ECOLOGY OF RUPRI GRASSLANDS AND IMPACT OF NOMADISM ON THE ECOSYSTEM

THESIS SUBMITTED FOR AWARD OF THE DEGREE OF

DOCTOR OF PHILOSOPHY

1994

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UNDER THE SUPERVISION OF

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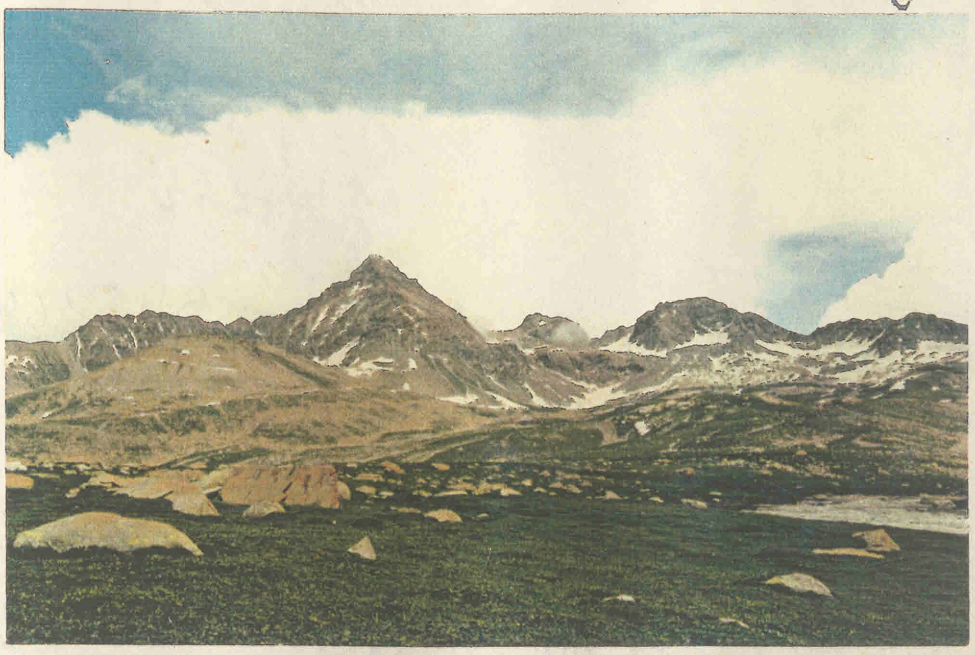
ECOLOGY OF RUPRI GRASSLANDS

AND

IMPACT OF NOMADISM ON THE ECOSYSTEM



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For Award of The Degree of
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C E R T I F I C A T E

It is certified that:

i) The thesis entitled, "**ECOLOGY OF RUPRI GRASSLANDS AND IMPACT OF NOMADISM ON THE ECOSYSTEM**, "embodies the work of the candidate Mr.Chander Mohan Seth, himself.

ii) The candidate has worked under my supervision for the period required under statutes.

iii) The candidate has put in attendance in the Department during the period required under rules.

iv) The thesis being submitted for the degree of Ph.D. by Mr.Chander Mohan Seth is worth consideration for the award of Ph.D. degree of the University of Jammu, Jammu. The thesis incorporates research work of the candidate and has not been earlier submitted in this or any other University.

v) The conduct of the research scholar remained excellent during the period of research.

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C.M. Seth

Panoramic view of PirPanjal mountain Range, District Rajouri, indicating Dhakyar Peak and Rupri study sites.



CHAPTER 1

INTRODUCTION

INTRODUCTION

Grazing land vegetation primarily is a mixture of herbaceous plants and is dominated by family Poaceae. Grasslands have been described as a type of vegetation that is subjected to periodic drought and is dominated by grass and grass like species. Different vernacular terms are in use in different parts of the world for grasslands. In Eurasia grasslands are refered as Steppes (Discontinuous cover), in North America as Prairies (continuous herbaceous cover), in South America as Ilanos or Pampas, in Africa as Savannas and in Australia as Rangelands (Groombridge, 1992). Pastures above tree line in French are called "Alps" or "Alpages", in Pyrenees as "Estibers" and in German as "Alpen" or "Almen" and in Alburz mountains these are known as Ilāqs (Encylo. Brit. Vol. 1, 1980). In Central Himalayas these are locally called as "Bugyals" and in Kashmir these are called as "Margs".

However, Encyclopaedia Britanica (vol. 8. 1980) classifies grasslands of world in two major types on the basis of latitude as;

1. Middle latitude grasslands $20^{o} - 40^{o}$
2. Tropical grasslands and Savanna. $0^{o} - 20^{o}$ Equator

Other type of pastures identified are

3. Alpine meadows and
4. Taiga Polar.

It has been estimated that grasslands covered about 40 % of the earth's surface prior to the impact of man and his domesticated animals (Clements et al, cf. Groombridge, 1992). Present day area under grasslands have been estimated as 27 % of the world's natural vegetation cover (Knystautas, 1987). However, estimates of the area under world's grasslands as estimated by various workers are as under:

Table 1 : Estimates of the area (in million Km^2) of the world's grasslands.

Category	Whittaker And Likens (1975)	Atlay, Ketner and Duvigneaud (1979)	Olson, Watts and Allison (1983)
Savanna	15.0	22.5	24.6
Temperate grassland	9.0	12.5	6.7
Total grassland	24.0	35.0	31.3
Grassland as % of world land area	16.1 %	23.7 %	20.7 %
Grassland as % world land area (excluding Antartica)	17.9 %	26.5 %	23.1 %

Ecologically the distribution of grasslands is predominantly governed by climatic factors, related cheifly with the latitudinal influences (Whyte, cf. Groombridge 1992). However, Puri et al. (1989) observed about the ecology of grasslands that, " a proper understanding of grassland types is complicated by the influence of the biotic factors." It has been further observed that apart from certin high alpine zones, the grasslands do not occur as climax formations and are mere a sub-climax in association with different forest climaxes. Except in the alpine regions the grasslands are bio-edaphic in nature and may be regarded as a sub-climax or dis-climax (Lal and Melkania, 1994; Singh,1994).

The Asiatic steppe extended from Manchuria westwards as far as the land now included in Bulgaria and Hungary. The continental climate of this vast stretch comprised of hot, dry summers with very cold winter which is inimical to the growth of trees and thus supported only grasslands. These vast grasslands were earlier inhabited by large herds of wild herbivores like horses, sheep and gazelles, etc. But later-on with the advent of domesticated animals several nomadic societies came into being in these areas who reared large herds/flocks of animals on these lands as a source of livelihood.

The Indian sub-continent by and large supports either tropical savanna, savanna woodland or dry deciduous forests. The total range of grassland types is very broad - from semi-desert, to seasonally inundated areas to montane habitats. There is no doubt that in India a very large area formerly supported dry woodland of various types, but there has been enormous amount of clearance, followed by fire and grazing. Champion and Seth (1968) thus recognised grassland types corresponding to each forest type in a particular ecological zone on the basis of parallelism that exists between grassland and forest types. Puri et al (local. cit.) classifies grassland types under various ecological zones of India. Under western Himalayan type he recoginses three sub - types viz; Tropical & sub - tropical,temperate and Alpine & subalpine grasslands. Dabadghao and Shankarnarayan (1973) identified five potential grassland types, which are given in table 2.

Table 2 : Area under different grass covers (based on Dabadghao, Shankar narayan, (1973); Lal and Melkania, 1994)

Characters	Ecological zones		
	Tropical	Sub - tropical	Temperate and Alpine
Grassland type	Sehima - Dichanthium	Dichanthium - Cenchrus - Lasiurus. Phragmites - Saccharum Imperata. Themeda- Arundinella.	Danthonia cachemyriana, Kobresia sp., Poa alpina and Phleum alpinum.

Climatic zone	Semi - arid zone of Central India Plateau, Chotta Nagpur Plateau and Aravalli ranges	Dry sub- humid, moist sub- humid and moist sub humid to humid montane zone. Gangetic plains, Brahmputra valley, Northern & North Western montane tract.	High hills Northern montane belt.
States.	Gujarat, Maharashta, Madhya pradesh, Orissa, Andhra Pradesh, Karnatka. Tamilnadu & Kerala	Rajasthan, Delhi, Punjab, North Gujarat, Western U.P Manipur, Assam, Tripura, West Bengal, Bihar, Part H.P & J&K	J&k, H.P, U.P, W.Bengal, Sikkim, Arunachal Pradesh, Assam etc.
Area			
Open grazing (m ha)	20.27	11.04	0.33
Forest area (m ha)	36.13	54.91	--

Yadava and Singh (1977) estimated total area of grassland in India as 13813.1 thousand hectares, Singh (1994) estimates that the area under grazing lands has decreased from 13.26 million Ha in 1980 to 11.60 million Ha in 1989-90. Govt. of India, Forest survey of India Ministry of Environment and forests have recently completed Satellite mapping of Alpine Pastures in Himalayas through the visual interpretation of Landsat imagery for the period 1981-84. Area under Alpine pastures in different Himalayan states is estimated in the following table 3:

Table 3 : Area under Alpine Pastures in Himalayas

S.no	Name of state	Geographical area (km^2)	Alpine Pasture land (km^2)	Permanent Snow (km^2)	Alpine as % of total geographical area
1.	Arunachal Pradesh	83580	12335	862	15.0 %
2.	Sikkim	7300	1626	842	22.3 %
3.	Utter Pradesh	294411	8524	4376	3.0 %
4.	Himachal Pradesh	55670	17296	4934	31.0 %
5.	Jammu and Kashmir	222240	131857	39097	59.33 %
	Total	663201	171638	50111	25.88 %

Source:- Forest Survey of India 1989.

Study concluded that alpine pastures in India occupy 1.52% of the total land area in the country. Casimir and Rao (1985) reported area under pasture and other grazing lands in Jammu and Kashmir as 1,25,000 ha.

The estimate of G.O.I also includes areas of Jammu and Kashmir under P.O.K. Infact total area under Indian control is only 1,38,942 Sq kms. Accordingly the area under alpine pastures is also an over estimate by the F.S.I. Following table indicates actual area under alpine and other kind of pastures in

the Jammu and Kashmir state (Malik, 1987).

Table 4 : Area under Alpine and other grazing land in J & K

S.No	Category	Area in km^2	Percentage of total geographical area
A.	**Areas under forest boundaries**		
1.	Alpine Pastures (Excluding Ladakh)	3030	2.18 %
2.	Other Pastures	1163	0.84 %
3.	Broad leaved forests	784	0.56 %
B.	**Areas under village boundaries**		
4.	Broad leaved forests	6600	4.75 %
5.	Permanent Pastures & other grazing lands	1210	0.87 %
	Total Pasture lands	12787	9.20 %

Source :- Forest Record No. 1. 1987.

Above figures however, do not include vast grasslands of Zanskar, Drass, Nubra and Rupshu grasslands of Changthang in Ladakh. Neither village figures nor forest department statistics indicate areas under village pastures or under alpine grasslands. Total area under high altitude steppes of Ladhak can safely be estimated as 39000 to 40000 km^2. Thus the

total area in the state under different types of grasslands, including top feed resources of broadleaved forests, can safely be estimated as 52787 km^2. Area under alpine pastures is not more than 44193 km^2 at present as against 131857 km^2 as interpreted by Forest Survey of India for whole Jammu and Kashmir state.

During the recent years ecologists from all over the world have tried to collect data on productivity, mineral cycling, and energy relationships of different ecosystems. This was mainly done under the aegies of **International Biological Programme**. The models thus evolved have enabled ecologists to evaluate the impact of human activities on the structural and functional relationships of the ecosystems. In terrestrial habitats like forests, grasslands and crop lands primary producers in the food and energy chain have been investigated both in tropical as well as temperate parts of the world. In India also extensive work have been done in tropical grasslands but very little information has been generated for temperate ecosystems. Work in the sub-alpine and alpine regions is almost negligible because of limited working period and poor accessibility. Singh (1994) and Lal & Melkania (1994) have recently summerized the status of grasslands and its future management strategies in India.

In India grasslands have been mainly studied for structural and functional parameters to express the effect of geo-climate on vegetation with special reference to the biotic influence on such lands. But very little attempts have been made to study pasture lands in relation to nomadism as a system of management for maintaining the socio-economy of pastoral and transhumance communities in different parts of the country whose sustenance and life style is directly dependent on the existance of good pastures and their livestock.

Himalayas, "The northern barrier of India", stretch from Nanga Parbat along the Indus to Namcha Barwa on the bend of the Tsang-Po in south east Tibet for 2250 kms, in east westerly direction (Polunin et al. 1984). Kashmir forms part of Western Himalayas. Its mountain ranges support extensive pasture lands and several nomadic tribes who have acclimatized over the centuries with the climate and vegetation of the area. State of Jammu and Kashmir has been of great interest to ecologists, geographers, historians, etc., due to its unique location and climatic conditions. Several scholars in the past have studied various aspects in isolation, but since all activities of man are directly related with the ecosystem, it requires the wholistic approach to study any single aspect of the system for

the betterment of humanity and sustained use of its resources.

Rupri marg (meadows) located in western PirPanjal mountain range forms one of the major oscillation channels for the migratory nomadic herders in J&K state. Every season the activities of the nomads involve cyclic spring and autumn oscillation along this corridor, therefore the site was selected for the purpose of present study as a representative site of Kashmir Alpines.

Majority of the population in state is rural. The state being mountainous, the rural population is by and large pastoral in nature. Besides rural population, state has also inherited good percentage of nomadic population who taking advantage of monsoonic, temperate and alpine vegetation transhumance from one ecological zone to another in a cyclic manner. It is this aspect of transhumance which have badly affected the ecology of the areas, more particularly the Alpine pastures.

In the present study, an effort has been made to interrelate the relationship of transhumance with the productivity of Alpine pastures and suggest measures for its improvement, if required. Casimir and Rao (1985) also observed that the

studies of " Man Environment " interaction should be initiated to analyze the influence of pastoral economies on different ecological zones to safegaurd the mountain ecosystems, especially those of Himalayas.

It is hoped that the results of present investigation will add to the present knowledge of grassland ecosystems in India more particularly the Alpine grassland ecosystems of Western Himalayas, which thus far have been relegated into the background.

CHAPTER 2

REVEIW OF LITERATURE

REVIEW OF LITERATURE

In all the natural conditions that help to determine the development of human life, climate plays a predominant part for it is chief factor in the formation of bioenvironment and it decides the vegetation and animal associations. Various anthropologists and social scientists have been involved for many years in studies pertaining to the process of evolution and origin of different societies of the world (Sharafeldin, 1982). Archaeological evidences prove that the agriculture and pastoralism developed more or less concomittantly in a close symbiotic relationship in different grassland zones of the world as agriculture continued to develop and population densities increased, more economic specialization emerged. Eventually, a full time herders appeared, especially as they began to expliot pasture areas further removed from the centres of cultivation.

Man, to meet its daily needs started

collecting around him a whole association of plants and animals as allies and dependents. Most of the human Geographers believe that earliest evidence of domestication dates from Neolithic age (Perpillou,1977) and in all 40 species of animals were domesticated but Billore (1978) believes that man started domestication from Pleistocene period and ever since grazing lands have been important to him. With cultivated plants,domestic animals and a piece of land, regular work and thought for the future, there appears the whole complex of pastoral agricultural or agri-pastoral civilizations. Khatana (1992) observes that it took several centuries for man to change over from food gathering stage to food producing stage and develop inter relationship with other biotic communities. He further observed that the pastoral systems are infact articulated by three major variables of the ecosystem, besides the environment viz., Man ,animals and the pastures.

Thus in India as well as abroad several scholars have tried to understand human geography in relation to history, ecology,trade, economy, etc., from time to time. They have tried to understand the human behaviour in utilization of resources for its betterment.

So, in order to gain vital information on the functional aspects of deteriorating ecosystems International Council of Scientific Unions(ICSU) established a programme in 1964 entitled "International Biological Programme" (IBP). Much work has been done in India and abroad under this programme and its findings have been published from time to time by ISTE (Misra and Gopal 1968) ISTE -INTECOL (Golley and Golley 1972; Golley and Medina 1975) INTECOL (Van Dobben and McConnel 1975) and others. Recently synthesis of grassland studies in various I B P plots of the world (1964 - 1974) have been summarized in several I B P series particularly I B P 3, I B P 18 and I B P 19 (Coupland, 1979).

HUMAN GEOGRAPHY

Human geography or social geography is the study of various races in the world,their origin, development of civilization and their interrelationships with other components of ecosystem. Bobek (1961) observed six stages of transition from food gatherers to food producers.

Perpillou (1977) observed that immense areas of steppe run through Central Asia from Manchuria to the Volga; in Africa they occupy the desert borders and the high plateaus that stretch from

Ethiopia right to cape; and they form large expanses in North and south America and in Australia. These areas from earliest times have been centres of modes of life depending on stock rearing. Yet there is a fundamental difference between pastoralism in the Old world and the New world. In the former pastoralism is of ancient date. It was unknown in the new world before the settlers, who brought with them the domestic animals and the custom of sedentory civilisation. He also classifies pastoral regions of the world into six zones based on the animals domesticated like, Ox, Sheep, Goat, Ass, Horse and Camel.

Gaisford (1981) observes that pastoral nomadism developed in the old world and identified five zones on the basis of domesticated animals like Camel, Cattle, Sheep and Goat, Horse and Reindeer.

Demiruren (1982) identified four basic systems of animal husbandry viz., Nomadic, Transhumance, Partial Settlement and migration from settlements. The nomadic system has been described as the oldest type of migratory sheep and goat husbandry in which families move with their herds in constant search of grazing and water.

Sharafeldin (1982) observed that

tribalism is the socio-political framework of nomadism.

Vidyarthi et al (1985) while studying the "Tribal culture of India" tried to trace the origin of Himalayan pastoral nomadic socities like Gujjars of Himachal Pradesh and Jammu & Kashmir, Gaddis of Himachal pradesh , Jadhs of Bhagirathi valley, Chaupans of Kashmir and Bakkerwals of J&K state.

Hasnain (1992) laid down five principles of tribal development as follows:

1. People should be allowed to develop on the lines of their own genius and nothing should be imposed upon them;
2. tribal rights in land and forests should be respected;
3. induction of too many outsiders into tribal areas should be avoided;
4. there should be no over-administration of tribal areas as far as possible;work should be done through their own social and cultural institutions and
5. the result should be judged not by the amount of money spent but by the quality of human character that is involved.

Khatanna (1992) observes that within

the main zones of Nomadic pastoralism man developed a systematic process of herbage conversion in a particular habitat. Areas which were suitable for cultivation of plants developed into agricultural lands and domestic animals in such regions were fodder based rather than pasture based. In the areas which were not suitable for agriculture but provided natural pastures, the domesticated animals were based on later. He further observes that this gave rise to two distinct branches of animal husbandry. While fodder based system gave rise to agrarian society, pasture based system of animal husbandry gave rise to nomadism and then to Nomadic pastoralism.

Majumdar et al (1992) while studying the social anthropology of Indian tribes estimated tribal population of India as 20 million mainly concentrated in north east, middle (central) and southern India. There is, however, no mention of north and north western tribal groups. On basis of occupation he classified Indian Tribes into six groups viz ., Food gathering tribes, agriculturist, shifting axe cultivation , handicrafts, pastoralism and industrial labour.

GRASS LANDS

Grazing lands include the worlds prairies, steppes, savannahs, deserts, tundra and under storey of most forested ecosystems. In India grazing lands occur in some form or the other, in almost all states and occupy the total area in thousands of 13813.1 Ha.

In India grazing lands from 1964-1974 have been studied under various programmes of IBP and Man and Biosphere. Ramam (1975) studied productivity of Tropical deciduous forest ecosystem under IBP India. Pandey (1978) reported that the synthesis of data on the production of organic matter from various research stations in temperate and tropical grasslands has been done by a large number of authors for a series of International Biological Programme volumes published by the Cambridge University Press. Bellore (1978) has summed up studies carried out in India at Varanasi, Rajkot, Kurukshtera, Ratlam, Ujjain, Pillani, Jodhpur, Udaipur, Delhi and other places for various structural and functional attributes of tropical grasslands.

Recently in Kashmir university the structural and functional aspects of several temperate meadow lands were studied by Kachroo et al 1971, Kaul et al. 1973, Gupta, 1979 and Koul 1981 and others. The

scanning of literature reveals that infact the exploratory work on the flora of Jammu & Kashmir state started much earlier.

Hooker (1872-1897) consolidated the information of several workers, who had explored the botanical wealth of the state uptill that time, into seven volumes of "Flora of British India".

Duthie (1894) worked on the flora of Kashmir, Beltistan and Gilgit with the prime objective of availability of fodder plant species in such areas which could be used as forage for cavalry of British Army .In Gilgit district he enlisted about 45 species of 17 families suitable for fodder. From Drass and Tilel, he reported use of **Prangos pabularia**, Lind as fodder in winter. He also reported poisonous species from Kashmir and black mountains of Hazara viz., **Delphinium speciosum** var.,**ranunculifolium** and **Stipa sibirica**.

Stewart (1916-17) in his botanical exploration of Ladakh, Drass and Rupsu enlisted 475 Plant species. He also observed that infact botanical and geographical explorations were initiated with the Bukhara adventure of Moorecroft (1819-1825). He further observed, "that if Indian side of Great Range of Himalayas is luxuriant and abundant in floristics, the

opposite is true on the other side ". He also reported existance of three main elements of floristics (1) Alpine (2) Desert (3) Oastic. In Suru valley he reported 142 plant species, mostly alpine. The oastic flora exists near lakes and springs and where there is no moisture, desert elements are found. At Rupsu he recorded 79 species and at Baralacha only 20 species.

Bews (1929) tried to collect an extensive and scattered information on grasses uptil that time and presented in his classical work on "The Worlds Grasses" their differentiation, distribution , economics and ecology . His work mainly concentrated on the studies carried out in Great Britain and South Africa. He established that in the world there are primitive and advance type of grasslands, evolutionary. The hygrophilous grasslands are primitive and xerophytic are advanced ecologically. His work dealt extensively with taxonomical details.

Bharucha and Dave (1944) observed that in most of the studies it was found that grasslands under biotic interference of man and animals have high value of Therophytes.

Bharucha and Dave (1952) worked on ecology of grasslands of Raita, Bombay in order to improve degraded lands into good pasture lands by way

of natural succession and effective enclosures , soil conservation and water conservation measures and manuring/ fertilization to meet the fodder requirement of Dairy Cattle. From year 1937 to 1939 effective protection increased population of perennial grasses and reduced population of non-grasses.

Chopra et al (1956) completed pioneer studies in enlisting 124 fodder plants from Jammu to Ladakh (800 - 14000). Of these 114 species belonged to Graminae and 10 species to family Cyperaceae. Out of these 22 species were reported to grow in abundance and provide maximum vegetative herbage to livestock. These species were also analyzed for their nutritive value and it was found that 28 grass species possess good nutritive value i.e., Calorific value of 250 or more. The calorific value of 28 grasses per 100 gms ranged from 250 to 290.

Bliss (1956) studied plant development in microenvironments of arctic and alpine tundras and found that in both the regions cryptophytes and chamaephytes predominated to a greater extent than expected in the Raunkier's normal Spectrum.

Raina (1959) enlisted 106 grass species in Himachal Pradesh from tropical to Alpine grasslands locally known as Charands in order to find

out nutritious and palatable grass species to meet the requirement of livestock under different Pasture Improvement schemes.

Pandeya (1960) recommended use of "Dominance Diagrams" instead of Raunkiaer's " Frequency Diagram" in so far as the Indian context of vegetation is concerned to express the "abstract homogeneity" actually present in grassland associations.

Pandey (1961) tried to prepare grassland map of 8 grassland associations of Sagar (Madhya Pradesh) on physiognomic basis. It was also established that grasslands in Sagar exist due to various anthropogenic factors viz., cutting, grazing and fire.

Pandeya (1961) compared two statistical methods viz., "Frequency Index community coefficient" and "Frequency cover Index community coefficient" methods for evaluating the difference and similarities between two stands or two grassland communities. The coeficients by the two were worked out as 64.9 and 70.6 respectively.It was not known whether the difference was statistically significant or not.

Prakash and Nanda (1961) identified four ecosystems in western Rajasthan (including one

sub-ecosystem) on the basis of physiognomy of grassland species, topography , climate and soil conditions.It was recommended that areas under each ecosystem should be managed in such a mannar so as to improve the specific type of grass assemblage suited to each type by adopting suitable grazing practices, soil working,soil and water conservation measures and other agronomic practices.

Gupta and Shankarnarayan (1962) described grasslands as extensive uniform tracts spreading over vast areas where the predominant vegetation cover is one or more of the various species of grasses with associated herbs, shrubs, legumes, sedges, etc., and rarely trees. On the basis of biotic and climatic factors it was established that South Indian Grasslands of Nilgiris are not climatic climax but a subclimax.

Legris (1962) used H. Gausson's method for mapping of vegetation of south India on environmental conditions. This helped in drawing bioclimatic zones. For this purpose he used ombrothermic diagrams, ecological formulae related to water balance, soil factors, xerothermaic index, etc. He recommended that the "plesioclimax" helps to

appreciate the ecological potentiality of the place and can also help to show homobioclimates of the world for the introduction of new species.

Dass et al (1963) carried out studies on grazing capacity studies in Grasslands of western Rajasthan. A 70% utilization was considered adequate to maintain the grassland in same status. The botanical composition indicated 13 species in 1957 and only 6 species in 1960. Six annual species were eliminated over a period of three years. The plant cover percentage which was 10.25% in 1957 increased to 28.27% in 1960. Animals were grazed in experimental paddock for 287 days, 259 days, 307 days,284 days from 1957 to 1961 and the net gain in body weight after the grazing was 1.13 kg, 1.00 kg, 0.53 kg and 1.22 kg respectively, and it was concluded that even in a poor condition , one wether per acre can be maintained of average body wt. of 25 to 27 kgs. Normal production was also maintained during the experimental period i.e., 1099 g per head per year. Annual carrying capacity was calculated to be 6.17 sheeps per hectare. Since, provision of forage is to be made for the entire year, in efficient stock management the grazing capacity is calculated by the following expression.

$$\text{C.C/Ha/yr} = \frac{\text{Total No. of Sheep days}}{365 \times \text{Area of grazing.}}$$

In the experimental paddock although number of sheep was increased every year, the average C.C increased from 3.70 to 8.10 Sheep/Ha/yr. For improvement of grasslands the standard rule followed in USA is "to take half and leave rest half" for improvement of soil and vegetation. As a safe yardstick recommended carrying capacity (C.C.) was proposed 2.47 wethers/Ha.

Meher-Homji (1964a) studied the life form and Biological spectra as epharmonic criteria of aridity and humidity in the tropics. His study established a correlation between the biological spectra of different regions of India and their bio-climates.

Misra (1964) used point-centered quarter method for structural assessment of grassland vegetation in Prairie of Canada and same was later applied in India as against 'point frame method', which has been recommended to contain certain advantages over the later.

Pandeya (1964 a) studied composition of fenced grassland associations of Sagar (M.P) These grasslands were analyzed for their analytic and synthetic characteristics.

Pandeya (1964 b), on the basis of

physiognomy, recognised 8 grassland associations of Sagar, M.P. under different degrees of grazing. It was observed that intensity of grazing decided the physiognomy and structure of communities. In the study, five degrees of "fidelity" were also distinguished. It was observed that life-forms of the speices change in response to the environment, especially intensity. Raunkiaer's life -forms or Biological spectrum is an excellent tool with the ecologists to express intensity of grazing. Average of all 8 plant communities in Sagar indicated that the percentage of hemicryptophytes is far below the normal and that of geophytes and therophytes is four times more than normal, which is obviously on account of over grazing in the grasslands. But, the significant life-forms of the grasslands are the hemicryptophytes and the geophytes as these growth forms are maintained solely on account of degree of grazing.

Iwaki et al (1964) studied Productivity, Nutrient Element Circulation, and Seasonal changes in Standing Crop in Kirigamine Grassland, Japan. Aboveground Biomass reached maximum in September (380 gm/m^{-2}). Grasses made the largest contribution to aboveground biomass.

Billings and Mooney (1968) studied effect of environmental factors on the adaptation of Arctic and Alpine plants. They identified fifteen characteristics in plants which are employed singularly or in combination to adapt to severe environments, viz., Life form, Seed dormancy, Seedling establishment, Chlorophyll content, Photosynthesis and Respiration, Drought resistance, Breaking of Dormancy, Growth, Food storage, Winter survival, Flowering, Pollination, Seed Production, Vegetative propagation and onset of Dormancy. Nitrogen and Phosphorous often limiting in cold soil.

Kulkarni et al (1968) while suggesting measures for Grazing and Range management in India pointed out that, "mere arithmatic calculation of the incidence of grazing in a region on the basis of its overall forest area and the total cattle population does not give a correct picture of what the grazing does to a forest." They also recommended certain measures to improve the range lands of India.

Singh (1968) studied above ground productivity of protective and unprotective grasslands of Varanasi from 1962 to 1965 . Site III with great biotic interference contained maximum number of annual

species. Maximum Aboveground biomass ranged from 555.55 gm/m^{-2} site I to 576.70 gm/m^{-2} site II to 570.54 gm/m^{-2} site III Results were compared with 1964/65 and exclosure. In all cases peak biomass was observed in september/october. The difference of biomass production on all sites was very significant. To calculate contribution of major perennial species concept of "Log Ratio" was used.

To find out efficiency of Herbage utilization, principle of Line (1959) was followed .It is based on, " the percentage utilization," that is, the difference between the pre grazing and the post grazing samples, expressed as a percentage of pre grazing sample, can be quoted to indicate the efficiency of utilization". But this method has been indicated as misleading to express grazing intestity.

Efficiency of utilization of grassland at Varanasi

	Site 1	
Period 63-64	I grazing	II grazing
1.Pregrazing/cutting herbage (g/Sqm)	525.86	290.82
2.Post grazing/cutting herbage (g/Sqm)	255.80	177.48
3.Herbage utilized (g/Sqm)	270.06	113.33
4.% Utilization or efficiency of utilization.	51.35%	38.96%

Reduction of efficiency after second grazing is due to accessibility of herbage above the grazing level before first grazing and not after second grazing. Net community production was assessed for four growing periods as a difference between maximum and minimum herbage weight. In all the sites net community production was maximum during the period June-October i.e., monsoonic period.

Brewer et al (1969) studied grassland and thicket vegetation of Michigan USA from 1960 to 1967. As compared to biomass they recorded vegetational weights which varied from 1320 to 3829 gm/m^{-2}. They also studied the invasion of grassland with other species.

Deschenes (1969) while studying life form spectra based on cover data of contrasting slopes of the grazed pastures of Northern New Jersy found that there was greater proportion of hemicryptophytes and geophytes on south facing slopes as compared to the north facing slopes. Grazing, Trampling as well as micro-climate may be responsible for the differences that exist between the two slopes. It was also established that. " the widely accepted idea that grasslands, prairies and pastures are hemicryptophytic habitats," hold true.

Singh and Misra (1969) compared

concepts of McNaughton (1967)for Californian Grasslands with grasslands of Varanasi. Results of three disturbed and two protected grassland types proved that species diversity increased productive efficiency of the system while dominance makes the system stable, though less efficient for production. This observation was in contrast to McNaughton's observation.

Shankarnarayan and Dabadghao (1970) carried out ecological studies on the grasslands of Jhansi and on the basis of physiognomy recognised nine communities.

Gupta et al (1971b) studied above ground productivity of grasslands of Jodhpur and compared the results with that of other sites in the world. In the study it was concluded that due to erratic nature of climate and productivity no specific conclusion can be drawn. However it was observed that production of grasslands is direct function of climate and the pressure of grazing stock.

Sims and Singh (1971) while working on nine U.S. IBP Grassland Biome sites established relationships between Abiotic and Biotic parameters and their relationship to grazed and ungrazed conditions. Net primary productivity and accumulation rates

indicate that grasslands have inherent mechanisms to adjust to grazing pressure. The most significant difference in the ungrazed and grazed grasslands is the contrasting behaviour of aboveground net production (ANP) and belowground net production (BNP) efficiencies. On all sites the efficiency of BNP is greater in grazed grasslands as compared to ungrazed grassland. The grazed grasslands have a mechanism to balance any loss in efficiency due to grazing by increasing the efficiency of below groud production. In the study it was also reported that there are contrasting adaptive mechanisms operating in tropical and temperate grasslands.

Ambasht et al (1972) reported peak standing crop biomass production of 2050 g/m^{-2} in protected grasslands of Varanasi. From July to October production increased due to rainy season and then remained more or less constant upto March and then reduced considerably till June/July. Net annual increment was 1359 g/m^{-2} and turnover was 1.51 years, as compared to Heteropogon grassland community (A.N Increment = 2883 g/m^{-2} and turnover 1.13 years).

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Dale and Anderson (1972) tested efficiency of numerical methods over traditional methods in Qualitative and Quantitative information

analysis of phytosociological studies. It was concluded that the greater efficiency in the analysis and structure of phytosociological data might be obtained from a synthesis of the two approaches.

Gupta et al (1972 a) studied the ecology and successional trends of 7 different grassland types of Rajasthan.

Gupta et al (1972 b) worked on the productivity of three principal grasses of Rajasthan at Jodhpur. They observed that the above ground phytomass was a direct function of the rainfall received and also the soil moisture, which is a limiting factor in arid zones. Average monthly phytomass was recorded maximum in Lasiurus sindicus ($307.2\ gm/m^{-2}$), followed by Cenchurus ciliaris ($260.3 gm/m^{-2}$) and C. setigerus ($118.8\ gm/m^{-2}$) in the year 1970-71. They also calculated the carrying capacity of these pastures in terms of cattle units per hectare basis under different rainfall conditions as under :-

Year	Rainfall in mm.	Cenchurus ciliaris	C.setigerus	Lasiurus sindicus
1968/69	185.9	2.1	1.30	4.12
1969/70	165.2	0.6	0.15	0.29
1970/71	515.0	6.9	3.40	7.10

Jain and Mishra (1972) under the IBP project worked on fenced grassland of Sagar for study of underground biomass production. It was observed that aboveground production in grasslands is of great significance to the ecolcgists and dairy scientists and underground prouduction is of great importance to soil development, its Conservation and soil organic matter. The study proved that underground biomass increased in three growing periods. Highest biomass production of 1537.36 gm/m^{-2} has been recorded in the months of September. Immediately after rainy season it declines, remains constant in winter with slight fluctuation in summer. Study also laid stress on proper sampling periods for Under Ground Biomass productivity studies as per seasons which can be two, three or four or even Six. This study also supported the view that the replacement of underground parts is more rapid in tropical grasslands than in the temperate regions on the basis of turnover value which comes to 0.83.

Le Houerou (1972) assessed the primary and secondary production of the Arid Grazing Lands ecosystems of North Africa. He classified the vegetation types into three main groups viz.,1) Forest and depleted forests (Silva); 2) steppes (saltus) and 3) cultigene (ager). The steppes were further sub-divided into four main categories viz., 1) Graminous

steppes; 2) Chamaephytic steppes; 3) Nanophanerophytic steppes and 4) Crassulescent steppes. The biomass and production varied enormously from one plant community to the next as a consequence of ecological factors mainly the water balance in the soils. Average yield of fodder in different pastures under varied rainfall conditions has been recorded as under:

Average annual	Average yields of dry fodder t/ha/year		
Rainfall mm	Good Pasture	Fair Pasture	Mediocre Pasture
75-100	100	50	20
100-150	150	100	40
150-200	200	120	50
200-250	300	150	80
250-300	600	300	150
300-350	800	500	220
350-400	1000	800	300

It was also observed that under proper management practices the yields can be increased upto 4,5, or even 6 times.The study concluded that due to increase in human population the rangelands have depleted and secondary production considerably reduced.

Savile (1972) listed nine environmental characteristics which affect arctic flowering plants and adaptability by them to withstand these factors viz., (1) Low winter temperature (2) Low summer temperature (3) Short summer (4) Strong wind (5) Long photoperiod (6) Low light intensity (7) Low nitrogen supply (8) Low precipitation (9) Simple population structure and low density.

Tadmore et al (1972) studied primary and secondary production of Arid grasslands of North African and Middle Eastern deserts. These deserts since ancient times are homes of nomadic Bedouin population. Experiments conducted in Negev desert of Israel (1962-71), on the stocking rate trial on the main pasture types of the area. The results were recorded as under:

Rainfall and yields of native vegetation, Migda 1962-1971

Year	Amount of Rain mm	Yield of native vegetation, t/ha	
		Fresh matter	Dry matter (oven weight)
1962/63	42 (b)	-	3.4
1963/64	377 (g)	13.4	3.1
1964/65	413 (g)	10.4	4.9
1965/66	318 (b)	10.3	3.6
1966/67	282 (g)	15.9	2.8

1967/68	308 (b)	11.3	2.6
1969/70	170 (b)	_	_
1970/71	238 (b)	_	_

g = good rainfall, b = bad rainfall year.

Herbage yields fluctuated far less than the rainfall fluctuations, especially in dry matter yields. Dry matter yields are almost constant at 3 t/ha . Optimum economic production depends on land/sheep value relationships and on supplementary fodder prices in the area.

Results of secondary production showed that production per animal was higher under the low stocking rate but it reduced considerably in drought years within certain limits, yield per animal rises with reduced stocking rates and yield per unit land normally decreases.

Dabadghao and Shankarnarayan (1973) observed that grasslands do not occur as the climatic climax in India. Grasslands in a broad sense represent that land on which gramineous species represent the dominant vegetation. In Jammu and Kashmir state 23 sites were studied (315 mts to 2650 mts a.s.l) from sub-tropical to temperate regions . But they, somehow

did not study alpine and steppe (Ladakh) grasslands of the state.

Kaul and Sapru (1973) studied seven meadowlands in and around University Campus of Kashmir. In all the seven sites they listed 64 plant species. High diversity was recorded at sites where there was biotic interference. Plantago lanceolata recorded high I.V.I of 36 to 39 at 4 sites due to low biotic interference. Whereas, Cynodon dactylon exhibited high I.V.I from 44 to 60 at 3 sites which were subjected to biotic interference. On protected sites values were low. Biomass production varied from 165 gm/m^{-2} for site II, 152 gm/m^{-2} for site IV to 90 gm/m^{-2} for site 1 under various degrees of biotic interference.

Agarwal (1974) studied biological spectrum of the flora of Gogunda and Prasad in Rajasthan. He observed higher percentage of therophytes and cryptophytes. While comparing with similar sites in India, it was observed that regions in the sub-tropical zones with dry winter are characterized by therophytic phytoclimate.

Bliss and Mark (1974) While studying High Alpine environments and Primary Production on the rock and Pillar Range, Central Otago, Newzealand

observed that Cushion and Herbified communities were subjected to severe environments : persistent strong winds, low air and soil temperatures with many freeze - Thaw cycles during the 5-month growing season, and moist frost-active soils. These ranges of Newzealand when compared with alpine communities of similar physiognomy from the Northern hemisphere, exhibited a very long snow free season, about 6 month and plants grew intermittently, throughout much of the period aboveground net production (ANP) of herbifieds was 208-255 gm/m^{-2} as compared to 126 gm/m^{-2} of cushion vegetation. Annual productivity was higher than for many physiognomically similiar communites. In Newzealand alpine environment, plants lack specialized over wintering buds. Here summer precipitation was much higher as compared to summer dry - alpine environments of Afghan Hindukush. So it had less water stress during the growing season.

Kaul and Sarin (1974) studied vertical distribution of plant communities in Bhaderwah hills of Doda district where they found well marked zonation of vegetation from lower (1600 mts) to higher elevation (3900 mts).

Mall and Billore (1974 a) while studying the seasonal variation in L.A.I of Ratlam

Grassland community found that there were significant periodic variations in L.A.I of all the categories viz., Total community, grass and forb. During the rainy season the intra-seasonal LAI changes were distinct due to availability of favourable edapho-climatic conditions during which the community was sensitive in ranges from 0.94 to 7.9, whereas, Bliss (1969) reports lower L.A.I. values for alpine communities due to environmental severity.

Mall and Billore (1974 b) studied dry matter structure and its dynamics in Sehima grassland community of Ratlam.In all 6 grasses, 9 forbs and 5 legume species were listed. Sehima nervosum possessed high I.V.I of 98., Themeda triandra of 55 followed by Heteropogon contortus of 41.4. Grasses contribute several fold more biomass than the forbs. Grasses are sensitive to changes in soil moisture and when soil water level goes down below the critical level there is a sudden fall in their biomass. The below ground plant parts are the main contributors of Biomass. The results are obtained from the fenced area. The four compartments viz., aboveground live, below ground, standing dead and litter attained their peak biomass in late September (363.1 gm/m^{-2}), November (873.0 gm/m^{-2}), December (315.6 gm/m^{-2}) and May (275.0 gm/m^{-2}) respectively.

Naik et al (1974) studied ecology of four grasslands of Ambikapur under different degrees of protection. The studied concluded that the aboveground biomass increased with the increase in protection, contribution of grasses to the aboveground biomass and dominance index decreased just after protection but increased subsequently. The variety of species and underground / aboveground plant biomass ratio decreased with the increase in protection. The aboveground biomass ranged from 105.1 gm/m^{-2} to 358.2 gm/m^{-2} depending on degree of protection and grazing and dead biomass including litter ranged from 98.5 gm/m^{-2} to 484.4 gm/m^{-2}. It was also observed that diversity decreased with the progressive elimination of biotic interference.

Singh and Yadava (1974) studied productivity of Kurukshetra grasslands (protected). A study of life forms indicate a thero-cryptophytic flora. Maximum aboveground biomass was recorded in September (1974 gm/m^{-2}) and maximum belowground biomass in November (1667 gm/m^{-2}). Aboveground net primary production was maximum during the rainy season(1706 gm/m^{-2}) and below ground during winter season (785 gm/m^{-2}).Total annual net primary production was estimated to be 3538 gm/m^{-2}. Annual efficiency of energy capture by the primary producers was calculated

to be 1.66 %. The yearlong growing season, abundant precipitation, higher light intensity, and preponderance of C_4 plants in tropical grasslands seem to favour greater efficiency of energy capture and greater net primary production. They have also critically analyzed various methods for the calculation of aboveground net primary productivity, below ground net primary productivity, net accumulation and disappearance rates. Various formulaes were also analyzed to account for the unaccounted productivity while drawing the balance sheet of productivity.

Redmann (1975) observed that it was IBP which gave impetus to the studies of productivity in various ecosystems both natural and man-made. Most of the studies completed by 1960 in North America mainly dealt with forage yield and it was later-on that productivity aspect of grasslands received attention.

The productivity of 10 grassland community stands of semiarid western north Dakota (USA) were studied by him. Herbage production (Shoot) mean of 2 years (1966 and 1967) ranged from 200 gm yr^{-1} m^{-2} in stand 7 to 77 gm yr^{-1} m^{-2} in stand 3.Root mass ranged from 6230 gm/m^{-2} stand 7 to 3030 gm/m^{-2} stand 9. Fresh mulch ranged from 320 gm/m^{-2} to 212 gm/m^{-2} . Chlorophyll values ranged from 78 mg/m^{-2} , stand 3, to 542 mg/m^{-2} stand 7.

Variation in chlorophyll was due to morphology, phenology and biomass. Warm season communities were more efficient in herbage production than cool season communities. On annual basis stand 7 comprising of Sporobolus hetrolepis community was more efficient with 0.12% and stand 3 comprising of Bouteloua gracilis community was least efficient with 0.06%.It was also observed that environmental pressures result into assemblages of species which handle drought condition by various modifications of the basic Endure-Evade-Escape theme.

Saxena (1975) lists seven effects of Biota on the vegetation of desert ecosystem of western Rajasthan. These effects are 1) Deformation of trees & shrubs, 2) Removal of propagules, 3) Casuality of plant material, 4) Increase of non - palatable material, 5) Compaction of top soil, 6) Soil erosion and 7) Retrogression of vegetation, He also reported plant density, basal cover and forage yield from protected & open grazing lands. The forage yield was almost 2 to 7 times more in protected areas than in open areas.

Sapru et al (1975) in the Jehlum Valley (Kashmir) observed Pines and Cedars confined to north eastern slopes, while the south western side had

insignificant tree cover due to poor and highly eroded soil. The phytoclimate was found to be that of thero-chamaephytic type. Areas subjected to heavy biotic interference were reported to support chamaephytic type of vegetation.

Singh et al (1975) reported productivity of Keylong alpine meadow H.P.(alt : 3515 mtrs a.s.l) as 518 gm yr^{-1} m^{-2}.

Wassink (1975), while studying productivity of four grazing levels in Ujjain tropical grasslands recorded total net production (TNP) from 1163.5 gm yr^{-1} m^{-2} to 2033.9 gm yr^{-1} m^{-2}.

Billore and Mall (1976) reported the effect of soil moisture on seasonal variation of chlorophyll contents in a fenced grassland of Ratlam. The chlorophyll content varied from maximum of 711.41 mg/m^{-2} to minimum of 0.6 mg/m^{-2} during mid September and May, respectively. The a/b ratio for the whole community was reported as 2.3. It was also observed that the value of chlorophyll content obtained at Ratlam compares well and is within the range of seven alpine communities (0.4 to 0.9 mg/m^{-2}) as reported by Bliss (1966).

