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ANIMAL DRAUGHT POWER OUTPUT DURING DIFFERENT OPERATIONS IN MOUNTAIN AGRICULTURE: A STUDY OF INDIAN CENTRAL HIMALAYA

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INTRODUCTION

In the Himalayan mountains, draught animal power (DAP) is the only feasible source of energy for agricultural work. Large-scale substitution by fossil fuel-operated energy systems in this region is not only difficult but also inappropriate. Within the foreseeable future there is unlikely to be a viable alternative to DAP, and, therefore, it becomes an important consideration in sustainable mountain agriculture.

In subsistence mountain farming, productivity can only be improved through mixed farming involving DAP. Despite its potential contribution to agriculture, DAP, at least in the context of mountain farming systems in the Indian Central Himalaya, is one of the least explored fields. Nevertheless, study by Singh and Naik (1987) provides us with interesting information on this very important aspect of mountain agriculture; examining as they do the close links between DAP and productivity/ sustainability. Average yields and intensity of cropping are found to be influenced more by availability of power per unit area than by irrigation, fertilizer consumption, and use of high-yielding varieties (Srivastava and Yadav 1987).

This paper attempts to quantify (i) DAP output during different agricultural operations; (ii) DAP potential and balance; (iii) bullock work hours; and (iv) DAP contribution to crop cultivation in mountain agriculture. Animals' energy contribution to raising different crops in mountain agriculture would help us understand and analyse links between DAP and mountain agriculture quantitatively, an exercise that might be useful in evolving techniques to increase production flows from the farming systems and enhance sustainability of mountain agriculture by manipulating animal power use in agriculture.

MATERIALS AND METHODS

The present study was conducted in 12 villages in four different farming systems, three villages in each, in the Indian Central Himalaya. The study sites were selected on the basis of stratified random sampling. The four Strata (agro-ecological zones representing different farming systems) are as follows:

- The Shivalik Hills/ Foothills of the Outer Himalaya
- The Middle Himalaya or Lesser Himalaya: Traditional Areas
- The Middle Himalaya or Lesser Himalaya: Transformed Areas
- The Greater Himalaya

In the Shivalik range and the foothills (also referred to as hills) of the Himalaya, farming takes place on comparatively fertile and flat land. Almost all the villages in this sub-region are located at lower altitudes, below 1,000m. In the Middle Himalaya (also referred to as middle mountains), altitude is one of the factors governing the use of animal energy, type of cropping pattern, cropping system and so on. Three locations of upto 1,200m, 1,200 -1,700m, and 1,700 - 2,500m were the basis for the selection of villages in the traditional and transformed farming systems. Almost all the villages selected in the Greater Himalayan zone (also referred to as high mountains) are above 2,500m.

The terms 'traditional' and 'transformed' are only applicable to the Middle Himalaya. In the Shivalik range, a mix of traditional and transformed patterns and high degree of uniformity are evident almost everywhere. The farming system can be classified broadly as transitional. Greater Himalayan

farming systems are also remarkably uniform. These are very traditional and almost primitive, more or less impervious to development interventions, unlike the systems at lower and mid-altitudes. On the contrary, villages in the Middle Himalaya are clearly distinguished; they are either traditional or transformed with respect to their farming systems. Transformation, nevertheless, is seldom complete. Some patches of land, especially those under rainfed conditions, are managed traditionally, even in transformed villages.

Since transformation of agriculture leads to changes in the use of energy, this criterion, obviously, would be of great help for the study of DAP issues. Three principal types of transformations in the farming systems of the Middle Himalaya are identified for study purposes: (i) transformation from foodgrain to vegetable-based cropping systems, (ii) transformation in terms of a genetic change in foodgrain crops followed by an alteration in cropping patterns, and (iii) transformation in terms of the development of an orchard-based farming system. From each transformed category, one village was selected. All the three transformed villages selected represented different altitudinal ranges.

In total, 404 families were selected randomly out of a total of 1,739 in the sample villages. Out of the selected families, 12 were landless, 152 marginal, 126 small, 62 medium, and 52 from the large holding category. Location and environmental background of the villages selected for the present study are shown in Table 1.

Table 1. Location and environmental background of study sites

Villages	District	Altitude m from msl	Catchment Area (River)	Farming System
Sivaliks/Foothills				· Cereal crop-dominated framing system; · Cattle-dominated herd; · Transitional phase of development; · Low to high risks.
Ganga Bhogpur	Pauri	600	Ganga	
Knandgaon	Dehradun	800	Ganga	
Naigoth	Udhamsingh Nagar	700	Kali	
Middle Himalaya:Traditional				· Cereal (millet) crop-dominated farming system, · Cattle-dominated herd; · Traditional system of food production; · Minimum risks.
Taily Sunoli	Almora	1200	Gagas-Ramganga	
Goom	Pauri	1600	Saneh-Ganga	
Banali	Tehri	1800	Bidalna-Tons	
Middle Himalaya: Transformed				· Horticulture-dominated (& genetically transformed cereal crop-dominated) farming system; · Buffalo-dominated herd; · Modern phase of development; · Very high risks.
Suri	Nainital	900	Kosi	
Kandhla Badethi	Uttarkashi	1250	Bhagirathi	
Chaupariyalgaon	Tehri	2000	Henwal-Ganga	
Greater Himalaya				· Livestock-dominated farming system; · Ovine (sheep and goat)-dominated herd; · Almost primitive system of food production · Minimum risks
Bagauri	Uttarkashi	2550	Bhagirathi	
Juma	Chamoli	2600	Alaknanda	
Gangi	Tehri	2650	Bhilangana	

Measurement of DAP Output

DAP output during different agricultural operations was measured by following the method used earlier by Matthews (1987). This method differs slightly from that of Singh and Naik (1987) and has the

advantage of calculating power directly into the metric system (kW) rather than into the outdated foot-pound system (horsepower). Bullock energy expended during threshing operation, however, was based on the estimates of Singh and Naik (1987).

Experiments on DAP output during Ploughing, leveling, weeding, and threshing operations were conducted at three sites in each village under all farming systems. DAP output during puddling was observed in the Shivalik hills and transformed Middle mountains at the equal number of sites. Whereas the experiment on DAP output during puddling was conducted in July at the time of paddy transplantation, those on other agricultural operations were conducted in the months of October and November when the fields were being prepared for wheat cultivation after the millet and paddy harvest.

Measuring the Energy Content for Human Labour

Measuring the energy content of human labour which is one of the major sources of motive power in rural energy systems, is infinitely more complex, both conceptually and empirically. In particular relation to human labour complexities arise because of varying views as to whether human labour is a factor of production that is substitutable by energy, or a form of energy that is substitutable by other forms of energy (Ramani et al. 1995). However, for the ease of analysis of a production system and/ or ecosystem functioning inevitably depicting energy flow pattern, considering human labour in terms of energy, becomes urgent particularly when a concrete strategy is to be evolved. Considerable variation in the criteria of converting human labour into energy content exists in the past studies. Energy figures used by Revelle (1976), Gopalan et al.. (1979) and Bhatia and Sharma (1990) seem to be towards higher side. In our analysis we have used human energy input value sponsored by ICAR (1978), i.e. 0.1 hp or 0.075 kW per adult per hour, for it appears appropriate when we compare human weight with that of a local bullock.

RESULTS AND DISCUSSION

Quantification of DAP Output

It is difficult to quantify the 'average' performance of animals. Average or daily performance depends on species and their breeds, animals' weight, rate and type of work, and geographical location. Climatic factors, such as excess heat, cold, and moisture, place additional stress on the work animals. Physiological state, quality of feed, designs of harnesses, yokes or implements, and human behaviour can also affect working performance of the animals. Physical condition, training and health of the animal, skill of the ploughman, texture of ground surface, and length and frequency of work periods are factors that can considerably affect the tractive efforts of the animals. An increase in speed causes a reduction in tractive effort exerted or in the length of the work period (Sarkar 1981 and Goe 1983).

Table 2 shows that highest draught power is expended when bullocks are used for ploughing. Though maximum tractive effort estimated is for puddling, the power expended was less than for ploughing due to considerable decrease in the rate of work. The average speed of bullocks was maximum when they were yoked for leveling operations, but decreased tractive effort reduces the power output in comparison to ploughing. The power developed in this operation is close to that in weeding and earthing-up. The data recorded are based on the performance of two bullocks, together weighing 500 kg, each bullock weighing 250 kg. Thus, at a given speed, the tractive efforts range from nine percent during weeding-earthing-up operations to 19 percent during puddling operations. For leveling and ploughing operations, these values are 10 and 16 percent. In general, tractive efforts, except for mules, asses, and elephants, range from 10 to 14 percent of body weight at speeds of 2.5 to four km per hour (Goe 1983), but, in our case, at about the same speed, tractive efforts during ploughing were nearly 16 percent of the body weight, and this might be indicative of a special ability of light, native draught animals to generate a greater percentage of body weight as tractive effort than heavy animals in other regions of the world.

A pair of hired bullocks on an average ploughs and levels 1,100 m^2 per day during eight hours' work, and this includes roughly one hour's rest. However, when the bullocks are one's own, they normally work for about five hours a day and, in this duration, they, on an average, plough and level just 700 m^2. Average depths and widths of furrow were recorded to be 13.5 and 14.0 cm, respectively. At a

Government farm in Chinyalisaur in Uttarkashi, Haryana bullocks ploughed a flat land area of 1,800 m^2 in just three hours' time.

Taking draught power developed during ploughing as a standard, per animal (average weight 250 kg) draught power output in our case comes out to 0.26 kW (0.35 hp), which is 30 percent less than 0.37 kW (0.50 hp) per animal average in India (Bhatia and Sharma 1990). It is because of the smaller size and lower weight of mountain animals. Lower draught power on this basis, however, is not indicative of local animals' poor performance because the small size and lower weight of local animals are suited to mountain specificities. The draught capacity of the native animals can be improved considerably through proper feeding and improved DAP harness management. Compared to the draught power capabilities shown in earlier experiments on DAP output in Central Himalaya (Singh and Naik 1987), there have been considerable improvements. About a decade ago, average DAP output per animal (average weight 187 kg) during ploughing operation was 0.19 kW (0.25 hp), i.e., 27 percent less than recorded now. This is due to better animal care resulting in 34 percent increase in average weight of the animal. Over the last decade, there has been substantial change in the DAP system, and draught animals have assumed a greater role and have been provided with better care.

Table 2. Bullock draught power output during different agricultural operations

Operations	Average Speed (km/h)	Tractive Effort (kgf)[1]	Power (kW)[2]
Ploughing	2.4	78	0.52
Levelling	2.7	48	0.36
Puddling*	1.6	95	0.42
Weeding & Earthing up*	2.6	47	0.34

Figures are based on eight hours' operation (seven hours' ploughing and one hour's levelling) by a pair of bullocks

Each bullock weighed 250 kg.

[1] 1 kgf = 9.806 Newton

[2] 1 kW = 1.34 hp

* Estimates based on Singh and Naik (1987)

DAP Potential and Balance

The potential value of the total power available for each hectare of land is presented in Table 3. Each bullock has been estimated to generate an average power value of 0.26 kW, on the basis of energy generated during ploughing. The total number of bullocks in a village has been multiplied by this average power value to obtain bullock power for a whole village, and thus for each zone. This value has been divided by total cropland area in the village to calculate the bullock power available for one hectare of cropland.

On the basis of considerable evidence, it has been accepted that 0.37 kW per ha of cropland should be available if any increase in productivity is to be expected (Mc Colly 1971). This shows that, if all the power is to be provided by bovines, all the zones, barring the traditional area in the Middle Himalaya, face a shortage, at least theoretically, of bovine power for agricultural work. While there is DAP surplus in traditional agriculture, Shivalik hill agriculture shows a quite substantial deficit. Transformed and high altitude agriculture indicate only a marginal DAP deficit. The high DAP deficit in the Shivaliks is, to some extent, substituted by tractors hired for land preparation.

Can this power gap be bridged up by human energy? Substitution of DAP with human energy is possible, but it would be less practicable. Some operations, e.g., ploughing, levelling, puddling, if they are carried out by humans would be impracticable or the production of the whole system would be drastically reduced. Other operations, e.g., irrigation, harvesting, transplanting, etc. in mountain agro-ecosystems use only human energy. Thus, in order to develop an efficient energy system, DAP and human power should be treated inseparably and not in terms of substituting one for the other.

The power required per ha, i.e., 0.37 kW, implies that a pair of bullocks is enough for two ha of cropland. This criterion, in fact, has been worked out for agriculture in the plains where draught capacity

of each bullock is estimated to be 0.37 kW (0.5 hp). Yet, the draught capacity per animal in the mountains, as already shown, is only 0.26 kW, i.e., about 30 percent less than its counterpart in the plains.

Table 3. DAP potential and balance for mountain agriculture

Particulars	Shivaliks	Middle Himalaya: Traditional	Middle Himalaya: Transformed	Greater Himalaya
Cropland Area, ha	228.33	118.33	68.00	43.33
Bullock No.	200	252	77	58
Available DAP, kW*	52.00	65.52	20.02	15.08
DAP, kW per ha of Cropland	0.23	0.55	0.29	0.35
Surplus (+), or Deficit (-) of DAP**	(-) 0.24	(+) 0.18	(-) 0.08	(-) 0.02

* DAP value of each bullock = 0.26 kW

** Based on 0.37 kW per ha requirement of total power. If the available human power is added, the total available power will be more than required

How much land can a pair of bullocks work without compromising the intended productivity? When farmers were asked this question, most of them said that a pair of bullocks can take care of 1.5 ha (75 *nalis*). In our case, average cropland area per pair of bullocks was as large as 2.28 ha in the Shivaliks and 1.74 ha in the transformed area in the Middle Himalaya, fairly agreeable in the Greater Himalaya (1.5 ha), and far less than appropriate in the traditional area in the Middle Himalaya (Table 4).

Table 4. Cropland area operated annually by available bullock pairs

Particulars	Shivaliks	Middle Himalaya: Traditional	Middle Himalaya: Transformed	Greater Himalaya
Cropland Area, ha	228.33	118.33	68.00	43.33
Available Bullock Pairs, No.	100	126	39	29
Area Operated Per Bullock Pair, ha	2.28	0.94	1.74	1.49
Balance in Area Operated Per Bullock Pair, ha*	(+) 0.78	(-) 0.56	(+) 0.24	(-) 0.01

* Based on 1.5 ha as a standard area to be operated by a pair of bullocks.

This suggests that the cropland area operational for a pair of bullocks in the mountains should be equal to 1.4 ha. This figure can be stretched to 1.5 ha. The corresponding power requirement for mountain agriculture would, therefore, be 0.35 kW per ha of cropland. The overall power balance would thus be slightly lower than shown in the Table.

Bullock work hours

Recording animal working hours is necessary to evaluate the power actually used in the farms. Use of human energy is inevitably linked to all agricultural operations carried out by draught animals, i.e., ploughing, levelling, puddling, weeding, and threshing. Other operations--hand-weeding, irrigation, transport of manure and application, breaking of clods, sowing and transplantation, fertilizer and pesticide application, harvesting and hand-threshing--use human energy only.

From Table 5 (all values expressed in terms of one ha cropland over a period of one year), it is clear that in the Shivalik villages ploughing and harvesting operations for all crops need more bullock and human hours, respectively. Time needed for ploughing differs from crop to crop, the minimum being for pulses, oilseeds, and fodder (40 hours each) and the maximum for vegetables and lowland wheat. Variations in the usage of bullocks for ploughing depends on how much preparation the fields need before sowing a particular crop. Farmers have general estimates based on their own experiences. The same is true for other operations. Among all crops, lowland wheat and vegetables need more animal and human labour, respectively.

Winter crops use more bullock hours, while summer crops use more human hours. On the whole, some 1700 bullock hours and 9000 human hours are needed to cultivate all crops in a period of one year in the Shivaliks. Human work hours are more than five times those of bullocks.

In the Middle Himalayan villages under traditional system, bullock and human hours spent on the various operations needed to raise summer crops needed more work than for winter crops. Human hours in this area are three times those of bullock hours. Upland wheat requires more bullock hours and upland rice more human hours (Table 6).

In the Middle Himalayan village under transformed agricultural management, summer cropping consumes more bullock and human hours than winter cropping. Human hours devoted to annual cropping are five times the bullock hours. Lowland wheat requires the highest number of bullock hours and summer vegetables the highest number of human hours (Table 7).

In the Greater Himalayan villages human hours devoted to crop cultivation are about nine times the bullock hours. Amaranth crop needs more human and bullock hours than other crops (Table 8).

Among the four areas studied, the transformed Middle Himalayan villages require maximum bullock and human hours followed by the Shivalik villages. Whereas the total bullock hours required by traditional Middle Himalayan villages is nearly twice of requirement of the Greater Himalayan villages, the overall human hours required for the latter are more than for the former. The total work hours invested in summer season cropping are more than in the winter season, but the difference is the greatest in the case of the Greater Himalayan villages (see Figure 1).

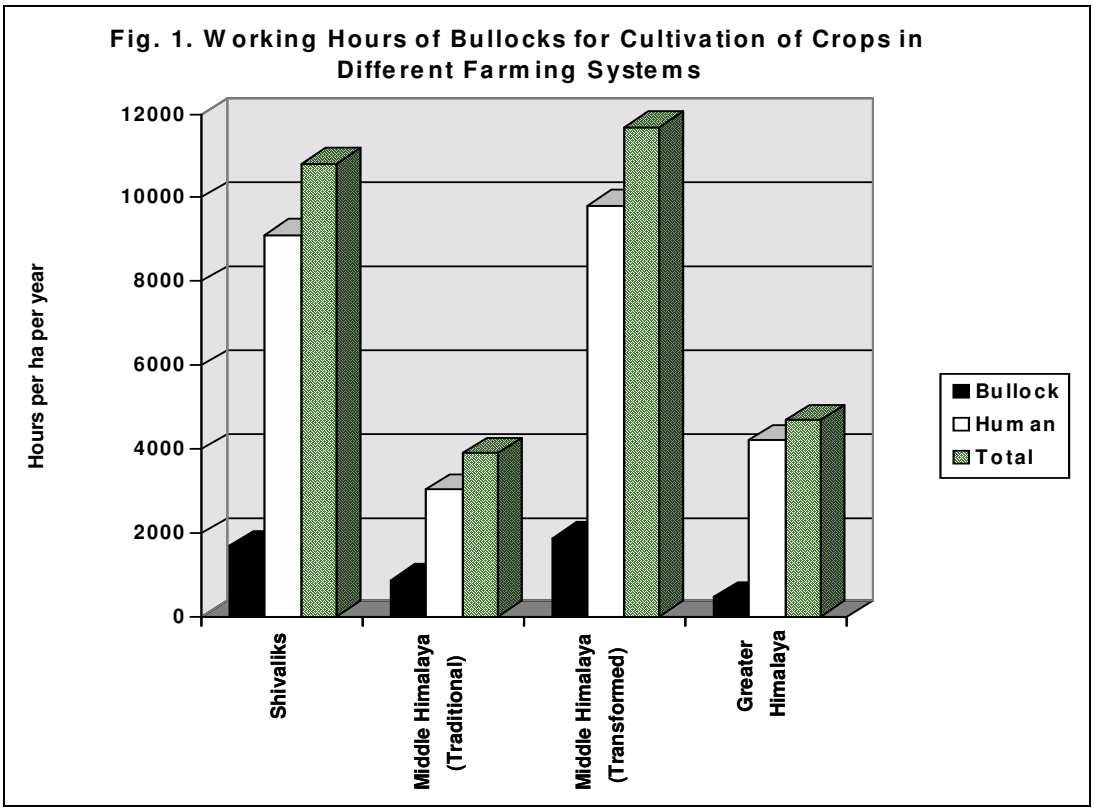


Table 5. Working hours of bullocks in various operations for cultivation of different crops per hectare of cropland in the Shivalik villages

Operations		Summer Crops								Winter Crops								Annual Total
		Up land Rice	Low land Rice	Maize	Oil-seeds	Pulses	Vege-tables	Fodder	Total Summer Crops	Up land Wheat	Low land Wheat	Barley	Pulses	Oil-seeds	Vege-tables	Fodder	Total Winter Crops	
1. Ploughing*	B:	80	80	80	40	40	120	40	480	80	120	80	40	40	120	40	520	1000
	H:	80	80	80	40	40	120	40	480	80	120	80	40	40	120	40	520	1000
2. Levelling	B:	18	18	18	9	9	27	9	108	18	27	18	9	9	27	9	117	225
	H:	18	18	18	9	9	27	9	108	18	27	18	9	9	27	9	117	225
3. Puddling	B:	-	60	-	-	-	-	-	60	-	-	-	-	-	-	-	-	60
	H:	-	180	-	-	-	-	-	180	-	-	-	-	-	-	-	-	180
4. Weeding	B:	-	-	80	-	-	-	-	80	-	-	-	-	-	-	-	-	80
	H:	18	27	45	-	18	200	-	308	-	18	-	-	-	250	-	268	576
5. Irrigation	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	H:	-	36	-	-	-	18	-	54	-	18	-	-	-	54	6	78	132
6. Manure Trans-	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
port & Application	H:	120	120	120	60	60	200	60	740	120	150	120	60	60	200	60	770	1510
7. Clod	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Breaking	H:	-	-	-	-	-	60	-	60	-	60	-	-	-	60	-	120	180
8. Sowing/	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Transplantation	H:	16	200	16	8	8	200	4	452	16	40	16	8	8	200	4	292	744
9. Fertilizer & Pes-	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ticide Application	H:	-	50	-	-	25	100	-	175	-	50	-	-	-	100	-	150	325
10. Harvesting	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	H:	180	200	180	200	200	400	180	1540	180	200	180	200	200	400	180	1540	3080
11. Threshing	B:	-	-	-	-	50	-	-	50	70	80	80	50	-	-	-	280	330
	H:	120	150	120	120	150	-	-	660	70	80	80	150	120	-	-	500	1160
Total	B:	98	158	178	49	99	147	49	778	168	227	178	99	49	147	49	917	1695
	H:	552	1061	579	437	510	1325	293	4757	484	763	494	467	437	1411	299	4355	9112

* One Tractor-hour = 10 Bullock Hours

B = Bullock, H = Human

Table 6. Working hours of bullocks in various operations for cultivation of different crops per hectare of cropland in the Middle Himalayan traditional villages

Operations		Summer Crops					Winter Crops			Annual Total
		Up land Rice	Finger Millets + Pulses	Barnyard Millet	Amaranth + Kidney bean	Total Summer Crops	Up land Wheat	Barley	Total Winter Crops	
1. Ploughing	B:	108	54	54	54	270	108	108	216	486
	H:	126	63	63	54	306	126	126	252	558
2. Levelling	B:	9	-	-	-	9	9	-	9	18
	H:	9	-	-	-	9	9	-	9	18
3. Puddling	B:	-	-	-	-	-	-	-	-	-
	H:	-	-	-	-	-	-	-	-	-
4. Weeding	B:	27	54	27	-	108	-	-	-	108
	H:	100	100	100	-	300	-	-	-	300
5. Irrigation	B:	-	-	-	-	-	-	-	-	-
	H:	-	-	-	-	-	-	-	-	-
6. Mannure Trans-	B:	-	-	-	-	-	-	-	-	-
port & Application	H:	125	50	50	-	225	125	125	250	475
7. Clod	B:	-	-	-	-	-	-	-	-	-
Breaking	H:	-	-	-	-	-	100	-	100	100
8. Sowing/	B:	-	-	-	-	-	-	-	-	-
Transplantation	H:	9	9	4	9	31	9	9	18	49
9. Fertilizer & Pes-	B:	-	-	-	-	-	-	-	-	-
ticide Application	H:	-	-	-	-	-	-	-	-	-
10. Harvesting	B:	-	-	-	-	-	-	-	-	-
	H:	150	180	150	180	660	150	150	300	960
11. Threshing	B:	-	50	50	25	125	75	75	150	275
	H:	120	100	100	100	420	75	75	150	570
Total	B:	144	158	131	79	512	192	183	375	887
	H:	639	502	467	343	1951	594	485	1079	3030

B = Bullock, H = Human

Table 7. Working hours of bullocks in various operations for cultivation of different crops per hectare of cropland in the Middle Himalayan transformed villages

Operations		Summer Crops								Winter Crops						Annual Total
		Up land Rice	Low land Rice	Finger Millet+ Pulses	Barn-yard Millet	Soya -bean	Oil-seeds	Vege-tables	Total Summer Crops	Up land Wheat	Low land Wheat	Pulses	Oil-seeds	Vege-tables	Total Winter Crops	
1. Ploughing	B:	108	108	54	54	108	54	162	648	108	162	108	108	162	648	1296
	H:	126	108	63	63	126	54	189	729	126	189	126	126	189	756	1485
2. Levelling	B:	9	9	4	4	9	4	13	52	9	13	4	4	13	43	95
	H:	9	9	4	4	9	4	13	52	9	13	4	4	13	43	95
3. Puddling	B:	-	63	-	-	-	-	-	63	-	-	-	-	-	-	63
	H:	-	189	-	-	-	-	-	189	-	-	-	-	-	-	189
4. Weeding	B:	-	-	54	27	-	-	-	81	-	-	-	-	-	-	81
	H:	-	54	154	127	154	-	600	1089	-	54	-	-	400	454	1543
5. Irrigation	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	H:	-	48	-	-	-	-	48	96	-	36	-	-	48	84	180
6. Mannure Trans-	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
port & Application	H:	150	150	50	50	150	50	200	800	125	150	100	100	200	675	1475
7. Clod	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Breaking	H:	-	-	-	-	-	-	189	189	-	100	-	-	189	289	478
8. Sowing/	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Transplantation	H:	9	200	9	4	9	4	250	485	9	54	4	4	250	321	806
9. Fertilizer & Pes-	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
tiside Application	H:	-	50	-	-	100	-	100	250	-	50	-	-	100	150	400
10. Harvesting	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	H:	150	200	180	150	150	150	150	1130	150	200	150	150	300	950	2080
11. Threshing	B:	-	-	50	50	50	-	-	150	75	80	50	-	-	205	355
	H:	120	150	100	100	100	150	-	720	75	80	100	100	-	355	1075
Total	B:	117	180	162	135	167	58	175	994	192	255	162	112	175	896	1890
	H:	564	1158	560	498	798	412	1739	5729	494	926	484	484	1689	4077	9806

B = Bullock, H = Human

Table 8. Working hours of bullocks in various operations for cultivation of different crops per hectare of cropland in the Grater Himalayan villages

Operations		Summer Crops					Winter Crops			Annual Total
		Amaranth	Buckwheat	Kidney bean	Potato	Total Summer Crops	Wheat	Naked Barley	Total Winter Crops	
1. Ploughing	B:	108	54	27	54	243	54	54	108	351
	H:	108	54	54	54	270	54	54	108	378
2. Levelling	B:	9	9	-	9	27	18	-	18	45
	H:	18	18	-	27	63	18	-	18	81
3. Puddling	B:	-	-	-	-	-	-	-	-	-
	H:	-	-	-	-	-	-	-	-	-
4. Weeding	B:	-	-	-	-	-	-	-	-	-
	H:	200	-	100	300	600	-	-	-	600
5. Irrigation	B:	-	-	-	-	-	-	-	-	-
	H:	-	-	-	-	-	-	-	-	-
6. Mannure Trans-	B:	-	-	-	-	-	-	-	-	-
port & Application	H:	150	75	75	200	500	150	50	200	700
7. Clod	B:	-	-	-	-	-	-	-	-	-
Breaking	H:	-	-	200	100	300	-	-	-	300
8. Sowing/	B:	-	-	-	-	-	-	-	-	-
Transplantation	H:	5	5	45	200	255	15	10	25	280
9. Fertilizer & Pes-	B:	-	-	-	-	-	-	-	-	-
ticide Application	H:	-	-	-	-	-	-	-	-	-
10. Harvesting	B:	-	-	-	-	-	-	-	-	-
	H:	200	200	200	250	850	150	100	250	1100
11. Threshing	B:	25	25	-	-	50	25		25	75
	H:	150	150	200	-	500	125	150	275	775
Total	B:	142	88	27	63	320	97	54	151	471
	H:	831	502	874	1131	3338	512	364	876	4214

B = Bullock, H = Human

To look at crop-wise requirements for operations, we find that the highest figure is for summer vegetables in the transformed Middle Himalayan villages. The highest figure for total bullock and human

hours is for lowland wheat and summer vegetables in the same category of villages, respectively. The greatest difference in human and bullock hours is in the case of the Greater Himalaya and smallest in the traditionally managed Middle Himalaya. The animate energy required for agriculture in Nepal given by Rijal et al. (1991) corroborates ours only in a few cases.

