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Research Papers

ALTERING INDIGENOUS FARMING PRACTICES IN NORTH WESTERN HIMALAYAS

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Since ancient time, the marginal farmers of western Himalayas have developed multitude of indigenous on-farm techniques (the methods by which inputs are powered) and technologies (the application of knowledge to the production system) for optimal production. Such practices have evolved from generations through various trial and errors. Traditional farming systems are the reservoirs of a huge variety of crops, many of which are still undocumented. The indigenous practices are interlinked with animal-forest-farm resources. Recent introduction of high yielding variety (HYV) of food and fruit crops has subsequently diverted the farming systems from mixed crop cultivation to mono-crop cultivation leading to the loss of agrobiodiversity. Conservation strategies related to sustainability of the indigenous farming systems are needed for overall environmental, economic and social development through adopting the traditional and appropriate modern techniques and technologies.

Agrobiodiversity is the most potential option for sustainability of the agriculture production system (Swift *et al.,*1994). Since millennia, ancient agriculture practices have, by and large, made significant contribution in maintaining the high genetic resources involving the locally available plant and animal resources. However, modern farming application as the consequence of 'Green Revolution' has resulted the farmer's dependency on market oriented resources leading to genetic erosion. This study analysed the pivotal factors which are responsible for maintaining the hill farming diversity and also discussed the possible reasons faltering such practices in relation to current environmental milieu in western Himalaya.

Traditional agrobiodiversity practices

Agriculture remains the key source of livelihood for all of the people of the area. Information regarding the indigenous knowledge (local techniques and technologies), has evolved over a long period of time after excessive informal trial and error. Such repository of knowledge plays vital role in equity, adaptability and sustainability of the society in longer perspectives. Unlike other parts of the Himalayan region (Ramakrishnan, 1992; Rao and Saxena, 1994) in western Himalaya too the traditional farming operation is a complex product of crop husbandry, animal husbandry and forest resources constituting interlinked diversified production systems. Inaccessibility, environmental heterogeneity and ecological fragility favoured the evolution of subsistence production systems sustained with organic matter and nutrients derived from the forest. Such production systems are the reservoirs of a huge variety of crops and cultivars many of which are still lesser known to the mainstream societies and are better adapted to eco-environmental and geo-climatic conditions and social set up as compared to the modern agriculture systems. Moreover, this diversity can virtually be judged through maintaining diverse farming systems, farming situations, cropping systems, crop diversity and genetic variability within species. Such farming system, comprised of four subsystems like forest, agriculture, livestock, and household in organic linkages with each other. No input from outside the system is required.

As many as seventeen crops are being cultivated (Singh *et al.,* 1997), almost all are local breed except wheat. This huge diversity has been maintained through a variety of crop compositions, cropping patterns and crop rotations (Singh, 1996b). Seventeen cultivated crops were grouped into five categories (i) cereals (paddy with two local cultivars, wheat with two cultivars one each local and HYV and barley local cultivar) (ii) millet and pseudomillet (Amaranths, buckwheat (3 cultivars), fingermillet and maize) (iii) pulse (blackbean, frenchbean, horsebean, soyabean, green gram and pea) (iv) vegetable (potato) and (v) oil seed (mustard). Out of seventeen, twelve crops were, in general harvested as mixed cropping confined in upland located terraced slopes during rainy season whereas, three crops namely wheat, barley and mustard were usually cultivated as monoculture in winter season; occasionally wheat is mixed with

mustard. Pulses were always intermixed with millet and pseudomillet and formed twelve different crop compositions. The number of crops constituting the mixture ranged from 2 to 5. Mixed cropping constituting high crop genetic diversity might have evolved to ensure optimal production under stressful geo-environmental conditions ensuring adequate stability of the area. Leaving the land under fallow for replenishment of nutrients was still practiced at higher elevation. But this old practice is disturbed due to introduction of HVY in the last decade or so.

An enormous diversity of cultivated and wild plants, providing edible products is one of the most stricking feature of maintaining traditional farming diversity and stability. As many as twenty-five plants include wild edible fruits and seeds are obtainable from nearby forest areas. Twelve wild plants used as vegetables, sauces and salad and ten wild fruit bearing species are cultivated on their private land. About ten species are used as condiments and species. Similarly, about fifteen species are used as fodder, fuel wood and timber purpose. Thus, the people of the western Himalayas harboured high diversity food production system as compared to indogangetic plains.

Landscape diversity

Conducive performance of such systems will be appreciated enormously by the measurement of diversity stored in various segments. The conditions for rich bio-diversity are created due to micro-geo-climatic variability influencing the diversified landscape even within a shorter distance. Varying site factors like altitude, slope direction, slopping pattern, landraces, temperature, humidity, rainfall, edaphic, factors, available irrigation facilities and distances from the snowline or plains are the driving forces for the diversification of farming landscape. Inaccessibility, marginality, ecological fragility, environmental heterogeneity, locally available resources and socio-economic conditions favoured evolution of stable production systems in a heterogeneous landscape. Such landscape variability favoured the maintenance of rich genetic diversity over centuries. The discrete origin of farm fields is, by and large, complex but its functional significance would be probably related to diversified benefit to each family. The existence of discrete parcels may serve to maintain crop genetic diversity, and also largely minimize the environmental risk factors, pest control and available resource use.

Optimal use of local resources

Yield of crops is absolutely depend upon the input of locally available organic manure derived from animal's dung and urine, forest resources and crop residues. Farmers left substantial portion of crop parts in field just after harvesting the crops. Left over residue ploughed back into the system which released significant amount of nutrients and ultimately reutilized by the subsequent crops. Significant amount of weeds are also harvested to avoid the competition. Harvested weed either left in crop field and/or given to animal as fodder which finally comeback to the system. This integrated production system is therefore, the result of the human-animal-nature interaction operating since generations.

The use of bullocks for draught power and humanbeings for labour is the important input into the system. Sharing of human labour through an exchange mechanism has been operating as tradition is a way of stability and equality of society. Men usually involved to perform heavy work like preparation of farm field, terraces and bunds and carrying head loads whereas women are involved in light and sedentary work like harvesting of crops, weeding, thrashing and other domestic chores.

Incorporation of new on-farm technologies

Introduction of HYV of food and fruit crops particularly wheat, rice and apple was introduced in 1970s. This change has invariably resulted is incorporation of new farm technologies, more dependency on external yield increasing inputs (agro-chemicals and seeds), high cost and in-flux of labour and market influences. Erosion of traditional values and knowledge, loss of genetic diversity and inequity in society rapidly imperils the native landraces and overall sustainability of the agriculture systems in western Himalaya. This reveals surprising facts of declining traditional crop diversity during last two decades (Singh, 1998). Some of the crops like *Setaria italica, Echinochloa frumentacea* and *Chenopodium album*

were once the major cultivated crops but now have completely disappeared from the area (Singh *et al.,* 1996). Similarly, species of *Fagopyrum, Eleusine coracana, Amaranthus paniculatus, Triticum aestivum* (local cultivar) and *Oriza sativa* (local cultivar) are now least cultivated and are on the verge of their extinction. When any species or cultivar is lost the centuries old traditional knowledge about the same also disappear. Some more interesting changes like a shift from subsistence heterogeneous agriculture production system to economy oriented market dependence homogeneous production system are distinctly visible. Similarly, it has been pointed out that women workforce oriented traditional agriculture system is gradually started shifting to men workforce oriented conventional agrihorticulture system. Lack of technical know-how and unplanned use of pesticides in farming system has remarkably accelerated the occupational health problems to the farmers (Singh, 1996a).

Search for alternatives

To assess what system of agriculture is best suited to these marginal farmers and environment is not straightforward. Neither traditional agriculture practices are economically suitable in present context nor high input of agro-chemicals demanding species are ecologically sustainable, that could exert intolerable pressures on these fragile, high mountain environment, is easily recommendable. Therefore, new alternatives must be derived from empirical and integrated scientific knowledge based on indigenous knowledge packages, which would narrow down the gaps incurred in the system. At higher elevations promotion of fruit bearing trees would not likely to be advisable due to adverse environmental conditions but should be promoted for integrated mixed crop cultivation, the area is eco-environmentally tuned to such crops. Promotion of such model could be initiated with the involvement of peoples' participation and with the help of non governmental organisations. It seems a wise strategy linking traditional crop production with economic development through value addition by adopting the traditional and non-traditional appropriate technologies for long term planing and sustainability of the area.

REFERENCES

Ramakrishnan, P.S. (1992). Shifting Agriculture and Sustainable Development: An Interdisciplinary Study from North-Eastern India. MAB Series Vol. 10. UNESCO Paris and Carnforth (UK), Parthenon Publishing Group.

Rao, K.S. and Saxena, K.G. (1994). Sustainable Development of Rehabilitation of Degraded Village Lands in Himalayas. Bishen Singh Mahendra Pal Singh, Dehradun

Singh, G.S. (1996a) Pesticides: A growing menace. Occupational and Environmental Health 3, 13-18.

Singh, G.S. (1996b). Changing traditional land use pattern in Himachal Himalayas at Kullu, Himachal Pradesh. In: Pathak, P.S. and Gopal, B. (eds.), Studies in Indian Agroecosystems, pp. 1-13.

Singh, G.S. (1998) Environmental, ecological and socio-economic impact of introduced corps in western Himalayas: A case study of Kullu Valley. Journal of Human Ecology 9, 63-72.

Singh, G.S., Saxena, K.G., Rao, K.S. and Ram, S.C. (1996). Traditional knowledge and threat of its extinction in Chhakinal Watershed in north-western Himalayas. Man in India. 76, 1-17

Singh, G.S., Rao, K.S. and Saxena, K.G. (1997). Energy and economic efficiency of the mountain farming system: A case study in the north-western Himalaya. Journal of Sustainable Agriculture 9, 25-49.

Swift, M.J., Bohren, L., Carter, S.E., Izac, A.M. and Woomer, P.L. (1994). Biological management of tropical soils: Integrating process research and farm practice. In: Woomer, P.L. and Swift, M.J. (eds.), The Biological Management of Tropical Soil Fertility. John Wiley and Sons.

PROTOZOAN DISEASES OF LIVESTOCK, WILD ANIMALS AND MAN IN HIMACHAL PRADESH - AN OVERVIEW

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INTRODUCTION

Location

The Himachal Pradesh is the North Western state of India situated south of Jammu and Kashmir, north-east of Punjab, north-west of Haryana and Uttaranchal and west of Tibet, between latitude 30° 22' 40" N and 33° 12' 40" N and longitude 75° 45' 55" E and 79° 04' 20" E with an altitude ranging from 350 m (low valleys) to 6,975 m (snow covered mountains) above mean sea level. It has a total geographical area of 56,673 km^2 including 9859 km^2 of permanent pastureland. The climate varies from sub-tropical to sub-arctic, while the rainfall varies from 350 to 3,800 mm per annum. The state is characterised by mild summer and moderate to severe winter with temperature varying from -25°C in January to 42°C in June. The region is well known for its biodiversity (Anonymous, 1985).

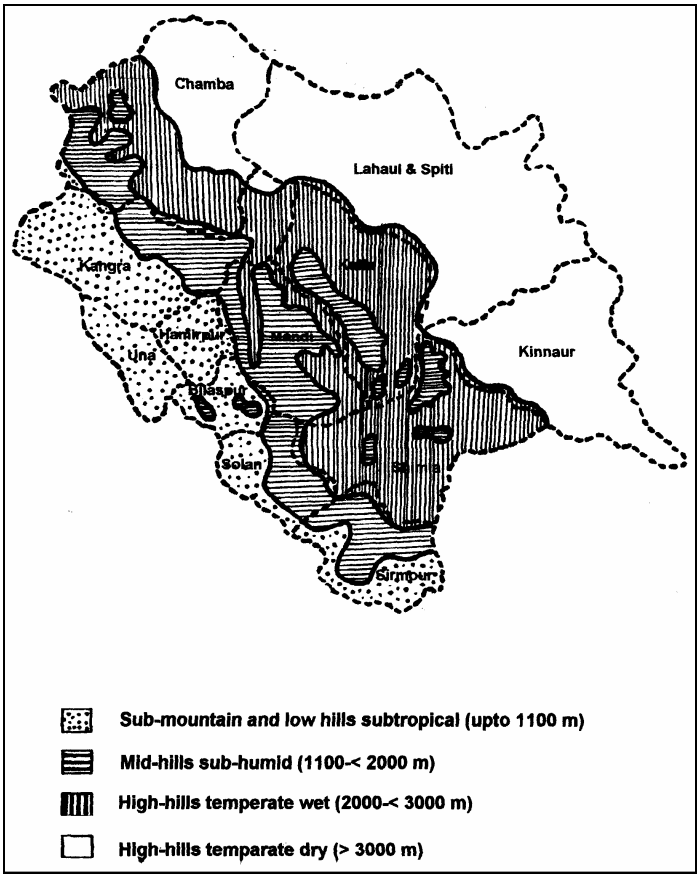

Figure 1. Agroclimatic zones of Himachal Pradesh

Agroclimatic zones

Agroclimatically the state is divided into 4 zones on the basis of topography, rainfall and altitude (Fig. 1).

Zone I	Submountainous low hills-subtropical (up to 1,100 m)
Zone II	Mid hills-subhumid (1,100- < 2,000 m)
Zone III	High hills temperate wet (2,000- < 3,000 m)
Zone IV	High hills temperate dry (> 3,000 m)

Climate

Himachal Pradesh lies in the lap of Himalayas. Its climate is largely conditioned by that single factor. The state is veiled from plains by the Shivalik range of mountains with its slopes covered with forests and meadows. The climatic conditions vary from hot and sub-humid tropical in southern low tracts, (450-900 m), warm and temperate (900-1800 m), cool and temperate (1900-2400 m) and cold alpine and glacial (2400-4800 m) in the northern and eastern high mountain ranges. The climate in Lahaul-Spiti and Kinnaur is of semi-arid high land type. Due to wide range of altitudes and climatic conditions, Himachal has rich flora and fauna contributing to rich biodiversity of western Himalayas.

Livestock and wild animals

About 92% population in Himachal Pradesh is rural and depends directly on agriculture, horticulture and animal husbandry (Anonymous, 1994). The state has a total livestock population of 50.93 lakh constituting 21.9 lakh cattle, 6.2 lakh buffaloes, 10.7 lakh sheep and 11.0 lakh goats and roughly about 1.0 lakh other animals (equines, mithun, yak, camel, pig, rabbit, etc.) excluding poultry against total human population of 51.11 lakh living in 16,807 inhabited villages (Table. 1). The livestock population has been almost static during 1982 to 1992. It increased by a meager 2.1% as compared to human population, which showed a growth of 19 % during this period (Chauhan, 1995).

Table 1. District wise livestock population in Himachal Pradesh (1992 census)

District	Cattle	Buffalo	Sheep	Goat	Dog	Others	Total	Poultry
Bilaspur	60,461	86,858	24,615	63,472	8,770	1,309	2,45,485	58,844
Chamba	2,38,988	34,832	2,58490	1,75,268	14,730	2,800	7,25,108	67,871
Hamirpur	60,671	94,089	49,498	30,719	8,500	1,783	2,45,260	28,810
Kangra	3,98,558	1,47,386	1,55,432	2,05,024	32,448	10,544	9,49,392	2,42,681
Kinnaur	20,937	3	57,720	28,622	2,182	4,358	1,13,822	5,795
Kullu	1,57,448	670	1,09,835	56,382	9,062	1,379	3,34,778	21,315
Lahul & Spiti	8,910	-	42,766	11,445	205	3,405	66,731	4,923
Mandi	4,30,331	1,07676	1,96,041	2,03,270	14,184	5,155	9,56,657	81,363
Shimla	3,29,055	23,258	1,26,531	95,831	16,469	5,866	5,97,010	45,082
Sirmaur	2,35,557	40,108	27,616	1,15,915	14,850	4,586	4,38,632	39,475
Solan	1,43,491	74,349	19,713	82,541	10,304	3,042	3,33,440	46,167
Una	67,209	91,694	6,088	47,100	13,731	826	2,26,648	21,776
H.P. (Total)	67,51,616	7,00,923	10,74,345	11,15,591	1,45,435	45,053	52,32,963	6,64,039

Source – Directorate of Economics and Statistics, Shimla (Himachal Pradesh), 1994.

Owing to differing climate in the state, it has a variety of wild life. The carnivorous animals include leopard or panther, hyena, ibex, jackal, wild dog, yellow jungle cat, fox, wolf, and marmot. Other animals are sambar, cheetal, barking deer, chausingha, ghural and hog deer. Kastura (musk deer) is found at high altitudes and hares, jungle fowl, peafowl, partridges and quails are plentiful in the lower hills. Kali pheasant is found in the low slopes and monal (snow pheasant), the state bird at high snowy altitudes.

Status of parasitic diseases

In Himachal Pradesh, animals are kept in a wide variety of husbandry systems and in different numbers - from a single cow kept for the family to large herds and flocks maintained in a range of systems. The traditional sheep and goat rearers called *Gaddis* are nomadic and their flocks are migratory in nature through well defined routes in Himalayan pasture (Bhasin and Singh, 1995). These animals remain confined to the low plains in zone I and II and border areas of Punjab during the winter season, but migrate to the alpine pasture land (3,000- 4,500 m above m.s.l.) in zone III and zone IV during spring and summer seasons. The constant movement of flocks of sheep and goats over a large area ranging different states may greatly facilitate the spread of infection among livestock. A recent estimate in Kangra district revealed that parasitic diseases are responsible for 24.5 % mortality and 40.0 % morbidity in various dairy farms (Chauhan *et al*., 1994).

The information discussed in this chapter is restricted to the studies on protozoan parasites of particular concern to the livestock industry and does not necessarily reflect the overall pattern of animal

disease in the state due to lack of research and reporting from far-flung remote areas of the state. Considerable information has been amassed on parasitic infections of livestock in Kangra district and to a lesser extent in other low hill and mid hill area, but hardly on any high hills zones of Lahaul and Spiti, Kinnaur, etc.

Specific protozoan diseases of general importance

Table 2 and 3 present a checklist of most important protozoan diseases observed in common livestock (cattle, buffalo, sheep, goat, etc.) and human beings based on the studies conducted in Himachal Pradesh. Coccidiosis and haemoprotista of livestock are the two major disease entity in Himachal Pradesh and dealt here in detail.

Table 2. Protozoan parasites frequently reported from domestic animals in Himachal Pradesh

Species	Host	References
Eimeria spp.	Cattle, buffalo, sheep, goat equine, rabbit, poultry	IVRI Annual reports, 1996-99
Babesia bigemina	Cattle, buffalo	Jithendran (1997, 2000)
Babesia equi	Horse	Sharma *et al*. (1998)
Theileria annulata	Cattle, buffalo	Jithendran (1997, 2000)
Trypanosoma evansi	Cattle, buffalo	Jithendran (2000)
Encephalitozoon cuniculi Rabbit	(kidney) Sharma *et al*. (1995)	

Table 3. Protozoan parasites diagnosed in human beings in Palampur area of Himachal Pradesh

Organism	Location	References
Giardia lamblia	Intestine	Personal observation
Entamoeba histolytica	Intestine	Personal observation
Plasmodium spp.	Blood	Personal observation

a. Protozoan parasites of intestinal tract

Coccidiosis

The term coccidiosis commonly used to refer to infection by members of the family Eimeriidae, which include the genera *Eimeria* and *Isospora*. Protozoan of *Eimeria* spp causes this disease of great economic importance. It is the genus *Eimeria* that is of concern in cattle, buffaloes, sheep, goat and other domestic animals.

Ruminants: Coccidiosis is a serious managemental disease in small ruminants and large ruminants below 6 month of age and morbidity in higher age groups. Coccidia damage the host's intestinal epithelial cells, making them more susceptible to bacterial invasion and allowing increased flow of tissue fluid into the intestinal lumen. Watery diarrhoea, which may be bloody in cattle is the major sign of infection and usually occurs about 2 weeks after ingestion of oocysts. It causes severe enteritis and diarrhoea. Clinical coccidiosis in cattle and buffalo is normally seen in animals over 4 weeks of age. Dehydration, weight loss, tenemus, rectal prolapse, anaemia or even death may occur in some cases depending upon the species involved. The disease in sheep and goat is chiefly confined to young animals up to 6 months of age and the infection is of mixed type. In sheep and goats young animals of < 6 months age are the main victims of coccidiosis. *E. arloengi, E. intricata, E. parva* and *E. ninakoyakimovae* were reported to occur in goats in H.P. out of the 11 species of coccidia known to harbour Indian goats (Gupta *et al.,* 1992; Mittra *et al*., 1998). However, good stock management and avoidance of stress can considerably reduce the risk of clinical disease due to coccidiosis. Adequate nutrition, good hygiene practices, reasonable sock density and prevention of other diseases are important. Coccidiostats may be used prophylactically during the anticipated period of risk or to treat clinical cases. Recently *Isospora* sp. has been observed in horse (HPKV Annual reports, 1998).

Poultry: Intestinal coccidiosis, caused by *Eimeria* and *Isospora* species, is very common in India and affect all categories of animals including poultry where it is still a problem, particularly under deep litter system. Medication first by sulphonamides and later by other drugs, have effectively controlled the

malady making poultry keeping a commercial preposition. However, occasional outbreaks are still not uncommon in commercial poultry keeping. Various *Eimeria* spp., which parasitize specific portions of the intestinal tract of chickens. Infections with coccidian are found in the intestinal tract often causing enteritis and diarrhoea. Coccidiosis is a major cause of mortality and sub optimal growth and conversion efficiency in immature flocks. The sporulated oocyst is the infective stage of the life cycle.

Rabbit

Coccidiosis caused *Eimeria* spp. is a major cause of morbidity and mortality in all age groups. The disease occurs in hepatic and intestinal forms, the latter being more common (Jithendran, 1997). Hepatic coccidiosis is caused by *E. stiedai*. The disease usually affects weaning rabbits of 5-8 weeks of age and is characterised by anorexia, ill thrift, weight loss and an enlarged abdomen. Grossly liver reveals number of white to yellowish spots and microscopically hyperplasia is encountered in bile duct. Death of young naive rabbits is observed before oocysts are being passed in faeces. Intestinal coccidiosis is also seen mainly in weaners, although 96 % rabbits shed oocysts, irrespective of age. Several *Eimeria* species have been documented which vary in pathogenicity and occupy the small or large intestine, or both (Fig. 2). The disease is characterised by weight loss, soft and watery faeces and severe dehydration before death. Mortality varies with the species of *Eimeria* involved, immune status of the host and amount of inoculum. Of the 25 species, which are reported to cause coccidiosis in rabbits, 8 have been reported from Himachal Predesh. Mixed infections were common and 82 % of the infected animals harboured 2-4 *Eimeria* species. In order of preponderance, *E. magna* was the most common (39.4 %) followed by *E. perforans* (16.7 %), *E. media* (16.7 %), *E. irresidua* (13.3 %), *E. stiedai* (6.1 %), *E. intestinalis* (3.3 %), *E. piriformis* (3.3 %) and *E. coecicola* (1.2 %). Jithendran and Bhat (1996) reported that the level of infection based on the oocysts per gram of faeces (OPG) revealed higher OPG in private farms (0.05-80x10^3) as compared to Government farms (0.3-16.5x10^3). The clinical coccidiosis observed in organised farms in various age groups is shown in Fig. 3. An outbreak of intestinal coccidiosis due to *E. perforans* in Angora rabbit was reported from Kangra valley (Krishna and Vaid, 1987) and recently a number of reports from this area have indicated that *E. magna* and *E. perforans* are prevalent in this region of which *E. magna* has been moderately pathogenic (Bhat and Jithendran, 1995). In commercially reared rabbits coccidiosis occurs in sub clinical form leading to growth retardation and altered feed conversion. The control of rabbit coccidiosis relies on improved management practices and chemical coccidiostats. The commonly used coccidiostats in this region are nitrofurans, sulpha drugs, clopidol, amprolium and monensin (Jithendran and Bhat, 1998).

b. Blood protista of animals

Himachal Pradesh is relatively free from blood-borne parasites when compared to other states in our country. This freedom is due to the fact that the state is also free from many tick species and biting insect vectors associated with transmission of such parasites except in warmer plain regions. Routine surveillance of blood smear from all species of animals carried out at our laboratory revealed species of protozoa, ricketsia and microfilaria (nematodes). Information on the epidemiology of these diseases in H.P. is scanty and merits further investigation.

Haemoprotozoan diseases caused by vector-borne blood protista constitute a disease entity of considerable economic importance in the state. Theileriosis, babesiosis and anaplasmosis are important and are on the increase over the last decade in low and mid hill regions. *Trypanosoma evansi* transmitted by biting flies were recorded in cattle, buffaloes and equines in warmer plains of Una district only.

Theileriosis

Theileriosis caused by *Theileria annulata* and transmitted through the bites of *Hyalomma* and *Rhipicephalus* has been considered as the most important blood protista in the region with higher incidence in exotic breeds and the crossbred stocks of all age groups consistent with the general epidemiology of the diseases in tropical areas (Jithendran, 1997). The disease in small ruminants has not been recorded. Cases of theileriosis are generally observed during summer or rainy season when the ticks have higher activity although sporadic outbreaks have been recorded year round. Clinically a rise of body temperature up to 107 ^oF and enlarged superficial lymph nodes accompanied by dullness, anorexia,

salivation, lacrymation and discharge from nostrils. The demonstration of Koch's blue bodies in the lymphocytes and monocytes of the lymph node smear or peripheral blood film is pathognomonic of the disease. Tetracycline has been used with great success in treating *Theileria* infected animals besides the commercially available schizont vaccine for prophylactic use. However, excluding the organised farms use of vaccine is not popular due to higher cost and non-availability. Transmission involves the tick vector and hence elimination of the vector population becomes essential for the control of theileriosis.

Babesiosis

Babesia bigemina is a common ailments in cattle transmitted by *Boophilus microplus* is manifested by pyrexia (40-42 ^{o}C) and haemoglobinurea. A cases equine piroplasmosis caused by *Babesia equi* infection in mare has been observed (Sharma *et al*., 1998) with a clinically subnormal temperature (100.2 ^{o}F) accompanied with haemoglobinuria and erythrocytes with 95 % parasitaemia. The disease in small ruminants has not been reported in the state. An outbreak of *Babesia* sp. has been reported among yak in the state. Further studies are required. The demonstration of characteristic piroplasmic stages in the erythrocytes from peripheral blood film is used for diagnosis. Berinil is drug of choice used in the region with great success in treating infected animals in addition to supportive therapy. Transmission involves the tick vector and hence elimination of the vector population becomes essential for the control of babesiosis.

Anaplasmosis

Though a ricketsial organism, belonging to the genus, *Anaplasma* occur in two forms, *A. marginale* and *A. centrale*. Although both the species have been recorded sporadically in cattle, the former has been well documented (Jithendran, 1997). Its importance needs a mention since it is usually found either alone or in association with *Theileria* and /or *Babesia* infection mostly in exotic and cross bred animals. A high body temperature (103-104 ^{o}F) is associated with pyrexia with increased lacrymation and salivation. In the animals suffering. The demonstration of characteristic organisms in erythrocytes is used for diagnosis. Control strategies applicable to other haemoprotozoan parasite are also effective against anaplasmosis as well.

Trypanosmosis

Trypanosomosis caused by *Trypanosoma evansi* is again a vector borne extracellular flagellate transmitted by biting flies. The disease outbreaks have been reported from warmer plains of Una district but without any incidence in hilly regions of the state so far. The demonstration of flagellates in the thin or thick blood films or by biological test by inoculation in laboratory animals is used for diagnosis. Quinapyramine sulfate and chloride salts are used in the region with great success. No vaccine is available. Elimination of the vector population (*Tabanus* fly) becomes essential for the control of trypanosomes.

c. Protozoan diseases of other organs

Encephalitozoonosis

Infection caused by microsporidian, *Encephalitozoon cuniculi* (*Nosema cuniculi*) is usually asymptomatic. Spores liberated from ruptured intestinal cells infect renal tubular epithelium and endothelium of capillaries in the central nervous system and occasionally characterised by neurological signs and polyuria. Histological examination shows granulomatous lesions in brain and kidney. This organism may be a threat to immunosuppressed human beings. An incidence of 2.8 % has been reported from Angora rabbits of Kullu and Kangra districts of Himachal Pradesh (Sharma *et al.,* 1995).

Toxoplasmosis

Toxoplasmosis caused by a coccidian parasite *Toxoplasma gondii* is a world wide zoonotic disease. The definitive host is cat and other feline animals. The infections occur in many warm-blooded animals including sheep, goats, pig, dog, poultry and mice etc. by consuming food contaminated by *Toxoplasma* oocysts. Abortion due to toxoplasmosis has also been diagnosed besides a significant high level of antibody titre in migratory sheep (31 %) and goats (60 %) (Jithendran and Vaid, 1996). *T. gondii* has been recognised as one of the cause of abortion and neonatal mortality in migratory sheep and goats

in Himachal Pradesh. Serological surveys revealed 36 % seroprevalence with a titre ranging from 1:25 to 1:5000 by modified agglutination test (Dubey *et al*., 1995; Jithendran and Vaid, 1996).

Sarcocystosis

Sarcocystis infection is encountered normally at the time of histopathological examination of herbivorous animals. In most animals this parasite does not cause clinical diseases. Life cycle in definitive hosts (dogs) is initiated by eating infected slaughterhouse wastes (offal) although no transmission studies were carried out in the state.

d. Protozoan Parasites recorded in other host species

Ruminants

Other less important parasitic infections are *Balantidium coli, Cryptosporidium sp.,* etc. in cattle. An outbreak of *Babesia* sp. has been reported among yak in the state.

Equine

Isospora spp. has been recorded in equines in Himachal Pradesh.

Pig

The protozoan, *Balantidium coli* is very commonly found in the colon of some pigs at pig farms maintained by army.

Dog and Cats

Only few cases of unidentified coccidian parasites and *Entamoeba* spp. were recorded.

Poultry

Besides coccidiosis rarely some flagellate parasites were also recorded in poultry mainly of *Trichomonas* species.

e. Parasitic zoonoses

There is a close contact of man and animals in the tribal areas of Himachal Predesh, where domestic animals are kept in basement of the house with human occupants in the first floor of same house. In addition, *Gaddis* also remain in close contact with sheep, goat and dogs throughout the year, exposing them to many animal born diseases of occupational risk. Their migratory life style is likely to have no access to permanent educational, medical and veterinary health services. They may also not have safe and sanitary water supplies leading to many zoonotic diseases.

Giardiosis caused by *Giardia* spp. and amoebosis caused by *Entamoeba* spp. seems to be the most common protozoan zoonotic diseases in human in the region. Another disease of clinical significance is toxoplasmosis. *Toxoplasma* usually causes a febrile illness. But in pregnant women it poses a danger to the foetus. Test for toxoplasmosis is usually done only by infertility clinics, as it is one of the causes of abortions. In some of the areas of upper Himachal, however, which is home to big cats rather than to the little domestic ones, the source of infection in humans seems to be quite different. Studies suggest that the ingestion of poorly cooked mutton, which harbours the developing phase of *Toxoplasma,* could be the mode of transmission.

REFERENCES

Anonymous. (1985). *Himachal Pradesh, brief facts*. Directorate of Economics and Statistics, Shimla, (H.P.).

Anonymous. (1994). *Statistical outline, Himachal Pradesh*. Directorate of Economics and Statistics, Shimla, (H.P.).

Bhat, T. K. and Jithendran, K.P. (1995). *Eimeria magna*: The effect of varying inoculum size on the course of infection in Angora rabbits. *World Rabbit Sci.,* 3:163-165.

Bhat, T.K., Jithendran, K.P. and Kurade, N.P. (1996). Rabbit coccidiosis and its control:A review. *World Rabbit Sci*., 4 : 37-41.

Chauhan, S.K. 1995. Trend in milk production in Himachal Pradesh. *Indian J. Animal Sci.,* 65: 583-588.

Chauhan, S.K., Sharma, R.K. and Gupta, Monika. 1994. Economic losses due to diseases and constraints for dairy development in Kangra district of Himachal Pradesh. *Indian J. Animal Sci.,* 64: 61-65.

Dubey, J.P., Somvanshi, R., Jithendran, K.P. and Rao, J.R. (1994). High seroprevalence of *Toxoplasma gondii* antibodies in goats from Kumaon region of India. *J. Vet. Parasitol.*, 7: 17-21.

Gupta, V.K., Katoch R.C., Agnihotri, R.K., Mittra, S. and Sambyal D.S (1992). Coccidiosis in Gaddi goats-a report. *J. Hill Res*., 5: 188-189.

HPKV Annual reports. (1990-1998). Himachal Pradesh Krishi Vishva Vidyalaya, Palampur (H.P.) IVRI Annual reports. (1986-1998). Indian Veterinary Research Institute, Izatnagar (U.P.).

Jithendran, K.P. (1990). Parasites pose a hindrance to rabbit rearing. *Indian Farming*, 40: 15.

Jithendran, K.P. (1994). Gastrointestinal parasitism in Gaddi sheep and goats in Kangra Valley, Himachal Pradesh. *J. Hill Res*., 7: 9-12.

Jithendran, K.P. (1995). Clinical coccidiosis in Angora rabbits. *Vet. Review.* 10: 21.

Jithendran, K.P. (1997a). Clinical studies on coccidiosis in Angora rabbits. *Blue Cross Book* (Hoechst). 8: 37-39.

Jithendran, K.P. (1997b). Blood protista of cattle and buffaloes in Kangra valley, Himachal Pradesh. *Indian J. Anim. Sci*., 67: 207-208.

Jithendran, K.P. (2000). A brief profile of blood protista of domestic animals in Himachal Pradesh. *Himachal Vet. J.*, 4: 19-21.

Jithendran, K.P. (1998). Rabbit production in sub Himalayan region. *Indian Farming*, May, 21.

Jithendran, K.P. and Bhat, T. K. (1996). Subclinical coccidiosis in Angora rabbits – A field study in Himachal Pradesh, India. *World Rabbit Science.* 4: 29-32.

Jithendran, K.P. and Bhat, T.K. (1998). Coccidiosis in Angora rabbits: A field study in Himachal Pradesh. In: Parasitic Diseases: New horizons. Proceedings of the 8th National Congress of Veterinary Parasitology and National Symposium on Molecular Parasitology. Oct 9-11, 1996, pp 41

Jithendran, K.P. and T.K.Bhat (1999). Coccidiosis in rabbits:A guide for the differential diagnosis of *Eimeria* species. (in press).