Jain (1976) tried to find out new

method of total litter production and Litter dissappearance in an input and output balance sheet of Biomass production, under IBP/PT India , in tropical grassland of Sagar.

Kaul and Sarin (1976) also observed that Bhaderwah hills possess geo-chamaephytic climate. Higher altitudes were rich in Chamaephytes and Hemicryptophytes upto 3500 mts., m.s.l. Chamaephytes dominated above 3500 mts completely.

Shankar et al (1976) studied application of various growth indices like relative growth rate (RGR), leaf area ratio (LAR), specfic leaf area ratio (SLR) and net assimilation rate (NAR) on Cenchrus ciliaris to understand various analytical parameters that determine the productivity of grasslands. Study concluded that 30 days interval and 15 cms height of defoliation appeared preferable to various other combination of intervals and heights of defoliation tested.

Naik and Mishra (1977) carried out ecological studies on four sites of Ambikapur Grasslands under different degrees of biotic stress (1) Grazed (2) Protected during study period (3) protected for two years (4) Protected for about ten years. Number

of species increased from site 1 to site 3 but decreased in site 4. Like, Singh and Misra (1969) they have also observed decrease in diversity with the progressive elimination of Biotic interference. There was increase in dominance Index with the increase in protection. They also tried to estimate net community production and efficiency of 4 grasslands of Ambikapur by using different methods of estimation as tried by Ovington (1963), Odum (1960) and Wiegert and Evans (1964). However first method was not tried at all.Only results of last two were compared. Net community production for site 3 and 4 by two methods was recorded as:

site 3 = 945.40 $gm/m^{-2}/yr^{-1}$ Odum method

644.39 $gm/m^{-2}/yr^{-1}$ Wiegert Evan method

site 4 = 873.39 $gm/m^{-2}/yr^{-1}$ Odum method

841.10 $gm/m^{-2}/yr^{-1}$ Wiegert Evan method

Difference of values was significant from 0.09 to 0.37., lowest was obtained for site I (grazed grassland) which is probably due to the reason that aboveground plant parts taken away by herbivores were not considered.

Billore (1978) observed it is a fact that net primary production per year in a stable

ecosystem ideally approaches zero. Since the production is entirely consumed and / or mineralized and the system starts at the same level as the year before".

Pandey (1978) recorded total annual net community production (aboveground plus underground) in Varanasi to be 2255 gm/m^{-2} / yr^{-1} or 7.0 gm^{-2} / day. The comparative study with other grasslands indicate that this site had a higher productivity than the temperate grassland. Net primary production was greatest during rainy season when water was available in abundance followed by winter and summer seasons. The seasonal variations played an important role in the growth patterns of major species.

Sen *et al* (1978) reported nutritive value of various Indian cattle feeds and nutrition requirement of cattle. The nutrition of animals consist of Water, Proteins, Fats, Crude Fibre, Soluble Carbohydrates, Minerals like Calcium, Phosphorous, Iron, Copper, Iodine, Cobolt, etc., Vitamins like A and D. Vitamin B and C are synthesized in ruminant body. In green pastures vitamins A, B, C, D and E are readily available. He laid down the feeding standards as 2.0 to 2.5 kg of dry matter per 100 kg of live weight of cattle. Dry matter should come from roughages and

concentrates. But no study has been made on green pasture feeding. In addition to this information with regards to DCP and energy (SE,TDN or ME) should be known which the ration should supply. Average requirement for the maintenance of adult cattle per head per day varies with the live weight of cattle. In a study for live weight from 150 kg to 550 kg the ration worked out varies as under :

Digestible crude Protein [DCP]	= From 0.102 kg to 0.336 kgs.
Starch Equivalent [SE]	= 0.95 to 3.18 kgs.
Total Digestible Nutrients [TDN]	= 1.27 to 3.71 kgs.
Metabolizing Energy [ME]	= 4.57 to 13.36 M cal.
Carotene	= 10 to 36 Mg.
Calcium	= 4 to 12 gm.
Phosphorous	= 4 to 12 gm.

For other categories the ration is increased for maintenance as well as production.

Coupland (1979) while summing up the findings of the results of the IBP plots of the world observed that it is difficult to make generalization, because of diferences in methodology and intensity of study, identical parameters were not measured at all sites and degree of completeness of reporting. However,

on basis of mean values some observations have been recorded by him.

Maximum green (live) shoot biomass ranged from 76 to 2088 gm/m^{-2}. The lowest values were typical of semi - arid temperate to tropical climates. Maximum production was associated with sub - humid tropical climate, maritime climate or with temperate habitat receiving natural irrigation. Intermediate values were from semi - natural and natural temperate grasslands. Mean green shoot biomass ranged from 50 gm/m^{-2} in arid grasslands to a high of 827 gm/m^{-2} in dry sub humid climate.

Dead shoot biomass ranged from 10 to 506 gm/m^{-2} with no trend evident in relation to habitat.

Maximum canopy biomass (green plus dead shoots) was used to calculate turnover rates. Values ranged from 86 to 3406 gm/m^{-2}. In tropical grasslands it averaged about 130 gm/m^{-2} in semi- arid, between 400 to 450 gm/m^{-2} in humid and about 1300 gm/m^{-2} in sub humid cliamte. In temperate regions the maximum canopy biomass varied from 350 to 400 gm/m^{-2} in natural grassland to 550 to 600 gm/m^{-2} in semi- natural types. Ratio of green biomass to dead biomass varied from 0.12 to 4.57 with a mean of 1.5. Mean biomass of litter ranged from 70 to 900 gm/m^{-2}.

Underground biomass ranged from 45 to 4707 gm/m^{-2} with a mean value of 700 gm/m^{-2}. The higher values in temperate than in tropical situation were probably due to in part to a slower rate of turover associated with lower temperatures. Ratio of mean underground and maximum canopy biomass ranged from 0.2 to 10.3. Ratio was smaller in tropical grasslands as compared to temperate grasslands.

Total annual net production ranged from 239 gm/m^{-2}/yr^{-1} to 4557 gm/m^{-2}/yr^{-1} in tropics. In temperate it ranged from 702 to 3470 gm/m^{-2}/yr^{-1}. Annual aboveground biomass production ranged from 82 to 3396 gm/m^{-2}/yr^{-1} in tropics and in temperate from 98 to 2430 gm/m^{-2}/yr^{-1}. He also observed that the estimates obtained from incremental analysis increased with frequency of sampling, which varied greatly from site to site. When compared with maiximum live shoot biomass it ranged from 0.7 to 3.8.

In a balanced system, he determined the rate of turnover by the relationship between standing crop and rate of production. The turnover time for above ground ranged from 0.26 yr to 1.4 yrs. Turnover time for underground ranged from 0.36 to 4.18 yrs, with values higher in temperate and less in

tropics. He also observed that no environmental trends are easily discernible probably because of variability in degree of use by livestock and in the methods of estimating shoot production.

It was also observed that integration of information concerning consumers in the various kinds of grasslands is more difficult than with producers for several reasons and as such studies have been made in a relatively few sites. In the system modules evolved it was observed that the static modules that have resulted should be considered tentatively since they are all based partly on assumptions. Lastly it was also observed by him that the information is scarce concerning the effect of grazing on primary production in most of the world's range lands.

Gupta (1979) recorded Total Net Production (T.N.P.) of grazed and fenced areas of Yusmarg Meadowland Kashmir (alt : 2400 mtrs a.s.l) as $1112.35 \text{ gm}^{-2} \text{ yr}^{-1}$ and $6112.39 \text{ gm}^{-2} \text{ yr}^{-1}$. While studying structure and function of Yusmarg Meadowlands located on northern slopes of PirPanjal range he recorded maximum number of plant species in summer and minimum in winter. The plants were thero-chamaephytic and thero-hemicryptophytic in nature. Most of the plants

completed their life cycle in one or two months except perennials which flourished throughout the year. Dominance of plants was not permanent but seasonal with the result the plant associations recorded a change periodically.

Numata (1979 b) worked on mathematical models to analyse homogeneity and heterogeneity of plant communities in IBP plots of Japan. When coefficient of homogeneity (CH) decreases, the distribution is more homogenous and vice-versa. He also studied biological spectrum of permanent quadrat for three years on the basis of Raunkiaer's life forms, Numata's migrule forms and Numata's Growth forms . In order to judge the status of pasture or meadow as poor, fair, good or excellent a modified measure of Degree of succession (DS) with the grazing rate (g) similar to forage value was used as Index of Grassland condition (IGC).Relationship between DS and Biomass curve was also established. Numata tried to compare the productivity of world's grasslands. The biomass dynamics of grassland communities and dominant grasses are closely related to DS.It was noticed that a plant community makes a new environment by its reaction to the old environment and another new community is established in new environment.

Sapru and Kachroo (1979) analysed the vegetation of Ladakh in relation to climate and observed that the area confines to a geo-chaemaephytic type of phytoclimate with a high proportion of therophytes. Cold winter was depicted by the preponderance of geophytes and chamaephytes, where as the therophytes reflected the aridity of that region.

Trivedi and Mishra (1979), while working on the productivity of grassland of Jhansi and Magan recorded 50 species and observed 23 species common at two sites. Rate of litter disappearance was faster than that of root disappearance. Total live biomass reached its peak in September and October with the value of 466.1 gm^{-2}, and 778.9 gm^{-2}. Standing dead matter reached maximum in December and November to a value of 121.2 and 123.4 gm^{-2} at two sites. Belowground biomass increased to the peak value of 767.7 gm^{-2} and 436.3 gm^{-2} at two sites. Belowground biomass showed biomodial growth with two peaks. Total biomass at two sites was 1283.1 gm^{-2} and 963.3 gm^{-2}. Aboveground net primary production was recorded as 912.2 and 689.2 gm^{-2} yr^{-1}. Belowground net primary production (BNP) was 1166.1 and 773.2 gm^{-2} yr^{-1} for two sites. Thus turn over values were found to be 1.61 and 1.77

respectively.

Singh and Ambasht (1980) while working on three study sites of grasslands in Varanasi observed that highest variety of species occured on heavily grazed areas. Low diversity was due to longer protection which results into high degree of dominance. It is also agreed that with increase in dominance , diversity decreases It has also been reported that grazing affects density as per species, in some it increases and in others it reduces. On grazing site annuals increase and in protected perennials dominate.

Harrington (1981) observed that physical disturbance of the soil surface by the hooves of animals can promote moisture penetration by excessive treading can cause compaction and shedding of moisture. He also analyzed various reasons for the wide spread degeneration of arid zone pastures in both developed and traditional economies which indicate that management decisions are strongly influenced by sociological and economic factors, the condition of animals is often secondary and that of pastures is rarely given any consideration et al. He also emphasised that in the past, solutions to arid zone problems have frequent been sought through technology,

resulting in the treatment of symptoms rather than the causes. He recognized four grazing systems in the world viz., True nomadism, Transhumance, semi-sedentary and sedentary.

Hudson et al. (1981) describes tundra vegetations as characterized by short stature, low biological density and low annual production. The decomposition rate is slow, resulting in considerable accumulation of dead organic matter. Following biomass and productivity of northern hemisphere environments have been recorded by them.

Typical values for stsnding crop, net annual primary productivity and sustained forage production.

Zone	Standing crop Kg/ha^{-1}	Net annual Pr. Productivity $Kg/ha/yr^{-1}$	Sustained forage Production $Kg/ha/yr^{-1}$
Polar desert	200	50	10
Tundra	7000	3000	200

They also emphasised that grazing management is the single most important aspect of rationalization of animal husbandry in northern region. In some countries good management is encouraged by legal and

administrative sanctions. In some countries fines are levied for range abuse and trespass grazing. In many countries lower and upper limit of animals is perscribed based upon the long term carrying capacity of the ranges it control.

Smith et al. (1981) have compiled research findings of various workers of the world in development of various agronomic practices for increasing the productivity of grasslands and feed quality of animals in XIV International Grassland Congress proceedings held at Kentucky, U.S.A.

Koul (1981) while studying structure and primary productivity of ground vegetation in Nilnag forest (alt :2100 mts) located on northern slopes of Pirpanjal ranges recorded 139 plant species in total and also observed that none of the species showed a consistant high number of I.V.I. throughout the vegetative period of nine months. Seasonally the plants showed different I.V.I. Different phenological phases were completed within nine months of vegetative period whereas, some species completed in short period of two months. Life forms exhibited thero-chamaephytic type of phytoclimate. The total net production (TNP) was estimated as 1036.4 $gm/m^{-2}/yr^{-1}$ and aboveground net

production (NP) as 635.5 $gm/m^{-2}/yr^{-1}$. The turnover rates in respect of aboveground live, aboveground dead, underground and litter were 82.13%, 73.45%, 70.09% and 115.4%, respectively. He also studied variation in root/shoot ratio which range from 0.07 to 1.19 and compared it with the results obtained by Gupta (1979) in the adjoining meadow of Yusmarg.

Singh and Krishnamurthy (1981) observed that shoot biomass has peak in monsoons which ranges from 4 gm/m^{-2} to 1974 gm/m^{-2}. Peak growth of belowground mass precedes, synchronizes or succeeds the peak growth of aboveground biomass and ranges from 51 gm/m^{-2} to 2368 gm/m^{-2}. Annual turnover rate of canopy biomass ranges from 44% to 155% and root biomass ranges from 44% to 206%. Comparison with temperate grasslands of USA indicate that in tropical grasslands the production per unit of plant biomass is more. Concentration of biomass belowground is more in temperate environment than tropical environment. All tropical grasslands have bimodal peaks in belowground biomass accumulation.

Williams (1981) while analyzing the evolutin of grazing systems of the world recognized four systems based on natural and man-made grasslands.

These systems are True nomadism, Semi-sedentary, Sedentary and Transhumance. He also observed that first grasses spread globally in late Cretaceous and became abundant by about Miocene. Grass speciation and the associated development of grasslands have continued uptill now.

Dhar and Kachroo (1983) observed that 2900 mts altitude may be considered as a starting point of Alpine Zone in Kashmir.They also observed that the number of plant species decreased with the increasing altitude owing to the prolonged snow cover. The alpines of Kashmir comprise largely of perennial herbs which on account of severe climatic condition have brief period of vegtation.The very brief period of growth shows the efficacy in utilizing solar energy and soil constituents in their survival. Favourable period of flowering range from June to August after which frost sets in. In certain cases some species reflower in september, also. Alpine plants are dwarf in size, due to severe winds and frost. The alpine plant associations are not uniform in their composition.

Gupta (1984) while working on nutrient contents of Important Forage Plants of western Rajasthan rangelands suggeested tnat besides an

increase in forge production, other factors like palatability, digestibility and protein contents are also of great importance as they play a major role in secondary farm production viz., milk, meat and wool. Such studies can help in deciding optimum stocking rate and grazing schedules. Study also concluded that the top feed of different species are rich in crude protein and calcium and they donot cause bloat in the animals like other high protein containing feeds. Even moisture contents of top feed is better than grasses which reduces free intake of water in animals. Unlike other forages, nutrients levels in these feeds, throughout the year, do not vary much and can be used as maintenance ration and as a source of supplementary feed along with grasses. In the study it was concluded that nutritional status of forge plants is of basic necessity to assess and improve the pasture productivity in terms of animal performance.

Harsh (1984) recommends introduction of top feed species both exotic and indigenous like Calligonum polygonoids, Zizyphus nummularia, Acacia nilotica, Prosopis cineraria, Acacia senegal and Salvadora oleoides to supplement the fodder resources in the silivpastoral or agroforestery practices so as to gain optimum live weight of animals in the lean

period in arid and semi-arid areas of Rajasthan.

Mertia (1984) reported that the natural rangelands are highly denuded due to heavy stocking pressure, Land actually available for grazing (A.C.U) is 1 hectare out of a total geographical area of 3 ha/ACU. In the study it is also suggested that the best way to utilize the native rangelands is through grazing which is dependent upon carrying capacity for optimised livestock production. Results of experiments carried out at Rajasthan revealed that continuous controlled grazing and supplemental stall feeding helps animals to gain weight than countinuous controlled grazing only . In second experiment with five treatments proved that sheep gained weight when grazed alone than mixed grazing. In another experiment it was concluded that deferred rotational grazing system is superior to the continuous grazing. With regard to milk production also deferred rotational grazing system was recorded to be superior.

Mauria (1984) while working on three grazing intensities of Sheep and Goat for proper utilization of Arid Range Land Resources in Rajasthan observed that the grassland management by putting more than one kind of animals is always beneficial as it

allows the utilization of diversified forage species more efficiently. He also asserted that carrying capacity of the land should be known before hand in order to fix the number of different animals to be introduced in a particular pasture. It was also observed that in places where feed is scarce and of low nutritive value, smaller animals like sheep and goat with lower maintenance needs are suitable, being more efficient converters of available herbage. Researches conducted at (ICAR) Avikanagar has led to infer that goat and sheep are more economical than cattle.

Melkania et al. (1984) summarized production potential and chemical composition of 22 sites in lower Himalayan, Mid - Himalayan grasslands and Alpine meadows. The dry matter yield was estimated as 735.0 to 850.5 $gm/m^{-2}/yr^{-1}$ in Gordon Buggyal, Chamoli (alt : 3300-3600 mtrs a.s.l) and 820 $gm/m^{-2}/yr^{-1}$ of Sundhar Buggyal, Almora (alt : 3200 mtrs a.s.l).

Sharma (1984) worked on the grazing behaviour of livestock in desert conditions of Rajasthan. The proper grazing hours for cattle, sheep and goat were recorded as 5 A.M to 12.0 noon from April to June, 3.0 P.M to 7.0 P.M from July to October and

8.0 A.M to 12.0 noon; 3.0 P.M to 5 P.M from November to March, suitable grazing hours for different species grazing in rangelands. It was also observed that the preference shown by animals for certain forage plants is very helpful in planning and managing the range and pasture lands. In order to have best utilisation of rangeland products it was recommended that sheep and goats follow cattle. Goats will eat up thorny bushes which otherwise are troublesome to cattle.

Solanki (1984) also supported the concept of silvipastoral practices in order to achieve maximum productivity per unit time with the help of top feed species.

Casimir and Aparna Rao (1985) while studying Pastoral ecology of the Nomadic Bakerwal in Jammu and Kashmir listed 26 species in five transects of winter pastures varying from altitude 308 mts to 623 mts.Out of all Granda (Carissa spinarum) was most frequent with 42.9% frequency.In Beri Bahak near Banihal pass they listed 10 species in eight transects out of which Chrysopogon echinulatus (Mitha grass) was more frequent in 5 transects and totally absent in remaining transects. Taraxacum officinale (Hand) with 10.7% frequency occured almost in all transects. At

Chandanwari they studied eight transects and listed only six species.Out of which Chrysopogon echinulatus with 40.9% was more frequent and occured in all transects. Plantago griffthii was next frequent with 23.7% and Trifolium repens had only 20% frequency.It was also observed that only hardest species can withstand the constant mechanical stress and the result was invariably monoculture of Chrysopogon echinulatus.

Raina (1987) studied vegetation of Bhaderwah forest. He reported that the vegetation of area is represented by 323 genera having 488 species belonging to 92 families. The biological spectrum indicated a thero-hemicryptophytic phytoclimate of the region. Biomass of ground vegetation was studied on seasonal basis. Aboveground live biomass of all the species recorded maximum value (759.1 gm/m^{-2} site I,site II= 760.9 gm/m^{-2}, site III= 806.5 gm/m^{-2}) in summer and minimum values in winter (site I=470 gm/m^{-2},site II=467.2 gm/m^{-2}, site III=497.2 gm/m^{-2}). Aboveground standing dead recorded maximum value in winter. Underground attain maximum value in summer and minimum in spring season.

Ambasht (1988) describes extensive grasslands biomass of world as prairies of the great plains of North America,the steppes of North Asia, the

savanna of Africa and Australia, Ilanos of Venezuela, the cerrado of Brazil, the catinga and pampas of central and south America, the miambo of East Africa and Kuroo of South Africa. Grasslands are roughly spread over 24×10^6 Km^2 area out of total land area of 149×10^6 Km^2 and account for 1.45×10^{10} t/year production of dry biomass. The tropical grasslands account for 15 $\times 10^6$ Km^2 land area and production of 1.05×10^{10} t/year and the remaining 9×10^6 Km^2 land area is occupied by the temperate grasslands accounting for 0.45×10^{10} t/year. He worked on 19 sites which include 12 grass dominated grazing lands and 7 under tree plantations with wide spread sites conditions from western Himalaya to eastern Himalaya. It was observed that grazing land sites show moderate productivity of 10 - 20 t/ha/yr which compares well with the world average of tropical grasslands. The plantation forest of Tectona grandis, 13 yr old is very poor producer & inferior to grazing lands but Alnus nepalensis in eastern Himalaya is efficient producer with net productivity from 13 t in 56 yr old stand to 25 t/ha/yr in 7 year old stand.

Saxena (1988) while working on status of Oran grazing lands of Indian Desert listed majority of grasslands as "poor" and recommended introduction of top feed species with deferred-rotational grazing

system according to carrying capacity for sustained production of grasslands.

Sharma and Jamwal (1988) while studying flora of upper Lidder valley of Kashmir Himalayas (altitude 2100 mts to 4740 mts) observed that the floristic composition of the alpine vegetation of both flanks of upper Lidder valley was much the same but for the moisture condition and aspect governing the presence, absence or rarity of certain components in one or the other flank. They also recorded the presence of Sedum and Androsace, sporadically occurying Oxytropis cachemiriana and on side rocks a dense growth of Saxifraga pulvinaria.

Singh (1988) and Shankaranaryan et al (1990) recommended various management systems for improvement of grasslands of Rajasthan, like fencing, soil and moisture conservation measures, reseeding, improved grasses, fertilizer use, grass - legume mixtures, grazing management, proper stocking rate, silvipastoral practices, etc.

Puri et al. (1989) described that the alpine plants usually have few annuals and the perennials have long tap root with a woody root stock

which remains alive during unfavourable season. Among the high alpine grasslands mixed association of grasses, sedges and herbs are seen.

Mir, (1990) observed that the problems and prospects in pasture and foddar development in cold Arid zone of Ladakh are obviously all together different from other parts of the Jammu and Kashmir state. Low productivity is due to the climatic diversities, short growing season, soil moisture stress, high wind velocity, high rate of evapo-transpiration, low soil fertility and high pH, proliferation of weeds, low percentage of legume components, effects of wind erosion, low vegetative cover percentage and shortage of fodder seed. These observations however, are not supported with any of the scientific results.

Bhatt et al (1992) studied fodder qualities of six multipurpose shrubs in Garhwal Himalayas to work out a viable annual calender of fodder supply cheifly during winter season (alt., 600-1200 mts). The study concluded that overall nutritional quality of all the shrubs is highest during monsoons as nutrients are maximum (calcium, potassium and phosphate) with low fibre and tannin content. It drops

in winter, flowering and at fruiting stage. Spring season has the least nutritional value. They recommended that shrubs can be additive or supplement fodder in addition to fodder trees.

Casimir and Rao (1992) studied Animal Husbandry in the Lidder Valley of Kashmir with the help of Remote Sensing in the Himalayas. Aboveground dry matter production for three types of pastures was estimated as under :

Dry matter production of Lidder Valley

Pasture type	Area ha	Status	Aboveground Annual dry matter production gm/m^{-2}	Total production tonnes
1.	67.6	Unbroken covering of vegetation. Grasses, dandelions and clover.	350	236.6
2.	219.8	Many plants would occur which animals would not eat with major signs of erosion.	200	439.6
3.	444.4	Vast majority of the pastures on higher slopes mixed with scree and large rocks. Plants found in type 1 and 2 are rare in this type.	100	444.4
		Total		1120.6
		Allow for slope error		753.6

On basis of daily requirement of herbage, and period of 90 days available for grazing, it was estimated that the requirement for an animal population of 1651, ranged from 576.0 tonnes to 808.4 tonnes, thus leaving a surplus of 8.1%. It was concluded that the graing land situated at the western end of Lidder valley has not yet reached the limits of its capacity. It was further recorded that in order to obtain defnite information on the burden being placed on the individual pastures it will be necessary to correlate these to the numbers of animals in the herds belonging to the different households. Longer term analysis was recommended to record the ecological changes and destruction of vegetation in the area.

Numata (1992) suggested some empirical formulae to assess the degradation of grassland ecosystems and their recovery. He proposed input and output of seeds in soils and in plant community as analogous to energy flow or nutrient cycling in an ecosystem. On this basis he assessed floristic and life form composition, biological spectrum, the degree and rate of succession. He concluded that pastures deteriorate when the stocking rate exceeds the carrying capacity. The dynamic situation of a pasture can be indicated with the help

of Degree of succession (DS) and the progressive and retrogressive movement on a sere can be shown by the rate of succession (RS). The grassland conditions can be quantified in relation to grazing capacity by the Index of grassland condition (IGC).The studies are based on the work carried out in Nepal, Brazil and Japan.

Saxena et al. (1992) suggested several measures in rehabilitation of Arid Grazing lands in the Thar desert of India. The measures suggested include soil conservation measures, exclosures, reseeding, weeding, introduction of top feed species, sprinkle irrigation, etc. The management measures include citizen's participation in any development programme and different utilization practices. It was recommended that an excellent grassland in arid areas can support 2.5-3 cattle units/ha. Deferred rotational grazing systems have been proved ideal. They have also suggested some legislative measures to improve the degraded grazing lands.

Tiwari (1992) studied biomass through a non harvest technique by evolving component wise biomass models for trees. Study was conducted in Rajaji National Park near Dehradun on five principal

tree species. Method has been recommended as useful for studying regional biomass without damage to trees/ecosystem.

Pande et al. (1993) studied Litter (Leaf & Twig) decomposition of four tree species at New Forest DehraDun by litter bag method. Study concluded that macrofauna plays a significant role in decomposition process, especially in tropical climate where macroclimatic conditions are congenial for the faunal activity. It creates a source of secondary resourse, which decomposes by the diverse community of microbiota. It was also observed that microbiota influences more the decomposition rate at the later stages of decomposition process.

Sharma et al (1993) investigated life form classification and Biological spectrum of the flora of Shahjahanpur district, Utter Pradesh and recorded that ten life forms repersent the vegetation of the area. The life forms reported were mesophanerophytes (9.4%), nanophanerophytes (19.4%). Chamaephytes (3.6 %), hemicryptophytes (1.7 %), geophytes (6.5%), hydrophytes (5.6 %), therophytes (50.4 %), lianas (2.9 %), parasites (0.3 %) and epiphytes (0.2 %) , Biological spectrum of the area was

Thero-nanophanerophytic . The dominance of therophytes appears due to grazing pressure . Try has also been made to compare life forms of the area with that of Raunkiaer's classes and with that of Ellenberg and Mueller Dombois.

Singh et al. (1993) while studying Production and Decomposition of Leaf Litter in four forest species of Uttar Pradesh observed that, "in course of time the income equals the loss and a steady state accumulation is attained". In the study it was concluded that the species having highest nitrogen percentage showed fastest decomposition rate and that with lowest nitrogen content decomposed very slowly.

Thakur et al (1993) used prediction equations in estimating total aboveground biomases of twelve shrub species of temperate areas of Himachal Pradesh.

Negi et al (1994) reported overall grazing pressure in the central Himalayan alpine meadow as 6.5 animal units/ha. Productivity values ranged from 1.8 to 3.1 t/ha/yr in protected to 1.0 to 3.2 t/ha/yr in free grazed meadow. Of total biomass produced in meadow (1672 t) about 32% was removed in grazing over

the season (May to September). Of this 74% was consumed by sheep, 15% by goats and 11% by horses.

Pathak (1994) strongly advocated adoption of Silvi-pastoral practices in order to increase the fodder production in India, based on twenty years research studies at Indian grasslands and Fodder Research Institute (IGFRI) at Jhansi.

Samson et al (1994) recently studied the ecological significance of the occurance of C_3 and C_4 photosynthetic sub-types in Indian grasses. Out of 358 species of Himalayan grasses C_3 types are 78% and C_4 types are 22%.

Singh and Kachroo (1994) observed that the PirPanjal forests exhibited a divergent phytoclimate. The chamaephytic plant climate was attributed to the biotic disturbances and biochores in the area, longitudinal and latitudinal differences and microclimates. All these factors operated either singly ot together, in one or the other way to define the phytoclimate of the area. With increase in altitude chamaephytes and hemi-cryptophytes increased in percentage and therophytes and geophytes decreased in percentage.

CHAPTER 3

MATERIALS & METHODS

MATERIALS AND METHODS

As already discussed the study site consisted of Rupri Group of Margs located at an average elevation of 3400 mts a.s.l. in Pirpanjal range of Rajouri district.

After the preliminary survey of the area it was decided to select the study sites at different altitudes so as to have wide array of data for structural and functional analysis of alpine meadows. Nomadic population was surveyed and complete inventory of sheep, goats, kids, lambs, cows, buffalloes, horses & other cattle was recorded to find out the carrying capacity, utilisation rate and intensity of grazing of the pasture lands.There is free

grazing on all pasture lands except that boundaries of each herdsmen are drawn by precedence & understanding.At lower elevation,boundaries are demarcated at some places by erection of wall around the marg with loose stones.

For comparative studies one enclosure, each 1 mt x 1 mt was established in Behak of Puran Singh & Behak of Mohd Hussain at Sewari,Behak of Karam Din in Badjari and one in Bela.Since life cycle of plants in alpine meadows range from one week to two months due to limited growing season, it was decided to take frequent readings at an interval of ten days initially and seven days afterwards upto month of August and again at ten days interval till the first snowfall in the area.

STRUCTURE

In this study were included various phytosociological analysis like floristic composition, frequency,Abundance, Density, Basal area cover and mapping of vegetation. Since crop in all the meadows was by & large uniform and not much variation existed, it was decided to follow the quardrat method of analysis (Weaver and Clements, 1938, Misra 1968). Quardrat size was decided with the help of species area curve

method (Oosting, 1956, Misra 1968). On this basis size of the quardrat selected was 10 cm X 10 cm. In each marg three samples were taken from free grazing area and three samples each from enclosures for comparative studies.

The mapping of vegetation and the forage cover was recorded with the help of chart mapping based on visual observation and photographs (Weaver et al 1938) taken on each visit of the study site. These two methods were employed to study the structure of vegetation due to effect of grazing and other environmental factors keeping in view the short working season, long distance involved to reach the margs (study sites) and confounding of personal bias due to human error.

For calculating Importance Value Index (I.V.I) of a species in a stand or plant community, the absolute values recorded were converted into relative values of Frequency, Diversity and Dominance. All these relative values were then summed to get IVI to represent the dominance and ecological success of species (Curtis and McIntosh 1950, Misra 1968).

Life forms were studied by using Raunkiaer's (1934) and Misra (1968) classification.

Species Diversity Index was determined for all the three sites both open and closed by using Shannon's Index of diversity (H') by applying the formula:

$$H' = \sum_{i=1}^{i=s} Pi \log e Pi$$

Where

H ' = Index of species diversity.

s = Number of species.

P = Proportion of total sample belonging to the ith species.

e = base of natural logarithms.

Index of Dominanee (C) was calculated by using the formula of Simpson (1949) :

$$C = E\,(ni/N)^2$$

Where

ni =IVI for each species &

N =Total of importance values.

Jaccard's index of similarity was calculated by using the formula : (Billore,1978)

$$ISJ = \frac{C}{a+b+C} \times 100$$

Where

ISJ= Index of similarity by Jaccard.

C = Number of common sps in fenced & grazed sites.

a = Number of sps.unique to fenced sites.

b = Number of sps.unique to grazed sites.

COMPUTER GRAPHICS

Graphs and Bar charts have been obtained by using the study site data of different parameters in HARVARD GRAPHICS software. For all other purposes WS4 package have been used.

BIOMASS & PRODUCTIVITY

Various sampling sizes have been used by various workers.Most common unit for sampling herbaceous communities is 1 m^{-2} (Odum, 1960). Quadrat size of 0.4 m^{-2} and 0.5 m^{-2} have also been used (Billing & Bliss, 1959, Gupta 1979) and 25cm^{-2} (5 cm x 5 cm) for Biomass studies by Koul (1981) and Raina (1987).

In the present study of Biomass 10x10 cm quardrat was selected and for soil studies, monolith of 10x10x10 cm was taken since it was observed that maximum depth upto which roots penterate is 10cms only.

For estimation of below ground parts, soil monoliths were washed with water and plants with clear roots were taken out and packed in polythene bags. These were brought to laboratory for further analysis.

Plant material was then separated into above ground live, above ground dead and underground parts. Litter was collected manually with the help of forceps from 10x10cm quardrats.No species wise analysis was carried out for Biomass studies as present study was concerned with the total production of herbage vis-a-vis live stock consumption in the pasture and neither it was possible to carry out biomass studies of individual species owing to their small size.

All plant parts were oven dried at 80 ^{o}C for a period of 24 hrs, or till these gave a constant weight.Dry weight of each part was recorded for determining productivity of the biomass.Net production was calculated following Billore (1978),Gupta (1979) and Koul (1981).Annual increment of plant matter was obtained by adding up all increments during the study period.Turn over rates were calculated following Dahlman and Kucera (1965).

STUDY OF NOMADISM

For study of nomadism a socio-anthropological proforma was devised (Annexure 1).This proforma was filled up with the help of personnel interviews with several Bakkerwal families in Nowshera, Sunderbani, Tiryath, Rajouri, Jhangar, Manglamata, Kanara,Paoni,Chingus areas in Shiwaliks and at high altitude margs of Ruperi, Bela, Badjari, Sewari, Khodra, Gitanali, Ikhni, Andrechi, etc. Several interviews were also conducted in Kathua, Udhampur and Jammu districts.Help of old historical records of forest department, settlement department and travelogues were consulted to find out the origin of Bakkerwals, existence of Choupans,Gaddis,Gujjars and Changpas and their occupation of grazing lands.Help of political history of J&K and surrounding territories of NWFP, Afghanistan,Punjab & Gujarat was also taken into account while studying the effect of Nomadism in the state (Moorcroft et al,1819-25; Vigne, 1880; Cunningham, 1977; Drew, 1875; Webber, 1902; Schau, 1910; McDonell, 1894-96; Blunt, 1904-07; Lovergrove, 1908-09; Milward, 1910; Wright, 1914; Stewart, 1916-17; Coventry, 1917-20 and 1929; Lambert, 1927-28; Deans, 1928; Hoon, 1930-31; Clutterbuck,1933-43; Wreford, 1943; Pathania, 1944-47; Stebbing, 1962; Lawerence, 1967; Bamzai, 1973; Casimir & Rao, 1985, 1992; Rao, 1988, 1990, 1992; Khatana, 1992).

CHAPTER 4

OBSERVATIONS

4.1 GENERAL SURVEY OF GRASSLANDS

Most of the nomadic, seminomadic and sedentary pastoral populations of Jammu and Kashmir state use broad leaved bush forests of Shiwaliks, temperate undergrowth and subalpine and alpine pastures of Pirpanjal and Greater Himalayas to rear the livestock and cattle population. These grazing areas are locally known as :

1. Adak : Broadleaved Pvt., forest in Shiwaliks. (Plate 1,Fig-1)
2. Kaps : Area meant for grass cutting. (Plate 1,Fig-2)
3. Letris: Grass encl., in Distt., Rajouri. (Plate 1,Fig-3)

PLATE 1 : Types of Grasslands in
Jammu and Kashmir State.

Fig 1 : Adak
Fig 2 : Kaps
Fig 3 : Letris







PLATE . 1.

4. Bahak : Summer grazing ground. (Plate 2,Fig-1)

5. Margs : Alpine meadows. (Plate 2,Fig-2)

6. Dhoks : Bandobasti summer pasture. (Plate 2,Fig-3)

Pirpanjal range virtually divides Kashmir valley from Jammu division. Pir is the Dogri word for mountain peak. Pantsal the Kashmiri word. Pirpanjal, which is a distortion of the word Pir Pantsal, is infact a reduplication of the term (Lawerence, 1967). Its southern slopes face onslaght of monsoons, whereas, northern slopes are completly devoid of any monsoonic environmental effects. (Duthie 1894, Lawerence 1967, Dhar and Kachroo 1983). Several studies have been carried out on ecological aspects of northern slopes of Pirpanjal (Sapru 1975, Gupta 1979, Kaul 1981, Sharma 1988) but southern slopes and tablelands popularly known as alpine "Margs" have not been studied so far. Pirpanjal range contain some of the best meadows in the alpine ecotone interspersed with some of the best high altitude blue coloured glacial lakes. These pastures with perennial source of water affords herdsmen the best sites for livestock rearing. Total area under alpine pasture in the Pirpanjal range is estimated about 1,16,163 Ha. Forest Survey of India (G.O.I.Publication, 1989) reports total area under Alpine pasturelands, as 1,31,857 Sq Kms.

PLATE 2 : Types of Grasslands in Jammu and Kashmir State.

Fig 1 : Bahak
Fig 2 : Margs
Fig 3 : Dhoks



PLATE.2.

Since, most of the nomadic herdsmen of Reasi, Rajouri and Poonch pass through these meadows and semi-nomadic communities of foot hills also use these meadows or Bahaks for summer pasturage, meadows of Pirpanjal become an ideal site for carrying out ecological studies vis-a-vis nomads. Out of several passes in Pirpanjal, Rupri also forms one of the major corridors for oscillation of nomadic herdsmen, hence it was selected as the representative site for the present study.

STUDY SITES

Study sites are situated in the lap of famous Dhakyar Peak (4650 Mts). On its western defile is located Rupri-ki-gali (4102 mts a.s.l) and Rupri Pass (4085 mts) whereas on eastern side is Budhil Pir pass (4264 mts a.s.l). There are several group of alpine meadows surrounding Dhakyar Peak popularly known as Rupri Marg. It contains Khodra, Sewari, Badjari and Bela on southern side and Guranbatta, Jadi and Rupri Bahak on Northern side. For present study three sites were selected at different elevations (Plate 3).

1. Sewari 3200 Mts a.s.l.
2. Badjari 3400 Mts a.s.l.
3. Bela 3600 Mts a.s.l.

PLATE 3 : Location Map of
Rupri Margs.

1 : Sewari Marg 3200 mts.
: Badjari Marg 3400 mts.
: Bela Marg 3600 mts.



PLATE . 3.

On these meadows cattle and livestock population of Budhil, Kandi and Darhal villages graze for pasturage in summer. Study site is approachable from Budhal town (1800 mts.). From Budhal town upto the study site, it is a 12 Kms steep ascend. Rupri group of Margs are located between longitude $74^{o}.35'$ and $74^{o}.40'$ East and latitude $33^{o}.25'$ to $33^{o}.35'$ North in Rajouri district of Jammu division, although northern parts fall in Kashmir division.

1. Sewari Marg is irrigated by natural springs and two glacial nallas. It is about 2 Kms long and 2 kms wide. ($4\ Km^{2}$). In this marg 497 sheep and goats, 73 kids and lambs and 259 other cattle grazed during the study period.(Plate 4,Fig-1).

2. Badjari Marg is irrigated by two rivulets coming out of saucer shaped glacial lake **Samot Sar.** This marg is also about 3 Kms wide and 2 km long. ($6\ Km^{2}$). In this marg 1164 sheep and goats, 297 kids and lambs and 68 other cattle grazed during the study period. (Plate 4, Fig-2)

3. Bela Marg is the highest meadow which is irrigated by Katori Sar, Dhakyar Sar and several other glacial nallas. Above Bela marg there are only stony defiles sheltering group of alpine plants, here and there.

PLATE 4 : Physiographic location of Rupri Margs.

Fig 1 : Sewari Marg irrigated by two glacial nallas.

Fig 2 : Badjari Marg irrigated by Samot Sar.

Fig 3 : Bela Marg irrigated by Katori Sar and melting of snow.







PLATE.4.

Marg is about 2 Kms wide and 4 Km long (8 km^2). Samot Sar and Katori sar are source of Ans River which joins river Chenab at Arnas. In this marg 2215 sheep and goats, 334 kids and lambs and 59 other cattle grazed during the study period. (Plate 4, Fig-3).

4.1.1 GEOLOGY

The geology of Pirpanjal mountain range has been studied by Lydekker (1876), Middlemiss (1911) and Wadia (1928). Infact Wadia (1928) was the first to present a systematic geological map of Thana Mandi-Bafliaz-Tatakuti region of Pir panjal range. He classified rocks of this region into three important tectonic zones.

1. The foreland comprising Murrees and Shiwaliks with Sirban limestone inliers.
2. The autochthonous zone comprising Panjal volcanics and Eocenes folded into an overturned anticline.
3. The Kashmir nappe comprising ancient crystalline sediments with a cover of Upper Palaeozoic and Mesozoic rocks folded into a synclinorium.

These three tectonic zones are

seperated by two important thrust planes, namely the Panjal thrust and the Murree thrust. In fact the entire Ramban- Kaukut - Banihal - Gulabgarh Budhil region is folded into a regional anticlinorium.

Based on the strike mapping, order of superposition, lithological characters and sedimentary and metamorphic facies variation studies, fossil evidences, regional grade of metamorphism and stratigraphic parallelism, the rocks of the area vary from Cambro-Silurian to Triassic in age (Sharma et al 1979). (Table 5 , Plate 5).

Table 5: Stratigraphic Table of Pir Panjal range (Dhakyar)

Age	Formation
Miocene	Murree formation
Post carboniferous	Sarkanth, Alos and Dhundrat granite
Triassic	Trias limestone
Permian	Zewan formation
Lower Permian	Gondwana plant beds
Upper Carboniferous to lower Permian	Panjal formation ---> Panjal Trap ---> Gondwana plant bed ---> Agglomeratic slates
Middle carboniferous	Fenestella shales
Lower carboniferous	Banihal formation
Devonian	Muth Quartzite.
Cambro-Silurian	Bhaderwah formation
Precambrian	Salkhala formation

PLATE 5 : Geological Map of Study area showing anti and syncline formations.

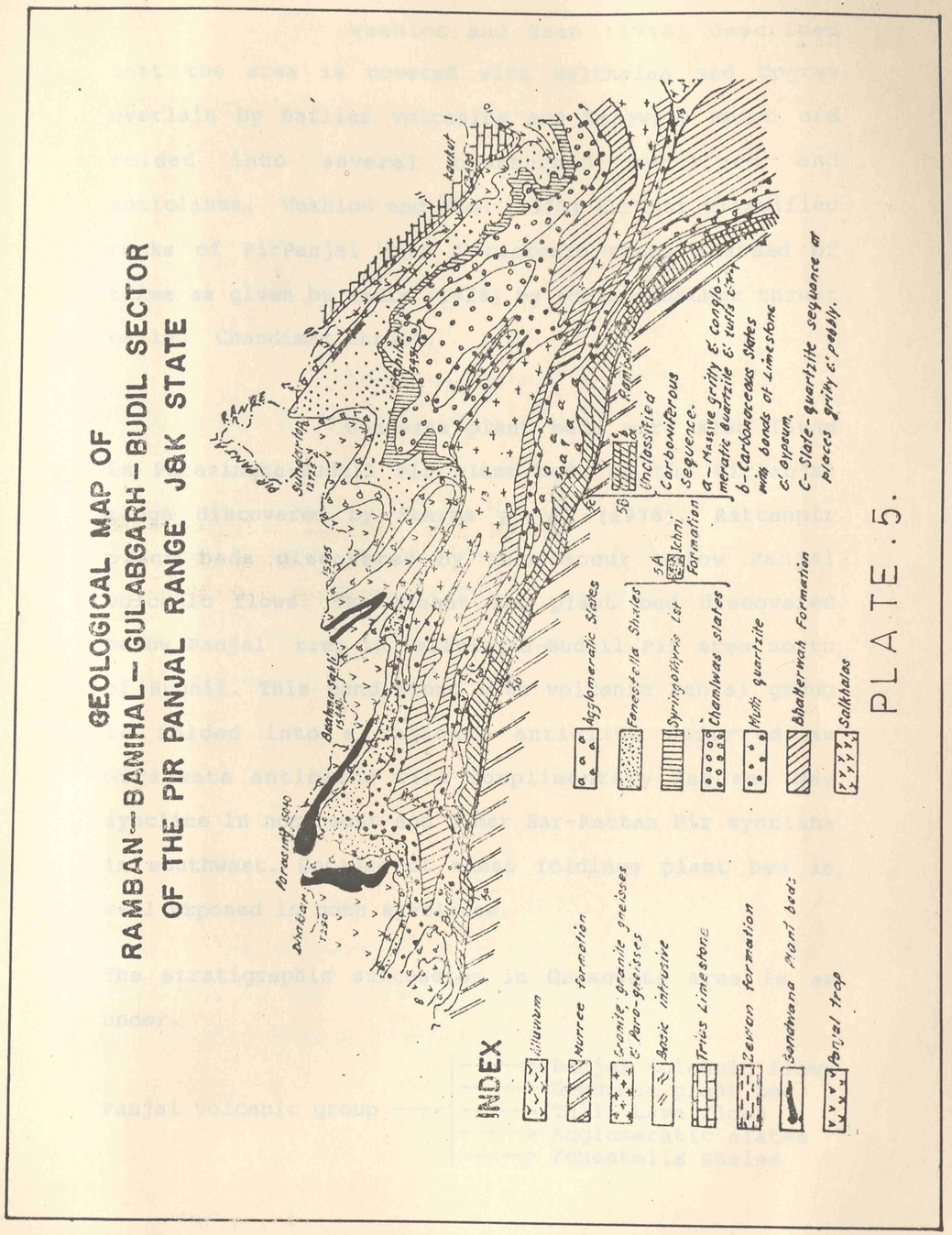


PLATE. 5.

