

Ecology, soil and crop management for livelihoods in Ladakh region: An Overview

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ABSTRACT

The Ladakh region is the cold arid region of Jammu and Kashmir state in north India where agriculture is the main occupation. The soils of the region are alkaline, poor in fertility and prone to erosion. The low temperature of the area during most part of the year accompanied with scanty rainfall, low humidity, more evaporation transpiration and soil erosion hazards pose obstacles for agricultural production. The glacial erosion is quite predominant in the cold arid region of Ladakh. Application of organic manures, compost and biofertilizer can improve soil health. Livestock management has great scope for livelihood security. Plantation of agroforestry, medicinal plants, fruits and vegetables can help in management of wastelands and restoration of poor agricultural lands. Soil and water conservation including rainwater harvesting, agronomic measures such as crop rotation, mulching and integrated nutrient management, especially green manuring and mixed use of FYM and fertilizers, are useful in management of soil and water resources for sustaining agricultural production vis-à-vis economic upliftment of the farmers in the region.

Key words: soil conservation, water management, cold arid zone, high altitude

INTRODUCTION

Ladakh, a Trans-Himalayan Region of Jammu and Kashmir State, situated between 32° and 25'N-Latitude to 75-80° E-longitude is versatile in altitude ranging from 2400 to 4500m. It harbours great variation in geography and climate from arctic to cold desert with land of high passes and rugged topography and as such is known as one of the "Cold Arid Zone" or "Cold Desert Zone" of India (Fig. 1).



Fig. 1. Ladakh region of Jammu & Kashmir, India

This region possesses an area of 96,701km² which is all mountainous barren and nude except for its 235 villages. Villages always remain separated by weeks rather months together owing to intense winter cold. The only tow highways ice-sealed from the world about seven months in a year. A thin scattered population of 2,90,492 souls (2011 Census) somehow manages to dwell. This is what Ladakh is! Barring a few soils of Sindh valley all are highly alkaline in soil reaction. Very low of temperature of the area during most part of the year accompanied with scanty rainfall, low humidity, more evaporation transpiration and soil erosion hazards pose obstacles for the growth of wide flora in this cold arid region as well as agricultural production.

Agriculture in Ladakh

In spite of the rugged topography and mountainous area accompanied with suffering from heavy soil erosion during melting of the snow as well as landslides, the most of the land of Ladakh Region has been made suitable for cultivation. Agriculture, in fact, constitutes the main livelihood of the people of the region to bear the self sufficiency. The villages are generally located near

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the patches of land with well levelled ground and irrigation facilities where cultivation becomes, thereby a doable practice.

In order to upgrade and increase irrigation facilities in the state a considerable thrust has been given to boost up this sector for which various projects have been launched (Anonymous, 2008). Under these irrigation projects by the Planning Commission of India, Leh irrigation schemes has already been completed at a cost of Rs 90.40 crore for providing irrigation facilities to the farming communities of Leh. Mixed farming is the main practice, consisting of growing of food crops, vegetables, and fruit trees and rearing of livestock.

Cultivation of food crops

In Ladakh region most of the agricultural area is single cropped because of long severe winter and short cropping season. Double cropping is possible in areas having altitude less than 3000 m, where field pea, lentil and French bean can be grown as leguminous crop. Other field crops grown in cold Arid Region are barley, wheat, mustard and smaller millet. Actually, the low summer temperature in Ladakh makes it possible to cultivate the winter (Rabi) crops grown in rest of the country. As cold arid region of Ladakh is a remote area by virtue of its location amid the inaccessible peaks of Higher Himalayas so agricultural developed is in isolation and it is marked by relatively less diversity of agricultural flora. However in changed scenario of agro-climatic dimensions through solar green houses in Ladakh accompanied with more financial and technical, know how, it has now become appropriate to exploit the prospects and potential dimensions through solar green houses in Ladakh accompanied with more financial and technical of new crops like vegetables and fruit crops.

