

## Prospects of Sustainable Livestock Farming in the Uttarakhand Himalaya, India

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### Abstract

Livestock farming forms an integral part in the economy of the Uttarakhand Himalaya and plays an important role in the mixed crop farming system. In addition, high diversity in livestock composition is the characteristic features of the mainland of Uttarakhand. The state obtains high potential of milk production because of availability of fodder as a form of extensive grasslands, which are locally known as *bugyals* or *kharaks* and fodder trees. Livestock, other than milk production, are widely used for manure, plowing fields and transportation of goods. The availability of extensive grasslands and feasible climatic conditions manifest a way for sustainable livestock farming in Uttarakhand, particularly in the temperate zone between 1400 m and 2200 m, where production of milk is high. Valley regions are generally known for rearing of drought animals with low milk producing capacity. This paper aims to discuss on the prospects of sustainable livestock farming and to trace the temporal changes that took place over the past years in terms of livestock population, composition, and the governmental policies and planning for developing livestock sector. It draws implications on these experiences for livestock planners and policy-makers and raises several research issues related to livestock sector development.

**Keywords:** grassland, Livestock farming, Uttarakhand Himalaya

### Introduction

Livestock rearing is an integral component of mountain farming systems. In the Uttarakhand Himalaya, there is a dynamic relationship among common property resources (CPRs), livestock, and crops in the mixed crop-livestock farming systems. Livestock depend, to a great extent, on fodder grown on the community land, forestland, and as well as on crop residue. Meanwhile, the animals provide milk, manure, and much needed draught power. Livestock are therefore, an important to the sustainability of hills and mountain farming. About 80% of the population's livelihood is based on livestock rearing under subsistence cereal farming systems.

In the Uttarakhand Himalaya, landholdings are small and fragmented. It consists mostly of marginal mid-slopes and valley regions. The concentration of human settlement is high. Agricultural farming is based upon the centuries old practices, carried on the narrow patches of terraced fields. The production and productivity of subsistence cereal crops is very low. The majority of farmers operate mixed crop-livestock farming systems under different types of agro-ecosystems. Geographic and topographic variations have combined to provide a microcosm of the Earth's livestock farming systems (Jodha and Shrestha 1990), which can precisely be visualized in the fragile terrain of Uttarakhand Himalaya. The mounting pressure of increasing human populations on the mid-slopes and valley regions provide a way for decreasing land resources with fragmentation of agricultural land over the centuries. Under such circumstances, sustainable livestock farming, which is inevitable, provides a base for livelihood of the populace. Here, the term sustainable livestock farming refers for rearing of a sizeable livestock, producing enough milk and milk based products and balancing draught power and fodder supply in fragile ecosystem. Therefore, the sustainability in livelihood, of the marginal farmers whose economy is tremendously based upon mixed subsistence crops-livestock farming, could be attended.

The most common livestock species in the mixed crop farming systems are cattle, buffaloes, sheep and goats. Milk at a large scale produced from buffalo and cow, which is sold at the service centers of the nearby villages and is the partial source of income of the people. Bullocks are mainly used for plowing the fields. Goats are reared at a large scale, particularly above 1800 m and used for meat, wool, and also for transportation. Horses and ponies are also reared moderately and mostly used for transportation between the service centers and remote villages. Manure is obtained from cattle, buffaloes, and goats.

### Study area

Uttarakhand became the 27th state of the Republic of India on November 9, 2000, which was carved out of Uttar Pradesh State. It occupies an area of 51,125 sq km and a population of about 8.5 million with 159 persons per sq km (2001). This state lies between 28° 53' 24"-31° 27' 50" N and 77° 34' 27"-81° 02' 22" E. Of its total geographical area, about 47, 325 sq km (92.6%) is covered by mountains, which is the mainland of Uttarakhand, while 3800 sq km (7.4%) is *Tarai* plains. The total snow covered area of its mountainous region is 7,632 sq km

(16.1%), with an elevation of over 4000 m. The mid Himalayan region (at a height of 1000 to 3500 m) is found with many high mountain peaks, fertile lands, meadows, mountain rivers, streams, and picturesque valleys. The *Tarai* plains are 150 km long and 40 km wide, and they are about 230 m above sea level. The entire region is geographically important and is comprised of the two distinct landscapes, i.e., the Garhwal and Kumaon Himalayas.

