wild medicinal and aromatic plants (MAPs), with traditional crops being replaced by more remunerative crops such as chives (*Allium stracheyi*) and caraway (*Carum carvi*), among others. The present study is an attempt to highlight the causal factors behind changes in the lifestyles of these traditional people, as described above, and concludes with proposals for possible alternatives for a sustainable future for these people.

Key words: Agro-biodiversity, biodiversity, grazing pressure, livestock population, medicinal and aromatic plants (MAPs), transhumance.

INTRODUCTION

Askote conservation landscape

The Askote conservation landscape is located in eastern Kumaun, in the state of Uttarakhand, and lies between the coordinates 80°15′ to 81°5′ E longitude and 29°5′ to 30°32′ N latitude, and is bounded by the international border with the Tibetan Autonomous region of the Peoples' Republic of China in the north. The Kali River forms the boundary in the South-East of the landscape till Jauljibi, which also constitutes the border of India with the Kingdom of Nepal (Figure 1). Encompassing an area of 4463 km^2, the entire project landscape is about 120 km long and in average, about 51.5 km wide. There is a great altitudinal range within the landscape, from 560 m amsl at Jauljibi, to 7434 m at the summit of Nandadevi East, and constitutes the Centrum of the bio-geographic elements of the Western Himalaya, the Central Himalaya and the Tibetan Plateau (Negi, 1010). As a result, the landscape is biodiversity rich, containing reportedly 2607 species of vascular plants, 265 species of birds and 37 of mammals. The landscape contains 129 revenue villages spread from sub-tropical to alpine altitude zone, falling within the Dharchula and Munsiari Tehsils.

The altitude frequency within the landscape is as follows: 12 per cent of the villages lie in the sub-tropical altitudes, 55% in the warm temperate, 18% in the cold temperate, 7% in the sub-alpine and 8% in the alpine zone. Overall population density for the landscape is 21 people/km^2 and the per capita availability of agriculture land in the landscape is 0.13 ha (Table 1). Permanent human habitations occupy the lower altitudes, up to the temperate zone, which are densely populated. In comparison, there are only a few settlements in the cold-temperate area and villages in the alpine zone are only

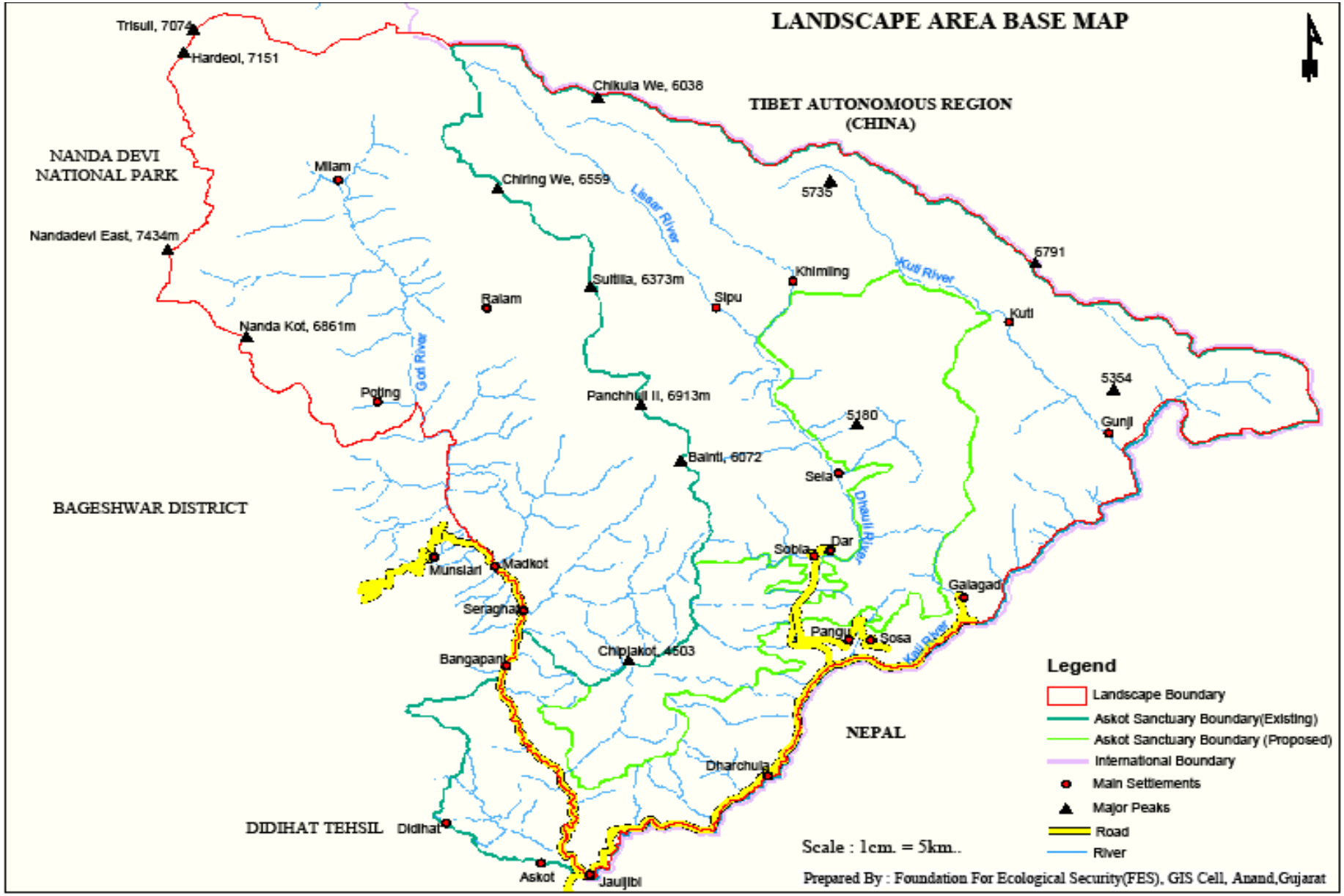

Figure 1. The Askote Conservation Landscape.

