Four
DAP Management

Many variables influencing mountain agriculture determine the use of DAP. In order to examine the different DAP management systems, a quantitative assessment of the contributions of draught animals has been made. Various draught animal husbandry practices and the main constraints in the DAP system have also been closely examined. An understanding of DAP management during the current process of agricultural transformation would also help us assess the future prospects of DAP and its links with agricultural development.

4.1 Livestock Population and Composition

The data presented in Table 4.1 are on livestock population and herd structure at village and household levels. Livestock are classified into broad categories according to their functions. In the study of draught animals, this classification seems logical because comparison in terms of broad functional groups is more credible.

While in the Shivalik hills and middle mountains bovine-dominated herds are found, in the high Himalayas the overall livestock population is represented by ovine species (on an average 96%). The Greater Himalayan zone is ideally a livestock-based farming system, whereas, in the lower zones, cropping is the predominant land-based activity. Ovines (sheep and goats) are almost entirely fed on grazing and browsing grasses, bushes, and other vegetation found on common property resources (CPRs). On the other hand, cattle (bullocks and cows) partly depend on grazing and forage supplies from the commons and partly on crop residues and tree fodder from cropland (the agro-forestry system), but buffaloes are mostly stall-fed. Abundance of grazing areas are found in the alpine meadows of the Greater Himalayas, therefore a dense population of goats and sheep and a livestock-dominated farming system has developed. A considerable proportion of ovines (25%) is also found in the herds in hill villages, and this is attributable to comparatively larger areas of common land and the presence of grazing grounds in the subtropical forests in the adjoining *Terai* area. Ovines are not found to any considerate extent in the livestock populations of middle mountain villages. In the lower and middle areas of the Himalayas, goats are the main, or sometimes the only, ovines in the high Himalayan region. The high altitudes are very suitable for sheep raising. Sheep can withstand cold, and the alpine pastures, apart from being a source

Table 4.1: Livestock Population and Composition (Per Village and Per Household Averages) at Different Study Area

k Species	Shivaliks		Middle Him.: Traditional		Middle Him: Transformed		Greater Himalayas	
	Per Village	Per Household	Per Village	Per Household	Per Village	Per Household	Per Village	Per Household
A. Bovines	**859 [75.22]**	**3.16**	**791 [92.73]**	**7.00**	**204 [84.65]**	**2.73**	**527 [3.31]**	**4.39**
a. Cattle	*674 [59.02]*	*2.48*	*668 [78.31]*	*5.91*	*95 [39.42]*	*1.27*	*457 [2.87]*	*3.81*
i. Bullocks	200 [17.51]	0.74	252 [29.54]	2.23	77 [31.95]	1.03	58 [0.36]	0.48
ii. Cows	297 [26.01]	1.09	257 [30.13]	2.27	9 [3.73]	0.12	223 [1.40]	1.86
iii. Male Calves	107 [9.37]	0.39	77 [9.03]	0.68	4 [1.66]	0.05	102 [0.64]	0.85
vi. Female Calves	70 [6.13]	0.26	82 [9.61]	0.73	5 [2.07]	0.07	74 [0.46]	0.62
b. Buffaloes	*185 [16.20]*	*0.68*	*123 [14.42*	*1.09*	*109 [45.23]*	*1.46*	*70 [0.44]*	*0.58*
i. She-buffaloes	133 [11.65]	0.49	86 [10.08]	0.76	62 [25.73]	0.83	60 [0.38]	0.50
ii. Female Calves	52 [4.55]	0.19	37 [4.34]	0.33	47 [19.50]	0.63	10 [0.06]	0.08
B. Ovines	**283 [24.78]**	**1.04**	**51 [5.98]**	**0.45**	**30 [12.45]**	**0.40**	**15290 [96.02]**	**127.42**
a. Goats	250 [21.89]	0.92	51 [5.98]	0.45	30 [12.45]	0.40	4497 [28.24]	37.48
b. Sheep	33 [2.89]	0.12	-	-	-	-	10793 [67.78]	89.94
C. Pack Animals	**-**	**-**	**11 [1.29]**	**0.10**	**7 [2.90]**	**0.09**	**106 [0.67]**	**0.88**
a. Mules	-	-	11 [1.29]	0.10	7 [2.90]	0.09	10 [0.06]	0.08
b. Horses	-	-	-	-	-	-	96 [0.60]	0.80
Total Population (A+B+C)	**1142 [100.00]**	**4.20**	**853 [100.00]**	**7.55**	**241 [100.00]**	**3.22**	**15923 [100.00]**	**132.69**
Total Cattle Units*	**921**	**3.39**	**817**	**7.23**	**247**	**3.29**	**3642**	**30.35**

Figures in parentheses are percentages of the total livestock population.

