CHAPTER VIII

# STOCKING RATE, CARRYING CAPACITY AND LIVESTOCK MANAGEMENT

## 8.1 INTRODUCTION

Indian Himalayan pastures are beyond the carrying capacity because they are stocked more than double the actual number of animals it can fed (Gupta 1986). This pressure has lead to the deterioration of vegetation in terms of quality and quantity, and accelerated soil erosion that aggravated the degradation of the habitat and loss in soil fertility.

Grazing carrying capacity can be defined as the grazing ability of a pasture land which can support adequately to a constant number of grazing animals for a definite period every year, without deteriorating the same land in respect to grazing value or other proper land uses and expressed in number of livestock per appropriate unit area (Sundriyal 1989a; Gupta 1990). In the Himalaya, cattle are mainly dependent on forests and pastures for their fodder requirement. If the forage removal is more than the net primary production, the vegetation of the area will be lost in one way or the other in course of time. Forage removal beyond the carrying capacity severely effects herbage compensation and non-palatable species proliferates in such areas. Proliferation of non-palatable species will definitely reduce the grazing carrying capacity and pasture quality. The importance of establishing an ecologically sound grazing regime with proper stocking rate is obvious for sustainable and ecologically sound management of pasture (Gupta 1986). Generally, there are more animals grazing on these lands than they can carry. Due to ill effect of overgrazing, these ecosystems display the sign of deterioration and disruption on herbage compensation process. There is a

need to manage these grasslands for maintaining balance between sustained animal production and the plant productivity by the application of ecological principles. Attention has now rightly been drawn towards scientific management of grasslands by maintaining the grazing ability.

In the Yuksam-Dzongri trekking corridor, due to increased number of tourist trekkers in the recent years, the livestock enterprise (mainly pack animals) has become a potential and expanding income-generating sector. This has necessitated the study on livestock production, economy and environmental linkages. Estimation of grazing carrying capacity is very essential for sustainable management of the trekking corridor in the Khangchendzonga Biosphere Reserve. Current stocking rate and its comparison with the carrying capacity are needed for development of strategies of sustainable management. The present chapter deals with the estimation of livestock stocking rate and grazing carrying capacity of different pastures at different ecological zones along the Yuksam-Dzongri trail in the Khangchendzonga Biosphere Reserve.

## 8.2 METHODS

The four ecological pastures (warm temperate, cool temperate, subalpine and alpine) as described earlier were considered for the estimation of livestock stocking rate and grazing carrying capacity. Foraging characteristics of different grazing livestock have been studied and presented in Chapter IV. The conversion of cow equivalent unit (CEU) for different livestock were calculated based on daily forage consumption rate. Stocking rate was calculated as the number of livestock per unit area.

$$\text{Stocking rate} = \frac{\text{Livestock number (CEU)}}{\text{Total area (ha)}}$$

The livestock grazing carrying capacity was estimated by the formula given by Brown (1954).

$$\text{Carrying capacity} = \frac{\text{Total forage production (ha}^{-1}) \times \text{Forage use factor}}{\text{Forage demand}}$$

Forage demand is the dry forage consumption per animal per year. Forage use factor was calculated as the ratio between aboveground forage removal by grazing to the aboveground net biomass in exclosure plots per unit area basis.

## 8.3 RESULTS

### 8.3.1 Current Stocking Rate

All the livestock grazing animals have been converted into cow equivalent units based on the forage consumption by each animal types and differed between temperate and alpine/subalpine sites (Table 8.1). At temperate pasture, one dzo is equivalent to 1.14 cow, one horse to 1.03 cow, one sheep to 0.37 cow and one goat to 0.38 cow, whereas in alpine and subalpine pastures, one dzo is equivalent to 1.14 cow, one yak to 0.92 cow, one horse to 1.01 cow and one sheep to 0.33 cow (Table 8.1).

Different livestocks have separate time period of grazing at various pastures. At Yuksam (warm temperate), 454 cows grazed for the whole year, 22 horse for 140 days, 461 sheep for 255 days, 122 dzos for 180 days and 311 goats grazed for the whole year. At Sachen (cool temperate), 45 cows, 7 horse and 23 dzos grazed for three months only

(Sachen is the winter resident area for Tshoka villagers when Tshoka village gets covered with snow during mid-December to mid-February). At Deorali (subalpine), 38 cows grazed for 20 days, 25 yaks for 80 days, 13 horses for 13 days and 60 dzos for 13 days. At Dzongri (alpine), 38 cows grazed for 90 days, 78 yaks for 285 days, 13 horses for 100 days, 461 sheep for 110 days and 122 dzos for 160 days (Table 8.2).