Table 1. Land use across the altitudinal gradient in the landscape.

Land use area (Sqkm)	< 1200 Sub-tropical	1200 - 2200 Warm-temperate	2200 - 3000 Cold- temperate	3000 - 3500 Sub-alpine	3500 - 5500 Alpine	> 5500 Nival
Agriculture land	16.26	60.12	16.06	10.11	0.38	0.00
Civil & Soyam	22.24	104.95	169.70	175.29	1320.99	227.27
Van Panchayat	18.31	112.13	127.14	111.40	1424.51	276.55
Reserve forests	8.53	51.88	110.34	59.91	35.73	0.00
Total	65.35	329.07	423.23	356.72	2781.61	503.82

seasonally occupied, and form part of the transhumant land use practices common in high mountain areas. The landscape being described renders little land suitable for agriculture. Of a total land area of about 4,463 km^2, only about 103 km^2 or just 2.31% of the area is cultivated land. For about 68,939 people in 14,010 households, who live in 129 villages in the landscape, highly fragmented holdings, this 2.31% of land do not suffice even for subsistence. An estimation of the proportion of food grain produced locally in 80 villages in the Gori basin indicate that only close to half the food grain requirement of human and their livestock are met from agriculture (FES, 2003). In fact, the means of sustenance remains not agriculture, but the collection of the wild resources, including medicinal and aromatic plants (MAPs). This fact alone becomes all the more accentuated, when one analyzes the actual land use configuration within the landscape (Table 1). Reserve forests cover only 8% of the landscape area, while the Van Panchayats or village forests cover 34.48%, with the Civil and Soyam revenue land constituting the rest 54.59%. The present study however, primarily confines itself to the summer habitations of the Bhotiya community residing within the valleys-Darma, Vyas and Johaar, and delves into the factors that sustain the very livelihood of the stakeholders.

THE MODE OF SUSTENANCE

Bhotiya is a generic term derived from *Bodh,* the ancient name for Tibet, and is commonly used to describe the border tribes who conduct Trans-Himalayan trade. However, the people themselves resent being referred to as *Bhotiya* and prefer to be known by their indigenous names-*Shoka* and *Rang*. Primarily Mongoloid in appearance, with occasional Aryan and aboriginal traits still perceivable, the Shokas and Rang are actually an agglomeration of independent and mutually exclusive sub-groups like the Tolchchhas, the Marchchhas and the Jads, residing within the State of Uttarakhand, in the frontline areas bordering on Tibet.

Transhumance

The migratory folks practicing the transhumance (the annual movement from the winter homes to their high altitude summer residences) are termed as *Kuncha.* Transhumance enables the *kunchas* to gather rare Himalayan herbs, chiefly *Kutki* (*Picrorhiza kurrooa*), *gandrayan* (*Pleurospermum angelicoides*), *Atis* (*Aconitum heterophyllum*) and *Hathazari* (*Dactylorhiza hatagirea*) and to utilize agricultural land in the summer villages by making use of the growing season to raise specialized high altitude crops, such as buckwheats-*phaphar* (*Fagopyrum esculentum*) and *palthi* (*Fagopyrum tataricum*), which are adapted to grow in poor soils. This agricultural endeavour provides them with almost 50% of their dietary needs. Yet another class-*the anwals* (the traditional shepherds), practice pastoral nomadism as an appropriate technology, which allows them the utilization of marginal resources unsuitable for other uses, and at the same time maintain a breed of sheep and goat that is much larger and more productive than those raised by sedentary peasants. Additionally, the livestock population can be harnessed as energy converters in environments, which would otherwise be less productive to human population. Notwithstanding, the economics of these two governing principles of sustenance, a marked decline in the trans-humance has been observed over the last two decades, born out of (i) the severance of trade with Tibet, post 1962 Indo-China war and (ii) lure of government services with extension of the reservation (Negi, 2010).

Trade: Past and present

The Shokas and Rang had a barter trade

relationship with the Tibetans and were masters of the trans-Himalayan trade. Sheep and goats transported the trade merchandise. They transported the grain over the passes from June to October, and returned with borax, salt and wool. The Bhotiya traders jealously guarded their trade routes and maintained a monopoly over the trans-Himalayan trade with Tibet. The main items exported were food grain, sugar, gur (unrefined sugar), spices, tobacco, cotton cloths, hardware, corals, beads, etc, while the main items of imports were wool, gold, chirbi, Thi (a sweet), Yak's tail, Yak's skin, corals, precious stones, salt, etc. Western Tibet depended on the Bhotiya trade for its food grain supply. This apart, since Pastoralism was closely related to the Bhotiya trade economy, the Bhotiyas' livestock population comprising of Sheep, goats, ponies, yak, and Jhuppu, all primarily were of Tibetan stock.

Post the Sino-India war in 1962, the thriving trans-Himalayan trade, the very means of sustenance came to a grinding halt. It needs to be taken into account that (i) at least two-third of the Bhotiya population lived almost exclusively on income from trade, and (ii) the transhumance lifestyle of raising sheep and goats for pack animals and the family movement from winter village to summer village had developed around the need to maintain trade relations. Thus, disruption of the trade not only deprived professional traders of their livelihood, but it also had an adverse effect on the livelihood of several other professions, which were indirectly dependent on the continuance of trade. For example, there no longer remained a demand for the freight shepherds who used to carry merchandise for the Bhotiya traders- to and fro from Tibet. Traditional crafts also suffered, since as long as Tibetan wool and silk (Appendix 1) was imported in sufficient quantities, weaving art flourished.