* **Conversion factor** : Cow=1.0, Bullock=1.2, Cow Calf=0.5, Buffalo=1.5, Buffalo Calf=0.75, Goat=0.2, Sheep=0.2 Mule/Horses=1.0.

of fodder, also help facilitate the growth of fine quality wool. Sheep are reared by virtually all families, especially for their wool. Wool trading is one of the oldest occupations in this area.

Pack animals account for only a meagre proportion of the livestock population, with the percentage being greatest in the transformed villages (3%), whereas there are none in the hills. Pack animals in mountain regions usually include donkeys, horses, mules, and ponies. In our samples, there were only mules and horses. In the Greater Himalayas, however, ovines (mostly the males) are also used as pack animals. In our sample village, Gangi, bucks and rams were found transporting more luggage and farm produce than traditional pack horses. Each buck or ram carries 10kg at a time on an average; the range is from six to 12kg.

Among the bovines, while the hills and middle mountains (traditional) constitute the majority of cattle (59 and 78%, respectively), the middle mountains (transformed) have more buffaloes (45%). Among the cattle, bullocks account for 32 per cent in the transformed villages, 30 per cent in traditional villages, and only 18 per cent in the hill villages. In our samples there were no male buffaloes, either adult or young. Buffalo bulls are kept for breeding purposes only. A village usually keeps only one buffalo bull, sometimes two to three villages share a single bull. Male buffalo calves are also not maintained. A few days after birth, they are deprived of milk and starved to death.

The average livestock holding size is, naturally, highest (133 livestock head per household) in villages that have livestock-dominated farming systems, i.e., the Greater Himalayan villages practising transhumance. In the Middle Himalayan villages practising the transformed agricultural system, the average livestock holding size (a little over 3 head) is the smallest. The livestock holding size is moderate (a little over 4 head) in the hill villages and fairly large (nearly 8 head per household) in traditional middle mountain villages. The livestock holding size pattern suggests that, as we proceed from the primitive type of farming system (the livestock-based transhumant system in the Greater Himalayas) to the present traditional system in the Middle Himalayas, to the transitional system in the hills, and finally reaching the modern farming system, the importance of animals decreases. The relationship between animal size and development is virtually negative.

Buffaloes are obviously preferred in the transformed management system. Most, but not all, households, on an average, maintain one or more buffaloes. The larger grazing areas in the foothills and Greater Himalayas emphasise the priority for grazing animals rather than stall-fed ones. When feed supplies, especially green fodder, are limited, buffaloes are given preference. In the middle mountains feed supplies have become scarce as a result of large-scale deforestation. In the transformed areas, fodder scarcity has intensified due to the introduction of commercial crops that do not provide fodder. Thus, livestock holdings here are small and to convert the scarce feed resources into more remunerative, directly consumable or marketable products, buffaloes are preferred.

Maintaining unproductive periods without grazing support is difficult. An optimum livestock size is also necessary for soil fertility management under the traditional system. A greater density of external inputs for cropping in the transformed system also reduces the demand for animals producing dung.

Cattle populations are most dense in Middle Himalayan villages practising the traditional agricultural system (nearly 6 head per household, on an average), followed by the Greater Himalayan villages and hill villages, the smallest being in the transformed villages in the Middle Himalayan zone. The bullock holdings, except for in traditional villages, however, do not correspond to cattle holdings. While each household in the traditional villages owns, on an average, more than the required number, i.e., two bullocks, in all the other categories the number is below the required figure: in the transformed villages only one bullock per household is kept, and this is more than in the hills and the Greater Himalayan region. This is because of the greater proportion of females in the cattle population in the hills and the Greater Himalayas. Despite the lower percentage of cattle in the herd in the transformed system, bullock holdings are fairly large, and this is augmented by the almost negligible proportion of females in the cattle population. The traditional system is exceptionally rich in cattle with nearly equal proportions of males and females. Cattle sizes and sex ratios are the main determinants of adjustments in DAP in the mountain farming system. A holding of less than two bullocks per household suggests a certain amount of hiring or sharing. The hill villages also hire mechanical (tractor) equipment, and this might be the reason for smaller bullock holdings in these villages.

When we look at livestock holdings in terms of cattle units, they are nearly equal in the hills and middle mountains (transformed). In comparison to the overall livestock holdings, the value of cattle units decreases drastically in the Greater Himalayan villages because of the very large proportion of ovines (Table 4.1).