Wakhloo and Shah (1968) described that the area is covered with Salkhalas and Dogras overlain by Bafliaz volcanics and Tanawals which are folded into several overturned synclines and anticlines. Wakhloo and Shah (1970) further classified rocks of PirPanjal into 4 tectonic zones instead of three as given by Wadia (1928) by adding another thrust called Chandimar thrust.

Gondwana plant beds were also found in Parasingha-Budhil Pir plant beds on the PirPanjal range discovered by Sharma et al (1976). Rattanpir plant beds discovered by them occur below Panjal volcanic flows. The Nishat Bag plant bed discovered below Panjal trap in Parasingha-Budhil Pir area north of Budhil. This band along with volcanic Panjal group is folded into a regional anticline referred as Guranwata anticline with complimentary Kaunsar Nag syncline in northeast and Simar Sar-Rattan Pir syncline in southwest. Because of these foldings plant bed is well exposed in both synclines.

The stratigraphic succession in Guranwata area is as under.

Panjal volcanic group ----
- -----> Panjal volcanic flows
- -----> Gondwana plant bed
- -----> Thill Lava flows
- -----> Agglomeratic slates
- -----> Fenestella shales

They also discovered for the first time Rhecopteris flora from Budhil Pir-Parasigha area. Discovery is of great significance as it occurs admixed with Glossopteris flora. Gulabgarh plant beds occur below Zewan formation in adjoinig areas of Gulabgarh area of PirPanjal.

Sharma et al (1979, 1981) describes rocks, mapped by Wadia as Dogra slates, and pointed out that these rocks are actually quartzite, conglomerate, boulder bed, pebbly phyllite and slate which represent Agglomoratic slate with intercalated plant bed and is underlain by lower and middle Carboniferous sequence, as suggested by the discovery of fish and plant fossils within the so called Dogra slates of Ratanpir area and Fenestella fossils in the eastern extension of the area in Budhil valley.

All the rock formations trend, in general, in northwest-southeast direction and dip invariably to the northeast. The various litho-units are repeated several times due to folding into several overturned synclines and anticlines. The cores of anticlines are formed by the Kalamund Quartizite

(Tanawal) of Devonian Carboniferous age or the overlying agglomeratic slate, while the cores of synclines are occupied by Panjal trap, which at places is overlapped by outlines of Mandi limestone of Premo-Triassic age and the Rajpura Formation of Eocene age. The Tanawal group comprising of the Digdaul quartzite and Hala quartzite merge into each other in Ans nalla of steeply plunging anticlinal closure, but reappears again in Jadi-Rupri area southeast of PirPanjal pass. Presence of Tanawal quartzite in Phulwari area of Ans valley indicate age of this group as Devonian to carboniferous.

On the southwestern side, the area is traversed by an important tectonic plane referred to as the Murree thrust along which the Pre-Tertiary sequence with outlines of Nummulatic Limestone has been thrust over the tertiary belt. The entire sequence covering southwestern slope of the Pir-Panjal range right upto the Murree thrust is infact a part of the Kashmir sedimentary basin and is autochthonous and there is no break between Nappe Zone and Autochthonous folded belt of Wadia (1928).

The origin of Agglomeratic slate has been a matter of controversy such as volcanic, fluvial,

fluvioglacial, glacial, etc. Infact they are formed by a complex process of marine sedimentation in an upheaving basis accomplished with volcanic explosions in the lower Permian period, conspicuous among others near Budhil Pir pass. Panjal Trap of Rattan Pir Girjan valley is the westerly stike extension of the trap land of Dhakyar - Simar Sar - Rupri area. Panjal valcanic flows occur as massive to bedded lava flows. It is also exposed in Budhil.

On the origin of "Margs" Lawerence (1967), confirmed the observation of Frederic Drew (1875), that "at heights where mountain tarns are numerous, there are abundant and unequivocal signs of former glaciation; both in the form of rock groovings and polishings, moraines and scratched stones. On Kashmir side of range,numerous small valleys running parallel with the strike of rocks and known by the local name of "Margs" (Persian word signifying a garden abounding in plants) are generally surrounded by rounded masses of detrital matter which, in the opinon of present writer are unquestionably of glacial origin. These moraines are well exhibited at summer station of Gulmarg. At Sonmarg at an elevation of 9000 feet the undulating valleys are entirely made of old moraines". Higher margs where best grazing areas were found, were

named at that time as Ilak (The summer quarters of Persian Nomad tribes are also known as Ilaks).

Same is true of most of the alpine Margs located on both sides of the ridge of Pir Panjal range. These margs are flat and undulating grazing grounds surrounded by detrital material of falling rocks due to weathering of stony defiles. This detrital material moves down with seasonal and permanent glaciers and finally get buried in Margs. Both Margs and stony slopes form one of the excellent grazing grounds for different kind of animals. It was observed that vegetation composition in stony defiles is entirely different from that of main meadows. Even height of plants is much more than the herbage of main meadows.

4.1.2 SOILS

Most of the soils of "Margs" are glacial moraines. Upper 0-10 cms., is black in colour whereas, beyond 10 cms. soil is yellowish or greyish in colour. At places there are bands of small gritty material. Most of the "Margs" are well drained but few are poor in drainage which develop into marshy or Bog like conditions. One such example is Lokat and Bod Banguz meadow along the cease fire line [CFL] in

Baramulla district. But "Margs" along Pir Panjal are by and large well drained.

The soil structure and Physico-chemical parameters of the soils of three study sites are given in Table 6.

Table 6 : Physico-chemical characteristics of soils of three study sities (Rupri Marg)

S.No.	study site	Clay %	Sand %	Silt %	Texture	pH	OC% *	OM% !	N% #	C/N @ ratio	Phosphorous Kg/ha	Potassium Kg/ha	EC (mill. mhos/cm)
1	Sewari	18.58	21.12	60.30	Silty loam	5.2	9.0	15.51	0.364	24.72	19.04	63.16	0.36
2	Badjari	19.12	20.98	58.10	Silty loam	5.25	8.4	14.4	0.350	27.54	14.32	61.37	0.32
3	Bela	19.33	20.31	58.42	Silty loam	5.3	12.0	20.69	0.401	24.73	34.72	63.32	0.46
	Mean x	19.01	20.80	58.94	Silty loam	5.25	9.8	16.87	0.372	25.66	22.70	62.62	0.38

* OC ---> Organic Carbon

! OM ---> Organic Matter.

N ---> Nitogen

@ C/N ---> Carbon/Nitrogen ratio.

The soil profiles of Sewari, Badjari and Bela have been presented in Plate 6, Figs-1,2 & 3, which indicate upper black coloured mature soils 10 cms. deep, containing all root growth of plants and the light coloured lower horizon without any root peneteration or very less root growth.

PLATE 6 : Soil profiles of
Study sites.

Fig 1 : Sewari Marg
Fig 2 : Badjari Marg
Fig 3 : Bela Marg



PLATE . 6.

The minerological analysis of soils of three margs was as under :

S.No.	Marg	Ca + Mg (milli equivalents per 100 gms.)	Na (milli equivalents per 100 gms.)	K (milli equivalents per 100 gms.)
1	Sewari	2.44	0.834	0.072
2	Badjari	2.04	0.808	0.070
3	Bela	2.44	0.838	0.070
Mean	$\bar{x}$	2.31	0.827	0.071

Soil temperature recorded at Sewari marg was as under :

S.No.	Month	upto 25 cms depth (in °C)		upto 30 cms depth (in °C)	
		Noon	Morning	Noon	Morning
1	August	1.4	1.3	1.2	1.1
2	September	1.3	1.2	1.16	1.0

Soil moisture of three study sites recorded for time

series is as under :

Month/Date	Sewari %age	Badjari %age	Bela %age
June 1992	38	36	30
July 1992	38.6	33.30	42
Aug 1992	35.53	36	43.27
Sep 1992	42	38.50	42.50

4.1.3 CLIMATE

The climate in Indian sub continent is governed by latitude, altitude, aspect, proximity, or remoteness from sea and disposition in relation to the mountain and prevailing currents (Maslekar, 1981).

The Himalayas has a profound influence on the climate of the subcontinent.Forming an almost impassable barrier to the north, the Himalaya act as climatic divide, affecting the air and water circulation systems of the region and exercising the dominating influence on the meteorological conditions over the sub continent to the south and the central Asian highland to the north.Infact a substantial part

of what we receive as monsoon rain is largely because of the orographic influence of the Himalaya on the monsoon winds.

By its east-west direction, great height and extent, the Himalayan ranges obstruct the passage of extremely cold continental air from the north into the sub continent in winter and in summer it faces the rain bearing monsoonal winds to ascend and thereby give up most of their moisture as rain and snow on the Indian side before crossing the range northwards.Thus mechanical and thermal destortions caused by grat Himalayan range are responsible for the weather of the sub-continent (Mani, 1981).

The basic patterns of weather and climate over the Himalaya are governed by the summer and winter monsoon systems of Asia.In addition, the Himalaya is affected by extra-tropical weather systems that move over the north of the sub continent from west to east in winter.There are two periods of wet weather in the Himalayan region; the winter range brought by the "Western disturbances" and summer rains brought by the summer monsoon winds.The western Himalaya, beyond the reach of monsoons, receives most of the precipitaion in winter.

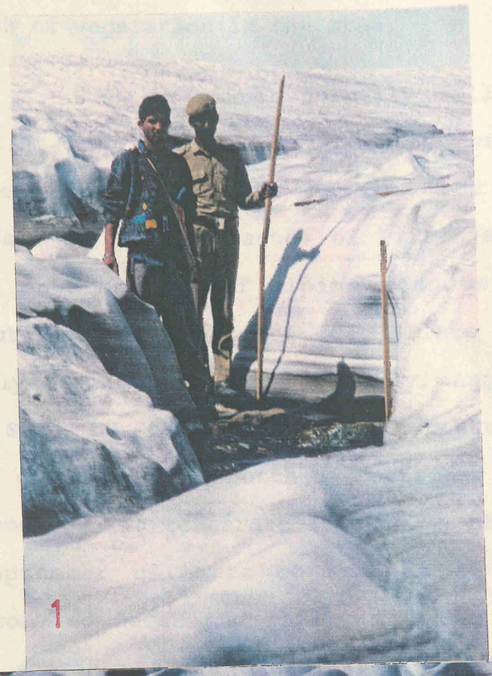
Keeping above environmental factors in view, the general climate of the area varies from subtropical in the south to temperate and alpine in the north.Four seasons (Summer, Winter, Autumn, Spring) of the subcontinent are also identified in Rajouri district.The climate of the area is greatly influenced both by monsoonic and continental winds.Topography and altitude also influence the general climate of the area.The tract on the north is enclosed by PirPanjal mountain barrier which do not permit monsonic rains to enter Kashmir valley.Thus southern slopes experience more rainfall than northern slopes of pirpanjal and northern slopes experience more snowfall than southern slopes of PirPanjal.Since, altitude of the area varies from 700 mts in south to 4650 mts in north, accordingly climate varies from subtropical to temperate and alpine in the north.

Winter is quite severe in the mountainous region in the north and at lower altitudes towards south. Months of January and February are coldest.The southern plains also experience pool frost in winter.In Feb/March severe hailstorms also lash the lower altitudes which damage both agricultural crops as well as young seedlings in the forest.During summer lower altitudes experience very high temperatures,

PLATE 7 : Snowfall at high altitude
Marga

Fig 1 : Snowfall at Dela Marg
Fig 2 : Effect of wind and rising temperature on melting of snow.

PLATE.7.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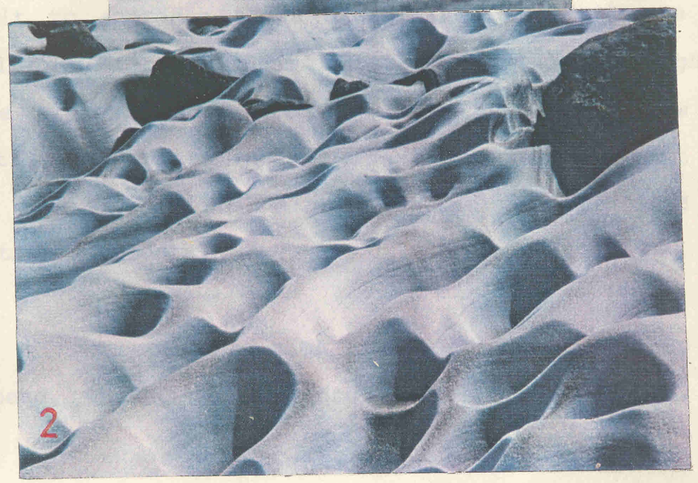
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which sometime result into forest fires, but higher elevations are pleasantly warm. The area also experiences both spring and monsoonic rains which help in lush growth of vegetation in the area.

Snow in winter normally falls above 700 mts a.s.l.At lower altitudes it does not stay long but at higher elevations snow remains for longer periods.Snowfall at higher reaches of PirPanjal start from October onwards.Most of alpine meadows remain under snow uptil the beginning of July (Plate 7, Fig-1). It is only during the months of July, August and some part of September that the mountain pastures are available for grazing.In the month of September most of the flocks come down in temperate forests.In the later part of September climatic conditions at higher altitudes become so harsh and chilly that it becomes difficult to approach these areas.First snowfall was recored on 2.10.92. After first snowfall all high altitude alpine meadows remain under perpetual snow cover till the month of July.There is no movement during winter months along these meadows and oscillation corridors.

Wind at high altitude blow at a very high speed, which results into whethering of rocks,

PLATE 8 : Climatic and edaphic environment of Margs.

Fig 1 : Sweeping clouds at Sewari Marg.

Fig 2 : Frost lifting at Bela Marg.

Fig 3 : Bela Marg effected by frost lifting.







PLATE · 8 ·

avalanches and blowing of snow storms (sleets).Effect of wind and rising soil temperature in summer results into cascading effect of melting snows breaking monotony of uniform snow mat all over the meadows (Plate 7, Fig-2).

Infrequent and sudden hail storm at such high altitudes is a common phenomenon in summer months which some time results into damage of flocks and their kids.Sweeping clouds is also another environmental factor on these alpine meadows which always keep the area humid with poor visibility for the herdsmen and their flock (Plate 8, Fig-1).

Thawing effect due to frost just before the snow fall and immedialtely after the snow starts melting on these high altitude meadows is another environmental factor which results into the formation of mound like structures (frost lifting) all over the area especially near the poorly drained soils and lake banks or near the retreating snow line (Plate 8, Figs-2 & 3). Due to frost lifting, the composition and distribution of alpine vegetation is greatly influenced. Even the productivity of alpine pastures on these frost lifted soils varies from those areas which are free from frost lifting.

4.1.4 TEMPERATURE

Temperature of the area has been recorded with the help of minimum and maximum thermometers both at lower elevation (700 mts) and for the growing season at the study site (3300 mts).

Yearwise monthly temperature have been recorded and presented in the Table 7.

Table 7 : Mean monthly temperature of the area for 90-91, 91-92 & 92-93

Month	Year/Temperature °C							
	90-91		91-92		92-93		Average	
	mean min.	mean max.	mean min.	mean max.	mean min.	mean max.	mean min.	mean max.
January	6.2	16.8	9.0	21.0	10.0	19.4	8.4	19.06
February	10.2	23.0	13.0	25.0	11.4	20.0	11.53	22.67
March	10.5	20.8	17.0	28.0	14.5	23.6	14.00	24.13
April	15.0	27.0	14.0	28.0	16.0	27.0	15.00	27.33
May	21.0	35.0	22.0	37.0	22.5	35.0	21.84	35.67
June	25.0	38.0	25.1	37.0	26.0	38.0	25.37	37.67
July	24.5	31.5	24.7	31.0	24.8	32.6	24.67	31.70
August	22.5	32.0	24.2	30.3	24.3	31.5	23.67	31.27
September	23.0	29.0	22.5	27.8	21.4	31.9	22.30	29.57
October	15.0	28.0	16.8	28.4	16.4	30.8	16.07	29.06
November	9.0	23.0	13.4	26.5	10.1	24.7	10.83	24.73
December	9.0	20.0	11.1	21.3	8.5	22.1	9.54	21.14

The mean temperatures recorded at the study site during

1992 is as under :

Month	Mean Minimum °C	Mean Maximum °C
July	10.90	15.95
August	10.48	19.38
September	10.92	12.92

First snowfall was recorded on 2.10.92.

4.1.5 RAIN FALL

Rainfall is the most significant environmental factor in growth of alpine vegetation & time available for grazing at high altitudes.During several interviews with nomadic Bakkerwals it was recorded that pastures of Gurez, Tilel, Deosai (prior to 1947) and Drass Matyan, Minamarg, Marwa, Wadwan located in Greater Himalayan ranges are much better than rainy meadows of PirPanjal.Since monsoonic rains do not reach most of the alpine meadows of Greater and Tethys Himalayas, it keeps pastures free of humid conditions and several pests.Hygienic meadows keep livestock also free of diseases like ticks, etc., and improves quality of fleece.This is one of the main reasons, which had attracted nomads, again and again,

for summer grazing, in addition to the vastness of the meadow lands in these area of the state.

On the other hand, meadows of Pir-Panjal especially on the southern slopes receive high rainfall due to monsoons.The effect of retreating monsoons is sometimes devastating.Rainfall for the months of September used to be 145 m.m. but during two days of September 1992 i.e., 10 and 11, 9/92 it rained 147 m.m. causing severe floods and land slides which resulted in extensive damage to the migratory flocks and herdsmen Deras during their autumn oscillation across the PirPanjal.

Av. Rainfall recorded for 8 years by regional station of SKUAST at Rajouri and the rain fall from 1953 to 1960 as recorded in the Rajouri working plan of the forest department is reproduced in Table 8 :

Table 8 : Average monthly Rainfall (in mm) for the study area (Average of 8 yrs) alongwith the data for the year 1991,92 & 93.

Month	Average of 8 Years * SKUAST 1981-88 Rajouri	Average of 1953-60 WP RAJOURI **	91-92 FCD Rajouri ***	92-93
January	85.0	146.00	135	151
February	87.4	114.00	111	154
March	85.0	57.91	73	298
April	56.3	112.27	110.5	18
May	39.6	47.75	37	28
June	81.8	60.71	65.63	8
July	291.9	412.75	263	303
August	290.0	341.63	142	704
September	115.9	176.02	177.5	335
October	22.9	69.08	4.0	8
November	11.2	28.45	15	35
December	42.8	76.20	94	95
Annual	1209.8	1643.89	1227.63	2137
Mean of year	100.81	136.99	102.30	178.08

* SKAUST --> Sher-i-Kashmir Agriculture University.

** WP --> Working Plan Forest Department.

*** FCD --> Flood Control Department.

4.1.6 OMBROTHERMIC DIAGRAM

Ombrothermic diagram (Legris,1962) of the study area has been expressed in Plate No 9. In the diagram months of May, June, October and November appear to be dry. Heavy rainfall months are July , August and September. From December to February area receives winter rainfall with heavy snowfall on

PLATE 9 : Ombrothermic digram of Study area (Rajouri district).

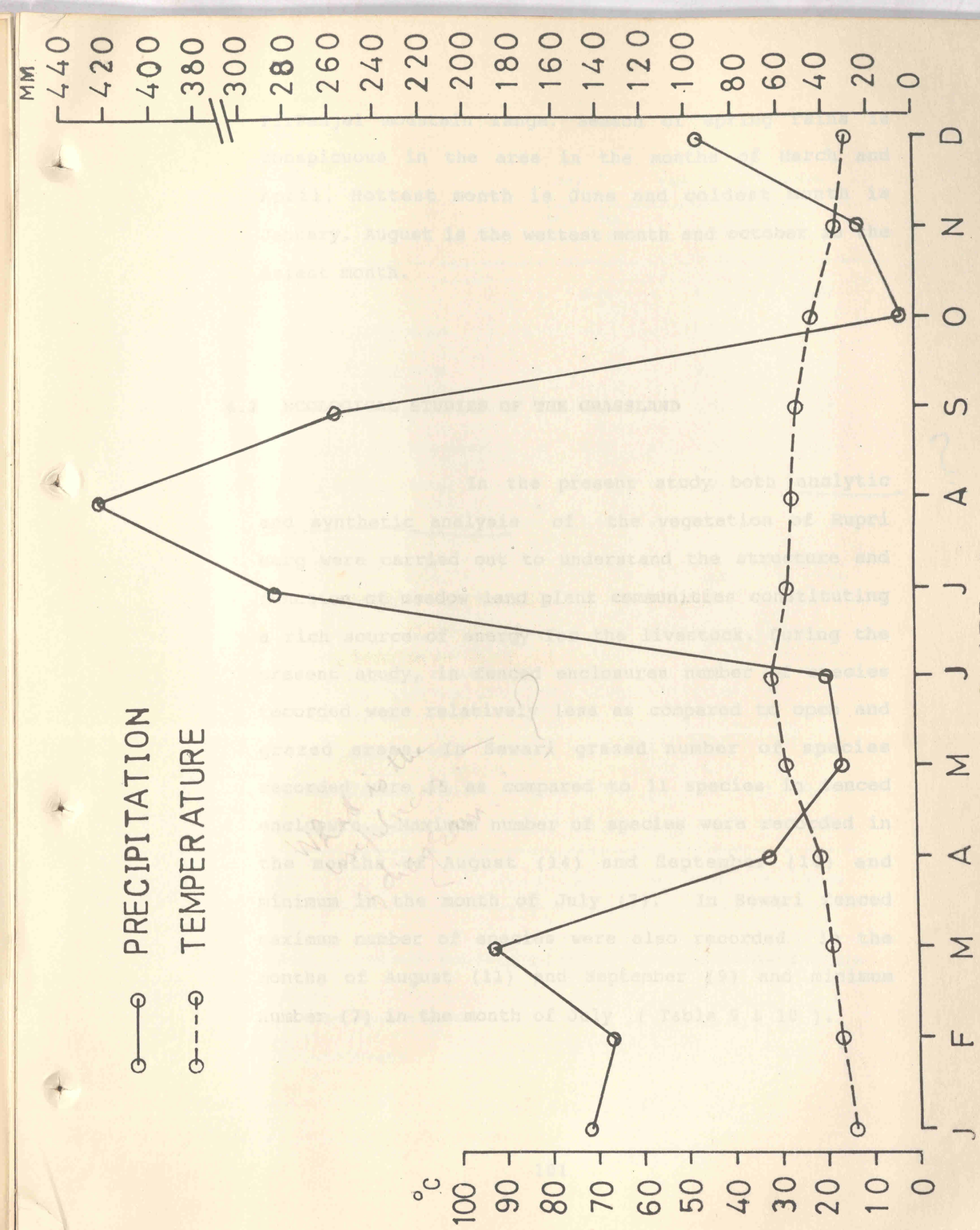


PLATE 9

PirPanjal mountain range. Season of spring rains is conspicuous in the area in the months of March and April. Hottest month is June and coldest month is January. August is the wettest month and october is the driest month.

4.2 ECOLOGICAL STUDIES OF THE GRASSLAND

In the present study both analytic and synthetic analysis of the vegetation of Rupri Marg were carried out to understand the structure and function of meadow land plant communities constituting a rich source of energy for the livestock. During the present study, in fenced enclosures number of species recorded were relatively less as compared to open and grazed areas. In Sewari grazed number of species recorded were 15 as compared to 11 species in fenced enclosure. Maximum number of species were recorded in the months of August (14) and September (10) and minimum in the month of July (7). In Sewari fenced maximum number of species were also recorded in the months of August (11) and September (9) and minimum number (7) in the month of July (Table 9 & 10).

Table 9: Monthwise Species distribution and Herbage cover percentage of Sewari grazed site.

Sno	Species	July		August		September	
		** P/A	*** C %	P/A	C%	P/A	C%
1.	Grasses *	+	3.44	+	6.76	+	4.62
2.	Anemone obtusiloba D.Don	-	-	+	0.44	-	-
3.	Alchemilla trollii Rothm	-	-	+	0.17	-	-
4.	Cerastium cerastioides (L.)Britton	+	0.62	+	0.55	+	0.28
5.	Cortia depressa (D.Don) Norman.	+	2.35	+	1.71	+	1.55
6.	Fragaria nubicola Lindley	-	-	+	1.01	+	0.75
7.	Geum elatum Wallich.	+	1.19	+	1.41	-	-
8.	Gentiana carinata Griseb.	-	-	+	0.13	+	0.08
9.	Lagotis cashmeriana (Royle) Rupr.	-	-	+	0.35	-	-
10.	Polygonum affine D.Don	-	-	+	0.62	-	-
11.	Ranunculus pulchellus C.Meyer.	+	1.54	+	2.75	+	1.04
12.	Saxifraga sibirica L.	-	-	+	0.07	+	0.39
13.	Sibbaldia cuneata Hornem.	+	2.10	+	3.24	+	6.86
14.	Taraxacum officinale Wigg.	+	4.79	+	8.95	+	6.85
15.	Thalictrum alpinum L.	-	-	-	-	+	0.17
	Total	7	16.03	14	28.16	10	22.59

* Grasses --> Graminoids include Cynodon dactylon, Poa alpina and Setaria viridis

** P/A --> Presence/Absence

*** C % --> Cover %

Table 10: Monthwise Species distribution and Herbage cover percentage of Sewari enclosure.

Sno	Species	July		August		September	
		** P/A	*** C %	P/A	C%	P/A	C%
1.	Grasses *	+	4.04	+	8.49	+	10.56
2.	Anemone obtusiloba D.Don	+	0.42	+	3.83	+	0.75
3.	Cerastium cerastioides (L.)Britton	+	0.40	+	0.54	+	0.54
4.	Cortia depressa (D.Don) Norman.	+	0.42	+	1.41	+	1.04
5.	Euphrasia himalayica Wettst.	-	-	+	0.10	-	-
6.	Gentiana carinata Griseb.	-	-	+	0.17	+	0.17
7.	Gentiana depressor D.Don	-	-	+	0.07	-	-
8.	Polygonum affine D.Don	-	-	+	0.21	+	1.54
9.	Ranunculus pulchellus C.Meyer.	+	9.81	+	3.67	+	1.54
10.	Sibbaldia cuneata Hornem.	+	0.27	+	7.70	+	3.73
11.	Taraxacum officinale Wigg.	+	5.25	+	14.97	+	15.14
	Total	7	20.61	11	40.89	9	35.01

* Grasses --> Graminoids include Cynodon dactylon, Poa alpina and Setaria viridis

** P/A --> Presence/Absence

*** C % --> Cover %

In Badjari grazed, number of species recorded were 20 as compared to 8 species in fenced enclosure. Maximum number of species were recorded in the month of August (18) and minimum were recorded in the months of July and September (11). Whereas, in

Badjari fenced enclosure maximum number of species (8) were recorded in the month of August and minimum (6) in the months of July and September (Table 11 & 12).

Table 11: Monthwise Species distribution and Herbage cover percentage of Badjari grazed site.

Sno	Species	July		August		September	
		** P/A	*** C %	P/A	C%	P/A	C%
1.	Grasses *	+	4.80	+	6.77	+	6.95
2.	Alchimilla trolli Rothm	-	-	+	0.76	-	-
3.	Anemone obtusiloba D.Don	-	-	+	0.30	+	0.03
4.	Androsace sempervivoides Jacquem	+	0.88	+	0.15	-	-
5.	Anaphilis triplinervis C.B.Clarke	+	0.69	+	0.10	-	-
6.	Cerastium cerastioides (L.)Britton	-	-	+	0.19	+	0.35
7.	Cortia depressa (D.Don) Norman.	+	1.23	+	1.74	+	0.89
8.	Euphrasia himalayica Wettst	-	-	+	0.46	+	0.30
9.	Fragaria nubicola Lindley	-	-	+	0.28	-	-
10.	Geum elatum Wallich.	+	0.50	+	2.76	-	-
11.	Gentiana carinata Griseb.	+	0.17	+	0.21	+	0.29
12.	Gentiana depressa D.Don	-	-	+	0.05	+	0.15
13.	Polygonum affine D.Don	-	-	-	-	+	1.06
14.	Primula elliptica Royle	+	0.31	-	-	-	-
15.	Ranunculus pulchellus C.Meyer.	+	0.77	+	1.50	+	0.25
16.	Saxifraga sibirica L.	-	-	+	0.13	-	-
17.	Sibbaldia cuneata Hornem.	+	4.61	+	10.07	+	11.55
18.	Tanacetum dolichophyllum Kitam	+	0.31	+	0.16	-	-
19.	Taraxacum officinale Wigg.	+	1.95	+	2.93	+	1.78
20.	Thalictrum alpinum L.	-	-	+	0.10	-	-
	Total	11	16.22	18	28.66	11	23.60

* Grasses --> Graminoids include Cynodon dactylon, Poa alpina and Setaria viridis
** P/A --> Presence/Absence

*** C % --> Cover %

Table 12: Monthwise species distribution and Herbage cover percentage of Badjari enclosure

Sno	Species	July		August		September	
		** P/A	*** C %	P/A	C%	P/A	C%
1.	Grasses *	+	4.85	+	6.61	+	10.54
2.	Anemone obtusiloba D.Don	-	-	+	2.03	-	-
3.	Cerastium cerastioides (L.)Britton	-	-	+	0.22	+	0.57
4.	Cortia depressa (D.Don) Norman.	+	4.08	+	2.65	+	3.25
5.	Geum elatum Wallich	+	4.37	+	0.35	-	-
6.	Ranunculus pulchellus C.Meyer.	+	0.25	+	1.97	+	1.74
7.	Sibbaldia cuneata Hornem.	+	4.33	+	13.66	+	8.72
8.	Taraxacum officinale Wigg.	+	2.92	+	4.86	+	8.58
	Total	6	20.80	8	32.35	6	33.40

* Grasses --> Graminoids include Cynodon dactylon, Poa alpina and Setaria viridis

** P/A --> Presence/Absence

*** C % --> Cover %

In Bela open total number of species recorded were 20 and in fenced area species recorded were 12. In Bela open maximum number of species (17) were recorded in the month of August and minimum (12) in the month of July. In Bela fenced maximum

number of species (11) were recorded in the month of September and minimum number (7) in the month of July (Table 13 & 14).

Table 13: Monthwise Species distribution and Herbage cover percentage of Bela grazed site.

Sno	Species	July		August		September	
		** P/A	*** C %	P/A	C%	P/A	C%
1.	Grasses *	+	2.30	+	5.07	+	2.39
2.	Anemone obtusiloba D.Don	+	1.07	+	0.11	-	-
3.	Androsace semprvivoides Jacquem.	+	3.01	+	0.14	+	0.75
4.	Anaphilis triplinervis C.B.Clarke	-	-	+	0.21	+	1.06
5.	Bistorta vivipara (L.) Gray.	+	0.71	+	2.29	+	1.58
6.	Cortia depressa (D.Don) Norman.	+	0.38	+	2.50	+	1.48
7.	Euphrasia himalayica Wettst	-	-	-	-	+	0.39
8.	Geum elatum Wallich.	+	1.21	+	4.07	+	1.93
9.	Gentiana carinata Griseb.	-	-	+	0.15	-	-
10.	Gentiana depressa D.Don.	-	-	+	0.15	+	0.33
11.	Lagotis cashmeriana Kitam	-	-	+	1.37	+	0.43
12.	Polygonum affine D.Don	-	-	+	0.39	-	-
13.	Primula elliptica Royle	+	0.15	-	-	-	-
14.	Ranunculus pulchellus C.Meyer.	+	0.17	+	0.24	-	-
15.	Rhodiola himalensis D. Don.	+	3.66	+	1.81	+	2.56
16.	Saxifraga sibirica L.	-	-	+	0.04	+	0.17
17.	Sibbaldia cuneata Hornem.	+	2.28	+	13.20	+	5.35
18.	Tanacetum dolichophyllum Kitam.	+	0.06	-	-	+	0.18
19.	Taraxacum officinale Wigg.	+	0.62	+	1.05	-	-
20.	Thalictrum alpinum L.	-	-	+	2.57	+	1.94
	Total	12	15.62	17	35.36	14	20.54

* Grasses --> Graminoids include Cynodon dactylon, Poa alpina and Setaria viridis

** P/A --> Presence/Absence

*** C % --> Cover %

Table 14: Monthwise Species distribution and Herbage cover percentage of Bela enclosure site.

Sno	Species	July		August		September	
		** P/A	*** C %	P/A	C%	P/A	C%
1.	Grasses *	+	4.63	+	4.91	+	6.03
2.	Anaphilis triplinervis C.B.Clarke	-	-	-	-	+	0.18
3.	Bistorta vivipara (L.) Gray.	+	0.83	+	4.82	+	5.00
4.	Cortia depressa (D.Don) Norman.	+	0.34	+	2.56	+	0.33
5.	Euphrasia himalayica Wettst	-	-	+	0.15	+	0.33
6.	Geum elatum Wallich.	+	1.92	+	4.35	+	0.67
7.	Gentiana depressa D.Don.	-	-	-	-	+	0.62
8.	Rhodiola himalensis D. Don.	+	4.08	+	4.96	+	0.71
9.	Sibbaldia cuneata Hornem.	+	4.67	+	8.74	+	6.87
10.	Tanacetum dolichophyllum Kitam.	+	0.28	-	-	+	0.09
11.	Thalictrum alpinum L.	-	-	+	3.24	+	0.83
12.	Viola biflora L.	-	-	+	0.53	-	-
	Total	7	16.75	9	34.26	11	21.66

* Grasses --> Graminoids include Cynodon dactylon, Poa alpina and Setaria viridis

** P/A --> Presence/Absence

*** C % --> Cover %

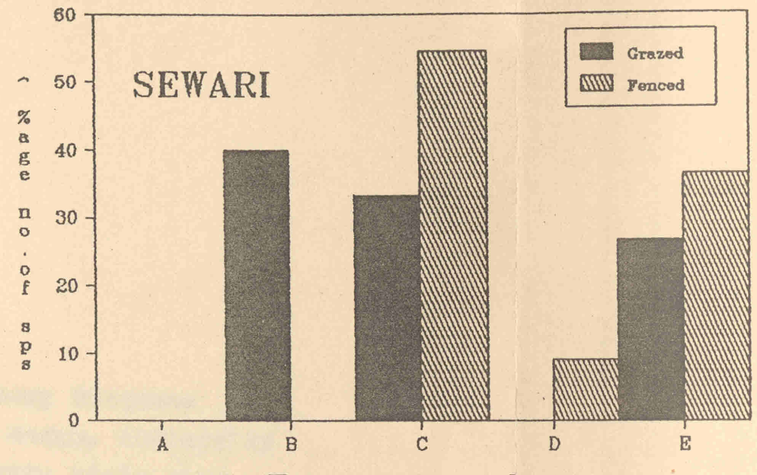
4.2.1 FREQUENCY

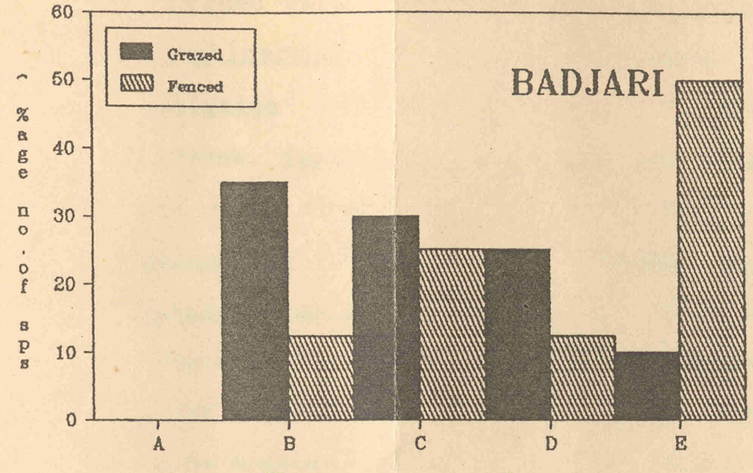
Measure of frequency expresses the distribution or dispersion of various species in a plant community. During the present study grasses were found to be most frequent as compared to other species an all the sites both open to grazing and closed to grazing. Poa alpina, Setaria viridis & Cynodon dactylon constituted the graminoid flora of Rupri Margs and are grouped as grasses for the purpose of structural and functional studies of the plant community.

In Sewari open grasses were most frequent with 100% frequency followed by Taraxacum officinale 93.32% and Sibbaldia cuneata 88.32%. Lagotis cashmeriana was least represented with 25% frequency.In Sewari enclosure grasses, Taraxacum officinale and Ranunculus pulchellus with 100% frequency were the most frequent, followed by Anemone obtusiloba (81.25%) and Sibbaldia cuneata (62.50%). Least frequent species were Gentiana carinata , Polygonum affine , Euphrasia himalayica and Gentiana depressa with 50% frequency (Tables 15 & 16). The frequency diagrams based on Raunkiaer's law of frequency (cf. Misra, 1968) indicate both grazed and fenced sites as heterogenous (Plate 10 : Fig-1).

PLATE 10 : Frequency Diagrams Rupri Margs, indicating frequency class wise distribution of plant species in Sewari, Badjari and Bela Margs. and the mean values of the Rupri Margs.

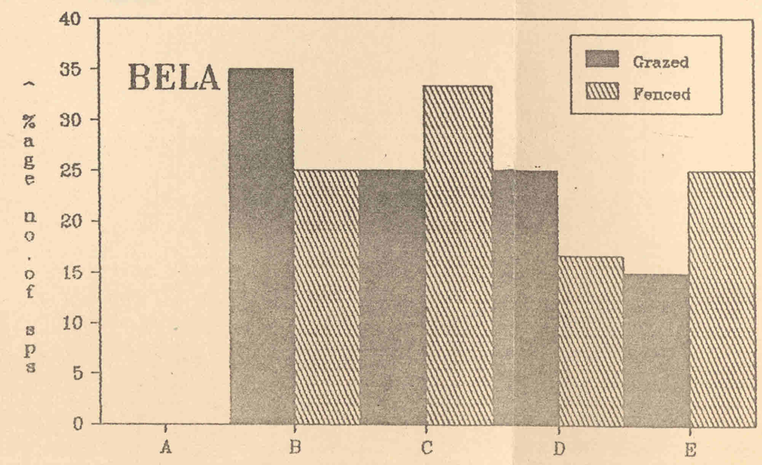
FREQUENCY DIAGRAM RUPRI MARGS





Law of frequency (Raunkiaer's 1934)

A > B > C >=< D < E



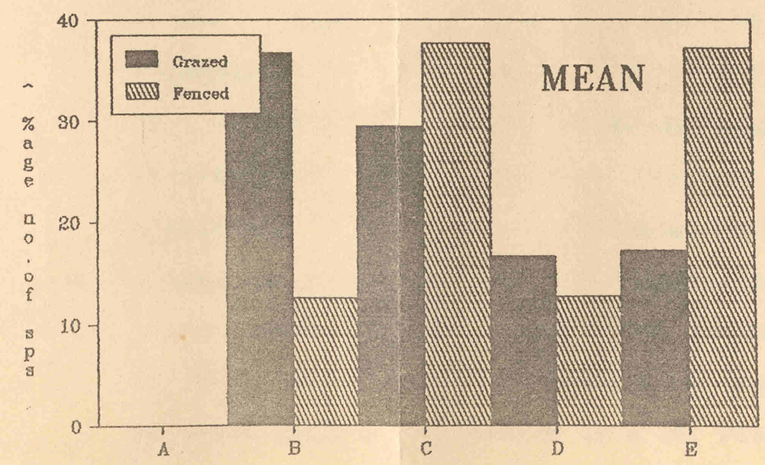


PLATE :10

In Badjari open, grasses were the most frequent with 100% frequency, followed by Sibbaldia cuneata with 97.50% and Ranunculus pulchellus 66.90%. The least frequent species recorded were Tanacetum dolichophyllum , Anaphilis triplinervis , Fragaria nubicola and Primula elliptica with 25% frequency. In Badjari enclosure Grasses, Taraxacum officinale and Sibbaldia cuneata are most frequent (100%) followed by Ranunculus pulchellus (87.50%) and Anemone obtusiloba 75%. Cerastium cerastioides with 50% frequency is the least frequent. The frequency diagram indicated grazed site plant community as heterogenous but closed site tends to be homogenous (Tables 17 & 18, Plate 10 : Fig-2).

In Bela open Grasses were the most frequent (90%) followed by Sibbaldia cuneata (86.67%) and Thalictrun alpinum (84.37%). Anemone obtusiloba is least frequent with 33.24% frequency. In Bela enclosure Grasses and Sibbaldia cuneata are most frequent with 91.66% frequency followed by Rhodiola himalensis (83.33%) and Bistorta vivipara (75%) . Tanacetum dolichophyllum and Anaphilis triplinervis were least frequent (25%). The frequency diagrams indicate both grazed and fenced sites are heterogenous in plant composition (Tables 19 & 20, Plate 10 : Fig-3).