However, with the opening of the trade once again, agricultural produce, which had a low limited value in the local markets, have now become the chief form of export, from these valleys. For example, potatoes are sold at 6 Yuan/kg, radish at 12 Yuan/kg, grated and dried radish for 30 Yuan/kg and hill tobacco for 12 Yuan/kg (1Yuan = 6 Re) (Hoon, 1996). This fact alone offers immense scope of increasing the revenue by promoting agro-business and bringing all the abandoned fields under cultivation. However, the Shokas and Rang believe that a duty free structure with less government interference would ensure prosperity and thus help in sustaining this unique lifestyle and culture, they believe. Additionally, it needs to be emphasized here that if trade potential is to be enhanced, then one will have to make a study of the commodities that could be traded at present with the Tibetans, for the same reason that the commodities of the past, namely say *Fagopyrum sp*. and the products made out of the same-the acreage of the said crop has drastically reduced since then, with whatever produce being procured out of cultivation, barely meeting the requirements of the resident population (Negi, 2010).

BIODIVERSITY: ISSUES AND PROSPECTS

As per the study conducted by FES 2003, over 2359 species, including Angiosperms- 2258 species, 891 genera and 170 families; Gymnosperms- 7 species, 7 genera and 4 families, and of Pteridophytes- 94 species, 38 genera and 25 families, have been reported from the landscape, inclusive of 234 near-endemics and 24 endemic species. Among the taxonomic groups, species richness in the family Orchidaceae (120 species) is exceptionally high, representing 50.8% of the entire Northwest Himalaya. The above analysis does not include diversity based on bioactive constituents in plants or of genetic diversity. For example, in *Podophyllum hexandrum*, resin and bioactive constituents seem to increase with increasing altitude (Purohit et al., 1998; 1999). As relates to fauna, over 80% of the representative mammalian fauna fall under various protected categories. Twelve of these are listed as endangered Himalayan taxa, including *Uncia uncia, Moschus chrysogaster chrysogaster, Tragopan satyra, Lophophorus impejanus* and *Catreus wallichii,* among others.

MAPs extraction

Of the 103 villages surveyed in the Gori basin (Johaar valley), about 80 per cent of the villages were involved in collection and trade of plants form the wild (Virdi, 2003). Interestingly though, the collections from the wild represents just 13% of the total earning of the 518 surveyed households! The contribution of agriculture, natural resource based livelihoods, such as livestock rearing, wood and bamboo-based handicraft and earning from employment in service, remains prime source of a family's income. Among the medicinal and aromatic plants (MAPs), it is the illegally extracted ones- *Picrorhiza kurrooa*, *Aconitum heterophyllum*, *Dactylorhiza hatagirea*, *Chaerophyllum villosum*, *Pleurospermum angelicoides* and *Cordyceps sinensis* that bring in the greater remuneration and thus traded in large volumes (Appendix 2).

Prospects of cultivation of MAPs: A case study of Johaar valley

Large-scale collection has led to the depletion in the yield of major MAPs as reflected by the amount procured by a harvester per day. For example, in Johaar valley, collectors reported that until five years ago, they were able to collect about 200 gm of dry Atis (*Aconitum heterophyllum*) in one day. Now they do not get more than 70 to 100 gm a day (Alam and Belt, 2004; Belt et al., 2003). There are a number of reasons for the excessive collection. Firstly, both collectors and contractors are

primarily interested in higher incomes in the short run and have little concern for sustainability. As the contracts are given for only one year, the contractors are primarily interested in maximizing the volume of collection, irrespective of long-term effect. Secondly, since the collectors are paid according to the volume, their prime concern is to harvest as much as they can in the limited time available to them, irrespective of the consequences. Thirdly, many collectors do not possess ownership over the resources that they exploit (prima facie example of tragedy of the commons), and very often take recourse to collection methods, which are detrimental to any long-term availability of resources (Alam and Belt, 2004; Belt et al., 2003). Even though, the requisite knowledge base as relates to the cultivation of some of the remunerative MAPs, like *Atis* (*Aconitum heterophyllum*), *Dolu* (*Rheum australe*), *Gandrayan* (*Pleurospermum angelicoides*), *Kutki* (*Picrorhiza kurrooa*) exists within the landscape, as exemplified by low-scale cultivation of the same in their kitchen gardens, however the stakeholders remain elusive to large scale commercial cultivation. The principle factors behind low interest as regards the cultivation of MAPs at present are the following (Negi, 2007b);

(i) High risk involved: There is general feeling among the farmers that the cultivation of medicinal plants is a high-risk activity.
(ii) Long growing period: Many medicinal plants can be harvested only after three years or more.
(iii) Lower yields: In the absence of requisite know-how, the yields are low.
(iv) Lack of financial and technological support: Weak linkages between the institutes and the farmers; lack of technology in terms of harvesting, storage, transportation and quality improvement; lack of financial support-say to raise fences to protect the crop from the wild animals, or to create irrigation channels, all add up to dither the farmer from cultivating MAPs.
(v) Lack of institutional support: Lack of buy-back arrangement, and limitations imposed by access to markets directly, has resulted in middlemen exercising a complete control over the stakeholders.
(vi) Lower prices of the MAPs: The scope of cultivation is also hindered by the current low price of most of the MAPs grown or collected, as compared with the wild harvested lot.

