# Nine
# Augmenting DAP in Mountain Agriculture

DAP is a powerful means of increasing agricultural productivity and the sustainability of the system - and not a solution to all problems. To use it as an essential ingredient for agricultural sustainability, the DAP has to be combined with other agricultural techniques, policies, and programmes.

The following sections highlight some potential technological and institutional options that can contribute to augmenting the DAP, thus stimulating the process of agricultural sustainability.

## 9.1 Potential Options

Improvement in the use of the existing potential of DAP resources would inevitably lead to increased agricultural productivity in the region. It can be secured through the following.

- Increasing the number of days of bullock use per year and the number of work hours per day. This will be possible through diversification in crop production, e.g., multiple cropping, mixed cropping, cash cropping, annual-perennial links, etc.

- Using more animal species as DAP resources; for example, yaks, which are found in high Himalayan areas, are regular breeders, may live up to 40 years of age and may give birth to 20 or even more offspring (Negi 1990), dry cows - as used extensively in Bangladesh, donkeys, mules, and horses

- Involving work animals in more activities, for example, some transhumant societies use bullocks as pack animals also

- Increasing power output per animal - this can be achieved through improved matching designs of yokes, harnesses, and animal-drawn implements; providing balanced nutrition and better health care to the mothers, calves, and work animals; and proper training of animals

- Consolidation of scattered holdings, if possible – this will contribute to efficient DAP management by avoiding loss of time and energy in mobility

- Improving the condition of CPRs, e.g., common forests, grazing lands, etc through the several techniques and strategies explained in detail by Jodha (1992b, 1995a) and Miller (1995) which would ensure regular fodder and other biomass supplies to the farming system and would be a key element to improving the sustainability of the system.

## 9.2 Technological Options

Research and technology must look at the DAP system as an integral part of the whole system. The DAP system, to be upgraded, needs technological innovations not only for use by scientists but also by farmers. Farmers' traditional technologies may be instrumental in guiding such innovations. Technological advances should not remain confined to laboratories, but they should reach the farms and they must be within the financial means of farming communities.

It will be necessary to re-emphasise that, to be effective, technological advances in the DAP system must be combined with the perspective-based strategies for sustainable mountain agriculture (Jodha et al. 1992).

The best research and development efforts should be applied to the DAP system and technologies, in a search for ways in which farmers may make better use of a resource already at their command. Such techniques, suggests Kemp (1987), may lead to an improvement in the status of the draught animal, so that its value as an effective contributor to food production and rural prosperity will be more readily recognised and accepted.

Animal nutrition and optimum rates of work are two areas in need of further investigation. These two criteria vary according to the geographical area in question. Animal nutrition requires consideration of the feed resources available in the mountain region, while the rate of work would largely depend on the interactions between the task, the implement, the harness, the animals, and the operator (Kemp 1987).

*i. Nutrition of Draught Animals*

Feeding practices commonly followed by farmers in the mountains are simple. They depend on naturally available feed resources and crop by-products in various seasons. Therefore, performance of livestock, in terms of growth, reproduction, and working capacity, is influenced by the availability of feeds and their feeding schedule.

Animals should be fed a balanced diet which provides all the nutrients required by any animal in a 24-hour cycle. In a balanced diet, the quantity of various ingredients

increases or decreases according to the body weight and working capacity of the animal. Draught animals should be fed for maintenance and work production. Energy and other nutrients needed to maintain the health and other physiological activities when the animal is in a resting state are called maintenance rations. Rations apart from maintenance which provide the energy to work are called work production ratios.

Normally animals are maintained if green fodder of good quality (legume) is available. If the fodder is not of good quality, then other green fodders (non-legume) should be supplemented with adequate quantities of concentrate mixture. If the fodder available is of very poor quality (such as dried grass and crop residues), urea treatment can be applied to improve their digestibility.