4.2 Distribution and Density of Draught Animals

The spread of draught animals throughout each zone depends on a number of factors. The most important factor is the land holding size. An overwhelming majority of farmers in each zone in the Central Himalayas have marginal and small landholdings. On an average, 95 per cent in the Shivalik zone are marginal and small holdings. As we ascend towards the Greater Himalayas, the percentage of these landholding groups decreases from 67 in the Middle Himalayas (traditional) to 64 in the same zone where transformed agriculture is practised and 63 in the Greater Himalayas. Most of the population of bullocks, the only draught animals in the region, however, are with the small and medium landholding groups, except in the Shivalik or foothill zone where more than three-quarters of the bullock population is concentrated in the marginal and small holding groups. In the Greater Himalayas, two-thirds of the total bullock population is owned by the medium-sized holding group (Table 4.2). Among all the sample villages, Bagauri, a village in the Greater Himalayan zone, has no bullocks. The distribution of

animals according to landholding categories among villages within each zone is very uneven (see also Annex 12).

In order to be functional, each household should keep two bullocks. But the overall average suggests that, apart from the traditional Middle Himalayan zone, holdings are less than functional, being the smallest (0.48) in the Greater Himalayas. In the Shivalik hills the average is only 0.74 bullocks per family and in the transformed Middle Himalayas, only 1.13 bullocks are kept. Comparatively, the overall bullock holding in the traditional Middle Himalayan area is 2.23.

The fact that holdings do not meet requirements indicates that sharing and hiring take place. In the Shivalik hills and Middle Himalayas (traditional) holdings increase with an increase in landholdings up to medium farmlands but are the least on large farms in the former zone and decrease slightly in the latter. In the other two zones, nevertheless, holdings increase with the size of landholding (see also Annex 13).

Bullock density (number of bullocks per ha of cultivated area) decreases constantly with an increase holding size in the first three zones; they decrease most sharply in traditional areas in the Middle Himalayas. In the Greater Himalayas, however, bullock density increases sharply on small farms and then decrease with the increasing holding size. The overall average is the lowest on the Shivalik hills, followed by transformed areas in the Middle Himalayas and the Greater Himalayas; and it is highest in traditional area of the Middle Himalayas. Among all the zones, traditional areas in the Middle Himalayas are the richest in terms of both bullock holdings and density. Bullock density figures, with respect to various landholding groups, corroborate those of Singh (1995) and Subrahmanyam and Rao (1995) in their studies of southern and western regions of India. It is interesting to note that the average density across zones of draught animals in our case (1.37) is appreciably higher than that at all-India level (0.48) (see also Annex 14).

The degree of remoteness is a powerful factor affecting bullock population. A greater degree of remoteness has been found to encourage more a greater population of bullocks in the villages. Banali, one of the remotest villages, for example, has the largest number. Gangi, another village, the remotest of all the sample villages, ranked third in bullock population. Gangi, being very far from the plains, does not have a greater demand for bullocks from the surrounding villages. In the villages of the inner Himalayas, the bullock trading system is negligible. Taily Sunoli, another village in the traditional area of the Middle Himalayas, which ranks second in bullock population, is also very far from the plains; though very close to the main road. The villages which are very far from the plains practising traditional agriculture also favour the DAP system and discourage bullock trading. The situation of adult male migration leads to a decrease in bullock holding size and density and affects DAP management overall, as also the limited substitution of DAP by tractors in the Shivalik villages. The total effect depends on the relative strengths of all these factors.

Table 4.2 Distribution and Density of Draught Animals

Landholding Category	Shivaliks			Middle Himalayas: Traditional			Middle Himalayas: Transformed			Greater Himalayas		
	Bullock Population No. per Village (%)	Bullock Holding Size, No.per Household	Bullock Density No. per ha Cropland	Bullock Population No. per Village (%)	Bullock Holding Size, No.per Household	Bullock Density No. per ha Cropland	Bullock Population No. per Village (%)	Bullock Holding Size, No.per Household	Bullock Density No. per ha Cropland	Bullock Population No. per Village (%)	Bullock Holding Size, No.per Household	Bullock Density No. per ha Cropland
Marginal	77 [38.50]	0.67	1.96	39 [15.48]	1.50	4.02	11 [14.29]	0.44	1.82	5 [8.62]	0.07	0.46
Small	84 [42.00]	0.77	1.36	108 [42.84]	2.16	2.64	25 [32.47]	1.09	1.45	7 [12.07]	1.40	2.79
Medium	23 [11.50]	1.64	1.05	92 [36.51]	2.96	1.78	25 [32.47]	1.39	0.95	39 [67.24]	1.86	1.70
Large	16 [8.00]	0.48	0.15	13 [5.16]	2.17	0.82	16 [20.78]	1.78	0.87	7 [12.07]	2.33	1.00
Overall	200 [100.00]	0.74	0.88	252 [100.00]	2.23	2.13	77 [100.00]	1.03	1.13	58 [100.00]	0.48	1.34

4.3 Sharing and Hiring of DAP

DAP sharing and hiring is a way of coping with the prevailing state of unequal distribution, population size, and density of draught animals. While sharing bullocks or ploughing has been an old practice in community-based agricultural activities, hiring arrangements are a recent phenomenon that has been strengthened by external development interventions in recent years. Mountain farmers have witnessed three styles of change stages in DAP usage patterns over the last 30-40 years. These are as follow.