Jithendran, K.P. and Rao J.R.. (1996). Parasitic zoonoses : Role of migratory sheep and goats in Himachal Pradesh. *Himaparyavaran,* 8: 6-8.

Jithendran, K.P. and Sharma, A.K. (1998). A case of theileriosis in a cow: A case report. *Indian Vet. Med. J*., 22: 251-252.

Jithendran, K.P., Sharma, O.P., Dawra, R.K., Makkar, H.P.S. and Singh, B. (1998). Survey on animal husbandry practices, bottlenecks in animal production and strategies for improvement: a profile of selected villages in Himachal Pradesh. *ENVIS Bulletin*, 5: 6-13.

Jithendran, K.P. and Vaid, J. (1995). Infectious abortion in sheep and goats in Himachal Pradesh- Facts and Trends. *Vet. Review*. 11: 24-26.

Katoch, R., Mandial, R.K. and Agnihotri, R.K. (1998). Endoparasites of horses in mid hill areas of Himachal Pradesh. Abstract submitted in X NCVP, Jabalpur, 4-6 December, 1998. pp. 70-71.

Krishna, L., Jithendran, K.P. and Vaid, J. (1989). Incidence of common parasitic infections amongst ruminants in Kangra Valley of Himachal Pradesh. *Int. J. Anim. Sci.*, 4: 183-184.

Krishna, L. and Vaid, J., 1987. Intestinal coccidiosis in Angora rabbits - an outbreak. *Indian Vet. J*., 64: 986-987.

Mittoo, H.K. (1993). *Himachal Pradesh*. National Book Trust (India). 126 p.

Sharma, A.K., Gupta, V.K., Kishtwaria, R.S. and Pal, B. (1998). Concurrent *Anaplasma marginale* and *Theileria annulata* infection in a Jersey cow. A case report. *BlueCross Book* (Hoechst):11:45-46.

Sharma, A.K., Joshi, V.B., Gupta, V.K. and Pal, B. (1998). *Babesia equi* infection in a mare: A case report. *Centaur,* 14: 71-74.

Sharma, A.K., Kumar, R. and Paliwal, O.P. (1995). Occurrence of nosematosis in German Angora rabbits. *Indian Vet. Med. J.*, 19: 235-238.

Sharma, A.K., Mandial, R.K., Gupta, V.K. and Varshney, A.C. (1999). Prevalence of bovine theileriosis in Palam valley of Himachal Pradesh. *Indian Vet. J*., 76: 267-268.

BHARAT MERINO FINE WOOL SHEEP BREED OF SUB TEMPERATE COLD CLIMATE

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Indian woolen market is very big and market oriented. There is growing demand for apparel wool as India is importing fine wool (nearly 18 million Kg in 1994) from Australia and Newzealand. Under these circumstances, Bharat merino, a novel fine wool sheep breed is produced at Central Sheep and Wool Research Institute, Avikanagar, to cater the need for fine wool, for indigenous woolen market. The breed is produced through selective crossing of exotic fine wool breeds Rambouillet, Soviet merino rams with native Rajasthan wool sheep viz., Nali, Chokla, Malpura and Jaisalmeri. The breed has 75 percent exotic fine climatic inheritance. The animals can be adapted to diverse agro climatic conditions i.e. semi arid hot and sub temperate cold areas in India. The animals can be reared on conventional grazing system with concentrate feed supplementation as per schedule.

The growth traits are as follows. At birth lambs weigh 3-4 kg and attain 16-18 kg by eanling stage i.e. at three months age, 22-24 kg at six months and 30-35 kg at twelve months (Table 1). The adult body weight is about 40-80 kg depending on age. Generally males weigh more than females. The animals have good reproductive potential. The average age at first mating is 18 months. First lambing occurs at 22-23 months. Ewcs (adult females) weigh 38 to 40 kg at service. Gestation length is 150 days with lambing interval of 13 months. The average longevity of ewes is 4-5 years (Table 2).

Table 1. Least square means of growth traits in Bharat Merino

	Body weight (kg)			
	At Birth	Three Months	Six Months	Twelve Months
Overall μ	3.54±0.02 (3161)	17.07±0.12 (2938)	23.18±0.15 (2560)	31.99±0.18 (1970)
Mannavanur	3.80±0.02 (1368)	17.47±0.15 (1313)	22.74±0.20 (1117)	31.80±0.22 (924)
Avikanagar	3.30±0.02 (1793)	16.68±0.12 (1625)	23.63±0.16 (1443)	32.17±0.20 (1046)
Male	3.64±0.02 (1565)	17.90±0.13 (1436)	24.50±0.18 (1234)	33.76±0.21 (877)
Female	3.44±0.02 (1696)	16.50±0.13 (1502)	21.86±0.17 (1326)	30.21±0.20 (1093)
Single	3.93±0.02 (2791)	18.31±0.09 (2598)	24.18±0.12 (2290)	32.37±0.13 (1752)
Twin	3.15±0.04 (370)	15.84±0.02 (340)	22.18±0.27 (270)	31.61±0.32 (218)
Spring	3.66±0.02 (2223)	17.48±0.11 (2109)	24.65±0.15 (1822)	32.35±0.17 (1494)
Autumn	3.42±0.03 (938)	16.67±0.16 (829)	21.71±0.20 (738)	31.62±0.36 (476)

* Figures in parenthesis indicate number of observations.

Table 2. Reproductive traits in Bharat Merino (Least Square Means)

Trait	Ewes weight at service (kg)	Ewes weight at lambing (kg)	Service period (Months)	Lambing Interval (months)
Population Mean	39.32±0.11 (2967)	42.28±0.14 (2967)	7.5 (4934)	12 (1284)
Mannavanur	40.88±0.14 (1792)	43.93±0.17 (1390)	8.9 (792)	13.7 (712)
Avikanagar	37.77±0.13 (3142)	40.63±0.16 (1577)	6.2 (1112)	10.7 (572)

Figures in Parentheses indicate Number of observations.

Each animal produces 2.5-2.7 kg fine wool annually (Figure 2). The average fiber diameter is 18 microns and medullation percent is less than one. The animals maintained under hot climate produce short staple length (4-5 cms) fibers, as the animals have to be clipped twice in a year. Animals maintained under cold climate produce more wool with long staple length (9.4 cms) as the animals need to be clopped once in a year (Table 3). Generally males produce wool as high as 5.5 kg under cold climatic

conditions. High wool yield is obtained at 3-6 years age, there after yield decreases. Peak yield is seen at 4-5 years age (Figure 3). The quality of wool is comparable with that of imported exotic merino wool.

Table 3. Physical wool parameters of Bharat merino sheep

Parameter	At Mannavanur	At Avikanagar
Staple length (cm)	8.7	2.88-5.5
Fiber diameter (u)	19	17-20
Fleece yield (kg)	2.8 (annual)	1.3 (six months)
Medullation (%)	<1	1.08

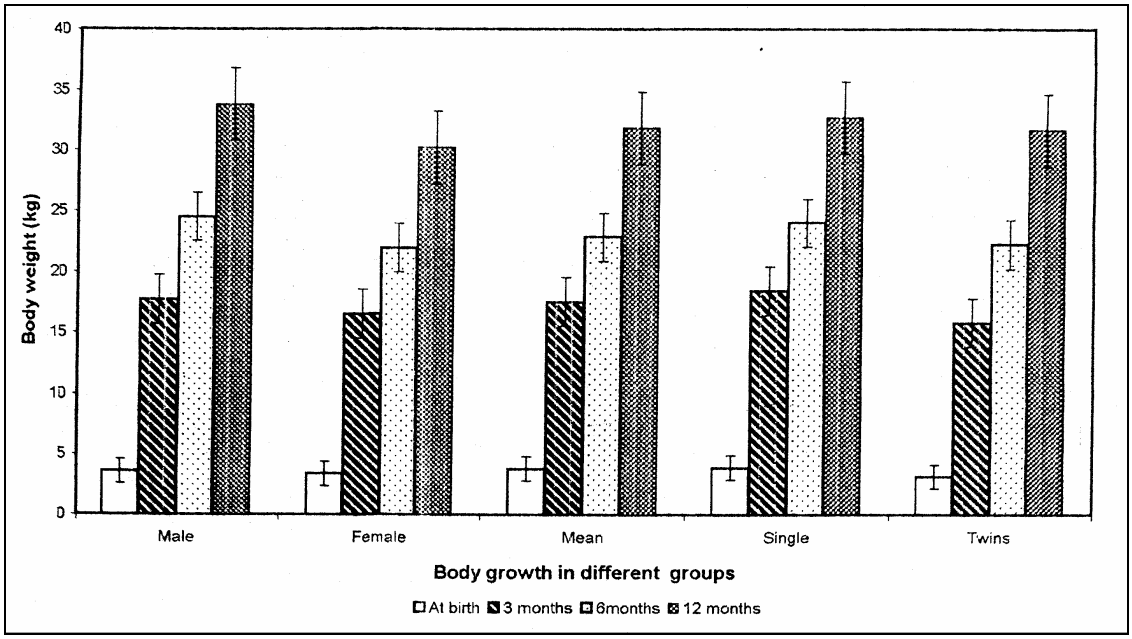

Figure 1. Growth traits in Bharat merino sheep

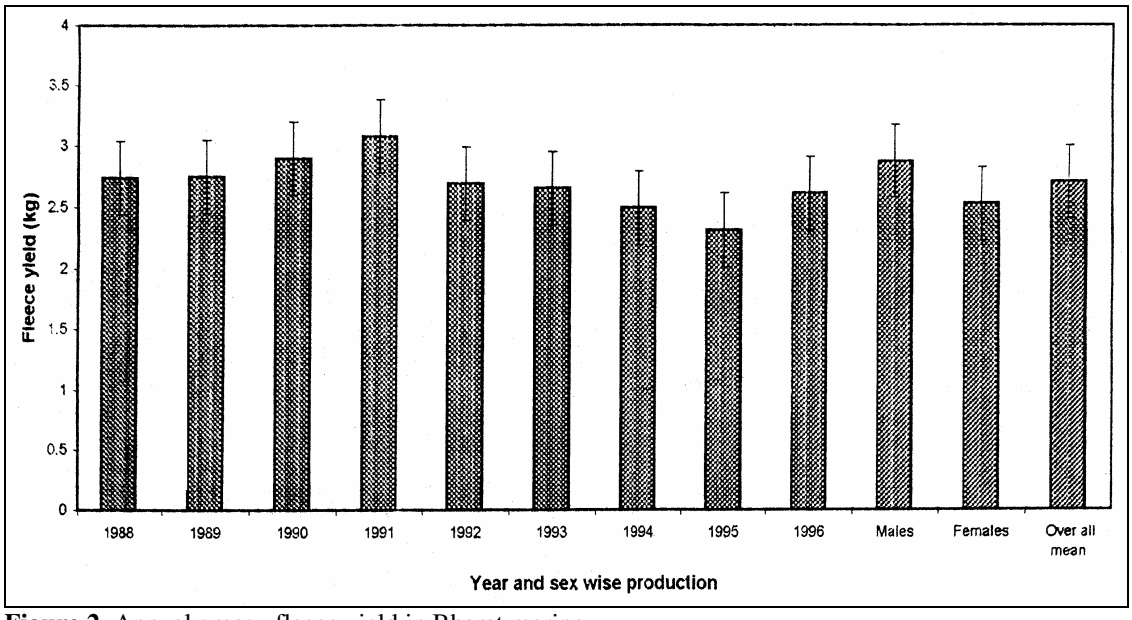

Figure 2. Annual greasy fleece yield in Bharat merino

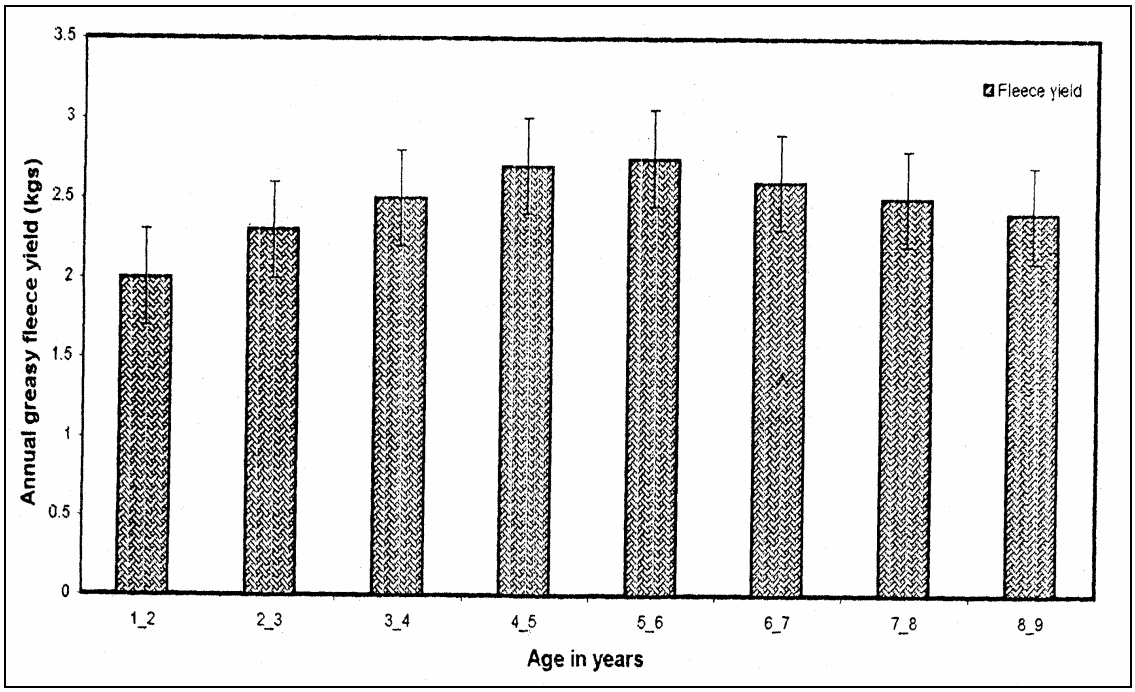

Figure 3. Greasy fleece yield of Bharat merino (age wise profile)

Wool of Bharat merino can be grouped as short fiber wool (staple length 3-4 cms) and long fiber wool (staple length 8-10 cms). The long fibers can be processed on worsted machinery and utilized for worsted suiting knitwear. The short fibers can be utilised on woolen spinning system and can be used for production of shawls and fine wool blankets. Research conducted on blending properties of Bharat merino wool at Avikanagar, Rajasthan showed that 30-70 and 50-50 percent woll-polyster blends could be processed efficiently and blended yarns can be used for worsted suiting. Similarly blending of Bharat merino wool with acrylic, ramie and nutural silk also possible. Pure Bharat merino wool can also be utilized in decentralised khadi sector for hard charaka spinning of shawls and blankets.

As the performance and wool quality of Bharat merino is on par with exotic merino wool, emphasis should be given to economically and augmented production of Bharat merino wool and its blended products as import substitute in those areas which are exclusively reserved for imported merino wool. The breed has to be popularised among farming community especially in cold hilly areas for fine wool production to meet the growing demand for apparel wool.

SILTATION PROBLEMS IN SUKHNA LAKE IN CHANDIGARH, NW INDIA AND COMMENTS ON GEOHYDROGICAL CHANGES IN THE YAMUNA-SATLUJ REGION

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INTRODUCTION

During the last hundred years or so, deforestation and wind-water borne soil erosion have been steadily increasing and have now become the major environmental problems the world over (Menard, 1963; Sioli, 1985; Endlicher, 1990; Barrow, 1991; Boardman and Favis Mortlock, 1993; Jones, 1993) and in India especially in the Himalya (Rieger, 1981; S. Singh, 1981; Ives, 1981; G. Singh *et al.,* 1990; J. Singh *et al.,* 1984; Kayastha, 1992) and NW Indian Siwalik Hill region (Glover, 1946; Gorrie, 1946; Bansal and Mittal, 1982; Mittal *et al.,* 1986; Grewal *et al.,* 1990 ; Y. Singh, 1990a; Kukal *et al.,* 1991; Saha *et al.,* 1991; Kukal and Sur, 1992). Chandigarh and Morni Siwalik Hills (CMSHs) lying in the present day states of Punjab and Haryana received special attention during the last decade because their location is adjacent to Chandigarh, the City Beautiful built as the Capital City of the erstwhile State of Punjab and now of Haryana and Union Territory (U.T.) of Chandigarh too (Mehta and Y. Singh, 1995; Y. Singh, 1990b, 1990c, 1992, 1996, 2001, 2002).

Y. Singh (2001) elaborated the state of forests in the Chandigarh and Morni Hills between the years 1966-1991 and indicated that by and large, these hills supporting open and scrub forests reflect 'badland' topography. Due to high rate of water-soil erosion there has been a change in the profile of stream beds with the result during rainy season the water often overflows their banks and floods the adjacent lands. It has also been shown by him (Y. Singh, 1996) that the Chandigarh Siwalik Hills (CSHs) lying at 30° 43′.1 - 31° 1.7′ N. Lat. and 76° 32.7′ - 76° 54.5′ E. Long. between Satluj and Ghaggar rivers covering an area of 302.55 sq km have experienced vast change due to environmental vicissitudes consequential to high rate of developmental boom experienced by Chandigarh, as reflected by the fact that these hills suffer from high rate of soil loss averaging 367.5 tons/ha/yr.

The man-made Sukhna Lake brought into existence through blocking of the water flow in the Sukhna Choe originating from these hills by raising of stone-cum-earthen embankments, is experiencing siltation over the years right from its completion in 1958. The present paper projects the geographical location of the lake with catchment area, the extent of water spread, changes in water storage capacity, vegetational aspects, as well as the extent of siltation in spatial frame work and the remedial measures taken over the time period of its existence for 43 years. Such a comprehensive study of the structure and ecology of the picturesque water body has not been attempted earlier.

Location and characteristics of the lake

Roughly kidney shaped, the lake is located at 32° 42′ N Lat. and 76° 54′ E Long. with its concavity facing the Siwalik Hills (Figs. 1-3). Its northern boundary adjoining the Siwalik Hills is natural and irregular and SW embankment, artificially built out of hewed stones, has a rockfill earth dam 12.8 m high. The lake is 1.52 km long and 1.49 km wide with initial storage capacity of 1,074 ha-m of water. The submergence area is 228 ha (565 acres) at a maximum lake level of 353.57 m (1,160 ft) above mean sea level(msl) with maximum flood level being at 354.02 m (1,161 ft) above msl. After completion in 1958 the water spread area of the lake was 188 ha and the average depth was 4.69 m with deepest point at 343.2 m (1,126 ft) above msl.

The dam's SW embankment is downstream Sukhna Choe at the confluence with it of two seasonal tributaries namely, Kansal and Suketri (Ghareri and Nepli tributaries) Choes (seasonal streams).

Out of the total catchment area of 4,027 ha, 76.4% lies in hilly forest catchment of Kansal, Nepali and Ghareri streams in the Siwaliks wherein the average slop is of 30°. The catchment areas of these streams in the Siwalik Hill are 214.31 ha, 1,285.48 ha and 514.00 ha respectively. The remaining 23.6% of Sukhna catchment (993.21 ha inclusive of the lake bed) extending from northern margin of the

lake to the hills comprises of agricultural fields, the area under stream beds, pastures and forest area along with the lake on the slopes of the piedmont plain.

Figure 1.Chandigarh Terrain and drainage lines based on Satellite Imagery IRS IA LISS 1, November 1991 (Courtesy Central Ground Water Board, Chandigarh). 1. Sukhna Lake; 2. Chandigarh City; 3. SAS Nagar (Mohali); 4. Panchkula; 5. Chandigarh Siwalik Hills; 6. Morni Siwalik Hills; 7. Ghaggar river; 8. Himalayan Hills, Kalka Range; 9. Haryana region; 10. Punjab region.

Figure 2.View of Sukhna Lake, when full of water after the rainy season it provides recreational avenues for the residents of Chandigarh and its two satellite towns.

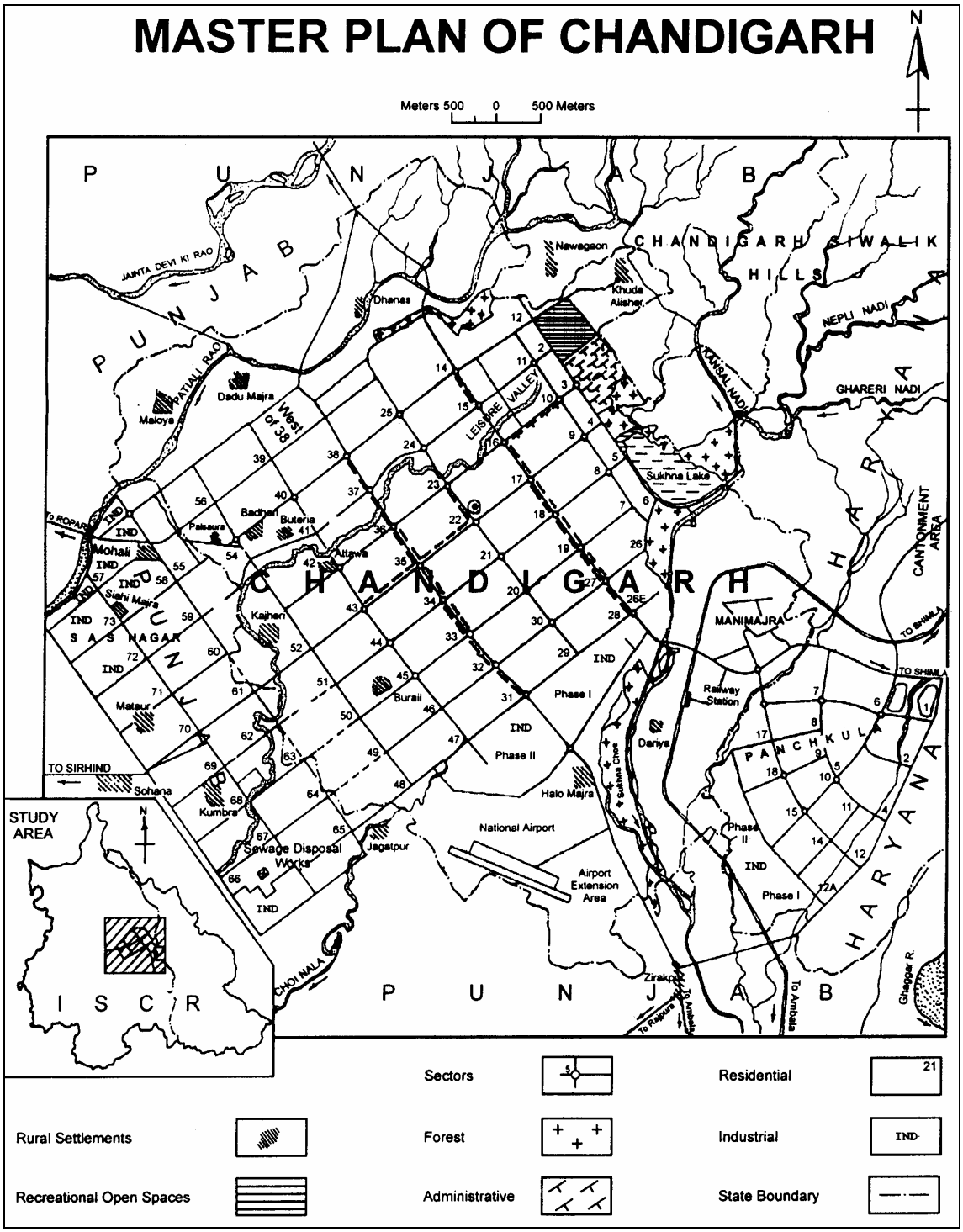

Figure 3. Master Plan of Chandigarh illustrating the salient features of residential and road systems (November 1993). [Based on: A. SOI Guide Map of Chandigarh; B. Landsat TM, FCC, June 13, 1988; C. Chief Architect Chandigarh (U.T.); D. Divisional Town Planner Punjaba & Haryana.]

Broadly speaking, the Sukhna and its catchment areas form part of Semi Natural Drainage Ecosystem (SNDE) which itself is dependent upon Natural Hilly Ecosystem (NHE) of CSHs. The origin and functioning of drainage lines (rivulets, streams and rivers) give rise to the SNDE. Its functioning is dependent upon the inequalities in the nature of rock formation, vegetation and soils and the fact that the land areas must possess some degree of slope, run off accumulating quickly in small gulleys which coalesce to form lager channels and ultimately these channels converge to form streams, rivulets and eventually the rivers.

Obviously from the above it can be derived that the balanced existence of the Sukhna Lake is entirely dependent upon efficient functioning of NHE and SNDE in the CSHs. Any deviation in the functioning of NHE and SNDE resulting in increased water run off with heavy silt load will effect the life of the lake. That is what has actually happened in case of Sukhna which is experiencing heavy siltation load as shown hereafter.

Siltation of the sukhna lake

The catchment area of the *choes* feeding the lake has rugged terrain, steep slopes, plenty of gulleys, very deep water table and the soils are predominantly alluvial sandy embedded with layers of clay and are highly susceptible to soil erosion by water run-off action. The impact of rain drops, quick flow of run-off and exposed soil coupled with hill denudation due to deforestation and animal grazing, are ideal conditions in the area for soil erosion. Naturally, the water flowing into the lake is heavily loaded with silt. The situation is accentuated by the fact that on an average 50% of the total rain in the Siwalik ends in run-off (Misra *et al.,* 1978). Thus due to higher run-off there is accelerated pace of erosion in the catchment areas of the seasonal stream tributaries of Sukhna choe resulting in the higher rate of sedimentation in the reservoir of Sukhna Lake and stream beds. Naturally, the silt deposited year after year in the lake bed reduces the water storage capacity, depth, water spread area and submergence area at lake level (Tables 1-5, Figs. 3-4).

Table 1. Sukhna reservoir: sedimentation and changes in water storage capacity (ha-m)

Year/period	Average annual sediment inflow	Total sediment yield	Cumulative sediment yield	Water storage capacity	Percent loss in original storage capacity
1958		Formation of the lake		1.074.40	
1959-64	49.95	249.75	249.75	824.65	23.24
1964-69	32.19	160.95	410.70	663.70	38.22
1969-74	23.80	119.00	529.70	544.70	49.30
1974-79	12.45	62.25	591.95	482.45	55.09
1979-84	4.03	20.15	612.10	462.30	56.97
1984-89	13.02	65.10	677.20	397.20	63.03

Based on information provided by CSWCR & TI, Chandigarh (see Bansal and Grewal, 1986,1990)

Table 2. Sukhna lake: changes in water storage capacity, 1958-1989

Year	Water storage capacity (ha-m)	Percent of original storage capacity	Percent loss in original storage capacity
1958	1074.40	100.00	-
1976	338.00	31.45	68.55
1978	590.00	54.91	45.09
1988	366.00	34.06	65.94
1989	397.20	36.96	63.04

Source: CSWCR & TI (1993)

Table 3. Sukhna lake: changes in submergence area at full lake level (353.57m above msl), 1958-1989

Year	Submergence area (ha)	Percent loss in submerged area
1958	228.60	-
1982	157.60	31.06
1987	152.80	33.16
1989	142.00	37.89

Source: Bansal and Grewal (1986, 1990) and CSWCR & TI (1993).

Table 4. Sukhna lake: changes in average water spread area, 1958-1990

Year	Water spread area	Percent loss in water spread area
1958	188.00	-
1982	118.00	37.24
1990	115.90	38.36

Source: Bansal and Mishra (1982) and CSWCR & TI (1993).

Figure 4. Although full of water, the stored water level has fallen in the winter and summer months as indicated by mark on the stone embankment in the SW (Photo 24th March, 2002).

Figure 5. Heavy sedimentation of Sukhna Lake bed. The resultant vegetation consists of mainly *Typha* in the foreground. Members of Hydrocharitaceae and Ceratophyllaceae as well as grasses and sedges commonly grow on Lake margins (Photo June 1993).

Table 5. Sukhna lake: level of the deepest point in the lake bed, 1958-1990

Year	Deepest point (m above msl)	Rise in lake bed (m)
1958	343.20	-
1983	349.65	6.45
1987	349.85	6.65
1990	350.30	7.10

Based on information provided by Department of Environment, U.T. Chandigarh Administration.

Vegetation of the lake

The common water weeds of Sukhna are not many. Only few species of grasses and sedges on the margins and, *Typha,* Hydrocharitaceae and Ceratophyllaceae growing in water are noticeable. Over 100 species of flowering plants have been reported from Sukhna Lake catchment area. Along with grasses and sedges many of these grow on the lake margins and even the summer dried up lake bed has several weeds (Fig. 5). Trees, bushes and herbaceous elements are in plentiful in the vicinity of the lake. This vegetation does not differ much from that is present elsewhere in CMSHs (cf. Y. Singh, 2001).

Animals

Sukhna Lake serves as a sanctuary for a large number of birds. About 30 species are residents and the rest are migratory, mainly the winter migrants. So far, about 150 different species of birds have been spotted from Sukhna Wetland Bird Sanctuary. Kansal Khol comprises the wild life sanctuary where large deer (grey and brown) with massive antlers, wild bear, spotted deer, jackal, Indian mangoose and wild cat can often be seen.

Pissiculture is the main economic activity associated with the lake. According to the information provided by U.T. Administration the annual fish catch had been 30 tons in 1987, 33 tons in 1988, 35 tons in 1989 and 37 tons in 1990. Fish seed of about a dozen different fishes is introduced in the lake periodically (thrice a year) and few wild types also occur.

Sukhna Reservoir: changes in water storage capacity

In the early years, after the lake came into existence, the annual rate of siltation was very high. The crucial factor before 1980s was the mass deforestation in the catchment basins of Sukhna, Nepli, Suketri and Kansal rendering steep slopping bare hills prone to excessive erosion. By 1971 about half the storage capacity of the reservoir was lost. Sedimentation further increased and in the year 1976 the loss in water storage capacity rose to about 68.5% of the total i.e. water storage capacity dropped from 1,074.4 ha-m to 338 ha-m (Tables 1,2 Fig.4). Storage capacity was partially recouped by desilting the area near Boat Club (Constructed in 1960 near the western end of the lake) for restoring boating activities which had almost come to stand still. The average annual sedimentation inflow came down to 4.03 ha-m during 1979-1984 from original 49.95 ha-m during 1959-1965 due to vegetative (aforestation and reforestation) and mechanical measures taken to check erosion as annual average sediment yield declined with slow run-off. However, it increased once again during 1984-1989 to 13.02 ha-m due to mass deforestation in 1986 in CSHs especially the Sukhna catchment.

It may be noted that due to siltation there has been an average annual loss of 2.91% in storage capacity of Lake reservoir over a period of twenty year (1958-1978). It got reduced to 2.03% in 1989. Water storage capacity of the lake declined in 1988 to 34.06% of the original but "Shramdan" (voluntary physical help) carried out in 1988 and 1989 with removal of 99,052 m^3 (9.905 ha-m) and 353,750 m^3 (35.375 ha-m) respectively, raised the reservoir capacity to 36.97% (Tables 1,2,7).

1. Within three decades the cumulative sediment deposition till 1989 resulted in a total loss of 677.20 ha-m in water storage capacity of lake (see Fig. 9). The average density of sediment deposit in the lake in 1989 was 1.20 gm/cc. Subsequently, with this deposition there was rise in the lake bed and decline of submergence and water spread area of the lake.
2. The loss of submergence area at full lake level (353.57 m above msl) during the first 24 years (1958-1982) has been to the tune of 31.06% i.e. an average annual loss of 1.29%. But during the next 5 years (1982-1987) there was a decline of 2.1%, however, during 1987-1989, a sharp decline of 4.73%, brought down water submerged area to 62.11% of the original (Table 3).

3. The water spread area decreased by 37.24% during 1958-1982 and rose to 38.36% in 1990 reducing it to 61.64% of the original in 1958 (Table 4, Fig. 4).
4. With sedimentation, the deepest point in the lake bed rose by 6.45m during the first 25 years (1958-1983) at an average annual rate of 0.26m. But during the next four years the deepest point rose by 0.2m only. However, in the next three years (1987-1990) there was an abrupt rise of 0.45m raising the deepest point in lake by 7.10m in just 32 years (1958-1990)period (Table 5). From the original water depth of 8.53m (Bansal and Misra, 1982) during summers at normal water level, the water depth has come down to less than 1.8m because of gradual inflow of silt due to erosion in the adjoining Sukhna catchment of CSHs. With this enormous siltation, often unwanted vegetation comes up over the lake bed (Figs. 5,7). In spite of all the efforts to control and remove siltation of lake, large patches of dry land with vegetation emerge during summer season which are indicative of the changes in vegetation succession taking place in various parameters of the lake reservoir.