Table 15 : Importance Value Index analysis of Sewari grazed

S no	Species	Frequency%	* RF	Abundance	Density	** RD	Relative Dominance	*** IVI
1.	Grasses	100.00	19.30	17.67	17.67	44.34	24.01	87.65
2.	Anemone obtusiloba	33.30	3.31	3.20	1.07	1.50	3.45	8.26
3.	Alchemilla trolli	29.15	1.21	1.0	0.29	0.115	0.47	1.795
4.	Cortia depressa	42.55	7.85	3.14	1.46	2.75	8.58	19.18
5.	Cerastium cerastioides	54.60	9.47	2.55	1.56	3.812	1.45	14.73
6.	Fragaria nubicola	44.40	2.35	7.5	3.31	2.90	1.67	6.92
7.	Gentina carinata	41.62	2.97	1.125	0.49	0.472	0.51	3.952
8.	Geum elatum	41.65	1.68	3.25	1.45	0.852	28.16	30.69
9.	Lagotis cashmeriana	25.00	0.44	2.0	0.50	0.142	1.36	1.942
10.	Polygonum affine	33.30	1.22	1.0	0.33	0.47	0.46	2.15
11.	Ranunculus pulchellus	83.30	15.87	6.78	5.60	15.60	9.21	40.68
12.	Saxifraga sibirica	33.30	0.68	1.0	0.33	0.110	0.037	0.827
13.	Sibbaldia cuneata	88.32	14.46	6.24	5.68	15.98	11.83	42.27
14.	Taraxacum officinale	93.32	17.87	4.37	3.77	10.66	8.47	37.00
15.	Thalictrum alpinum	33.30	1.32	1.5	0.49	0.18	0.35	1.85

* RF -----> Relative Frequency

** RD -----> Relative Density

*** IVI-----> Importance Value Index

Table 16 : Importance Value Index analysis of Sewari enclosure

S no	Species	Frequency%	* RF	Abundance	Density	** RD	Relative Dominance	*** IVI
1.	Grass	100.00	16.39	17.64	17.64	42.26	30.34	88.99
2.	Anemone obtusiloba	81.25	12.69	5.14	3.71	9.10	15.06	36.85
3.	Cerastium cerastioides	56.25	9.21	4.50	2.42	6.04	2.84	18.09
4.	Cortia depressa	56.25	9.38	1.75	1.00	2.26	7.40	19.04
5.	Euphrasia himalayica	50.00	1.09	3.15	1.50	0.56	1.38	3.03
6.	Gentiana carinata	50.00	2.21	1.00	0.50	0.46	0.66	3.33
7.	Gentiana depressa	50.00	2.31	1.50	0.75	0.26	0.26	2.83
8.	Polygonum affine	50.00	2.19	2.00	1.00	0.79	1.80	4.78
9.	Ranunculus pulchellus	100.00	16.39	5.78	5.78	14.02	11.96	42.37
10.	Sibbaldia cuneata	62.50	11.69	8.07	5.35	12.38	14.07	38.14
11.	Taraxacum officinale	100.00	16.39	5.00	5.00	11.87	14.21	42.47

* RF -----> Relative Frequency

** RD -----> Relative Density

*** IVI-----> Importance Value Index

Table 17 : Importance Value Index analysis of Badjari grazed site

S no	Species	Frequency%	* RF	Abundance	Density	** RD	Relative Dominance	*** IVI
1.	Grasses	100.00	17.65	13.84	13.84	37.20	16.58	71.43
2.	Anemone obtusiloba	44.80	3.37	1.5	0.682	0.95	1.94	6.26
3.	Androsace ~~sarmentosa~~ sarmentoides	62.50	2.16	4.5	2.25	1.13	5.87	8.36
4.	Alchemilla trolli	41.66	2.52	2.0	0.75	0.60	1.10	4.22
5.	Anaphilis triplinervis	25.00	0.83	4.0	1.0	1.68	0.54	3.05
6.	Cerastium cerastioides	43.20	3.54	2.276	0.914	1.26	0.74	5.54
7.	Cortia depressa	59.00	10.21	2.753	1.725	4.44	8.89	23.54
8.	Euphrasia himalayica	31.40	4.22	3.1	1.33	1.74	0.83	6.79
9.	Fragaria nubicola	25.00	0.38	14.0	3.5	0.28	1.58	2.24
10.	Gentiana carinata	31.84	3.28	1.08	0.353	0.62	0.32	4.22
11.	Geum elatum	55.00	3.76	2.148	0.966	1.34	16.49	21.59
12.	Gentiana depressa	66.00	2.42	1.5	1.00	0.55	3.64	6.61
13.	Primula elliptica	25.00	0.45	6.0	1.5	0.34	5.85	6.64
14.	Polygonum affine	66.00	1.25	2.5	1.66	0.46	2.07	3.78
15.	Ranunculus pulchellus	66.90	11.23	2.917	1.988	5.29	2.85	19.37
16.	Saxifraga sibirica	30.34	1.81	1.25	0.54	0.34	0.06	2.21
17.	Sibbaldia cuneata	97.50	17.11	15.11	15.12	36.71	27.74	81.56
18.	Taraxacum officinale	65.60	11.28	2.335	1.417	4.47	2.81	18.56
19.	Tanacetum dolichophyllum	25.00	0.93	1.34	0.61	0.28	0.507	1.72
20.	Thalictrum alpinum	41.50	1.60	1.5	0.66	0.32	0.41	2.33

* RF -----> Relative Frequency

** RD -----> Relative Density

*** IVI-----> Importance Value Index

Table 18: Importance Value Index analysis of Badjari Enclosure site

S no	Species	Frequency%	* RF	Abundance	Density	** RD	Relative Dominance	*** IVI
1.	Grass	100.00	21.15	13.58	13.58	38.37	22.66	83.17
2.	Anemone obtusiloba	75.00	10.59	3.25	3.25	4.76	11.97	27.32
3.	Cerastium cerastioides	50.00	6.11	2.50	1.75	2.28	1.80	10.19
4.	Cortia depressa	56.25	11.52	3.00	1.84	3.79	12.57	27.88
5.	Geum elatum	22.22	02.24	0.41	0.27	1.05	5.98	9.27
6.	Ranunculus pulchellus	87.50	15.71	4.00	3.67	9.59	6.88	32.18
7.	Sibbaldia cuneata	100.00	21.15	12.42	12.42	33.63	29.94	84.72
8.	Taraxacum officinale	100.00	11.53	3.25	3.13	6.52	9.94	27.99

* RF -----> Relative Frequency

** RD -----> Relative Density

*** IVI-----> Importance Value Index

Table 19 : Importance Value Index analysis of Bela grazed site

S no	Species	Frequency%	* RF	Abundance	Density	** RD	Relative Dominance	*** IVI
1.	Grasses	90.00	14.21	11.57	10.872	26.86	7.85	48.92
2.	Androsace [illegible]	38.34	3.60	3.70	1.428	2.62	1.95	8.17
3.	Anemone obtusiloba	33.24	0.43	1.00	0.33	0.07	0.55	1.05
4.	Anaphilis triplinervis	54.17	5.35	2.928	1.547	2.21	0.50	8.06
5.	Bistorta vivipara	59.38	7.05	6.037	4.036	8.11	3.50	18.66
6.	Cortia depressa	62.96	9.63	1.767	1.397	2.91	4.30	16.84
7.	Euphrasia himalayica	66.67	0.74	3.50	1.75	0.46	0.69	1.89
8.	Gentiana carinata	33.34	1.32	1.667	0.554	0.44	0.30	2.06
9.	Gentiana depressa	66.67	2.08	3.00	0.495	0.44	0.05	2.57
10.	Geum elatum	73.61	6.38	3.477	2.131	3.50	21.82	31.70
11.	Lagotis cashmeriana	44.45	1.59	1.834	0.733	0.47	1.07	3.13
12.	Polygonum affine	33.34	0.45	1.00	0.33	0.29	0.25	0.99
13.	Primula elliptica	33.34	1.43	2.00	0.66	0.32	1.51	3.26
14.	Ranunculus pulchellus	45.25	4.40	1.428	0.76	1.08	0.66	6.14
15.	Rhodiola himalensis	64.16	12.77	8.116	6.235	18.87	24.97	56.61
16.	Saxifraga sibirica	33.34	0.82	1.50	0.495	0.30	13.72	14.84
17.	Sibbaldia cuneata	86.67	13.84	13.74	12.667	24.07	13.92	51.83
18.	Taraxacum officinale	33.34	1.74	2.50	0.83	0.91	1.00	3.65
19.	Tanacetum dolichophyllum	41.67	2.28	1.75	0.60	0.53	0.31	3.12
20.	Thalictrum alpinum	84.37	9.90	3.392	2.867	5.54	1.08	16.52

* RF -----> Relative Frequency

** RD -----> Relative Density

*** IVI-----> Importance Value Index

Table 20 : Importance Value Index analysis of Bela Enclosure site

S no	Species	Frequency%	* RF	Abundance	Density	** RD	Relative Dominance	*** IVI
1.	Grasses	91.66	19.01	18.00	18.00	46.35	12.80	78.16
2.	Anaphilis triplinervis	25.00	2.08	1.00	1.00	0.22	0.32	2.62
3.	Bistorta vivipara	75.00	12.16	9.00	5.70	8.20	2.08	22.44
4.	Cortia depressa	43.75	10.92	3.125	2.50	1.75	7.67	20.34
5.	Euphrasia himalayica	50.00	7.45	2.00	1.34	2.41	0.51	10.37
6.	Geum elatum	50.00	1.04	1.00	0.50	0.16	5.06	6.26
7.	Gentiana depressa	50.00	4.20	1.50	1.00	1.26	0.14	5.60
8.	Rhodiola himalensis	83.33	7.47	14.166	14.166	12.28	56.27	76.02
9.	Sibbaldia cuneata	91.66	19.01	11.416	11.333	24.46	12.35	55.82
10.	Tanacetum dolichophyllum	25.00	1.52	1.00	0.50	0.17	0.24	1.93
11.	Thalictrum alpinum	65.00	12.59	2.60	1.50	2.17	0.54	15.30
12.	Viola biflora	37.50	2.55	1.50	1.50	0.57	2.02	5.14

* RF -----> Relative Frequency

** RD -----> Relative Density

*** IVI-----> Importance Value Index

4.2.2 ABUNDANCE

Abundance is expressed as a number of individuals per quadrat of occurance (Misra, 1968).The abundance of different plant species in all the three study sites of Rupri Marg in both grazed and fenced

areas is given in Tables 15-20. An analysis of the analytical characters of the plant community in the Sewari grazed reveal that Grasses are most abundant with a value of 17.67 and Saxifraga sibirica along with other two species Alchimilla trolli and Polygonum affine were least abundant with a value of only 1.0. In Sewari fenced Grasses were most abundant (17.64) but Gentiana carinata recorded minimum value of 1.0.

In Badjari grazed Sibbaldia cuneata recorded maximum abundance (15.11) and Gentiana carinata recorded minimum abundance (1.08). Similarly, in fenced site Grasses were more abundant (13.58) and Geum elatum was least abundant (0.41).

In Bela grazed same trend of Badzari was recorded with Sibbaldia cuneata recording maximum abundance (13.74) and Polygonum affine and Anemone obtusiloba recording minimum abundance (1.0). In Bela fenced Grasses recorded maximum value of 18 and three species viz., Geum elatum , Tanacetum dolichophyllum and Anaphilis triplinervis recorded minimum value of 1.0 only.

4.2.3 DENSITY

Density gives an idea of the degree

of competition between the members of the same species as well as of one species with the other. The terms abundance and density represents the numerical strength of species in the community (Misra, 1968). Whereas, abundance when considered with frequency expresses the synthetic characters of the distribution pattern of the species but, density expresses the numerical strength of an individual species per unit area in a community. Density and frequency if taken together, gives an idea of community structure (Oosting, 1958).

The density of species in Sewari grazed site recorded maximum number of individuals of grasses taken together (1767 per m^2) followed by Sibbaldia cuneata (568 per m^2). Minimum density of 29 per m^2 was recorded in case Alchemilla trolli. In Sewari fenced different trend was noticed with Grasses recording density of 1764 per m followed by Ranunculus pulchellus (578 per m^2). Gentiana carinata recorded minimum density of 50 per m^2.

In Badzari grazed Sibbaldia cuneata recorded density of 1512 per m^2 followed Grasses with 1384 per m^2. Minimum density of 35 per m^2 was recorded in case of Gentiana carinata. In case of Badzari fenced Grasses were more dense with 1358 per m^2 density and Geum elatum recording minimum density of

27 per m^2.

In Bela grazed *Sibbaldia cuneata* recorded maximum density of 1267 per m^2 followed by Grasses with density of 1087 per m^2. Least dense species were *Anemone obtusiloba* and *Polygonum affine* with a value of only 33 per m^2. Bela fenced site recorded maximum density of Grasses (1800 per m^2) followed by *Rhodiola himalensis* (1416 per m^2). *Geum elatum* and *Tanacetum dolichophyllum* recorded minimum density 50 per m^2 (Tables 15-20).

4.2.4 BASAL AREA COVER AND DOMINANCE

Basal area cover refers to the ground actually penetrated by the stems of a plant species as compared to the herbage cover which actually refers to the area of ground occupied by the foliage, stems and branches and the inflorenscence together. Herbage cover would actually mean the crown area of a particular species. Basal area cover on the other hand is infact the chief analytical character determining the dominance and nature of community (Misra, 1968). On the basis of basal area cover and density of plant species per unit area, the relative dominance of all species have been worked out and recorded in Tables 15-20.

DOMINANCE

Dominance is a characteristic of vegetation which expresses the predominating influences of one or more species in a stand, so that the population of other species is more or less repressed or is reduced in number and vitality. Dominants are expressed as those species which are highly successful in a particular habitat. Cover and population density are the chief controlling factors of dominace.

In Sewari open Geum elatum is most dominant species (28.16%) followed by grasses (24.01%). Saxifraga sibirica is least dominant (0.037%) and. In Sewari enclosure grasses are most dominant (30.34%) and Gentiana depressa with 0.26% is least dominant.

In Badjari open Sibbaldia cuneata is the dominant (27.74%) followed by grasses 16.58%. Saxifraga sibirica is the least dominant (0.06%). Similarly , in Badjari enclosure Sibbaldia cuneata is the most dominant species (29.72%) followed by grasses (22.66%). Cerastium cerastioides is least dominant (1.80%).

In Bela open Rhodiola himalensis is

most dominant (24.97%) followed by Geum elatum (21.82%). Similarly in Bela enclosure Rhodiola himalensis is most dominant (56.27%) followed by grasses (12.80%) and Sibbaldia cuneata (12.35%).

Index of Dominance

The index of Dominance for all species varied from 0.00,00,07 to 0.077 in Sewari open and from 0.00,00,89 to 0.088 in Sewari closed. In Badjari open index varied from 0.00,003 to 0.057 and from 0.0079 to 0.077 in closed site. In Bela open index of dominance ranged from 0.00,00,12 to 0.0356 and from 0.00,02,9 to 0.346 in closed site (Table 21).

Table 21: Index Of Dominance of different species in grazed and fenced sites of Rupri Marg

S No.	Species	Sewari grazed	Sewari fenced	Badjari grazed	Badjari fenced	Bela grazed	Bela fenced
1.	Grasses	0.077	0.088	0.057	0.077	0.0266	0.067
2.	Alchemilla trolli	0.00003	-	0.00019	-	-	-
3.	Androsacae sempervivoides	-	-	0.00077	-	0.00074	-
4.	Anemone obtusiloba	0.011	0.015	0.0004	0.009	0.000012	-
5.	Anaphilis triplinervis	-	-	0.0001	-	0.00072	0.000076
6.	Bistorta vivipara	-	-	-	-	0.0038	0.0056
7.	Cerastium cerastioides	0.0023	0.0036	0.0003	0.0013	-	-
8.	Cortia depressa	0.0032	0.004	0.006	0.009	0.0031	0.0046
9.	Euphrasia himalayica	-	0.0001	0.0005	-	0.000039	0.0012
10.	Fragaria nubicola	0.0004	-	0.00005	-	-	-
11.	Gentiana carinata	0.00016	0.00012	0.00019	-	0.000047	-
12.	Gentiana depressa	-	0.000089	0.00048	-	0.00007	0.00035
13.	Geum elatum	0.006	-	0.005	-	0.0111	0.0004
14.	Lagotis cashmeriana	0.00003	-	-	-	0.0001	-
15.	Polygonum affine	0.00005	0.00025	0.00016	-	0.00001	-
16.	Primula elliptica	-	-	0.00049	-	0.00012	-
17.	Ranunculus pulchellus	0.016	0.020	0.004	0.012	0.0004	-
18.	Rhodiola himalensis	-	-	-	-	0.0356	0.064
19.	Saxifraga sibirica	0.000007	-	0.00005	-	0.00244	-
20.	Sibbaldia cuneata	0.017	0.016	0.074	0.086	0.0298	0.346
21.	Taraxacum officinale	0.013	0.020	0.0038	0.0079	0.00015	-
22.	Tanacetum dolichophyllum	-	-	0.00003	-	0.0001	0.00004
23.	Thalictrum alpinum	0.000034	-	0.00006	-	0.0030	0.0026
24.	Viola biflora	-	-	-	-	-	0.00029
	H / *	1.91	1.86	2.28	1.62	2.35	1.34
	I S J **	52.94		35.00		52.38	

* H / ----> Index of species diversity. ** I S J ----> Jaccard's index of similarity.

SPECIES DIVERSITY INDEX

It is one of the most important characteristics of the community. An analysis of synthetic function of different plant communities in Sewari, Badjari and Bela Margs indicate that all grazed site's communities possesed comparatively higher index of species diversity than those of fences sites. Bela grazed recorded high species diversity index (2.35) followed by Badjari grazed (2.28) and Sewari grazed (1.91). Similarly in fenced sities trend was observed in a reverse order with species diversity index ranging from 1.86 in Sewari, followed by 1.62 in Badjari and 1.34 in Bela (Table 21).

From above it is clear that all the fenced sites indicated high index of Dominance but low species Diversity as compared to grazed sites. Thus there is an inverse relationship between species diversity and species dominance. More the diversity less the dominace or vice versa.

4.2.5 SPECIES COMPOSITION (IVI)

Importance value Index (IVI) is the reflection of combined effect of Relative frequency , Relative density and Relative Dominance of species constituting different communities. In present context

infact IVI is the reflection of ecological success of a plant species to withstand the grazing pressure of nomadic livestock and reaction to the combined effect of climate and edaphic conditions of the site.

In Sewari grazed grasses posses highest IVI (87.65) followed by Sibbaldia cuneata (42.27) and Ranunculus pulchellus (40.68). Minimum IVI of 0.82 was recorded for Saxifraga sibirica . Different trend was recorded in Sewari closed area. Grasses with 88.99 possesed highest IVI followed by Taraxacum officinale (42.47) and Ranunculus pulchellus (42.37) (Tables 15 & 16).

In Badjari grazed Sibbaldia cuneata recorded highest IVI (81.56) followed by Grasses (71.43) and Cortia depressa (23.54). Tanacetum dolichophyllum possessed minimum IVI (1.72). Similar trend was noticed in enclosed site with Sibbaldia cuneata recording highest IVI (84.72) followed by Grasses (82.47). Geum elatum recorded minimum IVI (9.27). (Tables 17 & 18).

In Bela grazed Rhodiola himalensis recorded highest IVI (56.61) followed by Sibbaldia cuneata (51.83) and grasses (48.92). Polygonum affine was recorded with minimum IVI (0.99). In

PLATE 11 : Important grass and forb elements of alpine meadows.

Fig 1 : Cortia depressa. A rosette perennial ideally suited to withstand the grazing pressure.

Fig 2 : Gentiana carinata. A tender species, tries to seek protection near boulders or scree slopes.

Fig 3 : Lagotis cashmeriana. Extremely palatable species, appears late in season in the meadows. Commonly in pure associations and gregarious in nature on scree slopes or around big boulders.







PLATE .11.

PLATE 12 : Important grass and forb elements of Alpine meadow.

Fig 1 : Anemone obtusiloba. An important species in the valley bottoms, appears immediate after melting of snow.

Fig 2 : Rhodiola himalensis. Appears gregariously at high altitude Marg of Bela. Not grazed by livestock.

Fig 3 : Sibbaldia cumeata. Very hardy species forming cushions in Alpine meadows, grows gregariously and is able to withstand the grazing and trampling effect of heavy cattle.

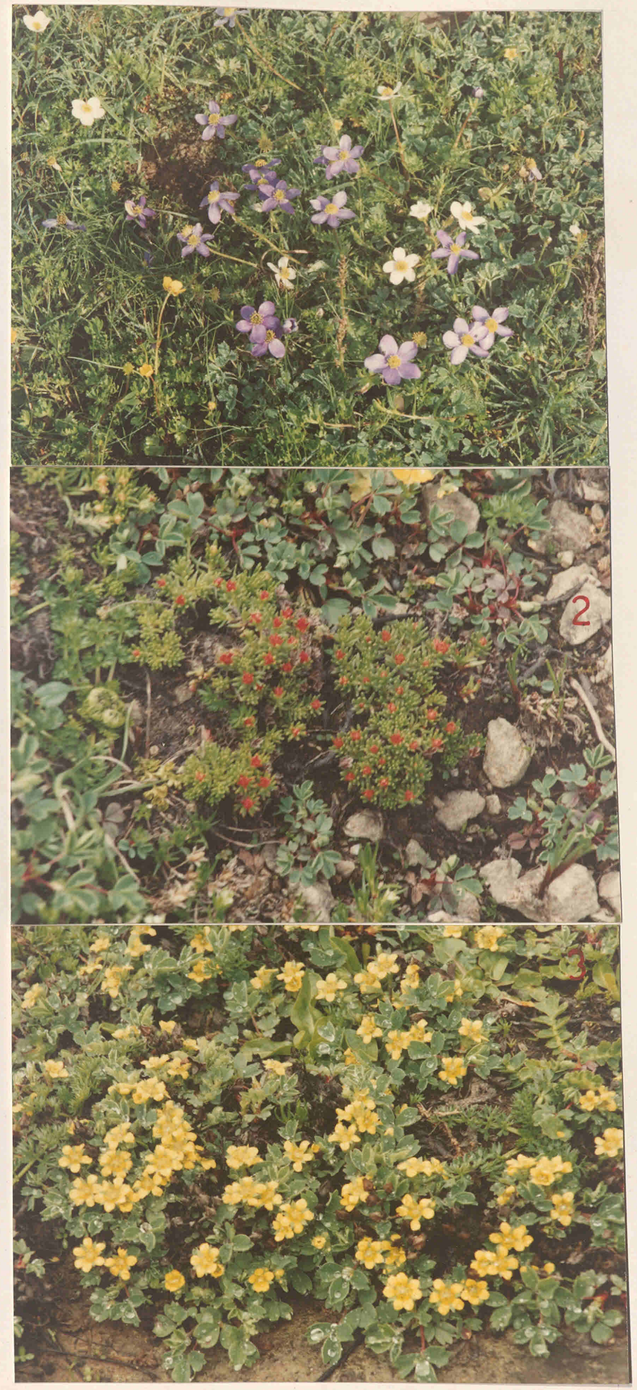


PLATE . 12 .

PLATE 13 : Important grass and forb elements of Alpine meadows.

Fig 1 : Poa alpina, Sibbaldia cuneata and Alchemilla trolli (in flowers) association.

Fig 2 : Anaphilis triplinervis growing in pure associations especially at heavily grazed sites.



PLATE .13.

PLATE 14 : Important Grass and forb elements of alpine meadows.

Fig 1 : Geum elatum and Taraxacum o officinale. Rosette species ideally suited for grazing.

Fig 2 : Tanacetum dolichophyllum. Tender species seeking protection near sheltered niches.



PLATE . 14 .

PLATE 15 : Important Grass and forb elements of alpine meadows.

Fig 1 : Euphrasia himalayica coming up gregariously in last week of september. Plants complete their life cycle in one or two weeks.

Fig 2 : Androsace sempervivoides. Grows gregariously on saddles of Nargs in early part of July. Blank spaces are conspicous due to grazing and trampling.



PLATE.15.

enclosed site grasses recorded highest IVI (78.16) followed by Rhodiola himalensis (76.02) and Sibbaldia cuneata (55.82). 1.93 IVI was recorded for Tanacetum dolichophyllum (Tables 19 & 20; Plate 11, Figs. 1,2,3; Plate 12, Figs. 1,2,3; Plate 13, Figs. 1,2; Plate 14, Figs. 1 & 2).

PLATE 15 Figs 1,2.

4.2.6 MAPPING OF VEGETATION

Vegetation is more than the mere grouping of individual plants. It is the result of interactions of numerous factors.The effect of the plants upon the place in which they live and their influence upon each other are especially significant (Weaver et al. 1938). Infact the object of range management is to produce the most valuable yield of forage possible and to harvest the crop through the medium of livestock in such a manner that the yield will be sustained from year to year.

Different methods employed to study vegetation could be List, Basal or Clip quadrats. It could be Frequency or Abundance quadrats . The vegetation have also been studied by laying permanent or temperory quadrats and then mapping vegetation either visually on graph or with the help of photograph charts (Cooper, 1924; Weaver et al, 1938; Misra, 1968).

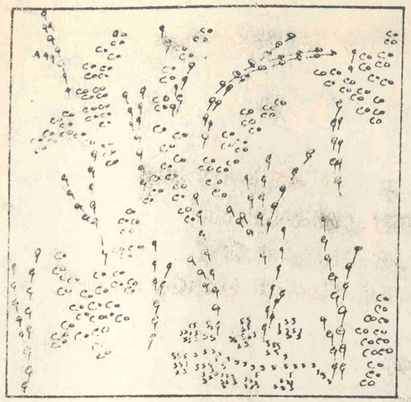
In the present study method of photograph charts was also employed to study the effect of grazing and protection on the development of plant communities in addition to the charting of vegetation from the quadrats, visually. Advantages of photograph charts over the charting by hand are enormous due to its saving of time, increased accuracy owing to the elimination of the personal bias and visual record in three dimensions. Another advantage is enlargement of negative and superimposition so as to directly observe the changes in composition, density and record various phases of phenology in the life cycle of individual species. Since smaller quadrats are desirable for a herbaceous layers and larger ones for trees (Cain, 1934), in charting by hand smaller size of 10 x 10 cms was preferred in the present study. Charting of vegetation and photographs were taken periodically at every visit to the study site from July to September 1992. Species wise percentage area covered is recorded in Tables 9 to 14. The periodic variation for all the three sites of Sewari, Badjari and Bela for both grazed and protected enclosures has been reflected in photographs and vegetation maps. (Plate 16, Figs. 1,2,3; Plate 17, Figs. 1,2,3; Plate 18, Figs. 1,2,3; Plate 19, Figs. 1,2,3; Plate 20, Figs. 1,2,3; Plate 21,22,23,24).

PLATE 16 : Vegetation Maps of some of the representative quadrats of Rupri Marga on 12.7.92 for both grazed and fenced sites.

Fig 1 a : Sewari grazed
1 b : Sewari fenced
Fig 2 a : Badjari grazed
2 b : Badjari fenced
Fig 3 a : Bela grazed
3 b : Bela fenced.

Species	Symbol
Grasses	G
Sibbaldia cumeata	S
Geum elatum	Ge
Cortia depressa	Co
Bistorta vivipera	Bi
Thelictrum alpinum	Th
Rhodiola himalensis	R
Lagotis cashperiana	Lg
Ranunculus pulchellus	Rn
Taraxacum officinale	Tx
Cerastium cerasticides	Cm
Anemone obtusiloba	A
Anaphilis triplinervis	Ap
Androsace sempervivoides	Am
Primula elliptica	P
Tanacetum dolichophyllum	T
Alchemilla trolli	Al
Saxifraga sibirica	Sx
Viola biflora	V
Gentiana Carinata	Gn
Euphrasia himalayica	E
Gentiana depressa	Gnd

SEWARI GRAZED



12-7-92

FIG.1a.

SEWARI FENCED

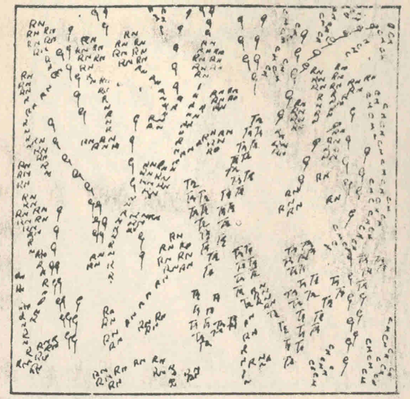
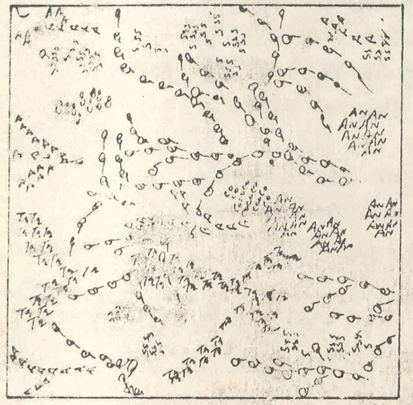


FIG.1b. 12-7-92

BADJARI GRAZED



12-7-92

FIG.2a

BADJARI FENCED

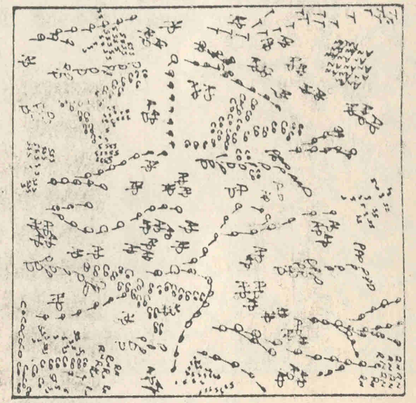
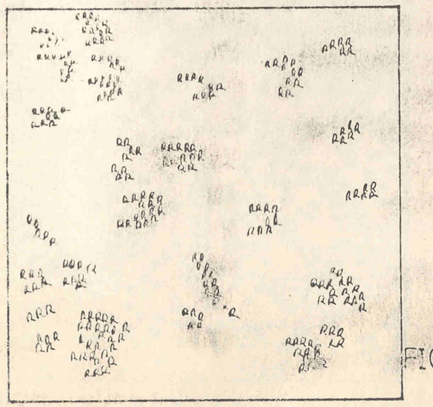


FIG2b. 12-7-92

BELA GRAZED



12-7-92

FIG.3a

BELA FENCED

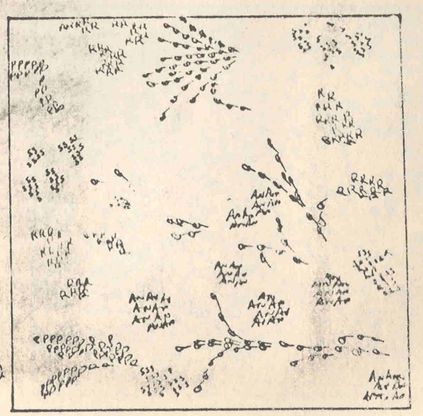
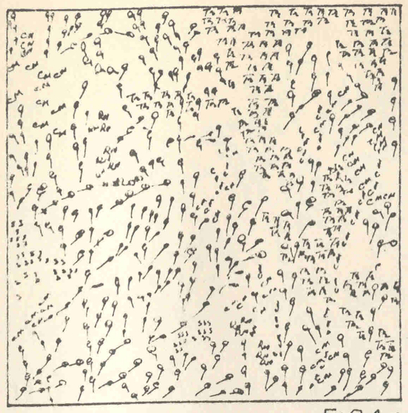


FIG.3b

PLATE 17 : Vegetation Maps of some of the representative quadrats of Rupri Nerga on 21.8.92 for both grazed and fenced sites .

Fig 1a,b: Sewari grazed and fenced.
Fig 2a,b: Badjari grazed and fenced.
Fig 3a,b: Bela grazed and fenced.

SEWARI GRAZED



21-8-92 Fig.1a.

SEWARI FENCED

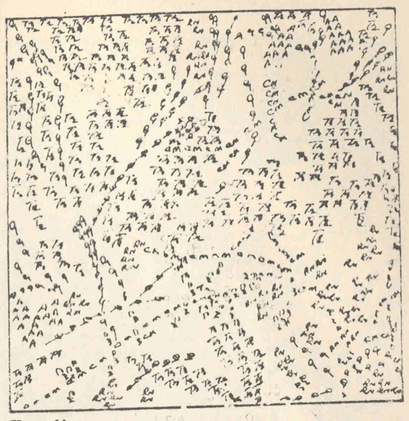
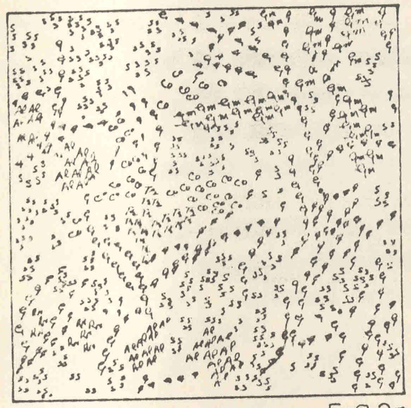


Fig.1b. 21-8-92

BADJARI GRAZED



21-8-92 Fig.2a.

BADJARI FENCED

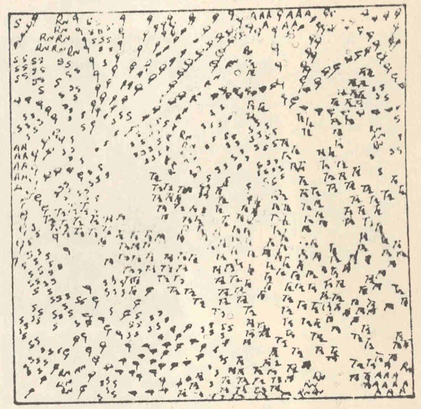
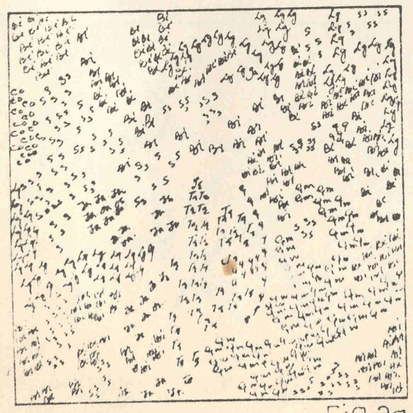


Fig.2b. 21-8-92

BELA GRAZED



21-8-92 Fig.3a.

BELA FENCED

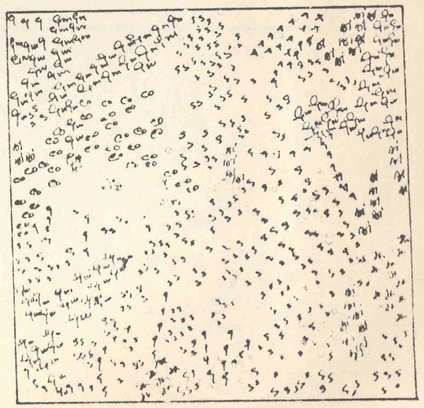


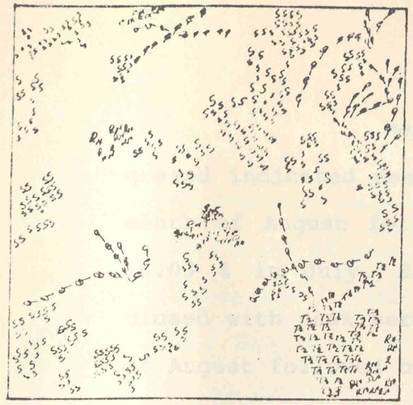
Fig.3b. 21-8-92

PLATE.17.

PLATE 18 : Vegetation Maps of some of the representative quadrats of Rupzi Nerga on 25.9.92 for both grazed and fenced sites.

Fig 1a,b: Sewari grazed and fenced.
Fig 2a,b: Badjari grazed and fenced.
Fig 3a,b: Bela grazed and fenced.

SEWARI GRAZED



25-9-92 Fig.1a.

SEWARI FENCED

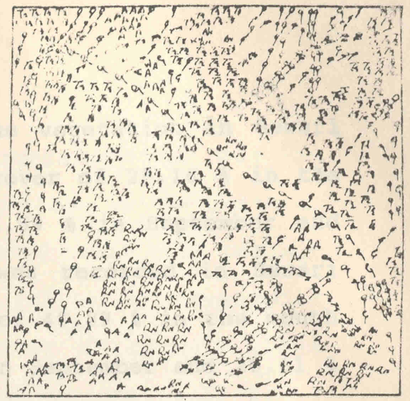
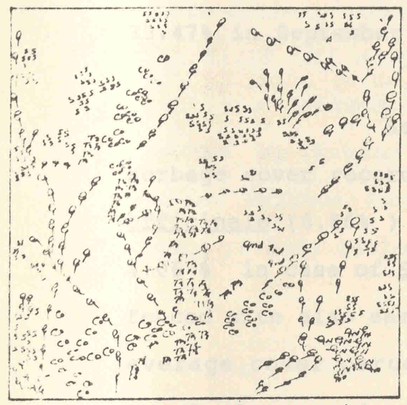


Fig.1b. 25-9-92

BADJARI GRAZED



25-9-92 Fig.2a.

BADJARI FENCED

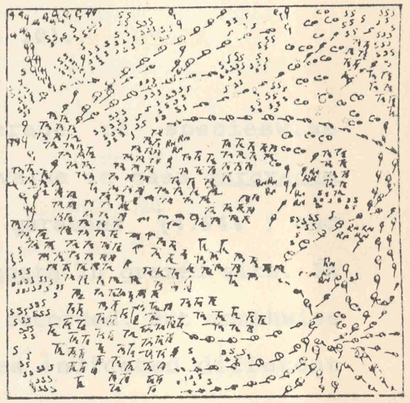
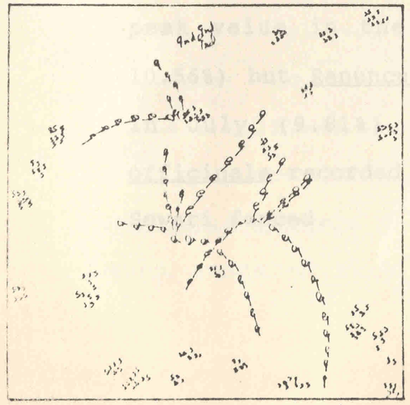


Fig.2b. 25-9-92

BELA GRAZED



25-9-92 Fig.3a.

BELA FENCED

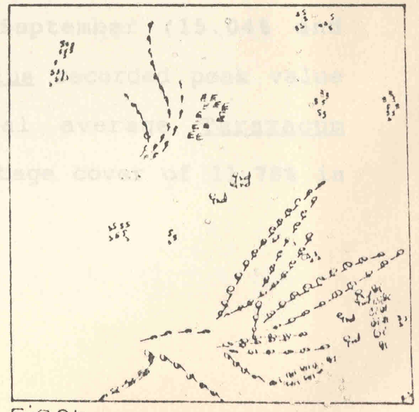


Fig.3b. 25-9-92

Mapping of the vegetation in Sewari grazed indicated peak herbage cover of 28.16 % in the month of August followed by 22.59 % in September and 16.03 % in July. Same trend was recorded in Sewari closed with peak herbage cover of 40.89 % in the month of August followed by 35.01 % in September and 20.61 % in July. When compared with grazed sites fenced enclosures recorded 22.22% more herbage cover percentage in the month of July, 31.13% in August and 35.47% in September (Tables 9 & 10).

Seasonal average of specieswise herbage cover recorded maximum value in case Taraxacum officinale (6.86%) followed by garasses (4.94%) and 4.06 % in case of Sibbaldia cuneata in grazed site. In fenced site also same trend was recorded. But monthwise average cover percentage values indicated different trend. In grazed sites Taraxacum officinale recorded maximum value in the month of August (8.95%) but in enclosed area grasses and Taraxacum officinale showed peak value in the month of September (15.04% and 10.56%) but Ranunculus pulchellus recorded peak value in July (9.81%). In seasonal average Taraxacum officinale recorded maximum herbage cover of 11.78% in Sewari fenced.

Mapping of vegetation in Badjari grazed recorded peak herbage percentage in the month of August (28.66 %) while as, in fenced site peak herbage was recorded in the September (33.40 %). Monthwise species averages of herbage cover of grazed sites indicated maximum herbage cover of Grasses (4.80 %) in the month of July, followed by Sibbaldia cuneata(4.61 %) . In the month of August Sibbaldia cuneata attained maximum herbage cover of 10.07 % followed by Grasses (6.17 %).In the month of September Sibbaldia cuneata maintained maximum herbage cover of 11.55 % again followed by Grasses (6.95 %). Seasonal average recorded maximum herbage cover in case of Sibbaldia cuneata (8.74%) followed by grasses (6.17%).

Similarly monthwise species averages of herbage cover in fenced site recorded maximum herbage cover in month of July in case of Grasses (4.85 %) followed by Geum elatum (4.37 %). In the month of August Sibbaldia cuneata attained maximum herbage cover of 13.66 % followed by Grasses 6.61 %. In the month of September Grasses attained maximum herbage cover of 10.54 % followed by Sibbaldia cuneata 8.72 %. Seasonal average recorded maximum herbage cover in case of Sibbaldia cuneata (8.90%) followed by grasses (7.33%). When compared with grazed sites, fenced enclosure

recorded 22.01% more herbage cover in July, 11.40% more in August and 29% more cover in September. (Tables 11 & 12).

In Bela grazed and fenced sites peak herbage cover percentages of 35.36 % and 34.26 % were recorded in the month of August, respectively. Monthwise species average of herbage cover of grazed sites indicated maximum herbage cover of Rhodiola himalensis (3.66 %) in the month of July. In month of August maximum herbage cover was recorded in case of Sibbaldia cuneata (13.20 %). In month of September Sibbaldia cuneata maintained maximum herbage cover of 5.35 % . Seasonal average cover was maximum in case of Sibbaldia cuneata (6.34%).

In case of Bela closed site, monthwise species average of herbage cover recorded maximum value in case of Sibbaldia cuneata (4.67%) followed by ~~Rhodiola himalensis~~ Grasses (4.63 %). In the month of August maximum herbage cover of 48.74 % was recorded in case of Sibbaldia cuneata followed by 4.96 % of Rhodiola himalensis ~~Grasses~~. In the month of September again Sibbaldia cuneata recorded maximum value of 6.87 % followed by grasses (6.03%). Seasonal average was maximum in case of Sibbaldia cuneata (6.76%). When compared with grazed sites the seasonal average

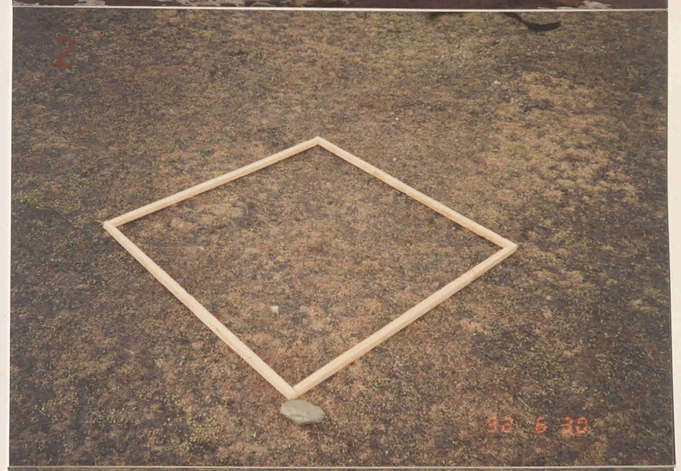
PLATE 19 : Condition of pastureland after melting of snow.

Fig 1 : Sewari Meadow at Valley bottom.

Fig 2 : Sewari Meadow site I selected for enclosure.

Fig 3 : Sewari Meadow site II selected for enclosure.





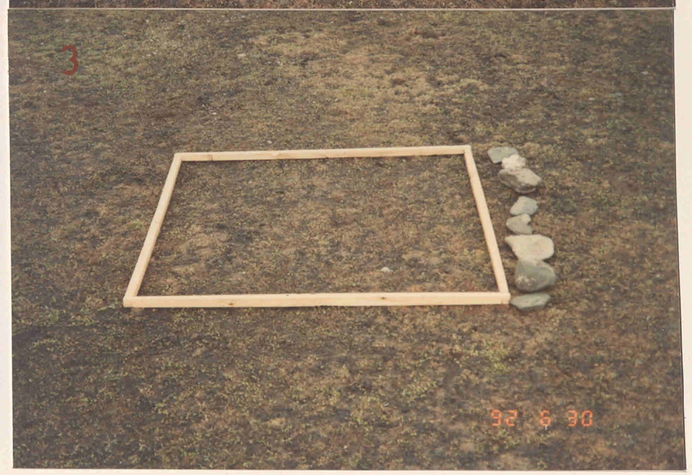


PLATE . 19.

PLATE 20 : Condition of pasturelands (Margs) in first week of July 1992.

Fig 1 : Sewari Marg
Fig 2 : Sadjari Marg
Fig 3 : Dolo Marg

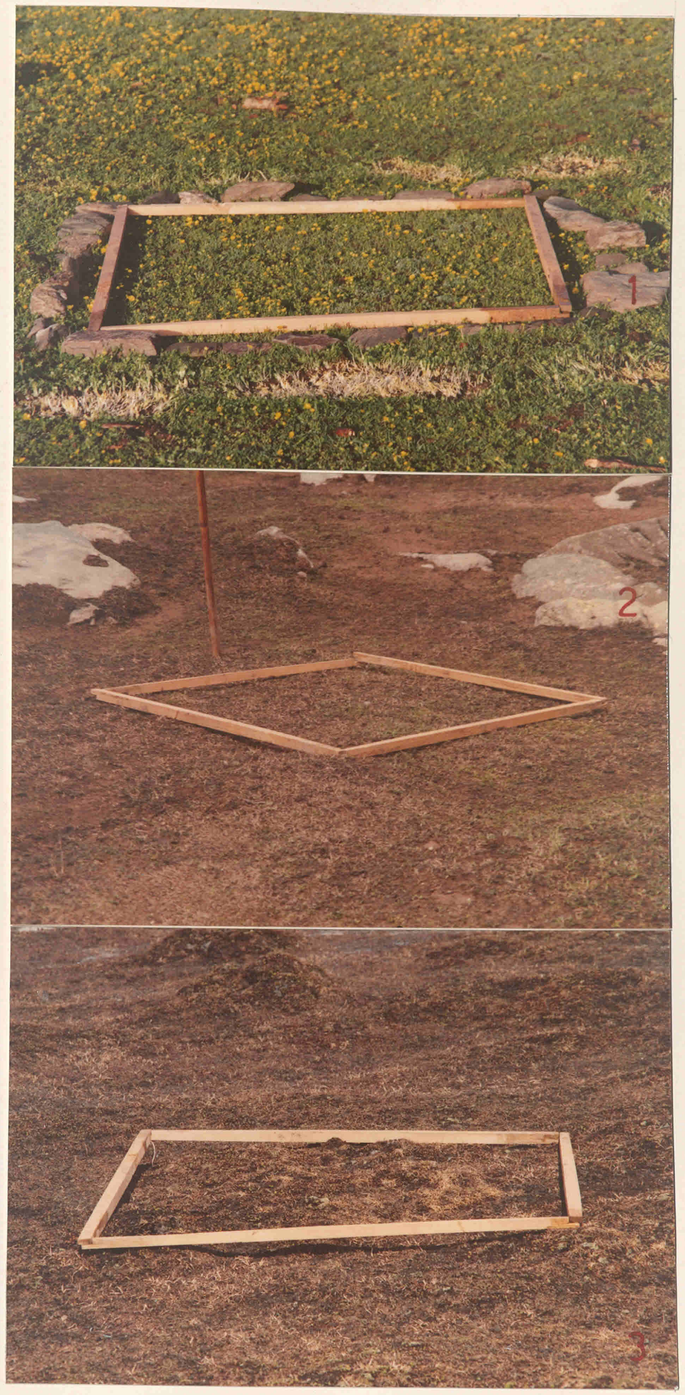


PLATE . 20.

PLATE 21 : Condition of Rupri Pastureland on 1.8.92.

Fig 1 : Sewari Marg
Fig 2 : Badjari Marg
Fig 3 : Bela Marg







PLATE.21.

PLATE 22 : Condition of Rupri Pastureland
on 14.8.92 .

Fig 1 : Sewari Marg
Fig 2 : Badjari Marg
Fig 3 : Bela Marg.





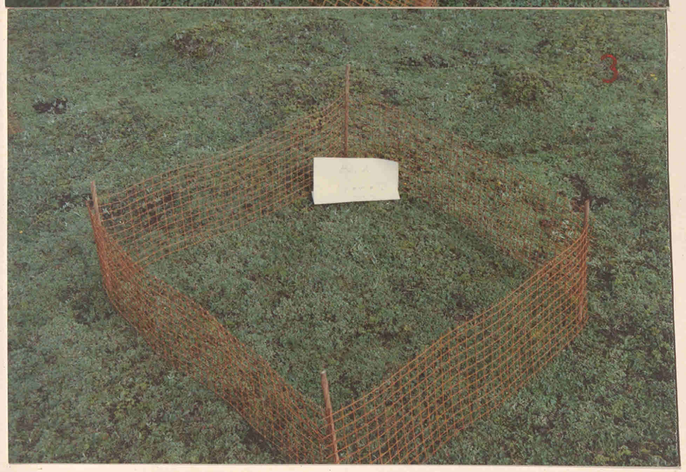


PLATE.22.