The animals were converted into cow equivalent units (cow) and estimated as 904 cows at Yuksam, 78 cows at Sachen, 143 cows at Deorali and 334 cows at Dzongri (Table 8.2). Current annual stocking rates were calculated for different pastures and recorded 1.29 cow $ha^{-1}$ for Yuksam, 0.49 cow $ha^{-1}$ for Sachen, 1.02 cow $ha^{-1}$ for Deorali and 0.56 cow $ha^{-1}$ for Dzongri (Table 8.2).

### 8.3.2 Grazing Carrying Capacity

Based on the aboveground net biomass productivity, animal forage demand and forage use factor, livestock grazing carrying capacity in terms of cow equivalent unit (cow) has been calculated for different pastures along the Yuksam-Dzongri trail and presented in Table 8.2. Forage used factor has been regarded as 50% of the aboveground biomass, this value is based on present study findings given in details in the biomass chapter. Out of the four different pastures studied, Yuksam pasture has the highest carrying capacity of 1.34 cow $ha^{-1}$ $year^{-1}$, followed by Sachen (1.18 cow $ha^{-1}$ $year^{-1}$), Deorali (0.96 cow $ha^{-1}$ $year^{-1}$) and least at the Dzongri alpine pasture with 0.86 cow $ha^{-1}$ $year^{-1}$ (Table 8.2). The potential carrying capacity of pastures based on 60% herbage

utilization has been estimated and recorded 1.61 cow $ha^{-1}$ for Yuksam, 1.42 cow $ha^{-1}$ for Sachen, 1.15 cow $ha^{-1}$ for Deorali and 1.03 cow $ha^{-1}$ for Dzongri (Fig. 8.1).

## 8.4 DISCUSSION

Pasture area conducive for grazing is highest at Yuksam followed by Dzongri, Sachen and Deorali. The pasture at Sachen is mainly used by Tshoka villagers in winter and also by pack animals during brief halting on the trek. Yuksam and Dzongri are more of settled pastures for longer period of grazing. Yuksam being populated settlement area faces highest annual stocking rate, while Dzongri being the remotest place only the summer grazing and pack animal grazing during tourist season reasonably makes the lower stocking rate. At Yuksam, the annual stocking rate is marginally smaller than carrying capacity, which clearly indicates that pastures have reached the limit where more scientific management is required. At Sachen, animal stocking is well below carrying capacity. The Dzongri pasture is also within the limits. The subalpine transition zone at Deorali pasture is more critical and fragile that has crossed the carrying capacity limit. This is a serious concern and a definite grazing regime for grazing livestock and regulation of pack animal halting has to be established for this pasture. Visible symptoms of site deterioration are already conspicuous at Deorali.

The carrying capacity of 1.34 cow $ha^{-1}$ at warm temperate (Yuksam), 1.18 cow $ha^{-1}$ at cool temperate (Sachen), 0.96 cow $ha^{-1}$ at subalpine (Deorali) and 0.86 cow $ha^{-1}$ at alpine (Dzongri) pasture is

comparable with the reports from Garhwal Himalaya (Gupta 1986) as they have reported 1.09 cow $ha^{-1}$ for warm temperate, 0.91 to 3.49 cow $ha^{-1}$ for cool temperate, 0.89 to 1.80 cow $ha^{-1}$ for subalpine and 0.65 to 1.81 cow $ha^{-1}$ for alpine. Grazing by different types of animals on the same range to obtain more efficient use is referred to as common use. It is well recognised that forage species selection varies considerably among different animal species on the same range. The species grazed by all types of animals in the same range is termed as dietary overlap. Controversy exists over how grazing capacity should be evaluated when common use is involved. Scarnecchia (1985, 1986) argues that grazing capacity should be based on animal-related factors because dietary overlaps between different animal species vary with terrain, season of use, grazing system, stocking rate, and year-to-year weather fluctuations that affect forage production and species composition. Hobbs and Carpenter (1986) advocate that animal unit equivalents should be weighed relative to degree of dietary overlap. They based their argument on the fact that different herbivores have different impact on the range due to their consumption of different forage. In the shortgrass prairie of eastern Colorado, 335 kg $ha^{-1}$ will give maximum economic returns and maintain forage production (Bement 1969). On the South-Eastern Oregon big sagebrush ranges, grass residues for 180 kg $ha^{-1}$ will maintain or improve range condition on most sites (Hyder 1953). In the California annual grassland type, from 300-1200 kg $ha^{-1}$ of maximum residue is needed depending on the site (Hooper & Heady 1970). In the present study sites, the forage residue needed to be left for good rangeland