Stage 1 : An independent DAP use system with arbitrary sharing of ploughs : Every farm family tended to keep at least one pair of bullocks and a pair of male calves to replace them after retirement.

Stage 2 : High intensity of DAP sharing : Many families started to keep only one bullock. At the time of ploughing and other agricultural operations it was used together with bullocks belonging to brothers and or close relatives.

Stage 3 : High intensity of DAP hiring : In this stage, many families ceased to keep draught animals and became dependent on hiring.

While all three patterns exist side by side in mountain agriculture, they vary in distribution and relative importance.

In the traditional areas of the Middle Himalayan zone, as many as 85 per cent of households are independent in DAP use. In the Greater Himalayas, nearly 60 per cent and, in transformed areas of the Middle Himalayas, nearly half of the total landholdings are independent in terms of draught power. In the Shivaliks or foothills, only a minority of farm households (37%) depend on independent DAP use. Nearly one-quarter of the total holdings in the Shivaliks depend on the sharing of DAP, and this is the highest figure amongst all the zones. Low-scale sharing is observable in all other zones, it being the lowest in the traditional middle mountain areas. Hiring intensity is the highest in the transformed area of the Middle Himalayas, with as many as 40 per cent of households depending on hiring for DAP. A little behind are the Shivalik hills. In the Greater Himalayan zone, 30 per cent of the holdings participate in hiring DAP. This figure seems high because one of our sample villages in this zone, Bagauri, has no draught animals. One-quarter of the total households in this village are landless, the rest come into the marginal landholding group. Out of these, 40 per cent of families use hand tools only, while others hire ploughs. In two other villages in the same zone, namely Gangi and Juma, the hiring system is absent.

Sharing-hiring ratios for the Shivalik, Middle Himalayan (traditional), Middle Himalayan (transformed), and Greater Himalayan zones work out at 0.67, 0.89, 0.26, and 0.31,

respectively. In two of the traditional middle mountain villages, Taily Sunoli and Banali, hiring is not practised at all, but the third traditional village, Goom, owing to its location, depends heavily on hiring.

Nevertheless, the sharing-hiring ratio is the higest in traditional areas. The same reason could be ascribed to the Greater Himalayan region where this ratio has narrowed because of one village's complete dependence on hiring DAP. In the transformed area this ratio is the lowest of all. Hiring out is virtually unheard of in the Greater Himalayas, but it is frequently found in the traditional mountain villages. Whereas the hiring out of all holdings and bullock holdings is equal in the traditional villages, it is in a one to three ratio in the transformed villages in the Middle Himalayas as well as in the Shivaliks (Table 4.3).

It can be inferred from the above that traditionalism together with remoteness promotes an independent DAP system, encourages sharing, raises the sharing-hiring ratio, and strengthens hiring-out management in the greater economic interests of all holdings and bullock owners. The transformation in agriculture, on the other hand, does just the reverse, apart from encouraging the hiring-out system in favour of bullock owners.

Apart from in the Shivalik zone, generally, dependence on sharing and hiring decreases with an increase in the size of land holdings, with the exception of medium-sized holdings in the Middle Himalayan zone. In the first zone, sharing and hiring persists throughout all landholding groups, but sharing is highest in the marginal group and hiring in the large group. Big farmers in two villages, namely Ganga Bhogpur and Khandgaon in this zone, depend to some extent on mechanical power so their DAP requirements have decreased. While the overall sharing and hiring percentages in traditional villages are the lowest, marginal and medium farmers in these villages actively participate in sharing and hiring activities, respectively. In the transformed villages, the sharing persists with marginal and small farmers, hiring prevails throughout all groups. More than half of the marginal farm families actively participate in hiring, small and medium farmers participate to the same degree (39%) and then there is a sharp decrease in the large farm category. In the Greater Himalayan villages farmers with large holdings are independent in the DAP system, the incidence of sharing is highest among small farmers and hiring highest among marginal ones. As already stated, two out of the three sample villages in this zone have no DAP hiring system. While hiring out is non-existent in the Greater Himalayan zone, it prevails in all other zones. Apart from the traditional middle mountain villages, large landholders do not hire out bullocks. The remarkable pattern in the traditional villages is that hiring-out at all holding and bullock-owning holding levels, apart from for marginal farm families, is equal, and at all holding levels it decreases with the size of landholding. All marginal landholders who own bullocks and half of the small holders in transformed villages take advantage of the DAP hiring-out system.