Measures already taken to check siltation of sukhna

1. First of all, the problems of siltation of Sukhna Lake was taken up by the Irrigation Department of the Punjab Government in 1971. During 1972-1973 Kansal Choe was diverted into Suketri Choe which joined the lake at its eastern end. But because of steep slopes of the diversion channel and due to reduction in the length, the inflow of silt into the lake got accelerated, especially in the area near Spillway Regulator. This step worked. in negative way.
2. Silt was removed from the Spillway Regulator area during dry season (April-June) every year creating a basin which receives silt during next monsoons. This helped in checking the spread of the silt in the remaining part of the lake.
3. At present the regional break up of the total 10,292.12 acres catchment area of Sukhna Lake being (a) Chandigarh 7,184 acres; (b) Punjab 583.19 acres; and (c) Haryana 2,524.93 acres. Earlier, for the proper maintenance of the water shed area of the lake, the Punjab Goveronment before state Reorganization in 1966 acquired an area of 6,172 acres which under. Punjab Reorganization Act 1966 was redistributed as 2,155.72 acres in Punjab and 4,016.28 acres in Haryana. However, the control of the whole area was later on vested with U.T. Chandigarh for undertaking composite soil conservation measures.
4. During 1972 detailed survey of catchment area was conducted by Indian Agricultural Research Institute(IARI), New Delhi. It was concluded that critical sources contributing sediment load in Sukhna Lake were stream bank erosion, steep sloping hills and steep bare hills which were severely gullied and suffered from landslips. The survey recommended that in order to check erosion evaluation of catchment or subcatchment on smaller unit basis was necessary.
5. During 6th Plan (1977-1978 to 1982-1983) the Forest Department of U.T. Chandigarh executed Central Government sponsored scheme of soil conservation at a cost of Rs. 73.41 lacs.
6. Scientists of Central Soil Water Conservation Research and Training Institute (CSWCR and TI), Chandigarh started work in 1974 for anti-erosion measures for the lake. They identified a village Sukhomajri located at the head of Kansal Choe for model water shed management. The process of sediment control was speeded up with the start of this work and also with the implementation of a subsequent Centrally Sponsored Scheme for Sediment Control of Sukhna Lake in 1978. Under these projects villagers were pursuaded to do away with their goats (which grazed freely over the hills of catchment area) and instead advised to go in for agriculture. A number of small dams were constructed for storing run off water to be made available for agriculture round the year. Soil conservation measures such as contour bunding and tree plantation were adopted which helped in reducing the silt in Sukhna from 141 tons/ha in 1974 to 14 tons/ha after 1979. The success of Sukhomajri Project provided an opportunity for the rejuvenation of the lake by operating new vistas of development of foothill areas.
7. In 1986, the annual auctions for seasonal lease of fodder grass from the forest areas adjoining villages on the periphery of the lake catchment were stopped by the Haryana Forest Department and the lease was given to Hill Management Societies of these villages. These societies in turn under took to protect the area from grazings. Since 1986, Haryana Government (Forest

Department) also stopped the auction of *bhabar* grass and instead the lease was given to the village societies under Social Fencing as well as Generation of Rural Employment Schemes.

8. Over the years a number of gabion structures and check dams have been constructed along the streams feeding the lake.
9. CSWCR andTI Chandigarh under the aegis of the IARI, New Delhi was entrusted with the task of monitoring the stream flow and sediment yield from Sukhna catchment since 1979.
10. Earlier, Irrigation and Power Research Institute, Amritsar had been carrying out studies on sedimentation of Sukhna Lake since sixties on yearly basis. Monitoring stations had been established on each of the three streams draining into Sukhna (Table 6).
11. In 1988, Ministry of Environment and Forest, Government of India, recognized 228.66 ha of Sukhna Lake as one of the National Wetlands that needed priority far conservation. The measures taken to conserve the Sukhna Wetland included plantation of locally suitable varieties of trees numbering 160,000 during 1989-1990, aerial spray of seeds and fertilizes in the entire catchment area and provided two decantations tanks near the Regulator to arrest silt (CSWCR and TI, 1993).

Table 6. Sukhna lake catchment: Monsoon water and sediment yield from forest area

A. Water yield (mm)

Gauging station	Average				
	(1958-1970)	(1971-1978)	(1979-1989)	1989	1990
Kansal	-	-	56.9	105.8	114.0
Nepli	-	-	77.0	130.7	124.9
Ghareri	-	-	37.9	62.1	67.1
Weighted average	215.9	294.7	63.0	110.3	111.9

B. Sediment yield (ha-m/km^2)

Gauging station	Average			
	(1958-1978)	(1979-1989)	1989	1990
Kansal	-	0.10	0.20	0.25
Nepli	-	0.16	0.31	0.37
Ghareri	-	0.05	0.10	0.17
Weighted average	0.94	0.12	0.24	0.29

Source: Bansal and Grewal (1990).

Benefits incurred from anti-erosion and anti-siltation measures:

Previously, enumerated measures to control grazing and fodder collections, reforestation and afforestation programmes, and the erosion control measures in the catchment area of Sukhna Lake proved to be highly effective in the restoration of the hills and in benefiting the local people. It has been found that the average annual deposit of 0.94 ha-m/ km^2 of earlier years (1958-1978) declined to 0.31 ha-m/ km^2 during 1980. The corresponding figure for 1985 was 0.04 ha-m/km^2 as compared to the average of 0.10 ha-m/ km^2 for 1979-1984. The corresponding figures for 1985, 1986 and 1989 were 0.04, 0.09 and 0.24 ha-m/ sq. km, respectively. This again indicates a rising trend of deposits however, providing average annual deposits of 0.12 ha-m/ km^2 during 1979-1989 with further rise in sediment yield to 0.29 ha-m/km^2 in 1990 (Table 6). While some of the silt from hilly forest area (76.4%) of the Sukhna catchment does not reach the lake and gets deposited in the piedmont plain, additional sediment is contributed by 23.6% piedmont plain area of the catchment extending from northern margin of the lake to the gauging station in the foot hills (Bansal and Grewal, 1986).

From foregoing account, it is amply clear that the average annual silt deposits are variable due to ineffectiveness of the measures taken as well as periodic differences in whether conditions. The monsoon water yield from the area of the catchment for the years 1979-1989 at weighted average of 63 mm is less than 367.77% of the average of 294.7 mm for 1970-1978 period. The water yield for 1990 is about 1.77 times the average for the proceeding 11 years (1979-1989) due to exceptionally heavy rains during the rainy season as indicated by the consistent increase in water yields from the three subcatchments (Table 6). All this points to the fact that anti erosion and anti-siltation measures in the catchment area and Sukhna Lake respectively need to be taken simultaneously and on a continuall basis.

Figure 6. Manual desilting of the dried up portion of the Sukhna Lake bed. Peoples' effort 'Shramdan' has been mounted since 1988 for this purpose. The silt has collected towards the SW embankment. In the basin adjoining the Siwalik Hills there is still enough water though shallow (Photo June, 1993).

Figure 7. Mechanical desilting of the Sukhna Lake bed. The foreground vegetation on the silted Lake bed consits of grasses, *Ipomea* and *Polygonum* SW - Dried up Spill Way on SW embankment (Photo June 1993).

Figure 8. *Shramdan* efforts by school children for removing of silt from the dried up lake bed portion near SW end. There is lot of vegetation (Photo June 1993).

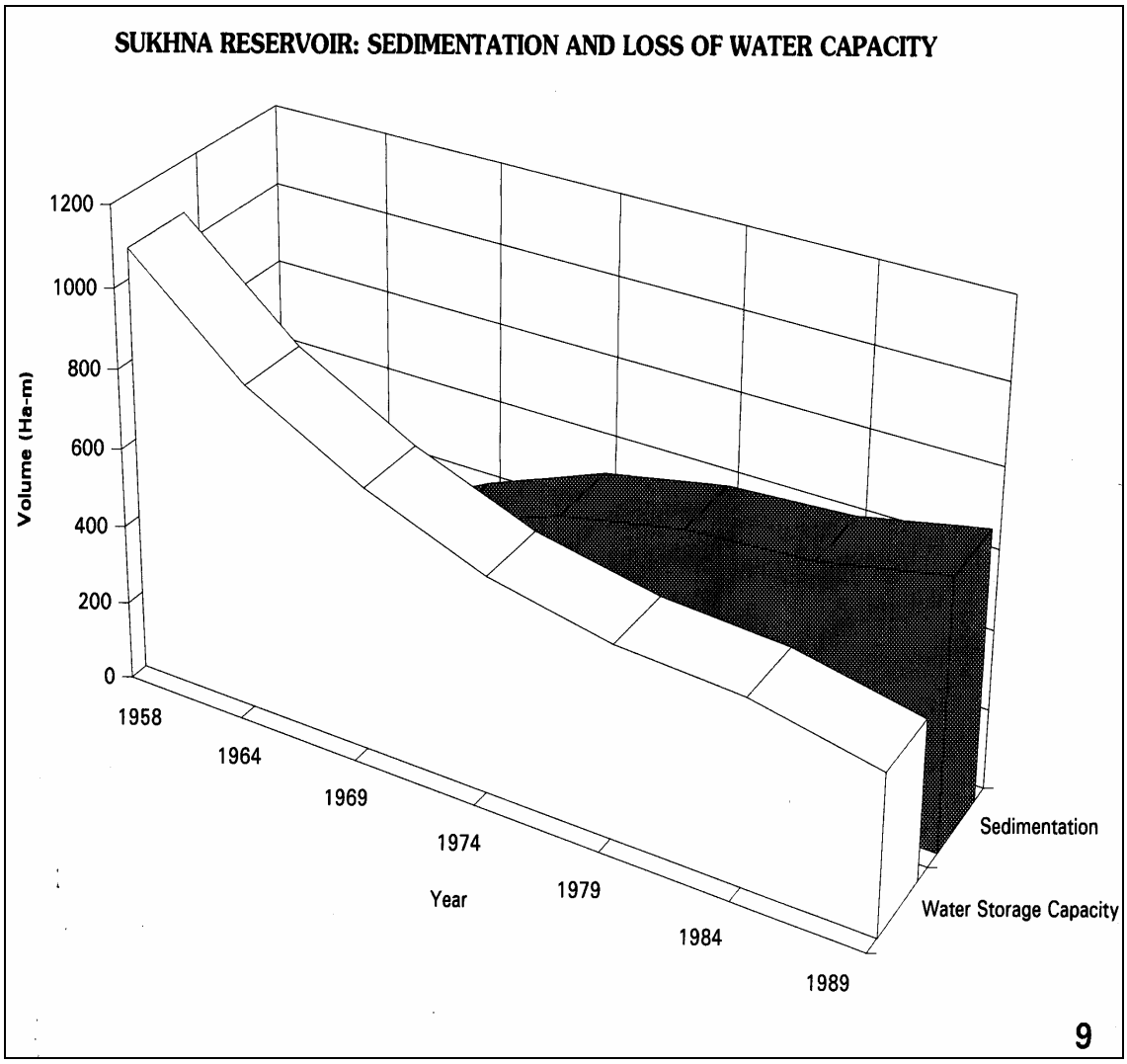

Figure 9. Graphic representation of sedimentation and water storage capacity of the Sukhna Lake during the years 1958-1989.

Desilting of the lake (*Shramdan*):

During April-July 1988 a unique 'peoples' effort '*Shramdan*' was mounted exhorting people of Chandigarh to render voluntary help in the removal of silt from the lake bed through manual labour (Figs. 6,8). In this effort all sections of society participated with great enthusiasm. In addition, excavation of silt was also carried out through mechanical measures (Fig. 7). This voluntary work for silt removal continued in the subsequent years till 1993 except for 1990 when no Shramdan was undertaken. The total silt so far removed from the lake bed comes to 10,18,800m^3 (Table 7). In 1989 for holding Third Asian Rowing Championship, Indian's longest Rowing Channel (2,170 m long, 62.5m wide and 3.00m deep) was constructed. These measures, though temporary, greatly helped in saving the lake from extinction due to siltation.

Desilting of Sukhna Lake as done by U.T. Administration by using man and animal, fossil fuel and electricity to generate mechanical power seems to be an unproductive exercise undertaken year after year as the amount of sediment removal is negligibly small as compared to expenditure involved and the magnitude of the siltation/sedimentation in the lake since silt removed every year constitutes far lesser proportion of the annual siltation in the lake.

Table 7. Desiltation of Sukna lake through *Shramdan*[+]

Year	Silt removed (m^3)
1988	99,050
1989	3,53,750
1990	No Shramdan
1991	84,900
1992	1,98,100
1993	2,83,000

[+]Silt removal figures given by Manchanda (1993) are highly variable as indicated by following year-wise data:

1988: 35,00,000 ft^3 (94,799.56 m^3)
1989: 1,25,00,000 ft^3 (3,38,569.88 m^3)
1990: No *Shramdan*
1991, 1992, 1993: 50,00,000 ft^3 x 3 (1,35,427.95 m^3 x 3)

Source: CSWCR & TI (1993)

Geo-hydrology of the Yamuna-Satluj Siwalik region

Coupled with the echo of the advancing Rajasthan desert, the problem of desiccation of the 'Yamuna-Sutlaj Divide' has been attracting the attention of the geographers, geologists, meteorologists and engineers for the past several decades. The region is bounded by the two great rivers of North India, the Yamuna on the east and Satluj on the west. These have perennial flow of water through out the year. Within the SNDE of CMSHs does not lie any river except the Ghaggar which is now a seasonal stream rising from the CMSHs and drying up before entering Rajasthan. Based on historical, archeological and physiographic evidences, G. Singh (1952) postulated that:-

(i) Ghaggar river was formerly a major and perennial stream and the Yamuna, the Satluj and small streams within the Divide which now fall into these rivers formerly drained into Ghaggar making it an important river system.

(ii) The small streams and torrents of Siwaliks which are thought to have deserted Ghaggar river and have joined Satluj (Budhki and Siswan *Nadis*) and Yamuna (Somb/Som and Holi *Nadis*) are much younger than the changes in the hydrography of the Divide. Some of the streams of the Siwaliks came into existence only about a century back when Siwaliks were deforested (also see Glover, 1946; Gorrie, 1946; Y. Singh, 1990a). Old Saraswati was in fact the Yamuna which in Vedic period pursued a westerly course to the sea and subsequently, it broke its course eastward to join the Ganga or the Ganges.

(iii) The Satluj has now shifted a great deal westward. Toward the end of 15th century it was flowing nearly 10 miles (16km) eastwards and then gradually its shift took place.

The above mentioned changes in the hydrograhpy of the rivers of CMSHs were possibly the chief causes of the desiccation of the Divide. The rate of desiccation in the region has been accelerating increasingly, particularly for the last one hundred years due to deforestation in NW Siwalik and the adjoining Himalayan region (see Bir, 2002). During the historic times there had been gradual decrease of surface and subterranean waters (due to poor infiltration, quick surface run-off and accelerated rate of extraction of underground waters e.g. Chandigarh over last 50 years) rather than any major climate changes being responsible for the desiccation of the 'Yamuna-Satluj Divide'. Over the periods, the deforestation in the NW Siwalik has been devastatingly high particularly in CMSHs. There has been redistribution of sand over fertile lands due to soil erosion in the hills. All these changes have continuously increased the desiccation of the region Field observations show that the intermittent choes of CMSHs highly dissect the hills and piedmont plains and dissipate from north to south into the upland and flood plains (see Y.Singh, 2001: Figs. 1-2, 3a, b, 4,6). By and large, now the Trans, Satluj-Yamuna region, suffers from lack of perennial surface water flows in its numerous streams or choes while earlier there used to be the fresh water flowing in some of them till about the middle of the 20th century. This change is the result of gradual desiccation of CMSHs where water infiltration during rains has greatly been reduced due to the destruction of vegetation over major portion of CMSHs.

DISCUSSION

Sukhna Choe and its tributary seasonal streams (Choes) are of intermittent nature as they receive water primariliy from seasonal surface run-off and stream flow occurs during rainy periods. These inlects of water into the Sukhna Lake carry sheets of soil run off down the surface slopes of hills in the catchment area. Over all, on an average 50% of total rain in the Siwaliks ends, in run-off (Misra *et al.,* 1978). Due to higher run-off, there has been accelerated pace of erosion in the catchment areas through which the seasonal streams flow and consequently higher rate of sedimentation in the water reservoir of Sukhna Lake and the beds of streams draining into it as shown earlier (Ref. Tables 1-7). The sedimentation rate in the lake is fluctuating over the years depending upon the condition of forest vegetation.

The catchment area of choes feeding the Sukhna Lake is large has steep slopes and the soils are predominantly alluvial in nature, obviously the water flowing into the lake is heavily loaded with silt which gets deposited year after year in the lake bed reducing its water storage capacity, depth, water spread area and full submergence area at full lake level as refereed to relier. According to Burgis and Moris (1987), if the ratio of the drainage area to the surface area of the lake is larger for a reservoir than for the natural lake, then the events in the catchment area have a great influence on the reservoir which responds very rapidly to the changes. This is what has actually happened in case of Sukhna Lake with respect to siltation.

Since there is no natural lake in the region, the man-made Sukhna Lake (actually the reservoir) has proved to be a boon for measurement of the amount of soil erosion taking place in the catchment area through siltation in the water body. Drainage basin or catchment area of a lake, stream or a set of streams is widely recognized as a fundamental unit in the geomorphogical milieu because (a) basins provide opportunity to estimate the amount of erosion, (ii) it is easy to estimate the volume of material which has accumulated in the reservoir and if the date of construction of the reservoir is known (as in case of Sukhna Lake) this, can provide the basis for an estimate of land erosion rate and (iii) the study of deposits within the basin mouth can provide considerable information about the environmental processes and about the chronology of events which occurred in the past (Gregory and Walling, 1979). Similar observations need to supplement the data on siltation about Sukhna Lake. Studies carried out on an experimental watershed near Chandigarh demonstrate that the burning of forests, felling of trees and over grazing increased the peak discharge of run off by 69%, 34% and 32% respectively (S. Singh, 1981); Since siltation in Sukhna Lake is a continuing process, preparation of future plans for control of siltation in Sukhna Lake should take into consideration these factors. Alongwith, data are essential on (i) nature of soil (porosity and solubility), (ii) development and type of vegetation (infiltration capacity), (iii) degree of surface slope and (iv), local climate conditions such as temperature, wind, humidity and of course, volume and intensity of precipitation since differences have been found in these parameters in various water sheds of the region. Any generalized approach for larger region e.g. NW Siwalik Hills as a whole is fraught with dangers of failure of anti-soil erosion scheme or their poor performance results.

Wetzel's (1983) remarks that "in such lake systems in which sedimentation has reduced water depths sufficiently for littoral dominance and in shallow lake basins which predominate the earth, rates of lake ontogeny (successional development of lake ecosystem) greatly accelerate" are highly appropriate for Sukhna Lake where in spite of all the efforts so far made to control and remove siltation, large patches of dry land with vegetation emerge during summer season which are indicative of the changes taking place in various parameters of the lake reservoir.

It will be appropriate to mention that at Hubbard Brook where O' Sullivan (1979) studied water shed ecosystem, large changes in sediment yield from the areas of the catchment which were clear-fell, indicate than man's impact upon watershed ecosystem may be profound even under normal land use regimes. Continuing he said that most man induced changes in watershed result in increased sediment yield although the reverse may, of course, apply if stabilization of the area is the object, like during reclamation of derelict land. This aptly applies to Sukhna Lake which though of 43 years existence, is till highly unstable and the problems of siltation remain the same as before since siltation rate has not stabilized at the minimal level suitable for the long life of the lake. The geoclimatic conditions in the Sukhna catchment require sustainble forestry and vegetation conservation efforts. Obviously, the biotic activity in the catchment area has to be at minimal level for the success of afforestation and reforestation

schemes and other anti-erosion measures are taken at regulated periodic intervals. This can happen and the lake can be saved for prosterity.

Finally, it may be stated with satifaction that the pictorial represantation of the vegetation of the catchment area of Sukhna Lake projected by Singh *et al.* (1998: 68-72) depicts an encourging situation as far as forests of Nepali Choe and Kansal Choe (*Nadis*) areas are concerned. Forest canopy is thick with plenaty of ground vegetation thus providing effective checks for slowing down the land erosion over the hillocks and ultimatly siltation in the lake.

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REFERENCES

Barrow, C.J. 1991. *Land Degradation: Development and Breakdown of Terrestrial Environments.* Cambridge University Press, Cambridge. pp 205-212.

Bansal, R.C. and Grewal, S.S. 1986. Studies on Sedimentation of Sukhna Lake, Chandigarh: Corrective measures and Hydrology. Annual Progress Report 1986. Central Soil and Water Conservation Research and Training Insititue Research Centre, Chandigarh. pp 1-6.

Bansal, R.C. and Grewal, S.S. 1990. Studies on Sedimentation of Sukhna Lake: Corrective measures and Hydrology. Annual Report 1990 Central Soil and Water Conservation Research & Training Institute Research Centre, Chandigarh. pp 1-6.

Bansal, R.C. and Mishra, P.R. 1982. Sedimentation of Sukhna Lake, Chandigarh. Status Report 1982. Central Soil and Water Conservation Research and Training Institute Research Centre, Chandigarh. pp 1-6.

Boardman, J. and Favis-Mortlock D.T. 1993. Climate change and soil erosion in Britain. *Geogra. J.* 159(2): 179-183.

Burgis, M.J. and Moris, P. 1987. *The Natural History of Lakes.* Cambridge University, Press, Cmabridge. pp 164.

CWSCR & TI 1993. Working paper on Conservation of Sukhna Lake. Cnetral Soil and Water Conservation Research and Training Institute Research Centre, Chandigarh.

Endlicher, W. 1990. Landscape damage in central Chile. *Applied Geogr. and Developm.* 35: 45-62.

Glover, H. 1946. *Erosion in Punjab its cause and cure: A Survey of Soil conservation.* Feroza Print Works, Lahore, Pakistan.

Gorrie, R. M. 1946. *Soil and Water Conservation in the Punjab.* Punjab Government Publ., Lahore.

Gregory, K. J. and Walling D.E. 1979. *Drainage Basin, Form and Presence: A Geomorphological Approach.* Edward Arnold Ltd., Great Britain.

Grewal, S. S. Mittal, S.P. and Singh, G. 1990. Rehabilitation of degraded lands in the Himalayan Foot Hills: Peoples Participation. *Ambio* 19(1): 45-48.

Ives, J.D. 1981. *Applied Mountain Geoecology: Can the Scientist Assist in the preservation of the Mountains.* In Lall, J.S. and Moddie, A.D. (Eds.). *The Himalaya : Aspects of Change.* India International Centre and Oxford University Press, Delhi. pp 377-402.

Jones, Dravid K.G. 1993. Slope in stability in warmer Britain. *Geographical J.* 159: 184-195.

Kayastha, S.L. 1992. *Forests and Ecology in the Himalaya.* In : Singh, R.B. (Ed.) *Dynamics of Mountain Geosystem,* Ashish Publishing House, New Delhi pp. 26-39 (30).

Kukal, S. S. and Sur, H. S. 1992. Soil erosion in the foothills of Lower Siwaliks. *J. Indian Soc. Soil. Sci.* 40: 162-167.

Kukal, S. S., Sur, H. S. and Gill, S. S. 1991. Factors responsible for soil erosion hazard in submontane Punjab, India. *Soil Use and Management* 7(1): 38-44.

Manchanda, S. 1993. A tribute to Sharmdanis. In: The Tribune, Chandigarh. Dated: July 17, 1993.
Mehta, S. and Singh, Y. 1995. Spatio-temporal changes in the Natural Hilly Ecosystem: A case study of the Chandigarh Siwalik Hills: *Trans. Inst. Indian Geographers* 16(2): 135-146.
Menard, H.W. 1963. Some Rates of Regional Erosion. *J. Geol.* 69: 154-161.
Mishra, P. R., Mittal, S. P. and Bansal, R. C. 1978. Managing land and water resources of Siwaliks. Proc. Nat. Sym. On "Land and Water Management in the Indus Basin (India)". Vol. I. *Land and Water Resources.* Published by the Indian Ecological Soc. PAU, Ludhiana. pp 215-220.
Mittal S. P., Mishra, P. R., Grewal S. S. and Agnihotri Y. 1986. Success story of Sukhomajri Watershed Management Project. *Indian J. Soil Conserv.* 14: 1-8.
O'Sullivan, P.E. 1979. The ecosystem-watershed concept in the environmental sciences. A Review. *Intern. J. Environ. Studies.* 13: 273-281.
Rieger, H. C. 1981. *Man Versus Mountain: The Destruction of Himalayan Ecosystem.* In Lall, J. S. and Moddie, A. D. (Eds.) *The Himalaya Aspects of Changes.* India International Centre and Oxford University Press, New Delhi. pp 351-376.
Saha, S.K. Kudrat, M.& Bhan, S.K. 1991. Erosoinal soil loss predictions using distal satellite data base and universal soil loss and Equation: soil loss mapping in Siwalik Hills in India. In : Shinji Murai (Ed.) *"Applications of Remote Sensing in Aisa and Oceania - Environmental Change Monitoring"* Published by Asian Assoc. of Remote Sensing, Hong Kong. pp 369-372.
Singh, G., Rambabu, N.P., Bhushan, L. S. & Abrol, I.P. 1990. Soil Erosion Rates of India.Proc. Internal. Sym.on Water Erosion Sedimentation and Resource Conservation. CSWCRTI, Dehradun, India. pp 32-38.
Singh, J.S., Pandey, U. and Tiwari, A.K. 1984. Man and Forests: A Central Himalaya case study. *Ambio* 13: 80-87.
Singh, G. 1952. The problem of desiccation of the Jamuna - Sutlej Divide. *The Geographer* 5: 27-37 (Yamuna).
Singh, S. 1981. Soil conservation and afforestation for moderating mitigating floods. *Proc. Intern. Conf.* Flood Disasters. Indian National Science Academy, New Delhi.
Singh, Y. 1990a. Requiem for Shivalik Forests *Spectrum, The Tribune,* Thrusday, August 9, 1990.
Singh, Y. 1990b. Landform features in the Chandigarh Siwalik Hills. *Res. Bull. (Sci) Panjab Univ.* 41 (1-4): 33-34.
Singh, Y. 1990c.Landform vegetation-relationship in Chandigarh Siwalik Hills. *J. Plant. Sci. Res.*6:33-44.
Singh, Y. 1992. Analysis of the Longitudinal Profiles of the Piedmont plains of Northern Punjab. *Indian Geogr. J.* 67 (2): 56-61.
Singh,Y.1996. Correlative degradational factors operative in Chandigarh Siwalik Hills.Proc.83rd Indian Sci. Congr.Session. Patiala Part III (Young scientists abstract of earth system sciences) pp.25-26.
Singh, Y. 2001. Geo-ecology of the Trans Satluj Punjab-Haryana Siwalik Hills, NW India. *Himalayan Ecology and Development : Envis Bulletin* 9(2) : 15-34.
Sioli, H. 1985. The effects of deforestation in Amazonia. *The Geographical J.* 151(2): 197-203.
Wetzel, R.G. 1983. *Limnology*. Saunders College Publishing, Philadelphia. pp 729.

VARIATION IN PLANT GROWTH PARAMETERS AND GRAIN YIELD OF HILL PADDY UNDER MIXED AND MONOCROPPING SYSTEM

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INTRODUCTION

Paddy (*Oryza sativa*) is one of the major crops of the hills. It is traditionally cultivated as a mixed crop under rainfed condition during the "Kharif season" (April – October). The hill natives maintain at least a hundred variety (landraces) of Paddy by cultivating them as a mixed crop (Zhardhari, 2000). But the modern concept of farmers is that field mixtures would reduce product yield and quality. So more and more farmers are switching over to monocropping of Paddy, which is resulting in loss of biodiversity and stability of hill agriculture. Crops have different ability to scavenge nutrients from the soil and divert it into the harvested portion of the crops. Hence either cropping system is expected to have an impact on plant growth parameters, nutrient use efficiency and hence grain yield of individual crops. Limited field scale information on differences in growth response of hill Paddy when planted as a mixed and monocrop prompted me to study the growth response and grain yield of paddy under different cropping system.

MATERIALS AND METHODS

A field experiment was carried out at the Institute's experimental site (79^0 38' 10'' E longitude 29^0 38' 15'' N latitude and 1150 m above mean sea level) during the 'Kharif ' season. The experiment was laid out in a completely randomized block design with three replicates. The plot size was 1m x 1m with 0.5m interplot and interblock space. There were three treatments namely T_1 = Paddy (local variety, control), T_2 = Paddy + Foxtail millet (*Setaria italica*) and T_3 = Paddy + Foxtail millet + Barnyard millet (*Echinochloa frumentaceae*). Local cultivation method was mimicked. Farmyard manure was applied to the plots at a rate of 1000 kg ha^{-1}. The seeds of all the three crops were broadcasted on the same day in their respective plots at a rate of 200 kg seed ha^{-1}. The soil was mixed with the help of a shovel and water was sprinkled on the plots. Seeds of all the three crops (Paddy, Foxtailmillet and Barnyardmillet) germinated within 7 - 12 days. Observations were recorded on plant height, tillers / plant, total biomass (shoot + root) at an interval of 20 days from the date of sowing at six dates. Grain yield was recorded at harvest. All data were analysed for statistical significance according to Snedecor and Cochran, (1989).

RESULTS AND DISCUSSION

Tiller number per plant, shoot height, shoot dry weight and root dry weight are examined across the cropping season. Tillering pattern is a dynamic process and deciding factor for production of spike bearing tillers. It is an important trait associated with the productivity of cereal crops e.g. Paddy. Significant differences in tiller number were observed due to differences in crop combinations (Table 1). The tiller number reduced due to stress in mixed cropping. The tiller number reduced by 15.76% when Foxtail millet was grown with Paddy and it recorded a reduction of 17.64 % when Barnyard millet was grown with Paddy and Foxtail millet.

Differences in shoot biomass are significant. Shoot dry weight reduced by11.05% in treatment 2 and 40.09 % in treatment 3. Average shoot height also fluctuated due to mixed cropping. The relationship between tiller number, root dry weight and shoot dry weight are examined. The relationships is positive and significant between tiller number and shoot biomass and root biomass (0.69 and 0.88 being the 'r' values under control, 0.72 and 0.80 under treatment 1, 0.45 and 0.75 under treatment 2 respectively, n = 18). Kawashima (1968) and Cheema et al. (1979) also reported positive correlation between tiller number and root biomass.

Table 1. Cropping season averages of plant growth parameters and grain yield of Paddy under different cropping system (pooled mean value ± 1 SE , n = 18 and 3 respectively).

Treatment	Tillers hill $^{-1}$	Shoot height (cm)	Shoot biomass (g hill $^{-1}$)	Root biomass (g hill $^{-1}$)	Grain yield (kg ha $^{-1}$)
P	8.50 ± 1.38	56.68 ± 8.93	6.51 ± 2.31	1.28 ± 0.06	1765.00 ± 30.77
P + F	7.16 ± 1.31	65.16 ± 14.47	5.79 ± 1.75	0.83 ± 0.18	1542.00 ± 25.19
P + F + B	7.00 ± 1.21	51.26 ± 8.01	3.90 ± 1.43	0.73 ± 0.16	1055.00 ± 23.74
df	17	17	17	17	
F – ratio	11.21	0.42	13.18	5.84	
P< 0.005	0.000	0.665	0.000	0.005	

P = Paddy (control).
P + F = Paddy + Foxtail millet (treatment 1).
P + F + B = Paddy + Foxtail millet + Barnyard millet (treatment 2).

Root biomass under control and treatments is also examined. The maximum root biomass is recorded under control (monocropping system). The relation between root biomass and shoot biomass is positive and the correlation coefficient highly significant, (r-values 0.87, 0.78 and 0.59 in control, treatment1 and treatment 2 respectively, n = 18).

The grain yield and plant biomass is reduced considerably when cultivated with millets compared to the pure stand of Paddy (Table 1). Such reduction is due to decrease in plant stand compared to that of sole cropping of Paddy. Similar results were obtained in grain yield of Finger millet by Siddeswaran et al. (1989). However the combined grain yield of Paddy and millets (treatment 1) (2323.40 kg ha^{-1}) is much higher when compared with sole cropping of Paddy. Paddy + Foxtail millet (treatment 2) combination recorded the second highest productivity (2312.66 kg ha^{-1}).

Drought stress is an important factor affecting the productivity of rainfed upland rice grown in nearly 6 million ha of land in India, on the other hand millets are known to be drought resistant. Early cessation of rainfall and limited availability of soil moisture due to its loss through surface runoff and poor water holding of soils lead to terminal stress and result in fewer grain number and poor grainfilling (Krupp et al., 1972). Similarly root system and its development are strongly influenced by soil edaphic factors (Mambani et al., 1990; Sharma et al., 1994). Temperature and concentration of reserve food affects growth rate. The extent to which internal and external factors influence the growth rate differs between species and reflects adaptation processes (Hsiao et al., 1976). The variations in plant growth parameters and grain yield are usually attributed to competition for resources such as light water and nutrients by different species. Complementarity in resource use between mixed crop components can limit competition between them and can lead to higher yields per unit land (Willey, 1990; Liebman 1995). Similar results are obtained in the present study also.

Thus it may be concluded that mixed cropping of Paddy and Millets is a better practice for net higher productivity coupled with more net return and greater risk coverage under rainfed condition in midhills of Himalayas.

Acknowledgements

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References

Cheema, S.S., Chaudhri, U. and Chaudhary, M.R. (1979) Rooting pattern of three rice varieties. *Crop Improvement* 6: 58 – 62.

Hsiao, T. C., Fereres, E., Acevedo, E. and Henderson, D. W. (1976) Water stress and dynamics of growth and yield of crop plants. In: *Water and plant life*, (Eds: Lange, O. L., Kappen, L. and Schulze, E. D.) Ecological studies Vol. 19. Springer, Berlin Heidelberg New York.

Kawashima, C. (1968) Root system formation in rice plant. *Japanese Journal of Crop Science* 57: 26 – 36.

Krupp, M. K., Abilay, W. P. and Alvarez, E. I. (1972) Some water stress effects on rice. In: *Rice Breeding,* IRRI, Los Banos, Philippines, pp. 663 – 675.

Liebman, M. (1995) Polyculture cropping systems. In: *Agroecology: The science of sustainable agriculture,* (Ed: Altieri, M. A.) pp. 205 – 218. Westview Press, Boulder, Co.

Mambani, B., De Datta, S. K. and Redulla, C. A. (1990) Soil physical behaviour and crop responses to tillage in lowland rice soils of varying clay content. *Plant and Soil* 126: 227 – 235.

Sharma, P. K., Pantuwan, G., Ingram, K. T. and De Datta, S. K. (1994) Rainfed lowland rice roots: soil and hydrological effects. In: *Rice Roots: Nutrients and Water Use*. International Rice Research Institute, Los Banos, Philippines, pp. 55 – 66.

Siddeswaran, K., Ramasamy, C. and Morachan, Y. B. (1989) Nutrient uptake of fingermillet as influenced by intercrops, border crops and N fertilization. *Madras Agricultural Journal* 76: 361 – 365.

Snedecor, G. W. and Cochran, W. G. (1989) Statistical Methods. State University Press, Ames Iowa 50010.

Willey, R. W. (1990) Resource use in intercropping systems. *Agriculture and Water Management* 17: 215 – 231.

Zhardhari, V. (2000) ' Barah Anaaj' – Twelve food grains: Traditional Mixed farming system. *LEISA INDIA*. September 2000.