For a long time now, roughages have been treated with various chemicals, such as sodium hydroxide, calcium hydroxide, and other chemicals, to improve their nutritive value. But ammonia treatment, rather than urea treatment, has a greater appeal than calcium or sodium hydroxide treatment. This treatment increases the nitrogen content of straw as well as the palatability, digestibility, and energy values. Urea treated straw, fed to livestock, results in increased intake and better growth rate than untreated straw.

For treating straw, 40 to 50g of urea are used per kg of straw, keeping the moisture level around 60 per cent. The stack, after urea treatment, is kept tight and covered for about four weeks before opening it for feeding. Here, urea is hydrolysed by the enzyme urease, releasing ammonia. It is safer, cheaper, and more convenient than other methods for storage and handling. It can be used conveniently on small farms. However, there is a wastage of two-thirds of the urea-ammonia (Kumar 1986).

Some physical treatments also help increase fodder value. Chopping roughages increases voluntary intake, grinding increases intake and digestibility of feed, and feed wastage is also reduced. Pelleting reduces dustiness and volume, resulting in increased feed intake. Soaking is one of the oldest and cheapest methods used in the villages. It removes dust from straws and stovers and makes them moist and improves their palatability. One to two hours' soaking increases feed consumption. Oxalates present in rice straw are removed by soaking, otherwise they bind calcium and reduce the availability of calcium for the animals (Kumar 1997).

a) Feeding Cows during Pregnancy

In the mountains, good care of animals is taken when they are producing milk or performing work. But, to have a healthy animal in future, the growth of the foetus should receive proper attention. So, it becomes very important to feed pregnant animals a balanced diet. During the last trimester of pregnancy, extra amounts of concentrate mixture are given to the animal. These extra amounts known as pregnancy allowances support the animal for the normal development of the foetus.

b) Feeding Growing Male Calves

Growing male calves should be fed more nutrients than the maintenance ration. After birth to 10 weeks of age, there is no difference in the growth of male and females. But afterwards the male grows faster. Just after birth, it is very important to give the calf the milk produced by the cow (colostrum) for three days. Colostrum is different from normal milk. It is rich in protein, vitamins, and antibodies, i.e., gamma globulins. Gamma globulins are absorbed into the system by the calf, developing resistance to all the diseases. Colostrum is also high in nutrients. It is slightly laxative and prevents constipation. Colostrum, being more easily digestible, provides more protein and minerals than normal milk. Normally 2.5 to 3.0 kg colostrum should be given daily. More colostrum than this at one time may cause diarrhoea. Calves are generally fed milk according to their body weights. Up to three weeks of age, the amount of milk given should be one-tenth of the body weight.

After two weeks of age, a 100g calf starter, which contains an appropriate amount of protein and energy ingredients, should be given. The quantity is increased gradually. Besides this, green soft roughage should be offered to the calf for the normal development of the rumen. The feeding schedule for calves up to three months of age is given in Table 9.1. After this age, good quality roughage should be fed to the calf and concentrate mixture should be gradually increased from 1.5 to 3.0 kg till the calf attains one year of age.

**Table 9.1: Feeding Schedule for Calves up to Three Months of Age**

| Age of Calf | Whole Milk (kg) | Skimmed Milk (kg) | Calf Starter* (kg) | Good Quality Roughage (kg) |
|---|---|---|---|---|
| 1st 3 days | 2.50 (Colostrum) | - | - | - |
| 4th to 7th day | 2.50 | - | - | - |
| 2nd week | 3.00 | - | 0.10 | 0.30 |
| 3rd week | 3.25 | - | 0.30 | 0.50 |
| 4th week | 3.00 | - | 0.40 | 0.60 |
| 5th week | 1.50 | 1.00 | 0.50 | 0.70 |
| 6th week | - | 2.50 | 0.65 | 0.75 |
| 7th week | - | 2.00 | 0.80 | 0.85 |
| 8th week | - | 1.75 | 1.00 | 1.00 |
| 9th week | - | 1.25 | 1.20 | 1.10 |
| 10th week | - | - | 1.30 | 1.20 |
| 11th week | - | - | 1.40 | 1.30 |
| 12th week | - | - | 1.50 | 1.50 |
| 13th week | - | - | 2.00 | 2.00 |