condition are recorded as 1130-3370 kg $ha^{-1}$ for warm temperate (Yuksam pasture), 1010-4880 kg $ha^{-1}$ for cool temperate (Sachen pasture), 1260-3520 kg $ha^{-1}$ for subalpine (Deorali pasture) and 134-3100 kg $ha^{-1}$ for alpine pasture (Dzongri pasture).

Carrying capacity is one of the indicators of the productivity of pasture and is not the determining factor. The pasture with a high carrying capacity for one species of livestock in one situation can have a very low carrying capacity for another species of livestock in a different situation. For example, a pasture with a high carrying capacity in the tropical and sub-tropical zones will have 'zero value' for yaks, as they cannot graze on it. Similarly, sheep or goats because of their ability to graze on bushes and weeds could very efficiently utilise a pasture of low carrying capacity. Grazing carrying capacity is regarded as 50% aboveground biomass utilisation as upper limit from the findings of the present study. Because of concentrate grazing near campsites, trail and near livestock sheds more prominently at Dzongri and Deorali, there has been an observable sign of vegetation loss, soil erosion and habitat degradation. This has deteriorated the site appearance conducive for tourism. Therefore, grazing in the vicinity of the campsites and sheds has to be minimized. Concentration of large number of pack animals during the same period should be avoided. Pack-animal number and movement should be regulated at the entry point. The major settlement area of Yuksam and its surrounding pasture has reached the carrying capacity limit. Collection of fodder, fuelwood, timber and other non-timber forest products might be another factor for vegetation deterioration. Another

site that is the Deorali pasture has crossed the limit. Therefore, a grazing regime has to be established at these two sites. Yuksam being a settlement area should concentrate on raising of more valuable fodder in agroforestry itself rather than free grazing. There is a lot of potential for strengthening the agroforestry and meeting the fodder demands at Yuksam. However, at Deorali the strategy has to be on establishing of grazing regime especially by working with the owners of pack animals and other livestock. If the pack animal related range management is done at Deorali the problem could be considerably solved.

The area has high potential for livestock related livelihood. The livestock types and range of pastures from the warm temperate to cool temperate, subalpine and alpine provide a situation of great potential for development. The livestock products have established market and pack animals already draw large proportion of income for local community. The area receives high rainfall and conducive relative humidity stimulates and promotes growth of vegetation. The concern is mainly on the management of the rangelands, which more or less have not received any scientific input until now. A concerted effort by the biosphere reserve managers involving the livestock graziers and owners has to be made on the scientific management of rangelands in an urgent basis. Linkages between livestock grazing, rangeland and tourism related activities and management options are shown in Fig.8.2. ■

**Table 8.1** Conversion of different animal groups in terms of cow equivalent unit (CEU) at different pastures along the Yuksam-Dzongri trail.

| Animal Type | Cow equivalent unit | |
|---|---|---|
| | Temperate | Alpine/subalpine |
| Dzo | 1.14 | 1.14 |
| Yak | - | 0.92 |
| Horse | 1.03 | 1.01 |
| Sheep | 0.37 | 0.33 |
| Goat | 0.38 | - |

**Table 8.2** Pasture area, livestock numbers, grazing days, stocking rate and grazing carrying capacity at different pastures along the Yuksam-Dzongri trail.

| Parameters | Name of the pastures | | | |
|---|---|---|---|---|
| | Yuksam | Sachen | Deoral i | Dzongri |
| Pasture area (ha) | 800 | 200 | 200 | 1360 |
| Area conducive for grazing (ha) | 700 | 160 | 140 | 600 |
| Livestock number | | | | |
| Cow | 454 | 45 | 38 | 38 |
| Yak | - | - | 25 | 78 |
| Horse | 22 | 7 | 13 | 13 |
| Sheep | 461 | - | - | 461 |
| Dzo | 122 | 23 | 60 | 122 |
| Goat | 311 | - | - | - |
| Duration of grazing (days $year^{-1}$) | | | | |
| Cow | 365 | 90 | 20 | 90 |
| Yak | - | - | 80 | 285 |
| Horse | 140 | 90 | 13 | 100 |
| Sheep | 255 | - | - | 110 |
| Dzo | 180 | 90 | 13 | 160 |
| Goat | 365 | - | - | - |
| Total cow equivalent unit | 904 | 78 | 143 | 334 |
| Annual stocking rate (Cow $ha^{-1}$) | 1.29 | 0.49 | 1.02 | 0.56 |
| Carrying capacity (Cow $ha^{-1}$ $year^{-1}$) | 1.34 | 1.18 | 0.96 | 0.86 |