A two-days (December 9-10, 2002) National Workshop
On

International Year of Mountain 2002

was organized at **G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263 643**

About 100 participants including scientists, researchers, administrators, and representatives from NGOs took part in the workshop. The workshop emphasized on the following topics:

- Advent of chapter – 13 in a Agenda –21 and the future directions of the global campaign for sustainable mountain development
- Biodiversity and IPR issues in relation to Mountains
- Medicinal and aromatic plant cultivation and importance of Institutional Finance for Sustenance
- Appropriate technologies for agricultural development in the mountains

STATUS AND PROSPECTS OF HORTICULTURE IN NEH REGION

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The northeastern region of India comprises eight states namely Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim. The region lies between 21°57' and 29°28' north latitude and 89°40' to 97°50' east longitude. The total geographical area of the region is 2.55 lakh km^2, which is about 8% of the country's total area. The physiography of the region is divided into three divisions namely Meghalaya plateau, the northeastern hills and the Brahmaputra valley. The NE hills alone accounts for 65% of the total land area while the Brahmaputra valley and the Meghalaya Plateau cover 22% and 13% of the area respectively. The region offers scope for cultivation of a wide variety of horticultural crops such as fruits, vegetables, flowers, tuber and rhizomatous crops and spices because of its diversities in topography, altitude and climatic conditions. A range of fruit crops varying from highly temperate types like walnut, apple, etc., to subtropical as well as tropical fruits are coming up well in this region. Similarly wide and diverse type of vegetables including indigenous ones are cultivated in the region. Despite the favourable factors and the scope for cultivation of horticultural crops, the development of horticulture has not picked up momentum as desired. The productivity of the horticultural crops is very low in the region. This paper describes the present status of horticultural crops, major constraints and future strategies for development of horticulture to insure sustainable horticultural production.

Weather, Soil and Crops in NE Region

The northeastern region faces vagaries of the high rainfall and consequently the nutrient depletion and the erosion, therefore enormous loss year after year. Agroclimatically the region is known for its wide diversities, representing temperate, subtropical and tropical areas. The diversity within a single region provides ample scope for growing a large variety of fruits, vegetables and plantation crops. Northeastern region with diverse soil and weather conditions comprises several typical agroecological situations, which inturn permit cultivation of large variety of crops. This diversity is manifested through erratic rainfall and similar fluctuations are witnessed in temperature, sunshine and relative humidity, etc.

The soil of NE region has not been surveyed thoroughly due to hilly terrain, poor communication, accessibility and dense forest. The soil of the region can be broadly classified into four groups namely, Red loamy soils, Red and Yellow soils, Laterite soils and Brown hill soils.

Table 1. Distribution of area according to elevation (Prasad, 1998)

Elevation	Area in million ha	Share percentage
Below 150m	9.23	34.88
150-300m	2.61	9.86
300-600m	2.89	10.92
600-1200m	4.76	17.99
More than 1200m	6.97	26.34

Present Status of Horticulture Crops in NE Region

About 362841.7 hectares area was brought under cultivation of fruit crops during 1995-1996 which indicates 49.42% increase in area coverage over 1993-1994. However in vegetables, 354690 hectares area was put under cultivation, which was 15.55 per cent higher than that of 1993-1994. The production of fruits and vegetables increased by 28.18 and 20.84 per cent respectively in 1995-1996 over 1993-1994. The highest increase in area (115.60%) and production (63.28%) of fruit crops were noticed in Assam and Mizoram, respectively over 1993-1994. However production of fruit crops decreased in Nagaland (8.42%) and Sikkim (44.33%) over 1993-1994. In vegetables, maximum increase in area and

production was noticed from Mizoram (120.83 and 75.72%), whereas area and production decreased in Nagaland (6.46 and 19.04%, respectively) and Meghalaya (12.36 and 11.18%, respectively).

Table 2. Agroclimatic zones of NE region and the horticulture crops grown in these zones.

Agroclimatic zone	Area	Crops
Temperate zone	**Arunachal:** Tawang, Dirang, Bomdila, Shergaon, Diban valley, Upper subansiri, Anini, North eastern part of Lohit and Northern part of east Siang **Meghalaya:** Upper Shillong, Mawphlong and Mairang **Mizoram:** Blue mountain, Halkhan, Turpang, Nauzuarzo, and Tiang **Nagaland:** Tuensong and Zunebota, Vangkung and higher areas of Mokachung **Sikkim:** gnathing, Chhangu, Serrathong, Lima, Zema, Karponag, Bordong, Resi, Kangdem, Melli param, Lachem Hilley and Yaksum	**Fruits:** Apple, pear peaches, plums, cherries, pistachio, almond, apricot, walnut, chestnut and kiwifruit. **Vegetables:** Cabbage, cauliflower, knoll-khol, broccoli, radish, turnip, beetroot, carrot, garlic, onion, spinach, cucumber, tomato, brinjal, okra, French bean, aspergus, bean, capsicum and peas
Subtropical zone	**Arunachal Pradesh:** Changyak, Naga, Khonsa, areas of trip district, Basar area of Siang district **Manipur:** Imphal valley **Meghalaya:** Jawai, Nongstonin, Nokrek, Kailash area of west garo hills, western part of east garo hills and Umkeang area **Mizoram:** As whole except lower valleys, adjoining area of Cachar and lower parts of Chhimtuipuii **Nagaland:** Mokachung district, lower parts of Kohima, Wokha and Monbhagti and Longhak valley. **Sikkim:** Namchi, Gayzing, Rongli, Rehnok, Mangan, Changthong, Uttre and Gangtok	**Fruits:** Mango, guava, citrus, litchi, low chilling peaches, pears, plums, almond, aonla etc. **Vegetables:** Brinjal, tomato, okra, beans, peas, all cucurbits, carrot, radish, turnip, cole crops, leafy vegetables, onion, garlic, chillies and capsicum etc. **Tuber crops:** Potato, sweet potato, colocasia, yams, alocasia **Ornamentals:** Rose, gladiolus, orchids, carnation, chrysanthemum, marigold, petunia, large number of other ornamental and foliage plants.
Tropical zone	**Arunachal Pradesh:** Southern part of lower Subansiri, Pasighat, Singhthow and lower part of Lohit **Assam:** Whole Assam except Karbi Anglong and North Cachar hills **Meghalaya:** Southern part of Jawai, adjoining part of Karimganj, Cachar, North Cachar Hills of Assam, southern part of Nongpol, eastern part of east Garo hills and west Khasi hills, lower part of west Garo hills **Manipur:** Manipur west district including Juibair area, Chrachanpur and Thallour of south district, Marera area **Mizoram:** Northern and western part, Chhimheipuii district **Nagaland:** Medzephena area of Dimapur sub division, sourthern part of Dimapur and Jampuii area **Tripura:** major part of Tripura **Sikkim:** Rongpoh area of east district	**Fruits:** Mango, citrus, banana, pineapple, papaya, grape, sapota **Vegetables:** Brinjal, tomato, okra, beans, gourds, amaranthus etc. **Tuber crops:** Cassava, sweet potato, amorphophallus, dioscorea, yams, coleus, colocasia etc. **Plantation crops:** Coconut, arecanut, cashew, oilpalm, rubber, coco **Spices:** Turmeric, ginger large cardamom, pepper etc. **Ornamentals:** Rose, chrysanthemum, jasmine, marigold, zenna, balsum, orchids etc.

Prospects for Horticulture in NE region

The northeastern region covers a total geographical area of 25.50 million hectares (Table 1). The agriculture in the region is broadly of two types, one practiced in the plains, valleys, foothills and terraced slope called "settled agriculture" and other on slopes of all possible gradients called "shifting cultivation or jhuming" by tribals of hill areas. The Himalayan ranges in Arunachal Pradesh extending to 5000m near the Selapass and 3000m near Tawang represent a typical Temperate Zone. At lower elevations are Naga Hills, the Miker hills and the Shillong plateau with an altitude of 1300 to 2500m above MSL having mild temperate to subtropical climate, while the Imphal valley of Manipur at 750m, represents a typical subtropical zone. The plains of Assam, Tripura and southern Mizoram are mainly tropical. The diversities within the single region provide ample evidence for the bright scope to grow a large variety of fruits, vegetables, flowers and plantation crops.

The region is one of the richest reservoir of genetic variability with 136 horticultural species growing in region (Table 2). This region is endowed with enormous genetic diversity in a number of crops like citrus, banana, mango, rice and maize. The region is the natural home of many citrus species like *Citrus indica, C. assamensis, C. latipes, C. ichagensis, C. macroptera, C. aurantium* and *Citrus reticulata* (Sheo Govind and Ghosh, 1997). Rich genetic diversity has also been reported in crops like yams, ginger and medicinal and aromatic plants. Large number of ornamental and flower species are grown wild and semi wild conditions and about 693 species of orchids are flourishing in the region. The region is reported to have immense potential for horticultural development since topographically and agroclimatically there are wide range of variation. As grain farming is proving unremunerative in the undulating topography of hilly tracts which is deprived of irrigation facilities despite the concerted efforts put forth by Government of India for the upliftment of this region. It becomes possible to exploit the untapped potential of the region through location specific horticulture and subsequently expanding the area under horticultural crops. Production of fruit crops can also be increased through adoption of scientific technologies. There is ample scope to increase the area under Sweet Orange, Acid Lime, Aonla, Guava, Jackfruit, Plum, Peach, Walnut and Kiwifruit. The trials conducted by ICAR Research Complex for NEH Region, Umiam and its regional centres have indicated that aonla, guava and peach can be successfully cultivated with improved production technologies (Anonymous, 1999).

Most of the existing orange orchards are of either seedling origin or inferior variety except for some orchards. These have to be replaced with suitable high yielding varieties. Though pineapple performs fairly well, growers are still unable to get good returns due to non-adoption of improved package of practices. Hence, there is need to adopt high density orcharding and method of induction of flowering in pineapple. In other fruit crops grafted/budded orchards of improved variety can be planted and maintained under improved production technologies for realizing better profit. Banana crop is well adopted in the region. This crop need priority research attention for increasing productivity and quality of produce. Jackfruit can be used as fruit, vegetable and animal feed. The existing trees are of seedling origin and have wide variability. Thus there is need for selection of superior clone and its multiplication through the vegetative method of propagation. Papaya is also having good potential in the region, which is mostly grown in backyard garden, and no compact orchard exists. Since it has been grown for the last several years, large mixed population has resulted which needs purification. Extraction of papain can be taken up on commercial scale to obtain better income. Pomegranate production has to be given a boost by introduction of improved varieties.

Apple industry in Arunachal Pradesh has failed to develop to a desired extent simply due to lack of follow up action for improved varieties along with adoption of scientific technologies to desired extent from the growers, developmental agencies and R & D institutions. Peaches and plums, which are well adopted, can be grown profitably by induction of early, mid and late maturing cultivars. Pears have good potential but existing trees are of inferior varieties. Productivity of pears can be increased by introduction of superior varieties. Preliminary results indicate that like walnut, apricot, chestnut, almond, cherry and kiwi fruit will be of immense value having bright scope for commercial cultivation at higher altitude of northeastern states. Jamun, jalpai and indigenous wild fruits can also be planted for obtaining fruits as well as fuel and timber.

Among the fruits mandarins, lemon, banana and pineapple alone constitute more than 2/3rd share for both area and production. Temperate fruits can be successfully grown in higher altitude of Arunachal

Pradesh, Nagaland and Manipur, while Shillong plateau is ideal for potato cultivation. Coconut and arecanut which are presently confined to Assam, Tripura and some parts of Meghalaya having sizable area under mango, jackfruit and litchi have to be extended to other nontraditional areas of north eastern region. Bay islands are well suited for the cultivation of coconut, pineapple and jackfruit whereas ginger and turmeric can be grown successfully in Meghalaya and Mizoram.

The horticultural development is moving at a faster pace throughout the country and in near future there will be a greater technology adoption both in the traditional horticultural enterprises as well as commercial sectors. The horticultural developments in NE region has to be brought to keep in pace with that of mainland. To bring the horticultural industry back from brink, some bold initiative like introduction of apple in Meghalaya, Nagaland and Arunachal Pradesh which has taken place in early seventies has to be repeated. The Arunachal Pradesh is one of the ideal place for apple cultivation. The Arunachal apples are known for its quality, which has won "All India Apple Prize" for the quality of the apples which is excellent. Arunachal Pradesh, if introduced with high yielding varieties of apple, sure it can make a big headway by exporting the produce to Bangladesh which presently depends on Bhutan besides meeting the internal demand of the northeastern markets.

The location specific technologies generated so for had only a limited applicability. Orange is the unique horticultural crop of the state but average productivity or orange is very poor in Arunachal Pradesh (2.62 Mt/hectare). When two villages of Mizoram and three villages in Tripura could sell oranges worth Rs. 35 lakhs and Rs. 54 Lakhs respectively (Bortakur, 1992), Why not it is possible in other parts of the region having good potential for orange cultivation. Therefore, there is need to refine location specific technologies through large number of on farm trials and frontline demonstration.

Strategies

- Indiscriminate introduction of planting materials from other region has to be avoided and indexing and certification programme should be implemented properly to ensure availability of quality planting material. Production technologies in fruit crops like pineapple, banana, orange and rejuvenation technologies for declined mandarin orange orchard, etc., are some useful technologies for dissemination among farmers so as to increase the productivity and quality of produce. Area should be increased under aonla, papaya, pomegranate, and jackfruit at low to mid altitude and walnut, chestnut, cherry, almond and kiwifruit at higher altitude of the region.
- Few crops like banana, citrus, pineapple, jackfruit, potato, cassava, sweet potato, ginger, turmeric, large cardamom, coconut, arecanut and good number of vegetable crops are well adopted in larger parts of the region. For ornamental orchids Sikkim, Arunachal Pradesh and Meghalaya have unique position for commercial cultivation. These crops need priority research attention for increasing the productivity and quality of the produce. Certain other fruit crops like litchi in Tripura, kiwi and avocado in Sikkim and Arunachal Pradesh, gauva and low chilling peaches in Meghalaya and Arunachal Pradesh have shown good potential and needs research support for their commercial scale cultivation. Among the spices, black pepper and cinnamon have good potential. Potato is the most important crop and its yield is quite high in Tripura (17.10t/ha). The yield of potato in Meghalaya is about 6.78t/ha against 24.4t/ha in West Bengal. The advantages of off-season cultivation have to be exploited to the maximum and potato cultivation should be increased in mid hills of the region. Orchids are the specialty of the region. Among the large number of native orchid species *Cymbidium* needs maximum research focus. Iris, *Lilium, Anthurium* etc., are some other crops to flourish the floriculture industry of the region.
- Orange is a unique horticultural crop of NE region and need priority research attention for increasing its productivity and quality of the fruits. Organic cultivation of oranges can pave the way for successful venture.
- Since the productivity of vegetables per unit area is much low in this region, there is ample scope for adopting plasticulture applications like polyhouse cultivation, drip irrigation and mulching. Low cost plastic house technologies have potential and opportunities in various agroclimatic zones of India for commercial vegetable production. These polyhouses with environment control facilities can be used

for successful cultivation of high value crops like tomato, capsicum, broccoli, Brussels sprout, lettuce, celery and cucumber, etc.

- Production of vegetable nursery under protected condition is becoming popular through out the country especially in hilly regions. Management of vegetable nursery in protected structure is easier and early nursery can be raised. Needless to emphasize that this practice eliminates dangers of destruction of nurseries by hailstorm, rain, etc., and protects from biotic and abiotic stresses. As a result cultivation of vegetables like cabbages, cauliflower, knol khol, tomato and onion has become commercial in cold desert region of the country such as Laddakh. This technology for raising nursery in poly houses should be tried in hilly areas of region.
- In recent past, throughout the world efforts have been made to control the vegetable pest by use of natural enemies, parasite, predators besides host specific insect viruses and other entomo-pathogenic micro-organisms and success has been achieved to a considerable extent. The IPM strategy combines biological, cultural, genetical and chemical methods in a compatible manner. This technology should be adapted in the region to control the diseases and pest in vegetables crops.
- IPM strategies like seed treatment with carbofuran, nursery management by sterilization of soil, use of fungicides in soil, use of bio pesticides in seed dressing, destruction of diseased plants in case of bacterial and viralincidence, avoidance of mono cropping in succession, wide spacing of plants so as to allow free air passage to keep plants dry and to take care of leaf moulds, early and late blight, encouraging the use of predators, and microbial pathogens for effective suppression of pests/diseases will fit well for revolutionizing the horticulture industry.

Conclusion

There is a need to create awareness and make the farmers receptive to the new technology through farmers participating demonstrations and training. Training facilities with respect to growing of horticultural crops and raising nursery has to be made available as per requirements. Therefore, there is a need for establishing a sound marketing system with forward and backward linkage so that vast potential of horticulture crops can be exploited through adoption of improved production technology.

Bibliography

Anonymous, 1999. Annual Report, ICAR Research Complex FOR NEH Region, Barapani

Bortakur, D.N. 1992. Agriculture of the North Eastern Region, Bee See Prakasan Guwahati

Prasad, R.N. 1998. Soil and Water conservation in NEH Region lecture delivered in National Seminar on Management Strategies for North Eastern Hill Ecosystem

Sheo Govind and Ghosh S.P. 1997. Citrus genetic resources of North Eastern Himalayan Region and their Utilization. Indian J. Hill Farming 10(1&2): 78-91

Summary of completed/ongoing projects, funded by IERP, GBPIHED

TO INCREASE PROFICIENCY IN CULTIVATION OF MEDICINAL AND AROMATIC PLANTS FOR ECOLOGICAL SUSTENANCE

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The methodology adopted was based on establishing linkages with various agencies including local NGOs, development and documentation of training material designing know-how dissemination approach, creation of field demonstration units, arranging visits and harnessing expertise of scientists and other technical resource.

The collaboration of NGOs functioning at 7 identified locations of Sirmour, Solan, Mandi and Kullu district was availed from the beginning. However, major part of the programme was carried out in Solan, Sirmour and Mandi districts. These sister NGOs helped in identification and selection of interested farmers according to circulated criteria over 250 farmers were enlisted for the programme and supplied lessons prepared by experts covering wide range of technical aspects.

During first stage 9 medicinal plants were included and with the progress of project more lessons on MAPs as recommended by experts were developed for the use of target group.

It was ensured that technologies dissemination using various approaches as per methodology developed e.g., postal service, on campus and field training's, crop demonstration, visits to resource centres, pharmacies and institutes were employed to achieve desired results.

To summarise 2 on campus, 16 field training, 24 crop demonstrations, 4 farmers visits were organised besides developing of technical material on 18 MAPs in Hindi in shape of lessons.

The involvement of farmwomen in the programme and formation of six cooperatives from the target groups were key features of the project.

RECYCLING OF ORGANIC WASTES BY VERMICOMPOSITING AND ITS UTILIZATION IN AGRICULTURE IN HIMACHAL PRADESH

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Lantana is one of the most problematic shrubs which has invaded vast areas and is one of the major menaces of cultivated and none cultivated lands of H.P. and Himalayan regions of the country. Being poisonous, this shrub has not fodder value, but it makes available huge nutrient rich succulent biomass, which can be effectively utilized as green manure or raw material for vermicomposting (used in present study) which is an easy and cheap technique to utilize obnoxious shrub like Lantana and other decomposable organic wastes.

Vermicompost is a mixture of excreta of earthworms, organic material including humus, live earthworms, their eggs and cocoons and other organisms. In this project, we have found that vermicompost prepared from Lantana green twigs and leaves (collected before flowering) in combination with fresh cow dung, was ready for use within a period of 6-7 weeks. At the harvesting stage, it becomes granular, dark brown, odourless crumbly powder. The nutrient composition of vermicompost was higher than its substrates i.e. lantana and fresh cow dung. It has higher N content (2.5%) and Fe content (0.68%) than FYM (1.4%N and 0.23% Fe0) and at per with FYM with respect to rest of macro and micro nutrients.

For agronomic testing of vermicompost, field experiments were conducted for two years in maize-wheat cropping sequence with maize as the main test crop and to see the residual effect of different treatments wheat crop was taken after maize crop in the same field. The two years study revealed that grain yield of maize increased significantly with graded doses of NPK fertilizer alongwith vermicompost

or FYM @ 10t./ha. Grain yield of maize obtained with 50 NPK fertilizer alongwith vermicompost or FYM was at par with that of 100% NPK fertilizer alone. Similar is the case with nutrient uptake by maize crop. Vermicompost and FYM were equally effective in increasing grain yield and nutrient uptake in maize crop. Increasing levels of NPK fertilizer resulted in increasing available NPK in soil and application or organic manure had favourable effect in increasing available NPK status of soil.

Application of organic manure i.e. vermicompost or FYM alongwith fertilizer NPK had beneficial residual effect in increasing yield, uptake of nutrients in wheat crop as well as available nutrient (NPK) in soil. The best treatment i.e. 50% NPK fertilizer alongwith vermicompost @ 10t./ha was tested in farmers fields. Vermicompost was prepared in farmers fields itself.

The main aim of the project was to utilize the waste materials and obnoxious shrubs like Lantana, which are creating health hazards by polluting soil, water and environment so by preparing vermicompost; this problem can be solved resulting into clean environment and valuable organic manure. This organic manure is helpful in increasing fertilizer use efficiency, soil fertility and hence crop productivity. From this study, we have concluded that by vermicomposting, we can utilize all types of decomposable organic waste viz. obnoxious shrubs and weeds, for wastes, dairy wastes, city wastes, kitchen wastes etc. to produce valuable organic manure within a period of 6-7 weeks. Hence in the scarcity of FYM vermicompost is the better substitute. Vermicomposting technique gives double benefits, i.e. it helps in cleaning the environment and saves the chemical fertilizer. The use of vermicompost @ 10t./ha to maize crop saves NPK fertilizer, the costly input by 50% in a maize wheat cropping system.

HIGH ALTITUDE PLANT SPECIES RESPONSE IN THE HIMALAYAN REGION TO GLOBAL CLIMATE CHANGE

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Noticeable changes in climate, largely due to anthropogenic impacts, have occurred in recent times. The changes in many regions especially in case of temperature have been hypothesized to be unprecedented. Any such change in climate is bound to perturb the natural systera. To understand the impact of changing climatic conditions i.e., temperature, precipitation and other environmental variables on high-altitude trees we studied the tree-ring samples of various conifer species growing in treeline zones. The soil sediments from an alpine meadow, the Valley of Flowers were also investigated to understand the temporal changes in plant communities vis-à-vis climate change.

Studies on Himalayan pine from ecotonal zones in Gangotri, Chorgad and Harshil in Uttarkashi have shown unprecedented surge in growth during the later part of the 20^{th} century especially since 1950s. This surge is attributed largely due to atmospheric CO_2 fertilization. This finding has great ecological/environmental implication, as such a species specific response will give a competitive edge to this species over the others in the ecosystem.

The Himalayan cedar tree-ring samples were studied from various forest sites in Uttarkashi region. The growth of trees in moisture stressed sites (sites with very thin soil cover and steep slope) was found to be very sensitive to variations in soil moisture regime. The cool and wet springs have been found to strongly favour the growth of trees. The strong relationship noted between tree-ring chronologies of Himalayan cedar and climatic regime during the spring season has been used to reconstruct temperature and precipitation for the length of the chronologies. The mean spring temperature reconstructing using the network of Himalayan cedar chronologies have shown 20^{th} century warming in context of the past four centuries. The existence of a strong, positive relationship between our reconstruction and high-latitude Northern Hemisphere temperature reconstruction indicates the importance of common forcing factor *i.e.*, anthropogenic influencing the climate over the two regions. The strong relationship between ring-width indices and spring precipitation has been also used to derive the precipitation variability over the western Himalayan region.

Similarly the analyses of tree-ring samples of *Taxus baccata, Albies pindrow* and *Abies spectabilis* from various forest stands have provided valuable information on tree-growth and climate relationship.

The results achieved in our study show that recent environmental changes have significant impact on tree-growth in high-altitude regions. The impact of atmospheric CO_2 fertilization on radial growth of pine has important ecological implications. Atmospheric CO_2 induced growth enhancement in trees will provide negative feedback to global carbon budget by locking up the carbon in living tissues. However, to endorse our present finding such study needs to be extended to wider geographic area.

Mean spring temperature reconstruction derived from tree-ring data network of *Cedrus deodara* has indicated 20^{th} century warming in context of the past four centuries. This warming has been hypothesized largely due to anthropogenic forcing. However more predictor chronologies covering wider network should be added to our present data set to obtain more robust reconstructions.

BUILDING A MODEL PLAN FOR BIODIVERSITY CONSERVATION AND SOCIO ECONOMIC DEVELOPMENT OF THE PEOPLE IN THE BUFFER ZONE OF THE VALLEY OF THE FLOWERS NATIONAL PARK BASED ON SUSTAINABLE ECO-TOURISM

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Study pertaining the management of grasslands in the valley of flowers National Park Garhwal Himalaya was conducted during 1997. The objective of the study was to evolve a model plan for bio-diversity conservation and Socio-economic development of the people living in the vicinity (buffer zone) of parks and sanctuaries based on sustainable eco-tourism.

The valley of flowers (87.50 km^2 30^0 48' N and 79^0 33 79^0 46' F) National Park can be divided into three broad eco-climatic zones viz. sub alpine (2800-3500 mt.). Lower alpine (3500-3700 mt.) and higher alpine (3700mt.) In each stratified zone random quadrates of 50x50 cm. were laid to quantify the vegetation parameters i.e. species diversity, richness, evenness, density and frequency. A total of 520 species of plants including 498 Angiosperms, 4 Gymnosperms and 18 Pteridophytes were recorded within the Valley of flowers. The ratios of monocot and dicot families, genera and species were 1:4.1, 1:3.5 and 1:4.3 respectively.

The new records were added to the existing list of plants viz. *Saussurea att, Duthiea bremoides, Lycopodium Selago, Salix Calyculate* and *Pimpinella hookerie*. Although the valley of flowers constitutes 1.3% of the total geographical area of the Chamoli district, yet it contributes 25% of the total flora. People's perception shows that species diversity is decreased in the valley of flowers. In the absence of quantitative data from the past studies it is not possible to infer whether species diversity has increased or decreased after the declaration of the park and resultant ban on livestock grazing since 1982. However, visual observations shows that the density of rare herbs such as P*olemonium caeruleum, Cypridium Himalayan, Dactylorrhiza hatagirea Herminium jesep, Companula latifelra* etc. (where as density of *Polygonium* and *Osmurda* has also increased in the valley of flowers National Park) have increased since the declaration of the valley as National Park.

Out of 31 rare and endangered plant species including 11 species listed in the Red Data Book (RDB) of the Indian plants recorded within the Valley of Flowers National Park, only 10 species appeared in the sample plots. *Aconitum heterophyllum* reported by earlier workers was not found during the present investigators. Most of the rare species were found in unusual microhabitat e.g. rocky slopes, forest edges. These species are rare because of restricted habitats, small population size range of distribution and over exploitation by man for the medicinal uses in the past. At present Brahma Kamal is experiencing a great pressure because of its use in worship in temples, so it has become endangered.

Polygonium polystachym (enemy of flowers), a fast growing herb was mostly found in presently eroded slopes, past camping sites, river bands and avalanches traps both within and outside of the park

<3800 m asl. This herb has been eradicated from this area by Impatiens sulcate mixed herb community. The number of species present within polygonium polyspohepatches with microclimatic conditions and altitudes. Past camping sites had test number of species (25 per stand) compared to other areas (39-42 per stand) within the same elevation range.

Considering the existing pattern of floristic distribution, its compositional behavior and declining trend in floristic diversity, long term conservation of floral diversity in the Valley of Flowers National park needs to be carried out in the following manners.

1. Identification and restoration of rare plants and their habitat.
2. Recovering and rehabilitation program in the outer fringes of the park.
3. Monitoring of areas which are dominated by tall and fast growing herbs.
4. Ecological research on threatened species.
5. Effective implementation of existing forest conservation Act and peoples participation in conservation of the area.
6. Development of nature interpretation and guided nature trails in the Valley of Flowers.
7. Some booklet and pictorial books should be prepared by forest development people pictures showing flowering plant and wild animals found in the Valley of Flowers. Some sky should be placed on the edge of trail regarding the conservation and distance to the Valley of Flowers.
8. Tourist at Ghangaria should be shown some video film for the conservation of Valley of Flowers.
9. According to the villagers grazing should be allowed to reduce polygonium weed and to disseminate the seeds of flowers from one place to another place in the Valley of Flowers.
10. Poaching of animals by smuggler militants and bridge guards should be stopped at Ghangaria, the gaps in Valley of Flowers should be patrolled during the off season. This job should be given to the local people of Bhyunder villages for their socio-economic upliftment and inclination towards the conservation of Valley of Flowers.
11. Dustbin in the shops in the way from Govind Ghat should be encouraged with the help of villagers.

DIATOM BIODIVERSITY IN THE HIMALAYAN LOTIC SYSTEMS

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Practically little is known about the aquatic biodiversity in India and almost nothing in case of the mountain [including Himalayan] streams and rivers. At the best we have fragmented point estimates of species richness and diversity. In order to have substantially representative information for a region, the Mandakini basin was selected because the author has already surveyed the Alaknanda Ganga in its middle and lower sections and some major tributaries in the lesser Himalaya. Also, only the Mandakini basin has less pine and more of *Oak-Rhododendron* and high altitude meadows. This difference made it logical to examine levels of local biodiversity.

In order to estimate biodiversity [species richness, diversity and evenness], intensive (all possible substrates in triplicate and integrated later) seasonal sampling was undertaken initially in 29 and later in 18 streams between 620-2600 m elevation. Those at low elevation drained Pine Forest (PFSLE) compared with the Mixed Forest in middle elevation (MFSME 1&2), while the Kharsu Oak-*R. campanulatum*-Supruce-Fir at higher elevation (KO-RFSHE). Floral components and their longitudinal distribution were also recorded. The relative abundance was estimated and used to see spatial variations and classify streams. The S, H and E were computed to obtain a picture of local and regional diversity.

Physical and Chemical Characterisation

In SLE streams the thermal regime varied from 6-28^{o}C. In SME the regime varied between 5-22. In SHE it varied from 4 to 19. The influence of altitude was obvious on the thermal regimes of these streams. The lower limit of temperature differed by 1^{o}C between SLE and SME and by 9^{o}C in SHE while the upper limit varied between 6-10/11^{o}C. This also resulted in greater fluctuation annually. Conductivity was high in the basin. The DO was high in SLE and SME compared with SHE. The nutrient level of SLE

and SHE was low with silicates ranging from 0.02 to 0.6, phosphates 0.15-0.75 and nitrates from 0.1-0.5 $mg1^{-1}$. The SHE had relatively lower levels of nutrients.

Flora

In the Mandakini basin 200 diatom taxa were recorded a large chunk which [117-taxa] was Biraphid. The next major component was monoraphid [45 taxa]. The remaining included 26 taxa of araphids and 12 taxa of raphidioids all belonging to *Eunotia* only. The araphids (14%) included *Diatoma* (8) and *Syndera* (9 taxa). Next were *Fragilaria, Meridion* and *Staurosirella*. The genera *Stauroneis, Peronia, Tabellaria, Denticula* and *Frustulia* were recorded for the first time in the Garhwal region.

- Araphids with no active means of locomotion are less at higher altitudes, more due to torrential flow of the river than to low temperature.
- The Mandakini, which was torrential at Soneprayag had fewer araphids.
- Other high altitude streams of the Mandakini basin had low temperature but not torrential flow [owing to low discharge] and thus were equally rich in araphids.
- About 50% of the araphids, around 80% of monoraphids and 60% biraphids were widely distributed in the basin.
- Seven [7] species were recorded across the gradient of the altitude and one each was restricted to some SLE-SME1 (*E. pectinalis* var, *minor)* and SME2-SHE (*E. crista* var. *galli), E. veneris* in DV2 and *E. kochelineis* in PB were restricted to SHE. In the basin, RW and K-M had highest number of *Eunotia* spp, 5 each.
- Of 200 diatom taxa recorded from the Mandakini basin, 122 taxa were common to the Alaknanda-Ganga basin. About 78 diatom taxa were new to this basin and hence the Garhwal region. These are hence, new records for the Garhwal region.

Abundance

In most of the streams only few taxa showed regular abundance. At higher altitude the number of RAT were low.

- The altitude exerts influence on the abundance of the taxa. While the RAT occur across the gradient of altitude they tend to attain high abundance only in a particular zone. Only *A. minutissima* cut across the barriers of altitude (evidenced by cluster analysis also) and exhibited dominance in SME1 and SME2. Other dominants were common in lower and middle or middle and higher or in lower, middles as well as higher elevation.
- Hence, no two streams were similar in abundance.
- *S. ulna* was exclusive to SLE. The taxa common to the SLE and SME only, included distant (with 3^{rd} or 4^{th} highest abundance) subdominants like *A. biasolettiana, A. lanceolata* and *C. placentula* var. euglypta.
- *S ulna* forma *mediocontracta* only was common to SME1 and SME2, as well as SME and SHE, while *E. minutum* and *C. placentula* in SME and SHE.

Two factors ANOVA based on raw data as well as mean abundance indicated significant difference in the abundance pattern among taxa as well as streams.

- Peculiarly, each stream had its own signature of abundance
- The micro-regimes of water current velocity, the size and shape of substratum and nutrient levels may act as limiting factors and prevent the same taxa from becoming abundant in all the streams of same elevation. This enhances the indicator value of diatoms as they can register even small variations in the physical or chemical characteristics of the stream.
- Two important conclusions were derived
- First, streams located at same altitude do not necessarily have similar dominants and subdominants and thus the community structure. They were similar only if forest was similar. In the SME like Kaidung, Sitapur, Byung and Sonc which are miles apart from the Dcoria brook and Mastura, the major abundants (dominants) were same, for instance *A. minutissima.*
- Secondly, the abundants varied with altitude. Different altitudes with different vegetation varied in abundants. The PFSLE were characterized by the abundance of *S. ulna* and *A. minutissima,* the MFSME1 and MFSME2 by *A. minutissima* alongwith *G. parvulum* and *C. affinis,* while the KO-RFSHE by *A. minutissima, C. placentula* var. *euglypta* and *C. affinis.* The difference would certainly magnify if a community analysis were performed. For instance SLE were represented by *S. ulna, A.*

minutissima or vis-à-vis RM as well as RW and BW plus KK, respectively. In MFSME1/2 it was *A. lanceolata-A. minutissima* (BG) or *A. minutissima-S. ulna* var. *oxyrhynchus* forma *mediocontracta* (SI, MS) or *A. minutissima-A. biasolettiana-S. ulna* var. *oxyrhynchus f. mediocontracta* (GB) or *A. minutissima-N. radiosa* (KI), compared with *A. minutissima-D. hyemale-A. biasolettiana* (AK) in SHE Longitudinal variation in the abundance was evident when K-M and S-M were compared. The latter located at middle elevation was characterised by the dominance of *C. affinis*, whereas the former (K-M) at lower elevation, by the dominance of *S. ulna.*

The Cluster analysis indicated complete segregation SLE, SME1 and SME with intrusion of SME2. S-M was distinct among SME1. Also, the site of Mandakini in the middle elevation was quite distinct from that in the lower elevation. The resemblance of Akashkamini with Kakra was due to same catchments.