The mainland of Uttarakhand constitutes about 92.6% of the total geographical land of the state. It is characterized by dominance of subsistence cereal crops. It is also a main source of livelihood. Besides, livestock rearing for milk and manure and forest-based non-timber products constitute major parts for livelihood. The availability of natural resources as forest, water, and soil and manpower is enormous as the forest (mostly temperate) covers about 60% land and the rivers are fed by the glaciers, which are perennial.

### Materials and methods

In the present study wide range of data, primary as well as secondary, were collected. Primary data were gathered through the case studies of the villages, selected based on their location, altitude, and nature of economy. Similarly, a case study of a dairy farm was done to facilitate the data interpretation, which also shows the potential of dairy farming in the study region. Secondary data were mainly gathered from the Directorate of Animal Husbandry, Dehradun, Uttarakhand. This study is also based upon the participation and observation method after rapid field visit. Apart from these, archival data were widely used.

### Livestock composition and distribution

Cattle (cows and bullocks), buffaloes, goats, and sheep constitute the livestock composition in the state. Rao and Saxena (1994) reported that a large proportion of livestock is raised under the mixed cropping system in Indian Himalaya. Cattle are most common (47.5%) followed by goats (15.8%), buffaloes (12.3%), and sheep (10.4%) in mixed crop farming systems in the central and eastern Himalayas. The landholdings are small and livestock provide a critical supplement to farm incomes as manure. Bullocks are used for plowing farmland. Mahendra Dev (1994) cautioned that livestock pressure under mixed crop-livestock farming system has been increased. In the low hills, the average number of livestock per household was 11 animals, out of which cattle accounting for 53%, sheep and goats for 36%. In the mid-hills, the numbers were eight animals in mixed farming systems and nine animals in vegetable-based farming systems.

Cattle constitute about 67.78 % of the total livestock population, out of which cows are 41.79 %. Buffaloes rank second with 23.72 % followed by goats (23.52 %) (Table 1). The population of crossbreed livestock is very low. Rearing of various species of animals is very common but their composition and distribution vary from the low-lying river valleys (about 500 m) to the highly elevated mountain regions (2900 m). The areas above 1500 m have more animals along with average to high yield varieties (HYV) than to the areas below of it. The economic viability of the cattle in the highland is also high because they are the major source of the economy of the populace after agriculture. In terms of to avail the fodder need, the highlands are very rich in fodder crops. In the highlands, the people hold two or more animals as an average (Sati, 2004). Cattle population is highest followed by buffaloes.

**Table 1: Livestock population and composition in the Uttarakhand Himalaya (2002-2003)**

Livestock	Number	Percent
Cattle	3125651	67.78
(i) Cow ( <i>Desi</i> )	1927405	41.79
(ii) Cow (Cross breed)	104031	2.25
(iii) Buffalo	1094215	23.72
Other livestock	1485700	32.21
(i) Sheep ( <i>Desi</i> )	263038	5.70
(ii) Sheep (Cross breed)	48667	1.05
(iii) Goats	1084790	23.52
(iv) Horse & mules	23830	0.51
(v) Pig ( <i>Desi</i> )	27136	0.58
(vi) Pig (Cross breed)	4415	0.09
(vii) Other animals	33824	0.73
Total livestock	4611351	100.00

Source: Directorate of Animal Husbandry, Dehradun, Uttaranchal

The animal-household ratio in the selective villages of the region is shown in Table 2. The villages are selected on the bases of altitude, distance from the main road, and horizontal differences within the places according to the upstream and downstream basins. Distance from the road and altitude are the two main indicators of household-animal ratio, which exhibits that the highly elevated and long distanced areas of the basin are possessing high ratio in comparison to the low altitude and nearness to the road. The number of milk producing animals is relatively high in the highlands than in the lowlands. It is because of the feasible climatic conditions and availability of fodder. It further denotes that a village, located at the high altitude has high animal/household ratio (4), and even its goats and sheep are more in number than those of the villages at relatively low altitude. Contrary, the villages at low altitude have more cows and buffaloes, while their animal/ household ratio is low (1.4 and 1 respectively).