PLATE 23 : Condition of Rupri Pasturland
on 28.8.92

Fig 1 : Sewari Marg
Fig 2 : Badjari Marg
Fig 3 : Bela Marg .

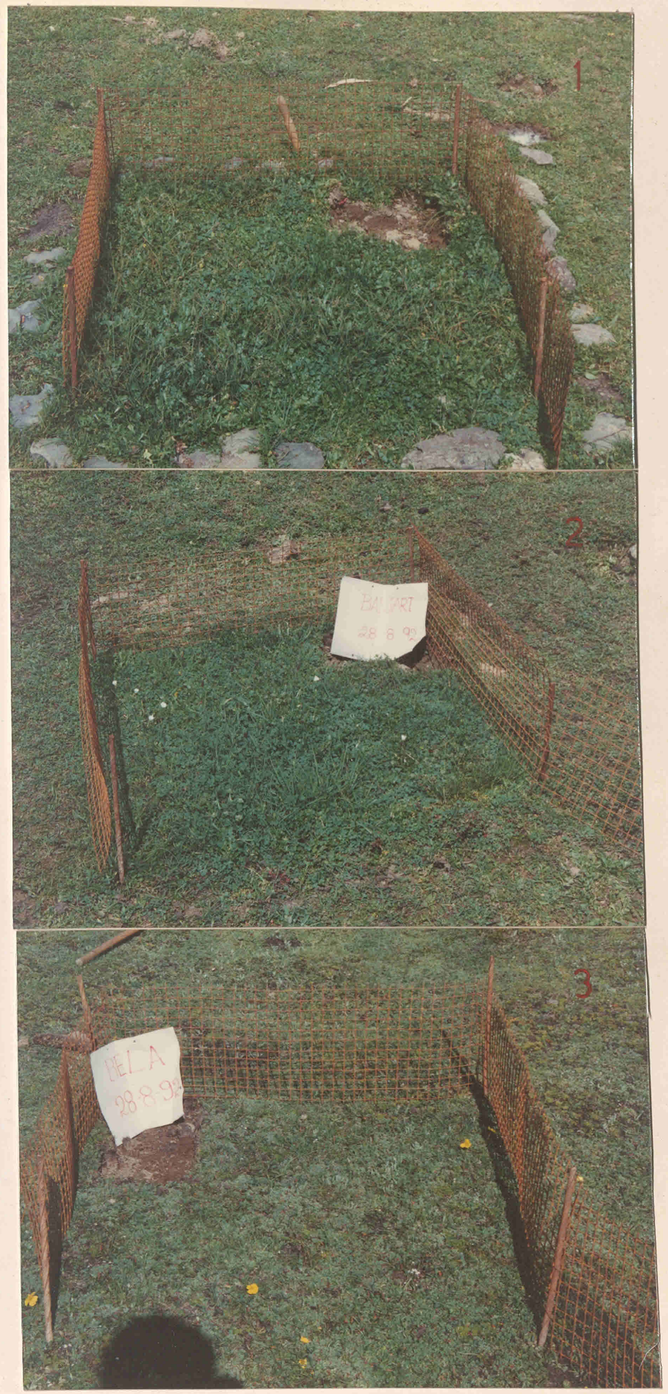


PLATE . 23.

PLATE 24 : Condition of Rupri Pastureland on 24.9.92.Grasses in these pictures have started drying due to frost and cold weather.

Fig 1 : Sewari Marg. I

Fig 2 : ~~Gela Marg.~~ Sewasi Marg II

Fig 3 : Badyari Marg

PLATE.24.



PLATE 25 : Condition of Rupri Pastureland on 7.11.92. After 2.10.92 PirPanjal meadows ~~come under~~ received continuous snowfall and the area becomes inhospitable for herders and their livestock.

Fig 1 : Sewari Marg I .
Fig 2 &3: Sewari Marg II.

PLATE.25.







indicated that fenced sites possessed only 1.56% herbage cover.

JACARD'S INDEX OF SIMILARITY

Jacard's Index of Similarity when compared with grazed and fenced sites for all the three areas indicated highest value 52.94% for Sewari followed by 52.38% for Bela and 35% for Badjari. The mean of all sites indicates the value of 46.53% between grazed and fenced sites. High values at Sewari and Bela indicate that fenced and grazed sites are more homogenous as compared to Badjari. (Table 22).

Table 22: Jaccard's Index of Similarity between grazed and fenced sites

S.No.	Site	No of sps common in Grazed and Fenced site C	No of sps unique to Fenced Site a	No of sps unique to Grazed Site b	Total	ISJ
1.	Sewari	9	2	6	17	52.94
2.	Badjari	7	-	13	20	35.00
3.	Bela	11	1	9	21	52.38
	Mean $\bar{x}$	9	1	9.34	19.34	46.53

LIFE FORM / BIOLOGICAL SPECTRUM

An analysis of biological spectrum of the area indicated Hemicryptophytic phytoclimatic life forms in all three grazed sites as compared to Geohemicryptophytic in fenced areas. In Sewari open Hemicryptophytes with 46.67% were more in number followed by chamaephytes 33.33%. Same trend was seen in Badjari with 40% Hemicryptophytes and 30% chamaephytes and in Bela with 50% Hemicryptophytes. 10% Therophytes were recorded in Badjari and Bela open sites only. In Sewari,Badjari and Bela fenced sites Hemicryptophytes were 36.36%, 57.14% and 41.67%, respectively. Geophytes were recorded more in Badjari and Bela with 28.57% and 25% as compared to Sewari with only 18.18%. Therophytes were recorded in Sewari and Bela enclosures with 18.18% and 25%. Badjari recorded no therophyte (Tables 23 & 24, Plate 26).

Table 23: Biological Spectrum of different life forms at the Rupri study sites (grazed)

S.No.	Site		% distribution of Life forms at grazed sites				
			Ch	H	Cr(g)	Th	Total
1.	Sewari	No.	5	7	3	-	15
		%age	33.33	46.67	20.00		100
2.	Badjari	No.	6	8	4	2	20
		%age	30.00	40.00	20.00	10.00	100
3.	Bela	No.	4	10	4	2	20
		%age	20.00	50.00	20.00	10.00	100
	Mean $\bar{x}$	No.	5	8.33	3.67	1.33	18.33
		%age	27.77	45.56	20.00	6.67	100.00
		Nor	9	26	4	13	

PLATE 26 : Biological spectrum polpgraph of Rupri grazed and fenced sites compared with Raunkiaer's normal distribution.

PH	Phanerophytes
N	Nanophanerophyte.
CH	Chamaephyte.
H	Hemi-cryptophyte.
G.	Geophyte.
HH	Halophyte, Hydrophyte.
TH	Therophyte.
S E	Succulent, Epiphyte.

BIOLOGICAL SPECTRUM

— RAUNKIAERS NORMAL

— RUPRI GRAZED

— RUPRI FENCED

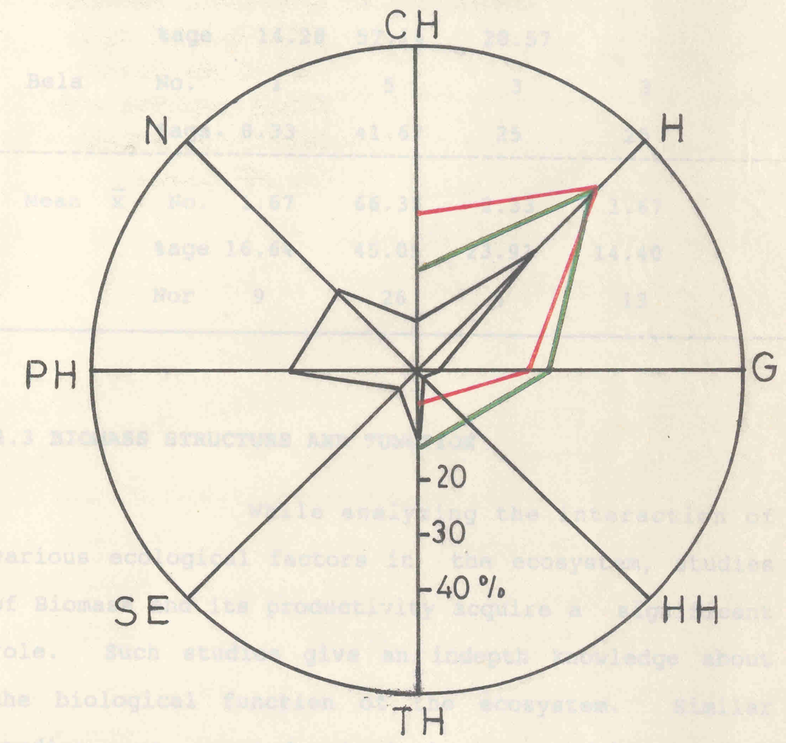


PLATE.26.

Table 24: Biological Spectrum of different life forms at the Rupri study sites (fenced)

S.No.	Site	% distribution of Life forms at fenced sites				
		Ch	H	Cr(g)	Th	Total
1.	Sewari	No. 3	4	2	2	11
		%age 27.27	36.36	18.18	18.18	100
2.	Badjari	No. 1	4	2	-	7
		%age 14.28	57.14	28.57		100
3.	Bela	No. 1	5	3	3	12
		%age 8.33	41.67	25	25	100
	Mean $\bar{x}$	No. 1.67	66.33	2.33	1.67	10
		%age 16.64	45.05	23.91	14.40	100
		Nor 9	26	4	13	-

4.3 BIOMASS STRUCTURE AND FUNCTION

While analyzing the interaction of various ecological factors in the ecosystem, studies of Biomass and its productivity acquire a significant role. Such studies give an indepth knowledge about the biological function of the ecosystem. Similar studies were carried out at the present site to find

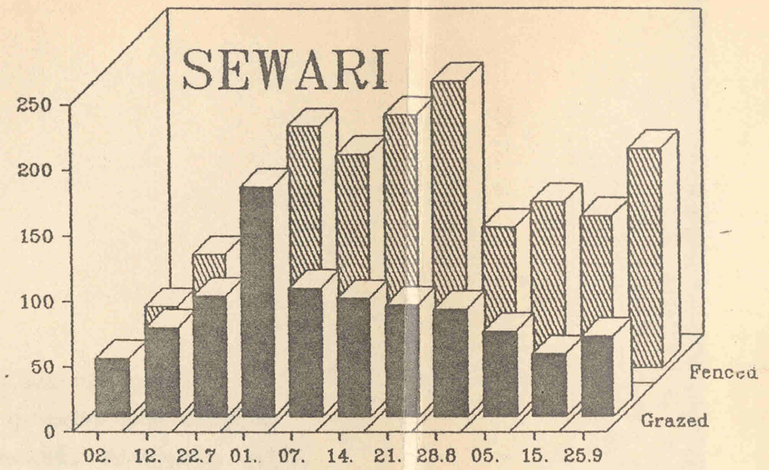
out biological function relationships in alpine meadows.

4.3.1. ABOVE GROUND LIVE BIOMASS (Table 25;Plate 27)

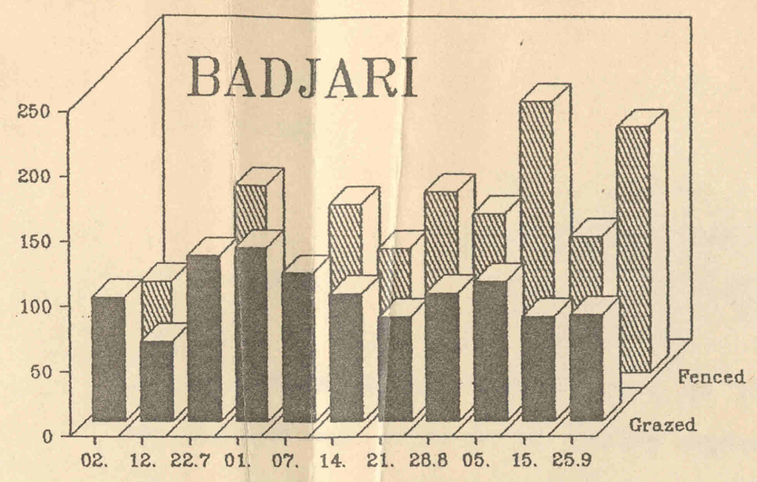
During the course of study peak biomass was recorded as 176.3 gm/m^{-2} on first of August 1992 in Sewari grazed site. From second July to first of August 1992 biomass showed increased trend but from first August upto fifteen September 1992 it decreased upto 48.4 gm/m^{-2}. On twenty fifth September 1992 there was again slight increase. The biomass production in Sewari fenced also recorded almost same trend. From second July 1992 it increased upto twenty first August 1992 to a maximum of 220.0 gm/m^{-2}. The productivity fluctuated after this date without any fixed trend.

In Badzari grazed biomass increased from second July to first August 1992 till it reached peak production of 134 gm/m^{-2} and started decreasing till twenty fifth September 1992. The biomass production varied from 80.6 gm/m^{-2} to 134 gm/m^{-2}. In Badjari fenced biomass production varied from 68 gm/m^{-2} to 210 gm/m^{-2}. On first & second July 1992 and fourteenth August 1992 production was less than the grazed area. Peak production of 145,

PLATE 27 : Total above ground live biomass of grazed and fenced sites at Sewari, Badjari, Bela Margs and Mean values of all sites. (Dry wt. gm/m^{-2})

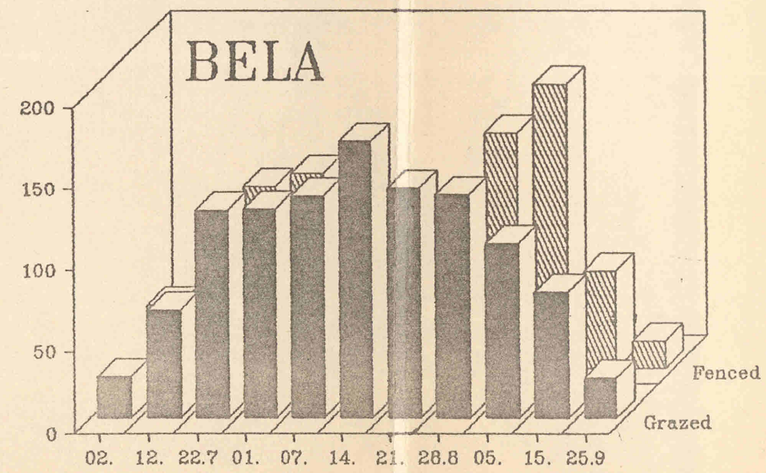


Dates of recording 1992

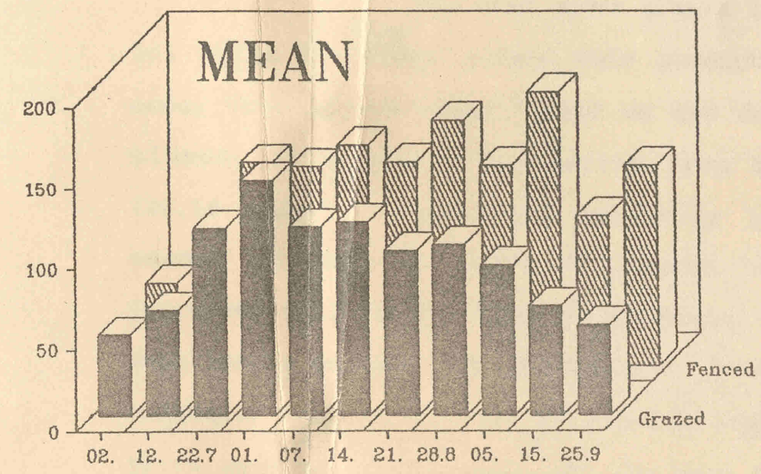


Dates of recording 1992

ABOVEGROUND LIVE BIOMASS RUPRI (gm/m-2)



Dates of recording 1992



Dates of recording 1992

PLATE :27

210, and 190 gm was recorded on twenty second July, fifth September and twenty fifth September 1992, respectively.

In Bela grazed sites biomass ranged from 24.4 gm/m^{-2} to 170 gm/m^{-2}. The peak production was recorded on fourteenth August 1992. In Bela fenced site biomass ranged from 17 gm/m^{-2} to 175 gm/m^{-2}. Peak production was recorded on fifth september 1992. In Bela fenced, biomass production on seven dates of recording was less than the grazed areas.

The mean above ground live biomass of all sites in ~~Sewari~~ Rupsi showed more production in fenced areas than grazed areas except on two dates. The mean biomass in grazed sites varied from 56.13 gm/m^{-2} to 146.10 gm/m^{-2}. Production gradually increases from second of July to first of August 1992 and then decreases till twenty fifth of September 1992 when area experiences extreme low temperatures, frost and finally snowfall. In fenced area the mean biomass varied from 52.00 gm/m^{-2} to 170.83 gm/m^{-2} and the peak production has been recorded on fifth September 1992.

Table 25: Total aboveground live biomass grazed and fenced sites at Rupri margs (Dry wt gm/m^{-2})

Site	Dates of recording										
	2.7.92	12.7.92	22.7.92	1.8.92	7.8.92	14.8.92	21.8.92	28.8.92	5.9.92	15.9.92	25.9.92
Sewari (g)	44.7	68.34	92.4	176.3	98.7	90.67	85.67	82.4	65.70	48.4	61.6
Sewari (f)	47.0	87.0	125.0	185.0	163.5	193.5	220.0	107.75	127.5	117.0	168.5
Badjari (g)	95.5	61.5	128.0	134.0	115.0	98.7	81.0	99.0	107.6	80.6	82.4
Badjari (f)	70.0	80.0	145.0	68.0	130.0	96.0	140.0	123.0	210.0	105.0	190.0
Bela (g)	25.0	66.0	127.0	128.0	136.0	170.0	141.0	137.0	107.0	77.4	24.4
Bela (f)	39.0	85.0	112.0	120.0	120.0	93.0	100.0	145.0	175.0	60.0	17.0
Grazed $\bar{x}$	55.06	65.28	115.8	146.10	116.56	119.79	102.55	106.13	93.43	68.0	56.13
Fenced $\bar{x}$	52.0	84.00	127.3	124.33	137.83	127.5	153.33	125.25	170.83	94.0	125.16

4.3.2 STANDING DEAD (Table 26;Plate 28)

The standing dead biomass fluctuated throughout the year recording maximum values at certain dates of observations.

In Sewari grazed site peak biomass was recorded immediate after snow melting. From first observation to the third recording (22nd July) the biomass exhibited declining trend. From first August upto twenty fifth September the biomass production remained at almost same levels except on twenty eighth August when biomass production declined to 44.6 gm/m^{-2}.

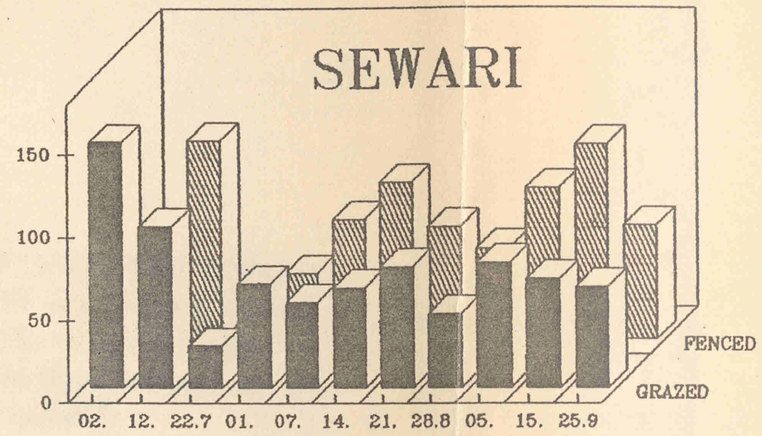
Biomass varied from 25.7 gm/m^{-2} to 148.4 gm/m^{-2}. There was alternate increase and decrease of biomass values on the dates of recording. In fenced enclosure biomass varied from 25 gm/m^{-2} to 120.5 gm/m^{-2}. Two peaks were recorded on twelveth July and fifteen September 1992.

In Badjari grazed the peak biomass was recorded on first reading just after snow clearance. It decreased sharply upto 42.25 gm/m^{-2} on twenty second July 1992, then gradually increased and maintained production above 100 gm/m^{-2}. In Badjari fenced biomass varied from 40 gm/m^{-2} to 102 gm/m^{-2}. Only on twelveth July 1992 biomass value exceeded 100 gm/m^{-2}.

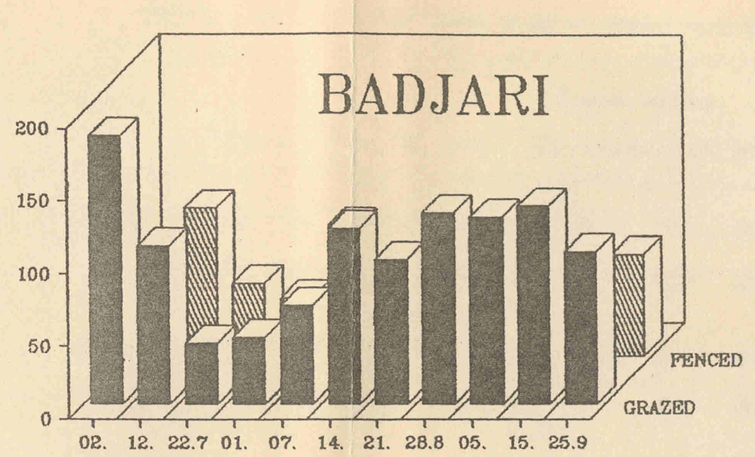
In Bela grazed the peak biomass value of 230.0 gm/m^{-2} was recorded on fourteenth of August 1992. The biomass varied from 38.4 gm/m^{-2} to 230.0 gm/m^{-2}. In Bela fenced peak biomass was recorded on twenty fifth of September 1992 (188 gm/m^{-2}). It varied from 100 gm/m^{-2} to 188 gm/m^{-2}.

Mean biomass production of grazed sites varied from 51.20 gm/m^{-2} to 137.23 gm/m^{-2} and in enclosed sites it varied from 78.33 gm/m^{-2} to 122.34 gm/m^{-2}. The mean values indicate that accumulation of

PLATE 28 : Total standing dead biomass of grazed and fenced sites at Semari, Hadjari, Bela Nargs and Mean values of all sites (gm/m^{-2})

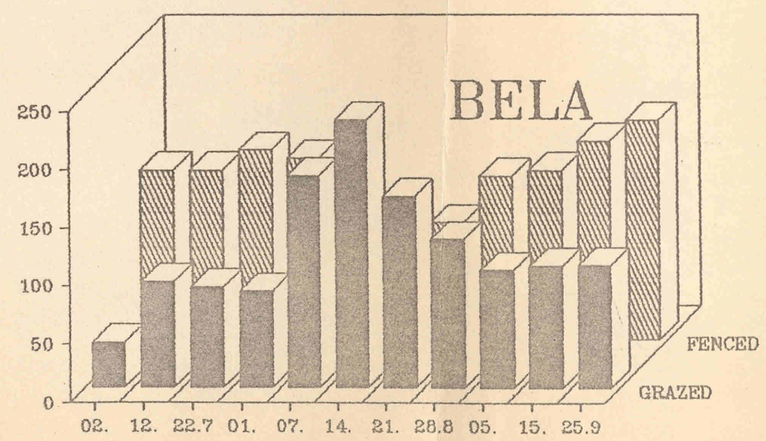


Dates of Recording 1992

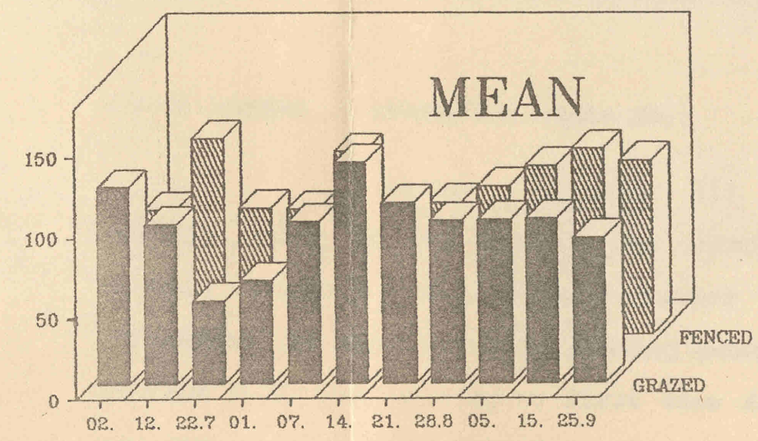


Dates of recording 1992

STANDING DEAD BIOMASS RUPRI (gm/m-2)



Dates of Recording 1992



Dates of recording 1992

PLATE :28

standing dead biomass was more in fenced ~~sites~~ grazed than in ~~grazed~~ fenced sites.

Table 26 : Total standing dead biomass grazed and fenced sites at Rupri Margs (Dry wt gm/m^{-2}).

Site	Dates of recording										
	2.7.92	12.7.92	22.7.92	1.8.92	7.8.92	14.8.92	21.8.92	28.8.92	5.9.92	15.9.92	25.9.92
Sewari (g)	148.4	97.4	25.7	63.0	51.67	60.7	73.0	44.6	75.6	66.0	61.0
Sewari (f)	30.0	120.0	25.0	40.0	72.0	94.5	67.5	55.0	91.0	117.5	68.5
Badjari (g)	185.5	109.0	42.25	46.3	68.5	121.0	100.0	132.3	129.0	137.0	105.7
Badjari (f)	60.0	102.0	50.0	40.0	90.0	47.0	80.0	83.0	80.0	60.0	70.0
Bela (g)	38.4	90.7	85.67	82.4	181.5	230.0	164.0	127.3	100.50	104.3	105.0
Bela (f)	145.0	145.0	162.0	155.0	180.0	100.0	100.0	140.0	145.0	170.0	188.0
Grazed $\bar{x}$	122.4	99.03	51.20	63.90	100.55	137.23	112.3	101.4	101.70	102.43	90.57
Fenced $\bar{x}$	78.33	122.34	79.0	78.33	114.0	80.5	82.5	92.66	105.30	115.8	108.3

4.3.3 LITTER (Table 27; Plate 29)

Litter includes all the plant material lying on the ground. The standing crop of ground litter at all sites remained fluctuating throughout the growing season showing general trend of decline from snow melting to first snow fall. However maximum values were recorded at the beginning of

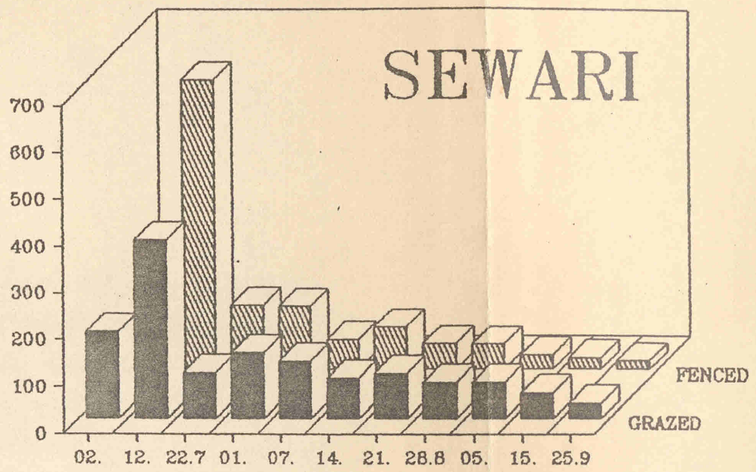
growing season and after snow melting.

Litter biomass accumulation in Sewari grazed ranged from 32.6 gm/m^{-2} to 382.4 gm/m^{-2}. Two peaks were recorded on twelveth July and ~~seventh~~ first August. From twenty first August there was gradual decrease in litter biomass till twenty fifth September 1992. Similar trend was observed in fenced enclosures. Peak value of 620 gm/m^{-2} was recorded on twelveth of July 1992 which gradually decreased to 19 gm/m^{-2} on twenty fifth of September 1992 immediately before first snow fall, except on fourteenth of August when the production was 91 gm/m^{-2}.

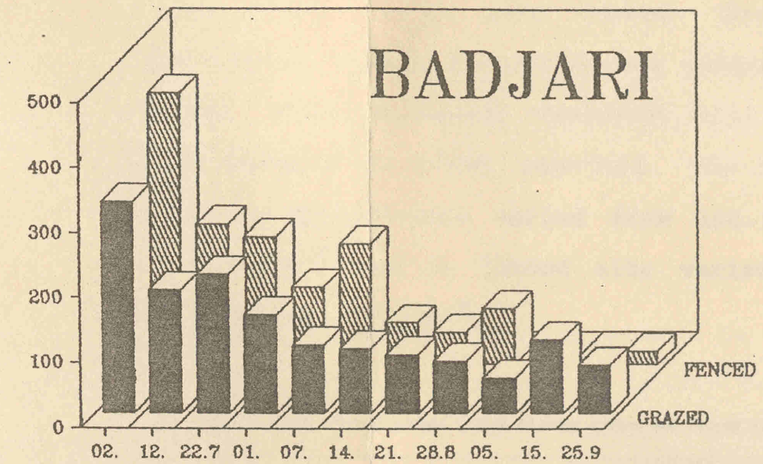
In Badjari grazed peak litter biomass was recorded just after snow melting and before arrival of cattle/livestock on the meadow. Biomass varied from 54 gm/m^{-2} to 324.75 gm/m^{-2}. It showed decreasing trend from snow melting to first snowfall except on twenty second July and fifteenth September. In fenced site almost same trend was observed and the value ranged from 0 to 420 gm/m^{-2}. On fifteenth September 1992 nil litter accumulation was recorded.

In Bela grazed litter biomass varied from 166.5 gm/m^{-2} to 388.34 gm/m^{-2}. Peak value was recorded on twenty second of July 1992. In Bela fenced

PLATE 29 : Total ground Litter Biomass of grazed and fenced sites at Sewari, Badjari and Bela Margs and mean values of all sites (gm/m^{-2}).

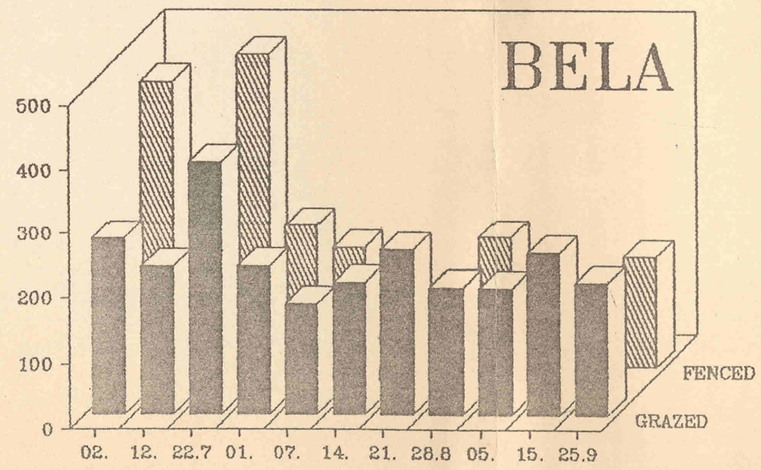


Dates of recording 1992

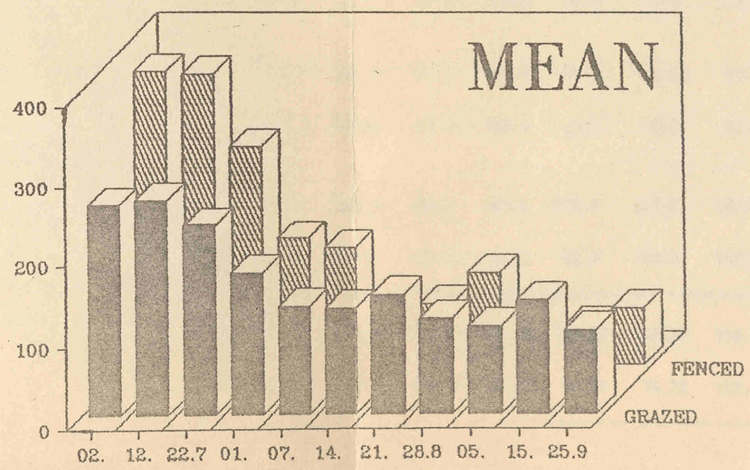


Dates of recording 1992

LITTER BIOMASS RUPRI (gm/m-2)



Dates of recording 1992



Dates of recording 1992

PLATE :29

litter biomass varied from 85 gm/m^{-2} to 482 gm/m^{-2}. Minimum litter biomass in fenced site was recorded on fourteenth August.

The mean litter biomass of grazed and fenced sites showed same trends. There was more accumulation immediately after snow clearance from the meadows, which gradually decreases till meadows are again covered by first snowfall. The mean biomass values in grazed site varied from 102.13 gm/m^{-2} to 259.72 gm/m^{-2} and in fenced site varied from 48.33 gm/m^{-2} to 366.66 gm/m^{-2}.

Table 27 : Total standing crop of ground litter biomass grazed and fenced sites at Rupri Margs (Dry wt gm/m^{-2}).

Site	Dates of recording										
	2.7.92	12.7.92	22.7.92	1.8.92	7.8.92	14.8.92	21.8.92	28.8.92	5.9.92	15.9.92	25.9.92
Sewari (g)	185.0	382.4	97.67	140.0	122.4	86.0	95.67	77.3	76.7	55.0	32.6
Sewari (f)	240.0	620.0	137.0	135.0	64.0	91.0	55.0	53.5	31.0	25.0	19.0
Badjari (g)	324.75	189.5	214.2	151.7	104.0	99.0	89.50	79.3	54.0	113.7	73.5
Badjari (f)	420.0	217.0	198.0	120.0	187.0	65.0	50.0	87.0	32.0	-	21.0
Bela (g)	269.4	225.0	388.34	225.7	166.5	199.7	251.0	192.0	190.3	247.0	200.3
Bela (f)	440.0	262.0	482.0	215.0	180.0	85.0	118.0	197.0	115.0	120.0	167.0
Grazed $\bar{x}$	259.72	265.63	233.40	172.46	130.96	128.23	145.39	116.2	107.0	138.56	102.13
Fenced $\bar{x}$	366.66	363.33	272.34	156.66	143.66	80.33	74.33	112.5	59.33	48.33	69.0

4.3.4 BELOWGROUND (Table 28; Plate 30)

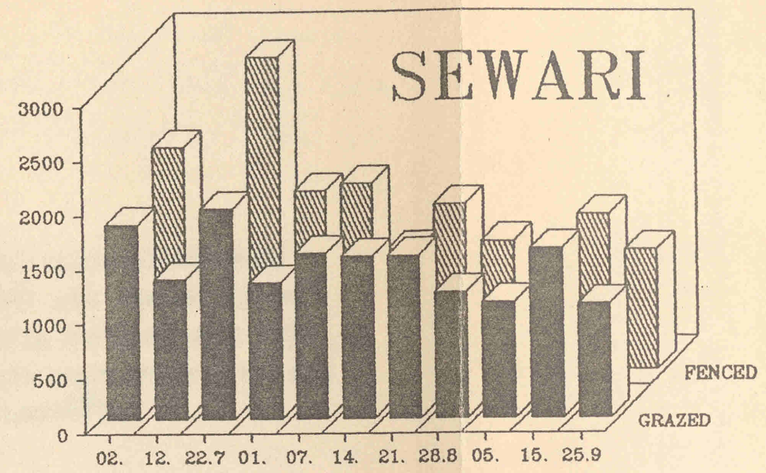
Belowground biomass in Sewari grazed varied from 1040.6 gm/m^{-2} to a maximum of 1927.4 gm/m^{-2}. Only one peak on twenty second of July 1992 was recorded. Same trend was observed in Sewari fenced where one peak value was recorded on twenty second of July 1992. Biomass varied from 1012.5 gm/m^{-2} to 2880 gm/m^{-2}.

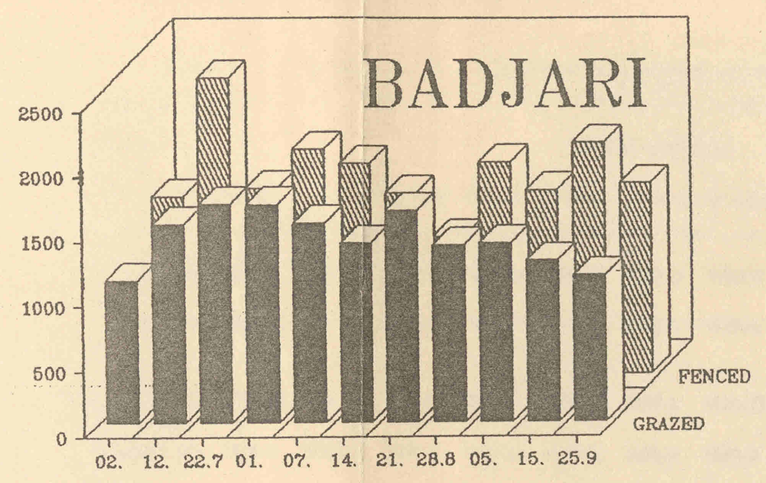
In Badjari grazed, belowground biomass ranged from 1091.25 gm/m^{-2} to 1680 gm/m^{-2}. Only one peak was recorded on twenty second of July 1992. In fenced enclosure biomass values varied from 1060 gm/m^{-2} to 2288 gm/m^{-2}. Peak value was recorded on twelveth of July 1992.

In Bela grazed, belowground biomass varied from 1410.0 gm/m^{-2} to 1919.3 gm/m^{-2}. Peak value was recorded on twenty second of July 1992. In fenced enclosure biomass varied from 1580 gm/m^{-2} to 2685 gm/m^{-2}. Only one peak value was recorded ~~in the month of~~ on twenty first of August 1992.

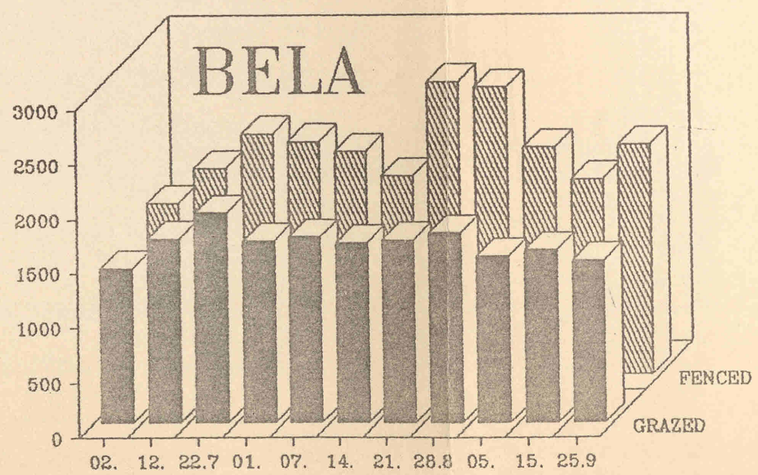
Mean belowground biomass of grazed and fenced sites indicated more production in fenced sites than grazed sites. Biomass values in grazed site

PLATE 30 : Total belowground Biomass of grazed and fenced sites at Sewari, Badjari and Bela Margs and mean values of all sites (gm/m^{-2}).





BELOWGROUND BIOMASS RUPRI (gm/m-2)



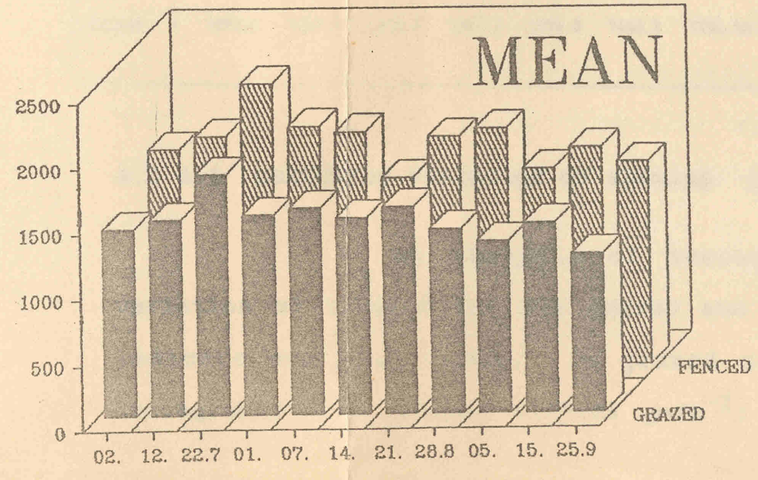


PLATE :30

varied from 1215.24 gm/m^{-2} to 1842.2 gm/m^{-2} and in fenced sites varied from 1443.3 gm/m^{-2} to 2175.6 gm/m^{-2}. Only one peak value was observed in both the cases on twenty second of July 1992.

Table 28 : Total standing crop of belowground biomass grazed and fenced sites at Rupri Margs (Dry wt gm/m^{-2}).

Site		Dates of recording										
		2.7.92	12.7.92	22.7.92	1.8.92	7.8.92	14.8.92	21.8.92	28.8.92	5.9.92	15.9.92	25.9.92
Sewari	(g)	1784.0	1280.0	1927.4	1244.66	1511.0	1487.0	1490.0	1147.3	1055.0	1548.34	1040.6
Sewari	(f)	2060.0	1118.0	2880.0	1650.0	1717.5	1110.0	1517.5	1180.5	1012.5	1426.0	1099.0
Badjari	(g)	1091.25	1526.0	1680.0	1676.3	1530.6	1378.4	1626.75	1359.0	1376.3	1242.3	1128.4
Badjari	(f)	1378.0	2288.0	1437.0	1737.0	1625.0	1400.0	1060.0	1635.0	1420.0	1790.0	1470.0
Bela	(g)	1410.0	1684.0	1919.3	1663.34	1700.0	1643.0	1670.0	1735.0	1517.3	1574.0	1476.72
Bela	(f)	1580.0	1890.0	2210.0	2137.0	2048.0	1820.0	2685.0	2637.0	2082.0	1785.0	2100.0
Grazed	$\bar{x}$	1428.42	1496.6	1842.2	1528.1	1580.5	1502.8	1585.58	1413.76	1316.20	1454.88	1215.24
Fenced	$\bar{x}$	1672.6	1765.3	2175.6	1841.3	1796.8	1443.3	1754.16	1817.5	1504.8	1667.0	1556.3

4.3.4.1 MONTHWISE VARIATION OF BIOMASS (Table 29)

An analysis of average monthwise variation of biomass for all grazed and fenced sites indicate one peak value. In grazed sites maximum aboveground live biomass (118.23 gm/m^{-2}) was recorded

in the month of August 1992 and in fenced site maximum biomass (133.65 gm/m^{-2}) was also recorded in the month of August 1992.

Standing dead peak values in both grazed (103.07 gm/m^{-2}) and fenced (109.8 gm/m^{-2}) was recorded in the months of August and September 1992, respectively.

Litter biomass was maximum in the month of July which gradually decreased till September 1992. Peak values in grazed and fenced sites were recorded in the month of July as 252.91 gm/m^{-2} and 335.11 gm/m^{-2}, respectively. This is due to the decomposition of all living parts under snow during winter.

Same trend was observed in accumulation of biomass in belowground parts. Grazed and fenced sites recorded only one peak value in the month of July 1992 which gradually decreased till September 1992. In grazed site peak value was 1589.07 gm/m^{-2} and in fenced site it was 1871.16 gm/m^{-2}. This could be due to the translocation of food material in the months of growing season to aboveground parts and accumulation of same in belowground parts during the winter. There is more belowground biomass

production in fenced area than in grazed area. Again an indication of more stress on belowground parts due to grazing.

Table 29: Month wise analysis of average Biomass (gm/m^{-2}) for grazed and fenced sites at Rupri Marg.

Month	Aboveground live		Standing dead		Litter		Belowground	
	Grazed	Fenced	Grazed	Fenced	Grazed	Fenced	Grazed	Fenced
7/92	78.71	87.77	90.87	93.22	252.91	335.11	1589.07	1871.16
8/92	118.23	133.65	103.07	83.52	138.65	113.49	1524.15	1730.61
9/92	74.45	129.99	98.23	109.80	115.89	40.16	1328.77	1576.03

4.3.4.2 TOTAL LIVE BIOMASS AND ROOT SHOOT RATIO (Table 30)

Root/Shoot ratio varied from 10.46 to 25.94 in grazed sites.In fenced sites it varied from 8.80 to 32.16.In monthwise average analysis it varied from 12.89 to 20.18 in grazed sites and 12.12 to 21.31 in fenced sites. Peak values were recorded in the month of July 1992 and minimum ratio was recorded in the months of August in grazed sites and September in fenced sites.

Total biomass in grazed site varied from 1271.37 gm/m^{-2} to 1958.00 gm/m^{-2}. Peak biomass was recorded on twenty second of July 1992. Similarly,

in fenced sites it varied from 1570.8 gm/m^{-2} to 2302.90 gm/m^{-2} and peak biomass was recorded on twenty second of July 1992. Analysis of average monthwise total production reveals that the production decreases from July to September gradually in case of both grazed and fenced sites.