Biodiversity

Altitudinal variations: The mean species richness, diversity and evenness tended to increase gradually with decrease in the altitude of the basin, hence showing a negative relationship. This however, was a trend not a rule, because there were pockets causing fluctuations. In the Mandakini basin the Shannon diversity for the diatom community was <3 in the SHE and >3 in the SME and SLE. Like Shannon diversity, the mean species richness and evenness also increased from SHE to SLE (with decreasing altitude). Notably, S tended to be exceptionally similar among the streams of SME1 (26 taxa). However, among the streams of each elevation these parameters exhibited a peak and a fall. Consequently, a bi-humped profile was observed for S and E while a tri-humped platykurtic profile for H in SLE, SME and SHE.

- On this basis centers of diversity were identified in each zone (SLE, SME, SHE) In SLE, the Rampur Gad. All SME1 were equally rich. However, the Byung Gad was relatively more diverse and even. In SME2 the Deoria brook was rich. In SHE, the Pothibasa Gad exhibited highest richness, while diversity and evenness was high in the Akashkamini.

The relationship of S, H and E, amongst themselves was by and large positive, because a number of species in a sample had similar abundance which was contrary to the usual observation that few species are common and many are quite rare which may be an indicator of pristine or 'undisturbed' environment. The trend of increasing H and E was more emphatic in the SHE, while that of S was not deterministic and the pockets were more in the SME. The basin vegetation does not seem to contribute significantly to diatom diversity. The Oak at middle (1000-2000 m) was more diverse than the high altitude (>2000 m) counterpart. Possibly, the prevailing thermal regime suppresses the manifestations of other abiotic factors, especially the variety of minerals and nutrients that may be present in a diverse forest through leaf litter, yet not available to diatoms.

Lateral variation

At mid elevation the Sona was species rich but less diverse than the Mandakini. At lower elevation the Rawan was richer than the Mandakini, although both of them were equally even and therefore similarly diverse. The Mandakini was less diverse than all the SLE stations (BW, RM, KK).

Longitudinal variations

The stations on the Mandakini followed the trend of increasing richness, diversity as well as evenness downstream of its origin. In case of the Kakra stream system also, but diversity as well as evenness increased from the headwater zone (AK).

The Himalayan mountain waters present temperate like conditions where the physical environment may have a greater influence on diversity. At intermediate levels of disturbance biodiversity maximizes which seems to be true for SLE. Disturbance can operate on local scale. Factors like predation, herbivory, fluctuations in physical factors and catastrophes can be lumped together as 'disturbance'. Another view on moderate amounts of disturbance includes fire, storm, sudden flow of water (from a storm). 'Frouts of abrupt change in the mountain realm' also amount to disturbance. On regional basis the number of species is sensitive to suitability of physical conditions, habitat heterogeneity and isolation from centers of dispersal.

BIODIVERSITY OF *DENDROBIUM* (ORCHIDACEAE) IN NORTH EASTERN INDIA: STUDIES ON THEIR CONSERVATION FOR SUSTAINABLE USE

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Biological diversity or Biodiversity is the variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part, this includes diversity within species, between species and of ecosystems.

Orchids are among the top in the market due to its beautiful flowers. The northeast India has a rich orchid biodiversity where the genus *Dendrobium* forms one of the important groups of commercially valuable and with scientific importance. *Dendrobium* species have medicinal uses also. For the improvement collection of germplasm of *Dendrobium*, study of phenology, palynology and seed morphometrics are essential. These aspects can leads to a sustainable development of orchid based cut flower/potted plant industry. An important feature of the project would be also to sustain environment friendly rural development and additional source of income to poor farmer and women in particular

Objective as stated in the project proposal

1. Exploration of the species in the region
2. Collection of germplasm for detailed scientific study
3. Phenological and palynological study for selection and plant improvement
4. Multiplication of the species

Highlights of the findings achieved in the project

During the tenure of the project some important findings have been made which are outlined below:

- Survey and collection of about 47 species of *Dendrobium*
- Germplasm collection which are maintained in NEHU campus
- Details morphological observation and characterization of the species
- Observation of different phenophases and their importance
- Characterization of pollen and study of pollination

Suggestion

In order to transfer the results of this project the expert at the time of recommending this project, suggested that another phase is required for field trial and transfer of packages for large-scale replication. Therefore, second phase of this project may be considered with one RA/SRF and one field attendant with poly-house for acclimatization and hardening of seedlings.

CERTAIN ETHNOZOOLOGICAL ASPECTS IN EAST SIANG AND WEST SIANG DISTRICTS OF ARUNACHAL PRADESH

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It makes a documentation of 95 lesser known animal species of ethnozoological importance, the tribal cultural relation of bio-diversity and their conservation and management practices, the flow of animals and animal parts in folk markets including the impact of anthropogenic activities on wildlife as well as track/route and licks etc. Out of 95 animal species that surveyed during the fieldwork, the composition of the animals corresponding to each family, genus and species of different groups (8 Orders- the enumerated groups are Mollusca, Annelida, Insecta, Pisces, Amphibia, Reptilia, Aves and mammalia) and their composition in each usage category (7 usage categories that is food, medicine, magico-religious belief; myths and folklore, omen reading and astrology; totem and avoidance; and other uses) coinciding with these three taxa are evaluated tabular form. The results are:

The corresponding total numbers of 64 families, 85 genera and 95 species used in each 7 usage categories comprise 38 (59.38%), 28 (48.75%), 40 (62.50%), 11 (17.19%), 15 (23.44%) and 21 (32.81%) families; 55 (64.71%), 32 (37.65%), 44 (51.76%), 11 (12.94%), 16 (18.82%) and 28 (32.94%) genera and

61 (64.21%), 36 (37.89%), 47 (49.47%), 12 (12.63%), 14 (14.74%), 18 (18.95%) and 34 (35.79%) species respectively. It also shows that the Mammalian group comprises the largest number that is 24 (37.50%) families, 34 (40%) genera, 39 (41.053%) species and Molluscan group shows the least number that is 1 (1.56%) families, 1 (1.18%) genera, 1 (1.05%) species.

The code and conducts of social institution control the socio-cultural life of the tribe, which in turn reinforces the IK. Due to the intrusion of alien culture the interest of traditional social institution is gradually weaning away from the young generation and thus the socio-ecological system has gone disintegrated, which is responsible for gradual eroding IK. This leads the people tendency towards commercialization of wild animals.

However, the phenomenon is an important step towards rising the standard of living and literacy in rural area. Ideally, they should value what they learn both at school and at home. To accomplish the goal the younger generation should be given opportunity to master the traditional culture and ecological knowledge of their elders.

Conclusion

It can be stated that the IKS is an important aspect of a society's culture of technology. Without due recognition for many aspects of rural social structure, there can be no full understanding or utilization of the valuable contributions of IK to sustainable management and conservation of biodiversity, nor can this contribution readily be enhanced by external support. An understanding of local knowledge systems, including institutions and organisational structures, can support existing sustainable practices and expedite appropriate changes.

APPLICATION OF SLOPING WATERSHED ENVIRONMENTAL ENGINEERING TECHNOLOGY (SWEET) IN RESTORATION OF DEGRADED JHUMLANDS OF ARUNACHAL PRADESH

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Agriculture is the main occupation of about 80% of the population of Arunachal Pradesh. Being a mountainous state, majority of them practice shifting cultivation along the mountain slopes. The Task Force on Shifting Cultivation constituted by the Ministry of Agriculture in its report of 1983 estimated the number of shifting cultivator family in the state to be 54,000 and an area of about 700 sq. km is brought under shifting cultivation every year. As per the State of Forest Report, 1999 of the Forest Survey of India, an estimated 0.23 million ha of area has been affected by shifting cultivation during the period 1987-97 in Arunachal Pradesh. Due to limited arable land and increasing population growth, the farming on the ecological fragile and marginal mountain lands including those situated on more than 30^0 slope will continue. Considering the adverse impacts of the shifting cultivation such as loss of precious top soil, nutrients and forest biodiversity, destabilization of slopes and its low productivity, sustainable farming alternatives need to be developed and implemented. If the shifting cultivation in its present form is allowed to continue, land degradation and the impoverished living conditions of resource-poor upland farmers are bound to worsen with time. However, as yet we have no viable alternative to shifting cultivation practice successfully tested and widely accepted by the people. Therefore, it is urgent to seek new options for farming sloping lands that can enhance crop yield, stabilize the slopes, conserve the soil to an acceptable level and modify the existing practice of shifting cultivation suitably so that they can be accepted widely by the people in the mountain areas.

Taking into consideration these objectives, the State Forest Research Institute (SFRI) made an effort to apply the Sloping Watershed Environmental Engineering Technology (SWEET) for rehabilitating the degraded jhum lands of Arunachal Pradesh. The SWEET was originally conceptualized by the G.B. Pant Institute of Himalayan Environment and Development, Almora as a regenerative technology and the SFRI adapted the technology to test it works as an alternative to shifting cultivation in the Eastern Himalayan state of Arunachal Pradesh. The adaptive test was carried out in the form of an action research project entitled, "Application of SWEET in restoration of degraded Jhumlands in

Arunachal Pradesh" sponsored by the G.B. Pant Institute of Himalayan Environment and Development, Almora. The project was started in 1996 and concluded in 1999.

The salient feature of this action research project was the active involvement of the villagers during the entire project implementation phase beginning from the planning and design stage of the project. An intensive PRA exercise for deciding the project components, the development of project on the farmer's own land, carrying out various project activities by the farmers themselves including contour marking and a detailed scientific analysis on various aspects of the project were other highlights of the projects. Although originally planned for 4 sites at different altitudes of Arunachal Pradesh, viz., Yazali, Julie, Boleng and Dirang, only 2 models at first two sites situated at two different altitudes could finally be developed. The logistic problem faced due to long distance was the main reason to abandon the model development works at Boleng and Dirang halfway. Along with the development of model, various research works such as assessment of nutrient build up, performance of different hedgerow species, trends in biological and economic productivity, and impact of the models on weed population density were carried out in order to assess the potentiality of the models to sustain continued agriculture and to examine their ecological and economic viability. The data obtained from the model plots were compared with that of adjacent jhum plots (both cropping and fallow) to compare the performance of the models in relation to the traditional jhum.

As already stated, the models under the project were planned and designed with active involvement of the villagers as possible alternatives to shifting cultivation in the given socio-ecological setups, the project components as well as the crops to be planted in the model plots were decided by the villagers and all the projects works were done by the land owners and villagers together, this helped the people in understanding the project philosophy in a better manner and ensured the acceptance of the models by the people.

The hedgerows (green terraces) were created along the contour lines as an alternative to bench terraces and cropping was done continuously in the alleys (inter-contour spaces). The relative performance of 5 hedgerow species viz., *Alnus nepalensis, Bahunia purpurea, Morus alba, Tephrosia candida* and *Thysanolaena maxima* was assessed. As hedgerow species, *Bahunia purpurea* and *Tephrosia candida* performed better as evidenced by higher economic yields per unit area and better nutrient build up than the other three species tried.

When compared with the adjacent jhum plots, the model plots and higher or similar output/input ratios, substantially reduced weed density and had higher biological and economic productivity. The output/input ration for SWEET model plots showed a continuous increasing trend from year to year and in the third year of the project the ration increased manifold.

In spite of continuous cropping, most soil nutrients in the SWEET model plots either remained constant or showed an increasing trend over a period of three years, however, in the adjacent jhum crop fields, all the soil nutrients got depleted significantly over the years.

Although a time span of 3-4 years period is too short to assess and conclude the performance and effectiveness of such models, initial results were quite encouraging and did indicate that the models have potential to work as viable alternatives to shifting cultivation in the given socio-ecological set ups. However, in order to confirm the conclusions, the SWEET models need top be maintained for at least five years and data on various aspects need to be collected for longer time period.

Selected Abstracts

Compiled by D.S. Negi
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Ahmed, Ajaz 2002. **Object-oriented forest management**. *The Indian Forester*, 128(3): 313-315. Dy. Conservator of Forests, Jammu and Kashmir State Forest Service, J&K, India. [CONSERVATION; FOREST MANAGEMENT; NATURAL RESOURCE]

Forest conservation and management in J&K has suffered for lack of application of existing scientific and operational knowledge. Forestry confined itself to administration and protection and these two activities became synonymous with management. The unfortunate results of this institutional history are obvious to every one. The alternatives suggested from time to time have been equally ineffective, as they have addressed the symptoms and not the underlying causes of the problem. The debate for some time has been dominated by access, control, tenure, and institutional issues. These are important in their own regard but more important are the operational and technological issues. The present paper discusses the problems faced with forest management in the state and proposes measures for improvement.

Atul and Sharma, Neeta Raj 2001. **Water culture an economical method for re-sprouting in damaged *Picrorhiza kurrooa* plants**. *Journal of Non-Timber Forest Products*, 8(3/4): 146-149. Department of Agroforestry and Environment, Himachal Pradesh Krishi Vishvavidyalaya, Palampur, H.P., India. [DIVERSITY; GERMPLASM; SEED GERMINATION]

Picrorhiza kurrooa has been industrially over exploited for *picrorhizin, kutkin, kerrin, vanillic acid, kutkiol, kutkisterol, etc*., and this has resulted it being classed under vulnerable and endangered ecological status. Keeping this in view every singly plant of this genetic resource is of utmost importance. So, the plants, which were unable to survive in field conditions, were tried to re-sprout for re-plantation. The germplasm collected from Chamba and Kinnaur areas of Himachal Pradesh were planted in the beds and the damaged plants or the plants or the plants that were unable to survive in the field condition were uprooted. Significant amount of re-sprouting of 80-90% was observed when the lower tip of the cut portion of stolons is dipped in water culture at 25-30^{o}C. Age of cutting and the incubation temperature showed a significant effect on the average per cent sprouting of the stolons. This water culture technique has proved to be helpful in reviving the lost stock of the endangered plant, is economical and can be easily replicated/adopted by the poor farmers.

Atul; Sharma, Shivesh and Punam 2002. **Effect of tree age class and storage on germination behaviour of some important forest tree species of north-western Himalayas**. *The Indian Forester*, 128(6): 660-666. Department of Agroforestry and Environment, COA, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, H.P. [DIAMETER; GERMPLASM; SEED GERMINATION]

Significantly higher germination in *Albizia* species was achieved within first eight days, when seeds of middle (32-48cm dbh) and mature (48-64cm dbh) trees i.e., of age class B or C, stored for six months were treated with acid and kept at 30^{o}C temperature conditions. In case of *Acacia catechu*, the seeds of mature tree (16-24cm dbh) i.e. age class C stored for a period of three or five months, treated with acid and germinated at 30^{o}C brought about significantly maximum increase in germination within only first six days. Irrespective of age class and incubation temperature, the seeds of *Alnus nitida* stored for a period of four months and treated with cold water showed significantly maximum germination within first fourteen days. A gradual but significant increase in germination till fourteen days was noticed in seeds of *Dalbergia sissoo* which were stored for a period of six months, treated with cold water and incubated at 30^{o}C temperature condition. The various tree diameter age classes had no significant effect on germination in seeds of *Alnus* and *Dalbergia sissoo* species.

Awasthi, Anjali; Uniyal, S.K. and Rawat, G.S. 2001. **Forest management down the ages: A case study from district Uttarkashi, Uttaranchal**. *Indian Journal of Forestry*, 24(3): 388-394. Wildlife Institute of India, P.O. Box # 18, Chandrabani, Dehradun 248001, Uttaranchal, India. [BROAD-LEAVED; CULTIVATION; FOREST MANAGEMENT; HIMALAYA; SOCIO-ECONOMIC]

Chronological survey of processes and events in the forest and land management in Uttarkashi district, Uttaranchal has been emphasized. The present status of forest in Uttarkashi is the result of past exploitation and management practices. The conflicts between forest managers and villagers shaped the ecoloyy of mountains. Since past few decades need of people's participation and their traditional knowledge of managing forests has been felt to slow down the process of degradation in the Himalaya.

Bhardwaj, S.D.; Panwar, Pankaj and Yadav, Vasu 2002. **Effect of initial collar diameter, shoot pruning and root pruning on performance of planting stock of *Celtis australis***. *The Indian Forester*, 128(6): 650-654. Department of Silviculture and Agroforestry, Dr.Y.S. Parmar University of Horticulture & Forestry, Nauni, Solan, H.P. [COLLAR DIAMETER; ROOT PRUNING; SEEDLING]

The planting stock of *Celtis australis* having collar diameter (1.0 to 1.50 cm), shoot pruning (6 cm above collar) and no root pruning are recommended for better establishment of the seedlings in degraded tracts of mid hill zones of Himachal Pradesh.

Bhasin, M.K. and Shampa, Nag 2002. **A demographic profile of the people of Jammu and Kashmir - 1. Population structure**. *Journal of Human Ecology*, 13(1&2): 1-55. Department of Anthropology, University of Delhi, Delhi 110007, India. [AGE COMPOSITION; CASTE GROUPS; JAMMU AND KASHMIR; POPULATION COMPOSITION; SEX RATIO]

The study presents the population structure of the caste groups, tribal groups and communities of Jammu and Kashmir. The study sample was collected from four districts of Jammu and Kashmir state; and comprised of Buddhist and Muslim (Bodhs, Baltis, Brokpas, Arghuns) from Ladakh region; Kashmir (Pandits and Muslims) for Srinagar region; Dogra (Brahmans, Rajputs and Scheduled Castes) and Muslim (Gujjars) from Jammu region. The sex ratio, age composition of these population groups give a picture of the structure/demographic pattern prevalent in the state of Jammu and Kashmir.

Bhasin, M.K. and Shampa, Nag 2002. **A demographic profile of the people of Jammu and Kashmir - 2. Estimates, trends and differentials in fertility**. *Journal of Human Ecology*, 13(1&2): 57-112. Department of Anthropology, University of Delhi, Delhi 110007, India. [CASTE GROUPS; FERTILITY MEASURES; JAMMU AND KASHMIR; TRIBAL GROUPS]

In the present study, an attempt is made to study the fertility patterns of various population groups from the state of Jammu and Kashmir. The relationship between fertility and ecological, biological and socio-economic factors are highlighted. The fact that fertility behaviour and gender inequality have a strong relationship is also emphasized. The various population groups of the state show differental fertility as a result of their diverse development profiles.

Bhasin, M.K. and Shampa, Nag 2002. **A demographic profile of the people of Jammu and Kashmir - 3.Estimates, trends and differentials in mortality**. *Journal of Human Ecology*, 13(1&2): 113-140. Department of Anthropology, University of Delhi, Delhi 110007, India. [CASTE GROUPS; JAMMU AND KASHMIR; MORTALITY MEASURES; SURVIVAL RATIOS; TRIBALS]

Mortality measures and determinants have been presented for the caste and tribal groups of Jammu and Kashmir. The various population groups reveal differential mortality particularly infant, child and under five mortality which are indicators of the groups environment and development. The major environmental, biological and socio-economic determinants found to influence the child survival.

Bhasin, M.K. and Shampa, Nag 2002. **A demographic profile of the people of Jammu and Kashmir 4. Selection intensity**. *Journal of Human Ecology*, 13(1&2): 147-166. Department of Anthropology, University of Delhi, Delhi 110007, India. [FERTILITY; JAMMU AND KASHMIR; MORTALITY; SELECTION INTENSITY]

Natural selection is one of the major evolutionary factors that brings about changes in the gene frequencies in a population through the action of differential fertility and mortality. Selection potential based on the differential fertility and mortality data have been computed for the major population groups of Jammu and Kashmir, using the methodology of Crow (1958) and Johnston and Kensinger (1971). It has been observed that irrespective of methodology, the index of total selection was the highest among Baltis of

Ladakh region while it was the lowest among Kashmiri Pandits of Kashmir region. The relative contribution of fertility to the index of total selection has been found exceeding that of mortality among Bodhs, Arghuns of Ladakh region; Kashmiri Pandits, Kashmiri Muslims of Kashmir Region and Dogra Rajputs and Gujjars of Jammu region. The reverse appeared true among Baltis, Brokpas of Ladakh region; and Dogra Brahmans and Dogra Scheduled Castes of Jammu region.

Bhasin, M.K. and Shampa, Nag 2002. **A demographic profile of the people of Jammu and Kashmir 5. Family planning**. *Journal of Human Ecology*, 13(1&2): 147-166. Department of Anthropology, University of Delhi, Delhi 110007, India. [CASTE AND TRIBAL GROUPS; FAMILY PLANNING METHODS; FERTILITY; JAMMU AND KASHMIR]

In the present study an attempt has been made to appraise women's knowledge of contraceptive methods and also the usage of family planning methods among caste and tribal groups of Jammu and Kashmir. Knowledge of contraceptive methods is widespread among all population groups, particularly the permanent methods. However, usage of contraceptives is not that widespread. Among all the method, the most commonly used are the permanent methods especially tubectomy. This is followed by IUDs.

Bhasin, M.K. and Shampa, Nag 2002. **A demographic profile of the people of Jammu and Kashmir 6. Regression analyses**. *Journal of Human Ecology*, 13(1&2): 167-176. Department of Anthropology, University of Delhi, Delhi 110007, India. [CORRELATION REGRESSION; ETHNIC GROUPS; FAMILY PLANNING METHODS; FERTILITY MEASURES; JAMMU AND KASHMIR; MORTALITY MEASURES]

Statistical tools mainly multiple regression have been utilised to study the impact of various ecological, biological and socio-economic variables on fertility, mortality and usage of family planning methods and various population groups of Ladakh region. Various variables show important bearing on the livebirths, infrant mortality and usage of family planning methods.

Chandel, R.S. and Singh, I.B. 2000. **Morphostratigraphy and fan morphology of Doon Valley**. *Journal of the Indian Society of Remote Sensing*, 28(4): 265-275. Department of Geology, Lucknow University, Lucknow 226007. [CLIMATIC CONDITIONS; DOON VALLEY; LANDFORMS; LANDSLIDE]

In the present study analysis of Landsat MSS, TM and SPOT imagery and digital analysis of IRS LISS-1 data of Doon Valley was carried out. Various geomorphic features were identified and classified, morphostratigraphy of the area has been established. Main geomorphic units of the area are Mussoorie Hill Range (Denudational). Siwalik Hills (Structural), Remnant Hills (Residual), Siwalik Piedmont, Doon Piedmont, River Terraces and Flood Plain. Three large fan lobes are identified on Doon Piedmont deposits Viz. Western fan lobe, Central fan lobe and Eastern fan lobe. Average slope of these three fan lobes are $2^{o}21'$, $2^{o}3'$, and $1^{o}24'$ for the western, central and eastern fan lobes respectively. Western and central fan lobes have been affected by neotectonic activity which is reflected in transverse profiles.

Chauhan, P.S.; Kumar, Rakesh and Negi, J.D.S. 2002. **Foliage water loss pattern in Sal (*Shorea robusta* gaertn. f.) and its associates under stress.** *The Indian Forester*, 128(6): 655-659. Forest Ecology & Environment Division, Forest Research Institute (ICFRE), Dehradun. [CANOPY; LAND USE PATTERN; MICROCLIMATE; NATURAL CONDITION]

An attempt has been made to understand the foliage water loss pattern in Sal forest in Barkot Forest Range of Dehradun Forest Division. The study reveals that heavy canopy opening resulted in increase in atmospheric temperature, which is causing stressful environment for the community. Under this stressful environment *Mallotus philippensis* appears to be drought tolerant species, which can cope with the adverse environment conditions to some extent. This has the conformity that in the Sal forest, where the moisture has become the limiting factor, *Mallotus philippensis* is the only species, which is colonising during the phase of retrogressive succession.

Chauhan, Y.S. and Pokhriyal, T.C. 2002. **Effects of nitrogen and *Rhizobium* inoculation treatments on some growth parameters in *Albizia lebbek* (L). Benth seedlings**. *The Indian Forester*, 10(2): 316-322.

Plant Physiology Branch, Botany Division, Forest Research Institute (ICFRE), Dehradun, Uttaranchal. [COLLAR DIAMETER; ENVIRONMENTAL CONDITION; NITROGEN FIXING; SEEDLING]

In this study, *Albizia lebbek* seedlings were treated with and without inorganic nitrogen and inoculated with *Rhizobium*. It was observed that the plants treated with both nitrogen and *Rhizobium* performed better than those, which received either one of them or none (control). Growth parameters i.e., plant height, collar diameter and root length were observed to follow an increasing pattern with growth irrespective of the nature of treatment. New leaf flushes appeared from April onwards reaching maximum in the month of August and September, followed a decreasing trend thereafter.

Dar, Farooq Ahmad; Gera, Mohit and Gera, Neelu 2002. **Effect of seed grading on germination pattern of some multi-purpose three species of Jammu region**. *The Indian Forester*, 128(5): 509-513. State Forest Research Institute, Jammu, J&K; Forest Research Institute, Dehradun, Uttaranchal. [GERMINATION VALUE; MULTIPURPOSE TREE; SEED GERMINATION]

A study was conducted in Seed Laboratory of Seed Development Division, Jammu to investigate the effect of seed grading, by size and weight, on germination of four multipurpose tree species, viz. *Acacia catechu, Pinus roxburghii, Albizia lebbek* and *Robinia pseudoacacia*. The results have shown that medium sized seed grade gave higher values of initial germination, total germination and germination values for all the species studied, except in case of *Robinia pseudoacacia*, where comparative values of total seed germination were recorded for small and medium sized seed grades. Grading of seeds before sowing is recommended to obtain uniform nursery stock in these species.

Dhar, Uppeandra; Rawal, R.S.; Airi, Subodh; Bhatt, I.D. and Samant, S.S. 2002. **Promoting outreach through conservation education programmes - Case study from Indian Himalayan Region**. *Current Science*, 82(7): 808-815. G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263643, India. [BIODIVERSITY CONSERVATION; BIOLOGICAL RESOURCES; EDUCATION PROGRAMME; ECO-CULTURAL DIVERSITY]

The UN conference on Environment and Development (1992) helped to mobilize international understanding on promoting the awareness component for conservation and sustainable use of biological resources. As a result, two broad initiative received focused attention: (i) orientation of education towards improving the capacity of the people to address environment and development issues, and (ii)integrating human dimension component into biological conservation programmes. On account of vastness of the area and prevailing eco-cultural diversity of the country, it is increasingly realized that there is an urgent need to develop programmes to address location/region-specific concerns. In this context, the Indian Himalayan Region (IHR) which represents a unique biogeographic entity, unfortunately, has not received due attention under the changing perspective of conservation science. Nevertheless, a few initiatives, including the present one, have yielded positive results. This paper analyses the results of a systematic conservation education programme (initiated by G.B. Pant Institute of Himalayan Environment and Development) and highlights its potential of becoming a model for the entire IHR.

Dhyani, B.L.; Samra, J.S.; Babu, Ram and Kumar, Nirmal 2001. **Environmental payoff of integrated watershed management programme in Garhwal Himalaya - a case study of ORP Fakot**. *Journal of soil and Water Conservation*, 45(3&4): 141-147. Central Soil & Water Conservation Research & Training Institute, 218 Kaulagarh Road, Dehradun 248195, Uttaranchal. [BIODIVERSITY; DEMOGRAPHIC PRESSURE; LAND USE PATTERN; SUSTAINABLE DEVELOPMENT; WATERSHED MANAGEMENT]

Development is a dynamic process and sensitive to various stimuli such as demographic pressure, programme and policies. Himalaya being highly sensitive to human interference, there are dangers of obvious ecological imbalances being set in motion in the region. Low productivity, rapid depletion of land and water resource, bio-diversity and environmental degradation are the consequences of past ill-coordinated gamut of developmental efforts. Participatory integrated watershed management programme approach demonstrated by Central Soil and Water Conservation Research and Training Institute, Dehradun in a 370 ha model watershed in Tehri Garhwal district of U.P. has resulted in change in land use pattern in favour of environmental improvement. Consequently runoff and soil loss from the watershed and decreased and

agricultural output increased significantly. The study revealed that environmental payoff and economic returns from watershed management project at Fakot are attractive to lead to sustainable development in the area.

Dimri, A.P.; Mohanty, U.C.; Madan, O.P. and Ravi, N. 2002. **Statistical model-based forecast of minimum and maximum temperatures at Manali**. *Current Science*, 82(8): 997-1003. Centre for Atmospheric Sciences, Indian Institute of Technology, Hauz Khas, New Delhi 110016; DS Faculty, Air Force Administrative College, Redfield, Coimbatore 641018, India. [METEOROLOGICAL DATA; TEMPERATURE RESPONSE]

Various types of avalanches frequent northwest Himalayan regions during winter months. Winter season over this region is frequented by westward moving weather systems called western disturbances (WDs). These weather systems yield enormous amount of precipitation. Knowledge of minimum and maximum temperatures during winter months is very useful for assessing human and natural hazards. Models for forecasting minimum and maximum temperatures have been developed for Manali in Himanchal Pradesh, for the months of December, January and February. These models are based on statistical techniques and use surface and upper air meteorological data from 1984 to 1989. The models are also tested with independent data and the results for 1995-96 are presented. The models yield good results with independent cases providing about 88% correct forecast within $\pm 2^{o}$C of the observed values.

Dongol, Chandra Man; Hughey, Kenneth F.D. and Bigsby, Hugh R. 2002. **Capital formation and Sustainable community forestry in Nepal**. *Mountain Ressearch and Development*, 22(1): 70-77. District Forest Office, Chandranighapur, Rauthat, Nepal; Environmental Management and Design Division, P.O. Box 84, Lincoln University, New Zealand; Commerce Division, P.O. Box 84, Lincoln University, New Zealand. [CAPITAL FORMATION; CLUSTER-ANALYSIS; COMMUNITY FORESTRY; NEPAL; SUSTAINABLE DEVELOPMENT]

This article investigates the role of capital formation in contributing to the sustainability of community forestry in Nepal, using a case study approach based on 23 forest user groups (FUGs). FUGs were classified in 3 categories on the basis of cluster analysis: (1) successful, (2) moderately successful, and (3) unsuccessful clusters. The results show that the elements of capital accumulation in a successful FUG were manageable mature forest, high prices for forest products, a system of charging for all forest products, and sales of surplus forest products outside the FUG. The results also suggest that the benefits of funds, community development, and forest improvement changed people's vision and behavior, as well as their attitude toward and understanding of community forestry. This change in attitude has increased interest in and awareness of community forestry and has stimulated thinking about the sustainability of community forestry. Local initiative of this sort makes community forests more secure, protected, and wisely managed for sustainable development.

Gautam, Ambika P.; Webb, Edward L. and Elumnoh, Apisit 2002. **GIS assessment of land use/land cover changes associated with community forestry implementation in the Middle Hills of Nepal**. *Mountain Ressearch and Development*, 22(1): 63-69. School of Environment, Resources and Development, Asian Institute of Technology, PO Box 4, Klong Luang, Pathum Thani 12120, Thailand. [COMMUNITY FORESTRY; DHULIKHEL; LAND USE CHANGE; NEPAL; RURAL DEVELOPMENT]

This study analyzed the spatial and temporal changes in land use between 1978 and 1992 in a typical watershed covering 543 km^2 in the Middle Hills of Nepal and used GIS to compare land use changes between village development committees (VDCs) with and without formally handed-over community forests during this period. The forest handover procedure followed the specifications of the national community forestry policy of Nepal. In the watershed, the total area of forested land (defined as high forest plus shrubland) declined by about 8% during the period. However, high forest increased over the study period, whereas shrubland cover declined. Between VDCs with community forests and those without, there were large differences in the rate of total forested area loss, with community forest VDCs losing less total forested area over the 14-year period. Moreover, in the group of VDCs with community forests, high forest area increased by 77%, in comparison with 13% for VDCs without community forests. Higher shrub loss in community forest VDCs was attributable to conversion into high forest via plantation establishment and

natural succession. The results of this study indicate the positive impacts of Nepal's community forestry activities on the extent of forest cover.

Gautam, Jagdish and Bhardwaj, S.D. 2001. **Effect to seed size and pre-sowing treatments on germination of ban oak *(Quercus leucotrichophora)***. *Indian Journal of Forestry*, 24(3): 311-315. Department of Silviculture and Agroforestry, University of Horticulture and Forestry, Nauni, Solan, H.P., India. [GERMINATION; HIMALAYA; NURSERY; SEEDLING]

The present investigations deal with seed size and pre-sowing treatments on the germination of ban oak. The medium size seeds excelled over other seed grades with respect to all the germinability attributes irrespective of the experimental conditions. Among the nine different pre-sowing treatments, the seeds treated with 100 ppm GA_3 for 24 hours registered the best germinability under laboratory as well as nursery conditions. The seeds subjected to cold water treatment for 24 hours or concentrated sulphuric acid dip for 10 minutes proved to be effective in promoting germination. The hot water treatment, however, severely paralysed the germination under both laboratory as well as nursery conditions.

Gera, Mohit; Koul, Ajay Raj and Gera, Neelu 2002. **Standardization of pricking stage of chir pine and khair germinants in root trainers**. *The Indian Forester*, 128(4): 398-402. Seed Development Division, SFRI, Janipur, Jammu (Jammu & Kashmir). [CHIR-PINE FOREST; GERMINATION; SURVIVAL PERCENT]

A trial was carried out to standardize the best stage for transplanting the germinants of *Pinus roxburghii* (Chir pine) and *Acacia catechu* (Khair in the root trainers to obtain maximum survival. Transplanting of germinants of Chir pine in 11-13 days and of Khair in 10-12 days after sowing, gave maximum survival per cent. Poor survival of transplanted germinants was recorded in case of direct sowing in both the species and transplantation at first leaf (needle) stage in case of Chir pine.