Table 4.3: Percentage of Different Landholding Groups Participating in Sharing, Hiring-in and Hiring-out Draught Animal Power

Landholding Category	Shivaliks			Middle Himalayas: Traditional			Middle Himalayas: Transformed			Greater Himalayas		
	Sharing	Hiring-in	Hiring-out All-Holdings/ Bullock Owning Holdings	Sharing	Hiring-in	Hiring-out All-Holdings/ Bullock Owning Holdings	Sharing	Hiring-in	Hiring-out All-Holdings/ Bullock Owning Holdings	Sharing	Hiring-in	Hiring-out All-Holdings/ Bullock Owning Holdings
Marginal	32.17	33.91	12.17/36.84	23.08	0.00	34.62/47.37	24.00	52.00	20.00/100.00	11.27	50.70	0.00
Small	26.61	35.78	11.93/30.95	0.00	2.00	24.00/24.00	8.70	39.13	26.09/50.00	20.00	0.00	0.00
Medium	7.14	14.29	7.14/9.09	6.45	22.58	19.35/19.35	0.00	38.89	11.11/16.67	9.52	0.00	0.00
Large	6.06	69.70	0.00	0.00	16.67	16.67/16.67	0.00	11.11	0.00	0.00	0.00	0.00
Overall	25.37	37.87	10.29/28.00	7.08	7.96	24.78/24.78	10.67	40.00	17.33/34.21	9.17	30.00	0.00

In the event that households cannot afford to own a pair of bullocks, sharing DAP is clearly a positive indicator, for it keeps the population of draught animals in balance, increases the efficient and economic use of the existing population, and induces social cohesion. Sharing occurs in three ways : (i) two families maintain one bullock each and share each other's bullock for agricultural work, (ii) one family ploughs the fields of another one season and the latter reciprocates in the next season, and (iii) sharing among close relatives living in different villages. The first practice was the most prevalent a decade ago, but now maintaining a single bullock is rare. Today, the last two practices are more prevalent. The sharing arrangement is most common among marginal and small holders, since in the larger landholding groups draught animals remain busy for longer durations, and it would be difficult for them to spare their animals.

With the emerging trend of commercialisation, it seems that the tendency to hire in and out will increase.

The hiring system operates in two ways; one hires only the draught animals, or one can hire both animals and ploughman. The current average rates in the former case are Rs 80 per day, and, in the latter, Rs 130 per day. The family hiring-in the DAP has to provide fodder for the animals and two meals for the ploughman, if hired with the animals. Over the decade, an almost 50 per cent increase in hiring rates has been observed. While the hiring-in of DAP saves the expenditure on rearing a bullock of one's own, hiring-out has created avenues of employment and income generation for others. The hiring arrangement also helps keep the bullock population under control. Both hiring and sharing practices, in this respect, are conducive to environmental conservation.

The three stages of development of the DAP system were talked about at the beginning of this section and are indicative of gradual deterioration of the DAP system; the alternative management emerging appears to be an appropriate response.

4.4 DAP and Aspects of Ethnicity

Social stratification and caste systems in the rural societies of the Central Himalayas are often considered unique. Caste is one of the fundamental and distinct social institutions in Hindu social life. It provides a system of hierarchical status ascription to different social groups, primarily based on birth, endogamy, and ritual purity. Studies of caste stratification synthesised by Rawat (1993) suggest that the hierarchy of various regional caste groups (*jatis*) in the system was primarily influenced by the 'varna' model, wherein ritual considerations of purity and pollution form the basis of differentiation. Members of a particular caste, which is the real social division at least at local or regional levels, observe certain ritual acts. The behaviour of a particular caste also influences the DAP system to a certain extent, particularly in the Kumaon Himalayas.

High-ranking Brahmins in Kumaon regard ploughing as beneath their dignity. Some high-ranking Brahmins, e.g., Joshi, Pandey, Tiwari, Pant, and Dalakoti, keep bullocks but do not till their lands, they rather employ a *halia* (ploughman) from other castes or

lower status brahmins, e.g., Bhatt, Sati, and Kawdal. The bullocks and agricultural implements would be their own. The *halia* is paid in foodgrains or cash (Rs 50 per day or less). If a Brahmin tills the land himself, ignoring the social customs, he is ostracized from his caste. He is then not permitted to share 'Hukka-pani' with people belonging to the same caste. This system does not apply to Garhwal. In Garhwal, only certain individuals from the Brahmin caste who work as priests are not supposed to plough themselves.

There was no household in our sample survey for whom ploughing was forbidden. This custom, in fact, is now disappearing and the current generation is rising above such customs. In the years to come this will no longer be a DAP-related issue.