**Table 2: Animal/household ratio in three villages of Uttarakhand Himalaya**

Village name	Height (m)	Accessibility	Cows	Buffaloes	Sheep	Goats	Oxen	Households	Animal/household ratio
Wan	2100	10 km from main road	62	35	135	106	21 pairs	104	4
Prethi	1600	5 km from road	67	65	Nil	Nil	16 pairs	105	1.4
Meing Gadhera	1010	On the road head	116	67	Nil	Nil	32 pairs	234	1

Source: Adopted from Sati (2005)

An analysis of temporal changes in livestock population and composition between 1988 and 2002 in the Uttarakhand Himalaya (Table 3) revealed that the cattle population has declined (-5.2), the buffalo population has increased significantly (+14.1). Among small ruminants, the sheep population has declined (-9.1), while goat population has increased (+7.1). The most noticeable change in the mountains is the considerable decline in sheep population. The similar trend can be noticed in change in composition of livestock as cattle and sheep have negative change (-3.0 and -1.0 respectively) and buffalo and goat have positive change (+2.0 and +1.4 respectively).

**Table 3: Change in livestock population in the Uttarakhand Himalaya (1988-2002)**

Livestock species	Increase in population (%)	Change in composition (%)
Cattle	-5.2	-3.0
Buffaloes	+14.1	+2.0
Sheep	-9.1	-1.0
Goats	+7.1	+1.4

Source: Directorate of Animal Husbandry, Dehradun, Uttarakhand

## Prospects of sustainable livestock farming

### Climate and availability of fodder

Mountain regions have the privilege of having divers favourable geographical conditions for the sustainable development of livestock farming. But at the same time, very few mountain areas could avail this opportunity. This factor is also applied with the Uttarakhand Himalaya, which obtains feasible climatic conditions and extensive grasslands but could not get impressive position in the field of sustainable livestock farming.

Extensive temperate grasslands are found in the entire mainland of Uttarakhand, mostly in the high reaches. During the summer, the people migrate to the higher reaches along with their cattle around for four months. Contrary, they move downwards during the winter. In the low-lying areas, fodder is available as a form of crop residue, grassland, and fodder trees, which the people collect and keep it for the rainy and winter seasons.

There are various sources of fodder - public forest, agricultural residue, shrub land, pasture and grazing land, terrace risers and private fodder trees. The most significant source of fodder and leaf litter (leaf litter is used as bedding material for livestock) is the public forests for the large majority of households. Degradation of forests in the mid-slopes, where concentration of population is high, has reduced the amount of fodder and leaf litter, with implications both for livestock productivity and productivity of agricultural lands.

Seven locations of the Uttarakhand Himalaya, which are the potential areas for fodder are shown in table 4. Altitude of these locations varies from 1900 m to 3400 m. These locations are characterized by the presence of coniferous forest mostly Banj (oak), tilong (*Quercus dilitata*), devdar (*Cedrus deodara*) and small variety of bamboo and alpine grasslands with varying varieties of herbs. These locations are further characterized by gentle to steep slopes, varies from one location to other. The human population, which is involved with interaction in these locations, also varies depending upon the nature of pastureland and availability of fodder. Furthermore, the number of villages and concentration of population in the mid-slopes and valley regions also influence the interaction of the population in the highland. The types of animal, which are seasonally carried for grazing in these locations, included goats, oxen, cows, and buffaloes and their numbers range from 150 to 350.