It is worth mentioning that hulled barley is used to prepare a drink like beer which is called chang.- C hang is a must commodity at all exuberant occasions of the region. Infect, naked barley (*Hordeum vulgare* L) also known as grim, is an ancient form of domesticated barley with an easier to remove hull. From this kind of barley tsampo, the staple food in Ladakh is made (Anonymous, 2011).

Vegetables production

According to Dolma (2009) a green revolution of all sorts was knocking at the doors of barren

landscape of Ladakh, where even a blade of grass was a rare sight. People who used to survive on herbs like nettle, are now producing more than 6 varieties of vegetables, consisting both of tuber and leafy in summer and have brought great change in the area. Farmers are now growing cabbage and cauliflowers of different varieties. Apart from this poly green house technologies had also been a successful attempt to produce seeds of onion, tomato, radish, carrot, brinjal, capsicum, green chili, broccoli etc. Cultivation of several new vegetables like parsley, celery, chenopodium and sweet turnip are also being grown in poly green houses. This has ensured the supply of vegetables to towns and cities during off season and further opened up a new arena for the farmers not only towards their own self sufficiency but also for export of seed outside the region. Scientists of Defense Institute of High Altitude of Research, a unit of DRDO (Defense Research and Development organization) in Leh have produced some exotic vegetables such as Sennel, Asparagus, leek, Pakenoi, brussen sprout, bhallot, Cherry- tomatoes, which are now being successfully grown by the farmers of Ladakh also. Some progressive farmers of central Ladakh are now growing garlic commercially. The commercial green house technology has also been adopted by the Army for promoting it among the farmers in Ladakh under operation "Sadbhavana".

Ladakh Autonomous Hill Development Council provides subsidy of Rs 80,000 to the farmers to establish green houses on their land. With the help of commercial green houses, vegetables are locally available. One of the main benefits is the extension of the vegetable availability a month before in autumn and advancement by one month in spring. While the open field vegetables survive only up to September. Tuber vegetables are available in July and August.

Fruit crop production

The fruit trees grown in Ladakh region consist of pome fruit (apple and pear), stone fruits (apricots, peach, plum, cherry, almond) and nut fruit (Walnut), aggregate (mulberry) berry (grape and etaerio of Achenes (strawberry). Unlike other crops, fruit trees are mostly perennial in nature, restricting, thereby, the diversification in fruit plants, except the few which have acclimatized in the cold arid region. It is remarkable to note that though the fruit crop production is limited to a few temperate fruits yet the fruits produced are sweeter and better coloured than in many parts of the state (Mir, 2000).

Apricot (*Prunus armenica*) locally known as "Chulli" is one of the most nutritive, delicious and commercially important fruit crops of Ladakh (Dorjey and Rinchen, 2012). It has a wide range of distribution in different parts of Ladakh including Dhaattanu, Garkhon Skurbuchan, Domkhar, Wanla, Khaltse and Timosgang. Apricot in Ladakh is believed to have been introduced a century back either from China or Central Asia. Since then this fruit has become one of the most preferred and commercially cultivated fruit crop of Ladakh and now has become an integral part of the people there. There are many varieties of apricot grown in Ladakh which differ from one another in taste (sweet, bitter, sour) size, shape and physical appearance. Some of these varieties include Halman, Laktse karmo, safaida, Khanteh etc. Halman and Laktse karmo are the most preferred ones for commercial purposes. From the commercial point of view apricot has been major the source of income for many Ladakhis who are engaged in cultivation and marketing of this fruit. Halman, Laktse karmo are with sweet kernel which is consumed as dry fruit and make a good market price of Rs. 100-150 per kg, while the seed with bitter kernel is used for oil extraction. The apricot oil (locally called tseghumar) is multipurpose oil with a peculiar apricot flavour and is sold at a remarkable price of Rs. 300-500/L.