Considering an eight-hour day, it can be observed that bullocks work for the greatest number of days (236) in the transformed Middle Himalayan villages, followed by the Shivalik villages (212), and traditional Middle Himalayan villages (111). The Greater Himalayan villages use the bullocks only for 59 days in a year.

DAP Contribution to Crop Cultivation

Tables 9 to 12 present data on the magnitude of power that actually goes into the cultivation of all major crops through various operations. All figures are based on per ha of cropland per year. In order to generate data on actual DAP contribution to the cultivation of individual crops per ha per year, the total hours devoted to an operation for the cultivation of a crop were multiplied by the DAP output (kW) for respective operations shown in Table 2. For threshing operation, energy estimate of 0.25 kW (Singh and Naik 1987) was used. One man-hour has been considered equal to 0.075 kWh (Ram 1982; Singh and Naik 1987).

The total DAP for ploughing for raising all major crops is the lowest (183 kWh) for the Greater Himalaya and the highest (674 kWh) for the Middle Himalaya (transformed areas). Ploughing operations for the preparing fields for raising lowland wheat crop and vegetables (84 kWh) in the Middle Himalaya (transformed areas) consume the maximum amount of DAP among all the zones, while kidney beans in the Greater Himalaya consume the lowest amount of DAP (14 kWh). This is due to the fact that tillage for lowland wheat and vegetables has to be done thrice, while kidney beans requires more human energy than bullock. power. Land under fodder crops in the Shivalik zone and under millets (finger millet and barnyard millet), pulses, oilseeds, and amaranth in the Middle Himalayan and Shivalik zones and under all crops (except amaranth) in the Greater Himalayan zone generally need little ploughing.

The human energy supplement during ploughing varies in the same fashion as bullock energy use, described above, does, because one man holds the plough for an equal number of hours as the bullocks work. However, in the Middle Himalayan villages, more human hours are spent during ploughing, for the corners of small terraced fields where the iron plough cannot reach, are to be prepared manually. Owing to less energy output, the total energy contribution of man will be less than that of bullocks.

Levelling operations for all crops are found to require a maximum amount of 81 kWh in the Shivaliks and a minimum of six kWh in the Middle Himalayan traditional areas with a range of from 10 kWh for cultivation of vegetables in the Shivaliks to one kWh for the cultivation of finger millet-pulses, barnyard millet, pulses, and oilseeds in the Middle Himalayan transformed areas. All the important crops in all zones, except for finger millet, barnyard millet, amaranth-kidney beans, and barley in the Middle Himalayan traditional villages and kidney beans and naked barley in the Greater Himalaya, require DAP input for levelling operations. The levelling is often omitted following ploughing if the terraced field is too narrow for the operation. Total human energy expended during levelling according to the DAP pattern.

Puddling operations for lowland rice cultivation consume 25 kWh and 27 kWh of bullock energy in the Shivaliks and Middle Himalayan transformed areas, respectively. This operation is not necessary for other crops including upland rice. The human energy supplement in this operation is more than for ploughing and levelling operations because of the greater number of mandays involved.

Weeding operations (earthing-up and interculture processes often associated) with bullocks use 37 kWh of energy in the traditional areas of the Middle Himalaya and nearly equal amounts (about 27 kWh) in the Shivaliks and transformed areas of the Middle Himalaya for the cultivation of all crops per ha annually. The Greater Himalaya uses no DAP for weeding operations. Bullock-drawn weeders are used only for maize (reported from only one sample village), upland rice (reported from only one sample village), finger millet-pulses, and barnyard millet crops. Among these crops, maize uses the highest amount of DAP (27 kWh) in the Shivaliks/ foothills, followed by finger millet-pulses (18 kWh) and

upland rice and barnyard millet (each 9 kWh) in the Middle Himalaya. The human energy inputs are most during the weeding of winter vegetables in the transformed areas of the Middle Himalaya and minimum for upland rice and lowland wheat.

DAP is not used for the irrigation of crops. Irrigation facilities exist only in two zones, the Shivaliks and the transformed Middle Himalaya. They may also exist in other zones, but only rarely. In areas in which irrigation facilities are plentiful, there is more likelihood that considerable changes have taken place with respect to agricultural practices. Millets, maize, oilseeds, barley, pulses, and pseudo-cereals are always raised in rainfed conditions. In the Middle Himalaya, rice and wheat crops at mid-altitudes and vegetables at high altitudes, where moisture percentage is high, are also raised without irrigation. Water from small rivulets and springs is sometimes diverted to vegetables at high altitudes in the Middle and Greater Himalaya. More human energy is needed for the irrigation of crops for transformed agriculture than for hill agriculture. Lowland rice and winter vegetables require more human energy inputs.

Transporting and applying manure involve human inputs only. In one of the sample villages, nearly 50 percent of the energy needed is met by employing mules. One mule hour service has been regarded equal to eight hours of human labour. The total human energy spent during compost transport and application is the maximum per ha area (113 kWh) in the Shivaliks with a resembling value (110 kWh) in the transformed Middle Himalaya and minimum in the traditional Middle Himalaya. Vegetables in the hills and mountains including potatoes in the Greater Himalaya, require high energy inputs to accomplish this task. In the fields in which finger millet, barnyard millet, pulses, oilseeds, and pseudo-cereals are grown, energy requirements for manure transport and application are the lowest. The energy expended in this operation, apart from individual crop requirements, varies according to the amount of manure available, distance from the households to the fields, cropping patterns/ rotations, and cropping intensities.

Clod breaking requires only human inputs. Clod breaking (or beating) is required especially to prepare the fields for lowland wheat after rice harvesting. The huge amounts of water used for cultivation of rice turns the soil compact and in such fields the first tillage results in unworkable clods or lumps, and these need to be beaten to finer or workable sizes. Lowland wheat in the Shivalik hill areas requires about eight kWh per ha of cultivated land. Even upland wheat areas under 'rice-wheat' rotations demand quite high amounts of human energy (8 kWh) for clod breaking. The maximum amount of energy (15 kWh), however, is invested in the preparation of the fields for kidney bean cultivation in the Greater Himalaya. Field preparation for vegetable cultivation in the Middle Himalayan transformed farming systems is also an energy-intensive exercise (about 14 kWh) when breaking of clods is to take place.

While sowing operations for cultivation of foodgrain crops demand low human energy inputs, transplantation of lowland rice and vegetables requires huge amounts of energy, because large mandays are employed in this process.

Human energy used for fertilizer and pesticide applications on all crops on every hectare of cropland annually is higher in transformed areas (30 kWh) than in the Shivaliks (24 kWh). Use of chemical fertilizers and pesticides in two other study areas is rare. Vegetables need a lot of work and the energy needed is higher than lowland rice and wheat. No upland crops, or crops raised under rainfed conditions, apart from soybeans, use human energy for chemical and pesticide applications. The energy requirement for soybeans for this operation is equal to the energy needed for vegetables.

The total human energy input for the harvesting crops on each ha of cropland annually is the highest (231 kWh) in the Shivaliks, followed by transformed agricultural areas (156 kWh), and the Greater Himalaya (83 kWh) and lowest (72 kWh) in the traditional agricultural areas. Energy used for harvesting of vegetable crops is greater than for foodgrain crops.

Table 9. DAP contribution to the cultivation of different crops through all agricultural operations (kWh/ha) in the Shivalik villages

Operations		Summer Crops								Winter Crops								Annual Total	Total Power (B+H)
		Up land Rice	Low land Rice	Maize	Oil-seeds	Pulses	Vege-tables	Fodder	Total Summer Crops	Up land Wheat	Low land Wheat	Barley	Pulses	Oil-seeds	Vege-tables	Fodder	Total Winter Crops		
1. Ploughing	B:	41.60	41.60	41.60	20.80	20.80	62.40	20.80	249.60	41.60	62.40	41.60	20.80	20.80	62.40	20.80	270.40	520.00	595.00
	H:	6.00	6.00	6.00	3.00	3.00	9.00	3.00	36.00	6.00	9.00	6.00	3.00	3.00	9.00	3.00	39.00	75.00	[41.92]
2. Levelling	B:	6.48	6.48	6.48	3.24	3.24	9.72	3.24	38.88	6.48	9.72	6.48	3.24	3.24	9.72	3.24	42.12	81.00	97.88
	H:	1.35	1.35	1.35	0.68	0.68	2.03	0.68	8.10	1.35	2.03	1.35	0.68	0.68	2.03	0.68	8.78	16.88	[6.90]
3. Puddling	B:	-	25.20	-	-	-	-	-	25.20	-	-	-	-	-	-	-	-	25.20	38.70
	H:	-	13.50	-	-	-	-	-	13.50	-	-	-	-	-	-	-	-	13.50	[2.73]
4. Weeding	B:	-	-	27.20	-	-	-	-	27.20	-	-	-	-	-	-	-	-	27.20	70.40
	H:	1.35	2.03	3.38	-	1.35	15.00	-	23.10	-	1.35	-	-	-	18.75	-	20.10	43.20	[4.96]
5. Irrigation	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.90
	H:	-	2.70	-	-	-	1.35	-	4.05	-	1.35	-	-	-	4.05	0.45	5.85	9.90	[0.70]
6. Mannure Trans-port & Application	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	113.25
	H:	9.00	9.00	9.00	4.50	4.50	15.00	4.50	55.50	9.00	11.25	9.00	4.50	4.50	15.00	4.50	57.75	113.25	[7.98]
7. Clod Breaking	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.50
	H:	-	-	-	-	-	4.50	-	4.50	-	4.50	-	-	-	4.50	-	9.00	13.50	[0.95]
8. Sowing/ Transplantation	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	55.80
	H:	1.20	15.00	1.20	0.60	0.60	15.00	0.30	33.90	1.20	3.00	1.20	0.60	0.60	15.00	0.30	21.90	55.80	[3.93]
9. Fertilizer & Pes-ticide Application	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24.38
	H:	-	3.75	-	-	1.88	7.50	-	13.13	-	3.75	-	-	-	7.50	-	11.25	24.38	[1.72]
10. Harvesting	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	231.00
	H:	13.50	15.00	13.50	15.00	15.00	30.00	13.50	115.50	13.50	15.00	13.50	15.00	15.00	30.00	13.50	115.50	231.00	[16.28]
11. Threshing	B:	-	-	-	-	12.50	-	-	12.50	17.50	20.00	20.00	12.50	-	-	-	70.00	82.50	169.50
	H:	9.00	11.25	9.00	9.00	11.25	-	-	49.50	5.25	6.00	6.00	11.25	9.00	-	-	37.50	87.00	[11.94]
Total	B:	48.08	73.28	75.28	24.04	36.54	72.12	24.04	353.38	65.58	92.12	68.08	36.54	24.04	72.12	24.04	382.52	735.90	1419.30
		[53.73]	[47.94]	[63.42]	[42.31]	[48.86]	[42.05]	[52.24]	[49.76]	[64.37]	[61.68]	[64.76]	[51.05]	[42.32]	[40.53]	[51.73]	[53.94]	[51.85]	
	H:	41.40	79.58	43.43	32.78	38.25	99.38	21.98	356.78	36.30	57.23	37.05	35.03	32.76	105.83	22.43	326.63	683.40	[100.00]
		[46.27]	[52.06]	[36.58]	[57.69]	[51.14]	[57.95]	[47.76]	[50.24]	[35.63]	[38.32]	[35.24]	[48.95]	[57.68]	[59.47]	[48.27]	[46.06]	[48.15]	
Total Power (B+H)		89.48	152.86	118.71	56.82	74.79	171.50	46.02	710.16	101.88	149.35	105.13	71.57	56.80	177.95	46.47	709.15	1419.30	

B = Bullock, H = Human

Figures in parentheses demote percent of total power (B+H).

Table 10. DAP contribution to the cultivation of different crops through all agricultural operations (kWh/ha) in the Middle Himalayan traditional villages

Operations		Summer Crops					Winter Crops			Annual Total	Total Power (B+H)
		Up land Rice	Finger Millets + Pulses	Barnyard Millet	Amaranth + Kidney bean	Total Summer Crops	Up land Wheat	Barley	Total Winter Crops		
1. Ploughing	B:	56.16	28.08	28.08	28.08	140.40	56.16	56.16	112.32	252.72	249.57
	H:	9.45	4.73	4.73	4.05	22.95	9.45	9.45	18.90	41.85	[49.77]
2. Levelling	B:	3.24	-	-	-	3.24	3.24	-	3.24	6.48	7.83
	H:	0.68	-	-	-	0.68	0.68	-	0.68	1.35	[1.32]
3. Puddling	B:	-	-	-	-	-	-	-	-	-	-
	H:	-	-	-	-	-	-	-	-	-	-
4. Weeding	B:	9.18	18.36	9.18	-	36.72	-	-	-	36.72	59.22
	H:	7.50	7.50	7.50	-	22.50	-	-	-	22.50	[10.00]
5. Irrigation	B:	-	-	-	-	-	-	-	-	-	-
	H:	-	-	-	-	-	-	-	-	-	-
6. Mannure Trans-port & Application	B:	-	-	-	-	-	-	-	-	-	35.63
	H:	9.38	3.75	3.75	-	16.88	9.38	9.38	18.75	35.63	[6.02]
7. Clod Breaking	B:	-	-	-	-	-	-	-	-	-	7.50
	H:	-	-	-	-	-	7.50	-	7.50	7.50	[1.27]
8. Sowing/ Transplantation	B:	-	-	-	-	-	-	-	-	-	3.68
	H:	0.68	0.68	0.30	0.68	2.33	0.68	0.68	1.35	3.68	[0.62]
9. Fertilizer & Pes-ticide Application	B:	-	-	-	-	-	-	-	-	-	-
	H:	-	-	-	-	-	-	-	-	-	-
10. Harvesting	B:	-	-	-	-	-	-	-	-	-	72.00
	H:	11.25	13.50	11.25	13.50	49.50	11.25	11.25	22.50	72.00	[12.16]
11. Threshing	B:	-	12.50	12.50	6.25	31.25	18.75	18.75	37.50	68.75	111.50
	H:	9.00	7.50	7.50	7.50	31.50	5.63	5.63	11.25	42.75	[18.84]
Total	B:	68.58	58.94	49.76	34.33	211.61	78.15	74.91	153.06	364.67	591.92
		[58.36]	[61.02]	[58.69]	[57.16]	[59.12]	[63.69]	[67.31]	[65.41]	[61.61]	[100.00]
	H:	47.93	37.65	35.03	25.73	146.33	44.55	36.38	80.93	227.25	
		[41.14]	[38.98]	[41.31]	[42.84]	[40.88]	[36.31]	[32.69]	[34.59]	[38.39]	
Total Power (B+H)		116.51	96.59	84.79	60.06	357.94	122.70	11.29	233.99	591.92	

B = Bullock, H = Human

Figures in parentheses denote percent of total power (B+H).

Table 11. DAP contribution to the cultivation of different crops through all agricultural operations (kWh/ha) in the Middle Himalayan transformed villages

Operations		Summer Crops								Winter Crops						Annual Total	Total Power (B+H)
		Up land Rice	Low land Rice	Finger Millet+ Pulses	Barn-yard Millet	Soya -bean	Oil-seeds	Vege-tables	Total Summer Crops	Up land Wheat	Low land Wheat	Pulses	Oil-seeds	Vege-tables	Total Winter Crops		
1. Ploughing	B:	56.16	56.16	28.08	28.08	56.16	28.08	84.24	336.96	56.16	84.24	56.16	56.16	84.24	336.96	673.92	785.30
	H:	9.45	8.10	4.73	4.73	9.45	4.05	14.18	54.68	9.45	14.18	9.45	9.45	14.18	56.70	111.38	[49.50]
2. Levelling	B:	3.24	3.24	1.44	1.44	3.24	1.44	4.68	18.72	3.24	4.68	1.44	1.44	4.68	15.48	34.20	41.33
	H:	0.68	0.68	0.30	0.30	0.68	0.30	0.98	3.90	0.68	0.98	0.30	0.30	0.98	3.23	7.13	[2.61]
3. Puddling	B:	-	26.46	-	-	-	-	-	26.46	-	-	-	-	-	-	26.46	40.64
	H:	-	14.18	-	-	-	-	-	14.18	-	-	-	-	-	-	14.18	[2.56]
4. Weeding	B:	-	-	18.36	9.18	-	-	-	27.54	-	-	-	-	-	-	27.54	143.27
	H:	-	4.05	11.55	9.53	11.55	-	45.00	81.68	-	4.05	-	-	30.00	34.05	115.73	[9.03]
5. Irrigation	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.50
	H:	-	3.60	-	-	-	-	3.60	7.20	-	2.70	-	-	3.60	6.30	13.50	[0.85]
6. Mannure Trans-port & Application	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	110.63
	H:	11.25	11.25	3.75	3.75	11.25	3.75	15.00	60.00	9.38	11.25	7.50	7.50	15.00	50.63	110.63	[6.97]
7. Clod Breaking	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35.85
	H:	-	-	-	-	-	-	14.18	14.18	-	7.50	-	-	14.18	21.68	35.85	[2.26]
8. Sowing/ Transplantation	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60.45
	H:	0.68	15.00	0.68	0.30	0.68	0.30	18.75	36.38	0.68	4.05	0.30	0.30	18.75	24.08	60.45	[3.81]
9. Fertilizer & Pes-ticide Application	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	30.00
	H:	-	3.75	-	-	7.50	-	7.50	18.75	-	3.75	-	-	7.50	11.25	30.00	[1.89]
10. Harvesting	B:	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	156.00
	H:	11.25	15.00	13.50	11.25	11.25	11.25	11.25	84.75	11.25	15.00	11.25	11.25	22.50	71.25	156.00	[9.83]
11. Threshing	B:	-	-	12.50	12.50	12.50	-	-	37.50	18.75	20.00	12.50	-	-	51.25	88.75	169.38
	H:	9.00	11.25	7.50	7.50	7.50	11.25	-	54.00	5.63	6.00	7.50	7.50	-	26.63	80.63	[10.68]
Total	B:	59.04	85.86	60.38	51.20	71.90	29.52	88.92	447.18	78.15	108.92	70.10	57.60	88.92	403.69	850.87	
		[58.41]	[49.71]	[58.98]	[57.82]	[54.57]	[48.86]	[40.54]	[51.00]	[67.83]	[61.06]	[65.88]	[61.34]	[41.24]	[56.90]	[53.63]	1586.35
	H:	42.30	86.85	42.00	37.35	59.85	30.90	130.43	429.68	37.07	69.45	36.30	36.30	126.68	305.78	735.46	[100.00]
		[41.59]	[50.29]	[41.02]	[42.18]	[45.43]	[51.14]	[59.46]	[49.00]	[32.17]	[38.94]	[34.12]	[38.66]	[58.76]	[43.10]	[46.36]	
Total Power (B+H)		101.70	172.71	102.38	88.55	131.75	60.42	219.35	876.86	115.22	178.37	106.40	93.90	215.60	709.47	1586.33	

B = Bullock, H = Human
Figures in parentheses denote percent of total power (B+H).

Table 12. DAP contribution to the cultivation of different crops through all agricultural operations (kWh/ha) in the Greater Himalayan villages

Operations		Summer Crops					Winter Crops			Annual Total	Total Power (B+H)
		Amaranth	Buckwheat	Kidney bean	Potato	Total Summer Crops	Wheat	Naked Barley	Total Winter Crops		
1. Ploughing	B:	56.16	28.08	14.04	28.08	126.36	28.08	28.08	56.16	182.52	210.87
	H:	8.10	4.05	4.05	4.05	20.25	4.05	4.05	8.10	28.35	[39.52]
2. Levelling	B:	3.24	3.24	-	3.24	9.72	6.48	-	6.48	16.20	22.28
	H:	1.35	1.35	-	2.03	4.73	1.35	-	1.35	6.08	[4.18]
3. Puddling	B:	-	-	-	-	-	-	-	-	-	-
	H:	-	-	-	-	-	-	-	-	-	-
4. Weeding	B:	-	-	-	-	-	-	-	-	-	45.00
	H:	15.00	-	7.50	22.50	45.00	-	-	-	45.00	[8.43]
5. Irrigation	B:	-	-	-	-	-	-	-	-	-	-
	H:	-	-	-	-	-	-	-	-	-	-
6. Mannure Trans-port & Application	B:	-	-	-	-	-	-	-	-	-	52.50
	H:	11.25	5.63	5.63	15.00	37.50	11.25	3.75	15.00	52.50	[9.84]
7. Clod Breaking	B:	-	-	-	-	-	-	-	-	-	22.50
	H:	-	-	15.00	7.50	22.50	-	-	-	22.50	[4.22]
8. Sowing/ Transplantation	B:	-	-	-	-	-	-	-	-	-	21.00
	H:	0.38	0.38	3.38	15.00	19.13	1.13	0.75	1.88	21.00	[3.94]
9. Fertilizer & Pes-ticide Application	B:	-	-	-	-	-	-	-	-	-	-
	H:	-	-	-	-	-	-	-	-	-	-
10. Harvesting	B:	-	-	-	-	-	-	-	-	-	82.50
	H:	15.00	15.00	15.00	18.75	63.75	11.25	7.50	18.75	82.50	[15.46]
11. Threshing	B:	6.25	6.25	-	-	12.50	6.25	-	6.25	18.75	76.88
	H:	11.25	11.25	15.00	-	15.00	9.38	11.25	20.63	58.13	[14.41]
Total	B:	65.65	37.57	14.04	31.32	148.58	40.81	28.08	68.89	217.47	
		[50.90]	[49.95]	[17.64]	[26.97]	[37.24]	[51.52]	[50.70]	[51.19]	[40.76]	533.52
	H:	63.33	37.65	65.55	84.83	250.35	38.40	27.30	65.70	316.05	[100.00]
		[49.10]	[50.05]	[82.36][	[73.03]	[62.76]	[48.48]	[49.30]	[48.81]	[59.24]	
Total Power (B+H)		128.98	75.22	79.59	116.15	398.93	79.21	55.38	134.59	533.52	

B = Bullock, H = Human
Figures in parentheses denote percent of total power (B+H).

Human energy for threshing of all crops on each ha land annually ranges from a high of 87 kWh to a low of about 43 kWh in the Shivalik hills and traditional agricultural areas, respectively. These

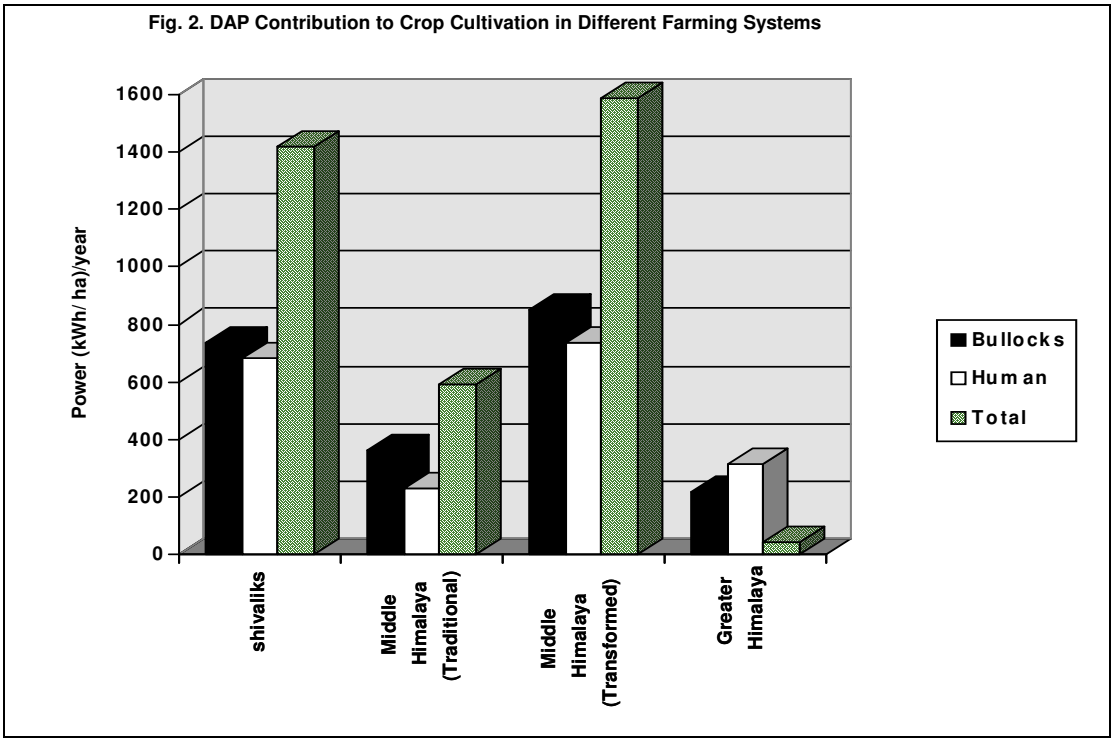
figures for transformed areas and the Greater Himalaya are 81 kWh and 58 kWh, respectively. Threshing wheat, barley, pulses, pseudo-cereals, and millets also uses animal energy input.