Source : Kumar (1997)

* Average composition of calf starter: crushed barley, maize, wheat, oats etc. 50 parts groundnut cake, linseed cake, soyabean cake, cotton seed cake, etc. 30 parts; wheat bran, rice bran, rice polish, etc. 8 parts; fish meal, meat, meal, dried skimmed milk, etc 10 parts, mineral mixture, 2 parts. To 100 kg of the above mixture, the following may be added : molasses 5-10% according to availability, antibiotic supplement 20 gm, Vit A supplement 10 gm, salt 500g

c) Feeding Work Bullocks

Cattle use large amounts of roughage in their diet. These animals can synthesize many amino acids and vitamin-B in the rumen. The nutrient requirements of an adult bullock are for maintenance and for mechanical work. The feed that would provide energy and nutrients for the essential physiological processes of life, even when the animal is not working, is known as the maintenance requirement. Nutrients required for the maintenance of adult cattle are given in Table 9.2.

The animal requires nutrients and energy for work, and they have to be included in the ration over and above maintenance requirements. The energy for work is supplied by the oxidation of the large number of nutrients in the system. The energy for muscular work is provided by the break down of phosphocreatine and ATP in the muscles. However, the amount of high-energy phosphate compounds in the muscles is limited. So, for the continuation of work, these compounds are re-synthesized by the reverse process. The energy needed for this renewal is provided by the oxidation of muscle glycogen and also the glucose brought to the muscles through the blood. Lactic acid is an intermediate stage in this oxidation and may accumulate when the muscles become fatigued.

In normal conditions, a working bullock first uses carbohydrates for energy from the feed, then the fats are used up. Finally, if the demand for energy is in excess, protein tissues, such as muscles, are used. Thus, in the diet of draught animals, if carbohydrates are in sufficient supply, then a mature animal at work needs no extra proteins than those provided in the maintenance diet.

Feed should be given to work bullocks according to their nutrient requirements, and these depend upon their work potential and body weight. The heavier the work, the greater the requirements. The feeding standards for draught animals are given in Table 9.3. Some green fodder should be given to meet the calcium and Vitamin-A requirements. Cereals such as maize, wheat, and barley should be given to working animals as they

**Table 9.2: Nutrients Required for Maintenance of Adult Cattle Per Head Per Day**

| Live Weight (kg) | DCP* (kg) | ME** (Mcal) | Carotene (mg) | Calcium (g) | Phosphorus (g) |
|---|---|---|---|---|---|
| 150 | 0.102 | 4.57 | 10 | 4 | 4 |
| 200 | 0.148 | 5.98 | 12 | 5 | 5 |
| 250 | 0.168 | 7.27 | 15 | 6 | 6 |
| 300 | 0.197 | 8.50 | 17 | 7 | 7 |
| 350 | 0.227 | 9.72 | 20 | 8 | 8 |
| 400 | 0.254 | 10.91 | 22 | 9 | 9 |

Source : Kumar (1997)

* Digestible crude protein (DCP).

** 3.615 Mcal of metabolizable energy (ME) = 1 kg of total digestible nutrients (TDN) = 4.409 Mcal of Digestble energy (DE) (Goe 1983).

Table 9.3: **Nutrients Required for Working Bullocks Per Head Per Day***

| Live Weight (kg) | Normal Work** | | Hard Work** | |
|---|---|---|---|---|
| | DCP (kg) | ME (Mcal) | DCP (kg) | ME (Mcal) |
| 200 | 0.24 | 7.20 | 0.25 | 9.70 |
| 300 | 0.33 | 11.20 | 0.42 | 14.40 |
| 400 | 0.45 | 14.40 | 0.57 | 17.30 |
| 500 | 0.56 | 17.60 | 0.71 | 23.00 |

Source : Adapted from Ray (1978), New Delhi : ICAR by Kumar (1997)

* These standards include maintenance needs.