Cultivation of medicinal plants

There are number of medicinal plants which can be grown in the cold arid zone of Ladakh. They have rare properties of curing human ailments. List of medicinal plants which stand used Amchies in Ladakh have been detailed elsewhere (Anonymous, 2003-2013). Like Siwaliks of Jammu region, Ladakh region of Jammu and Kashmir was also once an abode of medicinal plants (Sharma and Mir, 2000). There were about 500 plants in cold arid region of Ladakh having rare properties of curing human ailments but now some of them have become endangered due to their indiscriminate collection by Pharmaceutical agencies vis-a-vis of their overgrazing by the animals. Some among most of the species locally known are as burtse, yulang, tata known, longze etc.

Growing of poplars

Owing to scarcity of forest tree species in cold arid region of Ladakh, growing of various species of poplars hold a great promise to meet the future demands of the people in respect of fuel wood,

timber and fodder requirement for the livestock. The methodology of planting of the poplars is as follows:

Unlike other tree species the poplars are propagated through cuttings. Prior to breaking dormancy in the trees (during March-April) when day temperature starts rising, branch cutting of about 150 cm size are prepared from the tree branches. These can be then planted directly in small pits about 30×30×30 cm capacity. However, to get good sprouting, the branch cuttings should be soaked in water for about fortnight. With advancement of the season when the dry temperature rises to 25 °C by ending May, the new shoots begin to sprout. Up to end of August, the planted cuttings must be watered vigorously to combat high rate of water loss through evaporation/transpiration as well as leaching out of salts, the accumulation of which otherwise hinders their root development.

As poplar are also planted on field bunds or borders of canal areas other than enclosed patches of lands, these must be protected against animals especially goats and donkeys. This can be done by providing the shelters of the thorny shrub (*Hippophae rhamnoides*) around the saplings. Wrapping of gunny bags or placing of used tins around the saplings is another method which can be used for protecting the planted poplars against the attack of animals (Gupta *et al.*, 2007). On an average, the survival rate of the planted poplars by this method is more than 60 percent. The saplings are planted only at those places where the water supply is assured. The trees shed their leaves on the onset of winter season i.e during the end of October and enter in dormancy of period. The leaves are lopped during summer and used for natural fall, leaves are collected stored and used either as fodder or fuel during winter.

Economics of growing poplars

To work out the economics of growing poplars, a distance of 3m x 2m was adopted having 1666 number of trees per hectare (ha). Over a period of nine years the poplar trees attained a girth of 70 cm at breast height which is the desirable size for felling down the tree for commercial purposes and other uses. It is the point worth mentioning that for working of the returns only 84 percent of the trees have been assumed to be fit for the marketing purposes. The price escalation over a period of nine years was assumed to be neutralized with the interest amount on the working capital, hence was

Table 1. Cost of production of poplar/hectare in Ladakh
Nine year gestation at 3m × 2m Distance

Operation	Cost (Rs.)
Fencing for one hectare of land	40,000
Partial leveling of land, ploughing and construction of Irrigation channels	6,000
Digging of 1666 pits @Rs. 2 per pit	3,332
Cost of 1666 cuttings @ Rs. 3 per cutting	4,998
Cost of plantation @ Rs. 1 per cutting	1,666
Gap filling due to casualties in 2 nd and 3 rd year (approx. 1000 Nos.)	6,000
Cost of FYM/fertilizers for 9 years	3,000
Irrigation and watch and ward for 9 years	15,000
Pruning of trees	
3 rd year @ 10 plant/labor day	8,330
6 th year @ 5 plant/labor day	16,660
9 th year @ 5 plant/labor day	16,660
Miscellaneous unseen expenditure	30,000
Total	1,51,646

not considered in both income and expenditure, respectively. Cost of production of poplars and net profit per ha are shown in the Table 1 & 2.