Gerrard, John and Gardner, Rita 2002. **Relationships between landsliding and land use in the likhu khola drainage basin, middle hills, Nepal**. *Mountain Ressearch and Development*, 22(1): 48-55. School of Geography and Environmental Sciences, The University of Birmingham, Birmingham B15 2TT, UK; Director and Secretary, Royal Geographical Society with the Institute of British Geographers, 1 Kensington Gore, London SW7 2AR, UK. [DEFORESTATION; HIMALAYA; LAND DEGRADATION; LAND-USE; LANDSLIDING; NEPAL]

A great deal has been written about the relationship between landsliding and land use change, especially deforestation, in the Himalaya. But few detailed quantitative studies have examined this relationship. The present article reports the results of a 3-year study of landsliding in 4 subcatchments of the Likhu Khola drainage basin in the Middle Hills, Nepal. During the years of study (1991-1993), 381 landslides were noted, the vast majority of which were small failures on the risers of irrigated terraces (khet-land). Although significant in terms of labor input, these failures were insignificant with respect to land degradation and overall denudation. Most significant were larger failures on abandoned terraces and degraded forest. It was estimated that the average annual soil losses from the main land uses were 0.48 ton/ha for irrigated terraces, 3.65 ton/ha for rainfed terraces, 1.86 ton/ha for grassland, 0.80 ton/ha for forested land, and 23.95 ton/ha for forest scrub and abandoned land. The combined average erosion rate was 5.55 ton/ha. Thus, deforestation does not necessarily lead to large soil losses from landsliding; much depends on how the land is managed after deforestation.

Gurung, Naba Raj; Sankhayan, Prem Lall; Hofstad, Ole and Sitaula, Bishal K. 2002. **Factors affecting forest volume and biomass at watershed level: A study in Annapurna conservation area, Nepal**. *The Indian Forester*, 128(4): 379-390. P.O. Box 464, Pokhara, Nepal; Department of Forest Sciences, Agricultural University of Norway, N-1432, Aas, Norway; Department of Soil and Water Sciences, Agricultural University of Norway, N-1432, Aas, Norway. [BIOMASS; CONSERVATION; DIAMETER; NATURAL RESOURCE; NEPAL]

A study was carried out in Mardi watershed in Nepal to estimate the stem volume and biomass and analyze the factors responsible for their variations in different forest types. Tree height and diameter ast

breast height were measured in nine sample quadrants each in Mixed Hardwood Forest (MHF) and Oak Forest (OF) and 13 sample quadrants in High Mountain Mixed Forest (HMMF) for 56 tree species. The per hectare stem volume and biomass of trees in HMMF and OF was 2 to 3.5 times higher than that in MHF. The mean volume per hectare was 2.3 and 2.7 times higher and the stem density 2.5 and 2.7 times higher in the conservation area as compared to regional and national averages. Mean volume and biomass in the forests with high accessibility and low altitude differed significantly from those with medium and low accessibility and medium and high altitude. Mean volume and biomass did not vary significantly by slope classes and aspects. Distance, altitude and slope explained up to 93 per cent of the total variation in OF biomass. The usefulness of the study lies in providing baseline data for analyzing the changes in forest health, measured in terms of biomass and volume.

Heaman, Larry M.; Srivastava, R.K. and Sinha, A.K. 2002. **A precise U-Pb zircon/baddeleyite age for the Jasra igneous complex, Karbi-Analong District, Assam, NE India**. *Current Science*, 82(6): 744-748. Department of Earth and Atmospheric Sciences, University of Alberta, Alberta T6G 2E3, Canada; Department of Geology, Banaras Hindu University, Varanasi 221005, India. [ALKALINE MAGMATISM; FISSION TRACK TECHNIQUE; GEOLOGICAL MAP; MAGMATIC STAGE]

Five cretaceous alkaline-carbonatite igneous comlexes are reported from the Assam-Meghalaya plateau. These alkaline intrusions have been interpreted to be coeval and associated with the 117-105 Ma Rajmahal-Sylhet flood basalt province. With the existing age information it is possible that this alkaline magmatism may be a late magmatic stage of the Rajmahal-Sylhet large igneous province. Therefore, it is essential to determine high-precision ages for these alkaline complexes in order to understand the detailed temporal evolution and genesis of this basaltic and alkaline magmatism. Out of five igneous complexes, Sung Valley, Swangkre and Samchampi have been dated, but the emplacement ages of the other two, i.e. Jasra and Barpung, are poorly constrained. The present communication reports a new, high precision U-Ph zircon/baddeleyite age for a differentiated portion of gabbro phase of the Jasra igneous complex.

Jamir, S. Alemmeren and Pandey, H.N. 2002. **Status of biodiversity in the sacred groves of Jaintia Hills,Meghalaya**. *The Indian Forester*, 128(7): 738-744. Department of Botany, Fazl Ali College, Mokokchung, Nagaland; Department of Botany, North-Eastern Hill University, Shillong, India. [MEGHALAYA; SACRED GROVES]

In three sacred groves of Jaintia Hills (Meghalaya), covering a total area of approximately 28 ha, a total of 395 plant species was found distributed in 108 families. Proximity of this region to the species-rich regions of Eastern Himalayas, Myanmar, and South-Central China has resulted in high species and family richness of the groves. Complex community structure with many growth forms has also contributed to species richness. However, cultural and developmental activities have posed serious threats to the very survival of these groves.

Joshi, H.C.; Arya, S.C. and Samant, S.S. 2000. **Diversity, distribution and indigenous uses of plant species in Pindari area Nanda Devi Biosphere Reserve - II**. *Indian Journal of Forestry*, 24(4): 514-536. G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263643, Uttaranchal. [BIOSPHERE RESERVE; BUFFER ZONE; DIVERSITY; PROTECTED AREA]

Human dependence on the plant resources of the protected areas of the Indian Himalayan has been poorly attempted. Therefore, the present attempt has been made in a part of Nanda Devi Biosphere Reserve and reports 224 species belonging to 129 genera and 75 families. These species are distributed within different life forms i.e., trees (37 spp.), shrubs (30 spp.) and herbs (157 spp.). These species have been analyzed for species diversity, distribution and utilization patterns, nativity, endemism, rarity and indigenous uses. 145 species are native to Himalayan region, 4 species are endemic and 47 species are near endemic. Maximum species (171) are distributed in the zone 2100-2800 m. 146 species are used for the treatment of various ailments, 94 species as food (edible), 46 species as fodder, 35 species as fuel, 12 species as religious. 11 species in making agricultural tools, 5 species for house building and 6 species for various other purpose. Due to over-exploitation and habitat degradation *Acer caesium, Picrorhiza kurrooa, Nardostachys grandiflora* and *Dioscorea deltoidea* (all vulnerable) have been listed in Red Data Book of Indian Plants. These species along with other have been categorized as Critically Rare (13 spp.), Endangered (6 spp.),

Vulnerable (7 spp.), and Low Risk Near Threatened (1 spp.). Population assessment and extraction trends of these resources and conservation and management of priority species have been envisaged.

Juyal, K.P.; Parcha, S.K.; Mathur, N.S. and Singh, Jagmohan 2002. **Microfauna and age of the sangcha malla formation of Garhwal Tethys Himalaya, India**. *Current Science*, 82(4): 458-463. Wadia Institute of Himalayan Geology, Dehradun 248001; Oil and Natural Gas Corporation, KDMIPE, Dehradun 248001. [LADAKH HIMALAYA; MICROFAUNA]

Biostratigraphic investigations of the Sangcha Malla Formation in the type area of the Garhwal Tethys Himalaya were carried out during an expedition. Systematic investigations of samples from this unit led to the recovery of several well-preserved species of *Archaeoglobigerina, Rosita, Globotruncana, Globotruncanita, Heterohelix* and *Pseudotextularia*. The faunal assemblage is indicative of deposition under a deep marine condition. The foraminiferal taxa are recorded from the upper part of the Sangcha Malla Formation, which is the youngest marine litho-unit deposited in the Garhwal Tethys Himalaya. Stratigraphic distribution of the taxa indicates that this part of the Sangcha Malla Formation was deposited during the Campanian times. The fauna recovered herein from the Garhwal Tethys Himalaya shows a close affinity with that of the Zanskar region of Ladakh Himalaya and the Spiti region of Himachal Pradesh, suggesting thereby that during the Late Cretaceous times there were marine connections in these regions and the Upper Cretaceous sediments were deposited under similar (deep marine) palaeoenvironment.

Khanduri, V.P. and Sharma, C.M. 2002. **Intraspecific hybridization in *Pinus roxburghii* Sargent**. *Current Science*, 82(8): 1003-1005. Department of Forestry, HNB Garhwal University, Srinagar (Garhwal) 246174, India. [PINUS ROXBURGHII]

Inter-racial hybridization was performed successfully in *Pinus roxburghii* taking three different provenances, i.e. Pauri, Badiyargarh and Srinagar (locality-specific) at lower (900 m a msl) and higher (1900 m a msl) altitudes. The results revealed that cone and seed setting percentages in the selected provenances varied from 38.57 to 60.00% and 76.00% to 88.00% at the lower, and 36.00 to 58.33% and 68.00% to 84.67% at the higher altitudes, respectively. Controlled pollination resulted in enormous fertilization success, with no signs of incompatibility. Ovulate strobili remained receptive up to 5 days.

Khanna, Vinod; Ravichandran, M.S. and Kushwaha, S.P.S. 2001. **Corridor analysis in Rajaji-Corbett Elephant Reserve - A Remote Sensing and GIS approach**. *Journal of the Indian Society of Remote Sensing*, 29(1&2): 41-46. Zoological Survey of India, Dehradun; Zoological Survey of India, Chennai; Indian Institute of Remote Sensing, Dehradun. [BIOTIC PRESSURE; GRASSLANDS; LAND USE PATTERN; REMOTE SENSING]

This paper deals with corridor analysis in Rajaji-Corbett Elephant Reserve in the Shivaliks of Uttaranchal state. Efforts were made to detect changes in the state of forest cover *vis-a-vis* the status of corridors during the three periods i.e. 1967, 1986 and 1998 using remote sensing and GIS. The *ERDAS Imagine* digital image processing and *ArcView* GIS software packages were used for this purpose. Temporal satellite imagery and ground observations in the Rajaji-Corbett Elephant Reserve revealed forest loss, degradation and disturbances in the corridor areas, hindering elephant movement and restricting them to forest islands. Motichur-chilla corridor, despite being a highly favoured habitat for the elephant was found to be highly threatened followed by Kotdwar and Ramnagar corridors. Construction of wide bridges across Kunao-Chilla Canal, recreation of corridors through reforestation, reduction of all kinds of pressures in the corridor areas and providing higher protection to corridors are recommended.

Kiran, Ravi 2001. **Influence of available energy on reproductive growth of wheat (*Triticum aestivum* L.) intercropped with *Eucalyptus tereticornis***. *Indian Journal of Forestry*, 24(4): 409-413. Department of Soil Science/Agrometeorology, G.B. Pant University of Agriculture & Technology, Pantnagar 263145, Uttaranchal, India. [AGROFORESTRY SYSTEM; GRAIN YIELD; MICRO-CLIMATE CONDITION; PHOTOSYNTHESIS]

The investigation was carried out during *rabi* season 1996-97 to evaluate the effect of modified microclimate on the growth of wheat (*Triticum aestivum* L.) in an agroforestry system. The field experiment was conducted at Horticultural Research Centre, Patharchatta at G.B. Pant University of Agriculture and

Technology, Pantnagar. There were 15 tree rows considered as treatments of *Eucalyptus tereticornis* (planted in a Nelder fan design in March, 1989) at the angle of 24^{o} from each other, starting from north in anticlock-wise direction. Total number of treatments were 16 including control. Higher flag leaf/m at 80 days after sowing (up to 29% higher), number of fully emerged earhead (up to 39%) was recorded below trees than that of control. Grain yield was 71.54 - 49.16% and biological yield was 69.13 - 57.14% of control. Higher harvest index (14%) was found in some of the treatments below tree canopies than control. Available energy below trees ranged 51-63% during flowering stage and 53-63% during maturing stage of the control. Water table depth was lower below trees than control at each stage of crop. Water table depth did not fluctuate very much during vegetation phase, but, fluctuated during reproductive phase. Average water table depth was observed 71.1 and 82.0 cm under trees and in control, respectively.

Konwer, D.; Kataki, R. and Deka, D. 2001. **Fuel-wood characteristics of some indigenous tree species of North-East India**. *Indian Journal of Forestry*, 24(3): 316-319. Department of Energy, Tezpur University, Tezpur 784001, Assam. [FUEL-WOOD; NORTH EAST INDIA; PLANT SPECIES]

Fuel-wood characteristics of seven indigenous tree species of North-East India, viz., *Machilus bombycina* King, *Castanopsis indica* (Roxb.) A.DC., *Litsea monopetala* (Roxb.) Pers., *Litsea glutinosa* (Lour.) Robinson, *Lagerstroemia speciosa* (Linn.) Pers., Derris indica (Lamk.) Bennet and *Cassia fistula* L. were determined. Among all the tree species *Machilus bombycina* was found to be the best fuel-wood species followed by *Litsea glutinosa* and *Castanopsis indica*.

Krishna, Sridhar 2002. **Economic profile of Uttaranchal**. *Economic and Political Weekly*: 1843-1849. [CROP PRODUCTION; DEMOGRAPHIC CHARACTER; LAND-USE; LIVESTOCK; RURAL DEVELOPMENT]

The first states reorganisation commission had turned down the proposal for the creation of Uttaranchal on the grounds that it was not economically viable. The backward, agrarian character of the state, with fragmented and uneconomical landholdings, would seem to bear out this conclusion. However, with stress on diversification from agriculture to horticulture, investment in irrigation, infrastructure and promotion of tourism, Uttaranchal can be made viable.

Kumar, Kishor and Kad, Shashi 2002. **Early miocene cricetid rodent (Mammalia) from the murree group of Kalakot, Rajauri district, Jammu and Kashmir, India**. *Current Science*, 82(6): 736-740. Wadia Institute of Himalayan Geology, 33 General Mahadeo Singh Road, Dehradun 248001, Uttaranchal; Center for Advanced Study in Geology, Punjab University, Chandigarh 160014, India. [FOSSIL; SANDSTONES; SEDIMENTS]

Fossil dental remains of a small primitive cricetid rodent *Primus microps* (Hystricomorpha, Muroidea), are reported from the middle part of the lower Murree Group exposed near Kalakot (north-west Outer Himalaya) in the Rajauri district, Jammu and Kashmir, India. The new find clearly suggests and Early Miocene age for the fossiliferous bed and favours the view that the Subathu and Murree successions are separated by a considerable time gap.

Kumar, Manish; Pathak, Chitra and Singh, A.K. 2001. **Information Sources of Rural Poor - a study in U.S. Nagar District of Uttaranchal**. *IASSI Quarterly*, 19(3): 123-133. Deptartment of Agriculture Communication, G.B. Pant University of Agriculture and Technology, Pantnagar 263145, Uttaranchal. [DEVELOPMENT; INFORMATION TECHNOLOGY; SOCIO-ECONOMIC]

India is on the way to become a superpower in the Information Technology. The boom has contributed in the development of strong information dissemination system. Benefit of revolution remains confined mostly to the big cities. In rural areas poor still rely on their local communication system. Interpersonal sources of communication form the hub of their system. Mass media is merely playing the role of creating awareness among the poor. The concrete information regarding their development activities is derived from personal localite or personal cosmopolite sources. This paper aims to discuss the information sources of rural poor regarding development messages.

Kumar, Manisha; Bhardwaj, S.D. and Panwar, Pankaj 2001. **Effect of pod and seed size on germination parameters of *Albizia lebbeck***. *Indian Journal of Forestry*, 24(4): 496-499. Department of Silviculture and Agroforestry, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan 173230,H.P. [GERMINATION VALUE; SEED GERMINATION]

The pods and seeds were categorised into three size and three colour classes and their effects on the germination parameters were studied under laboratory conditions. It was found that the size and colour have marked influence on germination. Pod size of 8-16 cm length and pod colour of greyed orange group (166 B) gave highest germination. Similarly seed weight of 6-12 g and seed colour of brown group (200D) gave highest germination parameters.

Kumar, Manoj and Ahmad, Mukhtar 2001. **Infestation and population level of arctiid species (Lepidoptera: Arctiidae) on *Paulownia fortunei***. *Indian Journal of Forestry*, 24(4): 510-513. Division of Forest Entomolgy, Forest Research Institute, Dehradun 248006. [AGRO-FORESTRY; ECOSYSTEM; INSECTS; POPULATION DENSITY]

Three arctiid species, involved in multiple foliage injury to *Paulownia fortunei*, were identified as *Creatonotos transiens* Walker, *Spilarctia obliqua* Walker and *Cyana bianca* Walker. These were recorded first time in India infesting foliage of *P. fortunei*. Among these species, *C. transiens* and *S. obliqua* had shown relatively higher level of infestation and were considered as major defoliating pests of *P. fortunei* while *C. bianca* was seen occasionally. severe defoliation by the larvae of *S. obliqua* was recorded in *Paulownia* during 1997 and 1998.

Misra, R.M.; Mishra, R.K. and Bhandari, R.S. 2001. **Biological agents of *Heteropsylla cubana* on *Leucaena leucocephala* in Kalsi, Dehradun, Uttaranchal**. *Indian Journal of Forestry*, 24(4): 403-408. Division of Forest Entomology, Forest Research Institute, Dehradun, Uttaranchal, India. [CHEMICAL CONTROL; INSECTS; SPIDER FAUNA]

Heteropsylla cubana, the scourge of subabool is an introduced pest in India, causing tremendous damage to the plants. A survey of the predators in Kalsi Nursery, Kalsi revealed four species of coccinellid, one reduviid, spiders, dragon flies, formicids, lacewings, corrid bug, staphylinid and birds. Many of the predators are new records. A brief account of the predators and their potentialities are given in this paper.

Muruganandam, M. and Samra, J.S. 2001. **Historical perspectives of fisheries research and development in integrated watershed management**. *Journal of soil and Water Conservation*, 45(3&4): 121-126. CSWCRTI, Dehradun; CSWCRTI and Hill and Mountain Agro-Ecosystem Directorate, NATP, Dehradun; Centre Soil and Water Conservation Research and Training Institute (CSWCRTI), Dehradun 248195, Uttaranchal, India. [BIODIVERSITY; SOCIO-ECONOMIC; SUSTAINABLE DEVELOPMENT; WATERSHED MANAGEMENT]

Fish hunting and farming have a very long history from as early as vedic ages, but their contribution in watershed management programmes started only in the recent past. Both fish farming and watershed management have immense potential as well as challenges for sustainable development that need to be harnessed through resource optimisation. it is in this situation, a retrospect analysis was carried out reviewing the historical development of fisheries research and management in general and in the perspectives of watershed management programmes. The analysis revealed that fisheries management interventions in watershed programmes are very recent and it requires a strategies plan to match the demand-supply and resource generation-exploitation. This paper details the evolutionary status and future thrusts for the active development of fisheries in watershed management efforts towards establishing resource and knowledge based prosperity.

Nautiyal, D.C. 2001. **Cultivation of some rare and endangered medicinal plants in Tehri Garhwal and their therapeutic efficacy**. *Journal of Non-Timber Forest Products*, 8(1/2): 52-61. HIMCON, Ranichauri, Tehri Garhwal 249199, India. [AGRO-CLIMATIC CONDITION; ECONOMIC VALUE; GERMPLASM; MEDICINAL PLANT]

Conservation of biodiversity and germplasm of important plant species, particularly rare and endangered medicinal plants, has assumed greater significance especially when harvesting potential from the

wild fall short of the demand for commercial exploitation. In general, considering the increasing demand for herbal drugs. The consequent depletion of several species from the Himalaya, since half of the medicinal plants of the Indian flora occur in the high altitude of Himalaya. Therefore, it is imperative to initiate urgent steps to assess the status of occurrence and quantum availability of these plants in natural habitats. The present paper enumerates 30 species belonging to 20 families of flowering plants and were selected for cultivation according to prevailing agro-climatic conditions and their depleting status from this part of Himalaya. Thus, present report will help in collection of germplasm for further studies and would promote awareness among the public of Himalayan regions to protect and preserve the plant wealth, particularly medicinal plants. The species have been arranged alphabetically followed by family name, brief description of habit pertaining to flowering and fruiting period, their methods for propagation, distribution and brief medicinal uses.

Nautiyal, D.C. and Dewan, M.L. 2001. **Use of some important medicinal plants and herbs for treating common diseases at home in Uttaranchal**. *Journal of Non-Timber Forest Products*, 8(3/4): 174-178. HIMCON, Ranichauri, Tehri Garhwal 249199, Uttaranchal, India. [CLIMATIC ZONES; GARHWAL HIMALAYA; GERMPLASM; MEDICINAL PLANT]

The present study reports prevalent diseases among the communities living in Himalayan region and efforts for low cost preventive and curative healthcare services. The main emphasis is to promote awareness about the sustainable use of local easily available surrounding medicinal plants and to protect and conserve them in nature through cultivation. Since these Plants are not found to occur in all climatic zones, some are procured from the raw drug market. This communication includes a brief general classification of women, children and general diseases of old persons (Male & Female) and brief contents including plant parts use in formulations, their approximate proportion, fixed dose and period of taking. These formulations are prepared in the pressure of Vaidyas and experts of plant identification according to public need and positive health of an individual. The method of preparing medicines is very simple-*churn* powder.

Negi, G.C.S. and Joshi, Varun 2002. **Drinking water issues ans development of spring sanctuaries in a Mountain Watershed in the Indian Himalaya**. *Mountain Ressearch and Development*, 22(1): 29-31. G.B. Pant Institute of Himalayan Environment and Development,Garhwal Unit, PO Box 92, Srinagar-Garhwal 246174, India. [HOUSEHOLD; WATER MANAGEMENT; WATER RESOURCE]

The Himalaya barbor a wealth of springs and shallow wells used for drinking water and other household purposes. However, discharge from these sources has declined in recent decades-some springs have even dried up-making water a crucial development issue in the region. This article describes a field experiment to increase spring discharge with simole ecotechnology (spring sanctuary development) in the recharge zone of a nearly extinct spring in a Himalayan microwatershed in Uttaranchal. In the years after the experiment, water discharge increased from 1055 to 2153 L/d (1995-2000). Though much of this increase was probably because of above-average rainfall in the dry season of 2000, the results are very encouraging. In addition, the discharge of all springs in the watershed was pooled and more rational use of water was promoted.

Negi, J.D.S. and Chauhan, P.S. 2002. **Green house gases mitigation potential by sal *(Shorea robusta* Gaertn. F) forest in Doon Valley**. *The Indian Forester*, 128(7): 771-778. Forest Ecology & Environment Division, Forest Research Institute, Dehradun, Uttaranchal. [BIOMASS; DOON VALLEY; GREEN HOUSE GASES]

In the recent past most of the land in Doon Valley, which was under the forest cover, agriculture and orchard has been reduced remarkably and converted into a jungle of concrete. The manifold increase in the number of automobiles and industrial activities has caused rise in the concentration of Green House Gases (GHGs) resulting in an increase in atmospheric temperature. The present paper describes the estimated biomass and productivity of 11 representative sites for accounting carbon storage by Sal *(Shorea robusta*), which contributes 18.5-98.1% of the total crop. The standing biomass was calculated using prediction equations for each diameter classes in each site and expressed on hectare basis. Age of each crop was calculated with the help of age and diameter correlation for each quality class for determining productivity. The increase in temperature followed by the increased rainfall has ultimately provided the

favourable condition for fast decomposition and mineralisation resulting in high productivity and subsequently high carbon sequestration.

Negi, K.S. and Muneem, K.C. 2001. **Lentil: Germplasm status, Evaluation and performance of some promising genotypes in Central Himalaya**. *Journal of Non-Timber Forest Products*, 8(3/4): 181-183. National Bureau of Plant Genetic Resources (NBPGR), Regional Station, Bhowali, 263132, Niglat, District Nainital, Uttaranchal. [CENTRAL HIMALAYA; GERMPLASM; GRAIN YIELD]

The present paper highlights the status of lentil germplasm and some of the promising genotypes were selected for conducting trial in temperate condition for continuously 2 years. The performance of elite genotypes were identified in the Central Himalaya.

Negi, K.S.; Muneem, K.C.; Pandey, G.; Manral, H.; Pant, V.K. and Shukla, H.Y. 2001. **Status of some economically important under-exploited medicinal plant species in the Uttaranchal Hills**. *Journal of Non-Timber Forest Products*, 8(1/2): 1-13. National Bureau of Plant Genetic Resources (NBPGR), Regional Station, Bhowali 263132, District-Nainital, Uttaranchal. [AGRO-CLIMATIC ZONES; BIODIVERSITY; CONSERVATION; MEDICINAL PLANT]

Keeping in view the protection and conservation of the bio-diversity and related indigenous systems of medicines, the Indian Science of Medicines and Homeopathy (ISM & H) Department under the umbrella of the Ministry of Health and Family Welfare has identified and recognised 136 under-exploited plant species of medicinal value which are being used in Ayurveda, Sidha and Homeopathy. These plant species have been allocated to 34 different institutes/state agricultural universities (SAUs) organizations situated in different agro-climatic zones of India for the development of agro-techniques for wider cultivation in order to save conservation and make available raw material to the industry/indentors/users. The National Bureau of Plant Genetic Resources (NBPGR), New Delhi and its 3 regional stations, i.e., Bhowali, Shillong and Shimla have been allocated 20 plant species. The Bhowali station has been assigned 5 plant species, i.e. *Callicurpa macrophylla, Curcuma zedoaria, Piper retrofractum, Pistacia integerrima* and *Quercus infectoria* for the inventory of agro-techniques. The present paper highlights the status of these plant species and observation on their growth behaviour performance and adaptability in the study area.

Negi, K.S.; Pant, K.C. and Muneem, K.C. 2001. **Ricebean: Germplasm status, evaluation and performance of some promising genotypes in Central Himalaya**. *Journal of Non-Timber Forest Products*, 8(3/4): 143-145. National Bureau of Plant Genetic Resources (NBPGR), Regional Station, Bhowali 263132, Niglat, District Nainital, Uttaranchal, India. [CENTRAL HIMALAYA; GERMPLASM; GRAIN YIELD]

The present paper highlights the status of ricebean germplasm and some of the promising genotypes were selected for conducting trial in temperate condition for continuously 3 years. The performance of elite genotypes were identified in the Central Himalaya.

Negi, Y.S. and Bhalla, Pankaj 2002. **Collection and marketing of important medicinal and aromatic plants in tribal areas of Himachal Pradesh**. *The Indian Forester*, 128(6): 641-649. Department of Social Sciences, Dr.Y.S. Parmar University of Horticulture & Forestry, Nauni, Solan, H.P. [AGRO-CLIMATIC CONDITION; AROMATIC PLANTS; NATURAL RESOURCE; SUB-TROPICAL]

Collection and marketing of medicinal and aromatic plants is a highly labour oriented activity. Only right holders are allowed to collect these products. Illegal collection and marketing of the produce, however, also takes place; and the State Forest Department has taken some steps to check this practice. `Dhoop' *(Jurinea macrocephala*) and `Karu' *(Picrorrhiza kurrooa*) are the two important items collected in the area. These are followed by `Thuth'*(Salvia moorcroftiana*), `Banafsha' *(Viola serpens*) and `Patish' *(Aconitum* sps.) respectively. Collectors net share in consumer's rupee for different products is low and ranges from about 14 to 23 per cent for `dhoop' and 22 to 28 per cent for `karu'. Marketing channel, Collectors-Contractor-Broker-Wholesaler-Consumers was noted to be widely in use. Contractor's margins were also noted to be high. Labour charges are the major component of collectors cost and account for about 17 and 10 per cent of the consumer's price for `dhoop' and `karu' respectively. The study points out the need to curb the practice of unscientific extraction of this forest wealth. In order that the collectors get

remunerative prices, marketing of M&APs need to be streamlined and cooperative efforts may be promted. This will help in creating a say in the market for collectors of different M&APs from the State; who individually are only small-lot sellers.

Pande, P.K.; Negi, J.D.S. and Sharma, S.C. 2001. **Plant species diversity and vegetation analysis in moist temperate himalayan forest**. *Indian Journal of Forestry*, 24(4): 456-470. Wood Anatomy Discipline Botany Division, Forest Research Institute, New Forest, Dehradun 248006, India. [BIODIVERSITY; DIVERSITY INDEX; HIMALAYAN FORESTS; SHRUBS]

Present study deals with plant species diversity and other parameters on vegetation analysis in moist temperate forest of Kedarnath forest division (Garhwal Himalaya, UA). The whole area is divided into 8 subsites as per aspect and altitude (ranging from 1800-2800 m.a.s.l.). Total basal cover ($cm^2/100\ m^2$) ranged from 1519-6556 for trees; 7.24 to 74.33 for shrubs and 205 to 2027 for herbs at various sites. The range for diversity index (Shannon-Wiener index) was 1.26-2.09 for trees; 0-2.49 for shrubs and 1.45-3.0 for herbs. Diversity index was invariably higher for herbs than of the shrubs and trees. Site-VI and site-VIII were most similar sites of the area. Diversity index increases with decreasing altitude whereas concentration of dominance showed the reverse trend.

Phartyal, S.S.; Thapliyal, R.C.; Nayal, J.S. and Joshi, Geeta 2001. **Investigation of storage protocol of *Ulmus wallichiana* planchon seeds; effect of equilibrium moisture content on seed viability and vigour**. *Indian Journal of Forestry*, 24(3): 284-291. Forest Tree Seed Laboratory, Forest Research Institute (ICFRE), Dehradun, Uttaranchal. [GERMINATION INDEX; GERMINATION VALUE; MOISTURE CONTENT; RELATIVE HUMIDITY]

The effect of relative humidity (RH) and temperature on the equilibrium moisture content (EMC), moisture sorption isotherm, viability and vigour of *Ulmus wallichiana* seeds was studied at four temperature ranging from 20 to 50°C and at three RH levels, i.e., 11.2, 51.4 and 85.3 per cent. The maximum adsorption was recorded at higher RH and low temperatures while desorption was recorded at lower RH (11.2%) at all 4 temperatures and only at 40 and 50°C at 51.4% RH. Effect of RH and temperature on viability and vigour of seed during storage was quantified by the germination percentage, half viability period (p_{50}), germination value (GV), rate of loss of viability (d^1) and germination index (GI). The results indicate that at 11.2% RH and 20°C temperature seeds retained viability for longer period with high vigour.

Pilbeam, C.J.; Gregory, P.J.; Tripathi, B.P. and Munankarmy, R.C. 2002. **Fate of nitrogen-15-labelled fertilizer applied to maize-millet cropping systems in the mid-hills of Nepal**. *Biology and Fertility of Soil*, 35(1): 27-34. Department of Soil Science, The University of Reading, P.O. Box 233, Whiteknights, Reading RG6 6DW, UK; ARS-Lumle, P.O. Box 1, Pokhara, Nepal; ARS-Pakhribas, Dhankuta, Nepal. [MAIZE MILLET; NITROGEN FERTILIZER RECOVERY]

Maize grown in the mid-hills of Nepal traditionally received inputs of manure. However, N fertilizer is increasingly applied either alone or in combination with manure. This study investigated the effect of these different nutrient sources applied at three rates (0, 45, 90 kg N ha^{-1}) on crop yield in a maize-millet rotation at two locations (Pakhribas and Dordor Gaun) in the mid-hills of Nepal and measured the recovery of ^{15}N-labelled urea applied as a top-dressing to maize at three rates (11.25, 22.5, 45 kg N ha^{-1}). Grain and straw yields of maize were greater following the application of fertilizer either alone or in combination with manure, rather than manure alone. Millet yields were unaffected by the rate or form of N inputs to maize. Little (<25%) of the applied fertilizer was recorded in the maize crop, with only a further 3% recovered by the subsequent millet crop. On average, 58% of the applied fertilizer was recovered in the 0- to 60-cm soil layer at maize harvest, mainly in non-mineral N forms. Transformations and movement of applied fertilizer N were shown to be rapid, occuring within 7 days of application. Approximately one-third of the applied fertilizer was unaccounted for in the crop-soil system at maize harvest. It was concluded that fertilizer was rapidly immobilized and that its subsequent rate of turnover was low so that an application of fertilizer to one crop made no substantial contribution to the nutrition of the next.

Pundir, Y.P.S. and Singh, Dhan 2002. **Ethno-botanical wild food plants of Jaunsar-Bawar (Western Himalaya), Uttaranchal**. *The Indian Forester*, 128(5): 571-582. Department of Botany, D.B.S. College, Dehradun, Uttaranchal. [MEDICINAL PLANT; WESTERN HIMALAYA; WILD EDIBLE PLANT]

The paper reports forty wild edible food plants used by the natives of Jaunsar - Bawar tribal area. A list of 137 more wild food plants already reported from this area by the authors is also given.

Rao, K.H.V.Durga; Kumar, C.S.Krishna and Prasad, V.Hari 2001. **Irrigation Water Requirements and Supply Analysis in Dehradun Region- An Integrated Remote Sensing and GIS approach**. *Photonirvachak*, 29(1/2): 59-67. Indian Institute of Remote Sensing, Department of Space, 4-Kalidas Road, Dehradun 248001; Central Water & Power Research Station, Pune 411024, India. [ECONOMIC CONDITION; REMOTE SENSING; SATELLITE DATA; WATER MANAGEMENT]

The paper focuses on analysing the irrigation water supply and demand of different crops under three main canals for kharif and rabi seasons in Dehradun region of Uttaranchal state. Crop acreage maps of rabi and Kharif seasons have been prepared using LANDSAT TM 5 digital data by applying different image processing and classification techniques. Crop water and irrigation water requirements of different crops have been computed using CROPWAT computer program. Canal discharges have been compared with the irrigation water planning and management and found to be more that the irrigation water requirements in many months, that shows the need of revising the irrigation water management.