** Normal work : 2-4 hours of ploughing per day; Hard work : 6 hours' ploughing per day

are responsible for production of propionic acid in the rumen, which is a good source of glucose and energy. Crop residues, as per availability, should be provided to draught animals. The quality of the crop residues can be improved through proper chemical treatment. Jaggery, molasses, and mustard oil which are rich in energy, can also be fed to the animals.

d) Computation of Rations

In the computation of rations, we should consider the following points.

- The capacity for consumption should be known by the total amount of dry matter (DM) in the ration which the animal can consume. Cattle generally consume 2.25 to 2.50 kg of DM per 100 kg of live weight.

- The main portion of the total DM to be consumed should come from roughages and the rest from concentrates. In adult bullocks, two-thirds to three-fourths of the total DM should come from roughages.

- After the amount of DM consumption of the animal is known, the quantities of available feeds and fodder are worked out in such a way that the required amounts of protein and energy are supplied in the rations.

The following are examples of balanced rations for draught bullocks.

Example I

A bullock of 250 kg body weight (which is the average body weight in the mountains) and working hard should be fed the following rations.

1. Normal green fodder 6.0 kg
2. Straws 3.5 kg
3. Concentrate mixture 3.0 kg

The concentrate mixture should be as follows.

| | | |
|---|---|---|
| a. | *Guar* meal or any oilseed cake | 12 parts |
| b. | Barley, wheat, oat, maize, etc | 30 parts |
| c. | Gram | 27 parts |
| d. | Wheat bran, rice bran, etc. | 28 parts |
| e. | Mineral mixture | 2 parts |
| f. | Salt | 1 part |

In place of normal green fodder, a farmer can use locally available grass, green sorghum, etc.

Example II

If protein-rich green fodder is available, the balanced rations for the average weight bullock working hard should be as follows.

| | | |
|---|---|---|
| 1. | Protein-rich green fodder | 10 kg |
| 2. | Straws | 2.5 kg |
| 3. | Concentrate mixture | 2.5 kg |

The concentrate mixture should be as follows.

| | | |
|---|---|---|
| a. | *Guar* meal, any oil cake, etc | 42 parts |
| b. | Wheat bran, rice bran, etc | 55 parts |
| c. | Mineral mixture | 2 parts |
| d. | Salt | 1 part |

For protein-rich green fodder, the farmers can use any leguminous fodder cultivated in the lowland areas of the hills and Shivaliks and the leaves of *Grewia optiva, Celtis australis,* etc in the upper mountainous areas.

Example III

For a normal working bullock of average weight the balanced feed should be computed as follows.

| | | |
|---|---|---|
| 1. | Non-legume (grass, tree leavesetc) green | 6.0 kg |
| 2. | Straws | 2.5 kg |
| 3. | Concentrate mixture (as in Example II) | 1.25 kg |

If protein-rich green fodder is available, the following ration should be given.

| | | |
|---|---|---|
| 1. | Legume fodder | 7.5 kg |
| 2. | Straws | 2.5 kg |
| 3. | Concentrate mixture (as in Example II) | 1.0 kg |

If the draught animal is fed according to the norms given above, they will be able to use the feed resources available more efficiently. The animal will remain healthy and its working strength will increase substantially, and it will contribute to the DAP system more efficiently and more economically.

*ii. Designing New Harnesses and Implements*

Consideration of engineering principles involved in transferring power from an animal to an implement will result in improved yoke, harness, and implement design.

If draught animals could be equipped with more efficient and more comfortable harnesses, their pulling capacity could easily be tripled and their working lives increased by a factor of two or three (BRT 1990). Apart from providing increased pull, the newly-designed yokes and harnesses would be helpful in eliminating suffering. The scientific finding is that the power developed by draught animals may be increased by 15 to 23 per cent by using improved designs of yokes and harnesses (Sharma 1994).

Due to inherent local factors and environmental considerations, there may be a considerable decrease in the draught animal population in future. There is the possibility of designing a new harness system that could use only one animal, rather than a pair. It has been found that a pair of animals is 14 to 20 per cent less efficient than a single one in terms of power conversion efficiency (Kumar 1991). If it is usable and acceptable to farmers, the draught animal population might be reduced to half its present size.