Rearing of livestock

Rearing of livestock mainly comprises of yaks, cows, goats, sheep, asses, and horses, jersey cows yak cow hybrids (Dzomo). Yak, jersey cow, yak cow hybrids and goats serve as the milch animals, whereas yak, ox, horse, donkey, and double hemp camel are utilized as draught animals. Sheep goats and yak are the main animals used for producing meat. Pashmina goats provide a special type of wool known as pashm which is used for making pashmina both fine and rough. The fine pashm is obtained from undercoat of the small sized goats, rearing at the higher altitudes ranging from 3,600-4,500 m. In due course of time, only finer outer coat

drops, leaving merely outer tough coat available. The pashm obtained from outer rough coat is used in making ropes, coarse carpets and other rough materials. Apart from the animals reared for the above said purposes such as milk, meat, wool and social status and a draught power, they are used for preparing manure and compost. It is remarkable to note that the cold arid region possesses exclusive potential of rearing pashmina goats, especially Changthang area.

Pashmina goats and pastures in Changthang

As already mentioned, Ladakh region of Jammu and Kashmir state, is not only the land of many passes and gompas but also alpine meadows, which constitute the grazing grounds for "pashmina goats". Changthang area is one of the glaring examples in this respect (Gupta, 2006; Gupta, 2009). The people of Changthang are called as "Changpas" – an old tribe of Ladakh.

Traditionally, the Changpas have been rearing "Pashmina goats" from time immemorial to obtain raw wool locally known as "pasham" which is used for making time and superior quality Kashmiri shawals. Although changthang sprawls over an area of 2,200 km yet 80-85 percent of its land is unproductive and barren. Despite restricted real grazing meadows land (15-20% of the total), the livelihood of Changpas is live stocks rearing like other Ladakhis. Besides pashmina goats, they also rear sheep, cows, horses and yaks. As most of the land of the area is practically unproductive, most of the Changpas are nomads. They frequently move from one place to another in search of meadows for their livestock feeding. But it is alas! That these meadows are now getting extinct due to their exploitation of overgrazing and tourist influx. If proper measures are not taken well in time, the changpas will be in trouble as out of the 2 lakh

Table 2. Gross and net income of poplar plantation/hectare in ladakh
Nine Year Gestation

Particulars	Cost (Rs.)
Firewood (twigs) received in three pruning (3 rd year, 6 th year and 9 th year) @ Rs. 50 per tree in tree life of 9 years	83,300
Poplar cutting fit for propagation received through pruning @20 cuttings/tree during 6 th year and 30 cuttings/tree during 9 th year	2,49,900
Cost of 1400 nos. of grown up trees sold in situ @ 700/=per tree (assuming only 84% fit to fell)	9,80,000
Gross turn	13,13,200
Gross expenditure for 9 years	1,51,646
Net return	11,61,554
Average net income for 1 year	1,29,061

pashmina goats in Ladakh around 1.5 lakh feed only on Changthang meadows. These pashmina wool worth crore of rupees, is removed from the pashmina goats during the month of May when due to higher temperature, pashm starts shedding. So combing out operations being in month of May and go up to July and August. The quality of pashmina is determined on the quantity of coarse outer coat that it contains. Pashmina having 20-30 % outer hairy coat is of good quality. On an average, there is about 250-350 g yield of pashmina per goat and yield of hairy coat varies from 50-750 g per goat. After combing spinning and weaving the pashm, the Changpas get pashmina cloth. They then sell to the dealers from Leh and Srinagar at suitable rate. There is also barter system for sale and purchase of goods. In exchange of pashmina, they purchase food grains, sugar, kerosene oil etc.

Although Changthang region in Ladakh produces about 80% of the country's pashmina fetching Rs 3,000 per kilogram, yet it was marred by the stench of death of 25,000 pashmina goat's during February-March 2013 (Gupta, 2013). Several reasons have been given with regards to death of these goats. According to government officials in Leh and residents, most of the goats have died due to starvation. There were very little rains last summer due to which there were not enough pastures. Heavy snowfall to the extent of 121 cm cut off the region from the outside, causing delay in the fodder supply from the government. Whatever pastures available were buried under snow, making grazing impossible. Mostly old and young goats were died.