**Table 4: Potential areas of fodder in the highlands of Uttarakhand Himalyas**

Highland <i>kharak</i> areas (m)	Nature of slope	Forest type	No. of people	Total no. of animals*
Bedani Bugyal (3200-3400)	Gentle to moderate; south-east facing	Extensive alpine grassland	100-120	300-350 goats, oxen and buffaloes
Khankharakhet region (2800- 3000)	Moderate to high; north east facing	Coniferous forest and grassland	100-120	300-350 goats, cows, oxen and buffaloes
Ghais-blan region (2400-2600)	Moderate to high; south-east facing	Coniferous and oak forest and grassland	80-100	300-320 goats, oxen and buffaloes
Kanpurgarhi region (2400-2600)	Gentle to moderate; north-east facing	Coniferous and oak forest and grassland	100-120	300-350 goats, cows, oxen and buffaloes
Love-kush top (2200- 2600)	Moderate to high; north east facing	Coniferous and oak forest and grassland	60-80	150-170 cows, oxen and buffaloes
Bhararisen region (1900- 2100)	Moderate to high; north east facing	Coniferous/oak forest and grassland	60-80	150-170 cows, oxen and buffaloes
Naini Danda (1900- 2100)	Moderate to high; north east facing	Coniferous and oak forest and grassland	60-80	150-170 cows, oxen and buffaloes

\*Types listed by numerical strength, *Source*: Adapted from Sati (2006, 2008).

The farmers have encouraged fodder planting on private land (agro-forestry) and more efficient collection of urine and dung for composite fertilizer. Similarly, the Soil Conservation Department of the State Government initiated better regeneration of existing forests. There is a theory that livestock numbers do not determine soil fertility, but rather the way in which manure is managed does. Stall-feeding, as opposed to grazing, has a greater manure retrieval rate. A large proportion of farmers have reported an increase in soil fertility on both *khet* (irrigated lowland) and *bari* (dry upland) in the roadside villages with more stall fed animals. (Vaidya et al, 1995).

### Dairy Farming

Dairy farming is main activity and source of livelihood of livestock-dependent farming communities in the mountains. It involves with natural resources base-forest/rangelands, croplands, livestock breeds, feeding, health management, marketing, and consumption of the product. Smallholder dairy farming has enormous potential. It can contribute to family income, generate gainful employment especially for women, elevate living standards of the producer, fight malnutrition especially amongst children and enhances sustainable agriculture. Crop-livestock-forest integrity is a key factor to the sustainability of mountain livelihoods. Augmentation of dairy farming systems lead to the way for enhanced performance of the overall production system.

Dairy farming is an integral part of subsistence agriculture. Smallholders comprising majority of farmers are accustomed to rear some animals as an essential component of the farming system such as ploughing fields, producing manure, milk, meat, and wool. Among the various basic needs the animals fulfill, milk is the most important as far as family is concerned. Dairy animals are the best means to convert local vegetative biomass into

useful products and work, and the high value biodiversity into the products of still higher value, such as dairy products fondly consumed by masses (Singh, 1995). Dairy animals therefore, occupy predominant place in the herd in Uttarakhand Himalaya.

In the Uttarakhand Himalaya, cattle and buffaloes are the only dairying species. The use of goats and sheep as dairy animals is extremely rare. They are used for meat, wool, and transportation purposes. The species of cow and buffalo are indigenous; consequently, the milk production is low. In the valley regions, the high yield variety (HYV) jersey cows were introduced, but the success was rare. Because in the valley regions, the climate (comparatively hot) and low availability of fodder do not support for the rearing of HYV animals. The HYV buffaloes, locally known as 'murrh' breed, are reared in the highland areas. However their proportion in the total buffaloes is just negligible.

**Table 5: Milk yield and fodder requirement (per day) of three villages in Uttarakhand Himalya**

Name of village (Height in m)	Accessibility from road	Milk yield cow (l) (indigenous)	Milk yield buffalo (l) (indigenous)	Fodder used oak/other (Wint./Summ)	Crop residue (whole year)
Kimoli (1900 m)	10 km	80	300	800/900	300
Prethi (1600 m)	5 km	50	150	600/700	400
Ali (1200 m)	½ km	20	25	Nil/200	400

Source: Adopted from Sati (2004)

The milk production and fodder requirement (per day) vary from one place to another according to altitude (Table 5). The milk production was higher in high altitude villages. The milk obtained from buffaloes was higher than that from cows. Similarly, availability of oak fodder plays a favourable role in the production of milk. The fodder requirement is satisfactory in the high altitude as there are large grassland and forestland in surrounding of such villages. The climatic conditions are very feasible for production of milk and rearing of high yielding variety animals in the entire state. The areas, which are well connected by the roads, may be used for introducing hybrid cows. This process will help to boost up the economy of the villages.