Rawat, Laxmi and Singh, S.P. 2001. **Production and decomposition of understorey vegetation of a high altitude oak *(Quercus semecarpifolia* S.) forest of Central Himalaya, India I. Production of herbaceous vegetation**. *Indian Journal of Forestry*, 24(3): 362-367. Forest Ecology and Environment Division, Forest Research Institute, New Forest, Dehradun 248006; Botany Department, Kumaun University, Nainital, Uttaranchal, India. [BIOMASS; CENTRAL HIMALAYA; HIGH ALTITUDE]

Production of herbaceous vegetation of a *Quercus semecarpifolia* S. forest of Kumaun Himalaya, India has been reported. The standing live and dead shoot biomass of main herb species, *Senecio rufinervis, Polygonum amplexicaule* and *Selinum Candollii* and other herb species have been reported. The total biomass of standing live shoots ranged between 0.017-1.90 t ha^{-1} and total biomass of standing dead shoots ranged from 0.58 t ha^{-1} to 0.95 t ha^{-1} in a year. The monthly values of below ground biomass ranged from 1.71 ha^{-1} to 3.92 t ha^{-1}. The analysis of variance between all these values for different months showed significant variation. The total Net Primary Production was 3.04 t ha^{-1}, which the above ground parts accounted for 56.3 per cent and below ground parts 43.8 per cent.

Rawat, Laxmi and Singh, S.P. 2001. **Production and decomposition of understorey vegetation of a high altitude oak *(Quercus semecarpifolia* S.) forest of Central Himalaya, India. II. Decomposition of understorey vegetation**. *Indian Journal of Forestry*, 24(4): 437-441. Forest Ecology and Environment Division, Forest Research Institute, New Forest, Dehradun 248006, India. [CLIMATIC CONDITIONS; HIGH ALTITUDE; LEAF LITTER; ORGANIC MATTERS]

Decomposition of leaf litter of shrub and herb species of a *Quercus semecarpifolia* S. forest of Kumaun Himalaya, India has been studied. Two main shrub species, *Viburnum cotinifolium* and *Berberis asiatica* and three main herb species, *Senecio rufinervis, Polygonum amplexicaule* and *Selinum candollii* were investigated separately by litter bag method. Leaves of both the shrub species decomposed almost completely in 11 months (330 days), whereas it took only 7 months (210 days) for each of the herb species to decompose completely. The values of annual decomposition constant (K) were in order of *Selinum candollii* (7.66)> *Senecio rufinervis* (7.2)> Polygonum amplexicaule (5.42)> *Berberis asiatica* (4.77)> *Viburnum cotinifolium* (3.86). Various decay parameters and time required for loss of one half and 95% of the original leaf litter dry weight are also given.

Rawat, R.S. 2001. **Phytosociological studies of woody vegetation along an altitudinal gradient in a montane forest of Garhwal Himalayas**. *Indian Journal of Forestry*, 24(4): 419-426. Ecology Loboratory, Department of Botany, H.N.B. Garhwal University, Srinagar 246174, UA, India. [DIVERSITY; GARHWAL HIMALAYA; SEEDLING]

In the present study, various phytosociological attributes of woody vegetation were analysed along an altitudinal gradient from 1700 to 2100 m above msl in a mountain flank of Garhwal Himalayas. The flank was surveyed for floristic composition, distribution pattern, species diversity and dominance at each stratum of woody vegetation. Maximum number of tree, sapling and seedling species were recorded on upper slope and minimum number on lower slope. *Alnus nepalensis, Lyonia ovalifolia, Quaercus leucotrichophora, Rhododendron arboreum* (tree species) and *Berberis aristata* (shrub species) were present on all slopes. *Rhododendron arboreum* was dominant species on upper and middle slopes whereas *Quercus leucotrichophora* was dominant on lower slope in the tree stratum. Majority of the woody species showed contagious distribution pattern followed by random. Diversity index and concentration of dominance values confirmed the temperate nature of this forest.

Rawat, R.S. 2001. **Some medicinal plants in Garhwal Himalaya**. *Journal of Non-Timber Forest Products*, 8(3/4): 207-218. Plant Physiology Branch, Forest Research Institute, Dehradun 248006, Uttaranchal. [CONSERVATION; GARHWAL HIMALAYA; MEDICINAL PLANT; MICRO-CLIMATIC CONDITION]

Literature on Garhwal Himalayan vegetation has been reviewed and based on these, about 50 potential medicinal plant species are described in this paper with their botanical names arranged alphabetically, alongwith their chief characteristics and medicinal values.

Sah, Jay P. and Heinen, Joel T. 2001. **Wetland resource use and conservation attitdes among indigenous and migrant peoples in Ghodaghodi Lake area, Nepal**. *Environmental Conservation*, 28(4): 345-356. Department of Biological Sciences, Florida International University, Miami, FL 33199; Department of Environmental Studies, Florida International University, Miami, FL 33199, USA. [CONSERVATION ATTITUDES; ETHNICITY; NEPAL; RESOURCE USE; THARUS; WETLAND CONSERVATION]

Nepal has a number of wetlands in the lowland region of the country along the southern Indo-Nepalese border that have experienced great pressures from growing human populations due in part to migration of people from the mountains. A questionnaire survey and informal interviews with key informants in 1998 were used to explore the socio-economic status of indigenous and non-indigenous inhabitants, use patterns of forest and wetland resources and attitudes about conservation in Ghodaghodi Lake, a proposed Ramsar site, in the lowlands of western Nepal. Tharus, indigenous to the region, represented 33% of the populations; the rest were migrants from the mountains. Tharus had lower literacy rates,larger landholdings and kept different livestock species. Most Tharu families were dependent on extraction from wetlands; all groups used forest for fuelwood but mountain settlers used forest for fodder more than did tharus. Most respondents expressed willingness to participate in the conservation of Ghodaghodi Lake; however, only 12%, mostly mountain settlers, had ever participated in formal conservation activities. Conservation attitudes were strongly influenced by educational level and resource use. Educated males of higher caste and mountain origin who had previously participated in formal management activities were more positive towards conservation than other groups. There is a need to implement a participatory integrated management plan, to include community development, education and off-farm income generation, to assure participation of Tharus and lower caste households of mountain origin in the conservation and management of wetlands and forests in the area.

Samal, P.K.; Shah, Anubha; Tiwari, S.C. and Agrawal, D.K. 2002. **Indigenous animal health care practices and their relevance to bioresource conservation in Indian Central Himalaya**. *International Journal of Sustainable Development and World Ecology*, 8: 167-178. G.B.Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263643, India. [ANIMAL HEALTH CARE; BIORESOURCES; CONSERVATION; DEVELOPMENT; INDEGENOUS KNOWLEDGE; INDIAN CENTRAL HIMALAYA]

In mountain ecosystems like those of the Central Himalayan region of India, local people are dependent on their immediate bioresources for their survival. For their own well-being, as well as for that of their life-support systems like livestock, the mountain people, based on their generations of experience, have evolved indigenous health care practices. The raw materials for these practices are largely drawn from the

surrounding bioresources. The Centre Himalayan region of India supports about four million livestock, which play a vital role in the livelihood of the inhabitants. The draught animal is the only means of ploughing; cattle dung is the major component of manuring and the income from livestock contributes substantially to the total income of the local farmers. In this remote ecosystem, where modern veterinary infrastructure is very poor both quantitatively and qualitatively, the locals have evolved indigenous health care practices to maintain their livestock. The practices, based on locally available bioresources, are effective in healing diseases, do not have financial and are easily administrable. However, under ruthless exploitation of bioresources for diverse needs, the medicinally important plants, too, are disappearing, which, in due course, may adversely affect the indigenous practices. Through a survey covering eight settlements between 900-1800 m asl in the region, an effort was made to document the indigenous animal health care practices and the medicinal plants which are used in these practices. As many as 350 knowledgeable respondents were interviewed. It was observed that the raw material for the indigenous treatments was drawn from the immediate bioresources, making it obvious that the bioresources should be maintained and supported as a priority if the valuable indigenous health care practices are to be continued.

Sarkar, B.C.; Deota, B.S.; Raju, P.L.N. and Jugran, D.K. 2001. **A geographic information system approach to evaluation of groundwater potentially of shamri micro-watershed in the Shimla Taluk, Himachal Pradesh**. *Journal of the Indian Society of Remote Sensing*, 29(3): 151-164. Indian School of Mines, Dhanbad; M.S. University of Baroda, Vadodara; Indian Institute of Remote Sensing, Dehradun. [GIS; GROUND-WATER; LAND USE PATTERN; MICRO-WATERSHED; SATELLITE DATA]

GIS a potential tool for facilitating the generation and use of thematic information has been applied to groundwater potentially of the Shamri mircro-watershed in Shimla Taluk. The role of various parameters, namely, drainage, lineament, lithology, slope and landuse have been emphasised for delineation of groundwater potential zones. IRS-1C PAN and LISS III FCC merged satellite images on 1:25000 scale and Topographic map no. 53E/4/SE together with field traverses have been used as the data source. A multi-criteria evaluation following probability weighted approach has been applied for overlay analysis that allows a linear combination of weights of each thematic map with the individual capability value. The resultant map indicates a high groundwater potentiality in the flood plains, river terraces and river channels in the vicinity of the Shamri nala. Other sites of high potentiality include places showing break in slopes and criss-crossing of lineaments.

Satyal, G.S.; Samant, S.S. and Kumar, K. 2002. **Indigenous knowledge and conservation of medicinal plants used by the Bhotia tribes in Kumaun Himalaya, India**. *International Journal of Sustainable Development and World Ecology*, 9(3): 159-166. G.B.Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263643, India. [AGRO-TECHNIQUES; CONSERVATION; DIVERSITY; INDIGENOUS KNOWLEDGE; MEDICINAL PLANTS]

The present study deals with indigenous knowledge on 34 medicinal plants of Kumaun Higher Himalaya used by the Bhotia tribes. Most of the species are native to the Himalayan region. *Angelica glauca* and *Allium stracheyi* are narrow range endemic and *Allium stracheyi, Picroriza kurrooa* and *Nardostachys grandiflora* have been recorded in the *Red Data Book of Indian Plants*. Apart from indigenous uses, the majority of the species are used in the pharmaceutical industry and a few are among the major sources of income generation. The annual production of medicinal plants is comparable with the annual production of traditional crops. Hence, development of proper agro-techniques for cultivation, harvesting in the proper season and *in situ* conservation of these species is envisaged.

Sen, K.K.; Semwal, R.L.; Rana, U.; Nautiyal, S.; Maikhuri, R.K.; Rao, K.S. and Saxena, K.G. 2002. **Patterns and implications of land use/cover change**. *Mountain Ressearch and Development*, 22(1): 56-62. G.B.Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263643; G.B. Pant Institute of Himalayan Environment and Development, Garhwal Unit, PO Box 92, Srinagar (Garhwal) 246174; School of Environmental Sciences, Jawaharlal Nehru University, New Delhi 110067, India. [AGRICULTURAL EXPANSION; FOREST RESOURCES; INDIAN HIMALAYA; LAND USE CHANGE; SOCIOECONOMIC FACTORS]

Land use/cover changes during the period 1963-1993 and their ecological and socioeconomic implications in Pranmati Watershed in the Indian Himalaya were analyzed on the basis of information extracted from archival records, satellite data, participatory discussions, and field measurement. Agricultural land use was practiced on 14.2% of the watershed area in 1963 compared with 18.5% in 1993. More than 50% of the agricultural expansion occurred in community forests between 1850 and 2400 m and on 20-30^{o} slopes. The increase in area under cash crops, potato, and amaranth accompanied an 86% increase in the mean monetary value of crop produce but at the cost of abandoning the traditional crops *Fagopyrum esculentum, F. tataricum, Panicum miliaceum,* and *Setaria italica*. Agricultural land use changes were such that mean manure input at the watershed scale increased by 50%, and fodder output from crops decreased by 40%, implying the increasing pressure on forests. Local forest management institutions have not been adequately empowered to respond to the growing economic aspirations of people and the increasing population pressure. Research and policy support for improvement in traditional soil fertility management practices and forest resource-based economic development opportunities for local people is needed to reduce the threat from agriculture to forest ecosystems.

Sharma, J.K.; Mishra, V.K. and Verma, K.S. 2001. **Seasonal trends in foliar macronutrients and optimum lopping time of *Bauhinia retusa* and *Mallotus philippinensis*-potential agroforestry species**. *Indian Journal of Forestry*, 24(4): 427-432. Department of Silviculture and Agroforestry, University of Horticulture and Forestry, P.O. Nauni-Solan, H.P. 173230. [AGRO-FORESTRY; GREEN FODDER; LIVESTOCK; NUTRIENT CONCENTRATION]

The tree foliage constitutes an important source of nutrient-rich green fodder to sustain the livestock in several regions of our country especially during winter months when grasses become dry and unpalatable. Knowledge of the changes in nutrients concentration of the leaf with the advancement of growing season helps in specifying the optimum lopping time to harvest nutrient rich fodder. Variations in the macronutrients content of leaves of *Bauhinia retusa* and *Mallotus philippinensis* from leaf emergence to leaf fall were studied to determine the range of nutrient concentration, seasonal trend, average seasonal nutrient content and optimum lopping time. There were three trends in the nutrient concentration with the advancement of leaf age and active growing season. First: N,P and K concentration decreased with the advancement of growing season. Second: Mg and S did not follow any particular trend. Third: Ca concentration improved with the advancement of leaf age and season. The concentration of N,P and S were higher in the foliage of *Mallotus philippinensis* whereas concentration of K, Ca and Mg were higher in the leaves of *Bauhinia retusa*. Further, based on the seasonal nutrient trends the optimum lopping time for *Bauhinia retusa* and *Mallotus philippinensis* are recommended as October to January and December to February, respectively.

Sharma, O.P. 2002. **Efficient resin tapping and its processing in Himachal Pradesh: an overview**. *The Indian Forester*, 128(4): 371-378. Managing Director, Himachal Pradesh State Forest Corporation Limited, Kasumpati, Shimla, H.P., India. [CHIR-PINE FOREST; DIAMETER]

In the present paper, Resin, one of the important Non-Timber Forest Produce (NTFP) of Himachal Pradesh has been discussed with special emphasis on its extraction and processing and based on the Himachal Pradesh experience, ways and means to improve upon methods of extraction and processing of resin thus cutting down the westage on fuel and resin lost as wastage have been suggested.

Singh, Dhruv Sen and Mishra, Ajai 2002. **Role of tributary glaciers on landscape modification in the Gangotri Glacier area, Garhwal Himalaya, India**. *Current Science*, 82(5): 567-571. Department of Geology, University of Lucknow, Lucknow 226007,India. [GANGOTRI GLACIER; LANDFORMS; LANDSCAPE ECOLOGY]

Studies on glacies landforms are helpful in the palaeoclimatic reconstructions. However, it may lead to misinterpretation if the secondary processes that modify the landforms and landscape are not taken into consideration. The tributary glaciers are identified as an important agent, which form, affect and modify the landforms/landscape. The landforms and landscape readjust according to the new set of conditions created by tributary glaciers, and get modified. Therefore, to study the geomorphological landforms and their palaeoclimatic implications, the role of transverse tributary glaciers is of prime importance.

Singh, Jasbir; Chandra, Anup; Saikia, H.C. and Thakuria, G. 2002. **Socio-economic study of Karbi tribe of silonijan - a case study in Karbi-Anglong district of Assam**. *The Indian Forester*, 128(4): 403-411. Shifting Cultivation Division, Rain Forest Research Institute, Jorhat, Assam. [HOUSEHOLD; LITERACY RATE; SEX RATIO; SHIFTING CULTIVATION; SOCIO-ECONOMIC]

A socio-economic study was conducted in four villages of Karbi Anglong District of Assam. Cent per cent households were surveyed. Sex ratio (females per 1000 males) was found very high among the shifting cultivators. Literacy rate and annual income and saving is very low among the shifting cultivators. It is revealed that overall socio-economic condition of the shifting cultivators is very poor. Better educational levels and adequate efficient infrastructural facilities will provide impetus to the positive growth of socio-economics of the shifting cultivators. In addition to this, sustainable land use system like agro-forestry and forest based industry, cash crops, etc. can be introduced in the jhum area. It will not only improve the ecology of the area but also will help in upliftment of shifting cultivators.

Singh, Lakhan; Sinha, B.P. and Rao, D.U.M. 2002. **Social Features of the villagers in Doon Valley Watershed project**. *Indian J. Soil Cons.*, 29(2): 169-172. Zonal Coordination Unit, Zone IV (ICAR) CSAUA&T Campus, Kanpur 208002, U.P., India. [DOON VALLEY; LAND HOLDING; SOCIAL FEATURES; WATERSHED]

The social features are important for people's participation. In order to become aware about features of a social system it is necessary to determine the personal and socio-situational characteristics of villagers. A study was initiated during 1997 where Integrated Watershed Management Project was implemented in Doon Valley. Farmers from two groups of two villages (successful and less successful) were found more or less same regarding age, educational level and land holdings. About three-fourth of respondents, belonged to marginal farm category. Their land holdings were scattered at different locations on hill terraces and fragmented into many plots and located more than a km away from their houses. Two sets of villages differ on one aspect - farmers of less successful villages did not follow small family norms with the results most of nuclear families with large size had been there.

Singh, Ombir 2002. **influence of seedling height on survival and growth of silver fir *(Abies pindrow*, space) in field plantings**. *The Indian Forester*, 128(5): 567-570. Himalayan Forest Research Institute, Shimla, H.P. [ROOT-SHOOT RATIO; SEEDLING; SILVER FIR]

The study was undertaken to determine optimum height of Silver fir seedlings for field planting and to cull inferior seedlings at planting stage to raise quality plantations. Experiment was conducted with four-height classes viz., 15-20, 21-25, 26-30 and 31-35 cm height seedlings. The best results were obtained with seedlings of 21-25 cm tall in respect of survival and growth in early establishment of seedlings in plantations.

Singh, S.P. 2002. **Balancing the approaches of environmental conservation by considering ecosystem services as well as biodiversity**. *Current Science*, 82(11): 1331-1335. Department of Botany, Kumaun University, Nainital 263002, Uttaranchal. [BIODIVERSITY; ENVIRONMENTAL CONSERVATION; HIMALAYA; NATURAL ECOSYSTEM]

In recent years, most plans for conservation have focused on biodiversity, ignoring the importance of the ecosystem services. This paper discusses limitations of the biodiversity-centred approach to conservation and reasons why ecosystem services need to be included to provide a balanced approach to conservation. To achieve this objectives, there is need to improve the identification and valuation of ecosystem services. By focusing on biodiversity conservation, we may ignore many areas that are rich in biodiversity but are important to human welfare and are under the threat of environmental degradation.

Singh, Sanjay K. 2001. **Phenological succession of herbaceous communities in the sub-alpine and alpine pastures of Great Himalayan National Park, Western Himalaya**. *Indian Journal of Forestry*, 24(3): 337-341. Wildlife Institute of India, Post Box #18, Chandrabani, Dehradun 248001, India. [CLIMATIC CONDITIONS; HIGH ALTITUDE; SUB-ALPINE; WESTERN HIMALAYA]

The flowering stages of herbaceous species of high altitude plants were recorded during the survey of 1996-98 in the sub alpine and alpine pastures *(thaches)* of Great Himalayan National Park (GHNP).

GHNP is located in the Western Himalaya, in district Kullu of Himachal Pradesh. The flowering of various high altitude species were recorded monthly in this area. The initiation of flowering was synchronized with the beginning of spring or rise in temperature and snowmelt. The flowering starts is late March in sub-alpine and in late April in alpine zone. In these high altitude pastures, the peaks of various phenophases succeed on after the other during the snow free period. It was noticed that plants complete their various growth cycles within a short period of favourable conditions, to ensure the survival of their progeny. The flowering phase of these species varied from (10-15) days to (1-3) months.

Sood, K.G.; Rawat, G.S.; Sharma, C.M. and Nautiyal, A.M. 2002. **Transportation of plants in hills - A comparative study**. *The Indian Forester*, 128(7): 745-750. Forest Operations Unit, Silviculture Division, Forest Research Institute, Dehradun, Uttaranchal. [PLANT TRANSPORTATION; SOIL CONSERVATION]

The knapsack type plant carrier designed and fabricated at FRI was subjected to extensive field trials for the transportation of plants in hill areas from the nurseries located at lower level to find out its suitability, efficiency and economics of operation and its comparison with the conventional method of transportation of plants under similar conditions, on which, detailed time and cost study was conducted at Gohri/Tal range of Soil Conservation Forest Division, Lansdowne (Uttaranchal). The plant carrier developed was found to be more advantageous, effective, economical and less strenuous as compared to conventional method of transportation of plants in hills.

Suresh, N.; Bagati, T.N.; Thakur, V.C.; Kumar, Rohtash and Sangode, S.J. 2002. **Optically stimulated luminescence dating of alluvial fan deposits of Pinjaur Dun, NW Sub Himalaya**. *Current Science*, 82(10): 1267-1274. Wadia Institute of Himalayan Geology, 33, General Mahadev Singh Road, Dehradun 248 001, India. [CLIMATIC CONDITIONS; MAIN BOUNDARY THRUST; SANDSTONES; SUB HIMALAYAN REGION]

The Quaternary deposits of Pinjaur Dun characterized by a series of alluvial fans, are indication of tectonic uplift of the northern part of the Sub Himalaya and variation in climate through the time of their sedimentation. The quartz optically stimulated luminescence ages of the exposed bottom and top of the fan deposits indicate that the sedimentation commenced well before 57 ka BP and continued up to around 20 ka BP. Presently the base of the river is about 30-40 m below the distal fan surface indicating that after the termination of fan sedimentation around 20 ka BP, river incision and subsequent terrace formations occurred probably due to change in climate and tectonism.

Tewari, S.K.; Shubhanjana and Pandey, S.B.S. 2002. **Productive behaviour of *Dalbergia sissoo* (Shisham)**. *The Indian Forester*, 128(3): 336-340. Department of Genetics and Plant Breeding, G.B. Pant University of Agriculture and Technology, Pantnagar; Forest Research Institute, Dehradun, Uttaranchal. [INFLORESCENCE; NATURAL CONDITION; POLLINATION]

Present investigation deals with the reproductive biology of *Dalbergia sissoo*. Under natural conditions, pod setting of 11.09% (1998) and 17.19% (1999) were observed. In isolated single buds 1.71 per cent (1998) and 7.97 per cent (1999) pod setting were observed. In the year 1998, in isolated whole inflorescence, 186 pods were formed out of 6840 buds and in 1999, out of 4248 buds, only 144 pods were formed. In emasculated and bagged buds, 9 pods were formed out of 299 emasculated buds in 1998 and in the year 1999, only 14 pods were formed from 468 buds. No pod formation was observed in emasculated and left oped buds indicate that a system of allogamous pollination is not working. Pod formation was also observed during hybridization (9.19 per cent in 1998 and 6.94 per cent in 1999) supports the idea that pod formation may take place if pollen even from other source is available.

Thakur, I.K.; Thakur, V. and Gupta, A. 2001. **The effect of age and season on rooting stem cuttings of thornless *Robinia pseudoacacia* Linn. in Western Himalayas**. *Indian Journal of Forestry*, 24(3): 385-387. Department of Tree Improvement and Genetic Resources, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan 173230, H.P., India. [MID-HILL CONDITIONS; STEM CUTTING; WESTERN HIMALAYA]

This paper reports on the effect of age and season on rooting of cuttings of thornless *Robinia pseudoacacia* in the Western Himalayas. Maximum rooting (78%) was obtained in the cuttings collected from two years old plants and planted on 15th July, whereas highest cutting with major roots (53%),number of major roots per cutting (1.93) and length of longest root (6.8 cm) were observed in cutting collected from 3 years old plants planted on the same date.

Thakur, P.S. 2002. **Effect of canopy management on vigour and biomass production potential in four agroforestry tree species from temperate region**. *The Indian Forester*, 128(5): 493-501. Department of Silviculture and Agroforestry, University of Horticulture and Forestry, Solan, Himachal Pradesh. [AGRO-FORESTRY; BIOMASS PRODUCTION; COLLAR DIAMETER; LEAF AREA INDEX]

Out of the four agroforestry tree spcies, namely *Grewia optiva, Celtis australis, Bauhinia variegata, Morus alba*, and two tree species (i.e. *G. optiva* and *M. alba*) maintained higher growth, vigour and foliage and branchwood biomass production potential for longer period when pollarded at 1.5 or 2.0 m. *G. optiva* and *M. alba*, responded better to canopy management practices like coppicing and pollarding as compared to *C. australis* and *B. variegata*. Collar diameter increased with increase in cutting heights in *G. optiva* and *M. alba*, but remained unchanged in *C. australis* and *B. variegata* up to fourth year of canopy management treatments. Significant decrease in shoot number, Leaf Area, Leaf Area Index (LAI) and foliage and branchwood biomass production occurred by fourth year of treatments although decrease was of higher magnitude at lower cutting heights in all the four tree species. *M. alba* followed by *G. optiva* produced maximum foliage and branchwood biomass at 2.0 m cutting height during the entire experimentation period.

Thakur, Sanjeev; Bhardwaj, S.D.; Guleria, Vipin and Paul, Dharam 2002. **Studies on variability of pod and seed traits in *Albizia Chinensis***. *The Indian Forester*, 128(3): 303-306. Regional Horticultural Research Station, Jachh, Nurpur, Kangra, Himachal Pradesh. [FODDER; NITROGEN FIXING; SUB-TROPICAL]

Studies on variability of pod and seed characters of *Albizia chinensis* were conducted through the estimates of range, mean, phenotypic and genotypic coefficients of variation, heritability and gentic advance as percent of mean. Significant variations in pod length, breadth, thickness and seed weight were found. High heritability coupled with high genetic advance was observed for pod breadth, pod thickness, pod weight and seed weight/pod. High positive values of genotypic correlation coefficient between pod and seed characters reveal that the traits are genetically controlled and selection can be very effective in tree improvement programme.

Topal, Y.S. and Samal, P.K. 2001. **Economic transition and collapse of sustainability: a study of three mountain tribes of Uttaranchal**. *IASSI Quarterly*, 19(3): 15-31. G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora, Uttaranchal. [ECONOMIC TRANSITION; MOUNTAIN TRIBES; SOCIO-ECONOMIC; SUSTAINABLE DEVELOPMENT]

An empirical study was conducted to understand the process of economic transition and its influence on sustainability among three mountain tribes of Uttaranchal, namely the Jaunsaris, the Bhotiyas and the Rajis. Though, the process of economic transition has necessarily evolved around the development, contemporary development measures could not ensure sustainable living of these tribes. Some of the major reasons behind this failure have been ignorance of age-old traditional economic institutions and pursuits, ecological specificity, culture traits, indigenous resource use patterns, identification of actual felt needs, and a non-participatory approach at the time of policy formulation and implementation. These lacunae have led the tribes towards unrealistic economic transition by disrupting their age-old economic institutions and practices, finally resulting in a collapse of sustainability. Polyandry and Jajmani relations among the Jaunsaris, transhumance, pastoralism and international trade among the Bhotiyas and, nomadism, trade in night and wooden crafts among the Rajis have become endangered traditional practices. There is an urgent need of rethinking on the consequences of economic transition that have taken place among these people and to incorporate specific tribe based socio-economic, ecological and cultural issues into polices and programmes immediately to formulate a holistic strategy for their sustainable development.

Uniyal, Sanjay Kumar; Awasthi, Anjali and Rawat, G.S. 2002. **Current status and distribution of commercially exploited medicinal and aromatic plants in upper Gori valley, Kumaon Himalaya, Uttaranchal**. *Current Science*, 82(10): 1246-1252. Wildlife Institute of India, P.O. Box No. 18, Chandrabani, Dehradun 248001. [CONSERVATION; DIVERSITY; KUMAON HIMALAYA; MEDICINAL PLANT]

Estimation of population status and biomass availability of 14 threatened medicinal and aromatic plant species (TMAPS) extracted and traded from the higher altitudes of Kumaon Himalaya was carried out. We used stratified random samples covering distinct landscape units or habitats. These TMAPS were distributed in nine different habitat types and had habitat-specific distribution. On the basis of their status and level of pressure at a local scale, we have grouped them into six categories and a conservation approach has been suggested.

Verma, T.D.; Sharma, Nirupama and Sood, Anil 2001. **Insect pests of important cultivated medicinal Plants in the mid hills of Himachal Pradesh**. *Journal of Non-Timber Forest Products*, 8(3/4): 191-195. Department of Entomology and Apiculture, Dr.Y.S. Parmar University of Horticulture and Forestry, Nauni-Solan 173230, H.P., India. [CULTIVATION; INSECTS; MEDICINAL PLANT]

In a survey study conducted in the mid hills of Himachal Pradesh on the insect pests of four cultivated medicinal plant species, viz., *Gloriosa superba* Linn., *Glaucium flavum* Crantz., *Asclepias curassavica* Linn. and *Psoralea corylifolia* Linn., 20 insect pests were found to be associated with these plants. Among them eight insect species belong to order Lepidoptera, seven to Coleoptera and five to Hemiptera. This is the first report from this area. Incidence, population levels, nature and extent of damage of the economic importance done by these insect species have been discussed.

News & Views

Compiled by S.N. Nandy, D.S. Negi, S.K. Sinha and P.M. Pandey
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Commercial fishing posing threat to Arunachal ecology

Rampant commercial fishing by using chemical poisons and electric shocks is posing a threat to the fragile ecology of Arunachal Pradesh. In a workshop organized by Itanagar Wildlife Sanctuary division and Doimukh *Gaon Buras* (village chiefs), the Environment and Forest Minister of the State said that the villagers should be alert to the threat posed to the ecology by such fishing activities and instead avail the benefits of various eco-development and forestry schemes for their economic uplift.

THE SENTINEL: August 7, 2002

UNICEF's rain water scheme for Nagaland

To cope with the water crisis in Nagaland, the Public Health Engineering (PHE) department has taken up a three phase model community based rooftop rain water harvesting scheme in collaboration with the UNICEF. The Government of Nagaland proposed the project and the beneficiaries were families living below poverty line.

THE SENTINEL: August 7, 2002

Fungus is goldmine for the hill people

Morchella esculenta, a fungus growing naturally on the humus rich floors on the central and western Himalayas at an altitude of 1800 to 3600 m is sold by the local inhabitants to middlemen in rates as high as Rs 5000 per kg, and they pass it on to star hotels and pharmaceutical companies earning a profit of 35-40%. The fungus, with a unique flavour is cooked as food and is used in medicinal and health care system by the traditional hill societies, who also consider it important for clinical use as well as rich nutritional value. Drs Maikhuri and Rao of the G.B. Pant Institute of Himalayan Environment and Development along with their team of researchers have recently carried out an extensive field study with regard to the collection of Morchella in the 40 villages of Niti valley in the higher Himalayas. They stressed on the need for scientific evaluation of ecological and economic implications of such traditional practices as no efforts have so far been made to cultivate Morchlla.

HINDUSTAN TIMES: August 8, 2002

First hydram installed in Una district

Under the draught prone area project (DPAP), the watershed development committee at Apramb village in Amb block of Una district, Himachal Pradesh has made a landmark achievement by installing the first ever hydrolic ram (hydram) for irrigation without using any energy of fuel. Hydram is an impulse device which uses the energy caused by the momentum of falling water to raise it to an elevation up to 25 to 30 times by using a combination of valves that produce hammering effect on the water trapped in the device. The government had received demand from many other districts to install hydram system so that the water shortage could be removed.

THE INDIAN EXPRESS: August 8, 2002

Siachen may soon be world's largest dump

Siachen, means place of roses, the world's coldest and highest battlefield could soon be one of the world's biggest dump. Army sources reveal that during 1998 alone, the Indian side was bombarded with 43,000 artillery shells and 2,30,000 rounds of small arms fire from the Pakistani side. Post-Kargil, the conflict intensified and one thousand strong infantry battalion is currently stationed on the northern, central and southern parts of the glacier, where natural disintegration is impossible as temperatures falls nearly -60^{o} celsius during winter. Army officers however, claim that they are using incinerators run on kerosene to destroy their waste, but they admit that a lot of the stuff cannot be disposed.

THE TIMES OF INDIA: August 11, 2002

Glaciers in HP hit by decreasing snowfall

The adverse impact of global warming is slowly but surely being felt in the mountain state of Himachal Pradesh. The snow line of glaciers has gradually moved up by as much as two or three km at various places in the higher reaches, causing concern to environmentalist and authorities. The balley tree, a variety of the willow, which enters to the fuel, fodder and fibre needs of the triblals when the valley is blocked for over six months in the winters, is also falling prey to insects and parasites. Scientists of Himalayan Forest Research Institute also admit the attack of aphids on the trees.

THE TIMES OF INDIA: August 27, 2002

HC seeks reports on preservation of Dal lake

The Jammu and Kashmir High Court (HC) has directed different departments of the government to give a detailed report on the measures being taken for the preservation of Dal lake. A division bench of the HC directed the divisional authorities to submit details of the unauthorized construction in the green belt forest area around the water body. However, the Lake and Waterways Development Authority, Srinagar regarding encroachments of the world famous lake have produced nothing before the court.

THE HINDU: September 1, 2002

Leh: world's highest zero waste town

Ladakh Ecological Development Group launched the alliance for a zero waste Leh by participating of poorest communities, tour and travel guides, environmental and women's group, and health specialists. There is almost no plastic bag available after a ban – demanded by citizens, came into place a few years ago and organic waste is collected and fed to the cattle, which almost every prosperous family owns. So maybe, given its attitude, Leh could well become the highest zero waste town in the world.

Bharati Chaturvedi for THE HINDUSTAN TIMES: September 2, 2002

Hundreds of HIV-infected people, in NE dying for lack of medicines

Hundreds of HIV-infected people have died in the north-eastern region because of the lack of access to medicines and inadequate healthcare facilities. According to various estimates, there could be up to 100,000 HIV-positive patients in the seven north eastern states, with more than 200,000 injecting drug users in the region. Manipur borders the heroin-producing 'Golden Triangle' of Laos, Myanmar and Thailand and has high rates of intravenous drug use – a key cause of HIV infection in the region. Anti-retroviral drugs required for treatment of HIV-AIDS are either not immediately available or in most cases unaffordable due to its high costs, according to President of Manipur Network of Positive People (MNPP).