Animal energy for threshing is maximum (about 89 kWh) in the transformed agricultural areas and minimum (about 19 kWh) in the Greater Himalaya. These values for the Shivalik hills and traditional agriculture are 83 and 69 kWh, respectively.

Among all the agricultural operations, the total (bullock and human) power contribution is the highest during ploughing. It ranges from about 40 to 42 percent for the Greater Himalayan and Shivalik hill agriculture to about 50 percent for the Middle Himalayan agriculture. Harvesting and threshing operations use quite high percentages of total power, second only to ploughing. Weeding (except in the Shivalik hill zone) and transporting and applying manure in terms of uses of power, are third. All other operations use only low amounts of total power. DAP predominates in ploughing, levelling, puddling, and weeding operations and, in the Middle Himalaya, in threshing also.

Looking at crop-wise contributions from bullock and human power, we find that it is summer vegetables in the transforming mountains areas that absorb maximum energy input per ha (about 219 kWh), followed by winter vegetables (about 216 kWh) and lowland wheat (about 178 kWh), in the same area, and winter vegetables (178 kWh) in the hills. In the traditional mountains and Greater Himalayan mountains, upland wheat (about 123 kWh) and amaranth (about 129 kWh) use the highest amounts of power. Fodder in the hills and naked barley in the Greater Himalaya use the lowest amounts of power, about 46 and 55 kWh per ha, respectively. Barley in the hills and traditional mountain areas, and upland wheat in the transformed mountain areas and Greater Himalayan zone use major share of DAP out of the total power input, i.e., about 65, 67, 68,, and 52 percent respectively, while vegetables, amaranth-kidney beans, vegetables, and kidney beans, in these respective areas, use the greatest share of human energy, i.e., nearly 57, 43, 59, and 82 percent, respectively. This pattern demonstrates that irrigated crops use more human energy (kidney beans in the Greater Himalaya being an exception) and un-irrigated crops generally use more DAP (see Figure 2 also).

Fig. 2. DAP Contribution to Crop Cultivation in Different Farming Systems



The overall bullock and human energy that goes into per ha crop cultivation through all operations annually amounts to about 1419, 592, 1586, and 534 kWh in the hills, traditional mountains,

transformed mountains, and high Himalaya, respectively. This means that agricultural transformation is an energy-intensive process. Transitional hill agriculture, in terms of power use, is in second place, traditional mountain agriculture in third place, and 'primitive' type high mountain agriculture last. Looking at the DAP contribution to overall power, we find that high mountain agriculture uses only about 41 percent DAP, hill agriculture about 52 percent, transformed agriculture about 54 percent, and traditional agriculture as much as 62 percent of DAP for crop cultivation. This pattern suggests that cropping intensity increases pressure on human beings in terms of energy needed. The reason of that high mountain agriculture is the exception is that there is less diversification in the cropping, and no household in a typical livestock-based farming setting (Bagauri, for example) owns any bullocks and many households carry out all operations manually. Furthermore, kidney beans, raised mainly around the homesteads, and potato cultivation require human energy for the most part. The contribution of human energy to the cultivation of other crops in this area, nevertheless, is only nearly 50 percent. The transformed agricultural system makes most efficient use of available DAP and human resources, and this is reflected in the greater degree of cropping diversification and higher crop yields in the area.

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REFERENCES

Bhatia, R and Sharma, R. 1990. Energy and agriculture: a review. In Desai, A V (ed.) *Patterns* of *Energy Use in Developing Countries.* New Delhi: Wiley Eastern India, 205-251.

Goe, M R. 1983. Current status of research on animal traction. *World Animal Review* **45**: 2-17.

Gopalan, C B, Ramasastri, V and Balasubramanium, S C. 1979. Nutritive Value of Indian Foods. Hyderabad, India: National Institute of Nutrition.

ICAR (Indian Council of agricultural Research). 1978. Report on Energy Requirements of Intensive Agricultural production 1977-78. Pantnagar, India: GBP university.

Matthews, M D P. 1987. Measuring draught animal power of Carabaos crossed with exotic buffaloes. *World Animal Review* **63**: 15-19.

Mc Colly, F. 1971. Proposal of agricultural mechanisation in the countries of South-east Asia. *Agricultural Mechanisation Asia*. Spring 1971: 25-35.

Ramani, K V, Reddy, A K N and Islam, M N(eds.). 1995. Rural Energy Planning: A Government-Enabled Market-Based Approach. Kuala Lumpur, Malaysia: APDC & GTZ, 252-253.

Ram, R A. 1982. Use of bullock power in farming system. Proceedings and Seminar Papers Bangalore, India: IIM.

Revelle, R. 1976. Energy use in rural India. *Science* **192**: 969-975.

Rijal, K, Bansal, N K and Grover, P D. 1991. Energy and subsistence Nepalese agriculture *Bioresource Technology* **36**: 1991.

Sarkar, R I. 1981. Improved utilization of animal draught power in Bangladesh. In Jackson et al (eds.) *Maximum Livestock Production from Minimum Land*. Mymensingh, Bangladesh: Bangladesh Agricultural university.

Singh, V and Naik, D G. 1987. Animal draught power in the mid-altitude Himalayan villages. In Pangtey, P S and Joshi, S C (eds.) *Western Himalaya: Environment, Problems and development, Vol. II.* Nainital, India: Gyanodaya Prakashan, 755-770.

Srivastava, N S L and Yadav, G C. 1987. Perspective planning for draught animal power for the year 2000. *Proceedings of National Seminar on Status of Animal Energy Utilization.* Bhopal, India: CIAE.

INCIDENCE OF POST-PARTUM ANESTRUS IN BOVINES OF RURAL AREA OF KUMAON REGION

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INTRODUCTION

The post partum anestrus in cattle has been identified as one of the major problem affecting the efficiency of reproduction and thus overall production in rural areas. A number of reports are available on the incidence of post-partum anestrus in cattle and buffaloes however, studies on incidence of anestrus in cattle reared under rural managemental conditions of Kumaon region are limited. This paper describes the occurrence of different forms of post-partum infertility in cattle under village managemental conditions.

MATERIALS AND METHODS

Analysis of the cases of 102 cattle subjected to gynaeco-clinical examination of mass infertility camps held in the five villages of Ramgarh Block, Distt. Nainital (U.P.) during the months of July to Oct., 1999 was done. The various conditions led to infertility were classified as true anestrus and subestrus (silent heat) that is noncyclical smooth and inactive ovaries and having palpable structure (corpus luteum) on the ovary.

RESULTS AND DISCUSSION

The incidence on patterns of different forms of post-partum anestrus among cattle are presented in Table - 1 and 2. The overall occurrence of post-partum anestrus in cattle was 50.00 percent. Out of which the number of cases which were identified as true anestrus-noncyclic ovaries were frequent (47.05%) in five villages. The silent heat or subsestrus that includes ovulation without showing any visual signs of estrus, which indicating the cyclical corpus luteum on right/left ovary and constituted the incidence rate of 2.94 percent only.

Table 1. Cynaecological examination of cattle in 5 villages of Nainital District

.Name of village	Total no. of animals	No. of pregnant diagnosed	No. of infertility cases			Post partum anestrus	Total infertility cases
			Cervicitis	Malnutrition	Repeat breeders		
Parwada	22	4	1	5	2	10	18
Surmane	18	4	-	3	2	9	14
Kaol	31	10	2	5	3	11	21
Jaspur	12	1	-	2	1	8	11
Gahna	19	2	-	3	1	13	17
Total	102	21	3	18	9	51	81

In this study the incidence of post-partum anestrus in cattle was lower than those reported by Barr and Hushim (1968), Chauhan and Singh (1979) and Srivastava and Kharche (1986) in buffaloes and Kumar and Kumar (1993) in cattle. Whereas, it was higher (32.70 percent) than reported by Singh et. al. (1986) in buffaloes. The incidence of true anestrus was higher (47%) than reported by Agarwal (1978), Luktuke and Sharma (1978), Chauhan and Singh (1979), Singh et. al. (1986), Benerjee (1987) and Patil (1989) where they have found the incidence rate of true anestrus between 30 to 40% in buffaloes. In present study the higher incidence of true anestrus in cattle could be due to low plane of nutrition which seems to be the major cause of infertility in this area.

Further the incidence of silent estrus was very lower (2.94%) than that reported by others (Chauhan and Singh 1979, Gautam and Kharche, 1992). This variation in the incidence as observed by

above workers may be due to the variation in the level of inheritance, geographical area of location, environmental and managemental practices including grazing and other feeding sources, water sources and farmers interest with particular breed of bovines.

Table 2. Incidence of Post-partum anestrus cattle in five villages

Particulars / Groups	I	II	III	IV	V	Total
Total cases examined	22	18	31	12	19	102
No. of true anestrus cases	9	9	10	8	12	48
Percentage of true anestrus	40.90	50.0	32.25	66.67	63.15	47.05
No. of subestrus cases	1	-	1	-	1	3
Percentage of subestrus	4.54	-	3.23	-	5.26	2.94
Total post partum anestrus	10	9	11	8	13	51
Percentage of total post-partum anestrus	45.45	50.0	35.48	66.67	68.42	50.0

This study reveals that post-partum true anestrus particularly due to low plane of nutrition is a major problem leading to infertility in majority cattle of this region.

REFERENCES

Agarwal, S.K. (1989). Incidence of anestrus in buffaloes. M.V.Sc. thesis submitted to RohilKhand University, Bareilly.

Banerjee, A.K. (1987). Studies on incidence of anestrus in the Murrha grade buffalo cows in the city Khatalas of Calcutta, West Bengal. Indian Journal of Animal Health. 26 (2) : 134-149.

Barr, A.M. and Hushim, E.L. (1968). Incidence of ovarian hypofunction in buffaloes. Zuchtlya 9 (3) : 206.

Chauhan, F.S. and Singh, M. (1979). Incidence of anestrus in buffaloes. Indian Vet. Journal. 56 (7) : 587-589.

Gautam, A.P. and Kharche, K.G. (1992). Studies on incidence of subestrus in buffaloes. Livestock Advisor. 77 (5) : 7-8.

Kumar, S. and Kumar, H. (1993). Clinical analysis of anestrum in rural bovines. Indian Journal Dairy Science 46 (2) : 80-84.

Lucktuke, S.N. and Sharma, L. (1978). Studies on incidence of true anestrus in rural cattle and buffaloes. Indian Vet. Journal. 55 (12): 940-942.

Patil, J.S., (1989). Reproductive disorders in buffaloes. Proceeding of II World Buffaloe Cong., New Delhi. pp. 11-12.

Shrivastava, A.K. and Kharche, K.G. (1986). Studies on incidence of normal and abnormal cycling post partum estrus interval. Livestock Advisor. 11 (8) : 23-27.

Singh, N., Garch, D.S. and Chauhan, F.S., (1986). Incidence of reproductive disorders in buffaloes and cows under field conditions. Livestock Advisor. 9 (1) : 55-59.

STRUCTURE OF FORESTS UNDER COMMUNITY CONSERVATION : A PRELIMINARY STUDY OF JARDHAR VILLAGE INITIATIVE IN GARHWAL HIMALAYA

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INTRODUCTION

The Himalaya a vast mountain system cover partly or fully eight countries of Asia i.e. Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan. The Himalayan ranges of the India lying within geographical limits of 26°20' and 35°40' North and 74°50' and 95°40' East, about 2500 km long, covering an area of 2,36,900 sq. km. India's recognition as one of four `megadiversity' centers of Asia and as one of ten largest forested areas in the world derives partly from the Himalaya. The Himalaya although cover only 18% of the geographical area of India, account for more than 50% of the India's forest cover, and 40% of the species endemic to the India sub-continent (Maikhuri *et al.,* 2000). Various programmes have been implemented, for the conservation of biological resources in the Indian Himalaya under the protected area network by establishing 3 biosphere reserves, 18 national parks and 71 wild life sanctuaries (covering 9.2% area of the Indian Himalaya). Enforcement in these protected areas has created a lot of conflicts between local people and protected area managers due to restrictions imposed on the traditional usufruct rights of the local people. These conflicts are causing major hurdles to achieve the goal of biodiversity conservation for which the protected areas have been setup (Gadgil, *et al.,* 1993; Nautiyal, 1998; Maikhuri *et al.,* 2000). Conservation of biological resources under community based conservation system has a long history in the Himalaya particularly in the Central Himalaya. Because the people of this region are well versed with the significance of natural resources which they harvest for meeting the essential livelihood needs. Various examples reveal the active participation and involvement of local people either at community or individual level towards conservation of the forest / natural resources. The Uttar Pradesh hills have a longer history of officially sanctioned local people's participation in forest management than any other part of the country. The *van panchayat* system is a village level institution and it has considerable potential for involving local communities in forest management for conservation. There are about 4,804 *van panchayats* in the U.P. hills covering an area of 2,44,800 hectares (Saxena, 1995).

The another important example of community based conservation is the well known Chipko movement and was the first movement of its kind in independent India. The Hariyali secred forest of the Garhwal Himalaya is also an example where people conserved the forest through socio-cultural and religious practices (Sinha and Maikhuri, 1998). The present study has been carried in the forest of Jardhar village (Tehri District) where villagers put efforts to conserve the surrounding forest (approximately 10 km^2) since last 20 years through their own indigenous knowledge. They have also given more emphasis for conservation of those species, having multiple use values. In the present study attempt was made to (i) analyse phytosociological attributes of different forest compartments; (ii) assess the regeneration potential and (iii) compare the structure of such protected patches with other (under govt. schemes) protected forests / reserved forests of the Central Himalaya.

METHODS

The phytosociological analysis of the all compartments of the Jardhar forest stands was done using standard methods as given in Ralhan *et al.,* 1982; Saxena & Singh, 1982. In case of trees and tree saplings of >10.5 cm. circumference (at Breast Height i.e. 1.37 m from the ground) have been grouped together (not studied separately). Also the size of the quardrats (10x10m) was kept similar for all strata (trees + sapling, tree seedlings and shrubs). Individuals whose CBH was below 10.5 cm were considered as seedlings. The

diversity was determined by using Shannon Wiener (1963) index, and concentration of dominance following Simpson (1949). Beta diversity (BD) was calculated following Whittakar (1975).

RESULTS AND DISCUSSION

The detailed characteristics of different forest compartments (sites) are mentioned in Table 1. A total of 81 species (20 species of trees, 24 species of shrubs and 37 species of herbs) were recorded from the Jardhar forest. Compartment wise distribution of species (trees and shrubs) is presented (Table 2a & 2b). However, herbaceous species (comprising of grasses (5), pteridophytes (3), sedges (2) and 27 forbs) are not categorized according specific locality (segments) wise and encountered across the compartments in Jardhar forest at the time of present study (Table 2b). The number of species in tree + sapling, seedling and shrub strata indicates that these forest stands are comparatively species rich. The Chauksaur stand is relatively species poor than Buransdhar and Hadyan forest stands. Although dominance was shared by a number of species, no single species was found to compete with *Quercus leucotrichophora;* a climax species. On the basis of density, basal cover and Importance Value Index (IVI), *Q. leucotricophora* was found to be the most important and dominant species in all the forest stands of Jardhar (Table 3a, 3b & 3c). However, the presence of *Pinus roxburghii* in these forest stands particular in Chauksaur compartment is an indication towards possible threat to the co-existance of climax and associated species (Table 3a). The forests of *Q. leucotricophora,* which is a late successional and climax species when disturbed by various anthropogenic factors (*i.e*. lopping, cutting burning *etc*), are invaded by the early successional species (light demanding species) such as chir - pine (*P. roxburghii)* due to changed microclimatic conditions (Semwal and Mehta, 1996). Total basal area (tree + saplings) ranged from 18.35 to 46.57 m^2 ha^{-1} and total density varied between 1082 and 4179 ha^{-1} across the forest stands (Table 3a, b & C). Total basal area and density of tree layer was reported in the range of 27-191.5 m^2 ha^{-1} and 350 to 1787 plants ha^{-1}, respectively, for various broad leaved, traditionally conserved (secred grove) and protected (Nanda Devi Biosphere Reserve) forests of Kumaun and Garhwal Himalaya (Saxena and Singh, 1982; Singh and Singh, 1987; Bhandari and Tiwari, 1997; Sinha and Maikhuri, 1998; Maikhuri *et al.,* 2000). Higher values of density and lower values of basal cover suggest that the Jardhar forest stands are younger and newly conserved. High tree density suggest that the diversity and luxuriance of these community forest stands may be maintained in healthy state if the extent of biotic pressure is maintained to a optimum limit. Low tree density, basal cover and less number of species in Chauksaur forest stand reflect the forest is under high biotic pressure coupled with other abiotic factors which are not necessarily conducive for tree growth.

The number (density) of seedlings of any species can be considered as the regeneration potential of that species. From the density values (Table 4a, b & c), it is concluded that the regeneration of oak (*Q. leucotrichophora*) in Chauksaur compartment is low, as compared to other compartments, however, not as alarming as has been pointed out elsewhere (Saxena *et al.,* 1978; Ralhan *et al.,* 1982; Tiwari and Singh, 1982; Saxena and Singh, 1984 and Bankoti *et al.,* 1986). The co-dominance of *Pinus roxburghii* with *Q. leucotrichophora* particularly in Chuaksaur forest stand (Table 4a) is an indication that due to various anthropogenic pressure oak is not regenerates in comparison to pine. Degradation of the oak forest through high anthropogenic pressure will provide appropriate conditions for the pine (an early successional, low nutrien demander and shade intolerant species) to invade, thereby posing a serious threat to the ecological balance of this region (Singh *et al.,* 1984).

In Jardhar forest stands species richness is very high in shrub layers (present study) than any other broad leaved forests of Garhwal Himalaya (Bhandari and Tiwari, 1997; Bhandari *et al.,* 1998). High species richness in shrub layers may be due to relatively less developed canopy in these young forests which permit sufficient sunlight to reach the ground resulting in the luxuriant growth of shrub species (Table 2b).

A/F ratio was used to assess the distribution pattern of the species. Distribution pattern indicated that most of plots species are distributed contagiously (clumped) followed by randomly. Regular as well as random distribution as observed in the present case has not been reported in shrub layers from this part of the Himalaya (Table 5). It is interesting that the distribution pattern of trees did not correspond with the distribution pattern of shrubs. Similar findings have been reported for Central Himalayan forests by different workers (Saxena and Singh, 1982; Bhandari and Tiwari, 1997). Clumped (contagious) distribution in natural vegetation has been reported by Greig-Smith (1957); Kershaw, (1973) and Singh and Yadava, (1974). Odum

(1971) described that in natural conditions, contagious (clumped) distribution is the most common type of distribution and is performed due to small but significant variations in the environmental conditions. Preponderance of random distribution in tree + sapling and seedling layers as compared to shrub layer reflects the dimension of biotic interferences in these strata.

In the present study, the similarity values for tree + sapling layers was 36.00 to 43.58%, for seedlings 47.90 to 62.80% and for shrubs 19.40 to 47.90% (Table 6). Saxena and Singh (1982) reported community coefficient values ranging between 1.30 and 32.50%, Ralhan *et al.,* (1982) between 8.11 and 64.18%, and Tiwari (1983) between 0.0 and 67.43% of different forests of Kumaun Himalaya. However, Mehta *et al.,* (1997) reported similarity 9.6% (between burnt grazed and unburnt grazed sites) to 74.9% (between unburnt protected and unburnt grazed sites) for the various forest compartments (sites) under different management regimes in Garhwal Himalaya. Low similarity between strata and stands indicates the microclimatic variations and hence species composition. Wikum and Wali, (1974) and Saxena and Singh, (1982) have pointed out the significant role of the site characteristics in plant distribution and similarity.

Diversity is a combination of two factors, the number of species present, referred to as species richness and the distribution of individuals among the species, referred to as evenness or equitability. Single species populations are defined as having a diversity of zero, regardless of the index used. Species diversity therefore, refers to the variations that exist among the different forms. In the present study Shannon - Wiener index of diversity has been used. The value of diversity ranged from 2.211 to 3.124, 3.097 to 3.350 and 2.596 to 3.203, respectively, for trees + saplings, seedlings and shrubs. The range of diversity in the present community forest stands is certainly higher than any other broad leaved forests of Central Himalaya (Ralhan *et al.,* 1982), however, it is lower than as reported for tropical forests (Knight, 1975). Moderate amount of anthropogenic pressure on Jardhar forest stands is helpful in maintaining the higher species diversity. Such view was also expressed by Thadani and Ashton (1995), Singh *et al.,* (1997).

The value of beta - diversity was 1.304, 1.53 and 1.41 for trees + sapling, seedling and shrub layers, respectively. These values are much lower than those reported for oak and chir pine forests of Kumaun (Tewari and Singh, 1985) and Garhwal (Bhandari *et al.,* 1997) Himalaya respectively. Small differences in the beta-diversity indicate that the growth forms among different stands respond in similar fashion (Adhikari *et al.,* 1991). Low value of beta diversity show that the species composition does not vary significantly across the slopes.

MAJOR CONCLUSIONS DRAWN

- ➔ As per the Champion and Seth's classification the Jardhar forest broadly falls under the "**Himalayan moist temperate forests"** category.
- ➔ In the present case trees and saplings were considered together (it is not possible to segregate them into trees and saplings now), hence the density value is significantly higher than reported. However, at the same time if sapling and tree density reported in the earlier studies is added together our values are quite comparable. In addition to this, Jardhar forest stands are newly regenerating after the protection given by local community and therefore, most of the individuals of different species are young having low basal cover and high density.
- ➔ Regeneration can be calculated on the basis of seedlings per unit area (please see the tables where all phytosociological attributes are given for different forest stands) and it has been briefly discussed in the present article. All the stands regeneration potential of *Q. leucotrichophora* (Oak) is high as compared to other species but co-dominance of *P. roxburghii* with *Q. leucotrichophora* (particularly in Chauksaur forest stand of the Jardhar forest) is an indication that if anthropogenic pressure will increase in that stand then oak will be replaced by pine as reported by earlier worker.
- ➔ IVI is used to evaluate the importance of a species in any ecosystem which reflects the sum total of relative frequency, relative density and relative dominance (basal cover) of a species. In the present case one can see that IVI was significantly higher for oak species than any other species in tree + sapling stratum and hence Oak is the species which is dominating the different stands of Jardhar forest. As far as shrub stratum is concerned it is evident that more than one species shared the importance in different forest compartments.

➔ It depends on the degree of protection is given to a forest. If the Jardhar forest is protected strictly like a sacred Oak - Rhododendron forest of 'Hariyali' (Density 1399 tree ha^{-1} and total basal cover 47.59 m^2 ha^{-1}) or as in the Nanda Devi Biosphere Reserve (Density 946 tree ha^{-1} and total basal cover 191.5 m^2 ha^{-1}), then, in due course of time it is most likely that the Jardhar forest will assume the similar structure having low density and diversity but high basal cover (it takes place due to poor regeneration of species in presence of well developed canopy and dominance by few big sized climax species). However, if the Jardhar forest is exploited at the same magnitude, as the other reserved Oak - Rhododendron forests of the Garhwal Himalaya are being disturbed currently, its diversity, density and basal cover will be like those forests studied by Ralhan *et al.,* 1982; Saxena and Singh, 1982, and other workers. Further, if the present level of anthropogenic pressure on Jardhar forest does not increase in future which is far less than existing pressure on the other govt. reserved Oak-Rhododendron forests of the region, it is most likely that Jardhar forest will remain species-rich and diverse as it is at present.

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Table 1. Some characteristics of the studied compartments (segments) of Jardhar forest

Compartments / segments	Aspects	Altitude (m)	Main features
1. Chauksaur	East & South	1800-2000	Old, comparatively degraded forest, sunny and located mainly on the ridge due to which high speed wind blows continuously
2. Hadyan	North	1600-2000	Young regenerated forest mainly from the old stock which had been over exploited in the past. Sunshine hours are limited.
3. Buransdhar	North & East	1500-2000	Old trees of oak (banj) and tree saplings are most frequent at the site. Some of the locations are sun facing while other are north facing and hence receive less sun rays especially during winter months

Table 2a. Tree species encountered on the three different compartments of the Jardhar forest.

Tree species	Vernacular name	Chauksaur compartment	Hadyan compartment	Buransdhar compartment
1.*Cinnamomum tamala* Nees	Dalchini	-	+	+
2.*Cornus capitata* Wall.	Bhamora	-	+	+
3.*Cornus macrophylla* Wall.	Khagsa	-	+	+
4.*Coculus laurifolius* DC.	Tilphara	-	+	+
5.*Englehardtia* sp	Mahuwa	+	-	+
6.*Fucus* sp	Chadula	-	-	+
7.*Litsaea* sp	Maliya	+	+	+
8.*Lonicera quinquilocularis* Hardw.	Bhatkukra	-	+	+
9.*Lyonia ovalifolia* Wall (Drude)	Aynar	+	+	+
10.*Machilus duthiei* King ex Hook.f.	Kaul	-	-	+
11.*Myrica esculenta* Buch - Ham.	Kafal	+	+	+
12.*Pinus roxburghii* Sarg.	Kulain	+	+	+
13.*Prunus cerasoides* D.Don	Paiyan	+	+	+
14.*Pyrus pashia* Buch-Ham.	Molu	+	+	+
15.*Quercus leucotrichophora* A. Camus	Banj	+	+	+
16.*Rhododendron arboreum* Smith	Burans	-	+	+
17.*Symplocos cretaegoides* Buch-Ham.	Lodh	-	+	+
18.*Rhus* sp	Akhoriya	-	+	-
19.*Viburnum* cotinifolium D.Don.	Gwaniya	+	+	+
20.*Viburnum* sp	Baith bamora	+	+	+

+ Species present ; - Species not present

Table 2b. Shrub species encountered on the three different compartments of the Jardhar forest.