While opportunities for MAPs cultivation do exists, efforts should be made to remove the bottlenecks, namely subsidies of 40 to 50% have been envisioned by the National Medicinal Plants Board, New Delhi, to be shared on an equal basis with the State Herbal Research and Development Institute, Gopeshwar (Uttarakhand), and farmers interested in the cultivation of MAPs. However, there is a clause stating that to benefit from the subsidy, a minimum of 20% of the cost of cultivation must be procured from a bank. In view of the terrain and the remoteness of these villages, banks are reluctant to provide such loans.

AGRO-BIODIVERSITY

Although agriculture land covers just 2.3% of the project landscape and though landholdings are marginal and fragmented, there is reportedly rich crop diversity. 211 different local varieties of food crops have been identified as grown in the landscape, of which 105 can be classified as cereals or pseudo cereals, 21 pulse crops, 10 oil-yielding plants, and 10 species (FES, 2003). 41 varieties of paddy (*Oryza sativa*) are grown here of which 31 are upland varieties, not requiring field flooding. 20 varieties of wheat and barley (*Triticum sp*.) are grown and 14 varieties of finger millet (*Eleusine coracana*) apart from 5 other millets from the *Panicum sp.* and *Pennisetum sp.* However, the villages located above 1800 meters do not cultivate more than 7 to 8 varieties of vegetables in a year due to the short growing season, however make use of 10 to 12 different wild plants as vegetable. The narrowing genetic base of traditional agriculture crops in the landscape is a matter of concern, since fewer varieties of *Triticum* sp., beans and peas and of paddy is grown now. Agriculture in the lower (sub-tropical to sub-temperate zone) in the landscape is characterized by subsistence cultivation of crops like oggal (*Fygopyrum esculentum*), phaphar (*F. tataricum*), barley (*Hordeum vulgare*), mandua (*Eleusine coracana*) mixed with chenna (*Panicum miliaceum*), been (*Phaseolus vulgaris*), mustard (*Brassica campestris*), and potato (*Solanum tuberosum*). Water availability is often a constraining factor, for example in Johaar valley, 14 of the 19 migratory villages, lack adequate supply of water.

Agriculture in Johaar valley: A case study

The per capita availability of agriculture land is poor, mountain soils are poor in nutrients and holdings are severely fragmented. On an average around 0.11% (or about 1.31 km^2) of the landscape comprises of cultivable agricultural land of which around 16% is devoted to the crops (or actually cultivated). The productive capacity of different field is kept in mind, for example while irrigated fields are used for growing wheat and paddy, the relatively degraded and gravely land is used for growing pulses and oil seed crops. The traditional methods of farming here incorporate some techniques to maintain and improve the fertility of the field (modified from Asher et al., 2002), (i) the agriculture is more for cash cropping than to meet the subsistence food requirement, with the use of large quantities of organic manure, and virtually no use of chemical fertilizers, (ii) single cropping because of the short growing season, and thus no mixed cropping.

The traditional methods of farming here incorporate (i) the cultivation of legumes or nitrogen fixing crops, in rotation after either one or two other crops, (ii) changing the crops grown- taking up the cultivation of low nutrient demanding crop alternatively after a high nutrient demanding crop, (iii) agriculture fields remain fallow during the winter period. While every inch of the cultivable land was put to use during the prosperous time prior to 1962 (or more appropriately 1965), post Sino-India war, brought about a change agricultural produce- the types of the crops being produced changed overnight. Today, one comes across three basic forms of agricultural fields (Negi, 2007a):

(i) Traditional fields that continue to be used are relatively big, flat with mostly sandy loam soil with no irrigation facility. Usually cereals, mustard, barley, buckwheat and some durum wheat are grown in these fields.
(ii) Vegetable gardens, usually very close to the homes or within the home precincts, often very rich in organic matter- those procured from the kitchen waste, or livestock manure or even leaf litter from the milch animals. However, vegetable gardens form a very small proportion of the total area under cultivation.
(iii) Fields within the village ruins. As most of the villages encountered bear a very desolate look with very few families actually residing in the villages, most of the dwellings have broken down, with crumbled walls protecting the crops being grown (chiefly *Carum carvi* and *Allium stracheyi*) within.

Since, the mountain soils by nature are poor in nutrients, and to produce any crop requires a heavy input of manure, which is made possible by procurement of nutrient cycling from the surrounding grasslands. Often, one encounters fallow land where the livestock are left in the night or the anwals (the transhumant herders) are told to make their stay accompanied by their stock of sheep and goats; all principally with an aim that a mass of the livestock manure could be procured, without any wastage, whatsoever. Manuring or nutrient enhancement is primarily done through these following means (i) application of composted manure: Phicchi grass (*Danthonia* sp.), often used as bedding for the cattle is mixed with manure to form the compost, (ii) crop residue: the stalks of crops, such as thoya (*Carum carvi*) and mustard are spread on to the fields and left to decompose. In addition some of the grass species growing in the wild too are collected and spread in the similar fashion to decompose and rot.

Polyculture: The preferred norm

The crop management involves a mixed range of crop rotation and multiple cropping patterns, involving inter-change of crops and mixture of crop varieties and different level of input for each of numerous small plots of land. Crops, such as oggal and phaphar (*Fagopyrum* spp.) are grown in all villages within the landscape (but not to the extent as observed in Darma valley), and often mixed with lentils, bean, sesame or mustard. Potato field is seldom changed, due to its consistency in the production. As long as the regular rotation between oggal and phaphar, and rotation between buckwheat and potatoes is observed, the yield of these crops does not go down and there is no need for extended periods of fallow. Subsistence crops cover more than 90% of the total area under cultivation. The short cultivation season available to these transhumant migrants dictate the cropping system to be followed. And thus only those crops, which would ripen within a very short span of three and half months to four months, are grown. Added to this fact is the situation, where these people are seldom able to capitalize on the early onset of the growing season, since the upward migration is influenced by a number of other factors, principally the availability of the intact route. Around 21 crops or vegetables are currently grown in these villages, all of which are seasonal (Table 2).