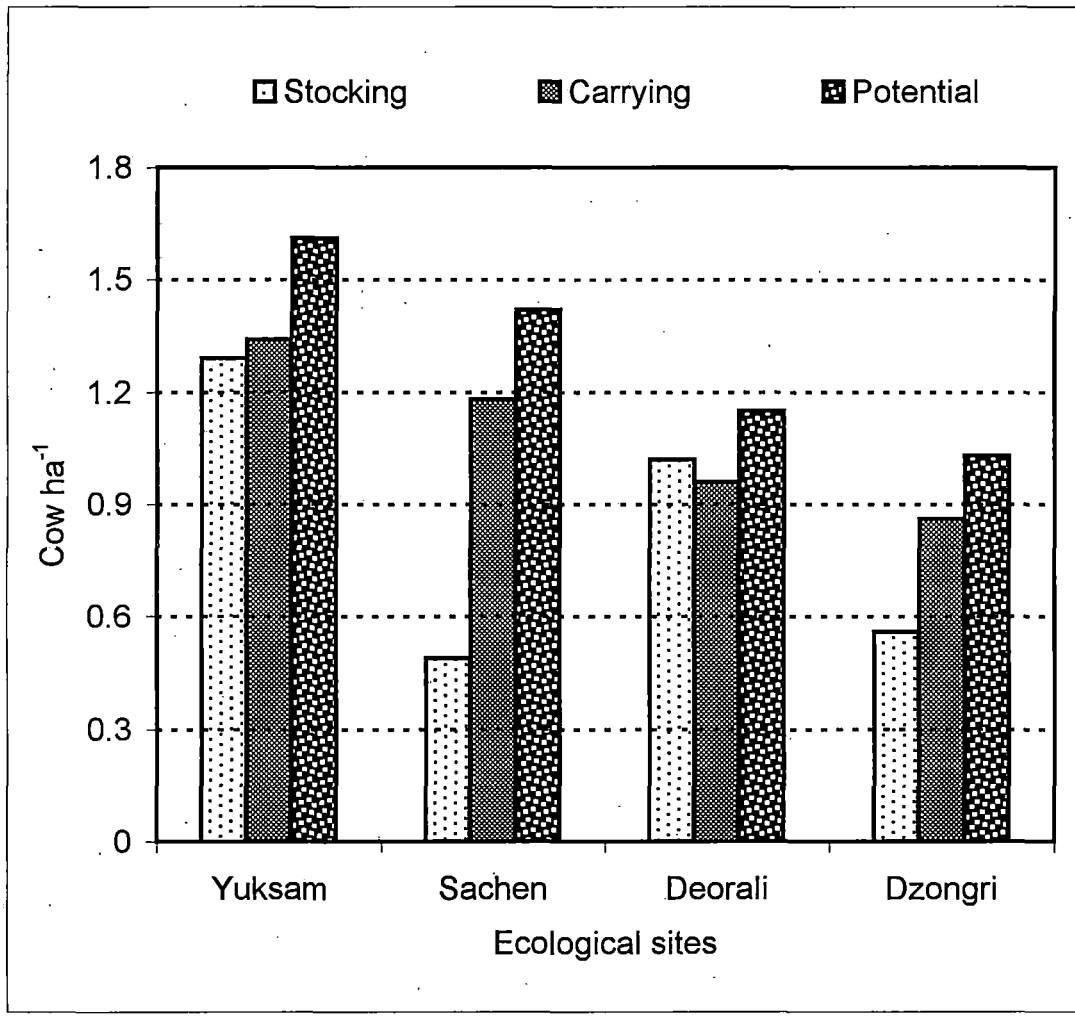


**Fig. 8.1** Current stocking rate of livestock, carrying capacity and potential carrying capacity of pastures at different ecological sites (Yuksam at 1700 m-warm temperate, Sachen at 2100 m- cool temperate, Deorali at 3800 m-subalpine/near timberline and Dzongri at 3900 m-alpine zone) along the Yuksam-Dzongri trail in Khangchendzonga Biosphere Reserve of Sikkim Himalaya.