Tree species	Vernacular name	Chauksaur compartment	Hadyan compartment	Buransdhar compartment
1. *Asparagus adscendens* Roxb.	Bhutroon	+	+	+
2. *Berberis asiatica* Roxb.	Kingora	+	+	+
3. *Berberis chitria* Lindl.	Totar	-	-	+
4. *Coriaria nepalensis* Wall.	Rikholya	+	+	+
5. *Cotoneaster bacillaris* Wall.	Ruins	+	+	+
6. *Cornus* sp	Gaunta	+	+	-
7. *Desmodium elagnas* DC	Chamlai	-	+	+
8. *Daphane paparacea* Decne.	-	-	-	+
9. *Euphorbia royleana* Boiss	Sullu	-	-	+
10. *Indigofera gerardiana* Wall.	Sakina	+	-	+
11. *Lonicera* sp	Garhruins	+	+	-
12. *Leucas* sp	-	+	-	-
13. *Myrisine africana* Linn.	Jhingariya	+	+	+
14. *Murraya* sp	Marchuliya	+	-	+
15. *Princepia utilis* Royle.	Bhenkal	+	+	-
16. *Pyracantha crenulata* D.Don.	Ghingaru	+	-	-
17. *Rhus parviflora* Roxb.	Tungla	+	-	+
18. *Rhus cotinus* Linn.	Jaltungla	-	-	+
19. *Rosa brunonii* Lindl	Kunjha	+	+	+
20. *Rubus ellipticus* Sm	Hinsar	+	+	+
21. *Rubus lasiocarpus* Sm	Kalihinsar	-	+	+
22. *Sarcococca* sp	-	-	+	+
23. *Woodfordia fruticosa* Kutz.	Dhaula	+	-	-
24. *Zanthoxylum alatum* Roxb.	Timru	+	-	-

Herbaceous species encountered across the compartment in Jardhar forest at the time of present study

Grasses: *Heteropogon contortus, Apluda mutica, Arundinella nepalensis, Eulalia quadrinervis, Pogonatherum crinitum* etc.

Pteridophytes : *Adiantum edgeworthii, Cheilenthus albomarginata, Onychium contiguum,* etc.

Sedges *: Cyperus niveus, Eriophorum comosum* etc.

Forbs : *Anaphalis cinnamomea, Aster peduncularis, Artemesia japonica, Bergenia legulata, Bidens pilosa, Clematis* sp, *Chrysopogon aciculatus, Deplazium* sp, *Desmodium microphyllum, Desmodium trifolium Eupatorium* sp, *Gerbera gossypina, Geranium nepalense,Geranium wallichianum, Heterophyllum gerardiana, Impatiens balsamina, Micromeria nuducularis, Nepata hindostana, Oxalis corniculata, Plectranthus* sp, *Reinwardtia indica, Salvia* sp, *Strobillanthus* sp, *Swertia chiraita*, *Thalictrum foliolosum, Urtica parviflora, Viola betonicefolia* etc.

+ Species present ; - Species not present

Table 3a. Phytosociological attributes of trees + tree sapling stratum of Chauksaur compartment of Jardhar forest.

Tree species	Frequency (%)	Abundance	Abundance / Frequency ratio	Density ha^{-1}	Total basal cover $M^2 ha^{-1}$	Relative frequency	Relative density	Relative dominance	Importance Value Index
1) *Englehardtia* sp	28.57	4.00	0.140	114.0	0.342	9.09	10.54	1.863	21.50
2) *Litsea* sp	28.57	2.00	0.070	57.0	0.057	9.09	5.27	0.130	14.66
3) *Lyonia ovalifolia* Wall (Drude)	14.30	2.00	0.139	28.0	0.028	4.55	2.58	0.152	7.282
4) *Myrica esculenta* Buch - Ham	42.85	1.66	0.038	71.0	0.497	13.63	5.56	2.708	22.90
5) *Pinus roxburghii* Sarg	42.85	1.33	0.031	57.0	1.767	13.63	5.27	9.63	28.53
6) *Prunus cerasoides* D.Don	14.30	2.00	0.139	28.0	0.056	4.55	2.58	0.305	7.435
7) *Pyrus pashia* Buch-Ham	28.57	1.00	0.035	28.0	0.056	9.09	2.58	0.305	11.975
8) *Quercus leucotrichophora* Acamus	71.42	8.80	0.123	628.0	15.45	22.72	58.04	84.20	164.96
9) *Viburnum cotinifolium* D.Don	14.30	1.00	0.070	14.0	0.014	4.55	1.29	0.076	5.916
10) *Vinburnum* sp	28.57	2.00	0.070	57.0	0.057	9.09	5.27	0.310	14.67
Total				**1082.0**	**18.35**				**300.00**

Table 3b. Phytosociological attributes of trees + tree sapling stratum of Hadyan compartment of Jardhar forest.

Tree species	Frequency (%)	Abundance	Abundance / Frequency ratio	Density ha^{-1}	Total basal cover $M^2 ha^{-1}$	Relative frequency	Relative density	Relative dominance	Importance Value Index
1) *Cinnamomum tamala* Nees	12.50	1.00	0.080	13	0.013	1.60	0.31	0.046	1.95
2) *Cornus capitata* Wall	100.00	6.00	0.060	600	4.20	12.79	14.36	15.112	42.26
3) *Cornus macrophylla* DC	25.00	1.00	0.040	25	0.458	3.20	0.60	1.648	5.448
4) *Coculus laurifolius* DC	12.50	1.00	0.080	13	0.026	1.60	0.31	0.093	2.003
5) *Litsea* sp	62.50	1.8	0.029	113	0.113	7.99	2.70	0.406	11.096
6) *Lonicera quinquilocularis* Hardw	37.50	1.33	0.035	50	0.40	4.80	1.20	1.440	7.44
7) *Lyonia ovalifolia* Wall (Drude)	55.56	4.00	0.072	250	1.25	7.11	5.98	4.500	17.59
8) *Myrica esculenta* Buch - Ham	38.00	1.33	0.035	50	0.25	4.86	1.20	0.900	6.96
9) *Pinus roxburghii* Sarg	37.50	3.00	0.080	113	2.71	4.80	2.70	9.751	17.251
10) *Prunus cerasoides* D.Don	25.00	2.00	0.080	50	0.20	3.20	1.20	0.720	5.12
11) *Pyrus pashia* Buch-Ham	50.00	1.75	0.035	88	0.264	6.40	2.11	0.950	9.46
12) *Quercus leucotrichophora* Acamus	100.00	20.25	0.203	2025	14.53	12.79	48.46	52.281	113.531
13) *Rhododendron arboreum* Smith	75.00	5.00	0.067	375	2.625	9.60	8.97	9.445	28.015
14) *Symplocos cretaegoides* Buch-Ham	25.00	2.50	0.100	63	0.126	3.20	1.50	0.453	5.153
15) *Rhus* sp	12.50	1.00	0.080	13	0.026	1.60	0.31	0.093	2.003
16) *Viburnum* cotinifolium D.Don	50.00	1.50	0.030	75	0.075	6.40	1.79	0.269	8.459
17) *Vinburnum* sp	63.00	4.20	0.067	263	0.526	8.06	6.29	1.892	16.459
Total				**4179**	**27.792**				**299.98**

Table 3c. Phytosociological attributes of trees + tree sapling stratum of Buransdhar compartment of Jardhar forest.

	Frequency %	Abundance	Abundance/ Frequency ratio	Density ha^{-1}	Total basal cover $M^2 ha^{-1}$	Relative frequency	Relative density	Relative dominance	Importance value index
1. *Cinnamomum tamala*	22.2	1.50	0.067	33	0.067	2.70	0.99	0.143	3.833
2. *Cornus capitata*	66.6	2.33	0.035	160	1.120	8.106	4.79	2.405	15.301
3. *Cornus macrophylla*	33.3	1.33	0.040	44	0.882	4.05	1.32	1.893	7.263
4. *Coculus laurifolius*	33.3	1.33	0.040	44	0.132	4.05	1.32	0.283	5.653
5. *Englehardtia* sp	11.1	1.00	0.090	22	0.066	1.35	0.66	0.141	2.151
6. *Fucus* sp	11.1	1.00	0.090	11	0.077	1.35	0.33	0.165	1.845
7. *Litsea* sp	66.6	2.83	0.042	180	0.360	8.11	5.39	0.773	14.273
8. *Lonicera quinquilocularis*	22.2	2.50	0.113	55	0.385	2.70	1.65	0.826	5.176
9. *Lyonia ovalifolia*	33.3	3.33	0.100	111	0.555	4.05	3.33	1.191	8.571
10. *Machilis duthiei*	22.2	1.00	0.045	22	0.088	2.70	0.66	0.188	3.548
11. *Myrica esculenta*	88.8	3.12	0.035	277	5.79	10.81	8.30	12.43	31.54
12. *Pinus roxburghii*	22.4	1.00	0.045	30	1.77	2.70	0.90	3.800	7.40
13. *Prunus cerasoides*	44.4	7.25	0.163	320	4.16	5.40	9.59	8.932	23.922
14. *Pyrus pashia*	44.4	1.75	0.039	77	0.385	5.40	2.31	0.827	8.537
15. *Quercus leucotrichophora*	88.8	12.37	0.139	1100	21.88	10.81	32.96	46.98	90.75
16. *Rhododendron arboreum*	88.8	7.12	0.080	630	8.19	10.81	18.88	17.586	47.276
17. *Symplocos cretaegoides*	44.4	1.00	0.023	44	0.308	5.46	1.32	0.661	7.381
18. *Viburnum* cotinifolium	55.5	2.00	0.036	111	0.222	6.76	3.33	0.476	10.566
19. *Vinburnum* sp	22.4	1.50	0.066	66	0.132	2.73	1.98	0.283	4.993
Total	-	-	-	**3337**	**46.57**	-	-	-	**299.88**

Table 4a. Phytosociological attributes of tree seedling stratum of Chauksaur compartment of Jardhar forest.

Tree species	Frequency (%)	Abundance	Abundance / Frequency ratio	Density ha^{-1}	Total basal cover $M^2 ha^{-1}$	Relative frequency	Relative density	Relative dominance	Importance Value Index
1) *Englehardtia* sp	42.85	2.00	0.047	85.00	0.0204	10.71	5.32	4.32	20.35
2) *Litsea* sp	42.85	3.66	0.085	157.00	0.0126	10.71	9.84	2.67	23.22
3) *Lyonia ovalifolia* Wall (Drude)	28.57	6.50	0.227	185.00	0.0629	7.14	11.59	13.34	32.07
4) *Myrica esculenta* Buch - Ham	28.57	4.50	0.157	128.00	0.64	7.14	8.02	13.58	28.74
5) *Pinus roxburghii* Sarg	57.14	1.75	0.031	100.00	0.065	14.28	6.26	13.79	34.33
6) *Prunus cerasoides* D.Don	42.85	5.00	0.117	214.00	0.0513	10.71	13.41	10.88	34.90
7) *Pyrus pashia* Buch-Ham	28.57	2.00	0.070	57.00	0.0046	7.14	3.57	0.97	11.68
8) *Quercus leucotrichophora* Acamus	57.14	6.50	0.114	371.00	0.152	14.28	23.24	32.25	69.77
9) *Viburnum* cotinifolium D.Don	28.57	2.50	0.087	71.00	0.011	7.14	4.45	2.33	13.92
10) *Vinburnum* sp	42.85	5.33	0.124	228.00	0.0274	10.71	14.28	5.81	30.8
Total				**1596.0**	**0.4712**				**299.98**

Table 4b. Phytosociological attributes of tree seedling stratum of Hadyan compartment of Jardhar forest.

Tree species	Frequency (%)	Abundance	Abundance / Frequency ratio	Density ha^{-1}	Total basal cover $M^2 ha^{-1}$	Relative frequency	Relative density	Relative dominance	Importance Value Index
1) Cornus capitata Wall	50.00	2.00	0.050	125	0.0137	11.69	7.23	4.00	22.90
2) Coculus laurifolius DC	25.00	1.50	0.060	38	0.0012	5.84	2.20	0.35	8.40
3) Litsea sp	38.00	3.67	0.097	138	0.0048	8.88	7.99	1.42	18.29
4) Lyonia ovalifolia Wall (Drude)	37.50	3.00	0.080	113	0.0088	8.77	6.54	2.60	17.91
5) Myrica esculenta Buch - Ham	38.00	3.67	0.097	138	0.0289	8.88	7.99	8.55	25.42
6) Pinus roxburghii Sarg	25.00	2.00	0.080	50	0.0155	5.84	2.89	4.58	13.31
7) Prunus cerasoides D.Don	1.25	3.00	2.400	38	0.0053	0.29	2.20	1.56	4.05
8) Pyrus pashia Buch-Ham	25.00	2.50	0.100	63	0.0061	5.84	3.64	1.80	11.28
9) Quercus leucotrichophora Acamus	88.00	8.57	0.094	750	0.210	20.57	43.40	62.16	126.13
10) Rhododendron arboreum Smith	25.00	4.00	0.160	100	0.031	5.84	5.78	8.88	20.5
11) Symplocos cretaegoides Buch-Ham	25.00	1.00	0.040	25	0.0013	5.84	1.45	0.38	7.67
12) Viburnum cotinifolium D.Don	25.00	2.00	0.080	50	0.004	5.84	2.89	1.18	9.90
13) Vinburnum sp	25.00	4.20	0.160	100	0.0072	5.84	5.78	2.13	13.75
Total				**1728**	**0.3378**				**299.51**

Table 4c. Phytosociological attributes of tree seedling stratum of Buransdhar compartment of Jardhar forest.

Tree species	Frequency (%)	Abundance	Abundance / Frequency ratio	Density ha^{-1}	Total basal cover $M^2 ha^{-1}$	Relative frequency	Relative density	Relative dominance	Importance Value Index
1) Cinnamomum tamala Nees	33.3	1.66	0.050	50	0.038	3.85	1.34	0.315	5.565
2) Cornus capitata Wall	44.4	2.25	0.050	100	0.021	5.13	2.68	2.076	9.868
3) Cornus macrophylla DC	44.4	2.26	0.050	100	0.0296	5.13	2.68	2.922	10.732
4) Coculus laurifolius DC	44.4	3.00	0.067	133	0.0182	5.13	3.56	1.78	10.47
5) Englehardtia sp	22.2	2.00	0.090	44	0.0061	2.56	1.17	0.60	4.33
6) Ficus sp.	22.2	2.00	0.090	44	0.0924	2.56	1.17	0.91	4.16
7) Litsea sp	33.3	1.12	0.033	77	0.0077	3.85	2.06	0.76	6.67
8) Lonicera quinquilocularis Hardw	22.2	3.00	0.135	66	0.0044	2.56	1.77	0.43	7.76
9) Lyonia ovalifolia Wall (Drude)	44.4	3.25	0.073	140	0.088	5.13	3.75	8.68	17.56
10) Machilis duthiei King ex Hook f.	22.2	3.00	0.135	66	0.0085	2.56	1.77	0.83	5.16
11) Myrica esculenta Buch - Ham	88.8	5.37	0.060	470	0.188	10.26	12.59	18.57	41.12
12) Pinus roxburghii Sarg	22.2	2.25	0.101	55	0.0286	2.56	1.47	2.02	6.85
13) Prunus cerasoides D.Don	44.4	4.50	0.101	200	0.0240	5.13	5.36	2.36	12.85
14) Pyrus pashia Buch-Ham	44.4	1.12	0.025	77	0.0154	5.13	2.06	1.52	8.70
15) Quercus leucotrichophora Acamus	100	13.22	0.132	1322	0.343	11.55	35.43	33.85	80.84
16) Rhododendron arboreum Smith	77.7	5.14	0.066	400	0.188	8.97	10.72	18.57	38.26
17) Symplocos cretaegoides Buch-Ham	55.5	1.6	0.028	88	0.0068	6.41	2.36	0.670	9.44
18) Viburnum cotinifolium D.Don	66.6	2.5	0.037	166	0.0210	7.69	4.45	2.07	14.21
19) Vinburnum sp	33.3	4.0	0.120	133	0.010	3.85	3.56	0.98	8.39
Total				**3731**	**1.0129**				**299.95**

Table 5. Distribution pattern of tree + sapling, tree seedling and shrub species in different compartments of Jardhar forest.

Compartments	**Distribution (%)**		
	Regular (r)	**Random (R)**	**Clumped (C)**
Chauksaur compartment			
Trees + saplings	0.00	30.00	70.00
Tree Seedlings	0.00	20.00	80.00
Shrubs	0.00	0.00	100.00
Hadyan compartment			
Trees + saplings	0.00	35.30	64.70
Tree Seedlings	0.00	15.38	84.62
Shrubs	0.00	0.00	100.00
Buransdhar compartment			
Trees + saplings	5.26	52.64	42.10
Tree Seedlings	5.26	31.58	63.16
Shrubs	0.00	0.00	100.00

Table 6. Similarity index (Community coefficient) calculated on the basis of density of trees + tree saplings, tree seedlings and shrub species for different compartments of Jardhar forest

	Chauksaur compartment	Hadyan compartment	Buransdhar compartment
Trees + tree saplings			
Chauksaur compartment	100	36.00	43.58
Hadyan compartment		100	40.37
Buransdhar compartment			100
Tree seedlings			
Chauksaur compartment	100	62.80	47.90
Hadyan compartment		100	60.10
Buransdhar compartment			100
Shrub species			
Chauksaur compartment	100	19.40	22.78
Hadyan compartment		100	47.90
Buransdhar compartment			100

Table 7. Species diversity (H) in different forest strata and beta diversity (B) of Jardhar forest

Compartments	Shannon-Wiener index of diversity (H)	Beta diversity (B)		
		Trees + tree saplings	Tree seedlings	Shrub species
Chauksaur compartment				
Trees + saplings	2.211			
Tree seedlings	3.097			
Shrubs	3.203			
Hadyan compartment				
Trees + saplings	2.825	1.304	1.532	1.410
Tree seedlings	3.350			
Shrubs	3.064			
Buransdhar compartment				
Trees + saplings	3.124			
Tree Seedlings	3.272			
Shrubs	2.596			

REFERENCES

Adhikari, B.S., Rikhari, H.C., Rawat, Y.S. and Singh, S.P. 1991. High altitude forests composition, diversity and profile structures in a part of Kumaun Himalaya. *Trop. Ecol.* 32 : 86-97.

Bankoti, T.N.S., Melkania, U. and Saxena, A.K. 1986. Vegetation analysis along an altitudinal gradient in Kumaun Himalaya. *Indian Journal of Ecology*. 13: 211-221.

Bhandari, B.S. and Tiwari, S.C. 1997. Dominance and diversity along an altitudinal gradient in a montane forest of Garhwal Himalaya. *Proc. Indian National Science Academy*. B 64: 437-446.

Bhandari, B.S., Mehta, J.P. and Tiwari, S.C. 1998. Dominance and diversity relations of woody vegetation structure along an altitudinal gradient in a montane forest of Garhwal Himalaya. *Journal of Tropical Forest Science* (In press).

Bhandari, B.S., Mehta, J.P., Nautiyal, B.P. and Tiwari, S.C. 1997. Structure of Chir Pine (*Pinus roxburghii* Sarg.) Community Along an Altitudinal Gradient in Garhwal Himalaya. *International Journal of Ecology and Environment Sciences* 23 : .67-74

Gadgil, M., Berkes, F. & Folke, C. 1993. Indigenous knowledge of biodiversity conservation. *Ambio* 22: 151-160.

Greig-Smith, P. 1957. *Quantitative Plant Ecology.* 2nd Edition. Bulterworth, London.

Kershaw, K.A. 1973. *Quantitative and Dynamic Plant Ecology*. (London: Edward Arnold Ltd.) 308pp.

Knight, D.H. 1975. A phytosociological analysis of species rich tropical forest on Barro Colorada Islands, Panama. *Ecologial Monograph*. 45: 259-284.

Maikhuri, R.K., Nautiyal, S., Rao, K.S., Chandrasekhar, K., Gavali, R. and Saxena, K.G. 2000. Analysis and resolution of protected area - people conflicts in Nanda Devi Biosphere Reserve, India *Environmental Conservation* 26 (4): in press.

Mehta, J.P., Tiwari, S.C. and Bhandari, B.S. 1997. Phytosociology of woody vegetation under different management regimes in Garhwal Himalaya. *Journal of Tropical Forest Science* 10 (1) : 24-34.

Nautiyal, S. 1998. Ecosystem function of buffer zone villages of Nanda Devi Biosphere Reserve, Ph.D. thesis, H.N.B. Garhwal University, Srinagar (Garhwal), India: 227pp.

Odum, E.P. 1971. *Fundamentals of Ecology*. III[rd] Edition W.B. Saunders Co., Philadelphia, U.S.A. 574pp.

Ralhan, P.K., Saxena, A.K. and Singh, J.S. 1982. Analysis of forest vegetation at and around Nainital in Kumaun Himalaya. *Proc. Indian National Science Academy.* B 48 : 121-137.

Saxena, A.K. and Singh, J.S. 1982. A phytosociological analysis of woody sepcies in forest communities of a part of Kumaun Himalaya. *Vegeratio*. 50: 3-32.

Saxena, A.K. and Singh, J.S. 1984. Tree population structure of certain Himalayan forest associations and implications concerning their future composition, *Vegetatio.* 58: 61-69.

Saxena, A.K., Pandey, U. and Singh, J.S. 1978. On the ecology of oak forest in Nainital Hills, Kumoun Himalaya. In : J.S. Singh and Brij Gopal (Eds.) *Glimpses of Ecology* : Prof. R. Misra Commemoration Volume. Jaipur International Scientific Publication, 167-180.

Saxena, N.C. 1995. Towards sustainable forestry in U.P. hills. Centre for Sustainable Development, Lal Bahadur Shastri National Academy of Administration, Mussoorie, U.P.

Semwal, R.L. and Mehta, J.P. 1996. Ecology of forest fires in Chir - pine (*Pinus roxburghii* Sarg.*)* forests of Garhwal Himalaya. *Current Science.* 70: 426-427.

Shannon, C.E. and Wiener, W.E. 1963. *The Mathematical Theory of Communication.* University of Illinois Press, Urbana, USA. 117pp.

Simpson, E.H. 1949. Measurement of diversity. *Nature* 163-188.

Singh, J.S. and Singh, S.P. 1987. Forest vegetation of Himalaya. *Botanical Review* 52: 80-192.

Singh, J.S. and Yadava, P.S. 1974. Seasonal variation in composition, plant biomass and net primary productivity of a Tropical grassland at Kurukshetra, India. *Ecological Monograph.* 44: 351 -375.

Singh, J.S., Chaturvedi, O.P. and Rawat, Y.S. 1984. Replacement of oak forest with pine in the Himalaya affects the nitrogen cycle. *Nature.* 311:54-56.

Singh, J.S., Rawat, Y.S. and Garkoti, S.C. 1997. Failure of brown oak (*Q. semicarpifolia*) to regenerate in Central Himalaya: a case of environmental semisurprise. *Current Science* Vol. 73(4): 371-374.

Sinha, B. and Maikhuri, R.K. 1998. Conservation through 'Socio-cultural - religious Practice' in Garhwal Himalaya: A Case Study of Hariyali Sacred Site. **In:** *Conserving the Sacred for Biodiversity Management.* Edited by P.S. Ramakrishnan, K..G. Saxena and U.M. Chandrashekara, Oxford and IBH Publishing Co., Ltd., New Delhi. 289-299.

Thadani, R. and Ashton, P.M.S. 1995. Regeneration of banj-oak (*Q. leucotrichophora* A. Camus) in the Central Himalaya. Forest Ecology and Management. 78: 217-224.

Tiwari, A.K. 1983. Analysis of vegetation and landuse in parts of Kumaun Himalaya through remote sensing and traditional techniques. *Ph.D. Thesis,* Kumaun University, Nainital, India.

Tiwari, J.C. and Singh, S.P. 1982. Vegetation analysis of a forest lying in transition zone between lower and upper Himalayan moist temperate forest. **In:** G.S. Paliwal (Ed.). The *Vegetational Wealth of Himalayas*, Puja Publishers New Delhi, pp. 104 -119.

Tiwari, J.C. and Singh, S.P. 1985. Analysis of woody vegetation in a mixed oak forest of Kumaun Himalaya. Proceedings of Indian National Science Academy 51(B) :232-347.

Whittaker , R.H. 1975. *Communities and Ecosystems*. 2nd ed. Mac Millan Publishing Co., New York. 385pp.

Wikum, D.A. and Wali, M.K. 1974. Analysis of North Dakota Gallery forest vegetation in relation to topographic and soil gradients. *Ecological Monograph*. 44: 441-464.

Summary of completed/ongoing projects

DEMOGRAPHIC, BIOLOGICAL AND CULTURAL PROXIMATES OF HEALTH AND DISEASE IN ARUNACHAL PRADESH

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The present study has been undertaken to find out the demographic, biological and cultural proximates of health and disease among the two tribes, viz., the Sherdukpen and Nocte of Arunachal Pradesh. An executive summary of the present work are as follows :

1. The infant mortality rate among the Sherdukpen is 12.61% while the same is 6.86% among the Nicte. In both tribes, infant mortality rate is higher among females than among the males.
2. Diarrhoeal diseases, respiratory diseases, pneumonia, and fever are found to be the major causes for infant mortality in both the tribes.
3. Parent's illiteracy and low occupational status, bigger family size, consanguinity, higher birth order, lower age at marriage and child birth, are the factors related to high infant mortality rate.
4. Reproductive wastage is 14.07% and 9.39% among the Sherdukpen and Nocte, respectively. The reproductive wastage is more in case of (a) mothers aged 35+years, (b) Mothers with higher birth order of 5+children, and © couples having consauguinaus marriage.
5. During the period of growth all anthropometric measurements register constant increase with corresponding increase in age of samples of both the populations. As expected, males have higher average values than females for various anthropometric measurements considered in both the populations.
6. About 41% of the Sherdukpen and 50% of the Nocte pre-school children suffer from malnutrition (mild, moderate, severe). Similarly, around 39% of the Sherdukpen and 36% of the Nocte school-aged children suffer from the tree grades of malnutrition. Among the Sherdukpen and the Nocte, percentage of malnourished adults is about 42% and 46%, respectively. Nutritional status is found to the inversely related to the family size, and a significant impact of education on nutritional status is found in both the tribal groups.
7. Haemoglobin level is significantly higher in the Sherdukpen than the Nocte, and in both populations, males have higher values than females. 15.94% Sherdukpen and 33.96% Nocte children suffer from anaemia. The percentage of anaemic adults is 15.08% and 18.06% in the Sherdukpen and the Nocte, respectively. In both the groups a greater percentage of females suffer from anaemia than the males. Family size and education are the factors found to be significantly related to haemoglobin levels in the two populations.
8. Systolic and diastolic blood pressure is significantly higher in males than females of both the tribes. Hypertension is not prevalent since only a couple of individuals in each population are found to be hypertensive.
9. Morbility pattern in the two populations show that diseases of the respiratory and digestive system are most common. Children are more affected than adults, and females are more affected than males. Morbility ailments are higher in the Nocte as compared to the Sherdukpen. Lower educational status and bigger family size are related to higher mobidity in both the tribes.
10. Occurrence of dental caries and gingivitis, is quite high in both sexes of the two populations. However, among the two, dental health of the Sherdukpen is better as compared to the Nocte. Both populations maintain poor dental hygiene, and many individuals indulge in smoking and chewing.
11. The overall health condition, in respect of various health indicators considered in the present study, is found to be better among the Sherdukpen than among the Nocte.