Changpas use horse and yaks for transport. Old persons and children usually ride on yaks whereas young ones utilize horses. Sometimes they have to go on foot long distances. They also depend upon many army vehicles which carry them. They have very good contact with army personnels who safeguard the India borders both from China and Pakistan.

Causes of Shrinking of Changthang Meadows

Indo-China border conflict - The wandering of the traditionally nomadic Ladakhi changpas across the Changthang, the Tibetan Plateau extending from Tibet to the Eastern Ladakh, border since 1962 war fought between China and India the Limited Plateau has now become poorer grazing grounds for the herds of pashmina goats and flocks of sheep reared by the Changpas.

Capturing of pastures

The traditional pastures have considerably shrunk after forcibly capturing some very important winter pasture reserves in Skagzhungin Kuyul border area by the China. The post Chinese episode also saw large number of Tibetan refugee, nomads settling in the Eastern Ladakh further along-with the locals. No doubt, the resulting conflicts over sharing the pastures were somehow resolved recently. But it was no use as the destruction caused by 50 years of overgrazing of the pasture in Changthang range had already become tremendously.

Various projects with regard to construction of roads and buildings as well as other development activities in Rupsho Smad Kharnak to other nomadic areas in Changthang would replace lot of forage range.

Impact of tourism

In just over 20 years of tourist influx in Changthang that commenced in 1994, the number of visitors and their impact has wreaked havoc on its fragile grassland ecosystem. Besides causing severe damage to the grazing lands led on by about 1,17,266 livestock from Karzok, Samad and Kharnak nomads agricultural lands are also affected. Number of the tourists from couple of hundreds in 1996 became few thousand in 2000 and 2001, which stood in a number of thousands in 2013 and 2014. Seasonality of the tourism to Changthang (June to September, peak season being middle July to ending August) further compounds the impact.

Camping in the pastures or near the feeding and breeding grounds of birds, driving off roads, washing of vehicles in the lakes, are a few of the several worth mentioning tourists activities. These activities have created disturbance to the wildlife and produce pollution also besides degradation of pastures. Hundreds of tourists during summer along with guides cooks, assistants and pack animals at the time of germination of the grasses go on trampling over the pastures. This results in the decay of grass species causing there by an acute shortage of forage. Trampling renders the soil compact which increases soil erosion. Not only have this pack animals of tourist groups eaten up the grasses of the pastures reserved for winter.

Soils of Ladakh Region and Their Problems

As most of the soils of Ladakh region are skeletal so they are shallow overlying the

weathered parent material. Due to unfavorable climatic condition, soil development is limited. At most of the places soil cover is very much affected by the wind erosion. The soil beds are exposed to wind erosion due to which not only land is robbed of its richest soil but also crops are either blown away or left to die with roots exposed or are covered by the drifting debris. The abrasive action of the wind erosion results in some detachment of tiny soil particles. These are transported by bounces along the surface of the ground or creep along the surface. It has been found that the soil losses are the highest in the bare fallow land and least under grass cover.

It is not only the wind erosion which affects the cold arid region but it is affected by glacial erosion also. It is quite prevalent in the area with wide spread slow moving surficial processes like periglacial solifluction and wind deflection. The glacial erosion is characterized by furrowing, cutting and scouring of the land is also very common in the area. The flash floods owing to enormous snow melt carry away a large amount of debris after causing great damage to their beds and side gullies.

The glacial erosion is quite predominant in the cold arid region of Ladakh. It is because the area has a large number of peaks which remain under perennial snow or receive snow for most of the time during winter months. Whenever there is movement of large mass glacier down slope, it brings with huge debris causing lot of soil erosion. Topographical variation also accelerates the sheet and gully erosion. The cold arid zone of Ladakh also suffers from land slide erosion. The land slide activity along the highway in Ladakh not only poses threat to the vehicular traffic but also carries a lot of debris.