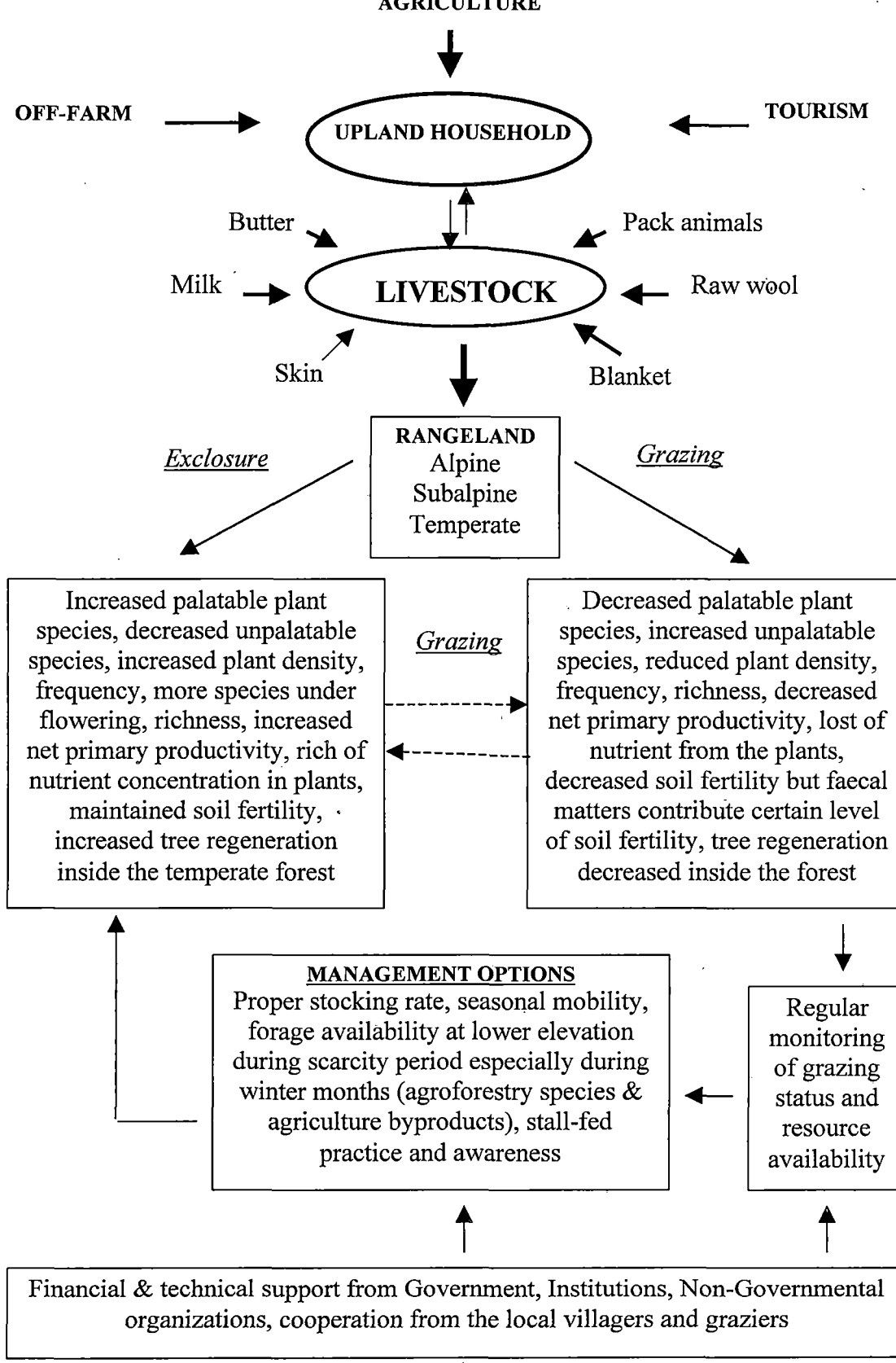


**Fig. 8.2** Linkages between livestock grazing and rangeland and its management options in the Khangchendzonga Biosphere Reserve