MICROBIOLOGICAL AND BIOCHEMICAL STUDIES OF THE TRADITIONAL

FERMENTED BEVERAGES OF THE DARJEELING HILLS AND SIKKIM

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Traditional fermented beverages constitute an integral part of dietary culture and have strong ritual importance among the ethnic people in the Darjeeling hills and Sikkim. Description of alcohol-drinking custome in the Sikkim Himalayas has been cited in some historical documents. On the basis of average consumption rate, common traditional fermented beverages are *kodo ko jaanr, bhaate jaanr, makai ko jaanr* and lesser-known alcoholic beverages which are consumed by less than 10% population are *gahoon kon jaanr, jao ko jaanr, simal tarul ko jaanr* and *faapar ko jaanr*. *Raksi* is a distilled liquor prepared from fermented starchy materials. Total annual consumption of kodo ko jaanr in the Darjeeling hills was 40178.7 ton and in Sikkim was 35748.7 ton; *bhaate jaanr* was 9538.8 ton in the Darjeeling hills and 6648.1 ton in Sikkim; makai ko jaanr was 10463.8 ton in the Darjeeling hills and 4800.7 ton in Sikkim during 1996-97. Survey data indicate that 57.6% of people prepare fermented beverages for home consumption in the Darjeeling hills and 76.7% in Sikkim. It showed that production of the traditional fermented beverages is mostly done at the individual household level.

Microbial load in *marcha* and *jaanr* smaples varied from 10^3 to 10^8 cfu/g. Sixty strains of filamentous moulds, 203 strains of yeasts and 163 strains of lactic acid bacteria were isolated from *marcha* and *jaanr* samples. Microorganisms originally associated with *marcha* and various types of *jaanr* samples were filamentous moulds: *Mucor circinelloides, Mucor* sp.(close to *Mucor hiemalis*), *Rhizopus chinensis, Rhizopus stolonifer* variety *lyococcus*; yeasts: *Saccharomycopsis fibuligeru, Hansenula anomala, Saccharomyces cerevisiae*; lactic acid bacteria: *Pediococcus pentosaceus* and *Lactobacillus* spp. *Marcha* making technology reflects the traditional method of sub-culturing desirable inocula from previous batch to new culture using rice as base substrates. This technique preserves the microbial biodiversity essential for beverages production. *Marcha* retains its potency *in situ* for over a year.

Proximate composition of *jaanr* and *raksi* samples has been analysed. Increase in alcohol, acidity, reducing sugar and mineral contents in almost all types of *jaanr* samples was remarkable. *Jaanr* contains about 1.7 MJ/100 g calorie and it serves as high calorie food beverage to low-income group of people. *Jaanr* is also rich in minerals mostly Fe, Zn, Mn and Co. Changes in microflora and some biochemical profiles during *kodo ko jaanr* and *bhaate jaanr* fermentation were studied. Amylolytic activity of isolates were tested and found that *Saccharomycopsis fibuligera* showed highest amylolytic activity indicating that it is the dominant and main starch-degrader in *jaanr* fermentation.

Kodo ko jaanr was prepared at the laboratory by using a mixture of cell suspension of selected strains of mould, yeasts and lactic acid bacteria, previously isolated from *marcha*. The product was organoleptically compared with market sample using the consumers' preference trail, and it was found that laboratory-made *jaanr* was more acceptable than the market sample. Laboratory-made *jaanr* may have advantages over the *jaanr* prepared by using *marcha* due to better quality, maintaining consistency and maximum utilization of susbtrates. Outlines of findings are :

- Microbial biodiversity ranging from filamentous moulds (*Mocor circinelloides, Mucor* sp.(close to *Mucor hiemalis*), *Rhizopus chinensis, Rhizopus stolonifer* variety *lyococcus*;) to amylolytic and alcohol-producing yeasts (*Saccharomycopsis fibuligera, Hansenula anomala, Saccharomyces cerevisiae*) and lactic acid bacteria (*Pediococcus pentosaceus* and *Lactobacillus* spp.) associated with *marcha* and various types of *jaanr* products has been isolated, characterised, identified, indexed and preserved.
- Proximate composition of these traditional fermented beverages have been determined to know their food value.
- Attemp was made to upgrade the traditional processing of beverages using selected strains instead of conventional marcha - a step for sustainable development in the Sikkim Himalayan regions.

ENVIRONMENTAL CORRELATES OF REPRODUCTIVE PHEROMONES IN HIMALAYAN TROUT

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To ascertain the environmental correlates of sex-pheromones release and action mechanism in *Schizothorax richardsonii,* initially the chronology of its reproductive behaviour is established. The development of pre ovulatory follicles is triggered by 14^0C temperature and 11.55 L:12.05 D photoperiod. The water held pre ovulatory females overnight attracts the males significantly as compared to the water held ovulatory females, water contained no fish and food odour (L-serine). This finding suggests the pre ovulatory ovary as a source of sex-pheromones.

The production of milt in males exposed with the water previously held pre ovulatory females and with the extract of pre ovulatory ovarian extract indicates that ovary at this level synthesize and release 'priming pheromones' that stimulate spermatogenesis is male.

The retention time (Rt), Rf value and biological activity of the purified and isolated compound (sub-fraction III) from the pre ovulatory ovarian extract of *S. richardsonii* are much close to the commercial sex steroid 17α, 20β-dihydroxy-4-pregnen-3-one (17α20βP). Hence former (sub-fraction III) may be considered the holocous/derivative of the later (17α20βP).

FINDINGS

For *S. richardsonii* 14^o C and 11.55 L: 12.05 D temperature-photoperiod regime favours the ovarian proliferation while maximum ovarian development occures on 18^o C and 13.44 L: 10.16 D.

- Milt in male is formed on 17-18^{o}C for a short period i.e. 20-25 days.
- Results of the experiments indicate that males exhibit a significant preference to the water which held females ($P<0.01$) over the water which held males, water that had not held any fish and also over the water containing food odour L-serine ($P<0.05$).
- Of ovarian extracts on introducing into the experimental maze, males show a significant preference ($P<0.01$) towards the ovary extract at pre ovulatory (POVE) stage over the extracts at ovulatory (OVE), post ovulatory (PtOVE) and regressed (ROE) stages of ovarian cycle.
- Of three purified fractions (free steroid fraction - F fr, glucuronide fraction - G fr, and sulphated fraction - S fr of pre ovulatory ovarian extract, G fr evokes significant attraction ($P<0.01$) in male as compared to others including food odour (L-serine).
- Milt volume (ml) is elevated four times more ($P<0.01$) in males exposed with the water that previously held pre ovulatory females and with free steroid fraction (F fr) of pre ovulatory ovarian extract as compared to the males treated with water which held post ovulatory female or with the extract of post ovulatory ovary.
- The milt volume increases maximum on 24 hr exposure.
- Of the commercially available sex steroids (Estrone, β-D glucuronide, 17, β-estradiol-3-17, β-estradiole-5-sulphate, βestradiole-3-glucuronide-17-sulphate and 17α20β-dihydroxy-4-pregnen-3-one (17α20βP), last one i.e. 17α20βP is found potent to attract *S. richardsonii* and to promote milt volume in 12 hr exposure period.
- None of the test solutions commercial sex-steroids, water which held pre ovulatory females free steroid (F fr) and glucuronidated (G fr) fractions of pre ovulatory ovarian extract (except sulphated fraction) elicit the sexual behaviour (locomoter, chasing and nudging activities) in male of the present study model.
- Based on physical, chemical (Rf: 0.27, Rt: 17.00 values) and biological characteristics (mode of action), the such fraction III isolated from the ovarian fraction (F fr) of *S. richardsonii* may be considered homologous/derivative of the sex steriod 17α20βP.

Selected Abstracts

Compiled by D.S. Negi
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Abrol, D.P. 1998. **Effect of climatic factors on population dynamics of *Andrena flavipes* pollinating apple flowers : A path analysis**. *Tropical Ecology*, 39(1): 143-147. Division of Entomology, Sher-e-Kashmir University of Agricultural Sciences and Technology, Regional Agricultural Research Station, R.S. Pura 181102, Jammu & Kashmir, India; corresponding address : 351/4, Channi Himmat Housing Colony, Jammu 180015, Jammu & Kashmir, India. [ANDRENA FLAVIPES; APPLE FLOWERS; PATH ANALYSIS; POLLINATION; WEATHER FACTORS]

The flight activity of *Andrena flavipes* Panzer (Hymenoptera : Andrenidae) pollinating apple flowers was related to some weather factors. The flight activity correlated positively with ambient temperature, light intensity, solar radiation, nectar-sugar concentration, soil temperature and negatively with relative humidity. Path coefficient analysis revealed whether the relationship expressed was direct or indirect. Of the six factors studied, the direct effect of ambient temperature, light intensity, solar radiation, soil temperature were positive and that of relative humidity negative. The direct effect of nectar-sugar concentration was positive and negligible.

Azhar-Hewitt, Farida 1999. **Women of the high pastures and the global economy: Reflections on the impacts of modernization in the hushe valley of the Karakoram, Northern Pakistan**. *Mountain Research and Development*, 19(2): 141-151. Department of Geography and Environmental Studies wilfrid Laurier University, 75 University Ave. West, Waterloo, ON, N2L 3C5, Canada. [GLOBAL ECONOMY; HOUSEHOLD; HUSHE VALLEY; LIVESTOCK]

In a Karakorum-Himalaya valley, women go to high pastures with the livestock. They possess detailed knowledge, wisdom, and skills relating to their environment. They know how to manage the resources of animals and plants which they process for subsistence, sale, and barter. They also make trips down to the village: tending their crops and caring for their household. It appears that small children, young women, and grandparents inhabit one world, while the younger men and boys live in another. This is because the men of this valley are turning to the outside world for more lucrative opportunities, abandoning their share of subsistence work. They migrate to the plains for work, or find position as porters with visiting mountaineering expeditions. This has produced a sad state of affairs for people who still believe in family values rather than individual rights, and for whom arranged marriage is an economic alliance between clans. It creates a situation in which the husband depends on his wife for sustenance, while regarding her as `backward' and `inferior'. This is the problem of women: their subservient position and forced inclusion into the capitalist system of labor-first by their own men due to the patriarchal division of labor, which turns partners and co-workers into master and servant; then by the male elite of the village, who maintain and confirm this division; then by bureaucrats and corporate power-holders of the global market economy into which the women are inserted, without their knowledge, consent, or control.

Bhardwaj, S.P. and Sindhwal, N.S. 1998. **Zero tillage and weed mulch for erosion control of sloping farm land in Doon valley**. *Indian J.Soil Cons.*, 26(2): 81-85. Central Soil and Water Conservation Research and Training Institute, Dehradun 248195, India. [DOON VALLEY; EROSION; MULCH; RUNOFF; SOIL AND NUTRIENT LOSS; ZERO TILLAGE]

Erosion is a serious problem in open tilled maize grown on slopes under high rainfall area of Doon Valley. To minimize erosion hazards, reduce cost of cultivation and increase the crop productivity an experiment was conducted on field size runoff plots at 4 per cent slope. Ground flora (grass and weeds) are effective in controlling soil erosion. Utilization of this advantage was attempted in the form of space management, allowing a strip of ground flora to grow, which was later cut and spread as mulch. This mulch (4.5-5.0 t ha^{-1}) added 75 kg N, 17 kg P and 144 kg K to the soil. Mulch resulted significant increase in infiltration and soil moisture. The moisture thus conserved was quite effective in ensuring good germination

and higher yield of wheat in rainfed areas. Zero tillage + weed mulch, normal tillage + weed mulch, zero tillage, contour cultivation and cultivated fallow treatment gave runoff : 22,31,42,51 and 52 per cent of rainfall, and 3,7,12,18 and 50 t ha^{-1} soil loss, respectively. Mulch also reduced and delayed the peaks of runoff. Slightly lower yield of maize in mulch plots was compensated by saving in weeding, improvement in soil moisture, fertility and increase in wheat yield.

Bisht, N.S.; Singh, Y.P. and Harsh, N.S.K. 1999. **Fungal diversity in Himalayas : A case study for conservation**. *Indian Forester*, 125(2): 149-158. Forest Research Institute, Dehradun, India. [BIODIVERSITY; CONSERVATION; FOREST COVER; PRTOTECTED AREA]

To study the mycological wealth of Kumaun Himalayas, extensive surveys were conducted. The common edible, poisonous, ectomycorrhizal, fungicolous, rare, wood-decaying fungi and their commercial uses are discussed. *In-situ* and *Ex-situ* conservation of fungi for fungal diversity has also been suggested.

Devi, Ch Gangarani; Damayanti, M. and Sharma, G.J. 1998. **Aseptic embryo culture of *Vanda coerulea* griff**. *J. Orchid Soc. India*, 12(1-2): 83-87. Department of Life Sciences, Manipur University, Imphal 795003, India. [EMBRYO CULTURE; GERMINATION; SEEDLING]

Immature embryos of *Vanda coerulea* were inoculated in both liquid and semi solid VW media (Vacin and Went, 1949), supplemented with vitamins and growth regulators like 1-Naphthalene aceticacid (NAA), 6-Benzyl amino purine (BAP), 6-Furfuryl amino purine, and Kinetin (KN). The semi-solid VW medium was enriched with 20% coconut water (CW). Germination of embryos occurred in both liquid and semi-solid media. However, higher percentage of, and faster rate of, germination were observed in VW liquid medium as compared to that in VW semi-solid medium. The differentiation of the protocorms into seedlings varied with the concentration and combination of growth regulators in VW semi-solid medium, enriched with 15% coconut water.

Devi, Y.Sunitibala and Laishram, J.M. 1998. ***In vitro* propagation of *Dendrobium* hybrids through shoot-tip and axillary bud culture**. *J. Orchid Soc. India*, 12(1-2): 79-81. Biotechnology Laboratory, College of Agriculture, Central Agricultural University, Imphal 795004, India. [CLONAL PROPAGATION; DENDROBIUM HYBRIDS; SHOOT-TIP]

Shoot-tips and axillary buds from young shoots of six *Dendrobium hybrids* viz. *Dendrobium* Kasem Gold x *D.* Thed Takiguchi, *D.* Sonia No. 28, *D.* New Sahin Red, *D.* Ekapol Panda No.1, *D.* Sakura Pink and *D.* Banyad Pink were cultured in VW (Vacin and Went, 1949) and MS (Murashige and Skoog, 1962) media supplemented with Naphthalene acetic acid (0.1 mgl^{-1}) and 6 Benzylaminopurine (1.0-2.0mgl^{-1}). Multiple shoots were induced in VW medium modified with addition of thiamine - HCl (1.0 mgl^{-1}), pyridoxine -HCl (1.0 mgl^{-1}), nicotinic acid (1.0 mgl^{-1}), adenine sulphate (100 mgl^{-1}), myo-inositol (100 mgl^{-1}), NAA (0.1 mgl^{-1}), and BAP (3.0-4.0 mgl^{-1}). Shoots were multiplied by cutting the mass of multiple shoots and subculturing in the same medium, thereby increasing the number of shoots.

Dhiman, A.K. 1998. **Ethnomedicinal uses of some pteridophytic species in India**. *Indian Fern Journal*, 15: 61-64. Botany Department, Gurukul Kangri University, Haridwar - 249404, U.P., India. [ETHNOMEDICINAL USE; PTERIDOPHYTES]

The present paper deals with ethnomedicinal uses of 15 species of pteridophytic group of plants which is considered least known and economically less important group of plants in the plant kingdom. Various folklore receipes being used throughout India by the different group of people have been given.

Dhyani, S.K. and Tripathi, R.S. 1999. **Tree growth and crop yield under agrisilvicultural practices in north-east India**. *Agroforestry Systems*, 44: 1-12. ICAR Research Complex for North Eastern Hills Region, Umiam (Barapani), Meghalaya, India; Present Address: Central Soil & Water Conservation Research and Training Institute, 218-Kaulagarh Road, Dehradun 248195, U.P., India. [ALNUS; CHERRY; INTERCROPS; MANDARIN; SLOPING LANDS]

Tree growth, survival and crop yield under agrisilvicultural practices were analyzed over a seven-year period in a split plot experiment on acid alfisol under rainfed conditions at ICAR Research Farm,

Barapani (Meghalaya), India. Three indigenous species including a fruit plant, and one introduced tree species formed the main plot treatments and three crop sequences were the sub-plot. The tree species were mandarin *(Citrus reticulata)*, alder *(Alnus nepalensis)*, cherry *(Prunus cerasoides)* and albizia *(Paraserianthes falcataria)*, and the crop sequences were (a) soybean (Glycine max)-linseed *(Linum usitatissimum)* for three years, then groundnut *(Arachis hypogea)*-mustard *(Brassica campestris)* for three years followed by soybean-linseed in the seventh year, (b) groundnut-mustard for three years, then soybean-linseed for three years and groundnut-mustard in the seventh year, and (c) sole trees (`tree only'). A positive effect of intercropping on height and diameter growth, crown width and timber volume was observed in alder, albizia and cherry but no appreciable differences for these parameters were observed in mandarin between the two situations. Alder and albizia attained maximum growth and woody biomass followed by cherry and the minimum growth was recorded by mandarin. The better growth and timber volume in the `tree+crop' situation was mainly due to the application of fertilizers and weeding. Crop yield reduction was observed with alder, mandarin and cherry and as the distance from tree increased, yield also improved. However, in albizia the proximity of tree did not reduce crop yield. The implications of the results are discussed in the context of the suitability of the species in this region and their usefulness in agroforestry systems.

Farooquee, N.A. 1999. **Cultural diversity : The key to Himalayan sustainability (A study of Indian Central Himalaya)**. *Man In India*, 79(1&2): 53-67. G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263643, India. [CROP DIVERSITY; DEMOGRAPHIC PROFILE; ECOLOGICAL DIVERSITY]

The Indian Central Himalaya has been receiving large amounts of development assistance, largely as a response to create infrastructural facilities for enhancing its production and better living. This paper suggests to understand how the present developmental initiatives have marginalised the Himalayan diversities, and has encouraged a narrowing of the economic, cultural and ecological characteristics of the region. Thus, has brought the society at the cross roads of unsustainability.

Garbyal, S.S. 1999. **`Jhuming' (Shifting cultivation) in Mizoram (India) and new land use policy - How far it has succeeded in containing this primitive agriculture practice**. *Indian Forester*, 125(2): 137-148. Director, Forest Education, New Forest, Dehradun, India. [LAND USE POLICY; MIZORAM; RURAL DEVELOPMENT; TRADE]

Shifting cultivation that is known as `jhuming' in Mizoram, is an integral part of the socio-cultural life of Mizos. With increase in population the jhuming cycle has shortened considerably and the productivity of land has fallen with devastating impact on the environment. The Govt. of Mizoram in 1984 launched a programme called New Land Use Policy (NLUP) with an objective to put an end to the practice of jhuming by providing alternative land based permanent occupation and stable income to the families practicing jhuming (jhumias) in rural areas thereby raising their standard of living. Assistance is provided for various trades or occupation for a period of three years. The programme is operated on yearly basis. In addition to the main trade, assistance is also provided for subsidiary trades so that the beneficiary earns income throughout the year. It is, however, found that the NLUP have not had any impact on jhuming as most of the beneficiaries are continuing jhuming even after receiving assistance under NLUP. Programme has also failed to bring out any perceptible improvement in the economic condition of the villagers. There has not been any significant change in the quality of life of the beneficiaries. There is a need to bring out changes in the attitudes towards jhuming. The programme needs restructuring. The beneficiaries, village councils and YMA need to be involved at all levels, proper marketing facilities for the products are required to be provided, utmost care is required while selecting the beneficiaries, the resources of various participating departments are required to be pooled in and effective monitoring and evaluation and evaluation system needs to be put in place.

Garforth, C.J.; Malla, Y.B.; Neopane, R.P. and Pandit, B.H. 1999. **Socioeconomic factors and agro-forestry improvements in the hills of Nepal**. *Mountain Research and Development*, 19(3): 273-278. Agriculture Extension and Rural Development Department, The University of Reading, Reading, UK; Nepal

Agroforestry Foundation, Kathmandu, Nepal. [AGROFORESTRY; GENDER DIVISION; LIVELIHOOD; LIVESTOCK MANAGEMENT]

Trees, crops, and livestock are integral parts of the complex farming systems on Nepalese hillsides. Any strategy for soil fertility improvement will take account of the interactions between these components, both on private farmland and common property and in public access forest and grazing areas. This requires a less restricted definition of the slope of agro-forestry than has often been applied previously. Agro-forestry can contribute to soil fertility improvement through increasing the quality and quantity of fodder and hence livestock manure, providing biomass for composting and slowing the loss of nutrients through runoff. Socioeconomic contextual factors that influence the introduction of agro-forestry innovations include the distribution and fragmentation of landholding, the relative importance of agriculture in household livelihoods, and the gender division of labor and management responsibilities within households. Studies of socioeconomic patterns within and between rural communities, can enable researchers to better focus their efforts. Examples from Nepal are presented and their implications for research design, method, and process, and for dissemination are explored.

Heinen, Joel T. and Mehta, Jai N. 1999. **Conceptual and legal issues in the designation and management of conservation areas in Nepal**. *Environmental Conservation*, 26(1): 21-29. Department of Environmental Studies, Florida International University, Miami, Florida 33199, USA; Yale School of Forestry and Environmental Studies, 205 Prospect Street, New Haven, Connecticut 06511, USA. [COMMUNITY-BASED CONSERVATION; CONSERVATION AREAS; NEPAL; PROTECTED AREA]

The modern era of wildlife and protected area conservation in Nepal began in 1973 with the passage of comprehensive legislation, and has evolved very quickly as new priorities and problems have emerged. Here we explore the legal and managerial development of conservation areas, a recently-defined category of protected area designed to promote conservation through local-level participation and development. A review of the Conservation Area Management Regulations of 1996 shows that there are several potential problems inherent in this designation. As written, the regulations move power from the government to organizations under governmental contract. Thus, management authority largely remains top-down from the standpoint of local users. Ws also question how well the designation will protect some sensitive wildlife species, since organizations do not have law enforcement authority under Nepalese legislation. Despite these concerns, there have been several successful conservation area programmes in existence in Nepal since the 1980s and most of the issues addressed are surmountable with the current regulations, providing that several criteria are met. We propose the His Majesty's Government and organizations under contract develop more definitive methods of disbursing funds for local-level projects, and institute social impact assessments. In addition, more attention must be paid to wildlife law enforcement; independent assessment of important wild population and unique habitats are needed. Finally, we discuss some broader issues that should be better addressed in Nepal and elsewhere, including cross-sectoral coordination within the government.

Jha, M.N.; Gupta, M.K. and Dimri, B.M. 1999. **Soil organic matter status under different social forestry plantations**. *Indian Forester*, 125(9): 883-890. Forest Soil and Land Reclamation Division, Forest Research Institute, Dehradun, U.P. [MONSOONS; PINUS ROXBURGHII; SOCIAL FORESTRY]

A study was conducted in Langha Forest Range of Mussoorie Division under 15 years old plantations of *Pinus roxburghii, Tectona grandis, Dalbergia sissoo, Eucalyptus, Acacia catechu* along with natural *Shorea robusta* forest and barren land to find out the status of soil organic matter. This study was conducted before and after monsoon to investigate the changes in SOM due to change of seasons. Before monsoon it was observed that SOM content was higher under natural *Shorea robusta* followed by *Dalbergia sissoo, Eucalyptus, Tectona grandis, Acacia catechu* and *Pinus roxburghii* plantations and least under barren land and after monsoon it was higher under *Eucalyptus* only in top (0-10 cm) layer but over all higher under the soils of natural *Shorea robusta* followed by *Eucalyptus, Dalbergia sissoo, Pinus roxburghii, Acacia catechu, Tectona grandis* and least under barren land. In general SOM was observed higher in post-monsoon in comparison to pre-monsoon period.

Jha, M.N.; Gupta, M.K.; Dimri, B.M. and Bedwal, H.S. 1999. **Soil moisture accretion with progressive rainfall under *Tectona grandis* (teak) and *Eucalyptus* plantations**. *Indian Forester*, 125(4): 392-400. Forest Soils and Land Reclamation Division, Forest Research Institute, Dehradun, India. [CUMULATIVE RAINFALL; EUCALYPTUS; REGRESSION EQUATION; TECTONA GRANDIS]

Gradual accretion of soil moisture in different depths with the progression of rainfall under *Tectona grandis* and *Eucalyptus* plantation at Langha range of Mussoorie Forest Division was studied. When cumulative rainfall rises upto 148.4mm, water percolates only upto 75 cm depth under both plantation. At CRF 815.2mm entire profile gets charged and no further increase in soil moisture was observed at 1421.1 m CRF, especially under *Tectona grandis*. The moisture accretion, in general, was higher in the soils supporting *Eucalyptus* in comparison to those under teak plantation and, in particular in the lower depths at the above CRF of 815.2 mm. It was observed that during dry months soil moisture has positive relationship with depth.