Out of the total number of crops cultivated, mention must be made of two intensively grown remunerative crops- Jambu (*Allium stracheyi*) and Caraway (*Carum carvi*). Allium, a highly priced spice sells for 150 to 200 Rs. in the local market at Munsiari. This crop along with the caraway covers the greater proportion of the cultivable land in Johaar. An additional feature of this crop is that per unit area, it gives a higher yield as the same is harvested twice in the very limited growing season. Allium happens to be the perennial crop (that is, the plants regenerate each year from the same vegetative stock every growing season without having to resort to fresh seeding for propagation). Of the threedifferent species of *Allium*: *Allium stracheyi*, *A. wallichii* and *A. humile,* it is only *A. stracheyi*, which is actually cultivated. In comparison caraway is a singular biennial crop. According to Asher et al., 2002, the Johaar valley alone yields around 1100 kg of caraway seeds annually, contributing as much as 1.76 lacs towards income from agriculture. Since the crop is remunerative, selling for 250 Rs. per kg, villagers are devoting a greater portion of their cultivable land to this crop, even though the crop is harvested after two years.

Issues of concern

It is not just the reduced period of stay in their summer homes, which has resulted in reduction in crop diversity, principally of species requiring relatively longer period to mature (among the traditional crops with negligible acreage at present, *Parilla frutescens, Macrotyloma uniflorum, Vigna* sp.*, Hordeum himalayens* and durum wheat-*Triticum himalayensis* (Appendix 3) are under threat in the region, due to lack of interest), it is

Table 2. Some of the crops encountered in the Johaar valley (source: Asher et al., 2002).

Crop species	Vernacular names	Area (ha) 2002	per cent of total area	Production (kg) 2001
Fagopyrum esculentum	Oggal/palthi	0.020	0.09	18
F. tataricum	Phaphar	4.380	21.03	2975
Hordeum himalayens	Uwa-jau	0.166	0.80	60
Solanum tuberosum	Alu	3.950	18.97	18,556
Brassica campestris	Sarson/mustard	6.960	33.42	3683
Triticum sp.	Nappal/durum wheat	0.218	1.04	40
Vigna sp.	Masoor	0.086	0.41	19
Pisum sp.	Kalon	0.004	0.02	7
	Other vegetables	0.012	0.06	Unavailable
	Total food crops	**15.795**	**75.85**	
Allium stracheyi	Jambu/chives	3.499	16.80	2431
Carum carvi	Thoya/caraway	1.328	6.38	1121
	Total spices	**4.827**	**23.18**	
Angelica glauca	Gandrayan	0.137	0.66	15
Aconitum heterophyllum	Atis	0.024	0.12	5
Rheum australe	Dolu	0.005	0.02	6
Saussurea costus	Kuth	0.030	0.15	-
Picrorhiza kurrooa	Kutki	0.005	0.02	-
	Total MAPs	**20.823**	**100.00**	

important to take note of the fact that little attention has been paid by the policy makers as well as by the agricultural scientist to focus on increasing the yield as well as palatability of these coarse crops. These facts alone or in contiguous with other less conspicuous factors, are behind the decline in the acreage of the traditional crops, not only in the region, but throughout the Central Himalayas (Table 3). This aspect of crop diversity or the loss of it, or of replacement of the traditional species with new or altogether alien species, needs an intensive study (Negi, 2010).

Another important aspect to take note of is the low soil fertility and proneness of the soil or the landscape in general to soil erosion, which again puts constraint to cultivation or diversification of agriculture. Infact Sen et al. (1997) found that soil erosion was higher for the introduced cash-oriented cropping systems than for traditional subsistence crop-based systems on all categories of slopes. Also, as mentioned, with traditional varieties, the requirements of soil-fertility management are in line with the available resources. In contrast, introduced varieties and crop species need more management and inputs to provide economic returns (Maikhuri et al., 1999). This then puts more pressure on support systems already under pressure from the expansion of agriculture, and increases grazing pressure, economic production and conservation requirements (Ramakrishnan et al., 1994; Rao and Saxena, 1994). It needs to be emphasized here that in contrast to the HYVs, the traditional crops provide more energy on a per unit basis compared to HYVs, and thus are best suited to the higher energy requirements of the local populace. The traditional crops are rich in proteins, dietary fats, carbohydrates and fiber, apart from being rich source of minerals (Table 4), and in addition, of medicinal value, too (Table 5). Infact, wherever the market forces have led to decline in the traditional crop varieties, the local populace has suffered due to dietary imbalances and energy insufficiencies. In contrast, the HYVs run high risks. Several studies (Anonymous, 1992; Puckett et al., 1987; Tatum, 1971) have indicated that the HYVs are prone to climatic vagaries, pest infection, and yield fluctuations, and thus could be catastrophic in regions, which are subsistence-based, with poor communication links. And thus, when one is concerned with the providence of food security, traditional crops are better equipped to provide the same.

Given the variability of mountain areas in terms of agro-ecological potential (soil fertility, rough terrain, fragility, among others) and market access, different types of development strategies need to be adopted based on agro-ecological potential and market access (Table 6). In areas with better agro-ecological conditions and access to markets and infrastructure, the strategies should be promoting land use intensification, crop diversification, and growing of cash crops, which offer higher incomes. Similarly, where market access is constrained and infrastructure is poor, less perishable-high volume and

Table 3. Acreage reductions for some traditional crop varieties in the Central Himalayas between 1970 to 74 and 1990 to 94 (not exclusive for Askote Landscape). Source: Maikhuri et al. (1999).