A case study of Bhararisen Dairy Farm (BDF) (Table 6), which is located at the water dividing of the Pindar and Ramganga rivers about 30 km away from Karanprayag township and about five km away from Diwalikhal on the way to Karanprayag-Ranikhet, was done. During the 1980s, the government of Uttar Pradesh set-up this farm, at an altitude of 2000 m. The ideal conditions such as climate, availability of fodder, and gentle slope favoured this dairy farm. In 1990, milk production per day was 3000 lt. (six lt./cow). Similarly, the total number of cows was 500. About 250 employees were working in this farm. In 2008, the entire scenario is changed. The area of the farm has reduced from 3 sq. km to 2 sq. km. Total number of cows is 300. Most of them are calves. Per day milk production has reduced and remained to 1500 lt. The milk consumption area is limited to CDPCUL Simli. It was revealed that withdrawal of government support and reduction of land is the main cause for decline in milk production. The agro-climatic conditions of Bhararisen and its surrounding areas favour rearing of high yield variety (HYV) of lactating animals. An interesting point came into focus regarding dairy farming in this region. Farmers say that the joint efforts by the community people and the government can enhance milk production. The government has to support financially at the time of adverse circumstances prevail.

**Table 6: Bhararisen Dairy Farm (BDF)**

SN.	Characteristic features	1990	2008
1.	Location	2000 m	2000 m
2.	Area cover	3 sq. km	2 sq. km
3.	Total number of cows	500	300
4.	Total number of employees	250	100
5.	Per day milk production	3000 lt.	1500 lt.
6.	Milk consumption area	Between Karanprayag and Dwarihat	CDPCUL Simli

Source: Adopted and modified from Sati (2008)

### Biogas plants

Generation of biogas plants has a promising role to reduce the burden of firewood in the mid-slopes and valley regions, where human population concentration is high. It is emerging in these areas greatly and becoming a supplement to firewood for household energy needs. Data were gathered regarding the generation and uses of biogas and their favourable impact on the local natural resource base particularly on firewood. Between Karanprayag to Gwaldom, which is one of the accessible areas and connected by road network, approximately 25% of the households were reported to have biogas plants. It is noticed that biogas had increased the importance of livestock at the farm level, but it had not replaced firewood altogether as a source of fuel because, the use of biogas is mainly limited to cooking food for the family. Households keeping biogas plants were generally more inclined towards smallholder dairy farming and kept at least two buffaloes in the herd because, buffaloes have greater manure output than local cattle. It was reported that two buffaloes give enough manure to generate cooking gas for a family of four to six.

### Farming of HYV breeds and constraints to its adoption

In the Uttarakhand Himalaya, a limited success in HYV cattle breeds can be noticed, where a number of crossbred cows was 104031 (5.4%) out of the total number of cows 1927405 (Table 1). Similarly, the total number of bullocks was 1,277,396 out of which, only 66,214 bullocks were crossbred (5%). Furthermore, the number of crossbred cows and bullocks was not evenly distributed. Out of the total breedable crossbred cows, 42% were in Nainital district alone – which has a big milk market and access to a road network (SHERPA 1991). In the total milk pool of the villages, the contribution of buffalo milk was as large as 98%. The number of buffaloes in the herd increased significantly and that of the cattle decreased or remained stagnant. There is high demand of semen of high yielding “Murrah” breed of Buffalo.