Jones, Jim Ellis 1999. **Poverty, land care, and sustainable livelihoods in hillside and mountain regions**. *Mountain Research and Development*, 19(3): 179-190. Silsoe Research Institute, Wrest Park, Silsoe, Bedfordshire MK45 4HS, UK. [AGRO-ECOLOGICAL; DIVERSITY; LAND CARE; LIVELIHOOD; POVERTY]

Resource-use decisions made by households and local communities in pursuit of today's survival and livelihood security are influenced by the policies, institutions, and technologies that impact on their lives. Such decisions are the main determinants of links between poverty elimination, improved land care, and sustainable rural livelihoods. In the long term such goals can be compatible but in the short term the need for increased yield with increasing populations is likely to undermine sustainable natural resource management. Increasing analysis and understanding of poverty, its measurement, and identification of the processes that create poverty, as well as improved land care are key to creating sustainable livelihoods. Hillside and mountainous areas are particularly vulnerable to poverty due to their inaccessibility, fragility, marginality, and diversity. Although many of the world hot spots for land degradation are found in hillside areas, there are also many bright spots where improvements in natural resource management are resulting in increased incomes. Poverty culmination will require revival of the community stake in the natural resource base, restoring local control over local resources, and use of local perspectives and traditional knowledge systems in development activities. New policies, institutions, and technologies will need to reflect these principles.

Khan, S.N.; Uniyal, Kamla; Dhiman, R.C. and Bhardwaj, Nidhi 1999. **Observations on the development of mycorrhiza in chir pine seedlings of different provenances**. *Indian Journal of Forestry*, 22(2): 95-100. Forest Pathology Division, Forest Research Institute, Dehradun, U.P., India. [ECTOMYCORRHIZAL; MYCORRHIZAL FUNGI; PINUS ROXBURGHII]

A quantitative and qualitative assessment of mycorrhiza development was made in uninoculated seedling stock of *Pinus roxburghii* raised from seeds of twenty provenances. Significant differences were observed in mycorrhiza formation by indigenous mycorrhizal fungi representing seven distinct groups of provenances. Kuthnoor, Dharashu, Deha and Dibkhan provenances form a separate group which shows significantly higher values for short root formation, mycorrhizal roots and per cent mycorrhizal roots per plant in relation to group of Dharmshala, Bhader Kali, Mashobra, Neri Nissoo and Chabal Ki Dhar provenances which show significantly lower values for all the three parameters. Six forms of mycorrhizae were observed out of which one, light to dark brown, smooth form was predominant in association with thirteen provenances followed by smooth, brown, loose hyphal and yellow to *sepia* in groups of seven, six and five provenances, whereas others were restricted to one and two provenances.

Khattri, K.N. 1999. **Probabilities of occurrence of great earthquakes in Himalaya**. *Current Science*, 77(7): 967-972. 100 Rajendra Nagar, Dehradun 248001, India. [EARTHQUAKES; MAIN CENTRAL THRUST; SEISMIC ZONE; TIME WINDOW]

The long-term conditional probabilities of occurrence of great earthquakes along the Himalaya plate boundary seismic zone have been estimated. The chance of occurrence of at least one great earthquake along this seismic zone in a period of 100 years (beginning with the year 1999) is estimated to be about 0.89. The 100-year probability of such an earthquake occurring in the Kashmir seismic gap is about 0.27, in the central

seismic gap is about 0.52 and in the Assam gap is about 0.21. The 25-year probabilities of their occurrence are 0.07, 0.17, and 0.05 for the Kashmir, the central and the Assam seismic gaps, respectively. These probabilities will serve in the assessment of the seismic hazard in the Himalaya and the adjoining Ganga plains.

Kirn, H.S.; Kapahi, B.K. and Srivastava, T.N. 1999. **Non-Timeber forest wealth of Jammu & Kashmir state (India) I. The medicinal plants**. *Journal of Non-Timber Forests Products*, 6(1/2): 1-18. Department of Botany, G.G.M. Science College, Jammu Tawi 180001, India; Regional Research Laboratory, Jammu Tawi 180001, India. [ETHNO-MEDICO-BOTANY; MEDICINAL PLANTS; NON-TIMBER FOREST]

Plant have been used since long for the basic needs of human being, food, shelter, fibre and medicine, etc. Much have been published on ethno-medico-botany of Jammu and Kashmir during the last two decades but no effort has been made to bring the otherwise scattered information together. In this paper an attempt is, therefore, made and information on ethno-medico-botany of 207 taxa is presented.

Kirn, H.S.; Kapahi, B.K. and Srivastava, T.N. 1999. **Ethnobotanical observation on the gymnosperms of Jammu and Kashmir state, India**. *Journal of Non-Timber Forests Products*, 6(1/2): 57-62. Department of Botany, Govt. Gandhi Memorial Science College, Jammu Tawi 180001, India; Regional Research Laboratory, Canal Road, Jammu Tawi 180001, India. [ETHNOBOTANICAL STUDY; GYMNOSPERMS; LOCATIONAL DISTRIBUTION]

Botanists have made significant contribution to the ethnobotany of Jammu and Kashmir, but Gymnosperms in quantity have surprisingly received a cold response in the past. Folklore claims of 11 taxa growing wild in Jammu and Kashmir state are presented in this paper.

Kishtwaria, J. 1999. **Time expenditure pattern of Gaddi tribal women of Himachal Pradesh**. *Journal of Human Ecology*, 10(4): 255-257. College of Home Science, HPKV, Palampur 176062, H.P., India. [GADDI; TIME EXPENDITURE PATTERN; TRIBAL WOMEN; UNEMPLOYED AND EMPLOYED]

Tribal women spent a large proportion of their time in carrying out household work, animal care, agricultural and allied tasks. However, gainfully employed respondents spent significantly less time while performing all these tasks than non-employed respondents. Thus, there is a scope to improve time use pattern of non-employed respondents for effective implementation on development policies and programmes in the free time available to them.

Kotal, Murali 1999. **Incidence of PTC tasters and defective colour vision among the koch of West Garo Hills, Meghalaya, North East India**. *Journal of Human Ecology*, 10(4): 315-316. Anthropological Survey of India, North East Regional Centre, Upper Lachumiere, Shillong 793001, Meghalaya, India. [GENETIC MARKERS; KOCH; MEGHALAYA; VARIATION]

A study of PTC taste perception and defective colour vision was carried among the Koch in West Garo Hills district of Meghalaya, North East India. It was found that the frequency of taster gene *(T)* among the Koch is 0.4437 and percentage frequency of red-green colour blindness was 3.6.

Kumar, Bhishm; Nachiappan, Rm P.; Rai, S.P.; Saravanakumar, U. and Navada, S.V. 1999. **Improved prediction of life expectancy for a Himalayan lake: Nainital, UP., India**. *Mountain Research and Development*, 19(2): 113-121. National Institute of Hydrology, Roorkee 247667, U.P.; Western Himalayan Regional Centre, NIH, Jammu 180003, J&K; Isotope Division, Bhabha Atomic Research Centre, Mumbai 400085, Maharashtra, India. [ACCUMULATION ZONE; HUMAN SETTLEMENT; RADIOMETRIC TECHNIQUES; SEDIMENTATION]

An attempt has been made to predict the life of Lake Nainital, a natural lake located in the Kumaun Himalaya with a fairly large human settlement around it. Sediment accumulation rates estimated by dating the lake sediment cores employing ^{210}Pb and ^{137}Cs dating techniques have been used for the purpose. The sediment accumulation rates estimated by radioisotope techniques are comparable to the rates obtained by the sediment balance method using suspended sediment data. The estimated useful life of the lake is about 2,200 years, which is much higher than the results obtained by earlier investigators who used short term bathymetric

data. In the present study, long-term (46 years) annual lake sounding data have also been analysed. Large bi-directional variations in the annual bathymetry imply that major errors are associated with the lake sounding data that led to the under-estimation of the life span of Lake Nainital by earlier investigators.

Kumar, Kireet and Satyal, G.S. 1999. **Cost analysis of losses caused by the Malpa landslide in Kumaun Himalaya - a basic framework for risk assessment**. *Current Science*, 77(8): 1023-1028. G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263 643, India. [COST ESTIMATE; LAND-USE PATTERN; LANDSLIDE]

Large scale landsliding of inhabited tracts in the Kumaun Himalaya have wrecked havoc to the natural environment and economy of the region. The village agricultural and pasture lands, communication routes, human and animal population and other structures are all severely affected by landslides, underlining their significance for the economy of the region. In 1998, one such landslide in the Malpa village of Kumaun region turned out to be one of the major disasters of recent times, taking a heavy toll of human life (207). Other losses includes animals (69), agricultural land (0.408 ha), huts (5), houses (5), and wooden bridge. According to the tehsil records, the total loss in monetary terms has been assessed at Rs. 38,51,400/-, but this assessment is highly underestimated as it ignores private losses. An attempt is, therefore, made in this paper to make a detailed analysis of all damages, both public and private to estimate the total cost of landslide damages. This estimated to be Rs. 56,94,203/- which is about 1.5 times the official estimate. The total cost of human life in terms of compensation decided by the government, comes out to be over Rs. 2 crores. The present study also highlights different aspects of landslide costs which must be included calculating the cost of damage.

Kumar, Kireet; Satyal, G.S. and Panda, Y.S. 1999. **Chemistry of drinking water sources in Almora district of Kumaun Himalaya, India**. *Proceedings of National Conference on Water Quality Management*: 10-19. G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora 263643, India. [ELECTRICAL CODUCTIVITY; LAND-USE PATTERN; pH MEASURE; SURFACE WATER]

Sound water resource management is the key to some of water related problems in hills which requires both quantitative and qualitative assessment of water sources. The present study is focused on qualitative aspect of domestic water supply sources in Almora district of Kumaun Himalaya. Surface water is main source for domestic water supply schemes in the region which is generally influenced by the changes in land use pattern. The chemistry of surface water in north and south zones of the district having different land use patterns is discussed and then results are compared with water quality standards. Surface water in south Almora is better in quality than north in terms of dissolved ions. Some influence of agricultural activities is noticed in the form of high nitrate levels in north zone. Most of the water samples contain flourides possibly from the bed rocks. However, in both the cases water has been found suitable for domestic water supply.

Kumar, Surendar 1999. **Chhota Shigri Glacier: its kinematic effects over the valley environment, in the northwest Himalaya**. *Current Science*, 77(4): 594-598. Wadia Institute of Himalayan Geology, Dehradun 248001, India. [ACCUMULATION ZONE; CONTOUR LINE; NET BALANCE; SURFACE VELOCITY]

The relation of surface lowering, net balance and flow dynamics reflects that vertical component of ice flow is downward in and around the equilibrium line while it is upward in the lower part (ablation zone) of Chhota Shigri Glacier. The submergence velocity in accumulation area is higher than the rise of surface and emergence velocity is lower than that of negative net balance. The basal sliding velocity is responsible for the movement of the glacier. The over-extension of the glacier at average snout position is one of the factors in controlling the temperature variation of the main Chandra river valley.

Lodhiyal, L.S.; Singh, S.P. and Lodhiyal, Neelu 1998. **Phenology, population structure and dynamics of Ringal Bamboo *(Arundinaria falcata)* in Nainital hill of Central Himalaya**. *Tropical Ecology*, 39(1): 109-115. Forest and Environment Unit, Centre for Development Studies, U.P. Academy of Administration, Nainital; Department of Botany, Kumaun University, Nainital, India. [ARUNDINARIA FALCATA;

NATALITY AND MORTALITY; PHENOLOGY; POPULATION DYNAMICS; POPULATION STRUCTURE]

Investigation on phenology, population structure and dynamics of *Arundinaria falcata* Nees (Ringal) from April 1984 to April 1985 in Kumaun Himalaya was carried out. The highest values for leaf area increment leaf dry weight increment, leaf growth rate, shoot height growth and specific leaf area were recorded, respectively in April, November, April, July and March. Population structure indicated inverted pyramidal shape across all the sampling dates. Of the total natality 92% occurred between April to August. However, the maximum mortality was recorded between August to December.

Mamgain, S.K. 1999. **Diversity, ecology and distribution of Indian *Lactuceae* (Asteraceae)**. *Indian Forester*, 125(4): 411-420. National Botanical Research Institute, Lucknow (U.P.). [COLD DESERT; DIVERSITY; LACTUCEAE; WASTELANDS]

The present communication deals with diversity, ecology and distribution of Indian *Lactuceae* (Asteraceae) which is represented by 10 genera namely *Lactuca* L., *Prenanthes* L., *Launaea* Cass., *Sonchus* L., *Reichardia* Roth, *Cicerbita* Wallr., *Ixeris*, Cass., *Chondrilla* L., *Dubyaea* DC and *Youngia* Cass., with 80 taxa in India. Among these 9 genera and 51 taxa are from the Western Himalaya, 7 genera and 31 taxa from Eastern Himalaya, 5 genera and 12 taxa from Western and Eastern Ghats and 6 genera and 15 taxa from Gangetic plains, Rajasthan and other parts of the country. The *Lactuceae* exhibit wide range of variations in its ecological habitats from sea coast to 5000 m in elevations and exhibit enormous diversity both intraspecifically and interspecifically. The Himalayas are shown to be major centre for *Lactuceae* diversity and distribution followed by Western Ghats and Gangetic plains. At generic level *Lactuca* exhibits maximum diversity with 25 species followed by *Youngia* and *Cicerbita*, all three are predominantly Himalayan. The genus *Dubyaea* is endemic to Sino-Himalayan region with 9 species, while 6 of its 9 species are highly localized in this region. The maximum diversity of *Lactuceae* in the Himalaya is due to a variety of climatic conditions and altitudes which in turn has resulted in diverse habitats. The *Lactuceae* inhabit every conceivable habitats and reveals a great amount of variation in the populations of different species. The distribution analysis of *Lactuceae* reveals that its members are chiefly distributed in the Himalaya and poorly represented in Western Ghats, Eastern Ghats and Gangetic plains.

Mawdsley, Emma 1999. **A new Himalayan state in India: popular perceptions of regionalism, politics, and development**. *Mountain Research and Development*, 19(2): 101-112. Department of Geography, University of Durham, Science Site, South Rd., Durham, DH1 3LE, UK. [BACKWARD CASTES; ECONOMIC GROWTH; HIMALAYAN STATE; POLITICAL REPRESENTATION; REGIONALISM]

In April 1998 the newly elected Government of India announced that it would oversee the creation of four new states within the Federal Union of India. One of these regions currently forms the Himalayan part of Uttar Pradesh, and will be known as Uttaranchal. The reason given for this decision is that the formation of a smaller, separate state will encourage greater administrative efficiency and political accountability in this `backward' mountain region. This proposal was first officially accepted by the Government of Uttar Pradesh in 1991, and ever since then development planners, academics, economics, and civil servants have discussed the economic and political viability of the proposal. However, much less is heard about what ordinary villagers and townpeople of this hill region think about these issues, despite the fact that their recent mass protest played a vital part in persuading the Central Government to accept the proposal for a separate hill state. This paper explores some of the perceptions of ordinary hill men and women on the subjects of regionalism, politics, and development.

Mehrotra, Arushi 1999. **Cotyledon and collar rot of *Bauhinia purpurea* and its management**. *Indian Journal of Forestry*, 22(2): 177-178. 4, New Forest, Forest Research Institute, Dehradun, U.P. [COLLAR ROT; COTYLEDON; FYM; SEEDLING]

Collar rot of *Bauhinia purpurea* caused by *Rhizoctonia solani* was recorded for the first time in India. The fungus also attacked cotyedons and caused rotting to varying extent. The disease was effectively controlled by seed treatment with Thiride @ 6g/kg and soil drenching with Dithane M-45 (0.3%) @ 20 ml per tube in root trainers prior to sowing of seeds.

Mitter, Harsh and Sharma, Anil 1999. **Propagation of *Taxus Baccata* Linn. by stem cuttings**. *Indian Forester*, 125(2): 159-162. General Manager, Rosin & Turpentine Factory, Bilaspur (formerly DFO Palampur); Assistant Director, IGCP, Palampur (formerly ACF, Palampur). [ROOTING RESPONSE; STEM CUTTING; TAXUS BACCATA]

Taxus baccata Linn. growing in Dhauladhar range is over exploited due to excessive collection of leaves for yield of anti-carcinogenic drugs like Taxol and Baccatin etc. The restoration and restocking of this II canopy tree under *Q. semecarpifolia* forests can be done through raising woody stem cuttings with growth regulators in February/July as the growth of seed raised plants is extremely slow. The experiments were carried out in the natural zone at forest nursery, Bir.

Mohsin, Faiz; Singh, R.P. and Singh, K. 1999. **Biomass distribution in *Poplus deltoide* under agroforestry system**. *Indian Forester*, 125(8): 794-798. Asstt. Professor, Directorate of Extension, G.B. Pant University of Agriculture and Technology, Pantnagar (U.P.); Head, Deptt. of Forestry, Kumaun University, Nainital (U.P.); Scientist Incharge, CIMAP, Boduppal, Uppal, Hyderabad (Andhra Pradesh). [AGROFORESTRY; BIOMASS; POPLAR]

Populus deltoides trees grown in stands treated with various *Mentha* and *Cymbopogon* spp. attained better growth than their pure stands at juvenile (2 and 3 years) and advanced (6 and 7 years) ages. Bolewood provided maximum contributed among all the components in pure as well as intercropped stands at all the age group of trees. It was further revealed that the total biomass was highest in the plantation of *P. deltoides* of all the ages intercropped with *Mentha* spp. It decreased in *Cymbopogon* spp. but still remained higher than that of pure stands which showed lowest biomass production.

Mondal, B. and Chaudhuri, Sarit 1999. **A note on palmar flexion creases among the Mann tribe of Meghalaya, North-East India**. *Journal of Human Ecology*, 10(4): 311-312. Department of Anthropology, North Eastern Hill University, Shillong 793014, Meghalaya, India; Department of Tribal Studies, Arunachal University, Itanagar 791111, Arunachal Pradesh, India. [MANN TRIBE; MEGHALAYA; PALMAR FLEXION CREASES; POPULATION VARIATION]

Palmar flexion creases in the Mann tribe of West Garo Hills district of Meghalaya, North East India were studied in a sample of bilateral palm prints of 123 male and 116 female subjects. It was found that there exists no bimanual or bisexual variation with regard to this trait in the present population. The Mann tribe was found to differ significantly from most of the other populations of North East India in respect of palmar flexion creases.

Nath, S.C. and Begum, D. 1998. **Bibliographic Information on Ethnobotany of North-Eastern India**. *Ethnobotany*, 10(): 122-126. Division of Plant Sciences and Ecology, Regional Research Laboratory, Jorhat 785006, Assam, India; Division of Library and Documentation, Regional Research Laboratory, Jorhat 785 006, Assam, India. [BIBLIOGRAPHY; ETHNOBOTANY; NORTH-EAST INDIA]

The paper deals with the bibliographic information on research and related activities carried out in North-Eastern part of India in the field of ethnobotany and allied aspects. The bibliography has covered 100 references compiled from different books and journals upto 1996.

Nautiyal, B.P. and Bhatt, A.B. 1999. **Niche width and diversity pattern in different landscapes of an alpine Grazingland in Garhwal Himalaya, India**. *Indian Forester*, 125(4): 375-380. Ecology Laboratory, Department of Botany, HNB Garhwal University, Srinagar. [ALPINE GRASSLAND; CONTINUUM INDEX; GARHWAL HIMALAYA; VEGETATION TYPE]

Niche width, b-diversity, equatibility and PxF index for important herbs and graminoids of an alpine grazingland in Panwali Kantha (Garhwal, Western Himalaya) at different aspects and altitudes have been discussed. *Phleum alpinum* among the graminoides exhibited maximum niche width the *Bupleurum lanceolatum* and *Taraxacum officinale* showed maximum niche location. Higher b-diversity and equatibility values at stand CDC II indicated rapid change in species composition and community heterogeneity

according to species adaptability and growth requirements. The continuum index values showed better impact of environmental gradients on the vegetation.

Negi, K.S. and Singh, B.M. 1999. **Exploration and collection of wild economically useful plants, medicinal, aromatic plants and paddy germplasm from Central Himalaya**. *Journal of Non-Timber Forests Products*, 6(1/2): 31-38. National Bureau of Plant Genetic Resources, Regional Station, Bhowali 263132, Niglat, Distt.- Nainital, India. [AROMATIC PLANT; CENTRAL HIMALAYA; GERMPLASM; MEDICINAL PLANTS]

Plant genetic resources were studied in Central Himalaya, which constitutes Garhwal and Kumaun regions of Uttar Pradesh by National Bureau of Plant Genetic Resources (NBPGR), Head Quarter, New Delhi and its regional station-Bhowali in October, 1996. In total, 107 accessions, mainly medicinal and aromatic plants (M. & AP.) from valley areas (lower altitude up to 1500 m a.s.l.), M. & AP. from Higher altitudes (alpine and meadows) up to 4000 m a.s.l., lesser known plants, wild relatives, wild economically useful plants and paddy germplasm were collected. It belongs to 67 species, 54 genera, many of the 63 accessions being dominant of the M. & AP. In case of paddy, some of the unexplored and promising areas of Central Himalayan villages, i.e., Tapovan, near Rishikesh (Distt.-Tehri) and Chakrata (Distt.- Dehradun), landraces and local/primitive cultivars are still common. The efforts are continued to maintain the collected plant material by *ex-situ* and *in-situ* conservation in NBPGR.

Pandey, Prabha and Rawat, R.S. 1999. **Some new observations on the Amritpur Granite Series, Kumaun Lesser Himalaya, India**. *Current Science*, 77(2): 296-299. National Geophysical Research Institute, Hyderabad 500007, India; Wadia Institute of Himalayan Geology, Dehradun 248001, India. [LITHO-TECTONIC SETUP; METAMORPHISM; MICROCLINE]

The precambrian Amritpur Granite Series (AGS) in the Kumaun Lesser Himalaya is a composite body of three distinct types, viz, Porphyritic Amritpur Granite (PAG), Equigranular Amritpur Granite (EAG) Amritpur Porphyry (AP) and extends for a length of 60 km. Signature of Precambrian, pre-Himalayan contact metamorphism in addition to the Himalayan regional metamorphism (greenschist to lower amphibolite facies) and subsequent retrograde metamorphism are observed in the AGS. The authors have provided definite evidence for a contact aureole zone around AGS in the east of Hairakhan, NE of Durgapipal and Chandadevi and reported the xenoliths of PAG and EAG types in AP at Jamrani indicating a younger age of AP.

Pandit, Atul; Tewari, Ashish and Ram, Jeet 1999. **Tree layer analysis and regeneration in a mixed conifer-oak forest in central Himalaya**. *Indian Journal of Forestry*, 21(4): 290-297. Department of Forestry, Kumaun University, Nainital 263002, India. [CROWN COVER; DIVERSITY INDEX; OAK FOREST; RELATIVE DENSITY]

The tree layer analysis was carried out in a high altitude Chir-pine mixed Oak forest situated between 1800-2100 m elevation. The low density of seedling and saplings in almost all the species in this forest indicates poor regeneration pattern. *Quercus leucotrichophora* due to serve lopping pressure fails to produce seeds. The most characteristic feature of the forest is the dominance of pine *(Pinus roxburghii)* and *Rhododendron arboreum* over Banj-oak *(Q. leucotrichophora* in the Oak zone. Repeated fires and other biotic factors are making the area poor, both in nutrients and top soil which will eventually result in the desertification of the Himalaya in the long run.

Pant, Kavita; Pandit, Atul; Tewari, Ashish and Koshyari, R.S. 1999. **Agroforestry patterns in the Tarai region of Central Himalaya**. *Indian Journal of Forestry*, 22(2): 123-128. Department of Forestry, Kumaun University, Nainital, U.P., India. [AGROFORESTRY; LAND-USE PATTERN; LIVESTOCK; SOCIO-ECONOMIC BENEFITS]

The present study deals with the status and patterns of agroforestry practices in Tarai region of Kumaun. The study was made in three villages (Narayanpur, Ganeshpur and Gangapur) of Udham Singh Nagar District lying between 28.9^{o}N latitude and 79.4^{o}E longitude. Among the trees planted Poplar is most preferred species. Study of agroforestry patterns reveals that bund planting is predominant in the areas

following with wayside and field plantations. In these villages 100% farmers have adopted agroforestry practices thereby reducing pressure on the surrounding natural forests.

Pathania, N.S.; Sehgal, O.P.; Paul, Debojit and Dilta, B.S. 1998. **Studies on micropropagation in *Dendrobium* CV. Sonia**. *J. Orchid Soc. India*, 12(1-2): 35-38. Department of Floriculture and Landscaping, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni 173230, India. [CLONE; DENDROBIUM HYBRIDS; MICROPROPAGATION; SHOOT-TIP]

In vitro studies were conducted to assess the regeneration response of stem explants (each bearing a bud) procured from shoots emerging from *Dendrobium* cv. Sonia pseudobulbs using four different culture media. Both Vacin and Went (VW, 1949) and Knudson C (KC, 1946) media favoured formation of protocorm like bodies (PLBs) and subsequent development of plantlets. KC medium supplemented with BAP (1.5 mgl^{-1}), NAA (0.4mgl^{-1}) and paelobutrazol (Imgl^{-1}) was found to be best for further multiplication of PLBs. All the media favoured rooting when supplemented with IBA (Imgl^{-1}) or NAA (1.8 mgl^{-1}) and paelobutrazol (0.5 mgl^{-1}). Hardening medium containing bark pieces, brick pieces, moss, and charcoal pieces (1:1:1:1) proved suitable for the establishment of *in vitro* rooted plantlets.

Prakash, Anil; Bhattacharyya, D.R.; Mohapatra, P.K. and Mahanta, J. 1998. **Anopheline fauna of the north-eastern states of India with notes on vectors of malaria**. *Proc. Nat. Acad. Sci. India*, 68(B)(III & IV): 217-229. Regional Medical Research Centre, NE Region (ICMR), P.B.#105, Dibrugarh 786001, India. [ANOPHELES; CHECKLIST; MALARIA VECTORS; MOSQUITO FAUNA]

Statewise checklist of anopheline mosquitoes recorded, so far, from the north-eastern region of India is prepared. It includes 42 mosquito species of genus *Anopheles*, the maximum (40) from Assam and the minimum (18) from Nagaland. Notes on various species groups of genus *Anopheles and malaria vectors in the north-eastern states have been provided.*

Pratap, Tej 1999. **Sustainable land management in marginal mountain areas of the Himalayan region**. *Mountain Research and Development*, 19(3): 251-260. International Centre for Integrated Mountain Development (ICIMOD) P.O. Box 3226, Kathmandu, Nepal. [CROPLAND; HINDUKUSH HIMALAYA; LANDHOLDING; LIVELIHOOD; NUTRIENT DYNAMICS]

This paper highlights the scarcity of arable cropland in the hills and mountains of the Himalayan region. This is one of the factors leading to food insecurity and poverty. Technological interventions were applied in some areas to increase the amount of land available by making productive use of marginal areas. This has been supported by strong political commitment which facilitates a favorable policy environment for investment in technological research, enterprise, and infrastructure development. These experiences indicate a new thinking which advocates research into *'niche based'* sustainable production systems on marginal lands as part of the solution to cropland scarcity. Better management of marginal land and improved livelihoods may result.