Crop	Acreage (ha/village)		Replacement crop	Decline in acreage of traditional crop (%)
	1970-74	1990-94		
Summer season crop				
Avena sativa	15.8	3.4	*Solanum tuberosum*	78.5
Echinochloa frumentacea	2.5	0.7	*Cajanus cajan*	72.0
Eleusine coracana	9.6	6.1	*Glycine max* (up to 1400 meters) and *Amaranthus frumentaceus* (above 1400 meters)	36.5
Fagopyrum esculentum	4.1	0.3	*Phaseolus vulgaris*	92.7
Fagopyrum tataricum	8.6	1.5	*Solanum tuberosum* and *Phaseolus vulgaris*	82.5
Macrotyloma uniflorum	2.1	0.0	*Glycine max* (up to 1400 meters) and *Amaranthus frumentaceus* (above 1400 meters)	100*
Oryza sativa (Satti) (Glutinous rice)	14.2	0.0	HYV rice	100
Dhan (Rice)	11.2	0.0	HYV rice	100
Panicum miliaceum	14.2	4.9	HYV rice	65.5
Parilla frutescens	1.3	0.0	*Phaseolus vulgaris*	100
Setaria italica	2.3	0.8	*Phaseolus vulgaris*	65.2
Vigna mungo	3.3	0.0	*Cajanus cajan* (up to 1800 meters) and *Amaranthus frumentaceus* (above 1800 meters)	100
Winter season crop				
Hordeum himalayensis	17.1	4.7	*Solanum tuberosum, Amaranthus frumentaceus* and *Phaseolus vulgaris*	72.5
Hordeum vulgare	7.0	1.1	*Brassica sp*. (HYVs)	84.3
Triticum aestivum + Brassica sp.	14.2	0.0	HYV wheat and *Brassica sp.* (HYVs)	100

* Even though over all acreage under the crops-rice and wheat did not change over the period but they were entirely replaced by high yielding varieties, and thus the replacement has been 100 per cent.

Table 4. Nutritional composition of the major crops grown in the landscape.

Nutrients	*Oryza sativa*	*Triticum spp.*	*Zea mays*	*Eleusine coracana*	*Panicum miliaceum*	*Hordeum vulgare*	*Fagopyrum tataricum*	*Fagopyrum esculentum*	*Amaranthus frumentaceus*
Protein (per cent)	7.6	11.1	10.0	7.1	12.5	11.5	10.3	10.2	15.8
Fat (per cent)	0.3	1.7	4.3	1.3	1.1	1.3	2.4	2.3	8.1
Carbohydrates (per cent)	79.4	75.5	73.4	76.3	68.9	69.3	65.0	73.5	65.5
Fiber (per cent)	0.2	2.4	2.3	-	2.2	3.9	8.6	15.2	5.0
Ash (per cent)	0.4	1.8	1.5	-	-	-	-	-	-
Iron mg/kg)	-	-	-	5.4	5.7	3.7	13.2	-	-
Iodine (mg/kg)	-	-	101.4	-	18.0	-	-	16-155	16-155
Minerals[1] (g/100g of edible portion)	1.9	1.5	-	2.8	1.9	2.7	-	2.3	3.5

Table 4. Contd.

Moisture[1] (g/100g of edible portion)	12.5	12.6	-	12.4	11.9	10.8	13.2	11.3	10.0
*MJ/kg	14.7	15.0	15.6	4.4	14.0	14.0	13.5	14.9	16.6

Source: Hoon (1996) (except for minerals and moisture content, which have been sourced from Gopalan et al. 1978. Nutritive value of Indian foods. National Institute of nutrition, Hyderabad). *Derived by applying factors of 4 Kcal/g of protein, 9 Kcal/g of carbohydrate and using the conversion factor of 4.18 convert Kcal into Kilo Joules. All percentages represent g/100g edible portion of the grain.

Table 5. Medicinal values of some local traditional crops. Adapted from Maikhuri et al. (1999).

Crop	Vernacular name	Chemical constituents	Medicinal uses
Avena sativa	Oat	Saponin, hordenine (an alkaloid), glucosides	The seeds are a nerve tonic, stimulant, and antispasmodic. It seems to exert a beneficial action upon the heart muscles and on the urinary organs, speedily relieving spasmodic conditions of bladder and ureter. Also for commercial exploitation of ergot used in medicine
Fagopyrum esculentum	Oggal/palthi	Rutin, fagopyrin, falvanone, glycosides	The paste of the leaves used as an ointment to cure the headache and when the leaves fried with ghee (purified liquid butter) eaten to cure fever. Grains are used for colic, choleric diarrhea and all kinds of abdominal ailments
F. tataricum	Phaphar	-do-	The bark is used for its astringent properties. Good source of rutine (a flavonol glucoside, which reduces increased capillary fragility due to hypertension) used in medicine.
Macrotyloma uniflorum	Gahat	-	Grain soup is used as cure for kidney stones
Panicum miliaceum	Cheena	Prolamin, glutelin, niacin, riboflavin etc	Grains cooked with curd are given to patients suffering from jaundice. The plant is also used to cure gonorrhea in Baluchistan.
Allium stracheyi	Jambu	Essential oil, sulphur Compounds	Used as condiments in the pulses and vegetable locally known as Sequa. After grinding with the root of *Saussurea costus* and fried with ghee the product is used to care stomachache.
Carum carvi	Thoya	Umbelliferone, scopoletin, glycosides and essential oil	Seed mixed with salt (seindha namak) crushed into powder and used to cure stomach pain. Seeds also used as a spice & condiment.