Though many programmes have been launched for improving cattle breeds for last three decades or so, the progress is not satisfactory. According to a recent estimates, crossbred cattle make up less than 2% of the total cattle population in the Central Indian Himalayas (Dhar 1997). The reasons for less progress were (i) the improved breed was supplied to the weaker sections without assessing the poor and marginal farmers’ means to maintain them and (ii) they were supplied in the accessible valley regions only, where climatic conditions and availability of fodder do not support the rearing of HYV breeds, (iii) a large number of artificial insemination centres was opened, but these centres hardly touched the remote rural areas. Sub-optimal nutrition and management, greater susceptibility to prevailing diseases and pests, poor utilization in other agricultural activities and lack of an organized marketing structure are among the constraints limiting the productivity of the crossbred population in the state. The constraints in the adoption of HYV cattle breeds are depicted in Table 7. It illustrates that the alternative, risk-free, and low-cost option of local cattle has greater preference since they adapt easily to local resources and diverse needs.

**Table 7: Advantages of local cattle over crossbreeds or exotic cattle in mountain farming systems**

Local cattle	Exotic breed (or crossbred)
1. Adapts to local feed sources and performs well on poor quality roughage and agricultural residues - more efficient at converting roughage to body weight	1. Requires quality fodder (legumes) and concentrates for economically viable performance- uneconomical if fed on agricultural residues and roughage alone
2. Resistant to prevailing diseases unaffected by weather extremes. Well adapted to movements in rugged terrain	2. Susceptible to prevailing diseases, veterinary support services mandatory- vulnerable to weather extremes. unadapted to movements in rugged terrain
3. Multipurpose - caters to diverse needs of mountain farmers- e.g., draught power, pack animal (at higher altitudes)	3. Single purpose, e.g., milk production - poor use in other diverse agricultural activities, e.g., draught power
4. Low input at low cost	4. High input at high cost
5. Reliance on externally purchased inputs and services minimal supplements, services need to be purchased	5. High input from outside the system required – feed

Source: Adopted from Singh (1995) and Joshi (1996).

Good quality fodder is prerequisite for maintenance of HYV breeds of cows and buffaloes. The main reason for poor availability of good quality fodder is very small and spatially fragmented farm size in the mainland of Uttarakhand. A majority of farm households in both the central and western Himalayan regions are marginal with land holdings below 0.5 ha, followed by small landholders with farm sizes ranging between 0.5 and 1.0 ha (Khosla and Raina.). In Himachal Pradesh, the number of small and marginal farmers increased from 77 to 82.1% between 1976/77 and 1985/86 (Rathore 1991). In the mountains and hills of Nepal, the majority of households (67.5% and 53.6% respectively) have farm sizes between 0.025 and 0.051 ha (Munankami 1996). The mainland agriculture is characterised by steep slopes, shallow fertile soils, nutrition deficiency, and terraced cultivated fields. Under such

conditions, growing quality fodder crops is extremely difficult. Marginal farmers therefore depend more on Common Property Rights (CPR), such as support lands, forests, and wastelands, for livestock rearing and getting economic benefits out of the free access to CPR.

Livestock population is decreasing as current trend shows. The household earlier had more than five animals now has one or two animals. LRMP (1986) stated that in relation to the amount of arable land per person, the livestock population is one of the highest in mountain regions of Himalaya'. Shrestha (1998) also reported that on average, a mountain household raises six to 10 head of livestock, including large and small ruminants. However, this trend of having six to 10 heads of livestock recedes in due course of time. Farming community, instead of rearing draught animals has chosen rearing of lactating cows and buffaloes. A study by Chand (1997) shows that composition of the cattle population in the state of Uttarakhand shows improvement because of an increase in the share of lactating cows and a decrease in the share of draught animals. This indicates that livestock owners were replacing draught animals with more productive animals as the number of improved animal breeds has increased with the development of the dairy sector. In another study by same author it was reported that the provision for the sale of milk and the scope to earn cash income played a strong role in reducing livestock pressure, thereby improving the quality of the herd and reducing the number of animals that are considered harmful to the ecology (Chand 1995). The present study contradictorily shows that though, animal population is decreasing considerably, yet there is no increase in high yielding lactating cows and buffaloes.