The soils are predominantly sandy derived from weathered debris of the rocks and are subject to the great diurnal as well as seasonal alteration of temperature which leads to a mechanical disintegration of the rocks, producing an abundance of loose debris and as such there is no chemical or organic matter (Humus) action to convert it into the soil cap. Because of scarcity of vegetation, it plays but only a minor role in the soil formation in the Ladakh region. As there is low rainfall so chemical weathering is slow and mineral resources are often high. Physical weathering is intense in the region because of temperature variation. The penetration of rainwater downwards

through cracks in boulders also accelerate weathering.

Most of the soils of Ladakh region are coarse textured with sand content ranging from 97 to 51 percent and clay content from 14.8 to 1.2 percent. However, the sand content in the soils of Kargil (Khurbathang Plateau) is relatively less with sandy loam as predominant surface texture. Most of the soils are neutral to moderately alkaline in soil reaction with pH ranging from 7.4 to 8.9 (sometimes as high as 9.5). They are characterized by low content in available N. The available P and K contents varied from medium to high respectively. Most of the soils of Ladakh region are found to be deficient in available Zn whereas the amount of the micronutrients like Cu, Fe and Mn is sufficient.

Reclamation of wastelands

In reclaiming the wastelands in Ladakh, the main objective must be to restore the life support system especially soil ecosystem and to restore the integrated agro pastoral systems of rural ecosystem. Since the soils of Ladakh region are less matured and as such coarse in texture. Coarse textured soils are characterized by gravelly/stony, sandy and silty type which is always poor in soil fertility and productivity. These soils are, therefore required to have more FYM, compost and night soil compost. Hence whichever quantity of organic manure is available with the farmers, they must add to these soils.

Rejuvenation of lands and creating awareness

As there is an acute shortage of fodder so Lucerne which is perennial leguminous forage crop, especially for irrigated areas so, it must be sown during April after melting snow. It not only provides the fodder but also enriches the fertility/productivity of soil by fixing atmospheric nitrogen.

There is dire need to educate the farmers to make use of right kind of seeds, species of plants and other inputs like manures and their preparation in the right way as well as right time of their application.

In proper management of land it would be much better if an emphasis is laid banking the women folk for proper utilization of barren or unproductive at higher altitudes in Ladakh Himalayas. It is because women of Ladakh are involved not only in various agricultural activities but also in certain generating activities like weaving, knitting and sewing.

To improve the animal health for getting more milk and meat, they must be fed with heavy feeds. For this purpose, wherever it becomes possible, the grasslands should be developed with growing of white clover.

Promotion of agro-forestry

As poplar tree holds an ideal combination for agro-forestry system under Ladakh region, hence its plantation should be practised as companion among cultivated crop like barley, wheat, peas and other vegetables.

Appropriate cultural practices for raising poplar nursery and plantation techniques are required to be developed to shorten the growth period of the poplars. Jammu and Kashmir Government must provide subsidy on transportation in providing the seed of potatoes and cereals to the farmers. Discourage the use of chemical fertilizer, while the use of organic fertilizers like vermin compost, use of *Rhizobium* culture for leguminous crops be encouraged. Azotobacter culture is another biofertilizer which can be used for growing vegetables and wheat/barley.

Growing of medicinal plants

As majority of the medicinal flora of Ladakh have become rare, endangered and threatened to extinct due to their unscientific exploitation, overgrazing of the pastures, uprooting for fuel and natural disaster. In the light of the above, there is a dire need to grow medicinal plants.

Develop package of practices of medicinal plants to popularize their commercial cultivation. To achieve this objective herbal gardens are required to be developed. Some of the rare and endangered medicinal plant species of Ladakh cold arid region are: *Aconitum heterophyllum*, *Aconitum violaceum*, *Acanthalimon lycopodioides*, *Anaphalis contorta*, *Aster tibeticus*, *Dianthus angulatus*, *Podophyllum hexandrum*, *Sassurea costus*, *Sassurea bracteale*, *Ulmus wallichiana*.