THE SENTINEL: September 5, 2002

Special funds for hill area diverted: Report

The Special Central Assistance plan, under the Hill Area Development Programme, forms a sub-component of the States' plan. As a result, other sectors or areas received priority while environmental concerns did not receive adequate attention and the funds mean for ecological preservation of hill area was used for non-plan or salary requirements, the report prepared by Ministry of Environment and Forests has said. The report said that the special assistance, meant for the ecological preservation of the hill areas, was used for the other purposes even as the rich environmental heritage of the Himalayan region was under severe pressure from natural as well as human-induced stresses. The report stressed the need to provide incentives to farmers of conserving the gene pool through promotion of traditional farming practices. To protect the fragile ecosystem of the Himalayas, the Central Government had also proposed certain restrictions which, if implemented may have a far-reaching impact.

THE BUSINESS LINE: September 23, 2002

Mining, construction change weather pattern?

The Union Government, in its latest report released in August, stated that global warming caused by increasing pollution and environment imbalances are some of the factors responsible for the sudden change in weather and failure of the monsoon. Continuous drought and failure of the monsoon in Himachal Pradesh has resulted in a loss of over Rs. 20 crore to the state. Apples, potatoes and off-season vegetable

crops, which play a significant role in the economy of the state, are the worst affected. Scientists say that the main reason for sudden change in the rain pattern is attributed to the large-scale unscientific mining combined with the setting up of big power an cement plants, roads and buildings. Illegal mining and quarrying has been going on unchecked for several years, which, further contributed to the environmental imbalance. A study conducted by an NGO regarding environmental imbalance revealed that over 5,000 hactares of land had been seriously affected by mining and construction activities. The report, based on this study, says large scale destruction of the state's forests by mining has resulted in severe drought and flash floods and the worst affected districts are Kinnaur, Solan, Shimla, and Bilaspur, which fall in the catchments areas of the Sutlej river of the state.

Ravinder Sood for THE TRIBUNE: September 23, 2002

Hindi Section

सिमटने लगी है अब भीमताल की भव्य झील

भीमताल झील जो कि नैनीताल जनपद में क्षेत्रफल की दृष्टि से सबसे बड़ी झील है तथा झील के मध्य स्थित प्राकृतिक टापू के कारण यह झील काफी प्रसिद्ध हैं, लेकिन झील में समाहित हो रहे मलबे के कारण झील की गहराई लगातार घटती जा रही है। जिससे झील की जल संग्रहण क्षमता में भी कमी आयी है। भीमताल झील समुद्र सतह से 1370 मीटर की ऊंचाई पर स्थित हैं। झील का क्षेत्रफल 85.3 हेक्टेयर तथा परिधी लगभग तीन किमी है। झील की लम्बाई 1677 मीटर तथा चौड़ाई 454 मीटर है। वर्ष 1871 में झील की गहराई जहां 39 मीटर थी, सन् 1975 में घटकर 27 मीटर तथा 1885 में घटकर 20 मीटर आंकी गयी। इस प्रकार झील की गहराई में प्रतिवर्ष कमी हो रही है। झील में लगातार मिट्टी भरते रहने से झील की औसत गहराई बीस मीटर से भी कम रह गयी है। झील के रखरखाव को लेकर दशम वित्त आयोग ने लगभग चार करोड़ की धनराशि से अधिक की एक महत्वाकांक्षी योजना स्वीकृत की थी जिसके तहत सीवर लाइन का निर्माण, झील से मलवा हटाना, झील के चारों ओर रेलिंग लगाना, झील के मध्य स्थित टापू का सौन्दर्यीकरण, झील के चारों ओर विद्युत व्यवस्था करना, झील के चारों ओर वृक्ष रोपित करना व झील के किनारे पार्किंग स्थल स्थापित करना थे। लेकिन इस महत्वाकांक्षी योजना कार्य खत्म हुए एक वर्ष से भी अधिक का समय हो गया, लेकिन झील की स्थिति सुधरने के बजाय और बदतर होती चली गयी है। झील जगह–जगह पोखरों में तब्दील हो गयी है तथा झील में समाहित होने वाले नालों की सफाई नहीं होने के कारण झील में मलवा लगातार समाहित होता जा रहा है। पर्यटन के साथ ही भीमताल झील हल्द्वानी व भावर क्षेत्र की पेयजल व सिंचाई का एक महत्वपूर्ण स्त्रोत है, लेकिन जल संग्रह कम होने के कारण झील में पर्याप्त मात्रा में पानी संग्रहित नही हो पाता है। जिस कारण इन क्षेत्रों को भी समुचित मात्रा में पानी की आपूर्ति नही हो पाती है।

दैनिक जागरणः जून 27, 2002

घट रहा है मानसरोवर झील का आकार

हिन्दू धर्मावलम्बियों के लिए पवित्र मानी जाने वाली मानसरोवर झील का आकार घट रहा है। लगभग 85 किमी0 की परिधि वाली इस झील का एक बड़ा भाग दलदल में बदल चुका है। हिन्दुओं के आदि देव शिव का निवास कैलाश पर्वत तिब्बत में पड़ता है। और इसी क्षेत्र में है पवित्र मानसरोवर झील। कहा जाता है कि हजारों वर्षो से मानसरोवर झील की स्थिति एक सी है। न्यून जनसंख्या और अत्यधिक ऊंचाई (लगभग 19000 फिट) वाले इस क्षेत्र में पर्यावरण प्रदूषण की समस्या पिछले कुछ वर्षों तक नहीं थी। लेकिन इस वर्ष इस क्षेत्र में बड़ी तेज गति से पारिस्थितिकी में बदलाव आये हैं। लगभग 85 किमी0 परिधि वाली मानसरोवर झील का कुछ हिस्सा दलदल में बदल गया है। एक दशक पूर्व झील की परिक्रमा पूरी करने में जो समय लगता था आज उसकी तुलना में कम समय लगता है। पार्वती सरोवर का आकार भी एक छोटे से पोखर जैसा रह गया है। सरोवर के बड़े भाग में मिट्टी भर चुकी है। और यह कई अलग–अलग भागों में बंट चुका है। ऊँ पर्वत की पहचान ही ऊँ शब्द से होती है। इस पर्वत पर भले ही कही बर्फ बारहों मास रहती है। लेकिन इस वर्ष पर्वत ऊँ शब्द साफ नहीं दिख रहा है। इसकी पुष्टि कई यात्रियों और पर्यटकों ने की है। कुल मिलाकर इस क्षेत्र में पारिस्थितिकी परिवर्तन हो रहे हैं। विश्व तापमान में हो रही बढ़ोत्तरी का असर यहां भी पड़ रहा है। यात्रियों और पर्यटकों द्वारा यहां फैलाया जाने वाला प्रदूषण भी एक कारण हो सकता है।

दैनिक जागरणः अगस्त 14, 2002

मिलने लगे हैं 'हिमयुग' की वापसी के संकेत

उत्तरांचल के कम ऊंचाई वाले क्षेत्रों में सितम्बर के पहले सप्ताह में हुए हिमपात को जहां कुछ लोग 'प्री मेच्योर बेबी' की संज्ञा दे रहे है तो वहीं कई इसे हिमयुग की वापसी के संकेत के तौर पर भी देख रहे हैं। हिमालय में अचानक सक्रिय हुए अल–निना (ठंडी करेंट) को भविष्य में मौसम के मिजाज में होने वाले अभूतपूर्व बदलावों से जोड़ कर देखा जा रहा है। उत्तरांचल सहित समूचे हिमालय के निचले स्थानों, यूरोप, रूस, चीन, नेपाल तथा दक्षिणी ध्रुव में इन दिनों मौसम में जो भारी उलटफेर देखने को मिल रहा है पर्यावरणविद उसे 'डीप फ्रिज' या 'हिमयुग' की वापसी के संकेतों से जोड़ कर देख रहे हैं। माना जा रहा है कि बारह हजार वर्ष के पहले आखिरी हिमयुग के बाद हिमालय तथा उत्तरी ध्रुव से पहली बार इतने व्यापक पैमाने पर बर्फ पिघल रही है। यही नहीं वर्ष 1980 के बाद से प्रकाश की गति कम होने से ब्लैक होल का क्षेत्र जिस तरह लगातार बढ़ रहा है वह भी इसी वापसी की ओर इशारा कर रहा है। हिमालय में हिमयुग की वापसी के जो संकेत सबसे ज्यादा मौसमविदों को चिंतित कर रहे हैं वह है दुनिया के जाने–माने ग्लेशियरविद प्रो0 लेनार्डो की दो महीने पहले तैयार की गई 'आइस कोर थ्योरी'। तिब्बत के सबसे बड़े ग्लेशियर जिम ब्यांग से लेनार्डो ने चालीस फीट की गहराई से आइस का टुकड़ा निकाल कर यह साबित किया है कि किस तरह हिमालयी क्षेत्रों में ठंडी करेंट (अल–निना) सक्रिय हो गई है। प्रो0 लेनार्डो के शोध का निष्कर्ष है कि अल–निना करेंट के कारण ही जिम ब्यांग ग्लेशियर का न केवल पिघलना रूका बल्कि इसके पीछे खिसकने की गति पर अंकुश लगा है। खबर है कि तिब्बत में प्रयोग के तौर पर किए इस परीक्षण को आने वाले दिनों में शीध्र ही उत्तरांचल के गोमुख सहित कई दूसरे हिमालयी ग्लेशियरों पर भी किया जाएगा। पर्यावरणविद् विपिन कुमार कहते हैं, यह सही है कि प्रो0 लेनार्डो की थ्योरी के बाद हिमालय में ठंडी करेंट के सक्रिय होने की बात सिद्ध हो गई है मगर इसे हिमयुग की वापसी से जोड़ कर देखना अभी जल्दबाजी होगी। उनका मानना है कि गंगोत्री ग्लेशियर का पिघलना अल–निना (ठंडी करेंट) के कारण ही गुजरे दो सालों से ठहरा हुआ है और जो आगे भी स्थिर रहेगा। मशहूर पर्यावरणविद डी0के0 मोहंती कहते हैं, सिर्फ हिमालय में बदल रहे मौसम से हिमयुग की वापसी होगी ऐसी नहीं है। इसके लिए पूरे विश्व का मौसम बदलेगा और जो बदल भी रहा है।

दैनिक जागरणः सितम्बर 17, 2002

मध्य हिमालय के औषधीय पौधों के अध्ययन को आठ करोड़ की चरक परियोजना

मध्य हिमालयी क्षेत्र में पाये जाने वाले औषधीय पौधों का अध्ययन रक्षा अनुसंधान एवं विकास संगठन ने शुरू कर दिया है। इसके लिए आठ करोड़ रूपये की लागत वाली चरक परियोजना शुरू की गयी है। इसके तहत फिलहाल पांच पौधों का चयन किया गया हैं इनके प्रारम्भिक अध्ययन में मलेरिया उन्नमूलन के लिए महत्वपूर्ण तत्व मिले हैं। आयुर्वेद के जनक चरक के नाम पर शुरू की गयी इस परियोजना का उद्देश्य हिमालयी क्षेत्रों मे पाये जाने वाले औषधीय पौधों के बारे में सम्पूर्ण जानकारी प्राप्त करना है, ताकि इनके औषधीय गुणों का पूरा उपयोग किया जा सके। यह कार्य रक्षा कृषि एवं अनुसंधान इकाई पिथौरागढ़, तेजपूर और लेह में किया जा रहा हैं। इस परियोजना के तहत औषधीय पौधों को हल्द्वानी, पिथौरागढ़ और जोशीमठ में उगाया जाएगा और इन तीनों का अलग–अलग जलवायु में उन पर प्रभाव का अध्ययन किया जाएगा। इधर सीमान्त जनपद पिथौरागढ़ के ऊंचाई वाले क्षेत्रों में पाई जाने वाली जड़ी बूटी यर्सो–गम्बों का वैज्ञानिक अध्ययन रक्षा कृषि अनुसंधान इकाई ने शुरू कर दिया हैं। शीध्र ही इसके गुणों की जानकारी मिल जाएगी। इस बूटी की चीन में बेहद मांग बताई जाती है, लेकिन अभी तक भारत में इसके उपयोग की पूरी जानकारी नही हैं। पहली बार रक्षा कृषि अनुसंधान इकाई ने यर्सो गम्बों का वैज्ञानिक अध्ययन करने की पहल की हैं।

दैनिक जागरणः नवम्बर 21, 2002

वैज्ञानिकों के लिए चुनौती बनी शीशम में बीमारी

भारतीय वन अनुसंधान संस्थान देहरादून के वैज्ञानिकों के लिए शीशम के वृक्षों में लगी गैनोडर्मा ल्यूसीडियम व फ्यूजेरियम बीमारियां एक चुनौती बन चुकी हैं। एक दशक से वे इन बीमारियों के वास्तविक कारण नहीं खोज पाए हैं, तकरीबन पांच हजार हेक्टेयर में खड़ा शीशम का जंगल गैनोडर्मा ल्यूसीडियम व फ्यूजेरियम बीमारियों की गिरफ्त में आने से तबाह होता जा रहा है। अगर समय रहते बीमारी का इलाज नहीं खोजा गया तो बहुत संभव है कि भविष्य में हमें उत्तरांचल के जंगलों में शीशम दिखाई ही न दें। तराई केन्द्रीय, तराई पूर्वी, तराई पश्चिमी, हल्द्वानी, देहरादून तथा हरिद्वार वन प्रभागों में तकरीबन पांच हजार हेक्टेयर वन क्षेत्र में शीशम का उम्दा जंगल खड़ा है। हल्द्वानी वन प्रभाग में शारदा रेंज में तकरीबन 300 हेक्टेयर वन क्षेत्र में शीशम का प्राकृतिक ढंग से विकसित जंगल है। इसमें पांच से लेकर साठ साल तक की आयु के वृक्ष हैं। वैसे भी टनकपुर के शीशम की

पूरे उत्तरांचल में मांग है। इस जंगल को भी बीमारी अपनी गिरफ्त में ले चुकी है और वृक्ष सूखने लगे हैं। पिछले एक दशक से शीशम गैनोडर्मा व ल्यूसीडियम बं बीमारी से हुए नुकसान का जायजा लिया। टीम ने शीशम के क्लोनल पौधे तैयार करने तथा बीमारी से ग्रस्त पेड़ के आगे खाई खोदने व कवक नाशक दवाइयां प्रयोग करने की सलाह दी। इतने बड़े पैमाने पर क्लोनल पौध तैयार करने का काम वन महकमा कर नहीं पाया। बाकी दोनों तरीके अपनाने के बाद भी कोई बात नहीं बनी और आज बीमारी अपने प्रचंड रूप में है। एफआरआई के वैज्ञानिक आज भी यह बता पाने की स्थिति में नहीं हैं कि बीमारी का वास्तविक कारण क्या है। यदि एफआरआई के वैज्ञानिक जल्द इसमें लगी बीमारियों के वास्तविक कारण नहीं खोज पाए तो बहुत संभव है कि भविष्य में जंगल में शीशम का पौधा दिखाई ही न दें।

अमर उजालाः दिसम्बर, 18, 2002

हर्बल स्टेट में करोड़ों की जड़ी–बूटी बर्बाद

उत्तरांचल को हर्बल स्टेट बनाने के नाम पर भले ही राज्य की सरकार हर रोज नई–नई घोषणाएं कर रही है, मगर राज्य के चमोली जिले के नंदादेवी मृगविहार और पिथौरागढ़ जिले के अस्कोट मृगविहार परिक्षेत्र में काश्तकारों द्वारा उगाई गई एक करोड़ रूपये से अधिक की जड़ी–बूटी बर्बाद हो गई है। राज्य सरकार द्वारा निजी भूमि से जड़ी–बूटी के विदोहन के लिए सुप्रीम कोर्ट से अनुमति न लेने के चलते यह स्थिति पैदा हुई। राज्य के सर्वाधिक जड़ी–बूटी उत्पादन वाले उच्च हिमालयी क्षेत्र के काश्तकारों ने इस व्यवसाय से ही हाथ खींच लिए हैं। अविभाजित उत्तर प्रदेश सरकार ने 1998 में निर्णय लिया कि उत्तरांचल के पर्वतीय जिलों में जड़ी–बूटी व्यवसाय को बढ़ावा देने के लिए काश्ताकारों को जड़ी–बूटी उगाने की अनुमति दी जाए। इसे लाभकारी मानते हुए उत्तरांचल के पिथौरागढ़, चमोली, उत्तरकाशी, बागेश्वर, रूद्रप्रयाग आदि जिलो के ऊंचाई वाले क्षेत्रो में रहने वाले काश्तकारों ने जड़ी–बूटी उगाने के लिए भेषज संघ और वन विभाग कार्यालय में रजिस्ट्रेशन कराया। काश्तकारों को रायल्टी माफ कर देने से सरकार को किसानों द्वारा उत्पादित जड़ी–बूटियां आसानी से मिलने लगी। व्यवसाय को फलते–फूलते देख सैकड़ों काश्तकारों ने पारंपरिक खेती से किनारा कर लिया और जड़ी–बूटी उत्पादन के काम पर जुट गए। पिथौरागढ़ जिले के धारचूला और मुनस्यारी ब्लाक में सर्वाधिक जड़ी–बूटी पैदा होती है। इसके चलते कुमाऊं मंडल में इन दो ब्लाकों में जड़ी–बूटी उत्पादित करने वालों की संख्या बढ़ गई। गढ़वाल मंडल में भी चमोली जिले में सर्वाधिक जड़ी–बूटी उत्पादित होने लगी। अनुमान है कि राज्य में काश्तकार ही एक साल में 80 लाख से लेकर दो करोड़ रूपये तक की जड़ी–बूटी बेचने में कामयाब रहे। डेढ़ वर्ष पूर्व सुप्रीम कोर्ट द्वारा उत्तरांचल के चमोली जिले के नंदादेवी मृगविहार और अस्कोट मृगविहार क्षेत्र में पातन कार्य पर रोक लगा दी। इस रोक के बाद जंगलों में पैदा होने वाली जड़ी–बूटी का विदोहन बंद हो गया। कुछ समय बाद वन विभाग ने मृगविहार क्षेत्र के उच्च हिमालयी गांवों में काश्तकारों द्वारा उगाई जाने वाली जड़ी–बूटी के विदोहन को भी रोक दिया। पिछले एक वर्ष से इस क्षेत्र में उगाई गई सालम मिसरी, गंदरायण, कुटकी, जम्बू, सतवा, रीठा, सालमपंजा, जटामासी, कूठ अलीज आदि जड़ी–बूटियां खेत में बर्बाद हो रही हैं। सुप्रीम कोर्ट के निर्देश के बाद भले ही विदोहन पर रोक लगी है, मगर उत्तरांचल सरकार ने विदोहन की अनुमति लेने के लिए कोई प्रयास नहीं किए। उत्तरांचल को हर्बल प्रदेश बनाने का वायदा करने वाली राज्य सरकार ने भले ही इसके प्रचार–प्रसार को कई करोड़ की योजनाएं घोषित कर दी हैं, मगर काश्तकारों द्वारा उत्पादित जड़ी–बूटी की बर्बादी से सरकार की मंशा पर ही प्रश्नचिह्न लग गया हैं।

अमर उजालाः दिसम्बर, 19, 2002

उत्तरांचल में विदेशी सुगन्धित वन हाजरी अभिशाप या वरदान

कुलदीप सिंह नेगी, दलपत चन्द भण्डारी, अनिरूद्ध शर्मा, के0एस0 राव* एवं सुनील नौटियाल*

राष्ट्रीय पादप आनुवंशिक संसाधन ब्यूरो, क्षेत्रीय केन्द्र– भवाली 263132, निगलाट, जिला नैनीताल,

**गोविन्द बल्लभ पन्त हिमालय पर्यावरण एवम् विकास संस्थान, कोसी–कटारमल, अल्मोड़ा 263643,*

उत्तरांचल के पर्वतीय क्षेत्रों में पिछले कुछ दशकों से कई विदेशी मूल की वनस्पतियॉ, जल, जंगल जमीन व खेत–खलिहानों में अनाधिकृत प्रविष्टि कर आज अभिशाप बनती जा रही है, जिसमें प्रमुख है कूरी (*लैन्टाना*), गाजरघास या कांग्रेस घास *(पार्थीनियम)*, काला बॉसा *(इयूपेटोरियम)*, तिपत्तिया *(आक्सेलिस)*, पीली कटेली, *(आर्जीमोन)*, जलकुम्भी *(आईकोर्निया)* आदि। यह वनस्पतियॉ देश के लगभग चार लाख हेक्टेयर से अधिक भूमि पर कब्जा जमाने के बाद हिमालयी भू–भाग के परिस्थितिकीय तंत्र को बुरी तरह गड़बढ़ाने लगी है। इनमें हिमाचल, जम्मू एवम् कश्मीर व उत्तरांचल राज्य प्रमुख हैं।

उत्तरांचल के निचले हिस्सों में बहुतायत से उगने वाल किनगोड़ा/किलमोडा *(बरबेरिस)*, साकिन *(इन्डीगोफेरा)*, रोहिणी *(मेल्लोट्स)*, तुंग *(रहस)*, हिंसरू/हिंसालु *(रूबस)*, वन–हल्दू *(हेडीकीयम)*, समेवा/सम्यौ (*वेलीरियाना*), रिंगाल *(एरून्डीनेरिया)*, कुज्जु *(रोजा)*, पाती *(आर्टीमार्सिया)*, सतावरी/अभीरूपत्री *(ऐस्पेरेगस)*, गुलवनफ्शा *(वायोला)*, घ्यूपाती/अस्मभेद/पाषाणभेद *(बर्जीनिया)*, टिमरू *(जेन्थोजाईलम)*, ऑवला *(फाईलैन्थस)*, हरड़ *(टरमीनेलिया)*, सिंसोड़/कन्डाली *(अर्टिका)*, काफल *(माइरिका)* जैसी स्थानीय, जंगली तथा स्वतः उगने वाली वनस्पतियॉ व जड़ी–बूटियॉ जहॉ भारतीय आर्युवेद, होम्योपेथी चिकित्सा पद्वति में महत्वपूर्ण स्थान रखते हुए पारिस्थितिकीय संतुलन को बनाये रखने में महत्वपूर्ण योगदान देती हैं, वही स्थानीय निवासियों की आर्थिकी का भी प्रमुख स्त्रोत है। विदेशी मूलज वनस्पतियों ने अतिक्रमण कर इनके अस्तित्व पर प्रश्न चिन्ह लगाने के साथ ही आधारित आर्थिकी पर दुष्प्रभाव डालते हुए पारिस्थितिकीय तंत्र को असंतुलित करने की भूमिका तैयार कर ली है। इन वनस्पतियों पर प्रभावी नियंत्रण के लिए इनको उपयोगी बनाकर बड़ी मात्रा में इसके व्यवसायिक दोहन के प्रयास किये जाने चाहिए। इन्हीं विदेशी मूलज वनस्पतियों में एक प्रमुख वन हाजरी आजकल चर्चा का विषय बनी हुई है। प्रस्तुत अध्ययन में संक्षिप्त रूप से विभिन्न पहलुओं पर प्रकाश डालकर इस वनस्पति को उत्तरांचल के लिए अभिशाप माने या वरदान रूप में ग्रहण करें का विश्लेषण प्रस्तुत है।

वन हाजरी को विभिन्न नामों से जाना जाता है, जैसे– गेंदी, जंगली गेंदा, गंधलो घास जबकि अपनी तीव्र बदबूदार परन्तु फूलों जैसी सुगन्ध के कारण आंग्लभाषा में स्टिकींग रोगर व टेजीटस के नाम से सुप्रसिद्ध है। यह एस्टेरेसी कुल के अर्न्तगत आता है। इसका वानस्पतिक नाम *टेजीटस माइन्यूटा* पर्याय *टेजीटस ग्लेनड्यूलीफेरा* है। इस संगधीय वनस्पति का उद्गम स्थान दक्षिण अमेरिका को माना जाता है, जबकि आज यह पौधा समुदाय पूरे विश्व में सर्वव्याप्त है तथा प्रमुख रूप से पूर्वी तथा दक्षिण अफ्रीका, यूरोप, आस्ट्रेलिया, न्यूजीलैण्ड, रूस एवम् भारतवर्ष में व्याप्त है। दक्षिण अफ्रीका के प्रमुख ग्रामीण इलाका ''सिसकी'' में वन हाजरी पौध उत्पादन व तेल उपज आर्थिक संसाधन के रूप में विख्यात है।

उत्तरांचल के परिप्रेक्ष्य में वन हाजरी का प्रवेशन द्रूत गति से शुष्क उष्ण–कटिबन्धीय, सम–शीतोष्ण व शीतोष्ण जलवायु में मुख्यतयाः 1000–2500 मीटर की ऊॅचाई पर सामान्यतः बंजर भूमि, सड़क के किनारे पर देखा जा सकता है।

वानस्पतिक परिचयः संसार भर में वन हाजरी की 40 जातियॉ प्रमुख रूप से अमेरिका में मौजूद है जबकि तीन जातियॉ भारतवर्ष मे प्रवेशन पा चुकी हैं। वन हाजरी का पौधा एकवर्षीय, शाखीय, तीव्र सुगन्धित, 40–200 से0मी0 ऊॅचाई लिये होता है। पत्तियॉ 7–15 से0मी0 लम्बी, पक्षवन्निदर, 11–19 संख्या में होती हैं, जो कि पतले–भालाकार, तेल–ग्रन्थियॉ बिन्दुवत् सदृश होते हैं। फूल हल्के पीले, संकीर्ण नलिकाकार, समशिख गुच्छों में समाहित होता हैं। रश्मिपुष्प 3–4 संख्याओं में, द्वि–दन्तुर तथा बिम्बपुष्प नलिकाकार होते हैं। बीज जिन्हें एकीन कहा जाता है काले रंग के लम्बे होते हैं।

एन0बी0पी0जी0आर0, क्षेत्रीय केन्द्र भवाली द्वारा वर्ष 1990 में अक्टूबर माह में ग्वालदम, जिला चमोली गढ़वाल, उत्तरांचल से वन हाजरी का संग्रह किया गया। अगामी वर्षो में बीज उत्पादन कर शाकीय प्रसारण कर इसे नमूना क्रमांक एन0आई0सी0 2740 आबंटित किया गया।

कृषिकरण: मुख्यतया बीजों द्वारा ही पादप वृद्धि व प्रसारण किया जाता है। 3 X 3 मीटर की नर्सरी का निर्माण कर बीजों को मार्च–अप्रैल माह मे बुआई कर मई–जून तक रोपाई के लिये तैयार हो जाते हैं। 500 ग्राम बीज प्रति हेक्टेअर की खेती के लिये पर्याप्त होते हैं। खेतों में 30 X 30 से0मी0 की दूरी पर पौधे रोपित करने चाहिए। वन हाजरी की पौध व पादप समुदाय हर किस्म की मिट्टी में उपज देती है परन्तु सर्वोत्तम खेती दुमट मटियार, छिद्रल व संरध्रता लिये हुए तथा पानी की अच्छी तरह से निकास किये भूमि में सर्वोत्तम मानी जाती है। फसल की कटाई 6–8 माह की अवधि पर दो बार की जाती है, एक शाकीय बहुलता पर (फूल आने से पूर्व) दूसरी बार फूलों की बहुलता पर। पहली कटाई करते वक्त पौधों को 10–15 से0मी0 छोड़कर काटना चाहिए।

आर्थिक पक्ष: वन हाजरी का हरबेज (पत्तियॉ, टहनियॉ, कोमल, शाखाऐ, पुष्पक्रम एवम् फूल) उत्पादन प्रति हेक्टेअर 61 क्विंटल प्रति छः माह में प्राप्त होता है। इसे वाष्प–आसवन संयत्र द्वारा 0.12 से 0.14 प्रतिशत के आधार पर 8 कि0ग्रा0 सुगन्धित तेल की प्राप्ति होती है तथा इस तेल की वर्तमान कीमत बाजार भाव 2500 रूपया प्रतिकिलो के हिसाब से 20 हजार रूपयों की आमदनी हो सकती है। अनुमानित उपज व तेल उत्पादन संक्षिप्त रूप से सारणी–1 में निर्दिष्ट किया गया है।

सारणी 1: वन हाजरी में अनुमानित उपज व सुगन्धित तेल उत्पादन (मात्र छः माह के अन्तराल में)

क्र.स.	हरबेज अवस्था	प्रति पौध हरबेज उत्पादन					
		कम से कम (ग्राम)	अधिक से अधिक (ग्राम)	औसत (ग्राम)	अनुमानित हरबेज उपज प्रति हेक्टेअर (क्विंटल)	प्रतिशत मात्रा %	अनुमानित तेल उत्पादन प्रति हेक्टेअर(कि0ग्रा0)
1.	(अ) प्रथम कटाईः बुआई के 4 माह बाद शाकीय अवस्था	11	420	32	36	0.14	5
2.	(ब) द्वितीय कटाईः बुआई के 6 माह बाद फूल बहुलता अवस्था	10	300	21	25	0.12	3

सुगन्धित तेल एवम् रासायनिक संघटकः मुख्यतया वन हाजरी के शाकीय भाग पत्तियॉ, कोमल डंठल व फूलों से सुगन्धित तेल प्राप्त होता है जो कि तीव्र सुगन्धित, थोड़ा–थोड़ा फूलों की महक जैसा होता है। तेल का निष्कर्षण प्रमुखतया वाष्प–आसवन या जल–आसवन संयत्र द्वारा किया जाता है। हरबेज काटने के 24 घंटे बाद तक आसवन कर लेना चाहिए। सुगन्धित तेल गर्म जलवायु में शीघ्र खराब हो जाता है। अतः शीतल स्थान पर इसका भण्डारण करना चाहिए तथा शीध्र ही बेच देना चाहिए। क्लीवेन्जर एवम् वाष्प–आसवन संयत्र द्वारा वर्ष 2001 में शाकीय व फूल वाले पौधों में तेल की प्रतिशत मात्रा अंकित किया गया है जो कि सारणी 2 में निर्दिष्ट है।

सारणी 2. विभिन्न मौसम व जलवायु में वन हाजरी (नमूना क्रमांक एन0आई0सी0 2740) के पादप भागो में सुगन्धित तेल की मात्रा

क्र0स0	पादप भाग	मात्रा (कि0ग्रा0)	तेल की मात्रा (मि0ली0)	प्रतिशत मात्रा (%)	पादप भागों की स्थिति	तारीख महीना व वर्ष	तेल का रंग	टिप्पणी
1.	पत्तियॉ, कोमल डंठल	311	429	0.14	अर्ध शुष्क	21 अगस्त, 2001	लाल–पीला	वाष्प आसवन संयत्र
2.	–तदैव–	01	1.8	0.18	अर्ध शुष्क	21 अगस्त, 2001	हरा–पीला	क्लीवेन्जर उपकरण द्वारा
3.	पत्तियॉ, डंठल, फूल एवं जड़	227.5	276	0.12	–तदैव–	11 अक्टूबर, 2001	लाल–पीला	वाष्प आसवन संयत्र

सुगन्धित तेल का रंग गहरा भूरा या लाल–पीला या हरा–पीला होता है। वन हाजरी के सुगन्धित तेल में एरोमाडेन्ड्रीनेम टेजीटोन, फिनाइल इथाइल एल्कोहल, ओसीमीन, सेलीसाई एल्डीहाइड, फिनाइल–एसीटाडीहाईड, यूडीसमोल, लीनाली एसीटेट, लीमोनीन, लीनालूल तथा असात कोबोनील घटक प्रमुखतया से मौजूद होते हैं।

वन हाजरी नमूना क्रमांक 2740 के सुगन्धित तेल में लगभग 37 वाष्पशील रासायनिक संघटको की संख्या उपस्थिति दर्ज की गयी जिनमें प्रमुख रासायनिक संघटको की संख्या 08 अंकित किया गया जो कि सारणी 3 में निर्दिष्ट है।

सारणी 3. वन हाजरी (नमूना क्रमांक एन0आई0सी0 2740) में सुगन्धित तेल के विभिन्न रासायनिक संघटक और प्रतिशत मात्रा

क्र0 संख्या	मुख्य रासायनिक संघटक	प्रतिशत मात्रा (%)
1.	अल्फा–पाइनीन	0.186
2.	कैम्फीन	0.037
3.	बीटा–पाइनीन	0.390
4.	सिस–बीटा आसीमीन	38.26
5.	ट्रान्स–बीटा आसीमीन	5.708
6.	लिनालूल	0.676
7.	कैम्फर	7.488
8.	केरियोफाइलीन	7.980

उपयोगिताः अमेरिका व यूरोपीय देशों में वन हाजरी का सुगन्धित तेल महक व ईत्र उद्योग में उपयोग में लाया जाता है जबकि भारतवर्ष में टेजीटोन नामक विषैले रसायन की उपस्थिति से इसका उपयोग ईत्र व सौन्दर्य प्रसाधन सामग्री उद्योग में प्रतिबन्धित माना जाता है।

वन हाजरी के शीर्षाभ/मुंडक पुष्पक्रम मृदुविरेचक, मूत्रवर्द्धक व स्वेदकारी माना जाता है। इसका वाष्पशील तीव्र सुगन्धित तेल उद्योग जगत में ''टेजीटस तेल'' से सुप्रसिद्ध है जो कि शमक प्रवृति, अल्प तनाव, ऐंठन, श्वसनी व सूजन प्रतिरोधी गुणधर्म को प्रदर्शित करता है। सुगन्धित तेल का उपयोग कीट–पंतगो, मक्खियों, चीटियों, मच्छरों, लाखानाशी व घावों में कीड़े पड़ने पर (मैगट कीट प्रतिरोधी) कारगर साबित हुआ है। लोक वनस्पति के रूप में स्थानीय निवासियों द्वारा वन हाजरी के पत्तों व फूलों के रस जो कि विषाणु प्रतिरोधी के रूप में जानवरों के ''खुरया रोग'' तथा ''रानीखेत विषाणु रोग'' को ठीक करने में उपयोग किया जाता है। वन हाजरी को ज्यादातर तम्बाकू वाले खेतों में लगाया जाता है क्योकि इस पादप समुदाय की जड़े गोलकृमि/सूत्रकृमि (नेमाटोड) प्रतिरोधी होती हैं। वन हाजरी के सम्पूर्ण पौधों का क्वाथ चमड़ी व ऑखों में जलन पैदा करता है। उत्तरांचल में ऐसी मान्यता है कि जिन खेतों में कुरमुलों (व्हाइट गर्ब) की भरमार रहती हैं, यदि खेतों के किनारे–किनारे वन हाजरी के पादप समुदाय को लगाया जाय तो इन हानिकारक कीटों से निजात मिल जाती हैं।