Raizada, A.; Joshi, S.P. and Srivastava, M.M. 1998. **Composition and vegetational diversity in an alpine grassland in the Garhwal Himalayas**. *Tropical Ecology*, 39(1): 133-141. Department of Botany, DAV (PG) College, Dehradun, India. [ALPINE GRASSLAND; COMMUNITIES; DIVERSITY; GRAZING; PROTECTION]

Vegetational composition and diversity were studied were studied in the alpine grassland Panwalikantha (3963m) in Garhwal Himalayas, which is intensively grazed in the summer months. Seven distinct plant communities, were identified. Importance value index (IVI), Sorenson's similarity index, Shannon's diversity index (H), Concentration of dominance (Cd) were calculated and cluster and analysis of sampling units was carried out. Species richness was highest (42) in the moderately grazed plot and least in the intensively grazed plot. Diversity (H) was also the highest in the moderately grazed plot (3.6) and least in the grazed site (1.58). Under continued grazing *Danthonia cachmeriana* and *Saxifraga androsacea* was replaced with *Carex nubigena* and *Trachydium roylei*. Results indicate that intensity of grazing directly affects species occurrence and diversity. Moderate grazing increased and continued protection decreased

species diversity, while unchecked grazing led to the disappearance of several species, and their gradual replacement with unpalatable herbs.

Rawat, G.S.; Sathyakumar, S. and Prasad, S. Narendra 1999. **Plant species diversity and community structure in the outer fringes of Kedarnath wildlife sanctuary, Western Himalaya: Conservation implications**. *Indian Forester*, 125(9): 873-882. Wildlife Institute of India, Chandrabani, Dehradun, U.P., India; Salim Ali Centre for Ornithology and Natural History, Kalampalayam, Coimbatore, Tamilnadu, India. [CONSERVATION; FUEL-WOOD; OAK-RHODODENDRON; SHRUB DENSITY]

Studies on the plant species diversity and community structure were carried in the outer fringes (1550m - 1900m) of Kedarnath Wildlife Sanctuary, Western Himalaya. Five sites were selected along the gradient of human use which represented various stages of Oak-Rhododendron *Quercus leucotrichophora - Rhododendron arboreum* community. The tree density varied significantly among the sites (ANOVA $p<0.001$) but there was no significant variation in the shrub density. The diversity of tree and shrub species have been compared separately at various sites using Shannon-Wiener index. The number of woody species was highest in the moderately disturbed site where as lowest in the Oak forest protected and artificially regenerated by the villagers. Moderately disturbed site showed best regeneration of ban Oak. However, maximum tree species diversity, structural (and possibly functional diversity) are exhibited by the old growth forest. Indicators of different seral stages have been identified and conservation implications discussed.

Rawat, Jaya and Pant, Chitralekha 1999. Structure of a chir pine community along two different aspects and altitudinal gradients. *Indian Journal of Forestry*, 22(2): 141-144. Department of Botany, HNB Garhwal University, Srinagar 246174, U.P., India. [BIODIVERSITY; CHIR-PINE; DIVERSITY INDEX; ELEVATIONAL GRADIENT]

The study reveals the structure of chir pine community along two aspects and four elevational zones in Garhwal Himalaya. The findings indicated that chir pine prefers sunny slopes with xeric conditions and is dominated in the drier south facing slopes. Therefore it should be recommended for the naked and drier slopes of Garhwal Himalaya as a pioneer species for vegetation cover.

Sah, V.K.; Bana, O.P.S. and Singh, Virendra 1998. **Biomass production and its allocation in components of young *Robinia pseudoacacia***. *Tropical Ecology*, 39(1): 125-131. Department of Forestry, Hill Campus, G.B. Pant University of Agriculture & Technology, Ranichauri, Tehri Garhwal, India. [ALLOMETRIC EQUATIONS; BIOMASS PRODUCTION; CURRENT ANNUAL INCREMENT; MEAN ANNUAL INCREMENT; ROBINIA PSEUDOACACIA]

The study deals with the biomass production and allocation in young (6 months to 4 years old) *Robinia pseudoacacia* L. plants. The height, basal girth and dry weight of each component of the plant increased with age. Satisfactory allometric equations relating to biomass of different components with basal girth (Bg) and squared basal diameter x height (bd^2h) were developed. The intercomponent biomass relationships were also highly significant and the resulting allometric equations carried smaller error than the equation using Bg as the independent variable. The mean annual increment has increased with age and did not equal current annual increment, indicating the individuals have not attained maturity. Number of root nodules per tree were significantly related to corresponding tree biomass and age.

Saroj, P.L.; Dwivedi, V.K.; Kumar, Ashok and Dadhwal, K.S. 1999. **Effect of forest species on the productivity of groundstorey crops**. *Indian Forester*, 125(8): 788-793. Central Soil & Water Conservation Research & Training Institute, Dehradun, U.P., India. [EUCALYPTUS HYBRID; FODDER YIELD; GROUNDSTOREY CROPS; MIXED PLANTATIONS]

The investigation was carried out at CSWCRTI, Research Farm, Selakui, Dehradun to see the productivity of groundstorey crops with different tree species. The cropping sequence (jowar-torai) was tested with three plantation i.e. *Eucalyptus* hybrid, *Bombax ceiba* and mixed plantations (natural) of *Cassia fistula, Bombax ceiba, Acacia catechu, Lannea coromandalica* and *Dalbergia sissoo*. It was observed that about 14.89, 12.79 and 12.14 t/ha green fodder yield of jowar can be obtained with *Bombax ceiba*, *Eucalyptus* hybrid and mixed plantations, respectively. The trend was same with toria and seed yield

recorded were 3.68, 2.78 and 2.38 q/ha under *Bombax ceiba, Eucalyptus* hybrid and mixed plantations, respectively. The yield of both the crops increases with increasing distance from the tree trunk, however the direction did not influence the yield of groundstorey crops.

Sharma, Binoy Raj; Mandal, Bikash; Chandra, Umesh and Saha, Bharat Chandra 1998. **An outbreak of *Cymbidium* rot epidemicat Kurseong (Darjeeling District)**. *J. Orchid Soc. India*, 12(1-2): 5-8. Krishi Vigyan Kendra, Bidhan Chandra Krishi Viswavidyalaya, Kalimpong 734301, India; IARI, Regional Station, Kalimpong, West Bengal 734301, India. [BACTERIAL PATHOGEN; CYMBIDIUM; ROOT ROT; ROT EPIDEMIC]

Several orchid growers, at Kurseong, suffered huge crop loss to *Cymbidium* rot epidemic during 1995-1997 monsoons. The severity of the disease varied with the nursery and the total loss was estimated at Rs. 7,73,500/-. *Pythium* was found associated with pseudobulb rot and *Fusarium* with root rot. Some remedial measures have been suggested.

Sharma, Jauti 1998. **Studies on *Vanda*: Effect of age of capsules (Pods) on *In vitro* seed germination**. *J. Orchid Soc. India*, 12(1-2): 43-45. Tissue Culture Laboratory, Botany Department, St. Anthony's College, Shillong 793001, India. [CAPSULE AGE; SEED GERMINATION; VANDA COERULEA]

In an endangered species *Vanda coerulea* Griff. ex Lindl., seeds from capsules (pods) at various stages of development were cultured asymbiotically *In vitro*. The germination percentage increased with the capsule age ranging from 180 days to 270 days. The seeds obtained from 270 days old capsules revealed the maximum seed germination on Knudson C medium.

Sharma, R.A. 1999. **Tree aerial volume models for *Pinus roxburghii***. *Indian Forester*, 125(3): 282-284. Director, Swedforest, New Delhi. [CROWN DIAMETER; PINE FOREST; REGRESSION EQUATION; STEM DIAMETER]

Three different approaches of developing tree aerial models have been presented based on a field study carried out in the coniferous forest Himalayas. The multiple correlation coefficient came out to be quite high in each model. The best model has been suggested based on the least residual and highest multiple correlation coefficient.

Sharma, R.C.; Sharma, Sanjeev and Khurana, D.K. 1999. **Assessment of poplar germplasm for resistance against *Alternaria alternata* causing leaf spot of poplars in Himachal Pradesh**. *Indian Forester*, 125(8): 784-787. Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (Himachal Pradesh). [ALTERNARIA ALTERNATA; GERMPLASM; PLYBOARD]

Growing demand of Poplar wood for manufacture of fruit boxes, plyboard, match sticks due to its fast growth and colourless wood have led to extensive plantation of this species. This has resulted in severe outbreak of a number of diseases. *Alternaria alternata* is one of the most destructive pathogens of *Populus* species in nurseries resulting in premature defoliation. During 1997, an experiment was conducted to assess 232 different clones/hybrids of *P. ciliata* and *P. deltoides* against *A. alternata*. Out of 29 clones and 75 hybrids of *P. ciliata*,3 clones and 22 hybrids remained free from the disease. In 11 clones and 2 hybrids of *P. ciliata*, disease reaction varied from resistant to moderately resistant. Out of 73 clones and 7 hybrids of *P. deltoides*, 64 clones and 7 hybrids remained free from the disease. All the 46 families of *P. deltoides* screened were found free from the disease.

Sharma, Suman and Bhardwaj, S.D. 1999. **Storage of acorns of *Quercus leucotrichophora* A. cam. ex bahadur**. *Indian Forester*, 125(8): 815-822. Department of Silviculture and Agroforestry, University of Horticulture and Forestry, Solan, H.P., India. [GERMINATION; PLOT DESIGN; POLYBAGS]

Investigations were carried out at Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.), India, to find out suitable storage method(s). The freshly collected acorns were put in storage at 5±1°C, 10±1°C and room temperature in polybags, canvas bags and tin containers laid out in Split Plot Design with three replications and storage longevity was determined by subjecting the acorns to germinability studies. The acorns stored at 5±1°C in polybags was proved to be the suitable method for better longevity of

acorns maintaining a maximum of 90 per cent germination for consecutive nine months and thereafter declined slightly maintaining 51.16 per cent germination after fifteen months of storage as compared to all other interactions. However, the seed stored at room temperature in tin containers proved to be least effective and lost its viability after three months of storage.

Shukla, B.K.; Singh, P. and Chauhan, A.S. 1998. **Orchid diversity in Sikkim and its conservation**. *J. Orchid Soc. India*, 12(1-2): 53-76. Botanical Survey of India, Sikkim Himalayan Circle, Gangtok 737103, India. [ALTITUDINAL ZONE; BIODIVERSITY; CONSERVATION STRATEGY; ENDEMIC ORCHID]

Orchidaceae, the second largest family of flowering plants in the world, show remarkable diversity in this smallest Himalayan state. Out of 184 genera and about 1200 species reported from India, 115 genera and about 496 species are represented in this region. The present paper elucidates correct nomenclature, phenological data, range of distribution and phytogeographical affinities of orchid species, reported from Sikkim so far. Diversity of orchids in different altitudinal zones has also been discussed. *Bulbophyllum, Dendrobium, Eria, Liparis* and *Oberonia* are the dominent genera in Sikkim whereas 88 genera like *Acrachaene, Amitostrgma, Androcorys, Anthyogonium, Arundina, Bletilla, Neottia* are represented by a single species each. Interestingly, 37 species are endemic to this state and there are several species which exhibit wide transoceanic distribution. Overexploitation of a number of species for horticultural purpose and destruction of their natural habitats have contributed to the depletion of biodiversity of many species, several species of orchids are threatened with extinction. Conservation strategy for such species has also been discussed.

Singh, Anoop; Kuniyal, C.P.; Lata, Hemant; Rajasekaran, C.; Prasad, P.; Bhadula, S.K. and Purohit, A.N. 1998. ***In vitro* propagation of *Aconitum Atrox* (Bruhl). Muk, A threatened medicinal herb from Garhwal Himalaya**. *Physiology & Molecular Biology of Plants*, 4(): 171-174. G.B. Pant Institute of Himalayan Environment and Development, Garhwal Unit, P.O. 92, Srinagar 246174, U.P., India; High Altitude Plant Physiology Research Centre, P.O. 14 Srinagar 246174, U.P., India. [CALLUS CULTURE; MEDICINAL HERB; SEEDLING; SOMATIC EMBRYO; TUBEROUS ROOTS]

Culture conditions for *Aconitum atrox* (Bruhl). Muk., a threatened medicinal species from Garhwal Himalaya were established. Young leaf explants and lateral buds were cultured on MS medium supplemented with 0.8 mg/L of BAP and NAA each. After three weeks, callus induction and excellent growth of creamish-brown calli was observed from leaf explants collected from mature plants and seedlings. Subculturing of calli derived from leaves showed the formation of whitish green globular somatic embryos, lateral tuberous roots and shoots. The lateral buds and shoot tips also showed callus induction and multiple shoots, but only a few roots were observed.

Singh, Arun P. 1999. **New forest, Dehradun, India: A unique man-made habitat for butterflies in the lower western Himalayas**. *Indian Forester*, 125(9): 913-922. Division of Forest Entomology, Forest Research Institute, (I.C.F.R.E.), Dehradun, India. [BUTTERFLY; FOOD PLANT; HABITAT]

Butterflies were collected for six years from New Forest campus which is a man-made habitat covering an area of 4.45 km^2 and located at Dehradun in Northern India. The aim of the study was to know butterfly species composition of this artificial habitat in relation to the Western Himalayas and also the number of larval food plant species of butterflies supported by this habitat. A total of 148 species belonging to 10 families and sub-families were found in New Forest which was one-third of the total found in the region. Three species found were `rare' as listed in the Schedule II of the Indian Wildlife Protection Act (1972, amended 1989). Larval food plants for all the butterfly species were present in New Forest. The proportions all the butterfly species in the families found here were in constancy with the region and were more closely related to the Western Himalaya, as compared to the Central Himalaya or the entire Indian Sub-Continent. All these findings suggest that New Forest provides a refuge for a large number of butterfly species found in the region, depicting a point diversity.

Singh, Jagdish and Dhiman, R.C. 1999. **Effect of weed control on the growth of *Populus deltoides* G3 at nursery stage**. *Indian Forester*, 125(8): 803-806. Division of Extension, Forest Research Institute, Dehradun. [COLLAR DIAMETER; GLYPHOSATE; POPULUS DELTOIDES; WEED CONTROL]

Weed control program has considerably enhanced the growth of *Populus deltoides* G3 at the nursery stage. Though T_4 (manual weeding), was the best method to control weed, but it is labour intensive and costly T_2 - (Glyphosate-4 application), at the rate of 5 ml diluted in 1 litre of water was also found equally good; thus it is recommended where there is labour scarcity.

Singh, N.V.; Sharma, R.C. and Chhimwal, C.B. 1999. **Evolution of genetically superior new clones of poplar *(POPULUS DELTOIDES)* for Tarai region**. *Indian Forester*, 125(3): 301-304. Sal Region, U.P. Forest Department, Haldwani (U.P.). [AGROFORESTRY; CLONE; POPULUS DELTOIDES]

The results of experiments conducted to establish superiority of newly evolved clones of Poplar *(Polulus deltoides)* over exotic clones has been described in this paper.

Singh, Punam and Mehrotra, Arushi 1999. **Seed borne fungi of two medicinal plants and their control**. *Journal of Non-Timber Forests Products*, 6(1/2): 63-66. Forest Research Institute, Dehradun 248006, India. [FUNGICIDES; MEDICINAL PLANTS; MYCOFLORA; SEED BORNE FUNGI]

Seed borne fungi of two medicinal plants namely *Withania somnifera* and *Solanum khasianum* were studied. Seed mycoflora of *W. somnifera* comprised *Fusarium solani, F.avenaceum, Fusarium* sp., *Alternaria alternata* and *Curvularia lunata* whereas seed mycoflora of *S. khasianum* included *F. avenaceum, Fusarium* Sp., *A. alternata, C. lunata* and three unidentified fungi. *Fusarium avenaceum* was the predominant seed borne fungus in both the cases. Emisan proved highly effective against seed mycoflora of *W. somnifera* and *S. khasianum* followed by Bavistin, Thiram, Dithane M-45 and Copper oxychloride. However, Copper oxychloride was almost ineffective in case of *W. somnifera*.

Thakur, I.K. 1999. **Vegetative propagation studies in ELM *(Ulmus wallichiana* planch)- A tree of high economic value**. *Journal of Non-Timber Forests Products*, 6(1/2): 71-73. Department of Tree Improvement & Genetic Resources, Dr. Y.S. Parmar University of Horticulture & Forestry, Nauni, Solan 173230, H.P., India. [ROOTING BEHAVIOUR; STEM CUTTING; ULMUS WALLICHIANA]

The present paper reports on the effect of auxins on rooting behaviour of stem cuttings of *Ulmus wallichiana* in the Western Himalayas. Maximum callusing (74.60%) was obtained with 1000 ppm of IAA treatment, whereas highest rooting percentage (64.93%) was recorded in 2000 ppm IBA treated cuttings. Shoot length was observed highest (167.11 cm) with 2000 ppm IBA treatment and lowest in 3000 ppm NAA treated cutting. However, a non-significant difference was noticed among different auxin concentrations for root shoot ratio.

Thomas, Sunny; Haridasan, K. and Borthakur, S.K. 1998. **Ethnobotanical observations on rattan palms among Adi and Nishing tribes in Arunachal Pradesh**. *Ethnobotany*, 10(1&2): 22-26. Systematic Botany Division, State Forest Research Institute, Itanagar 791111, Arunachal Pradesh, India. [ADI; ARUNACHAL PRADESH; ETHNOBOTANY; NISHING; RATTAN PALMS]

Arunachal Pradesh, the biodiversity-rich state in north east India is inhabited by about 25 major tribes with rich culture and traditions. The ethnobotanical importance of rattan palms in Arunachal Pradesh is described here.

Thomas, Sunny; Haridasan, K. and Borthakur, S.K. 1999. ***ZALCCA SECUNDA* - A stemless rattan palm from Arunachal Pradesh**. *Indian Forester*, 125(2): 230-232. Systematic Botany Division, State Forest Research Institute, Itanagar (Arunachal Pradesh); Reader, Department of Botany, Gauhati University, Guwahati (Assam). [ARUNACHAL PRADESH; CONSERVATION; ZALACCA SECUNDA]

Zalacca secunda - a stemless rattan was located during a taxonomic survey from the eastern part of Arunachal Pradesh. The paper describes the characteristic features of the genus *Zalacca* and the species *Z. secunda* from Arunachal Pradesh.

Tripathi, Sunil and Prakash, Ved 1998. **Studies on zingiberaceae lindley of N.E. India: I. On the re-discovery on *Rhynchanthus longiflorus* Hook. f**. *Indian Journal of Forestry*, 21(4): 333-336. Botany Division, Central Drug Research Institute, Lucknow 226001. [DIVERSITY; LEAF-SHOOT; RHYNCHANTHUS LONGIFLORUS]

The North-eastern region of India has maximum diversity of *Zingiberaceae in having 19 genera and about 90 species from among 22 genera and 180 species known from India. The present communication on the genus* Rhynchanthus Hook f., is the outcome of our critical taxonomic studies initiated recently on this family. This genus is known in India by only its type species (viz. *R. longiflorus* Hook. f.) from the Mizoram after Fischer's report (1932) and is based on our collection after more than six decades, which represents to be the first one for Indian herbaria. The genus is characterised by a boat-shaped stamen, obsolete or minute labellum and absence of lateral staminodes. The study further reveals the interesting characters of the genus and its close affinity with Hedychieae rather than with the Alpinieae to which it is generally assigned. It is described here with illustration.

Tyagi, P.C.; Agarwal, M.C. and Kumar, Nirmal 1999. **Provenance variation in seed parameters and germination of *Grewia optiva* drummond**. *Indian Forester*, 125(5): 517-521. Central Soil and Water Conservation Research and Training Institute, Dehradun, India. [GENETIC VARIATION; GERMINATION; GREWIA OPTIVA; REGRESSION EQUATION]

Statistical computation on seed traits and germination of the provenances revealed the existence of genetic variability. The correlation between different pairs of characters were determined and observed highly significant. The multiple regression equation using step-down regression technique revealed that the seed length and 100-seed weight might be used as the predictors of germination in *Grewia optiva*.

Uniyal, Kamla 1999. **Collar rot in *Azadirachta indica* and its control**. *Indian Forester*, 125(5): 513-516. Forest Pathology Division, Forest Research Institute, Dehradun, U.P., India. [AZADIRACHTA INDICA; COLLAR ROT; FUNGICIDES; SEEDLING]

During surveillance of nursery diseases a seedling disease causing collar rot in *Azadirachta indica* caused by *Fusarium semitectum* was recorded for the first time from Satyanarain nursery at Dehradun causing 3 to 66 per cent mortality in 2 to 3 months old seedlings. Pathogenicity of fungus was tested and effect of different fungicides was tested on the growth of the pathogen *in vitro*. Ziram and Bavistin were found most effective in checking the pathogen.

Usman, Samina; Rawat, Y.S. and Singh, S.P. 1998. **Mineralization and inorganic-N uptake in chir pine forest of Central Himalaya**. *Tropical Ecology*, 39(2): 193-199. Department of Botany, Kumaun University, Nainital 263002, India. [AMMONIUM-N; FOREST SOILS; N-MINERALIZATION]

Net N-mineralization and nitrification rates were measured by *in situ* incubation of soil in a needle leaf forest in central Himalaya. The seasonal pattern for both nitrification and ammonification was similar. Rainy season conditions were more favourable for N-mineralization. The size of the available nitrogen pool ranged from 8-30 ug g^{-1} with maximum values in the dry period (summer season) and minimum values during the wet period (rainy season). The trend for N-mineralization rate was opposite to that of the size of the available N.

Verma, K.S. and Mishra, V.K. 1999. **Foliage nutrient concentration and lopping time of agroforestry tree species in the Western Himalayan region of India**. *Agroforestry Systems*, 42(): 283-290. Department of Silviculture and Agroforestry, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni-Solan, 173230, H.P., India. [ACTIVE GROWTH SEASON; ALBIZIA STIPULATA; LOPPING TIME; OUGENIA OOJEINENSIS]

Tree foliage is a nutrient-rich and important source of green fodder to sustain the live-stock during the lean winter period of a season in the low and mid hill regions of Indian Himalaya. Knowledge of the variations in mineral nutrient composition of the foliage during an active growth season helps in determining optimum lopping time to harvest nutrient-rich fodder. Changes in the nutrient concentrations of *Albizia stipulata* and *Ougenia oojeinensis* foliage during the annual growth season were studied to find out an

optimum lopping time. Two dissimilar trends in variation of nutrients in foliage with the advancement of growth season were observed. These were: (1) depletion/dilution of N, P, K and S and (2) accumulation of Ca, Mg and Na. The depletion was more from October onwards, and accumulation reached to its maximum in November-December. Therefore, the period from October to December, preferably November, can be regarded as optimum lopping time for *A. stipulata* For *O. oojeinensis* the corresponding time could be September to November, preferably. *Ougenia* foliage contained higher concentration of N, P, Ca, Mg, and Na than that of *Albizia*.

Vij, S.P.; Jalota, Rajesh K. and Gupta, Ashish 1998. **Distribution pattern and substratum analysis of Shimla Hill Orchids**. *J. Orchid Soc. India*, 12(1-2): 15-28. Orchid laboratory, Botany Department, Punjab University, Chandigarh 160014, India. [EVERGREEN FOREST; ORCHID FLORA; SOIL PROFILE; SUBSTRATUM ANALYSIS]

The distribution pattern and substratum analysis of twenty ground growing species of orchids from Shimla hills was presently studied. The orchids were primarily found on north facing hills. On the basis of growth and distribution frequency of orchids, open grassy and/or gravely slopes; semi-shaded to shaded, humus-rich and moist forest floors; and disturbed situations along forest borders and road embankments were identified as orchid habitats. The orchids inhabiting open areas showed preference for lesser humidity, more light, and quick water drain-off whereas those inhabiting the shaded areas required humus-rich substratum and a regular supply of moisture, with less exposure to direct sunlight. The orchids in general, cohabited with a variety of vegetation; the shade-loving ones grew in association with ferns, whereas the light-loving ones grew with mosses, liverworts, and lichens. The soils in different localities varied in their texture as well as in their moisture and nutrient contents besides pH and conductivity. The adaptability of orchids to soils variously rich in carbon, nitrogen, phosphorous, and potassium suggested that these elements are important for their growth and development, and that the requirement is species specific.

News & Views

Compiled by S.N. Nandy, D.S. Negi and S.K. Sinha
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Ban all construction in and around Badrinath: Experts

On earthquake and landslide workshop held at Gopeshwar, experts said that any building activity around Badrinath caused a great danger of erosion and landslides in the extremely fragile environment. Earth scientists, engineering experts and environmentalists had a dialogue and exchange of views on building safe houses and taking other measures of survival in that seismic zone, where tectonic activity was taking place continuously. A suggestion was made for setting up a Himalayan Disaster Mitigation Centre, which would have all the data of seismic activity.

THE HINDUSTAN TIMES: June 7, 1999

Disaster up north: melting glaciers may unleash floods

Melting Himalayan glaciers may unleash a torrent of floods in mountain valleys of north India within next 40 years and after flood these rivers would dry up due to lack of glaciers. The study reveal by environmentalist Syed Iqbal Hasnain that the rate of ice accumulation is lower than that of melting due to global warming, thereby triggering death of Himalayan glaciers. Himalayan glaciers in Uttar Pradesh, Himachal Pradesh and Sikkim have reduced considerably, and by the year 2035 most of them will vanish at their present rate of decline. Recession of glaciers may decrease water resources and increase glacier related hazards like floods caused by sudden outburst of glacier lakes cause a serious threat in India, Nepal, Bhutan, Pakistan and China.