Water management

As the rainfall during summer is quite scanty and inadequate to support to higher plant productivity. Hence, to produce more fodder in the pastures, it is inevitable to develop suitable water conservational and utilization method. Moisture conservation in soils of Ladakh can be achieved by

compost mulch which will prevent evaporation losses. Drip irrigation, pitcher irrigation or sprinkle irrigation should be used where it is possible. It would be much better if all the fore said methods of irrigation need to be experimented to assess their usefulness in cold arid region.

Adoption of soil and water conservation measures

Adoption of soil and water conservation measures or resources conservation technologies for efficient utilization of land, water, vegetation and human resources, approach is the only solution in the present climate change dynamism. Generally, there are three kinds of measures which can be adopted to control soil and water. They may involve use of agronomic measures, biological measures and mechanical or engineering measures.

Bench terracing or land leveling of all sloping cultivated land is found to be the most suitable practice for soil and water conservation (Bali, 2014). Build up soil fertility after fresh bench terracing/land leveling by green manuring if possible or by using FYM/vermicompost. Adopting conservation agronomic measures such as crop rotation, mulching and integrated nutrient management, especially green manuring and mixed use of FYM and fertilizers, are useful in the region.

Afforestation/grassland development/horticulture of village common lands be done on priority in collaboration with Panchayats. Choose the tree and grass species in consultation with local villagers so that the planted vegetation may be useful for them especially to meet fodder and fuel wood needs as well as for consumption of fruits. Suitable grass species are required to be planted, especially in the overgrazing pastures and deforested areas.

A good pastures species in high grazed environment should have the following physio-morphological characteristics

- a) High speed production and germinability
- b) Seed viability persists in the soil for many years so that unfavorable seasons are efficiently tide over.
- c) Capabilities to disperse seed over long distance.
- d) Sprouting is fast following grazing or harvesting.
- e) Fast seeding establishment and perennial growth habit.
- f) Palatable and nutritious to animals.

REFERENCES

- Anonymous. 2011. Leh- A magical destination. *The State Times* **16** (322): 1.
- Anonymous. 2008. Trust on irrigation facilities. *The Tribune* **128** (262): 4.
- Anonymous. 2003-2013. Conservation and Sustainable utilization of medicinal plants, Jammu and Kashmir State. Plan Proposal for support under the PDFB. Scheme of the global Environmental Facility-GET. State Level Planning Committee, Jammu and Kashmir Forest Department.
- Bali, J.S. 2014. Conservation in brief. *Soil and Water conservation Today* **9**(1): 2.
- Chaudhary, A.K., Singh, A., Yadav, P.S and Thakur, S.K. 2013. Paddy cultivation in terraced fields in Hills-A traditional technique for sustainable soil and water conservation. *Indian Farmers Digest* **46**(1): 31-35.
- Dolma, Y. 2009. Solar green houses in Ladakh. *The Tribune* **129**(68): 2.
- Dorjey, K. and Rinchen, T. 2012. Ladakhi apricot. *The Daily Excelsior* **48**(97): 4.
- Gupta, R.D. 2006. Regreening the cold desert Himalayan wastelands. *Glimpses of Future* **21**(144): 4.
- Gupta, R.D. 2006. Lush green pastures vanishing in Ladakh. *The Daily Excelsior* **42**(8): 1.
- Gupta, R.D., Mir, A.A and Mahajan, A. 2007. Popularising poplars-Grow poplars in cold arid region of Ladakh. *Wastelands News*, August–October Issue, pp.14-16.
- Gupta, R.D. 2009. *Glimpses of North West Himalayas*. Radhakrishnan Anand & Co. Pacca Danga, Jammu Tawi-180001, J&K India.
- Gupta, R.D. 2013. People of Changthang region in Ladakh. *The Kashmir Times* **70** (165): 1.
- Singh, L. 2011. Ladakh- A Self- reliant agrarian economy. *The Daily Excelsior* **47**(16): 1.
- Sharma, J.P. and Mir, A.A. 2000. *Dynamics of cold arid agriculture*. Kalyani Publishers, Ludhiana.