There has been a general decline of livestock numbers in some areas, particularly in the mid-altitude where the decline per household is most prominent. Except rearing of bullocks for plowing the fields and one or two buffaloes for self-consuming of milk, the households do not prefer many animals. Two major factors of declining livestock populations in the state have been noticed. First is the use of chemical fertilizers in place of manure, though they are realizing the loss of soil by using chemical fertilizers and second is self-reliance of the people. Other than these factors, decrease in size of land holdings; reduced livestock feed resources, increasing population pressure and shortage of labour also deserve attention. It was noticed during field investigations that the rationale of keeping one or two number of cattle was mainly to provide milk and also to plough the fields.

The previous narrow technical approaches to livestock development in the hills and mountains neglected the social, cultural and ecological specificities of livestock production (Miller 1993). The governmental programmes and policies, which were framed for development of livestock, did not consider the development potentials and constraints. The traditional farming systems on undulating and marginal slopes of mountain areas are characterized with poor natural resource bases. The crossbreeding policies would have taken environment into account, in which animals had to live and produce and as well as the knowledge of livestock herders and their strategies in response to the changing biophysical and socioeconomic situations. Besides, little attention has been given to mobilizing local people and herders to strengthen their capacities to manage common property rights that are vital for livestock production systems. Inaccessibility, marginality, fragility, niche, and diversity characterize most mountain areas.

Livestock are traditionally significant in the state for both social and economic considerations. It is a religious practice that every household must have a cow, irrespective of its economic viability, because on many occasions, cow is worshiped. Similarly for milk, buffaloes are reared. The farming households keep a pair of or at least one bullock for draught purpose. However, the number and composition of animals may vary from village to village and from one household to another, according to the availability of grazing lands and the size of landholdings. The economic and religious importance of the animals in the entire state is noteworthy. The economy of the mainland of Uttarakhand depend mainly on agricultural practices and the animals help the farmers for plowing fields, providing manure for increasing production of crops.

During the last two decades or so, tremendous improvement in agricultural mechanization in the state has been noticed. In the mainland of Uttarakhand, particularly in mid-altitude, the farmers have shifted their cereal crops land into the cultivation of off-season vegetables. The return from the farmland is high in comparison to the subsistence cultivation. Large-scale emigration of farming community in the plains of Ganges and the major metropolitan cities of India recede the trend of mixed-crop livestock farming. Enough remittances enhance income of farming community thus livestock population reduced.

There is a vital need to frame policies and their implementation for livestock development, considering the conservation of biodiversity both floral and faunal species. It has been observed that indigenous species of livestock are more adaptable to the fragile mountain environments than the crossbreed one. Their potentials for economic enhancement of the region have yet to be utilized. A systematic study, keeping a better understanding of livestock development processes in relation to improving the livelihood of mountain farmers, agro-ecosystem, health, and natural resources in view, is indeed inevitable. That can focus on high pressure areas of mixed crop-livestock production systems where changes are occurring in livestock composition, forage resources, natural resource management practices, livestock management technologies, the role of gender in decision-making, marketing, farm

income, and profitability. These changes have not been quantitatively assessed in a way that would enable informed decision-making. The measures suggested for sustainable livestock farming are; (i) increase planting of fodder species (trees and grasses) on uncultivated community and private land (marginal land and terrace risers) and traditional edge of the agricultural fields, which will also be helpful for reducing soil erosion, promotion of efficient use of agricultural residues (stall feeding), (ii) encourage better management of common resources for fodder supply, such as community land and public forest and grasslands, which are under the forest department, (iii) promote appropriate, manageable productive animals, and (iv) cattle of the state are mostly indigenous and milk production is low, while, the climate of the region is feasible for rearing of 'murray' buffalo and improved breeds of cow. If proper policies for livestock development are framed and implemented, the improved breeds of cows and buffaloes can be reared for increasing milk production and sustainable livelihood. Keeping terrain and availability of forage in view, promotion of dairy farming as private or public enterprises has high possibility. The state has several locations to promote dairy farming where climatic conditions are conducive and enough forage can be obtained. Thus, better management of livestock in the state can contribute a lot to the sustainable development.

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