4.5 Bullock Nutrition

Draught animals in the hills and mountains are stall-fed and grazed. The mountain areas are devoid of cultivated fodder. However, cultivated fodder crops cover a sizable area of cropland in the hills. Sorghum and clover are the two main fodder crops cultivated. Green grasses during the flush season and tree leaves throughout the year are the main green fodder in the mountains. Herbaceous weeds extracted from the fields during weeding are also used for animal feed. Crop residues of wheat, rice, millets, and pulses (apart from soybeans and pigeon peas) and grass hay are the main dry roughages fed to the animals. The concentrate feeds generally include ground barley and wheat and this feed is often provided to the bullocks during ploughing season only. In some households, prior to the ploughing season, bullocks are fed ghee (refined butter), approximately half a kilo per bullock. Bullocks are also given special 'recipes' during certain festivals.

The amount of green and dry roughages stall-fed to a pair of bullocks is greater in the transformed middle mountains and the hills than in the traditional middle mountains and high Himalayas (Table 4.4). The amounts of fodder given in the table (values are on a fresh weight basis) does not include the biomass consumed during grazing.

Bullocks in the high Himalayas rely on grazing rather than on stall-feeding. In this zone they are grazed for about 2,100 hours a year. During the summer, they graze on alpine pastures and during winter on sub-alpine pastures. In traditional mountain areas too, the grazing period is quite long (about 1,700 hours per year). In the hills and transformed mountain areas grazing length is relatively shorter, about 900 and 700 hours, respectively.

Table 4.4: **Annual Feed Consumption and Grazing Period by Pairs of Bullocks at the Study Sites**

Item	Shivalik Hills	Middle Himalayas Traditional	Middle Himalayas Transformed	Greater Himalayas
Stall-fed Green Roughages, kg	2,497	1,111	2,625	694
Stall-fed Dry Roughages, kg	1,513	794	1,875	421
Stall-fed Concentrates, kg	106	111	118	29
Grazing Hours	860	1,168	665	2,084

On working days, bullocks are generally not grazed. They are only stall-fed. Grazing is also avoided when the weather is bad. Some roughages are also given to the animals at night when they return home after grazing. Concentrate feeds are known to farmers, but their use is particularly restricted on working days and this too depends on availability.

4.6 Castration and Training of Bullocks

Temperament, physical development, and training largely determine the amount of work a bullock is capable of doing (Goe 1983). Almost all male calves not to be used for breeding are castrated. These transhumant pastoralist societies seldom keep a bull in the herd, as is normally the case in other areas. Although most of the bullocks in the herd are castrated, those left uncastrated are used for breeding purposes.

Depending upon the breed, the type, and the growth of the animal, the best castration results are obtained when the animal is about 12 months old (Singh and Moore 1978). However, according to Goe (1983), early castration (before one year), while causing less stress, will suppress muscular development of the fore and hindquarters, especially the shoulder, neck, and thigh areas. While it is recommended that male cattle be castrated between1.5 to 2.0 years of age (FAO 1972), in the mountain areas, in most cases, canstration is carried out between 2.5-4.0 years (Table 4.5). Judging from the quality of mountain cattle (slow growth rate, light weight, and small body compared to breeds in the plains), this seems to be appropriate.

Table 4.5: Usual Age and Weight at which Bullocks are Trained for Work in Central Himalayan Villages, India

Age Castrated, yr.	2.5-4.0
Age Trained for Work, yr.	2.5-3.5
Duration of Training, days	15-20
Age Nose-ringing, yr.	2.5-3.0
Working Life, yr.	8.0-10.0
Mature Weight, kg	140-340

There are two methods of castration used in the mountains. The traditional method, locally known as *lodi*, is applied in many remote areas, mainly in tribal villages in the Greater Himalayas. The *lodi* method is very brutal. The animal is laid down on the ground with its limbs tied. The testicles are held between two canes and crushed by a stone. This heinous shock treatment given to the animal severely affects its health and reduces its capabilities for work in the long run. In the majority of villages, castration now is performed with an instrument known as Burdizzo's castrator, or castrating pincers , designed to crush and destroy the spermatic cord and the blood vessels that supply the blood to the testicles, leaving the testicles to dry up and be absorbed. The operation, if performed by an experienced operator, is bloodless and no open wound is left open to infestation by worms or insects. The farmers do not perform this by themselves. A trained operator from a nearby veterinary dispensary occasionally visits the villages and performs this operation. To avoid or minimise insect infestation and infection, farmers

have the operation carried out in winter (and only sometimes in summer). They generally try to avoid the rainy season.