Table 30 : Live Biomass gm/m^{-2} of aboveground and belowground parts and root/shoot ratio

A) Grazed Site

Date of recording	Aboveground	Belowground	Total	R/S ratio
02.07.92	55.06	1428.42	1483.48	25.94
12.07.92	65.28	1496.6	1561.88	22.92
22.07.92	115.8	1842.2	===>1958.00	15.90
01.08.92	146.10	1528.1	1674.20	10.46
07.08.92	116.56	1580.5	1697.06	13.56
14.08.92	119.79	1502.8	1622.59	12.54
21.08.92	102.55	1595.58	1698.13	15.56
28.08.92	106.13	1413.76	1519.89	13.32
05.09.92	93.43	1316.20	1409.63	14.08
15.09.92	68.80	1454.88	1523.68	21.14
25.09.92	56.13	1215.24	1271.37	21.60
Mean $\bar{x}$	95.05	1488.57	1583.63	15.66

B) Fenced Site

Date of recording	Aboveground	Belowground	Total	R/S ratio
02.07.92	52.0	1672.6	1724.6	32.16
12.07.92	84.0	1765.3	1849.3	21.01
22.07.92	127.3	2175.6 ===>	2302.9	17.09
01.08.92	124.33	1841.3	1965.63	14.43
07.08.92	137.83	1796.8	1934.63	13.03
14.08.92	127.5	1443.3	1570.8	11.32
21.08.92	153.33	1754.16	1907.49	11.44
28.08.92	125.25	1817.5	1942.75	14.51
05.09.92	170.83	1504.8	1675.63	8.80
15.09.92	94.00	1667	1761.00	17.73
25.09.92	125.16	1556.3	1681.46	12.43
Mean $\bar{x}$	120.13	1726.78	1846.92	15.81

C) Month wise total Biomass (gm/m^{-2}) and root/shoot ratio

Month	Aboveground		Belowground		Total		Root/Shoot Ratio	
	G	F	G	F	G	F	G	F
07.92	78.71	87.77	1589.07	1871.16	1667.	1958.	20.18	21.31
08.92	118.23	133.65	1524.15	1730.61	1642.	1863.	12.89	12.94
09.92	74.45	129.99	1328.77	1576.03	1402.	1706.	17.84	12.12

4.3.5 NET PRIMARY PRODUCTION (Table 31).

4.3.5.1 ABOVEGROUND NET PRODUCTION (ANP)

Aboveground net production was more in fenced sites than grazed sites. ANP of grazed sites varied from 100.90 $gm/m^{-2}/yr^{-1}$ to 197.30 $gm/m^{-2}/ yr^{-1}$. Whereas, it varied from 245.00 $gm/m^{-2}/ yr^{-1}$ to 491 $gm/m^{-2}/yr^{-1}$ in fenced sites (Plate 31).

Above ground live increment in grazed sites ranged from 100.9 $gm/m^{-2} /yr^{-1}$ to 145 $gm/m^{-2}/yr^{-1}$ and the turnover rates ranged from 0.75 to 0.85. Similarly, aboveground live increment in Sewari fenced sites varied from 163 $gm/m^{-2}/yr^{-1}$ to 353 $gm/m^{-2}/ yr^{-1}$ with turnover rates from 0.93 to 1.68 (Table 31 Plate 32).

PLATE 31 : Above ground net Production and total net production of Grazed and fenced sites at Sewari, Badjari and Bela Margs and mean for Rupri Margs ($gm/m^{-2}/yr^{-1}$).

RUPRI ABOVEGROUND NET PRODUCTION AND TOTAL NET PRODUCTION (gm−2 yr−1)

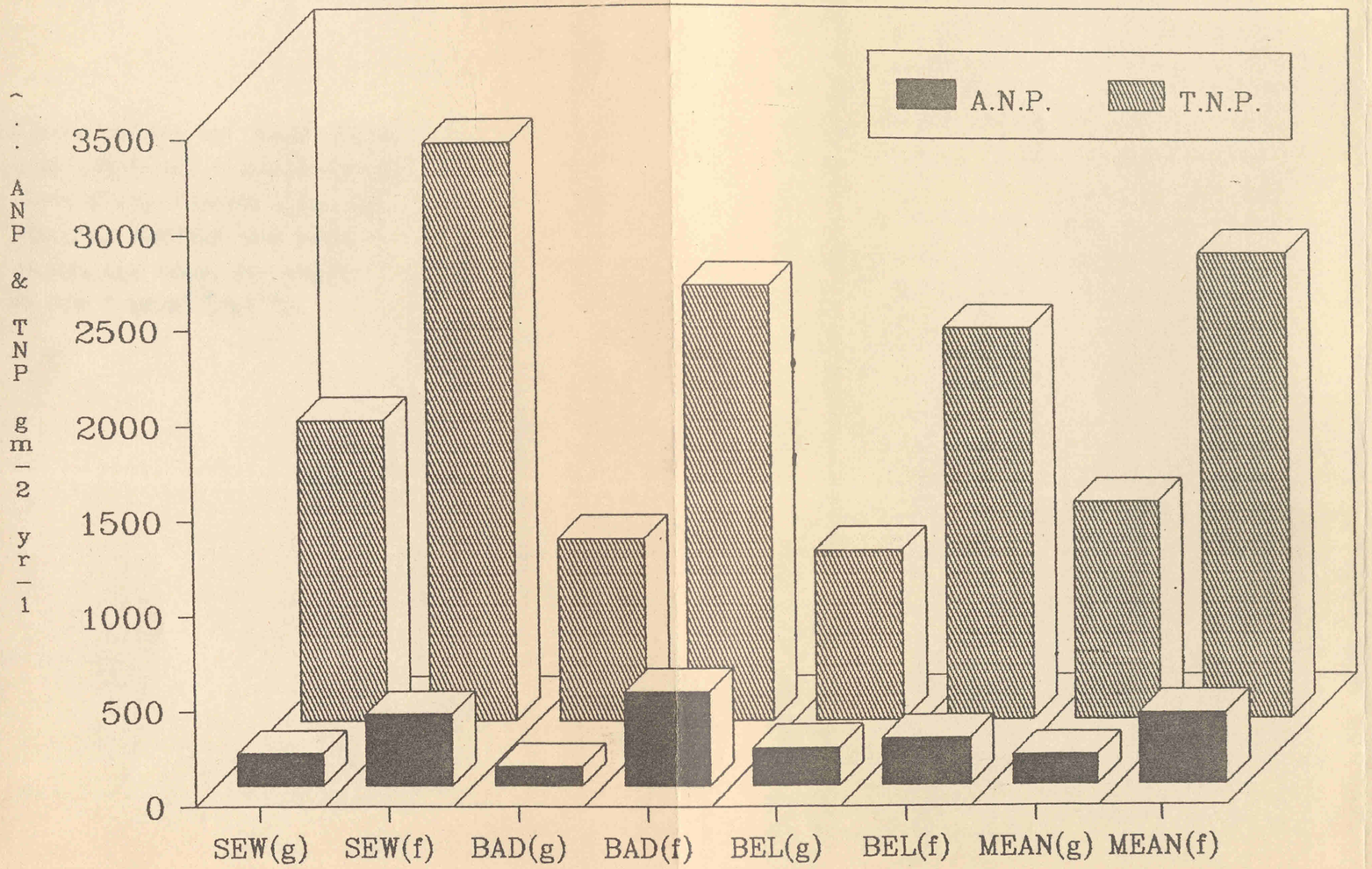


PLATE :31

Table 31 : Annual Net Prodcution of all sites at Rupri Marg ($gm/m^{-2}/yr^{-1}$). Average rate of daily production ($gm/m^{-2}/day^{-1}$) and turnover rates of aboveground live, aboveground dead, belowground and litter of all species.

Annual Increment	Sites						Average of all sites.	
	Sewari grazed	Sewari fenced	Badjari grazed	Badjari fenced	Bela grazed	Bela fenced	grazed	fenced
Aboveground live	131.60	265.75	100.90	353.00	145.00	163.00	125.83	260.58
Aboveground dead	89.63	227.00	119.05	138.00	204.40	130.00	137.69	165.00
Belowground	1410.08	2650.50	854.40	1785.00	694.66	1810.00	986.38	2081.83
Litter	249.40	407.00	84.40	104.00	304.54	384.00	212.78	298.33
Aboveground Net Production (A.N.P)	168.90	375.75	100.90	491.00	197.30	245.00	155.70	370.58
Total Net Production (T.N.P)	1578.98	3026.25	955.30	2276.00	891.96	2055.00	1142.08	2452.42
Average Rate of Production per day (Year long basis)								
Aboveground live	0.36	0.73	0.276	0.967	0.397	0.45	0.34	0.71
Aboveground dead	0.25	0.62	0.33	0.38	0.56	0.36	0.38	0.45
Belowground	3.86	7.26	2.34	4.89	1.90	4.96	2.70	5.70
Litter	0.68	1.11	0.23	0.285	0.83	1.05	0.58	0.85
Total	5.15	9.72	3.176	6.522	3.687	6.82	4.00	7.71
Turnover Rates %								
Aboveground live	0.746	1.21	0.75	1.68	0.85	0.93	0.78	1.27
Aboveground dead	0.60	1.89	0.66	1.35	0.89	0.69	0.72	1.31
Belowground	0.73	0.92	0.51	0.78	0.36	0.67	0.53	0.79
Litter	0.65	0.66	0.26	0.25	0.78	0.80	0.56	0.57

Aboveground Net Production (A.N.P) === Sum of positive increment in the standing live parts throughout the study period. + Positive increase of standing dead parts upto the peak of standing live biomass.

Total Net Production (T.N.P) === Aboveground Net Production + Belowground Net Production

Belowground Net Production (B.N.P) === Sum total of positive increases through successive sampling dates

4.3.5.2 BELOWGROUND NET PRODUCTION AND TURNOVER (TABLE 31, Plate 32)

Average belowground net production was more in fenced site than grazed site. Belowground net production of grazed and fenced sites was 986.38 $gm/m^{-2}/yr^{-1}$ and 2081.83 $gm/m^{-2}/yr^{-1}$, respectively.

Belowground annual increment in grazed sides was maximum at Sewari (1410.08 $gm/m^{-2}/yr^{-1}$ and minimum at Bela grazed (694.66 $gm/m^{-2}/ yr^{-1}$). In fenced sites annual increment of belowground production ranged from 1785 $gm/m^{-2}/yr^{-1}$ to 2650.50 $gm/m^{-2}/yr^{-1}$.

The turnover rates in grazed sites rangrd from 0.36 (36%) to 0.73 (73%). In fenced sites the turnover rates ranged from 0.67 (67%) to 0.92 (92%).The turnover rates of average grazed and fenced sites at Rupri Marg were recorded as 0.53 (53%) and 0.79 (79%) , respectively.

4.3.5.3 TOTAL NET PRODUCTION (T.N.P)

The total net production (T.N.P) value has been estimated for different grazing lands by adding aboveground (A.N.P) and the belowground net production (B.N.P) (Table 31, Plate 31). In all the three sites TNP was almost double in fenced sites than grazed sites. Maximum T.N.P was recorded in Sewari fenced (3026.25 $gm/m^{-2}/yr^{-1}$) and lowest in Bela grazed (891.96 $gm/m^{-2}/yr^{-1}$). T.N.P in grazed sites varied from 891.96 $gm/m^{-2}/yr^{-1}$ to 1578.90 $gm/m^{-2}/ yr^{-1}$,

PLATE 32 : Annual net production of grazed and fenced sites at Sewari, Badjari, Bela and for Aboveground live (AG live) , Aboveground dead (AG dead) , Litter and Belowground (B ground) and mean values for Rupri Marg. ($gm/m^{-2}/yr^{-1}$).

RUPRI ANNUAL NET PRODUCTION OF ALL SITES (gm−2 yr−1)

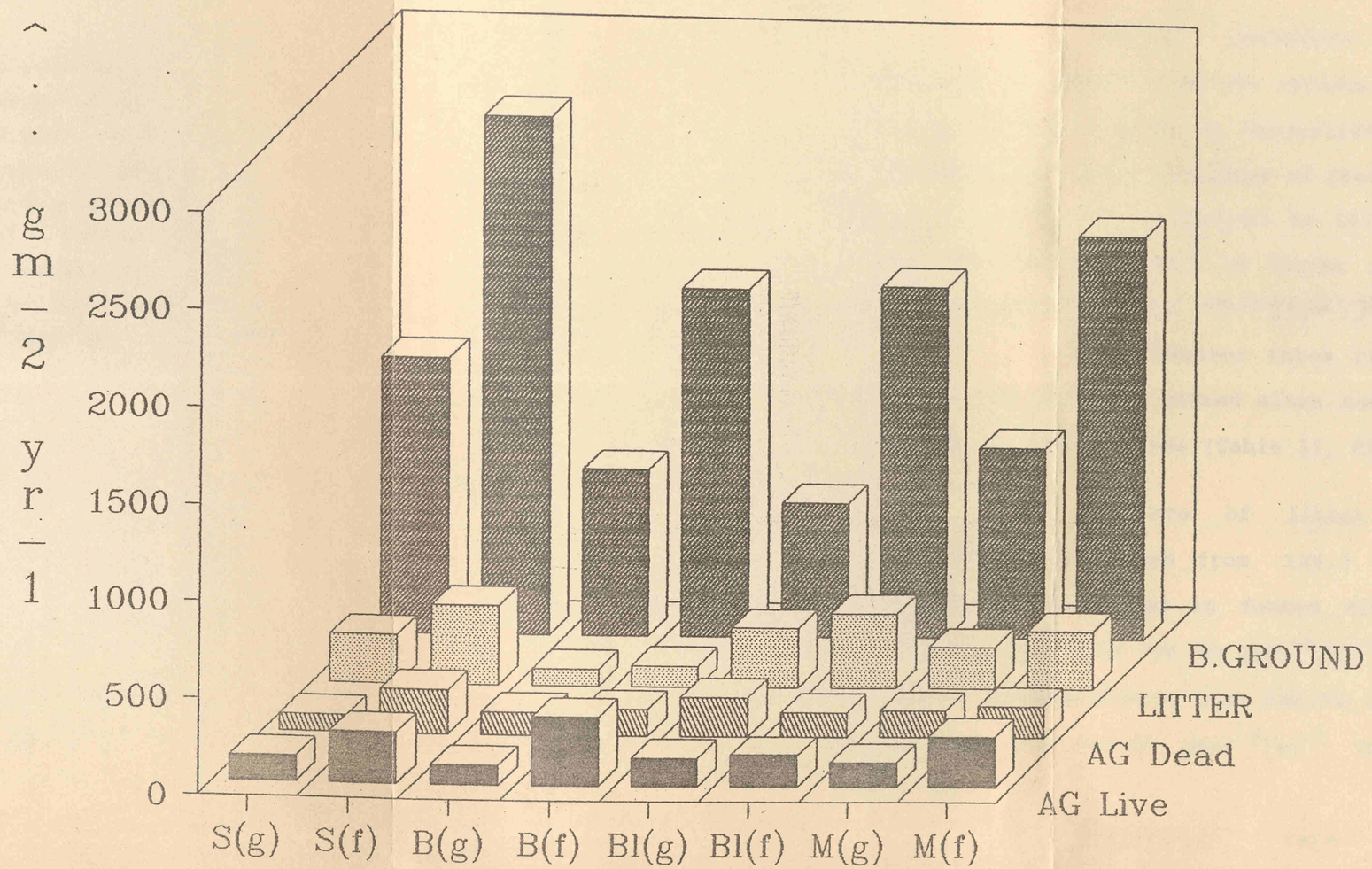


PLATE :32

and in fenced sites it varied from 2055 gm/m^{-2}/yr^{-1} to 3026.25 gm/m^{-2}/ yr^{-1} .

The average total net production of the community in both grazed and fenced sites of Rupri Marg was recorded as 1142.08 gm/m^{-2}/yr^{-1} and 2452.42 gm/m^{-2}/ yr^{-1}, respectively.

4.3.5.4 LITTER DISAPPEARANCE

Annual increment in litter compartment of grazed sites was maximum in Bela (304.54 gm/m^{-2}/yr^{-1}) and minimum at Badjari(84.40 gm/m^{-2}/yr^{-1}). In fenced sites annual increment of productivity ranged from 104 gm/m^{-2}/yr^{-1} at Badjari to 407.00 gm/m^{-2}/ yr^{-1} at Sewari. Average increament of litter in grazed & fenced sites was 212.78 gm/m^{-2}/yr^{-1} and 296.33 gm/m^{-2}/yr^{-1}, respectively.

The turnover rates ranged from 0.26 (26%) to 0.78 (78%) in grazed sites and 0.25 (25%) to 0.80 (80%) in fenced sites (Table 31, Plate 32).

The rate of litter disappearance in grazed sites varied from 164.1 gm/m^{-2}/ yr^{-1} to 440.05 gm/m^{-2}/ yr^{-1} and in fenced sites varied from 436.75 gm/m^{-2}/yr^{-1} to 760.00 gm/m^{-2}/yr^{-1}. Average rate of litter disappearance was 332.52 gm/m^{-2}/yr^{-1} in grazed site and 564.58 gm/m^{-2}/yr^{-1} in fenced sites (Table 32).

Obviously, rate of litter disappearance is more in fenced than grazed sites. Such

an observation was also recorded by Billore (1978) while comparing four grazing sites at Ujjain.

Table 32: Dry Matter Budget for different sites at Rupri Marg

Compartment	Sewari grazed	Sewari fenced	Badjari grazed	Badjari fenced	Bela grazed	Bela fenced	Average grazed	Average fenced
	Standing Crop ($gm/m^{-2}/yr^{-1}$)							
Total live	1493.65	1664.78	1578.05	1690.63	17390.21	2194.54	1603.63	1849.98
Aboveground live	83.17	140.15	98.48	123.36	103.52	106.00	95.05	123.17
Standing dead	69.73	71.00	106.50	69.27	119.07	148.18	98.43	96.15
Litter	122.79	133.68	135.74	127.00	232.29	216.45	163.61	159.04
Belowground	1410.48	1524.63	1419.57	1567.27	1635.69	2088.54	1488.59	1726.81
	Transfer Rates $gm/m^{-2}/yr^{-1}$							
T.N.P.	1578.98	3026.25	955.30	2276.00	891.96	2055.00	1142.08	2452.41
A.N.P.	168.90	375.75	100.90	491.00	197.30	245.00	155.70	370.58
B.N.P.	1410.08	2650.50	854.40	1785.00	694.66	1810.00	986.38	2081.83
A.N.P to Standing dead.	89.63	227.00	119.05	138.00	204.40	130.00	137.69	165.00
Standing dead to litter	177.00	183.50	193.85	128.00	137.80	87.00	169.55	132.83
A.N.P to litter	249.40	407.00	84.40	104.00	304.54	384.00	212.78	298.33
Litter to litter disappearance (LD)	393.40	436.75	440.05	760.00	164.10	497.00	332.52	564.58
B.N.P to belowground disappearance (BD)	886.80	1867.50	551.60	1228.00	442.58	900.00	626.99	1331.83
Total net Production to Total disappearance (TD)	1280.20	2304.25	991.65	1988.00	606.68	1397.00	959.51	1896.41

PLATE 33 : Dry matter budget of Rupri grazed and fenced sites.

DRY MATTER BUDGET

	Aboveground		Standing Dead		Litter
Sewari (G)	169	83.17	89.63	69.73	177	123.00
Sewari (F)	376	140.15	227.00	71.00	183	134.00
Badjari (G)	101	98.48	119.05	106.50	194	136.00
Badjari (F)	491	123.36	---------->	69.27	---------->	127.00
Bela (G)	197	103.52	138.00	119.07	128	232.00
Bela (F)	245	106.00	204 00	148.18	138	216.00
			130.00		87	

Live vegetation

GP	TNP
2052.7	1579
3933.8	3026
1241.5	955
2958.8	2276
1157.0	892
2637.7	2055

Belowground

1410	1410
2650	1524
854	1419
1785	1567
695	1635
1810	2088

Litter Disappearence

393
436
440
760
164
497
887
1867
551
1228
442
900

Belowground Disappearence

Plate 33

4.3.5.5 DRY MATTER BUDGET

Dry matter budget of Sewari, Badjari and Bela grazed and fenced sites have been reflected in Table 32.Generally, the diagramatic representation of dry matter dynamics are arranged in block and arrow diagram. In this diagram the vegetational components are considered as an independent compartment showing input and output. The values in boxes are the average standing crop of compartmental biomass of the year under study (Plate 33).

Values for TNP, TNP to aboveground net production (ANP) and TNP to belowground have been taken from Table 31. Belowground disappearance is calculated from the difference between peak belowground biomass and the succeeding minimum belowground biomass (Sims and Singh 1971), Billore (1978). However, Singh and Yadava (1974) proposes summation of significant negative changes in belowground biomass for calcution of Belowground dissaparance. Thus the dry matter budget of the study sites indicated that annually about1280.20, 991.65, and 606.68 $gm/m^{-2}/yr^{-1}$ of TNP for Sewari, Badjari and Bela grazed sites disappeared through grazing,litter,rodents and belowground losses. Similarly 2304.25, 1988.0, 1397.0 $gm/m^{-2}/yr^{-1}$ of TNP for Sewari, Badjari and Bela fenced sites disappeared

through litter, rodents and belowground losses.

The average dry matter budget of Rupri grazed and fenced sites indicate that annually 959.51 and 1896.41 $gm/m^{-2}/yr^{-1}$ of T.N.P. dissapeared through grazing, litter, rodents and belowground losses, respectively. In grazed site percentage of T.N.P. dissapeared is much more than the fenced sites, may be due to the grazing effect of nomadic flocks/herds.

4.3.5.6 SYSTEM TRANSFER FUNCTION

System transfer function is the quantity by which the system block multiplies the input to generate the output or, alternatively, as the ratio of output to input (Grodins, 1963; Billore, 1978 & Gupta, 1979). It is expressed in the following equation :

$$O = \frac{1}{K} I \qquad \text{OR} \qquad \frac{O}{I} = \frac{1}{K}$$

where O = Output, I = Input & $\frac{1}{K}$ = STF

In the present study, for each site

system transfer function have been studied for both grazed and fenced sites in order to observe intrinsic behaviour of each compartment.The average values for the Rupri Marg has also been calculated (Plates 34 & 35).

A perusal of the Table 33 shows that transfer functions differed in magnitude in both grazed and fenced sites. The annual transfer rate from total net production to aboveground net production was same in Sewari and Badjari grazed sites (0.11 of TNP) but in Bela grazed relatively higher rate of transfer was recorded (0.22). In Badjari fenced higher rate of transfer were recorded (0.22 of TNP) as compared to Sewari and Bela fenced (0.12). Annual transfer rate of total net production to belowground net production was higher in Sewari and Badjari grazed (0.89) as compared to Bela grazed where only 0.78 was recorded.Sewari and Bela fenced sites recorded highest transfer rate (0.87 & 0.88) as compared to Badjari fenced (0.78). Higher rate of conversion was recorded from above ground net production into standing dead. In Badjari and Bela grazed 1.18 & 1.04, respectively, of ANP was converted

into standing dead but in Sewari grazed only 0.53 was converted. Lower rates of conversion was recorded in fenced sites. In Badjari and Bela fenced sites,the transfer rates recorded are 0.28 & 0.53 respectively as compared to Sewari fenced (0.60).

It is observed that maximum conversion of ANP into standing dead was recorded in Badjari grazed (1.18) which was used under mixed grazing of Buffaloes,Sheep, Goats and Horses followed by Bela grazed (1.04) which was grazed only by sheep and goats and lowest in Sewari grazed (0.53) where maximum number of Buffaloes and other cattle grazed.

The movement of ANP to litter was slightly different to that of ANP to standing dead. In Sewari and Bela grazed highest conversion of ANP to litter was recorded (1.47 & 1.54) as compared to Badjari grazed (0.83). Similarly, in fenced sites, Bela fenced showed maximum conversion of 1.57 followed by Sewari 1.08 and Badjari 0.21.

The value for transfer of standing dead (SD) to litter was highest in Sewari grazed (1.97)

followed by Badjari grazed (1.62) and Bela grazed (0.67). In fenced sites highest value was recorded in Badjari (0.92) followed by Sewari (0.80) and Bela (0.67).

Litter to litter disappearance was the highest (5.21) in Badjari grazed and lowest in Bela grazed (0.53). In fenced sites highest value was recorded in Badjari (7.30) and lowest in Sewari 1.07). Same trend was observed in below ground net production to below ground disapparance. Highest value was recorded in Badjari grazed (0.64) followed by Bela (0.63) & Sewari (0.63). In fenced sites maximum value was recorded in Sewari (0.70) and minimum in Bela (0.50). High values of litter disapperance in Badjari sites as compared to others may be due to the negative values of biomass productivity on most of the dates of recording.

Thus within a year, in Sewari, Badjari and Bela grazed sites 81 % , 103 % and 68 % of TNP disappeared, whereas, in fenced sites 76 % , 87 % and 68 % of TNP disappeared from Sewari, Badjari and Bela sites,respectively.

Table 33 : System Transfer Function of Dry Matter Dynamics of different sites at Rupri Marg.

Compartment	System Transfer Function						Average	
	Sewari Grazed	Sewari Fenced	Badjari Grazed	Badjari Fenced	Bela Grazed	Bela Fenced	Grazed	Fenced
Total Net Production to Aboveground Net Production	0.11	0.12	0.11	0.22	0.22	0.12	0.147	0.15
Total Net Production to Belowground Net Production	0.89	0.87	0.89	0.78	0.78	0.88	0.853	0.85
Aboveground Net Production to Standing dead	0.53	0.60	1.18	0.28	1.04	0.53	0.92	0.47
Standing dead to Litter	1.97	0.80	1.62	0.92	0.67	0.67	1.42	0.79
Aboveground Net Production to Litter	1.47	1.08	0.83	0.21	1.54	1.57	1.28	0.95
Litter to Litter disappearance	1.57	1.07	5.21	7.30	0.53	1.29	2.43	3.22
Belowground Net Production to Belowground disappearance	0.63	0.70	0.64	0.69	0.63	0.50	0.63	0.63
Total Net Production to Total disappearance	0.81	0.76	1.03	0.87	0.68	0.68	0.84	0.77

PLATE 34 : System Transfer Function of Rupri grazed sites (average of Sewari, Badjari and Bela grazed sites) .

COMPARTMENTAL TRANSFER OF DRY MATTER

Average of Grazed Sites
Rupri Marq

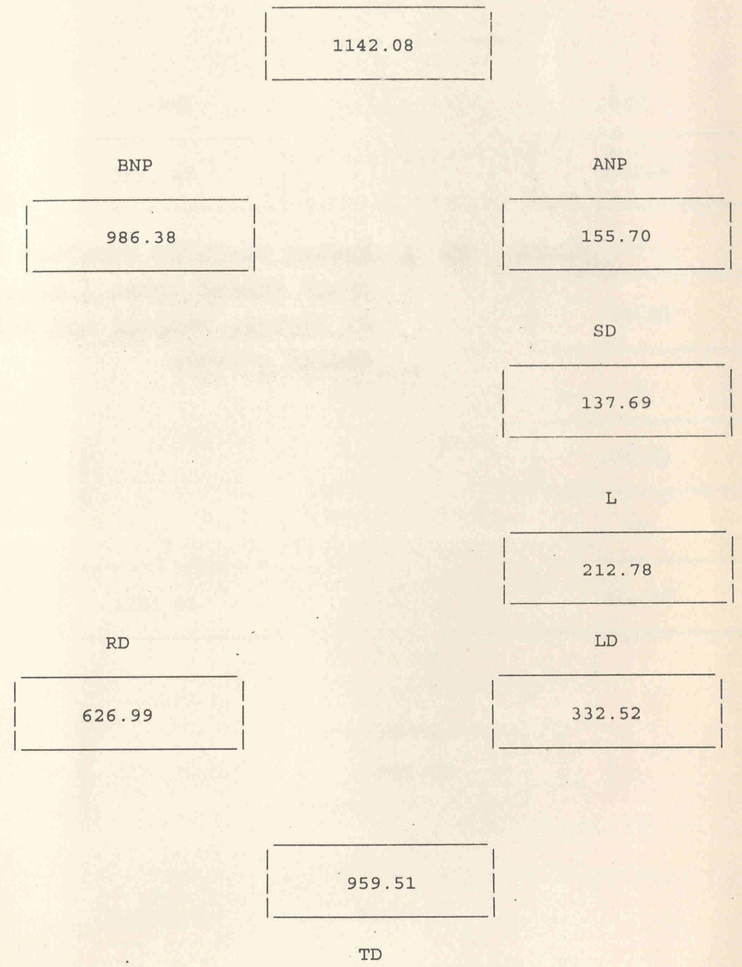


PLATE 34

PLATE 35 : System Transfer Function of Rupri fenced sites (average of Sewari, Radjari and Dela fenced sites).

COMPARTMENTAL TRANSFER OF DRY MATTER

Average of fenced sites
Rupri Marg

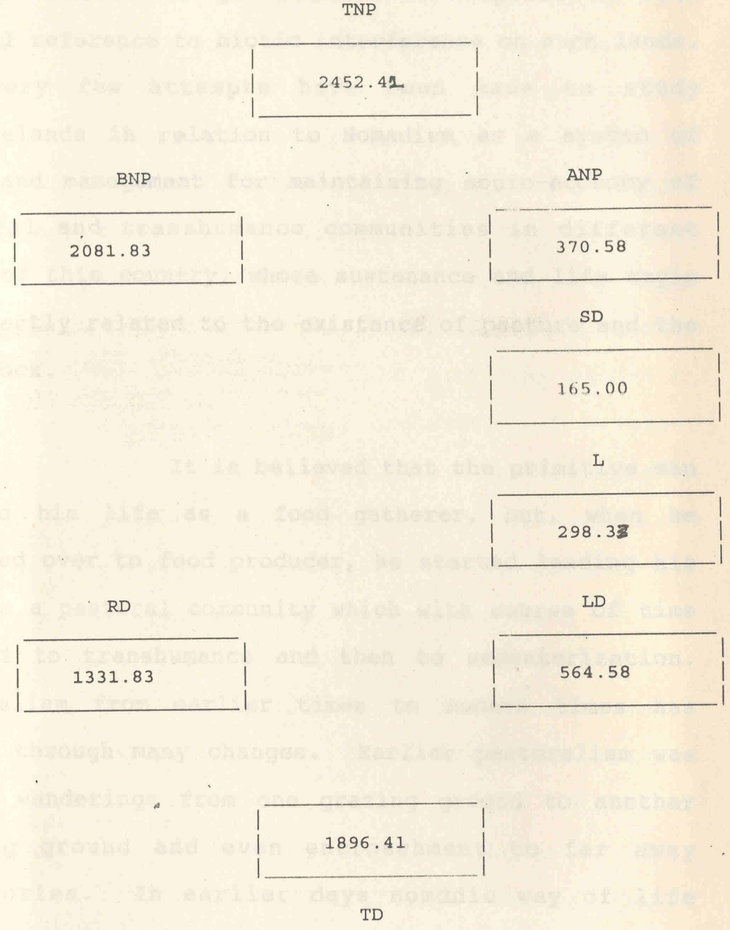


Plate 35

4.4 STUDY OF NOMADISM

Grasslands in India have been studied purely from structural and functional angles, to express effect of geo-climate on vegetation with special reference to biotic interference on such lands. But very few attempts have been made to study pasturelands in relation to Nomadism as a system of grassland management for maintaining socio-economy of pastoral and transhumance communities in different parts of this country, whose sustenance and life style is directly related to the existance of pasture and the livestock.

It is believed that the primitive man started his life as a food gatherer, but, when he switched over to food producer, he started leading his life as a pastoral community which with course of time changed to transhumance and then to sedenterization. Pastoralism from earlier times to modern times has passed through many changes. Earlier pastoralism was simple wanderings from one grazing ground to another grazing ground and even encroachment to far away territories. In earlier days nomadic way of life existed in almost all mountain ranges and grasslands of the world where agriculture was not possible. But in developed countries scientific studies led to better

development of pasture and livestock industry. But in under -developed countries like India much progress could not be made to improve the nomadic way of life, pasture and livestock development, although, several attempts are being made from first five year plan till today (Wealth of India Vol.VI.1970).In some parts of the world pastoralism is not nomadism of primitive times in true sense. These days their routes have been identified, pastures are alloted, etc. In Himalayas, Pamirs, Karakoram, Hindukush, Andes, Pynnennes, Alps, Elburz, Pampas and other mountain ranges of world, different forms of Nomadism exists. At some places it is properly and scientifically organised and in other it is still in its primitive form. At several places nomadic societies are taxed to maintain carrying capacity of pastures; they are encouraged for settlements; seeking of alternative jobs, etc.

Perpillou (1977) divided the world into seven pastoral regions based on animals reared like : 1.Ox; 2.Sheep; 3.Goat; 4.Ass; 5.Horse; 6.Camel; 7.Others like Yak, Ilama. Harrington (1981) and Williams (1981) identify four main grazing systems by which man exploits the rangelands of the world with his livestock. These are 1.True Nomadism; 2.Transhumance; 3.Semi-sedentary and 4.Sedentary.

In the present study, nomadism with special reference to Jammu and Kashmir state has been studied and its impact on the ecology of Rupri grassland has been analysed specifically.

4.4.1 GRAZING SYSTEMS IN JAMMU AND KASHMIR STATE

An appraisal of historical records like Alberuni's India, Firdaussi's Shahnama, Kalhana's Rajtarangni and recent works by Lawerence, Moorecroft, Drew, Vigne and Cunningham throw light on the people and places of Jammu and Kashmir state at different times of history. In Jammu and Kashmir state, population mainly resides in hills and is pastoral in nature. There are certain groups who still practise nomadism while others follow transhumance. Present grazing systems can thus be classified into:

1. Pastoral - Practising seasonal migration from lower altitude to higher altitude in same water-shed like Chaupons and local pastoral communities, both sedentary and semi-sedentary, residing in the villages at the foot hills of PirPanjal and other hills of the state (Plate 36 ; Fig. 1).

PLATE 36 : Grazing communities of J & K State.

Fig 1 : Pastoral Gujjar Bakkerwal grazier from Ans catchment.

Fig 2 : Nomadic Gujjars (Buniyara or Bodhi) near Patni Top on way to summer pasture at Jai Bhaderwah.

Fig 3 : Nomadic Changpas in Ladakh Changthang near Tso-moriri.



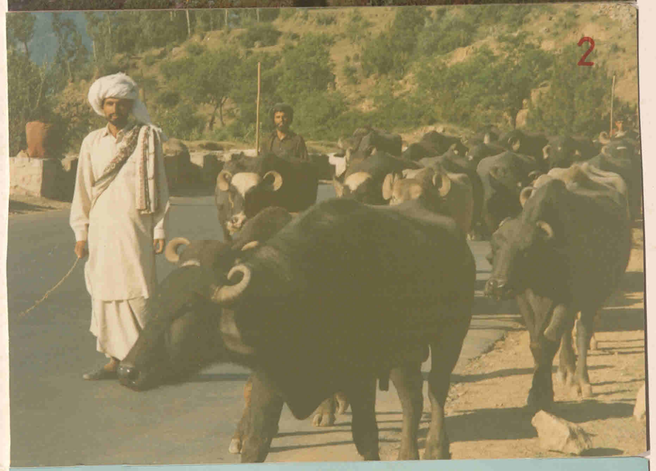




PLATE. 36.

2. Nomadic - Like Gujjars who seldom cross river Chenab (Chanderbhaga) and Changpas of Changthang (Plate 36 ; Figs. 2 & 3).

3. Transhumance - Practicising seasonal migration from lower Shiwaliks to Ladakh steppes like Bakkerwals and Gaddis.

4.4.2 POPULATION STRUCTURE

4.4.2.1 NOMADIC POPULATION

Right from first census by G.O.I. in 1891 till today, no clearcut exercise about the demographic structure of various tribes and ethenic communities have been made, especially, in Jammu & Kashmir state. It was only in Dogra rule of the state that G.O.I was requested to render services of census officers for carrying out census in Jammu & Kashmir state. Prior to 1947, tribal communities were grouped differently at different times. Sometimes, they were studied on the basis of religion they follow and at other times on the basis of languages they speak and at times on the basis of origin of communities. First clear cut account of the communities in Jammu & Kashmir state was recorded by R.G. Wreford in census of India, 1943.

Table 34 gives details of populations residing at the time of 1943 census in erstwhile Jammu and Kashmir state including parts of P.O.K.

Table 34 : Classification of population based on dialects

Language	Dialect	Speakers	District
Kohistani	Baubagi	590	Jammu
	Kaghani	491	Udhampur
	Kohistani	79	Udhampur
	Subtotal	**1160**	
Rajsthani	Gojri	282968	Reasi
	Labhani	771	Jammu
	Marwari	2	
	Subtotal	**283741**	
Western Pahari	Bhadervahi	22948	Udhampur
	Bakarwali	454	Reasi
	Chambiali	1572	Kathua
	Gaddi	6364	Udhampur
	Padari	5900	Udhampur
	Sarori	1893	Udhampur
	Pahari	492484	Poonch Jagir
	Subtotal	**531615**	
	Grand Total	**816516**	

In 1943, only Gujjars were considered as tribal community, who on basis of Gojri language were estimated as 3,81,457. The dispersion of Gujjars in various districts of J&K state in 1943 as compared to 1931 AD is given in Table 35.

Table 35 : Year/Population

District	1931	1941	Variation
Jammu	62936	68644	+6205
Kathua	17936	19473	+1537
Udhampur	24871	25194	+ 323
Reasi	71725	67200	-4525
Mirpur	26414	28564	+2150
Poonch Jagir	76647	62862	-13785
Chenari Jagir	578	494	-84
Baramulla	33982	32447	-1535
Anantnag	29742	28170	-1572
Muzaffarabad	55349	47589	-7760
Astore	644	47	
Gilgit	2454	773	-2278
Total	403278	381457	

All Bakkerwals were shown as Muslims

with population variations as under :

Bakkerwal Population (1931-1941).

S.No.	District	1931	1941
1.	Jammu	362	690
2.	Kathua	109	1044
3.	Udhampur	918	1379
4.	Reasi	2368	10688
5.	Mirpur	29	344
6.	Poonch	12	282
7.	Chenani	–	84
8.	Baramulla	27	7
9.	Anantnag	1523	769
10.	Muzaffrabad	1	12
	Total	5349	15299

Present constitution of Jammu and Kashmir recognises twelve ethnic groups as scheduled tribes. These are 1.Balti; 2.Deda; 3.Not Noto; 4.Drokpa, Brokpa, Dard, Shin; 5.Changpa; 6.Garra; 7. Mon; 8.Purigapa; 9.Gujjar; 10.Bakkarwal; 11.Gaddi and 12.Sippi. In the year 1987 a special mini survey was carried out by the Registrar General of India to identify the population structure of some of the ethnic tribes of Jammu and Kashmir State. This special

census estimated population of recognised tribes in the state as 7,98,245 constituting about 11 % of the total population. As per the census , population of some of the tribes is given in table 36.

Table 36 : SCHEDULED TRIBE POPULATION OF JAMMU AND KASHMIR STATE

S.No	District	Total Population	Changpa	Gujjar	Bakkerwal	Gaddi
1.	Jammu	31148	-	30908	151	33
2.	Kathua	20919	-	10069	743	7000
3.	Udhampur	76097	-	60229	4905	8664
4.	Doda	70508	-	53856	11508	2342
5.	Rajouri	104958	-	96934	8020	-
6.	Poonch	104240	-	101774	2465	-
	Sub total	**407870**		**353770**	**27792**	**18039**
7.	Anantnag	50172	-	46289	3848	-
8.	Pulwama	16156	-	17802	311	-
9.	Srinagar	43440	-	30428	286	-
10.	Badgam	9971	-	9873	38	-
11.	Baramulla	62034	-	42768	2289	-
12.	Kupwara	46552	-	46194	335	-
	Sub total	**228325**		**193354**	**7107**	
13.	Leh	74616	3507	15	-	-
14.	Kargil	77434	3	-	-	-
	Sub total	**152050**	**3510**	**15**	**-**	**-**
	Grand Total	790245	3510	547149	34899	18039

Source: Draft Tribal Sub Plan for 1994 - 95,Social Welfare Department,Government of Jammu and Kashmir.

Above figures however do not give clear indication of population of scheduled tribes who are engaged in nomadic grazing systems for rearing

their livestock in J & K state.Figures of Doda district seems to be duplication of Bakkerwal population, who migrate from Shiwalik districts of Jammu,Kathua and Udhampur.Doda district infact do not possess any Bakkerwal population except in summer months when these herders stay on summer pastures for about two to three months.

Gujjars of Kathua and Jammu districts are both sedentary and nomadic who migrate to Doda district in summer months for pasturage.But Gujjar population of other districts have either become sedentary or semi - sedentary.

Bakkerwal population of Jammu, Kathua, Udhampur, Rajouri and Poonch practice both semi - sedentary and nomadic life who transhumance upto Zanskar, Drass, Gurej, Tilel and Marwa - Wadwan. Bakkerwals of Kashmir province have almost become sedentary and rarely lead the nomadic life.

Areas like Bhaderwah, Marmat and Kishtwar in Doda district possess sedentary to semi - sedentary population of Gaddis, some of them still transhumance between shiwaliks and Padder mountains. In Kathua district main concentration of Gaddi population is in Daggar valley, Lohai, Malhar and

Machedi. Population in Udhampur district is by and large scattered. In this district Gaddi's either come in winter months for pasturage in broad leaved Rakhs or few scattered villages of Gaddi's are found in Dudu valley. Some of the Gaddi families are also found in Ans catchment where Gaddi's were given pasturage rights of Konsarnag meadows in the Pir Panjal range. Gaddi's by and large have become sedentarized and practice of herding of animals is on decline in the younger generations and their traditional areas of pasturage are being gradually taken over by the Bakkerwals. Raina (1956) also recorded that Gaddis belong to Udhampur district (Tehsils Ramnagar, Reasi and Udhampur), Kathua district (Tehsils Ramban, Kishtwar, Doda and Bhaderwah) migrate to high altitude pastures of Banihal, Dudu-Basantgarh, Padder, Marew-Wadhwan, Gulabgarh and some parts of Kashmir like Nandi Marg, etc.

In Ladakh, Changpas are true nomadic and their migrations are generally horizontal. Other tribes like Drokpa, Brokpa and Purigapa have an age old traditional system of grazing on the adjoing mountains of villages or pasture lands belonging to Buddhist monasteries of the area. These tribes are not nomadic

but lead an organized sedentary pastoral life.

In the present study detailed anthropological studies of nomadic Bakkerwals were conducted in Nowshera Forest division of Rajouri district from year 1990 to 1993. The study revealed that 1786 families of nomadic Bakkerwals bring their flocks in winter for pasturage. Population of these nomads was estimated as 8824. These figures however, donot include those Bakkerwals who have switched over to other professions of Government employment, military services or other private jobs. These figures are higher than those reflected in census of India.

At Rupri there were 78 families who own traditionally Bandobasti grazing rights in these margs. Most of the deras are sedentary population from Ans catchment villages located at the foot of PirPanjal mountain range. Shepherding community wise details of the Rupri Marg are given in Table 37.

Table 37 : Shepherding community wise number of Deras (families) who migrate to Rupri Margs for summer pasturage.

Marg	Bakkerwal Shepherd Herdsmen Deras		Others Shepherd/ Herdsmen Deras		Thakur Shepherd/ Herdsmen Deras	
	Jat	No	Jat	No	Jat	No
Sewari	Khatana	3	Azam	1	Muslim Bodla	7
	Chouhan	4	Khalotra	1	Hindhu Bodla	4
	Koli	1	Sradhna	1		
	Phayota	2				
	Chechi	3				
	Bazad	5				
	Phambra	2				
	Ladi	2				
Badjari	Chouhan	6	Lohar	1		
	Khatana	4	Khalotra	1		
	Kasana	1	Sradhna	1		
	Koli	5	Goti	1		
Bela	Kasana	1	Tagli	1		
	Khatana	2				
	Paswal	8				
	Bazad	3				
	Bokra	1				
	Chouhan	3				
	Chechi	2				
	Kalash	1				
Total		59		8		11

4.4.2.2 LIVESTOCK POPULATION

India carries a huge herd of livestock population much larger than any other country of the world to be properly and adequately fed and nourished. This has resulted in an acute imbalance between fodder resources and the number of animals to be fed (Wealth of India vol VI 1970). The livestock population of India and J&K state as per 1966 census is

given in Table 38.

Table 38 : Livestock Population of India and J&K

Category	India	J&K
Cattle	175,520,025	1,790,842
Buffaloes	52,864,964	428,351
Sheep	42,821,857	1,151,896
Goats	64,736,670	605,501
Horse & Ponies	1,156,351	65,797
Pigs	4,966,083	485
Camels	1,027,027	2,303
Other excluding Poultry	1,235,554	34,073
Total	344,328,531	4,079,248

In J&K sate first quinquennial livestock census was taken in the year 1940 under Kahcharai Act S.1994.Second census was taken in 1945.Earlier census were conducted by revenue department primarily for regulating grazing tax.It is reported that no copies of these census reports were available (Raina,1956.)