non-perishable agricultural commodities, such as honey, dry fruits and nuts, medicinal, aromatic and dye plants that suffer lower post-harvest losses should be promoted (Ruben and Pender, 2004). In general, emphasis should be to harness the locally available mountain's comparative advantages. For example, climatic and ecological variations in hills and mountain areas provide opportunities for ecological niche products such as fruits, vegetables, medicinal plants, herbs, spices, agro-forestry, tree farming, seed production, and many other high value-low volume crops. Thus, a part of action research and extension services should be oriented towards mountain areas to take into account mountain specificities, diversities, niches, socio-economic and cultural factors, and market access. In selecting crops and tree species along with biophysical suitability, distance from roads and accessibility factors should be taken into account, as they influence the performance of land use

Table 6. Developmental strategy based on agro-ecological potential and market access. Adapted from Ruben and Pender (2004).

Agro-ecological potential	Market access			
	High	**Potential villages**	**Low**	**Potential villages**
High	(i) High-value cash crops (ii) Horticulture, commercial dairy, intensive food crop production, etc. (iii) Investments in irrigation, land management, and the agro-processing cottage industry with institutional support base	Sirkha, Sirdang, Pangla	(i) High-value, low volume crops such as NTFPs and medicinal plants (ii) Subsistence food crops (iii) Infrastructure development to utilize the mountains high agro-ecological potential	Baling, Dugtu, Dantu, Bon, Goe, Sipu Budi, Napalchhu, Gunji, Nabi, Rongkong, Kuti Milam, Martoli, Burfu, Laspa
Low	(i) Commercial agro-forestry, farm forestry, livestock, pastoralism, off-farm employment (ii) Crafts and services for markets (iii) Promote technologies that enhance agricultural potentials and utilize local niches	Sosa, Sirkha, Sirdang Dar, Sela, Bungling Budi Paanto	(i) Agro-forestry, tree farming for timber and NTFPs, medicinal plants (ii) Subsistence agriculture with zero tillage, mixed cropping, livestock production (iii) Tourism and recreation (iv) Local Institutional based conservation programmes and strengthening of local institutions	Jipti, Gala, Simkhola Nangling, Dhakar, Marchha, Tedang Garbyang Tola, Rilkot, Lwa, Bilju

systems, which determine farmer's land use preferences.

LIVESTOCK POPULATION-ISSUES AND CONCERNS

Sheep, goats, cows, bullocks, buffaloes, horses, mules, yaks (inclusive of their hybrids-Jhuppu and Jomos) constitutes the livestock of the landscape. It is estimated that approximately 26,028 livestock graze in the project landscape (Table 7). Decline in the size as well as number of flocks has taken over the last few decades. It could easily be ascertained that the present decline in the livestock population, primarily of the sheep and goats, is principally borne out of (i) the loss of trade and the concomitant loss of utility of '*Laduwa*' (sheep and goats employed for carrying the merchandise/load), (ii) the loss of the low lying pastures or grazing grounds, and of the traditional forests, due to the promulgation of the Zamindari Act, and (iii) the levy of grazing taxes by the forest department, which makes this traditional lifestyle, least to say, unprofitable, and thus has been, if not the major, cause in reduction in the size of livestock population. Yet another factor, which though is less perceptible, is the depredation of the vital possession by the wildlife predation. The villagers subscribe to as much as 3% loss of livestock population due to predators, chiefly ascribed to *tharuwa* or the snow leopard (*Uncia uncia*).

Grazing pressure within the landscape: A study

The sustainability of seasonal grazing by large flocks of migratory sheep and goats in the alpine meadows in summer and the Himalayan foot-hills in winter has been much debated recently (Kala et al., 2002; Mahaney and Linyuan, 1991; Mishra and Rawat, 1998; Sundriyal and Joshi, 1990). Alpine pastures play an important role in relieving the grazing pressure on the forests and grazing lands of the lower altitudes, but the increased number of livestock and overuse of certain pasture can lead to degradation of high altitude grasslands including habitats for wild herbivores (Bhatnagar, 1997; Rawat and Uniyal, 1993). As already emphasized, a marked decline in the livestock population across the present landscape has occurred, and the inadvertent government policy to reduce the numbers of the livestock was one of the major causes behind the phenomenon. Hence, it became imperative that one carried out the census of the same, towards ascertaining the grazing pressure across the landscape, with a view if curtailment of the livestock population, is

Table 7. Conversion of livestock into cattle unit.

Livestock type	Total no. of livestock	Percentage of animals	Cattle unit	Total cattle units
JOHAAR				
Cow+ Ox	545	4.96	1.0	545
Yak	19	0.17	1.5	28.5
Jhuppu	25	0.23	1.0	25
Mule/horse	327	2.97	1.5	490.5
Sheep/goats	10,075	91.66	0.2	2,015
	10,991	**100**		**3,104**
VYAS				
Cow + Ox	803	22.43	1.0	803
Jhuppu	134	3.74	1.0	134
Mule/horse	188	5.25	1.5	282
Sheep/goats	2,455	68.57	0.2	491
	3,580	**100**		**1,710**
DARMA				
Cow + Ox	907	37.56	1.0	907
Yak	4	0.16	1.5	6
Jhuppu	82	3.39	1.0	82
Mule/horse	132	5.46	1.5	198
Sheep/goats	1290	53.42	0.2	258
	2,415	**100**		**1,451**
CHAUDAS				
Cow + Ox	2763	30.56	1.0	2763
Mule/horse	329	3.64	1.5	493.5
Sheep/goats	5950	65.80	0.2	1,190
	9,042	**100**		**4,446.5**
CHIPLA-KEDAR				
Sheep/goats	1000	100	0.2	200
	1000	**100**		**200**

altogether required, or not and if it does, to evolve mechanisms to lessen the same.