Nose-ringing is a common practice in all mountain areas, barring parts of Kumaon. In many villages in Almora district, this practice applies only to purchased bullocks or calves and not to *gharia* ones (those produced at home), for these bullocks are "gentle, disciplined, and easily manageable". In Garhwal, nose-ringing has increased in recent years, ever since the movement of bullocks from one area to the other began to take place, because of declining numbers of gharia bullocks. Nose-ringing becomes essential under such conditions, as the animal can be controlled in this way. The animal is ringed before training starts. It is done with an iron needle called a *syuda*. The needle is inserted in the nostril, piercing the nasal septum. A string is threaded through the hole. Normally, no antiseptic is applied on the wound; only mustard oil is applied occasionally.

Training the animal is very important. The optimum time for training depends on body weight and the physical development of the animal. In areas where not much feed is available, training should be delayed. In mountain areas, training usually commences from 2.5 to 3.5 years. Training an animal for heavy work before it attains maturity might have adverse effects. The time required to train an animal properly depends on the type of breed, the skill of the trainer, methods used, age and temperament of the animal, and type of work, e.g. ploughing, levelling, threshing. Mountain bullocks are generally trained in 15 to 20 days. There are many local methods of training. A pair of young bullocks is yoked (no other implement is attached) and made to walk and run in the field. The first operation they perform is levelling. Another method is by yoking the animals to a plough. The iron ploughshare is removed to avoid injury to the animals. One person handles the plough, while another walks in front of the bullocks holding out *gur* (jaggery) and salt to tempt the animals. Sometimes the animal is tied to a pole and is frightened, causing it to run in a circle.

4.7 Bullock Purchase and Sale

Until recently, 'farmer-to-farmer' bullock marketing was the dominant system in the mountains. Of late, 'farmer-to-middleman-to-farmer' bullock exchange has become popular, because of the feeling that bullocks are becoming a burden on the household during idle times. A local middleman, known as a *galledar* in Garhwal, will purchase bullocks from a farmer and exchange them against poor quality bullocks with another. In this process, the middle man will receive a commission. The middleman has a poor reputation. He is often regarded as a 'merciless', a 'cruel' or a 'wicked' man because he treats the bullocks he exchanges on commission in an inhuman manner.

In recent years, when the cattle population began to decrease and reproduction of bullocks on the farms, particularly in the transforming villages, became a rare occurrence, a 'farmer-trader-farmer' system of sale and purchase came into operation. This is an inter-regional arrangement. Traders are people from the plains adjoining the hills. In

accessible areas of Garhwal, this system is predominant. Come ploughing season and traders with large numbers of small-sized bullocks arrive. When the season is over, the bullocks will be taken to the plains.

The families hiring-out bullocks generally keep a pair throughout the year. However, about 10 per cent of the medium and large farms in accessible areas of Garhwal, according to the farmers' own estimates, actively participate in this system of purchase and sale. They purchase a pair of bullocks just before the onset of ploughing season and sell them after sowing season is over. In this process, the traders are the main beneficiaries. The farmers have to pay more while purchasing and incurr losses while selling the same pair of bullocks. Perhaps they do compensate the loss by saving on the maintenance costs.

Traders do not have bullocks who calve. They simply maintain them for sale. The hill breeds are bred in the mountains. Some of the remote villages are 'bullock banks'. These villages provide buffer stock for the other villages which do not keep bullocks for calving. Banali, one of our sample villages in the traditional area of the middle mountains, is a unique example of a place where intensive bullock breeding takes place.

The cost of a pair of bullocks ranges from Rs 2,500 to Rs 3,000 in the villages where bullocks are kept for breeding purposes and from Rs 3,500 to Rs 5,000 in other villages. Breeding is a good enterprise for villages such as Banali. During the previous year, the sale of bullocks and male calves fetched about Rs 900,000 for this village.

Bullock fairs taking place in the hills and mountains emphasise the importance of DAP in the mountain farming systems. These fairs are held twice a year before the onset of sowing. Both users and traders take advantage of such fairs.

Old, retired bullocks, in most cases, are kept at home in lieu of the services they have rendered to the family. But, in some areas, they are sold at nominal prices to outsiders who perhaps take them to abattoirs. In recent years, many incidents of protest have taken place against this practice in some parts of the Kumaon Himalayas.

4.8 Main Constraints

Identification of the main constraints is the first step to overcoming them and rendering the system sustainable. A summary can be found in Table 4.6.

Resource-related Constraints

Topographic variation creates some difficulties in using DAP. Undulated terrain, altitude variation, and steepness of slopes create some barriers by reducing accessibility to many areas and thus severely affecting the management of resources.