After 1947, first census was conducted in 1951, but data was not compiled .However first statutory livestock census was conducted in the year 1956 as a part of all India livestock census.Earlier, prior to enactment of Kahcharai Act Samvat2011 biennial enumerations were conducted.This census identified six types of sheep and three types of goats in the state. Sheep types are :

1. Karanah.
2. Gurez.
3. Chanthang.
4. Kashmiri.
5. Gaddie of Bhaderwah.
6. Bakkerwali.

Goat types are :

1. Bakkerwali or Kagani.
2. Beetal
3. The Pashmina Goat.

Cattle population assessed for different categories in the year 1945, 1951, 1956 & 1982 is reported in Table 39:

Table 39 : Livestock Population of J&K State

	Category	1945	1951	1956	1982
1.	Cattle	-	1319971	1757466	2325200
2.	Buffaloes	-	300577	374147	563100
3.	Horses & Ponies	-	54799	95736	127600
4.	Sheep	1504365	978809	1465381	1908700
5.	Goats	1095275	487415	813503	1003900
	Total	2599640	3141571	4506233	5928500

Department of sheep husbandry (1991-92) has updated livestock population figures of Jammu division up to the year 1988, District wise details are given in Table 40.

Table 40 : Sheep and Goat Population of Jammu Province

Distt	Population in lacs.			
	1982		1988	
	Sheep	Goat	Sheep	Goat
Jammu	0.36	1.26	0.66	2.01
Kathua	1.52	1.31	2.37	2.07
Udhampur	1.81	1.72	2.79	2.36
Doda	2.17	0.91	3.60	1.23
Rajouri	0.78	0.86	1.47	2.07
Poonch	1.79	1.43	1.61	0.79
Total	8.43	7.49	12.50	10.53

Out of this migratory or nomadic sheep population is reproted in Table 41.

Table 41 : Migratory Sheep Population of Jammu Province

A. District	Sheep Population in lacs		
	Migratory	Stationary	Total
Jammu	0.41	0.26	0.66
Kathua	1.42	0.95	2.37
Udhampur	1.67	1.12	2.79
Doda	2.16	1.44	3.60
Rajouri	0.88	0.59	1.47
Poonch	0.97	0.64	1.61
Total	7.50	5.00	12.50

Department of Sheep husbandry reported that 50% of sheep population in Jammmu province is cross bred but Aparna Rao (1985) reports 322,00 (75.7%) of the 4,25,000 migratory sheep is cross bred merino. Sheep husbandry has made no

assessement/census of migratory goats of nomads. From above table it is amply clear that the sheep and goat population including migratory herds have increased appreciably and the Government is not exercising any control to check the population of livestock who depend completly on natural resources of forage and pasturage. In 1951 sheep population was 9,80,000 and in 1988 it increased to 25.24 lacs and goat population which was 487415 have increased to 13.90 lac.

The detail inventory was carried out in Nowshera forest division of Rajouri district based on personnal interviews with 1788 nomadic Bakkerwal families and counting of their livestock. Results were recorded as under:

Sheep = 29675

Goats = 74129

Horses/ Mules = 4052

Total = 107856

At study sites of Rupri Marg inventory of cattle and livestock population is recorded in table 42.

Table 42 : Livestock Population Rupri Marg

Site	Livestock Population									
	Sheep		Goat		Buffaloes		Horses	Cattle		Total
	A	K	A	L	A	Y		A	Y	
Sewari	295	66	202	7	123	28	15	78	8	822
Badjari	925	236	239	61	39	-	13	16	-	1529
Bela	1490	219	725	115	9	1	37	11	1	2608
Total	2710	521	1166	183	171	29	65	105	9	4959

A = Adult

K = Kid

Y = Young

L = Lamb

At study site there were 78 deras of shepherding communities. The number of families (Dera) possessing different types of flocks / herds are recorded in table 43.

Table 43 : Type of Flock/Herd with Shepherding Families

Site	Families with only sheep	Families with only goat	Families with sheep and goat	Families with other cattle	Families with flock & cattle
Sewari	-	-	5	10	13
Badjari	-	-	6	7	12
Bela	3	-	5	4	14
Total	3	-	16	21	38

HERD / FLOCK SIZE

An assessment of size of nomadic herds was also computed in Nowshera Forest Division. Maximum number of families (250 Deras) possessed flock size of 10 to 20 followed by flock size of 20 to 30 (220 Deras), 30 to 40 (187 Deras) and 40 - 50 (148 Deras). Out of 1788 Bakkerwal shepherds surveyed, 1657 Deras owned flocks and 131 Deras were without any flock. 76% of Bakkerwal Deras possessed flock size upto 100, 12.70% possessed flock size from 100 to 200, 2.30% possessed 200 to 300, 0.95% possessed 300 to 400, 0.16% possessed 400 to 500 and 0.16% from 500 to 600. Only one family owned a herd/flock of 830 sheep and goats. 7.3% of Bakkerwal Deras did not own any flock. They either work as Ajris (Servants) with other Bakkerwals or migrate to Pahalgam and Sonmarg to work as guide, porters and horsemen for Amarnath Yatris (Pilgrims) or with tourists, alongwith other Bakkerwals who own small size of flocks.

An appraisal of study sites at Rupri meadows indicate that in Sewari eight families (Deras) possessed flock upto 10 followed by 10 to 20 and 40 -50 by three families each. In Badjari maximum number of families possessed 0-10 and 20-30 flock size, followed by 10-20, 40-50 and 180-190 (two families each). Only

one shepherding family possessed flock size of 240-250. In Bela maximum number of families (Four Deras each) possessed 60-70 and 90-100 flock size, followed by 20-30 (three families) and 100-110 (two families).

Since at Sewari and Badjari shepherding Deras (families) also keep quite substantial number of Buffaloes, Horses and other cattle (Table 43), they possess relatively small size of flock of sheep and goats. Since Bela meadow is highest in altitude as compared to Sewari and Badjari, shepherding communities prefer sheep and goats at such high altitude meadows (Margs) in preference to heavy cattle like Buffaloes. This is one of the reason that at Bela more number of families possess herd size of 60-70, 90-100 and above as is evident from (Table 44).

Table 44 : Herd / Flock size of Nomadic Bakkerwals in Nowshera Shiwaliks and at study site Rupri Marg

S.No	Study Area	No. of Families / Flock Size																		
		0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-90	90-100	100-110	110-120	120-130	130-140	140-150	150-160	160-170	170-180	180-190
1.	Nowshera Division	166	250	220	187	148	129	87	141	37	41	40	28	25	26	17	17	11	7
2.	Rupri Study Sites																		
a.	Sewari	8	3	-	-	3	1	1	-	-	2	-	-	-	-	-	-	-	-
b.	Badjari	3	2	3	-	2	-	-	1	1	1	-	1	-	1	-	-	-	2
c.	Bela	-	-	3	1	1	1	4	1	4	2	1	-	-	-	1	-	1	-
	Total Study site	11	5	6	1	6	2	5	2	5	5	1	1	-	1	1	-	1	2

Table

S.No	Study Area	No. of Families / Flock Size																	
		190-210	210-250	250-310	300-310	310-320	320-330	330-340	340-350	350-380	380-350	390-400	400-450	450-470	470-530	530-540	540-550		
1.	Nowshera Division	25	29	2	1	5	2	2	1	3	1	2	1	1	1	1	1		
2.	Rupri Study Sites																		
a.	Sewari	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
b.	Badjari	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
c.	Bela	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
	Total Study site	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-		

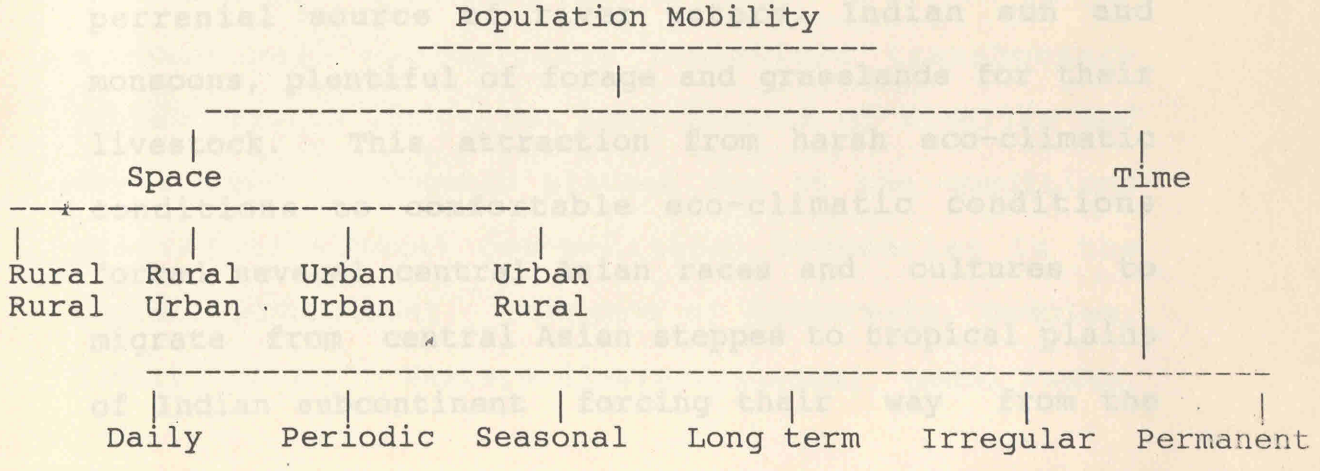
Table

S.No	Study Area	No. of Families / Flock Size											Total	Families without Flocks
		550-560	560-570	570-580	580-590	590-600	600-610	610-620	- - - - -	830				
1.	Nowshera Division	-	-	-	-	1	-	-		1			1657	131
2.	Rupri Study Sites													
a.	Sewari	-	-	-	-	-	-	-		-			18	-
b.	Badjari	-	-	-	-	-	-	-		-			18	-
c.	Bela	-	-	-	-	-	-	-		-			22	-
	Total Study site	-	-	-	-	-	-	-		-			58	-

4.4.3 MIGRATORY ROUTES

The word "migration" has been defined differently by different scholars. Geographers lay emphasis on time and space significance of mobility, while sociologists lay stress on social consequences of mobility, economists give importance to economic aspects of migration whereas ecologist lay emphasis on degradation of resources.The motive behind migration could be economic to earn more money and lead better life or there could be ethnic and historical causes for the motive behind migration viz., from political disturbances and instability (Sinha et al. 1987).

Migration has been classified differently by different authors based on space, time, volume, direction, cause, velocity, selectivity, organization, stability, behaviour, etc. Migrations based on space and time are classified as under (After Gould and Prothero cf. Sinha et al. 1987).



The factors which motivate human migrations from historical times can either be Push or Pull factors. Pull factors are those which attract individuals to migrate. Push factors are those which compel people to move out due to poverty, social outcaste, natural calamities, etc. Infact there is a mix of several factors which motivate individuals or groups of communities to move from one place to another and no single factor can be assigned as responsible for territorial or occupational migrations.

Himalayas, forming northern most barrier of Indian subcontinent, clearly demarcate two types of physiographic zones of Asia. On its northern side are dry plateaus of Tibet and central Asia and on southern sides are lush green forests of Indian tropics. Trans-Himalayan nomadic cultures always fancied comfortable life of Indo-Gangetic plains, due to availability of extensive cultivable lands, perrenial source of river waters, Indian sun and monsoons, plentiful of forage and grasslands for their livestock. This attraction from harsh eco-climatic conditions to comfortable eco-climatic conditions forced several central Asian races and cultures to migrate from central Asian steppes to tropical plains of Indian subcontinent forcing their way from the

impregneable mountain passes of Karakoram, Hindukush and Great Himalayan ranges. Famous passes through which great historical migrations took place are : 1. Karakoram Pass; 2. Kanjreb Pass;3. Darkot Pass; 4. Kilik Pass; 5. Khyber Pass;6. Bolan Pass; 7. Zozilla Pass; 8. Baralacha Pass.

Vigne (1880) and Cunningham (1977) have surveyed various mountain passes in Jammu & Kashmir state. Their details give vivid description of location and altitudes. Existance of various nomadic or seminomadic and pastoral societies all along 2500 Kms of Himalayan ranges from Nanga Parbat to Namcha Barwa is the result of these historical migrations (Schaller, 1980; Polunin et al, 1984). These communities in due course of time either became fully agriculturists or some adopted mixture of agriculture and livestock rearing, while others remained nomads. But there were certain communities who were nomadic in the Hindukush, Karakoram and Himalayan mountain ranges adopted more ecologically compatible transhumance system between lush green bush forests of Siwaliks and dry steppes of Tibetan plateau due to the conditions created by several geo-political bounderies in the Indian subcontinent. Presence of Bakkerwals, Gaddies, Gujars, of North Western Himalaya,Khadwal, Gaddi,Jadhs,

Marcha, Gujjars, Bhotias and Khasia or Khas of central Himalayas are the result of such environmentally suited adaptions (Chatterjee,1980 ; Rao, 1987; Khattana 1992; and Lal & Melkania,1994).

Very few anthropological studies have been conducted on Nomadic and pastoral societies of J & K state. But recently Aparna Rao (1988,1990,1992); Casmir et al (1985,1992) and Khatana, (1992) have done good work on Gujjars and Bakkerwals. Their works however, do not correlate their effect on the ecology of grasslands of the state.

Historically prior to 1847 A.D grazing migrations of nomadic herdsmen took place between Cis-Trans Kohistan in N.W.F.P and Deosai plains. From 1847 till 1947 grazing migrations were mainly concentrated between Kagan valley , Kishanganga valley and Deosai plains. The main oscillation channels between Kagan and Kishanganga valleys were connected through ThodiGalli (4236 mts.) and Babusar Pass (4173 mts.) linking districts of Hazara and Muzffrabad. During this period Bakkerwal herdsmen got foothold in Shiwaliks of J & K State and reoriented the seasonal oscillatory movements between Shiwalik's and Greater Himalayan pastures. After 1947 due to political

developments in the subcontinent these nomads totally left their places of origin in N.W.F.P and established their traditional migratory routes and pasturing rights in their new adopted country. Rao (1988) is also of the opinion that till 1947 a very large number of summer pastures of the Bakkerwal lay North of the Indo-Pakistan cease-fire-line. With the partition of sub-continent in 1947 their access to these pastures was cut off. She concluded that their present pasture lie between Alpine zone and colline belt of the state.

4.4.3.1 PRESENT MIGRATORY ROUTES

The present migratory routes include seasonal oscillatory movements from one ecological zone to another within the boundaries of state or outside state. In the present study, for identification of routes detail survey / interaction was carried out with the Bakkerwals of Nowshera forest Division from 1990 to 1993, with random interviews in other areas followed by visit to various routes at the time of migrations, high altitude pastures of PirPanjal and cross cheching of their statements at Drass and Zanskar in summer months.

1788 families studied in Nowshera area indicated following pattern of oscillation between winter herding Bush forests of Shiwaliks and summer meadows of PirPanjal, Greater Himalayas and Tethys Himalayas (Table 45).

Table 45: Distribution of summer pastures of 1788 Nomadic families of Nowshera Shiwaliks.

Mountain Range	Pasture (Summer Behak)	No. of families migrate
Pir-Panjal	Zamian walliGali	10
	Gulmarg	1
	Tangmarg	14
	Toshimaidan	4
	Chandimad	3
	Chhatapani	1
	Hilkaka	3
	Lorren Mandi PirPanjal	4 44
	Begum Pathri	5
	Zarginalla	13
	Sathri	1
	Thanamandi	1
	Rupri	1
	Belamarg	1
	Guran battan	28
	Yusmarg	2
	Konsarnag	9
	Asthanmarg	13
	Zazimarg	17
	Dudpathri	1
	Zazinad	17
	Kulgam	8
	Sungdi	4
	Banihal	1
Total		206

Mountain Range	Pasture (Summer Behak)	No. of families migrate
Kashmir valley	Malamgam	4
Hills	Lacchipur	1
	Baramulla	19
	Kupwara	2
	Sopore	9
	Bandipore	46
	Kangan	4
	Sitasar/ Sitamarg/ Harmukh pastures	18
	Gangbal/ Gangmarg	10
	Srinagar	10
	Ganderwal	1
	Dachigam	1
	Nagveri	10
	Tral	49
	Pampore	6
	Awantipore	1
	Hapatnad	1
Sonmarg	Sonmarg/ Thajwas	234
	Baltal	32
Pahalgam	Seer	4
	Pahalgam	217
	Aru	1
	Lidderwat	18
	Kolohoi	7
	Panjtarni	6
	Seshnag	4
	Amarnath	22
Total		737

Mountain Range	Pasture (Summer Behak)	No. of families migrate
Trans Himalayas	Minamarg	1
Drass	Matyan/ Pandrass	1
	Drass	36
	Battkullan	135
	Kirdi HeerBagan	35
	Labber	10
	Gunzem	3
Total		221

Mountain Range	Pasture (Summer Behak)	No. of families migrate
Great Himalayas	Michel	12
Gurez	Michel Gali	1
Tilel	Kazalban	6
Mitchel	Gurez	38
	Mianmarg	15
	Gadsar	21
	Ramel	11
	Pattalwan	4
	Tilel	156
	Maseetnad	18
	Kakamarg/ Kakbal	3
	Vishansar	1
	Satsar	1
	Hazigali	4
	Hazibel/ Hazibagh	20
	Chottigali	1
	Hatti	6
	Naushera	
	Noushri	3
	Gofil	3
Marwa/ Wadwan Kishtwar	Marwa	1
	Wadwan	10
	Nagneih	31
	Krishnai nalla	5
	Sukhnai	3
Total		374

Other Pastures
250
250

Similarly migration of herdsmen in Rupri group of Margs study site was also studied from 1990 to 1992.Following migrations have been recorded from different villages (Table 46, Plate 37).

Table 46 : Study Site Migratory Routes

Marg	No of families	Migratory distance kms	Villages of migration
Sewari	36	10 to 20	Swadi,Gundi,Drahman, Guler,Brott,Cusleer, Kabal,Tuliban,Goti.
Badjari	20	10 to 100	Choudrinar,Gundi,Harni, Swadi,Targain,Draz,Lathi, Jaglani.
Bela	22	10 to 60	Swadi,Jamola,Kandi.

Towards east about tweleve kms of ridge ascends from Gitanali Dhok & marg (2900 mts.) to Khodran Gali near Sewari marg.This ridge is water divide between Ischni catchment and Budhal nallah.There are several Dhoks of local sedentary population of Budhal and Gulabgarh areas on these margs.From Gitanali to Khodran Gali the other margs in ascending order are Abimarg (3000 mts.), Pathri (3050 mts.), Sangar (3100 mts.) and Khodran Marg (3150 mts.).The other margs towards Budhal Pir pass are Andrechi and Gagrot.These are vast group of margs catering to the needs of summer

PLATE 37 : Study site Migratory routes in Rajouri district.

GATEWAY

STUDY SITE MIGRATORY ROUTES

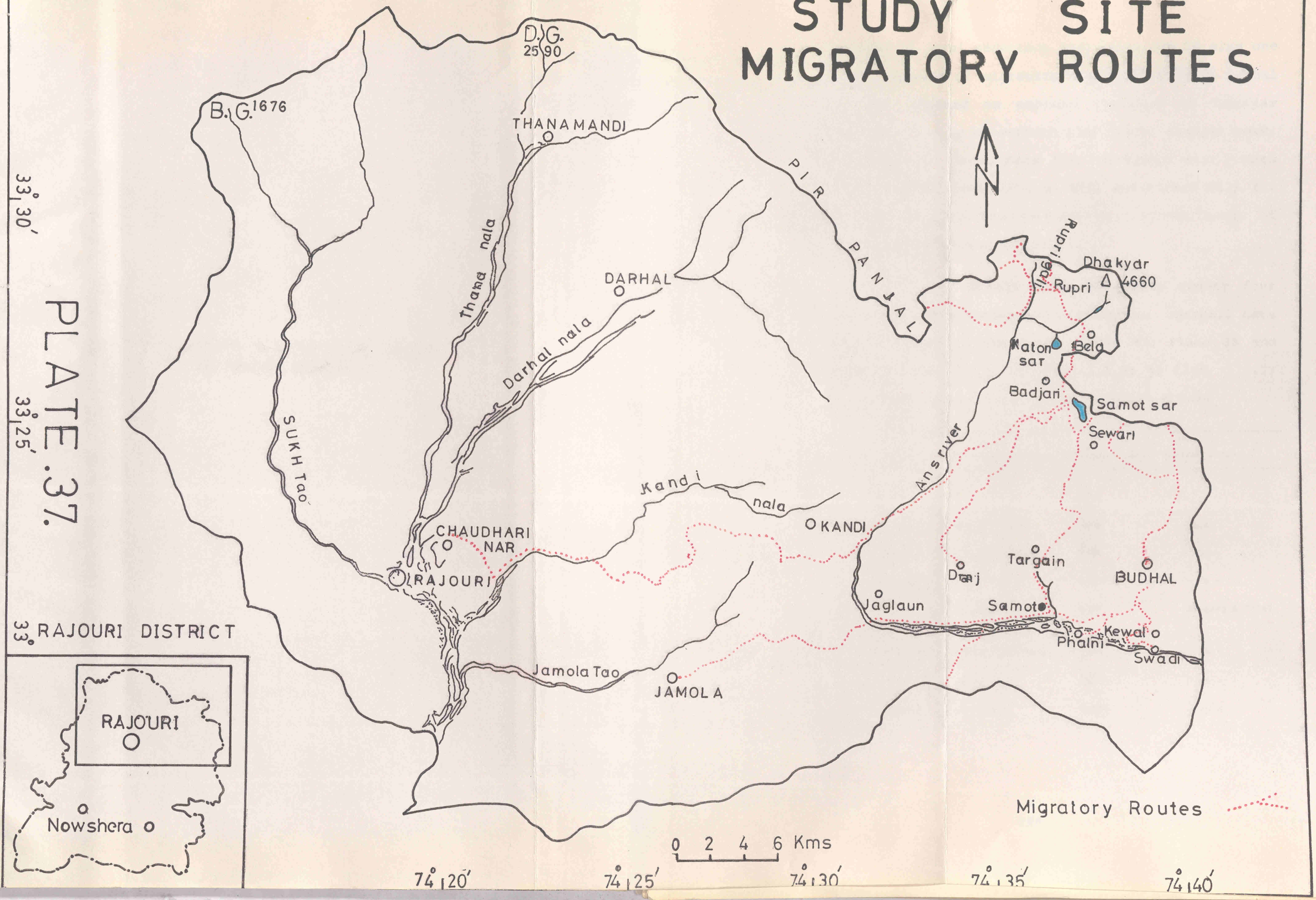


PLATE. 37.

GATEWAY

pasturage of local sedentary population and is also one of the highways of migrating shepherds through Budhal Pir pass located on eastern syncline of Dhakyar peak.Rupri Gali is on western syncline of Dhakyar peak. More than 50% Deras from Ans catchment also cross PirPanjal range from Rupri ki Gali and Budhal Gali for pasturage of their herds/flocks on northern margs of Rupri, Guranbatta and Satpathri.

On the basis of survey twenty four nomadic migratory routes and oscillation channels have been identified in the State (Table 47; Plate 38 and Plates 39 Figs. 1,2,3; 40 Figs. 1,2,3; 41 Figs. 1,2,3).

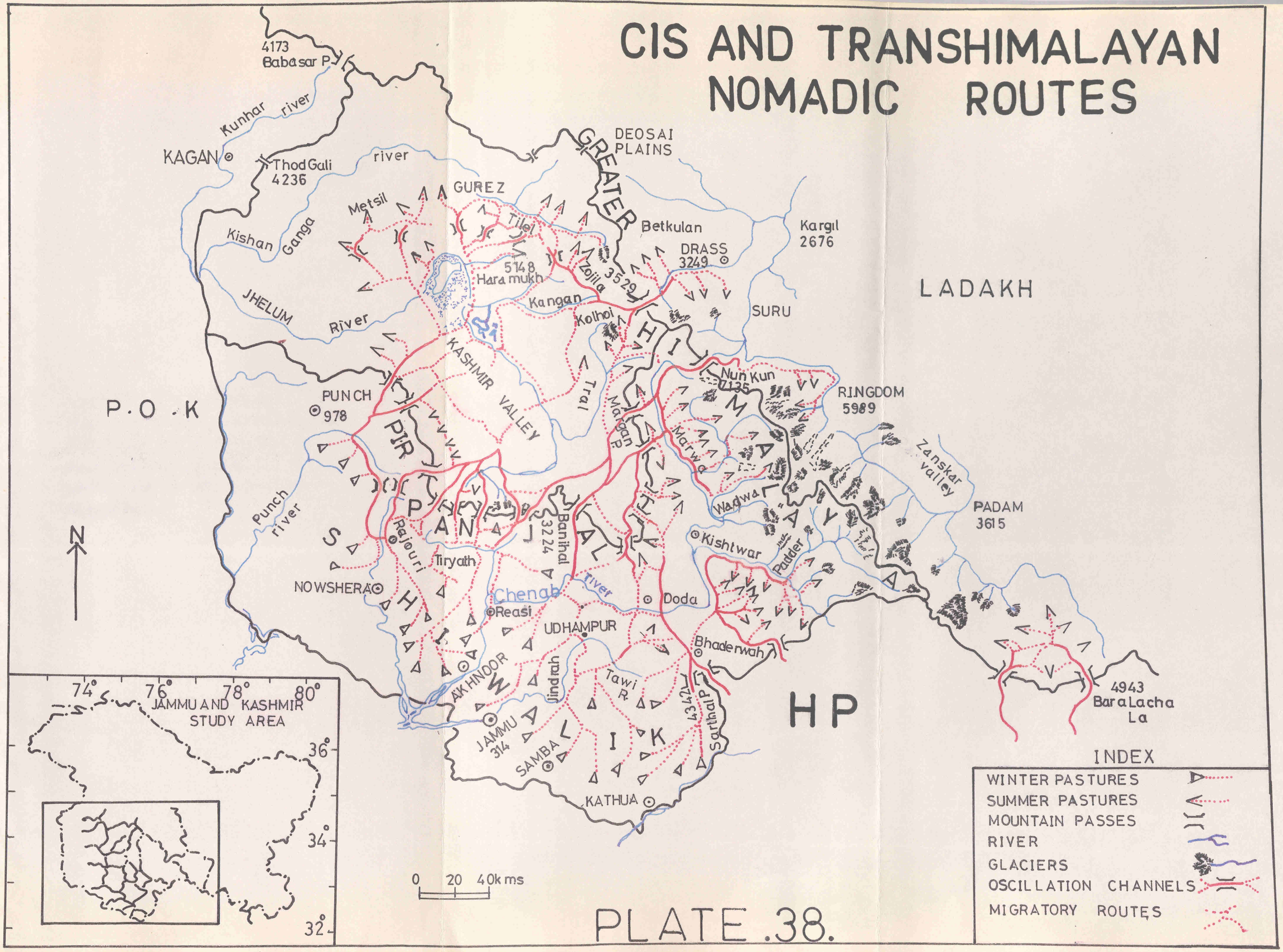
Table 47 : Migratory routes of Nomadic Herdsmen in J&K State.

S.No.	Winter Pasture	Oscillation Channel	Altitude(in mts)	Summer pasture
A.	PirPanjal Range			
1.	Poonch & Rajouri	Zamiawali Gali	4088	Gurej
2.	Poonch & Rajouri	Tosmainden Pass	4091	- do -
3.	Poonch & Rajouri	Nurpur Pass	4093	- do -
4.	Rajouri & Akhnoor Nowshera	Pirpanjal Pass	3491	Sonmarg & Tilel
5.	Rajouri & Darhal	Darhal / Jadimarg	3946	- do -
6.	Rajouri & Darhal	Barhal Pass	3830	- do -
7.	Rajouri, Budhal Taryath	Rupri Gali	4102	- do -

8.	Rajouri, Budhal Taryath	Rupri Pass	4099	- do -
9.	Budhal, Kandi Paoni, Taryath & Akhnoor	Budhil Pass	4264	- do -
10.	Paoni, Taryath Reasi	Konsar Nag Pass	3123	Phalgam Drass
11.	Taryath, Reasi	Zejimarg Pass	3809	- do -
12.	Udhampur, Reasi Jammu	Banihal Pass	3224	Marwa, Wadwan
13.	Udhampur, Jammu	Brari Gali	4310	Doda, Chandrani Marg Sahibanwali Marg.
14.	Udhampur, Jammu	Sahibanwalli Pass	4180	- do -
15.	Udhampur, Jammu	Muglmaidan Pass	3823	Kishtwar
16.	Udhampur, Jammu	Singpur Pass	3812	- do -
17.	Udhampur, Jammu	Symthen Pass	4119	- do -
18.	Mansar, Samba	Margan Pass, Chingam Pass	4311	Marwa, Wadwan
B.	Greater Himalaya			
19.	Kathua & Samba Kashmir via Margan	Sarital Pass Bobang Pass	4243 4523	Panikhar Suru to Rongdoum Valley
20.	Taryath, Akhnoor, Nowshera & Paoni	Zozilla	3529	Drass
21.	Himachal Pradesh Kulu, Spiti	Baralacha	4685	Lingti and Ponga valley Ladakh.
C.	Other Passes			
22.	Kathua, Billawer	Sarthal Pass (ChattarGala)	3703	Bhaderwah to Padder
23.	Himachal Pradesh Chamba District	Padri Pass	3511	Bhaderwah
24.	Himachal Pradesh Lahaul	Kellar Pass	4385	Padder

PLATE 38 : Cis and Trans Himalayan migratory routes. Transhumance Bakkerwal and Gaddis use 24 oscillation channels for their summer and autumn ~~for their~~ migrations.

CIS AND TRANSHIMALAYAN NOMADIC ROUTES



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- SUMMER PASTURES
- MOUNTAIN PASSES
- RIVER
- GLACIERS
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- MIGRATORY ROUTES

PLATE .38.

PLATE 39 : Pirpanjal corridors (passes or gallis) used by migrating herdsmen in their summer and autumn ~~es~~ oscillation.

Fig 1 : Zamianwali Gali 4088 mts. (Poonch district)
Fig 2 : Jadimarg pass 3946 mts. (Rajouri district)
Fig 3 : Barhal Pass 3830 mts. (Rajouri district)







PLATE.39.

PLATE 40 : PirPanjal corridors (passes or Galis) used by migratory herdsmen in their summer and autumn oscillation.

Fig 1	:	Rupri Gali	4102 mts.
Fig 2	:	Budhal Gali	4264 mts.
Fig 3	:	Konsar Gali Nag.	3123 mts.

PLATE.40.



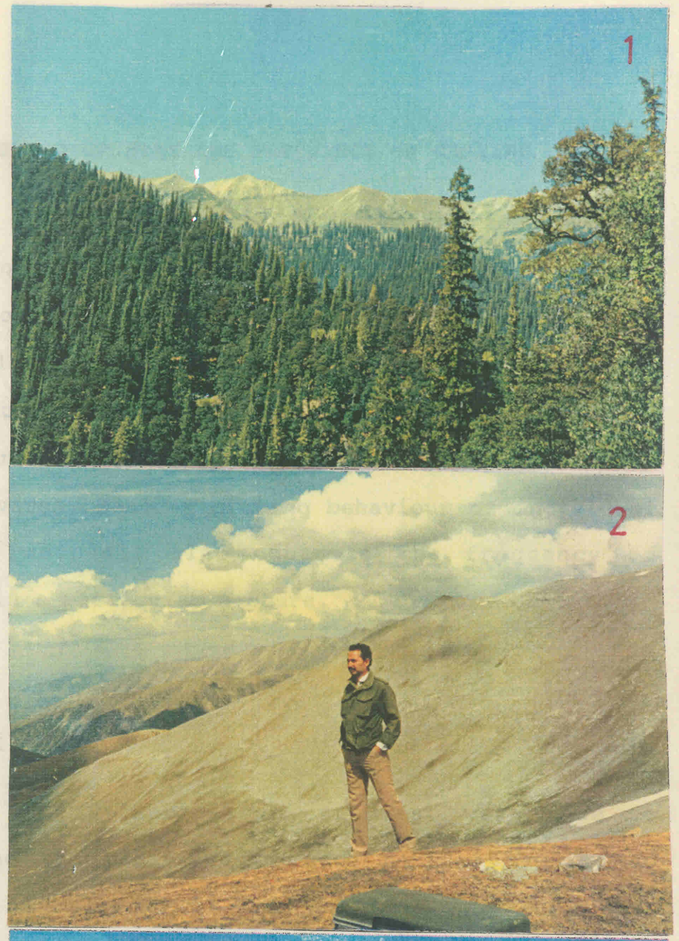
PLATE 41 : Oscillation channels in Doda district.

Fig 1 : Chandarani Marg and pass - - 4310 mts.

Fig 2 : Brari Gali 4310 mts.

Fig 3 : Symthen Pass 4119 mts.

PLATE.41.





4.4.4 PERIOD OF STAY AND FREQUENCY OF GRAZING

The period of stay and frequency of grazing of nomadic herdsmen and their flocks / herds depend on the season, temperature, rainfall and availability of pasturage. Higher temperature tempts nomads for early departure from Shiwaliks and lower temperature forces early departure from alpine meadows or vice versa. Besides grazing behaviour of individual animals, rainfall also controls the frequency of grazing in a particular pasture.

Period of Stay

Macro-level studies were made to understand the behaviour of each nomadic Kabila and Kafila in relation to seasonal movements both with respect to spatial and temporal movements and period of stay in alpine and winter pastures. At study site micro-level studies were also conducted for each herd/flock of their daily movement (Table 48; Plates 42 Figs. 1,2,3; 43 Figs. 1,2,3; 44 Figs. 1,2,3; 45 Figs, 1,2,3; 46 Figs. 1,2,3).

PLATE 42 : Summer migration of Transhumant Bakkerwals from Nowshera Shivaliks.

Fig 1 : First halt (Parao) of Bakkerwal Dera at Nowshera. Here Bakkerwal Deras camp for five to six days for completing official formalities to collect Identity card from Tehsildar and Grazing Form (Kahe-Charai Hotto) from the Forest department.

Fig 2 : Second halt (Parao) on their summer migration at Monial about 10 km from Nowshera along rivers side of Rajouri Tawi.

Fig 3 : Halt at intervening pastures at (26 Jun 91) Thana below Jadimarg and Barhal Galis. Here shepherds stay for five to ten days till passes are safe to cross.







PLATE. 42.

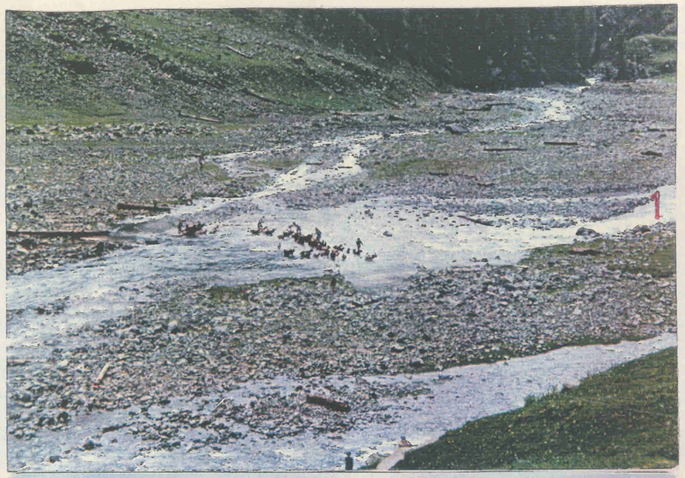
PLATE 43 : Summer migration of Trans-humant Bakkerwals from Rajouri district.

Fig 1 : Bakkerwal herdsmen (Deras) take several risks to cross rivers, nallas and sometimes glaciers to reach in time to their Trans Himalayan summer pastures. Here Bakkerwal Deras are crossing turbulent Chimer Nalla in Rajouri district on 27.6.90.

Fig 2 : Bakkerwal herdsmen crossing Bela marg on 13/7/92. In 1992 several Bakkerwal Deras were late by almost one month due to heavy snowfall on PirPanjal mountain range.

Fig 3 : Bakkerwal herdsmen crossing Bupri pass alongwith his flock on 29.6.90. While crossing these passes sometimes whole flocks alongwith the Dera perish under the snow or avalanches.

PLATE.43.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2


3

PLATE 44 : Trans Himalayan steppe.

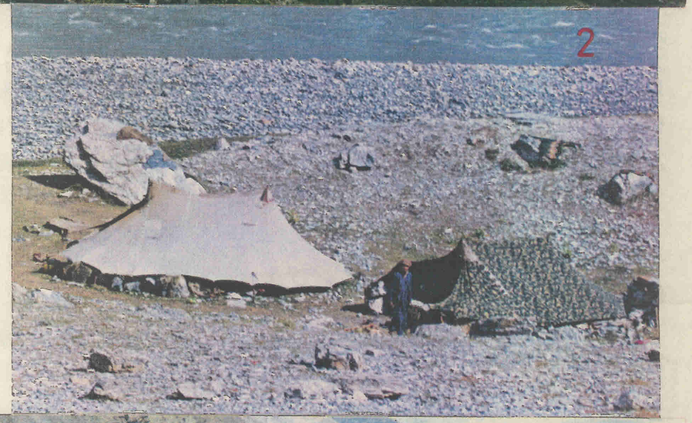
Fig 1 : Matyan pastureland at Drass. Kagani Bakkerwals prior to 1947 A.D. use to approach these steppes from Kishanganga valley to Gurej then Tilel and cross over to Botkulan and Drass. Whileas some Derms would go to Deosai Plains (now under POK).

Fig 2 : Bakkerwal Khemas (Tents) pitched along Drass river at Matyan.

Fig 3 : Bakkerwal herdsmen with his flock on his retreating journey near Pandrass on 26.8.93.

PLATE.44.





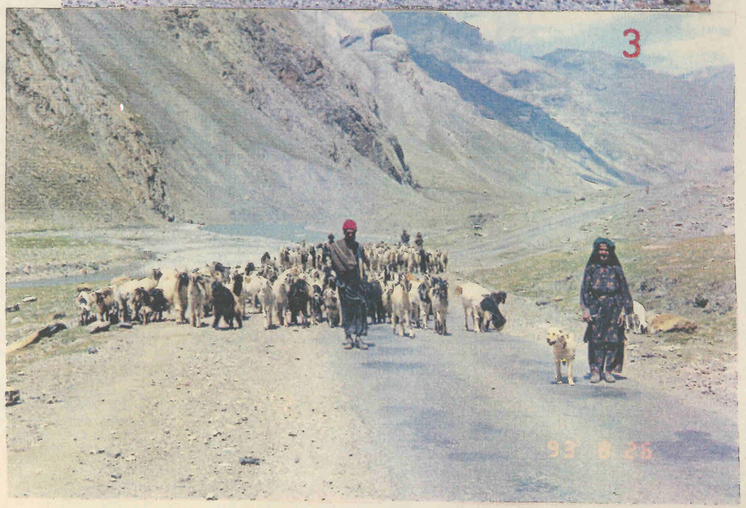


PLATE 45 : Trans Himalayan steppe.

Fig 1 : Rongdum Trans Himalayan pastures along the alluvial deposits of river Suru. These high altitude alpine pastures are one of the best in the state. Here grasses used to grow to a high ~~maaaax~~ height of Zanskari breed of Horses, but increased pressure of Bakkerwal herdsmen from Shivaliks has resulted into degraded conditions, in the western portion of the grassland.

Fig 2 : Sheep and Goat flock of Bakkerwal herdsmen grazing along river Suru near Rongdum.

Fig 3 : Bakkerwal Deras retreating for their autumn migration on 28.8.93. There are about seventy Bakkerwal Deras in Rongdum valley and all of them will cross Greater ~~Himalayaaa

PLATE 46 : Autumn oscillation near Taryath.

Fig 1 : Bakkerwal Kumba/Kafila (Ten Deras) crossing Kalaban saddle near Harichuma in Tiryath on 21.10.92 on way to Sunderbani Shivaliks.

Fig 2 : Bakkerwal Dera during Parao near Harichuma on their autumn migration to Sunderbani Shivaliks on 24.10.91.

Fig 3 Kalokhel Bakkerwal Dera camping at his last Parao near his winter pasturing (26.10.91) area in Sangad (Reasi). Before entering their Kothas (Kacha House) Bakkerwal Deras generally stay for ten to 15 days in tents outside their Kotha. This dera was seen alongwith his Charkha also used for weaving wollen yarn for Loi making. The Charkha alongwith other belonging was an important household item carried earlier by all Bakkerwal Deras. These days few Bakkerwal families still carry this item but most of them have abandoned this practice.

PLATE.46.







Table 48 : Time Table of Nomadic Migrations

Winter Pasture	Date of Departure	Summer Pasture	Date of Arrival
Gagrote (Nowshera)	15 to 20 Baisakh	Gurez,Tilel,Mitsel	1 to 5 Had 1 Assu to 2 Badu
Lamberi (Nowshera)	15 to 20 Baisakh	Gurez	5 to 10 Had
Rajal (Nowshera)	15 to 20 Baisakh	Pattalwan	4 to 5 Had
Kanara (Nowshera)	1 Jeth	Maseetnad	4 to 5 Had
Lamberi (Nowshera)	1 Jeth	Gadsar	1 to 5 Had 1 to 5 Assu
Shivkhodi (Reasi)	5 to 10 Baisakh	Wadwan Krishnainalla	10 Had 20 Bahdun
Tiryath (Reasi)	13 to 18 Baisakh	Drass	1 to 10 Had
Samba/Kathua Shiwaliks	1 to 10 Baisakh	Rongo valley Zanskar	1 to 10 Had
Baijnath/Palampur (Himachal Pradesh)	-do-	Lingti valley Zanskar	-do-

From the study it is concluded that transhumant nomadic herdsmen control their calander for the period of stay and cyclic movements in following manner.

Month	Period of Stay Winter pastures	Journey Days & intervening Pastures	Peroid of Stay Summer Pastures
January	At winter pasture	-	-
February	At winter pasture	-	-
March	At winter pasture	-	-
April	-	Start their migration on 1st Baisakh (10 to 12th April). Complete departure by above 28 to 30 Baisakh.	-
May	-		-
June	-	-	Reach 1st to 6th Had (15th to 20th June).
July	-	-	Summer pasture
August	-	-	Summer pasture
September	-	Enroute	Leave summer pasture 24 to 30th August.
October	Reach Winter pasture 15th to 20th October.	Enroute	-
November	At Winter pasture	-	-
December	At Winter pasture	-	-

Nomadic herdsmen from mid of October to mid of April stay for five months in Shiwalik winter pastures, from mid of April to mid of June for two months they spend in sojourn, from mid of June to almost last week of August for about two to three months stay at summer pastures and from last week of August to mid of October they spent in winter retreat for about two months.

At study site (Rupri Marg) following micro-level spatio-temporal movements were recorded (table 49).

Table 49 : Time Table of Seasonal Migration of sedentary and semi-sedentary families at Rupri Marg

Winter Pasture	Date of Departure	Date of Arrival	Summer Pasture	Date of Arrival	Date of Departure
Swadi,Guleer, Kabal (Ans nalla)	7.7.92 to 26.7.92	27.8.92 to 1.9.92	Sewari	9.7.92 to 27.7.92	26.8.92 to 30.8.92
Choudri Nar,Gundi, Swadi, Targain, Draz, Jaglani. (Rajouri & Ans nalla)	24.6.92 to 28.7 92	27.8.92 to 6.9.92	Badjari	26.6.92 to 28.7.92	26.8.92 to 30.8.92
Swadi, Jamola, Kandi. (Rajouri & Ans nalla)	10.7.92 to 22.7.92	27.8.92 to 6.9.92	Bela	11.7.92 to 22.7.92	26.8.92 to 30.8.92

From most of the wintering villages it is only one day journey up to Behaks of Rupri Marg, but, herdsmen those who come from as far way as Rajouri and Choudri Nar take three to four days to reach the summer pastures. Sheep and goats are first to reach these Behaks followed by Horses and Mules and Buffaloes & other cattle are last to arrive the Behaks. Infact, sheep/goat follow the melting snowline. Similarly, reverse is the order on way back home. Buffaloes and cattle are first to move, followed by horses and mules and then sheep and goats are the last to leave these alpine meadows. Some of the herdsmen possessing large

cattle herds also have intervening temperate enclosures (Dhoks, Letri) in Fir forests or Bandobasti Dhoks where they keep their cattle to graze on the enclosed pasturage of the season for about one or two months and then descend down to their respective villages. But villagers having small number of cattle and sheep and goat flocks move straight to winter grazing grounds, in the instant case, the Oak forest (Quercus incana forests of Ans catchment) and harvested kaps (grass enclosure) in their villages.