Although, it is not possible to calculate the exact requirement and availability of fodder for the landscape, but based on some assumptions of daily requirements of the animals and productivity of land, approximation can be attempted. To estimate the requirements, it was necessary to convert all species of livestock population into one species, on the basis of which the requirement of fodder can be assessed. We assume that one cattle unit is equal to 1.5 buffaloes, 0.20 sheep, goat, 1.5 horse, mules and ponies. Also assumed that one cattle unit requires about 20 kg fodder day^{-1} (Tables 7 and 8).

As per the facts brought forth by the study above (Table 8), there is no dirth of availability of fodder in the landscape in general. Infact per capita availability of fodder exceeds by a factor of 3, 2, 4 and 5 in case of Chipla Kedar, Darma valley, Vyas valley, and Johaar valley, respectively. This fact is also substantiated by the finding that the general populace, principally the anwals, did not express any concern as regards the non-availability of the fodder. Rather, the only problem, as enumerated by them happens to be the havoc caused by the foot and mouth disease (which we found to be rather prevalent throughout the landscape, principally in the Johaar valley, followed by Darma, which again happens to contain the largest number of the livestock population), and the lack of indifferent attitude, as regards timely vaccination by the relevant authorities (read state veterinary department). Infact, it were only the villagers of the Marchha in Darma valley and of Mappa in Johaar valley, who expressed the lack of availability of fodder, since none was available to them, in terms of Van Panchayat area, and hence were completely dependent

Table 8. Availability of fodder in the landscape (total pasture area) and the grazing pressure.

Study site	Cattle units	Fodder requirement (in tonnes)[1]	Pasture area* (in hectares)	Rate of fodder production (T/Ha/month)#	Fodder availability (Tonnes)[2]
Johaar	3104	7,449.6	82,500	1.0	82,500
Vyas	1710	4,104.0	36,500	1.0	36,500
Darma	1451	3,482.4	18,500	1.0	18,500
Chipla-Kedar	200	480	1200	1.0	1200
Total	**6465**	**15,516**	**1,20,200**		**1,38,700**

[1] Total requirement of the fodder has been calculated thus- One migratory season (lasting for a average period of 4 months, from mid-May till mid-September or of 120 days, multiplied by a factor 20 kg per day). [2] Compounded for a period of five months, assuming the fodder grass regeneration begins one month prior to the migratory season, i.e. from the month of April. * Rawat (2005) # Ram and Singh (1994).

upon payment of the minimum cess for the upkeep of their bare minimal livestock population (Appendix 4)

It is believed that the total net primary productivity in the Central Himalayan alpine meadows, which varies from 1.7 to 7.6 t/ha/yr, can be improved upon to yield greater biomass and productivity, if scientifically managed (Ram and Singh, 1994). Also, the Central Himalayan alpine meadows have greater productivity and stocking capacity (7.13 sheep/ha) than the values reported for other cold climate zones (0.4 to 2.0 sheep/ha). On an average the stocking capacity of alpine meadows in the Central Himalaya varies from 4.6 to 6.6 sheep/ha (Ram and Singh, 1994). However, even if the basic arithmetic relating to the population size and the available land area under the pastures or of the landscape itself concerned gives a go-ahead for increase in livestock population, one should be cautious in approach, as the problem affront is not as simple as it seems to be. Thus, as precaution, we do need to categorize different habitats and pastures, which are relatively more frequently visited in one particular migratory season, or wherein the resident time spent by the livestock is relatively greater, in comparison to those, less frequented and lesser grazed.

Conclusion

Since a significant proportion of people in this landscape are poor, it is proposed that efforts to diversify and strengthen the various options and assets, currently available within the landscape, be made. Strategies that could be explored include the following;

(i) Enhances livelihoods security: Access with regulation to the collection of certain medicinal plants from van Panchayat area, grazing rights meeting subsistence needs.
(ii) Improved infrastructure and capacities for livelihoods: Opportunities through adventure tourism, eco-tourism, and pilgrim-yatras exist and needs to be capitalized upon.
(iii) Revitalization of the erstwhile trade: Greater potential of Trans-border trade, horticulture produce, traditional wool-based products, can be realized.
(iv) Participatory plans: Participatory plans need to be built with village communities for the sustainable use and conservation of areas within the landscape. To begin with, concerted efforts to reinstitute and strengthen the traditional management system, governing the grazing pressure in the alpine meadows, could be explored.
(v) Biological research outputs: On the biodiversity front, on site population dynamics of certain key species of flora, and an analysis of the status of the ecological integrity of the landscape, for prioritization of areas and species for effective conservation action, needs to be carried out.
(vi) As relates to agriculture, diversification and better utilization of the crop diversity across the landscape in terms of agro-ecological potential (soil fertility, rough terrain, fragility, among others) and market access, needs to be explored.

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APPENDIX

Appendix 1. Surprisingly, the most coveted item of import, the Chinese silk arrives through the Nepal village-Changru, across the River Kali, to the village Garbyang, India. The modes operandi seems to avoid the custom duty across the border.

Appendix 2. Dactylorhiza hatazirea syn. Hathazari remains the most sought after MAP and as shown decline in yield over the last decade, due to overexploitation.

Appendix 3. Some of the crops, example Nappal (Triticum himalensis) have simply lost the race, either because of loss of interest by the locals, or because of their greater preference for the HYVs.

Appendix 4. The traditional management practices have managed to restrict the size of the livestock population as well as the duration of the grazing in the alpine pastures.