Table 4.6: Summary of Main Constraints and Their Effects on the Use of DAP in Mountain Agriculture

Main Constraints	Main Effects/Consequences
Resource – Related	
Topographic Variation (difficult and undulated terrain, reduced accessibility, altitudinal variation, weather extremes)	Difficulties in full use of DAP, loss of time and energy of humans and animals, difficulties in transportation of inputs and outputs, increased vulnerability
Fragmented and Scattered Holdings (small terraced fields, long distance between parcels of land)	Difficulties in efficient use of DAP, enormous loss of human and animal energy and time, less than potential yields, difficulties in transportation of inputs and outputs
Problem Soils (low water holding capacity, high proportion of gravels, nutrient deficiency, low pH, shallow depth, vulnerability to erosion)	Abandonment of DAP/cultivation practices on some terraces, DAP's positive impact not fully realised
Climatic Extremities (rains, snowfall, hail storms, strong winds, seasonal periodical hazards)	Breakdowns in the continuous use/benefits of DAP, decreased potential of draught animals, risks to animal health
Imbalanced Land Use (low CPRs – cultivated land ratio, changing cropping patterns, increased resource intensities)	Reduced grazing area and fodder supply leading to poor nutrition of draught animals, decrease in draught capability of animals, higher bullock maintenance costs
Changing Floristic Composition (endangered climax species, emphasis on monoculture of non-fodder trees and annual crops)	Decreased amounts of fodder for draught animals, reduced draught capabilities, decrease in use of draught animals
Changing Livestock Composition (less proportion of draught animals in herd)	Shortage of draught power for agriculture, overuse of existing animals leading to reduced draught capabilities, excessive burden on human beings for agricultural operations
Management – Related	
Lack of Improved Harnesses and Implements (often inefficient and primitive implements)	Draught capability not fully harnessed, increased cases of injuries, loss of animal days, slow rate of work
Improper/Inadequate Health Care (neglect of ethno-veterinary services, inadequate health care infrastructure)	Decrease in draught capability of animals, slow growth rate, high infertility incidence in females, reduced lifespan and working life, high mortality rate, loss of animal days
Mishandling of Animals (yoking to defective implements, overwork, inhuman/merciless treatment)	Continuous overstress on animals, reduced draught output, reduced working life
Conventional Animal Husbandry Policies and Programmes (changing husbandry priorities, crossbreeding, neglect of DAP)	Reduced proportion of draught animals, increased number of often unusable crossbred bullocks, reduced supply of draught power to agriculture, increased burden on human resources to cope with power-deficit

Fragmented and scattered landholdings are a result of overall terrain conditions. This situation is rendered more difficult by the law of inheritance which makes all heirs in a family co-parceners of private land. Fragmentation of property has taken place over many generations, leading to enormous losses in terms of human labour and DAP and also in terms of the time taken going from one tiny field to another.

Low CPR-cropland ratio in the mountains and the greater proportion of ecologically less important and non-fodder tree monocultures result in the lack of good nutritiion for draught animals and a consequent reduction in their capabilities. It also creates a lot of problems for agriculture (insufficient nutrient flow from forests/pastures to cropland) and in the social system (paucity of fuel, fodder, forest-based foods, foodgrains, minor timber for agricultural tools and implements, and timber for house construction).

The change in herd composition with a lower proportion of draught cattle has imposed another constraint on the DAP system. This is clearly reflected in the current livestock population trend and the emerging DAP systems which have to manage with less animals.

Reduction in grazing space and depletion of forage potential have made it difficult to maintain the productivity of large numbers of animals. Maintaining unproductive animals without CPR support is difficult. Moreover, the high cost of increased stall feeding favours keeping buffaloes rather than cows, in the context of milk prices based on the amount of fat in milk (Jodha 1992a).

Management-related Constraints

Harnesses and agricultural implements need improvement. Health care is inadequate, animals are mishandled, and conventional policies and programmes are constraints to progress.

Agricultural implements and harnesses are often primitive and inefficient. Some institutes and research organizations have produced improved designs but they are not suitable for increasing capabilities of draught animals or else. They cost too much. Extension facilities are inadequate. Harnesses and implements used today are almost the same as those seen in ancient works of art. "India has put satellites in space and harnessed the atom," says Ramaswamy, a leading DAP expert, "but our carts are 5,000 years old, because professors are scared they may not be promoted if they work on designing better ones." Because of the traditional defective yoke that inflicts injuries on the necks of animals, it is estimated that more than a million animal hours of work are lost annually in India. Earlier work (Sarkar 1981) confirmed that wooden ploughs in numerous shapes and sizes have many disadvantages. Twenty-four to 30 days are required to prepare one hectare of land with a pair of bullocks with these ploughs, and even after five to six passes one finds undisturbed soil 11 cm below the surface, resulting in poor yields from many crops. The line of draught does not pass through the centre of resistance of the plough and, therefore, the plough does not move steadily at a uniform depth.

Health services for draught animals are far from adequate. Conventional livestock husbandry policies and programmes also have several long - term negative repercussions on the DAP system, mainly by creating an environment for developing specialised milch breeds at the cost of multipurpose (strictly speaking, dual purpose) draught breeds suitable for mountain agro-ecosystems.