The draught of a plough (and any other agricultural implement) is dependent on weight, shape, and scouring properties; the size and number of furrows; presence of different attachments; soil characteristics; slope of land; speed of travel; and skill of the operator (Goe 1983). Efficient agricultural implements, therefore, need to be developed according to specific site characteristics.

The increased use of newly-designed yokes, harnesses, and implements will largely rely upon the vocational training of local craftsmen. It has to be ensured that local craftsmen are trained in the maintenance and repair of harnesses, yokes, and implements. The hand tools used in mountain agriculture should also be given new shapes and designs suitable to local site-specific conditions, and these must be acceptable to local farmers.

Such technological improvements in the tools, implements, yokes, and harnesses would increase DAP efficiency and help farmers increase their productivity by integrating DAP technology into their present system.

## 9.3 Institutional Options

The conventional institutional intervention, as we have observed, has a potentially negative impact, contributing to the process of unsustainability in the animal husbandry sector as far as DAP is concerned. An appropriate, perspective-based cattle breeding policy

would be instrumental in augmenting DAP in the mountains. To evolve a new breeding policy, the conventional policy should be reviewed thoroughly. There are specialised breeds for milk, meat, wool etc, but no specialised breeds of draught animals for mountain regions have ever been recognised. The traditional breeding and management skills of local farmers might be pivotal in developing a new breeding policy framework for mountain areas.

Lack of adequate policy measures for augmenting DAP for the development of sustainable mountain agriculture is a basic problem that needs to be addressed. DAP should be treated as an important ingredient of the integrated energy system and as an input qualifying for institutional and infrastructural support.

Adequate infrastructural facilities in terms of R & D and extension services for designing more efficient and matching harnesses and animal-drawn implements and for the improvement of the DAP system would greatly encourage efforts in the sustainable development of mountain agriculture. Statistics on draught animals, their usage patterns, and so on should be published from time to time to help the researchers and scholars in this field.

In the Central Himalayas, the chances of a perspective-based policy framework for promoting and improving the DAP system and ultimately developing sustainable agriculture are very bright. There are several NGOs and voluntary organizations in the region as well as grassroots' workers who are environmentally sensitive. In essence, there are a great many opportunities to infuse sensitivity into public institutions.

### 9.4 Humane Aspects

The traditional love for animals in India is amongst its greatest strengths. Good human behaviour towards animals is vital for harnessing their potential. A frightened animal, due to secretions of hormones, can work with greater vigour, but only for short durations. Animal's remaining under continuous strain, due to ill-treatment from the owner or driver, is detrimental to its health and work efficiency. Cruelty to animals can make them furious and violent, which might be risky for the driver. Inhuman treatment of animals reduces their working life and hence the economic gains they can provide.

In addition to their economic uses, draught animals are elements in complex cultural patterns. The sacred cow, for example, rules the psyche of the Indian masses. As a source of identity, security, and prestige for families, and a means of social cohesion through gifts and exchange with others, the draught animal gives humanity more than can be accounted for statistically. Humane treatment, love and care of animals, therefore, scores high on grounds of morality and justice.

Barbaric traditional methods of castration, underfeeding, imbalanced nutrition, work without food for long durations, and goading and beating with sharp sticks while performing work are examples of the maltreatment draught animals suffer.

Examples of the maltreatment of work animals one often confronts in the mountains are : barbaric methods of castration, underfeeding, imbalanced nutrition, work without rest and goading and beating with sharp sticks while performing work. These inhuman practices must be avoided. Draught animals are, after all, nurturers of a family and the only source of livelihood for many families. The animals understand the language of love and voice commands, and they return human affection in terms of vital contributions to livelihood.

Affectionate relationships and proper care, they say, doubles the working efficiency of animals. A properly yoked, properly harnessed and well-treated animal is more productive and cost-effective than those that are ill treated (Lord 1991). Humane aspects of dealing with the animals right from cow to calf care and while at work are crucial for maximum DAP output and sustained DAP input for agricultural production.