THE ECONOMIC TIMES: June 10, 1999

Environmentalists up in arms against Himachal Govt's move

The de-notification of a part of the Great Himalayan National Park (GHNP) in Kullu district by the Himachal Pradesh Government for setting up of a hydro-electric project, is being opposed by environmentalists. About 10 km^2 of the GHNP itself and a lot of its buffer zone would be affected by proposed 2051MW Parbati Hydel Project at the district. The environmentalists opposing the exclusion of this area from 'great ecological, faunal, floral, geomorphologic and geological importance of GHNP' and demanding restoration of the status of the Park.

THE HINDUSTAN TIMES: June 15, 1999

Himalayan glaciers recede

Incidents of landslides, changes in river regimes and floods will increase as Himalayan glaciers including the Gangotri glacier recede at a phenomenal rate, according to experts of Geological Survey of India. Most geologists agree that global warming combined with large scale deforestation and increased human activity near the glacier have let to the increased rate of recession. Inspite of the fact that Himalayan waters are the lifeblood of millions of Indians, the Government is ignoring, even various initiatives being taken out by our neighboring countries to monitor glaciers.

THE STATESMAN: July 1, 1999

Loktak lake dying a slow death

Loktak, the biggest natural lake in north-east India is dying, as out of its 289 km^2 area, at least 206 km^2 is covered by bio-mass, according to scientists. About 30 small rivers in Manipur along with 2,000 fisherfolk, who have made home on the lake, are dumping all kinds of debris into the lake. Before the construction of Ithal Barrage for power generation, most of the rivers did not empty themselves into the lake and flowed towards Myanmar, but the Loktak Hydroelectric Project had aggravated the problem.

THE HINDU: July 20, 1999

Extinction of snow leopards threatens mountain bio-diversity

Though the demand for fur made by snow leopard pelts may have gone down, but the demand for bones and body parts as marketable items for use in traditional Chinese medicine has gone up, according to the Conservation Director of the International Snow Leopard Trust. The estimated figure of this endangered species is about 4500-7500 are distributed through the mountain ranges of China, Bhutan, India, Nepal, Pakistan, and other south Asian states. Erosion of traditional knowledge, reduced herder vigilance, increased livestock numbers, and other animal husbandry changes are emerging as a grave threat to the endangered cat. Conservationists see an urgent need to continue long term research, which should focus on management issues like livestock depredation and rangeland competition between domestic stock and wild ungulates.

Ramyata Limbu for THE FINANCIAL EXPRESS: August 1, 1999

संकट में है हिमालय के कस्तूरी मृग का अस्तित्व

अर्न्तराष्ट्रीय बाजार में हिमालय की सुगंधित कस्तूरी की बढ़ती मांग ने कस्तूरी मृग की प्रजाति के अस्तित्व को ही संकट में डाल दिया है। यह १४,००० से १८,००० फीट की चाई पर हिमालय के बुग्यालों व बर्फीले क्षेत्रों में पाया जाता है। कस्तूरी की तीव्र सुगन्ध ही प्रजनन काल में मादा मृग को आकर्षित करती है। कस्तूरी मृग एकाकी होते है। अमीरो के शौक के कारण इनके अवैध आखेट व अर्न्तराष्ट्रीय बाजार में बढ़ती मांग ने इस प्रजाति के अस्तित्व को संकट की स्थिति में डाल दिया है। हिमालय क्षेत्र की कस्तूरी अत्यन्त सुगंधित होती हैं, वर्तमान में कस्तूरी मृग जो कि पूर्व में सम्पूर्ण हिमालय क्षेत्र में पाया जाता था, अब केवल चमोली, उत्तरकाशी व पिथौरागढ़ में ही सीमित संख्या में रह गए हैं। इंटर नेशनल यूनियन फॉर कंजरवेशन के कड़े निर्देशों में कस्तूरी मृग को संकटग्रस्त प्रजाति की श्रेणी में घोषित किया गया है। वर्षो से कस्तूरी की तस्करी का स्वर्ग बने चमोली एवं पिथौरागढ़ से कस्तूरी विदेशों को आपूर्ति होती रही हैं। पिथौरागढ़ जो नेपाल से लगा क्षेत्र है, इस रास्ते नेपाल व वहां से हांगकांग, जापान व फ्रॉंस के लिए हिमालय की कस्तूरी की तस्करी बेरोकटोक जारी है। एक नर कस्तूरी मृग से ३० से ५० ग्राम तक ही कस्तूरी मिलती है। २५ से ३० नर मृग मारने पर ही १ किलो कस्तूरी मिल पाती है। आक्सफोर्ड विश्वविद्यालय इग्लैंड़ में कार्यरत डा० ग्रीन जिन्होने १९७६ से १९७८ तक कस्तूरी मृगों पर हिमालय क्षेत्र में शोध कार्य किया था। उन्होने उस समय बताया था कि एक दशक में लगभग ५,३५० से १६,००० कस्तूरी मृग हिमालय क्षेत्र में मारे जाते हैं।

अमर उजालाः अगस्त 24, 1999

चीड़ के वृक्ष पर्यावरण के लिए घातक

कुमाउं विश्वविद्यालय के डीएसबी परिसर नैनीताल के वनस्पति विभाग के प्रो० आर० डी० खुल्बे ने स्वस्थ्य पर्यावरण के लिए चौड़ी पत्ती वाले पेड़ों को बढ़ावा देने के उद्देश्य से आम लोगों से जागरूक होने की अपील करते हुए कहा कि चीड़ के व्रक्ष पर्यावरण के लिए घातक होने के साथ साथ इनकी अधिकता से जंगल में पानी की कमी के साथ-साथ अम्लता का प्रभाव भी तेजी से फैल रहा है जिस कारण पहाड़ में अनेक जड़ी बूटियों के उत्पादन पर विपरीत प्रभाव पड़ रहा है। उन्होने अंधाधुंध निर्माण कार्य के साथ-साथ चीड़, यूकेलिप्टस आदि के प्रोत्साहन पर गहरी चिन्ता व्यक्त की।

दैनिक जागरणः अगस्त २५, १९९९

नैनी झील को बचाने के लिए जाल निकासी की नयी व्यवस्था करनी होगी

योजना आयोग का मानना है कि यदि उत्तर प्रदेश के कुमाउं क्षेत्र में नैनीताल और भीमताल की झीलों के आकर्षण को बचाये रखना है तो इस क्षेत्र में पानी की निकासी की व्यवस्था को चाक चौबंद रखना होगा ताकि भूस्खलन को रोका जा सके। नैनीताल व भीमताल की प्रसिद्वि झीलों की तलहटी में गाद जमने की वजह से कम होती जा रही गहराई और समय समय पर वहां होने वाले भूस्खलन पर योजना आयोग के एक अध्ययन में यह निष्कर्ष सामने आये हैं। आयोग का मानना है कि गाद जमने का क्रम इसी तरह जारी रहा तो जल्दी ही इन झीलों का आकर्षण समाप्त हो जाएगा। आयोग ने नार्वे के विशेषज्ञों के जरिए इसका अध्ययन कराया है। योजना आयोग के उपाध्यक्ष के०सी० पन्त के निर्देश के बाद आयोग के एक प्रतिनिधिमंड़ल ने जून १९९९ में नैनीताल जिले का दौरा कर नैनीताल व भीमताल की झीलों की कम होती गहरायी की जांच की व इस बात पर गहरी चिन्ता व्यक्त की है कि इन दोनों झीलों की गहराई आश्चर्यजनक ढंग से कम होती जा रही हैं। १९५० में नैनीताल झील की गहराई २४ मीटर थी। लेकिन वर्तमान में यह कम होकर १७ मीटर तक आ चुकी है। आयोग का मानना है कि यदि स्थिति यही रही तो अगले दस-पंद्रह साल में गहराई १० मीटर तक आ जाएगी।

दैनिक जागरण: अगस्त २५, १९९९

Shell-shocked animals disappear from J-K

The rare species of Kargil in Jammu & Kashmir disappeared from their native areas after the outbreak of recent Indo-Pak conflict. The victims are snow leopards, wolves, brown beer and ibex, mostly found in Drass, Batalik, Kargil and Karakurrum in Turtuk - all affected by the recent two-month-long conflict between India and Pakistan. Though the wildlife warden in Ladakh confirmed that the two-month-long shelling in Kargil did affect the wildlife, with rare species having migrated to safer places, but denied any casualties among these. With Pakistani shells still occasionally hitting the area, these wild animals are not returning to their native places.

THE INDIAN EXPRESS: September 21, 1999

बड़े बांधो से न पहाड़ो का हित, न मैदानों का : बहुगुणा

प्रख्यात पर्यावरणविद सुंदर लाल बहुगुणा ने पहाड़ों की खुशहाली और मैदानों की सुरक्षा को सुनिश्चित करने वाली एक व्यापक हिमालय नीति बनाए जाने की मांग की हैं। श्री बहुगुणा ने बड़े बांध बनाए जाने का विरोध करते हुए कहा कि इससे न तो पहाड़ों का हित होगा और न मैदानों का। बड़े बांधो की कभी न कभी टूटने की आशंका बनी रहती है और ऐसी स्थिति में मैदानी भागों में प्रलय मच जाएगी। उन्होने सुझाव दिया कि टिहरी परियोजना में बांध बनाने की बजाय सुरंगो से गुजरने वाली पानी के प्रवाह से ही बिजली पैदा करने के प्रयास किए जाने चाहिए। पहाड़ो पर सघन व्रक्षारोपण के जरिए जल संसाधनों की बर्बादी रोकी जानी चाहिए। उन्होने सफेदा तथा चीड़ को पर्यावरण के लिए खतरनाक बताया। श्री बहुगुणा पहाड़ों के लिए पांच प्रकार की व्रक्ष प्रजातियों की सिफारिश करते हैं। भोज्य पदार्थ एवं फल देने वाले व्रक्ष, ईधन तथा इमारती लकड़ी वाले व्रक्ष, उर्वरक देने वाले व्रक्ष, पशुचारा देने वाले व्रक्ष और रेशेदार व्रक्ष। उन्होने कहा कि अंग्रेजों ने व्यावसायिक द्रष्टिकोण अपनाते हुए हिमालय में केवल इमारती लकड़ी के पेड़ों को बढ़ावा दिया। उन्होने कहा कि उचित वन संरचना से पर्वतीय क्षेत्र की नदियो के प्रवाह को नियमित करके न केवल पानी की बर्बादी रोकी जा सकती है, बल्कि बाढ़ के खतरे से भी बचा जा सकता हैं। बढ़ते प्रदूषण के इस युग में जीवन वायु आक्सीजन तथा पेयजल की शुद्वता तथा प्रचुरता वनो से ही संभव हैं।

नवभारत टाईम्स: सितम्बर १८, १९९९

Gangotri may vanish in ten years: experts

The Gangotri Conservation Project (GCP), jointly administered by Government of India, State Government of Uttar Pradesh, Himalayan Environment Trust, environment experts and local representatives have recommended a monitoring station at Gangotri in view of disturbing reports about the Bhagirathi river shrinking drastically. The main objectives set out for GCP are to green and clean the Gangotri basin, develop low cost sanitation schemes and schemes for solid waste disposal, develop alternative energy programmes for conservation of environment with maximum involvement of local populace.

THE HINDUSTAN TIMES: September 27, 1999

Mining aggravates floods

The rainy season, this year has left an unbearable tale of disaster, thousands of people homeless, hundreds of acres of fertile land has been ravaged by the floods in Himachal Pradesh. The state government has suffered an estimated loss of Rs. 500 crore. In Kangra district alone over 100 link roads were damaged and yet to be restored. The reckless, unscientific mining and quarrying in the state have been attributed to be a major cause for the repeated flashfloods in this region. It is revealed that illegal mining and quarrying has taken a new turn in the past few years and political interference in the functioning of Forest and Mining Departments had worsened the matters. Experts feel that if no effective measures are adopted and sincere efforts made, the fury of floods will continue to hit the ecology of the state year after year.

THE TRIBUNE: October 2, 1999

NSCN, DHD ultras denuding NC Hills, Karbi Anglong forests

The rich forest cover of the two hill districts of North Cachar Hills and Karbi Anglong is under threat of denudation as the banned NSCN and local militant outfits are indulging in the illegal felling of trees by issuing permits to some timber contractors. In spite of being fully aware of the militants activities, the police officials are helpless to take proper action against the culprits, because of the difficult terrain in the border areas due to extremely harsh conditions and the shortage of adequate staff.

THE SENTINEL: October 6, 1999

Anti-quake building in N-E planned

The Indian Concrete Institute in Manipur is designing earthquake resistant buildings in the North-East to reduce the damage induced by the frequent tremors as the region is considered one of the most earthquake-prone zones in the world. Engineers and architects in the state have made a breakthrough in developing quake-resistant buildings. Prof. S.K. Jain of IIT has recommended the replacement of the traditional timber, with alternate material without changing the quake-resistant features of the 'Assam-type' houses.

THE TELEGRAPH: October 19, 1999

Bid to preserve Wullar lake

To preserve the world famous Wullar lake in North Kashmir, the largest freshwater lake in Asia, the Union Ministry of Environment and Forests has banned all types of industrial activity within seven km of the lake. In a notification issued recently, the ministry has impressed upon the State Pollution Control Board that no industrial activity should be allowed within the prescribed limit. Besides the lake has been declared a wetland, also been identified by the Environment Department for special attention in environmental point of view.

THE STATESMAN: October 21, 1999

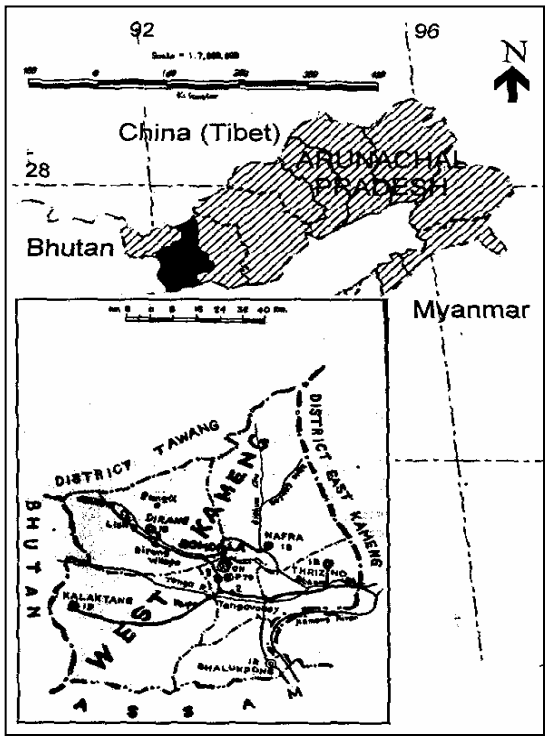
Rehabilitation issue likely to delay Tehri project

Evacuation of the old town and villages in the Tehri valley, as scheduled, remains an impossible task even as the game of passing the buck continues unabated. The task of rehabilitation of more then 30,000 oustees was handed over to the state government authorities after persistent complaints about insensitivity, irregularities and corruption by the officials of the Tehri Hydro Development Corporation. According to the survey, not less tan 9,546 families are yet to be rehabilitated. The next stage of construction of the dam project which involves filling up a substantial portion of the proposed reservoir. Besides over a 15,000 population of the Old Tehri, as many as 125 villages would be affected by the reservoir. Of these 37 villages are likely to be submerged completely, while remaining 88 would be partially submerged.

District Profile : WEST KAMENG DISTRICT

Compiled by S.N. Nandy
G.B. Pant Institute of Himalayan Environment andDevelopment, Kosi-Katarmal, Almora 263643, India

The West Kameng district is located in the western part of Arunachal Pradesh covering an area of 7422 km^2 accounts for 8.86% of the total area of the state. Its main land extends between 91°30' to 92°40'E longitudes and 26°54' to 28°01'N latitudes. The district is surrounded by East Kameng district in the east. Its northern boundary passes through the high peaks of the Himalayas that form the boundary between India and China (Tibet). The western boundary of the district demarcates Bhutan from India. Tawang district lies in the north-west of the district while the southern boundary extend to Sonitpur district of Assam. The name of the district is derived from Kameng river, a tributary of the Brahmaputra, that flows through the district.



Location map: West Kameng, Arunachal Pradesh.

The topography of the district is mostly mountainous. A greater part of it falls within the higher mountain zone, consisting a mass of tangled peaks and valleys. In West Kameng there are three principal mountain chains - part of Sela range, Bomdila range and Chaku range. The Sela range consists a series of mountains arranged in the form of big line from Tibet in the north, Bhutan in the west and thus forming a tough terrain to pass through it. The altitude of Sela range varies from 14000 to 15000 feet and Sela pass is 13714 feet high. The Bomdila range having an average height of 9000 feet, South of Bomdila range lies the Chaku range (foot-hills range) having hills of quite low altitudes and is full of tropical forests with trees of great economic value and various types of wild game.

Tenga, Bichom and Dirang Chu are the main rivers flowing through the district. All these rivers are tributaries of the river Kameng which flows through Bhalukpong circle of the district and joins the river Brahmaputra in plains of Assam.

The inhabitants of the district comprises mainly of Monpa (Dirang, Boot, Lish, and Kalaktang monpa), Miji (Sajalong), Sherdukpen, Aka, and Bugun (Khawa). The Monpas belong to the Tibeto-Mongoloid stock and are the largest tribe of the district, inhabiting mainly in Dirang and Kalaktang circles. The Mijis are settled in Nafra and Akas in Thrizino circle. The Khawas inhabit in Wanghoo, Kaspi, Singchung and Tenga areas. The Seherdukpens are mainly settled in 4 villages of Rupa, Jigaon, Sergaon, Thongre and also in Doimara area. By and large the inhabitants are Buddhists though Akas, Khawas and Mijis believe in indigenous religion and follow partly Buddhist and Hindu practices. Every tribe has its own society and village council.

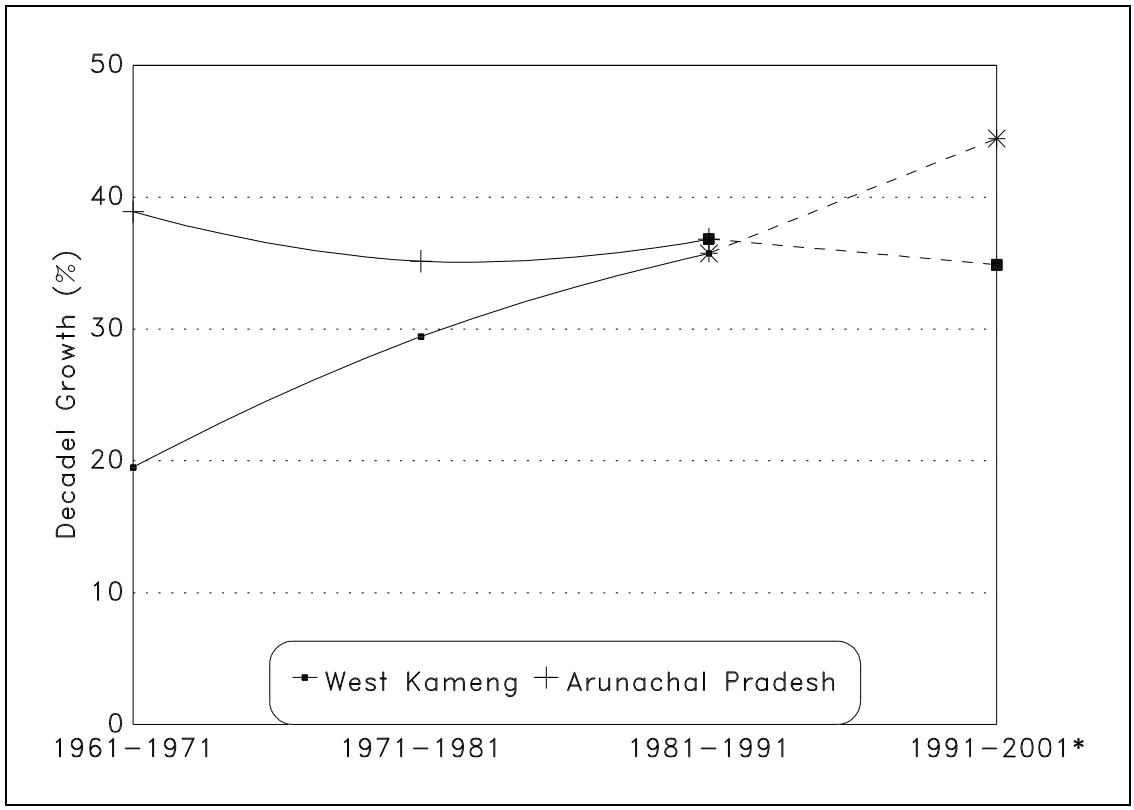
As per 1991 census, West Kameng district is having 170 villages with a population of 56,421 comprising of 30966 males and 25455 females. The district population accounts for 6.53% of total population of the state. The literate population of the district as per 1991 census is 20,585 forming 46.31% of total population comprising 55.03% of males and 35.22% of females (excluding the population of age group 0-6 years) and is higher than the literacy rate of the state (36.41%). The sex ratio (number of females per 1000 males) has decreased from 836 (1981 census) to 822 (1991 census) which is much less than the nation's figure (927) and also lower than the state's (859). However, the 1991 census

recorded a higher sex ratio (970) among children of age group 0-7, indicates a positive ratio towards the future decades.

The district is divided into three administrative sub-divisions *viz*. Bomdila, Nafra-Buragaon, and Rupa. All the circle head quarters of the district are connected with the district head quarters (Bomdila) by roads. Regular passenger services to Guwahati, Tezpur, Itanagar, Tawang and all the circle head quarters of the district are being provided by State Transport and private buses. Bhalukpong is the nearest railway station in the district situated at about 100 km from the Bomdila, while Salonibari (Tezpur, Assam) is the nearest airport about 160 km from the district head quarters

Amenities of the district (as on 31/3/98)	
Road length	1339 km
Electrified village	152
Electricity installed - Hydel	4480 kw
- Diesel sets	1269 kw
Craft centre	2
Forest - Reserve forest	1784 km^2
- Forest Division	4
Area under irrigation channel	1719 hect.
Cooperative societies	31
Rural Development	
- IRDP beneficiaries	755
- IRDP expenditure (Rs. in lakh)	35.92
Banks - Nationalized (SBI)	7
- Co-op. Apex Bank	1

According to 1991 census out of total 170 villages 117 villages of the district have been electrified. The hydel project has the major share of the total installed capacity of electricity in the district with capacities of Dirang (2000kw), Sessa (1500kw), Rahung (750kw), Rupa (200kw), and Jigaon (30kw).



Decadel growth rate of West Kameng district as compared to the State's growth rate; *Projected figure

Parameters	1981	1991	Rate of change(%)
Decadel growth	29.15 [35.15] (1971-81)	35.73 [36.83] (1981-91)	+22.57 [+4.78]
Density (persons/km^2)	7 [8]	8 [10]	+14.29 [+25.00]
Sex ratio (females/1000 males)	836 [862]	822 [859]	-1.67 [-0.35]
Literacy rate*	21.45 [20.09]	36.48 [28.72]	+70.07 [+42.96]
Urban population	9.29 [6.56]	10.02 [12.80]	+7.86 [+95.12]
SC Population	0.59 [0.5]	0.43 [0.47]	-27.12 [-6]
ST Population	55.58 [69.8]	52.99 [63.66]	-4.66 [-8.8]
Main workers	47.58	43.47 [39.34]	-8.64

* Includes population below 7 years age; Figure in [ ] represents the respective data of Arunachal Pradesh.

Block Level Data (as on 31/03/95)

Blocks	Dirang (Dirang circle)	Kalaktang (Kalaktang circle)	Nafra-Buragaon (Bomdila Sadar, Bhalukpong, Nafra, and Thrizino circles)
Head Quarters	Dirang	Kalaktang	Thrizino
No. of villages	36 (18)	49 (53)	85 (85)
Population	15531(12620)	14079 (8206)	26811 (20741)
Sex ratio	844 (841)	823 (824)	808 (833)
Decadel growth rate (1981-91)	23.07	71.57	29.27

Figures within ( ) represent the respective data of 1981 census.

Land utilization (in hect.) during the agricultural year 1994-95

Name of blocks	Net sown area	Area under current fallow	Fallow land other than current fallow	Other cultivation land excluding fallow land	Cultivable waste land	Land not available for cultivation
Dirang	2075	51	27	584	-	48
Kalaktang	2101	205	429	534	497	227
Nafra-Buragaon	2366	921	1148	865	726	619
West Kameng	6542	1177	1604	1983	1223	894

Area under major crops (in hect.) during the agricultural year 1994-95

Name of blocks	Paddy		Maize	Millet	Wheat	Barley
	WRC	TRC/Jhum	Rainfed/Jhum			
Dirang	247	151	1579	539	-	42
Kalaktang	28	258	1053	400	96	38
Nafra-Buragaon*	12	318	1246	396	140	18
West Kameng district	287	727	3878	1335	236	98

* Data of Bhalukpong circle under Nafra-Buragaon block are not available

Area brought under fertilizer: 1225 ha; Area under HIV/improved: 631 ha; Area brought under plant protection: 2310 ha.

Horticulture farm/garden (as on 31/03/95)

Name of blocks	Government farm	Horticulture nurseries	People's horticulture gardens
Dirang	2	1	249
Kalaktang	1	1	280
Nafra-Buragaon	-	2	831

Blocks	Dirang	Kalaktang	Nafra-Buragaon
No. of veterinary disp./aid centre/cattle upgrading centre	13	11	16
No. of villages electrified	26	45	59
No. of villages having drinking water supply facilities	36	49	84
Post & telegraph office	6	4	9
Schools - Pre-primary	29	10	22
- Primary	28	26	42
- Middle	6	5	6
- High	2	1	3
- H.S. School	-	2	1
- College	-	-	1
- Central School	-	2	1
- Private/Govt. Aided School	1	4	1
- Technical Institution/Training Centre	2	-	1
Medical units - General Hospital	-	-	1
- Primary Health Centre/Sub-centre	5	7	9
- Homeopathic dispensary	-	-	1
- T.B. Hospital/Leprosy clinic	-	-	1
No. of registered Small Scale Industries	1	1	1
No. of social and cultural organizations	2	5	8

[Sources: Census of India 1991, Block Level Statistics 1995, West Kameng District at a glance 1998, Brochure of West Kameng District, District Statistical Office, Bomdila (Arunachal Pradesh), The Encyclopedic District Gazetteers of India (Ed. S.C. Bhat)]