During the study year 1992, uptil 30th June, none of the herdsmen or his flocks had arrived at margs, except few sheep and goat flocks on the southern slope just below the margs inside Kharsu Oak forests (Quercus semicarpifolia) . On 1.7.92 all lakes were covered with thick blanket of snow. Snow on the margs was upto 15 to 20 feet deep. Snow had started melting on southern hotter slopes particullarly with scree slopes. Only one Ajri Bakkerwal was seen on this slope with a flock of 220 merino hybrid sheep. Several flocks of migratory Bakkerwals were seen crossing over to Kashmir valley from Rupri gali and Budhal Pass oscillation channels. Bela marg was also completely covered with snow except the hotter scree slopes facing this meadow.

Frequency of Grazing

Daily movements of sheep, goats, horses, mules and buffaloes/cattle were different in all the cases. Horses, mules, buffaloes and other cattle generally grazed on flat meadows, valley bottoms or fringes of margs and also stayed in these margs. But sheep and goats were kept in pens adjoining Kothas. These pens were either located below a big protruding rock or an enclosure made out of loose stone wall. The Shepherd dogs are similar to Tibetan or Ladhaki hounds, always stood ongaurd to protect the animals from predators like Leopards and black Bears.

In the morning just before sunrise (6 AM to 8 AM) one male member of the family would lead the flock and all other sheep and goat would follow in line, as if in parade, and go straight to sloping and higest pastures. Average distance these flocks trek is from 2 to 3 Kms on one side. Just before sunset all flocks return back (7 to 8 PM). They share the pasture for sometime with Buffaloes/ Cattle and then are hounded inside the pen. Buffaloes were seen taking rest once in early hours of the night and then during noon for about one hour but sheep and goat do not take rest except in night. During rainy days Sheep and Goats are

not taken out, but, other cattle and horses remain outside. Since, PirPanjal receives high rainfall during monsoons, herdsmen are scared of bad weather. Because, this results into slippery ground,marshy unhygeinic conditions, chilly weather, poor grazing, etc. All these factors lead to heavy mortality in flocks and herds. But, since, Transhimalayan pastures are much beyond monsoonic effect, shepherds prefer to transhumant in such far away areas, as it has all the good advantages of excellent pasturing and free from any diseases to livestock.

Horses graze all the 24 hrs in far off and highest pastures, particullarly Mares with their foals. Cattle also grazes for 24 hrs except one hour rest in night and one hour in noon and one hour for milking in morning. Sheep and goat graze only for 12 hours during day. There is no night grazing. On PirPanjal sheep and goat is milched very rarely. But at Zanskar, I was told by Bakkerwals that single family sells from 20 to 25 Kg Ghee to Kargili shopkeeper at Rungdum and their Lambardar Hazi Fisha told that Ghee produced from sheep and goat milk is sold at Rungdum upto 30 to 40 maunds (One Maund=40 Seer) per season, beside trading in wool and animals. Most of the meat requirement of Kargil is met from the livestock of

Bakkerwals from Drass and Zanskar.

4.4.5 EFFECT OF GRAZING AND TRAMPLING

Grazing animals, pasture plants and micro-organisms form the biotic components of the grazingland ecosystems. All three of these components interact with one another. Grazing animals affect the pasture through defoliation, treading and through return of nutrients. Conversely, the pasture affects grazing animals through the amount of feed available, the seasonal pattern of production and through pasture quality. Micro-organisms interact, directly or indirectly, with both pasture plants and grazing animals (Snaydon, 1982).

Effect of livestock grazing on plant and soil of grazing land has been reviewed by various workers in the past. (Weaver, 1950; Voigt and Weaver, 1951; Stoddart and Smith, 1955; Ellison, 1960; Brougham, 1971; Frame and Hunt, 1971; Tanton, 1974; Noy-Meir, 1976 and others). Most of the evidences reveal that grazing lands are affected by grazing process, especially overgrazing. The impact of grazing on the vegetation has also been studied in India by various workers (Whyte, 1964; Singh, 1968, 1969; Singh

and Misra, 1969; Prajapati, 1970; Chakravarty et al, 1970; Chakravarty and Bhatti, 1971; Gupta and Saxena, 1971, 1972; Kumar and Joshi, 1972; Dabadghao and Shankaranarayan (1973); Yadava and Singh, 1977; Billore, 1978 and others).

Effect of grazing or rather overgrazing in the hills of Jammu Shiwaliks has been very nicely and eloquently described by Sir, A.M. Stow the then Settlement Commissioner in 1919 (cf. Forest Enquiry Committee Report, 1938). Disastrous effects of overgrazing on the productivity of alpine pastures and broad leaved forests particularly by nomadic graziers from the Kagan valley, have been consistently highlighted since 1894 A.D. upto 1947 A.D. by the Jammu and Kashmir Forest Department in its annual reports. Stebbing (1962) while drawing the history of Forest conservancy in India from 1925 to 1947 A.D. expressed that the story of Jammu & Kashmir territories has been even more tragic and the pathetic part of it all was that the damage to forests was almost entirely due to foreign graziers known as "Bakkerwals".

The last concluding observation of the Enquiry Committee should have been an eye opener

and lesson for future planning and management of grasslands of Jammu and Kashmir state. The committee observed that, "The condition of the districts visited by us was very sad. The pen cannot possibly draw a picture of the state of affairs, regarding erosion in mere words of this Ilaqa." This state of affairs was noticed about fifty years ago and the conditions instead of improving over a period of time have still worsened all over the state especially in Kandi Ilaqa of Shiwalik's and Alpine meadows of Himalayas.

In the present study it has been concluded that the effect of grazing and trampling on the quantity and quality of pastures is linked to the type of animals who graze on these meadows.

The structural studies of the meadow vegetation indicated that the grazed sites possessed more number of plant speices than the fenced sites. Number of speices in grazed sites varied from fifteen to twenty and in fenced sites from eight to twelve. Vegetation of grazed sites was more open as a result of trampling, with herbage cover varying from 22.26% to 23.84% and fenced sites indicated the tendency of improvement of the site conditions with comparatively

closed type of vegetation and the average herbage cover varied from 24.22% to 32.17%. The month wise variations were comparatively more as compared to the seasonal averages of herbage cover (Table 9 to 14).

The compostion of species in grazed sites and fenced sites also indicated the affect of grazing. In grazed sites Grasses, Taraxacum officinale and Sibbaldia cuneata were more frequent at lower altitude margs of Sewari and Badjari, whereas, at higher altitude marg of Bela Grasses, Sibbaldia cuneata and Thalictrum alpinum were more frequent. In fenced sites Grasses, Ranunculus pulchellus , Sibbaldia cuneata and Taraxacum officinale were more frequent at Sewari and Badjari but in Bela Grasses, Sibbaldia cuneata and Rhodiola himalensis were more frequent (Tables 15 to 20).

Effect of grazing and trampling was also reflected in the Species Diversity Index of grazed and fenced sites. The grazed sites indicated high degree of species diversity index (1.91 to 2.35) as compared to fenced sites (1.34 to 1.86). In grazed sites Bela recorded highest species diversity index whereas in fenced sites Sewari recorded highest species

diversity index (Table 21).

Perusal of Table 21 also clearly depict that the fenced sites possesed high index of Dominance as compared to grazed sites although fenced sites reflected low species diversity. Thus it is observed that there exists an inverse relationship of species diversity with that of species dominance.

When Jaccard's Index of Similarity (Tables 21, 22) was employed to compare he effect of grazing on fenced and grazed sites, It was recorded that the value of JIS, was high in respect of Sewari and Bela (52.94 and 52.38) as compared to Badjari (35.00). Henced fenced and grazed sites were more homogenous at Sewari and Bela as compared to Badjari.

Effects of grazing and trampling was also reflected in the abundance and density of species comprising vegetation of fenced and grazed sites. Individual species behaved differently to different site conditions, different grazing intensities and the type of grazing animals. The density of grasses ranged from 1767 per m^2, 1384 per m^2 and 1087 per m^2 in Sewari, Badjari and Bela, respectively. But in fenced

sites grasses recorded density of 1764 per m^2, 1358 per m^2 and 1800 per m^2 in Sewari, Badjari and Bela margs, respectively. High density of grasses (Sewari), and Sibbaldia cuneata (Badjari and Bela) was recorded at grazed sites but in case of fenced sites grasses recorded high density in all the sites (Table 15 to 20).

The Importance Value Index (IVI) is the reflection of composite effect of grazing and trampling on the site and its reaction to the frequency, density, dominance and cover of individual species comprising the vegetation of pasture lands (Table 15 to 20). In the presence study the Importance Value Index (IVI) of grasses in case of grazed sites varied from 48.92 to 87.65 and in case of fenced sites varied from 78.16 to 88.89. Such a trend clearly indicates the prefernce of grass grazing in the grazed sites by the nomadic livestock, which otherwise show high IVI value of grasses in fenced and protected sites.

Another important tool which has been employed to analyse the effect of grazing and trampling is the effect of Raunkiaer's life forms expressed in

the form of Biological spectrum of an area. Raunkiaer's Biological spectrum, however, does not indicate any quantitative or qualitative status of the pasture, whether it contains more nutritious elements or non nutritious or poisnous elements. It may say about status of grassland whether heavily grazed or less grazed or protected, but cannot be applied for assessment of nutritive and productivity status of the grasslands.

In the present study ,there is more dominance of Hemicryptophytic and Chamaephytic species in grazed sites. In fenced areas it is Geo-hemicryptophytic. Presence of Therophytes is neglegible in grazed sites. Presence of more Hemicryptophytes both in grazed and fenced sites indicate that pastures contain more perrenial species than annuals, which are ideally adapted to face the onslaught of grazing by livestock and suitable mechanism to withstand the climatic extremes. There subterranean perrenating buds enable them to overcome the severity of snowfall which covers whole vegetation for almost 9 months (Table 23 & 24).

Best method however is the ecosystems approach to assess the affect of grazing, trampling on

the productivity of the grasslands. In the present study, since all pastures were open to free grazing, it was not possible to maintain a flock for three to five yrs and have controlled grzing to assess the grazing capacity and the secondary production. But in the present study an assessment of primary production and the present load on the pastures was made on natural conditions as existed during the period of study. It is apparent from figures given in table 50 & 51 that there is an intensive pressure on these pastures, varying from 0.22 Ha/HSU to 0.35 Ha/HSU and the C/C of these pastures is far too less as recorded in other cases.

A.N.P was more in all the fenced sites, than grazed sites (Table 31). Aboveground annual net production for Sewari, Badjari and Bela fenced sites was 375.75 $gm/m^{-2}/yr^{-1}$, 491 $gm/m^{-2}/ yr^{-1}$ and 245 $gm/m^2 /yr^{-1}$, respectively, whereas Aboveground net production for Sewari , Badjari and Bela grazed sites was recorded as 168.90 $gm/m^2/ yr^{-1}$, 100.90 $gm/m^{-2}/ yr^{-1}$ and 197.30 $gm/m^{-2}/yr^{-1}$.

If standard principle of 50 % consuption is applied, it seems that Sewari is grazed at optimum level, Badjari is heavily grazed and Bela is

also grazed at optimum level . From the result it is also apparent that sites where sheep/goat grazes, the pasturage utlization efficiency is more than in mixed grazing of Sewari and Badjari where more than 50 % of A.N.P is consumed and very less is left for recycling into the soil (40% prescribed by En. Bri. (1980) and 70% by Gupta, 1993).

These results show insignificant correlation with carrying capacity of land based on area & number of cattle/livestock. In C/C analysis based on number of animals per unit, Sewari marg had less number of animal units per ha (2.05), Badjari had more number of animal units per ha (2.54) and Bela possessed highest number of animal units per ha (3.26). But when compared with A.N.P only Badjari is overgraged,Sewari is medium grazed and Bela is optimum grazed . The difference could be due to difference in composition of animals. Although Badjari produced more (A.N.P of fenced site = 491 $gm/m^{-2}/yr^{-1}$)it is consumed more also (A.N.P grazed site = 100.90 $gm /m^{-2}/yr^{-1}$), but when calculated on the basis of animal units, productivity and area, entirely different results emerge.

On the basis of O'Conner's conversion norms of the livestock adopted by World Bank Project Report (1980) of J&K S.H. Deptt; the Himalayan stock units at the study sites are given in Table 50.

Table 50: Himalayan stock units grazed in Rupri Margs

S.N.	Pasture	S/G		B		H	Cattle		Total/H.S.U
		A	Y	A	Y		A	Y	
1.	Sewari	497	73	123	28	15	78	8	
	H S U	497	36.5	861	112	75	312	16	1899.5
2.	Badjari	1164	297	39		13	16		
	H S U	1164	148.5	273		65	64		1714.5
3.	Bela	2215	334	9	1	37	11	1	
	H S U	2215	167	63	4	185	44	2	2680

The conversion factors adopted (after O'Conner cf. World Bank Report, 1980) for different category of animals are 1 Sheep = 1 H.S.U; 1 Goat = 1 H.S.U; 1 Bull = 5 H.S.U; 1 Cow = 4 H.S.U; 1 Young Cattle = 2 H.S.U; 1 Male Buffalo = 8 H.S.U; 1 Female Buffalo = 7 H.S.U; 1 Young Buffalo = 4 H.S.U; 1 Horse or Pony = 5 H.S.U; 1 Donkey or Mule = 4 H.S.U; 1 Camel = 8 H.S.U; 1 Yak = 6 H.S.U .

PLATE 47 : Herding types at study sites.

Fig 1 : Buffaloe grazing at Sewari marg.
Fig 2 : Mixed grazing at Badjari marg.
Fig 3 : Sheep and goat grazing at Bela marg.

PLATE. 47.







The grazing intensity at the study sites is indicated in table 51:

Table 51: Grazing intensity at Rupri Marg

Pasture	H S U	Area (ha)	Grazing Intensity HSU/ha
Sewari	1899.5	400	4.74
Badjari	1714.5	600	2.86
Bela	2680.0	800	3.35

From above it is clear that Sewari Marg possessed highest grazing intensity with more number of Himalayan Stock Units (HSU) under cattle and less number of Himalayan Stock Units (HSU) under sheep and goats as compared to Badjari and Bela where there are more number of Himalayan Stock Units (HSU) under sheep / goats and less number under cattle (Plate 47, Figs. 1,2,3).

Gupta et al. (1993) recommended a sheep's dry matter requirement from 800 to 1200 gm. The pastured sheep requires 1.3 Kg (TDN) and 0.8 Kg (DCP) per 100 Kg body weight. This he estimated a sheep can get from 8 hrs of grazing. But, O'Conner (loc. cit.) recorded average annual requirements of a H.S.U as 500

Kgs of dry matter of 60-70% digestibility. On the basis of forage requirement based on H.S.U and productivity of study sites, the excess and deficit herbage availability is recorded in table 52.

Table 52: Herbage availability at Rupri Marg

Pasture	Area (ha)	Aboveground Net Production (Live)		H.S.U	Average requirement	Total requirement	Excess or Deficit
		Kg /ha/yr	Total qtls		kg/yr	qtls	qtls
Sewari	400	1316	5264	1879.5	500	9497.5	- 4233.5
Badjari	600	1009	6054	1714.5	500	8572.5	- 2518.5
Bela	800	1450	11600	2600.0	500	13402.5	- 1802.5

Above table indicates that the Margs where cattle graze, are more deficit in the availability of pasturage than those Margs where only sheep and goats graze. Since studied pastures do not have sufficient pasturage, in the present case sheep/goat has to pasture for almost 12 hours and that also after consuming energy in long treks of 3 to 6 Kms from the herding camp. Same is true of cattle and horses who almost graze day and night except 3 to 4 hrs milking and resting period. This also indicates that pastures do not support enough herbage for the livestock which comes here every year for two to three

months grazing. The milking cows and buffaloes in some cases, however, are compensated with Oak (Q. semicarpifolia) green leaf fodder @ 40 to 50 Kg once or twice a week. Those Deras who are near Oak forests almost daily feed the cattle at time of milking. Cattle is also provided "energy subsidy" in the shape of mineral salt. No additional input is provided during the period livestock stays at high altitude pastures.

On the basis of productivity and Himalayan Stock Units permissible the carrying capacity of Rupri pasture was thus worked out in Table 53.

Table 53: The carrying capacity of Rupri Marg

Pasture	Area (ha)	Aboveground Total production in qtls	H.S.U. Permisible	Carrying Capacity H.S.U/ha
Sewari	400	5264	1053	2.63
Badjari	600	6054	1210	2.01
Bela	800	11600	2288	2.86

It is quite evident that Sewari marg provides far less herbage to the animals grazing on its pasture, due to heavy grazing pressure by more number of cattle. In Badjari, there is a mixed grazing,

therefore, the situation slightly improves, but in Bela where only sheep/ goat grazes enough pasturage is available to livestock and is very near to prescribed limit of 500 Kg/annually.

Above observation also brings out clearly the effect of overgrazing on these alpine pastures. These pastures can be improved by simply reducing number of cattle and in their place sheep/goat be allowed for grazing. Cattle should be restricted only upto tree zone where enough fodder is available from undergrowth of forests and lopping of trees. Alpine pastures should be left only for sheep/goat. The study also brings out the fact that alpine pastures have tremendous scope of improvement by enforcing simple enclosures or rotational grazing which gives sufficient time for vertical growth of herbage. There is an overall crowding of Alpine and subalpine pastures which the Government should try to reduce. Existing fodder resources, particularly the alpine meadows of Pirpanjal cannot absorb more numbers which will lead to deterioration of pastures both qualitatively and quantitatively and thereby reduce the health of animals. This would lead to poor milk, meat and wool production and ultimately whole livestock industry,

grassland ecosystem of fragile Alpine zones will collapse.

In the present case optimum number of H.S.U at Sewari could be 1052.8, at Badjari 1210.8 and at Bela 2288. Such types of management measures will not only improve the condition of pastures but go a long way in the development of livestock industry.

Since alpine pastures are very rich in nutritious grass and herbs may be that the above ground biomass which is less in quantity provides enough nutrition in terms of total digestible nutrients (TDN), Digestible crude protein (DCP) and minerals as in present study it has been found that soils are quite rich in minerals and other major chemical components. Such type of study can be useful to correlate number of H.S.U with that of total nutrition available in pasture. It is a fact that tropical grasslands are poor in nutrition as compared to alpine and arctic vegetation, so may be for same quantity of herbage Alpine pastures provide more nutrition and minerals as compared to tropical grasslands.

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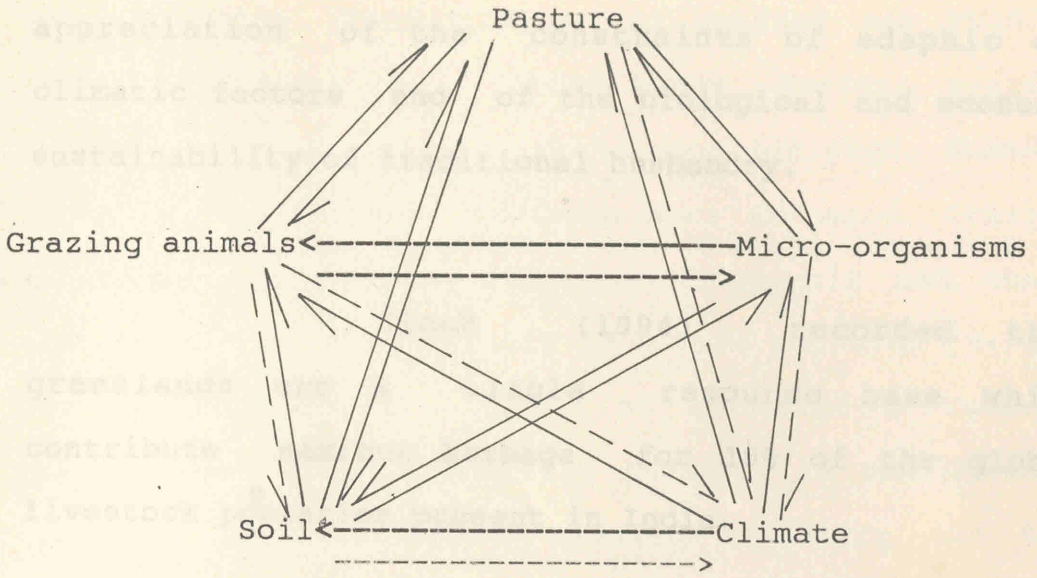
CHAPTER 5

DISCUSSION

DISCUSSION

Many early human civilizations developed in grassland regions of the world. Infact grasslands have been the cradle of many prosperous civilizations of modern day world. Grazing lands provide most of the feed to our livestock and the cheapest forms of animal production are based on grazing. Animal production from grazing is inseperable from plant production and especially from pasture production and management. These days researchers are thus concerned with plant-animal systems of production and the concerned ecosystem (Morley, 1981). In pasture ecosystems, grazing animals, the associated micro-organisms, the soil and the climatic conditions in a given site, are all parts of a complex interacting interdependant system-the

ecosystem. Such systems have been represented diagramatically. Each component affects, and is effected by each of the other components in the ecosystem. The magnitude of the various actions and reactions differ (Snaydon, 1981).



(After Snaydon, 1981)

Stocking rate and grazing management are the two most important management variables affecting herbage production, seasonal pattern of production, herbage quality and botanical composition.

Pearson et al (1987) observed that the biological components of grasslands or pastoral systems are the environment, plants and animals. These are closely related in cyclic fashion. The

properties of grassland or pastoral systems could be 1. Gassland productivity, 2. Efficiency, 3. Stability, 4. Sustainability, 5. Animal productivity and 6. Grassland systems. They suggested that the efforts to intensify grassland systems have failed due to non appreciation of the constraints of edaphic and climatic factors and of the biological and economic sustainability of traditional husbandry.

Singh (1994) recorded that grasslands are a single resource base which contribute maximum herbage for 15% of the global livestock population present in India.

The grazing systems of the world have been studied by Harrington (1981) and Williams (1981) who have identified four main ways by which man exploits the grasslands with his stock. The grazing systems have been categorised into 1. True Nomadism, 2. Transhumance, 3. Semi-sedentary and 4. Sedentary.

Present study, therefore, was undertaken to analyze the affect of Nomadism on the

ecology of alpine meadows (Margs) in Jammu and Kashmir State and the representative site was selected in the PirPanjal mountain range of Western Himalayas at Rupri (Average altitude 3400 mts.). The alpine vegetation was studied both for its structure and function. Productivity of meadows was studied both in grazed and fenced sites. Various grazing systems in vogue in the state were analyzed. Nomadic routes of migratory herdsmen were surveyed. Grazing behaviour of different type of animals and their affect on the productivity of alpine pastures (Margs) was also analyzed. Affect of uncontrolled nomadic grazing was also critically analyzed in the present work. In the end the grazing intensity and the prescribed utilization / carrying capacity of Rupri group of Margs was calculated based on area, himalayan stock units (HSU), feeding requirement and the productivity of pasture.

From the studies conducted in Alpine meadows of Rupri margs (Sewari, Badjari, Bela) and the data analyzed in foregoing chapters, the results indicate that the nomadism by pastoralist and transhuamant societies of Jammu and Kashmir State significantaly influence the structural and functional attributes of the alpine grasslands.

Ecologically the distribution of grasslands is predominantly governed by climatic factors, related chiefly with latitudinal influences (Whyte, 1964). Dabadghao and Shankarnarayan (1973) established eight main grassland types in India and Deschempsia / Deyeuxia type was indicated to represent temperate / alpine type of climate. Puri et al (1989) classified grasslands of India into three main broad types viz., Xerophilous, Mesophilous and Hygrophilous. The alpine meadows of the Himalayas have been included in mesophilous type of grasslands. They also concluded that the proper understanding of grasslands is rather complicated due to the influence of biotic factors. It was observed that except high alpine zones, the grasslands do not occur as climax formations and are mere a sub-climax or dis-climax (Lal and Melkania. 1994 ; Singh, 1994).

The vegetation of natural grasslands is primarily composed of seed-bearing herbaceous plant species, which can be classified on basis of Gross Morphology into two groups :

1. Grass and Grass like plants = Graminoids

2. Non grass like herbs, mostly broad leaved species = Forbs

It has been observed that the Turf grasses dominate moist habitats and Bunch grasses dominate arid habitats (Encyclopaedia Britanica Vol.8 1980).

Since edapho-climatic factors greatly influence the productivity of pastures besides biotic factors, detailed studies of soil and climate, of the study area, were carried out. Most of the soils of the margs (meadow land) are glacial moraines, and are formed due to weathering of rocks and decomposition of plant parts. Nutrients are cycled through primary and secondary producers. Soils of study sites were silty loam with good drainage. Average pH was 5.25. The organic carbon, organic matter, nitrogen percentage and C/N ratio has been recorded in Table 6. Soils are rich in minerals containing phosphorus @ 22.70 Kg/ha, potassium 62.62 kg/ha, Ca+Mg 2.31 milli equivalent per 100 gms, and Sodium 0.827 milli equivalent per 100 gms. Table 54 indicates comparative results of the some of the sites in Jammu and Kashmir Himalayas.

Table 54: Comparative analysis of Physico-chemical characterstics of different sites in J&K Himalayas.

Site	Texture	pH	OC%	OM%	N%	C/N ratio	Author
Yusmarg (Grazed)	Clayey loam	5.21	-	4.75	0.23	11.95	Gupta, 1979
Nilnag (Grazed)	Clayey silt	5.21	-	4.75	0.23	11.95	Koul, 1981
Bhaderwah	Clayey loam	3.4 to 7.1	0.1 to 1.4	0.2 to 2.3	0.03 to 0.06	-	Raina, 1987
Trikuta Hills (950 mts to 2450 mts)	Loam to Sandy loam	6.40 to 7.20	2.80 to 4.65	-	0.319 to 0.591	5.24 to 14.57	Kapur and Sarin, 1990
Jammu Shiwaliks	Calcare-ous soils	7.4 to 8.2	0.07 to 0.60	-	-	-	Gupta 1992 et al,
Rupri marg	Silty loam	5.25	9.8	16.87	0.372	25.66	Present study

Organic Carbon (OC%), Organic matter (OM%), Nitrogen (N%), Carbon / Nitrogen ratio (C/N ratio).

The pH values are comparable to those of all temperate sites indicated in the Table except the Jammu Shiwaliks which are located in subtropical zone of the State. The values of the remaining parameters like OM%, OC%, N%,and C/N ratio are much higher to the other lower altitude temperate

sites. In the temperate and alpine grasslands, soil leeching (downward movement of water-soluble soil constituents) is restricted both by the scarcity of percolating water and by the low solubility of soil materials. The soils of natural grasslands, consequently contain an abundance of organic matter at all depths; and chemical substances that are leeched precipitate at the bottom of soil profile. Consequently, temperate and alpine grassland soils have the capacity to release nutrient elements to plants slowly but steadily over a long period of time, thus permitting production of annual crops, even after destruction of the natural plant cover. The abundance of OM (humus) in grassland soils is reflected in the colour of soil profile. In temperate grasslands, organic content varies from 3% to 10% with colour of soil from chestnut to black. (Ency., Brita., Vol 8 1980). Same observations were recorded in the present study site of Rupri alpine meadows. Colour of top soil was black (Plate 7) due to rich contents of organic carbon and organic matter also reflected in high value of C/N ratio. Sims and Singh (1971) observed that grasslands have inherent mechanisms to adjust grazing pressure. The grazed grasslands have a mechanism to balance any loss in

efficiency due to grazing by increasing the efficiency of belowground production. Their observations also support the results of present findings. The mean root shoot ratio of the grazed site at Rupri was 15.66 and ranged from 10.46 to 25.94 during the study period.

Billore (1978) on the basis of bulk density of soils opined that concentration of animals may cause soil compaction, but he remarked that enough data was not available to generalize this statement.

Climate of the study site greatly influences the alpine vegetation. Due to long winter, heavy snow fall, hailstorms, limited growing period of two to three months, etc., the vegetation of the study sites is mainly climax type of alpine grasslands. Plant species growing in such severe and exacting type of environments possess certain characteristics which enable them to be the most successful species in extreme type of climatic conditions. Savile (1972) listed seven environmental adaptations which enables alpine plants to withstand such harsh factors like 1. low temperature in winter 2. low summer temperature 3. short summers 4. strong winds 5. low light intensity 6.

low nitrogen supply 7. simple population structure and low density. Dhar and Kachroo (1983) also recorded similar observations for Kashmir alpines.

Same type of environmental conditions prevail in the PirPanjal alpine meadows. The mean maximum and mean minimum temperature ranged from 19.38 ^{o}C to 10.48 ^{o}C for the growing season from July to September when for the same period temperature ranged from 31.70 ^{o}C to 22.30 ^{o}C in the Shiwaliks of the same district (Tables 7 & 8). First snowfall was recorded on 2.10.92 and the meadows remained under thick blanket of snow till last week of June or first week of July. Growing season extended from July to September for hardly three months only. Thawing and frost lifting and frequent clouds are common environmental constraints at high altitudes. Billings and Mooney (1968) also made similar observations on the adaptation of Arctic and alpine plants and identified fifteen characteristics in plants to adapt such severe environments. Bliss and Mark (1974) also made similar observations in high alpine environments of Newzealand. Douglas and Bliss (1977) emphasize that phenological patterns were closely related to the date of snow melt and early season temperature regions in alpine and sub-alpine

plants.

The phytosociological studies of the study area revealed that alpine meadows contain far less number of species as compared to temperate and tropical grasslands. Total number of species reported by Gupta (1979) in Yusmarg meadow (2400 mts) were only 60. In grazed site the number varied from 14 to 38 and in fenced site 18 to 45. At Nilnag (2300 mts) number of species reported in the understory of forest was 141 (Koul 1981). He also observed that low temperature and winter snow keep the number of species low. In Bhaderwah number of species reported at various altitudes were 488(Raina, 1987). At the present study site of Rupri (3300 mts) average number of species ranged from 20 in the grazed sites to 7 in the fenced sites. The number of species decreases with increasing environmental adversity. For example eastern Nebraska had 200 species but southern Saskatchewan had only 50 species (Encyl., Britan. Vol 8 1980). Stewarts (1916-17) recorded declining trend with altitude in Ladakh. At Suru valley total number of species recorded were 142, at Rupsu 79 and at Baralacha only 20 species. Gupta et al (1971) at Jodhpur observed that the number of species decreased with the intensity of grazing and quality of animals. The protected sites had only 35

species; site with sheep and goat grazing had 52 species and site third under heavy grazing of cattle, sheep and goat had only 29 species. Gupta (1979) also recorded the same trend in Yusmarg meadows of Kashmir where he listed less number of species on grazed sites due to several biotic factors like grazing, trampling and tourism and recorded maximum number of species in fenced areas as compared to grazed sites due to more species diversity and decreasing dominance.

The index of species diversity ranged from 1.91 to 2.35 in grazed sites and 1.34 to 1.86 in fenced sites in a reverse order of meadows at Rupri. Grazed sites possessed high diversity but low dominance but fenced sites recorded low diversity and high dominance (Table 21). On the basis of uniqueness and commonness of species occuring in closed and open "Margs" the Jaccard's Index of Similarity was as high as 52% in Sewari and Bela as compared to 35% in Badjari. The high similarity of species composition between different sites may be due to the effect of climate and altitude. Since, all the study sites were located in the alpine zone not much variation in species composition occured due to grazing. However, grazing in all the three sites stimulated more number

of species than in fenced sites where number of species was far less. It was also noticed that protection almost eliminated 50% of the species. Grazing enhanced species diversity. The enhancement of species diversity has also been reported by Singh (1968) and Singh and Misra (1969) for the grazing lands of Varanasi. These workers concluded that grazing creates open canopies which makes the invasion by annual and other perrenial species possible, thus increasing plant diversity. They also observed that same was true for fenced and protected areas where herbage canopies developed into full size, thus preventing the sunlight to reach the ground resulting into more competition for light and moisture and then eliminating the colonizing species. These workers while comparing the result with that of McNaughton (cf. Singh & Misra 1969) observed that species diversity increased productive efficiency of a system while protection makes the system stable, though less efficient for production. Kaul and Sapru (1973) for valley meadows recorded high diversity in areas of biotic interference. Naik and Mishra (1974) also supported the observation that protection reduces diversity but increases dominance. Singh and Ambasht (1980) were also of the same opinion that

with the increase in dominance, diversity decreases. Low diversity was due to longer protection which resulted into high degree of dominance.

During the present study grasses were found to be most frequent in grazed sites with frequency ranging from 90% to 100% at all sites but in fenced sites along with grasses other forb species like Sibbaldia cuneata, Taraxacum officinale, Ranunculus pulchellus also tend to be more frequent. Frequency percentage of grasses in protected sites varied from 91.66% to 100% . The frequency diagram based on Raunkiaer's Law of Frequency (cf. Misra 1968) indicate that species composition within individual sites was heterogenous. In a separate study else where it has been observed that graminoid life forms seem particularly well adopted to dominate in competition with forbs. New growth in cases of grasses is from a zone of cell division located at the bases of leaves and stems rather than at the tips, as in forbs and woody plants. This characteristics in grasses permits continuous growth even when the upper ends of shoots or the leaves are cut, eaten or burned. The growth zones in the stem also assist shoots that have been bent by trampling

to regain a vertical position (Encly. Britan. Vol 8 1980). This appears to be the only reason that grazed meadows have high frequency of grasses as compared to forbs. As have been recorded in present study in the enclosed areas, alongwith grasses other forb species also tend to be more frequent and may ultimately lead to the elimination of grasses. Besides this adaptability in grasses, alpine plants also tend to grow in cushion type mats or with characteristics rosette nature. Cushion type of plants protect meadows from trampling damage and act as shock absorbers and rosette nature helps to withstand grazing pressure and also inturn help protection of the growing bud. In case of rosette plants like Geum elatum, Cortia depressa, Taraxacum officinale etc., it has been observed that when outer whorls of leaves are eaten by livestock inner whorls take their place and the process of replenishment goes on. So in alpine meadows where grazing intensity is high, two type of plants commonly constitute the vegetation which are ideally suited ecologically to absorb the shock of trampling and grazing pressure viz., grasses and rosette & cushion forbs. Most tender species like Lagotis cashmeriana, Rheum emodi, Tanacetum dolichophyllum etc., were seen to grow in

protected areas like scree slopes or near big boulders or nalla crevices. Infact tender species tend to evade main meadows with grazing pressure but try to invade the same area with slight protection. During the study it was also observed that in the alpine zone there are natural protected niches of bio diversity where tender species take refuge for further dispersal at the appropriate time and site. Same observation was also recorded by Redmann (1975) when he recorded that environmental pressures result into assemblage of species which handle such conditions by development of various modifications of the basic **Endure-Evade-Escape** theme.

Pandeya (1960) remarked that India being a tropical country, the ecological conditions differ so widely from those of Europe and America that it becomes difficult to adjust our ecological results into their systems. He observed that the degree of homogeneity infact is present in "Abstract" form which cannot be expressed by Raunkiaer's "Frequency Diagrams" . While "Frequency Diagrams" are useful in judging the similarities between different associations, yet these fail to account for the abstract homogeneity present in the same association.

Hence he modified the expression into "Dominance Diagrams" which includes the cover by each species also. Almost same observations were recorded in the present study also. Based on Raunkiaer's frequency class classification plant communities in both grazed and fenced (Sewari, Badjari, Bela) of Rupri margs are heterogenous but based on dominance diagrams all sites indicated homogenous structure of plant communities.

Density of plants in a community gives an idea of the degree of competition between members of the same species as well as of one species with the other. Density and frequency if taken together gives an idea of community structure (Oosting, 1956). Terms, abundance and density represents the numerical strength of species in the community (Misra, 1968). In the present study grasses were recorded more dense in grazed sites as compared to other species. The density of grasses varied from 1087 to 1767 per m^2. But in high altitude site Sibbaldia cuneata had the highest density of 1267 per m^2. In fenced sites again grasses were more dense than other species. Grasses recorded density of 1358 to 1800 per m^2 followed by Ranunculus pulchellus,

Geum elatum and Rhodiola himalensis (Tables 15 to 20).

Relative dominance and Dominance Index was calculated with the help of basal area cover and density. Cover and population density are the chief controlling factors of dominance. Analysis of relative dominance gave entirely different results. At lower altitude of Sewari marg Geum elatum (28.16%) was most dominant at grazed sites and in fenced area grasses were most dominant (30.34%). In Badjari grazed and fenced sites Sibbaldia cuneata was most dominant species (27.74% and 31.72%), where as in highest located marg of Bela, Rhodiola himalensis was most dominant in grazed and fenced sites (24.97% and 56.27%). As discussed in foregoing paras grazed sites possessed high diversity but less dominance but in protected sites there was low diversity and high dominance. This observation has also been supported by other workers. However, response of individual species to varying climatic and boitic conditions is different at all sites. Gupta (1979) recorded that dominance of plants is not permanent feature at high altitude but it is seasonal with the result the plant associations recorded a change periodically. Singh and Ambasht (1980) also recorded same observation at

Varanasi that grazing affects density as per species, in some it increases and in others it decreases.

The concept of Importance Value Index has been used extensively as a means of assessing the biological contribution of species in a plant community. It is infact the collective and combined affect of relative values of frequency, density and dominance. This method of phytosociological analysis has also been used to assess the importance of floristic elements in ground vegetation, grasslands and meadows. In the present study the IVI with respect to grasses was high in Sewari closed and open sites (88.99 and 87.65). In Badjari grazed and fenced Sibbaldia cuneata recorded high IVI (81.56 and 84.72). In Bela grazed Rhodiola himalensis recorded high IVI (56.61) and in fenced grasses recorded the high IVI value (78.16) followed by Rhodiola himalensis (76.02). Koul (1981) observed that high IVI is due to lack of biotic interference. At Nilnag, he recorded that Stipa sibirica showed extremely high IVI since it escapes grazing, being poisonous, but it also indicates the signs of heavy grazing pressure. Almost same observations were recorded in the present study where at lower

altitude marg grasses indicated more IVI than the forbs in both grazed and fenced sites. In next higher meadow Sibbaldia cuneata indicated high IVI value, may be because of the combined effect of grazing pressure, soil and climatic factors. Species being more hardy and perennial in nature survives the grazing pressure of cattle as compared to other species in the plant community. At the highest located marg different trend was recorded. High value of Rhodiola himalensis was due to non palatability of the species. May be this is the only reason that in Bela grazed site grasses are eaten and destroyed by the livestock and Rhodiola himalensis gets a chance to colonise the empty spaces and grows gregariously. Whereas in fenced sites grasses get equal opportunity to grow in compitition with Rhodiola himalensis which is reflected in the high IVI value of grasses in Bela fenced. So the IVI reflects different reactions of individual species within the community and with the edaphic and biotic factors at particular site depending on the altitude of margs located in the alpine zone of PirPanjal mountain ranges.

In Bela grazed and fenced sites not much difference in herbage cover was recorded, may be

due to the grazing by light footed animals like sheep and goat. In all the cases herbage covered hardly 40% of the ground. The 60% blanks were obviously the result of grazing and trampling by the heavy cattle in Sewari and Badjari margs whereas due to sheep and goat grazing at Bela much trampling damage was not recorded in the grazed site except that it effected the IVI values of the individual species (Tables 9-14).

The general condition of meadows (margs) is highly degraded as more than 60% of ground is without any herbage cover. The herbage in fenced sites at Sewari and Badjari covered more area than grazed sites, showing signs of improvement of the site, more herbage production and filling of blanks with the colonising plant species. More herbage cover percentage in the month of August was due to high temperature and rainfall. In the early part of July and later period of September the temperature is extremely low and areas come under snow. The effect of permafrost and chilling conditions also reduced the plant growth. From studies it is concluded that at high altitude meadows (margs) only month of August is ideal for excellent plant growth and herbage production and suitable for animal grazing.

The vegetation in all the study sites open to free grazing is by and large open. Marshall and Dodd (1973) explained that consumers affect both aboveground and belowground parts in two important ways : 1. Effect on production potential by reducing the amount of radiation intercepting plant parts; 2. The alteration of source and sink relationship within the plants by altering the relative proportions of the plant parts. Cattle grazing on plants, thus reduces the leaf area and ultimately the herbage production.

In the present study, the biological spectrum of Rupri marg indicated Hemi-cryptophytic type of phytoclimate of PirPanjal meadows. Braun-Blankquet (1932) was also of the same opinion that grasslands are generally rich in hemicryptophytes. He also ascribed the presence of two third of chamaephytes and one third of hemicryptophytes due to cold temperatures at higher altitude. Almost same trend have been recorded at individual sites (Sewari, Badjari, Bela) at Rupri marg (Tables 23, 24). Meher-Homji (1964) described that chamaephytes are dominant in areas with arid and semi-arid climates. The dryness of climate leads to

the preponderance of chamaephytic type of vegetation. Cain (1950) recorded that overgrazing and trampling tends to increase the percentage of therophytes by introduction of weedy grasses and forbs of this type. Kaul and Sarin (1976) recorded that the altitude had a direct relationship on the number of hemicryptophytes and chamaephytes. Koul (1981) concluded in his study of Nilnag that the number of therophytes exceeded that of Raunkiaer's normal due to the grazing pressure which promoted growth of therophytes and the phytoclimate was thero-chamaephytic. Dhar et al. (1983) also observed that alpine and sub-alpine vegetation of Kashmir valley showed abundance of hemicryptophytes and chamaephytes and the climate was hemi-chamaephytic. Raina (1987) was also of the same opinion in case of lifeforms of Bhaderwah area in Jammu and Kashmir. In the present study also similar trend was recorded owing to the neglegible presence of therophytes and more presence of hemicryptophytes and chamaephytes (Tables 23 & 24 ; Plate 25). The comparative biological spectrum of different sites in India and the World are given in Table 55.

Table 55 : Comparative biological spectrum of the different sites in India and World. Life form values are in percentage . (Modified after Deschenes 1969, Singh & Yadava 1974, Gupta 1979, Koul 1981, Melkania, 1988 and Singh 1994).

Site	Life forms								
	TH	HH	G	H	CH	NP	PH	L	Author
Lolab valley (J&K)	7.9	0.4	13.8	17.6	17.2	-	28.2	4.3	Wali, 1966
Trikuta Hills (J&K)	31.6	1.72	4.6	13.8	22.23	14.76	9.38	1.53	Sharma,1973
Dachigam reserve (J&K)	25.1	5.6	22.7	23.1	8.8	-	14.5	-	Singh & Kachroo, 1976
Bhaderwah (J&K)	11.4	16.8	9.0	18.1	25.0	-	25.8	4.12	Kaul & Sarin, 1976
Jehlum valley (J&K)	36.0	-	7.0	6.0	28.0	-	18.0	-	Sapru et al,1977
Kashmir Alpine Subalpine	23.46	6.5	1.0	32.0	29.3	-	7.02	1.17	Dhar & Kachroo, 1978
Yusmarg (J&K) Grazed	22.73	4.55	11.36	25.00	27.27	2.27	6.82	-	Gupta, 1979
Nilnag (J&K) Grazed	26.61	2.15	7.91	26.61	30.90	-	5.75	-	Koul, 1981
Bhaderwah (J&K)	29.3	3.30	4.5	37.1	11.50	6.14	6.35	1.40	Raina, 1987
PirPanjal (J&K)	25.3	5.7	11.7	15.4	27.7	-	14.2	1.12	Singh & Kachroo,1994
Varanasi	68.7	-	7.8	20.30	3.1	-	-	-	Singh & Yadav, 1974
Kurukshtra	6.25	-	6.2	18.7	10.40	-	-	-	- do -
Alpine Central Himalayan (3450-5500 m)	25.2	-	5.6	57.4	4.7	-	7.3	-	Saxena et al 1982
Gordon Bugyal(3500-3600 m)	25.9	-	11.1	38.9	18.5	-	5.6	-	Melkania, 1988
Southeastern Michigan									
South facing slope	6.4	-	8.5	57.5	2.1	-	25.5	-	Cooper, 1961
North facing slope	0.0	-	13.5	49.5	1.1	-	35.9	-	(cf Deschenes,1969)
Northern New Jersey									
South facing slope	14.7	-	10.8	67.0	7.5	-	-	-	Deschenes, 1969
North facing slope	21.2	-	12.0	61.3	5.5	-	-	-	
Rupri Marg (3200 to 3600 m)									
Grazed	6.67	-	20.0	45.56	27.77	-	-	-	Present
Fenced	14.40	-	23.91	45.05	16.64	-	-	-	study
Raunkiaer's Normal	13.00	2.0	4.0	26.00	9.00	15.00	28.00	-	

Universally accepted idea that grasslands, prairies and pastures are hemicryptophytic habitats as observed by Deschenes (1969) hold true for the alpine meadows of PirPanjal at Rupri Marg.

The behaviour of lifeforms in relation to grazing and trampling pressure seems to be different in sub-tropical, temperate and alpine grasslands. Bharucha and Dave (1944) beleived that the high value of therophytes are an indicator of the amount of influence of man and animals while working in the grasslands of Bombay. Bliss (1956) recorded predominance of cryptophytes and chamaephytes in arctic and alpine tundra microenvironments. Pandeya (1964) indicated that due to overgrazing in the grasslands of Sagar there is more percentage of geophytes and therophytes than hemicryptophytes. Le Houerou (1972) classified grasslands of North Africa on the basis of life forms. In sub-tropical regions Agarwal (1974) recorded higher percentage of therophytes and cryptophytes. In temperate regions of Kashmir, Jehlum valley forests, Sapru et al (1975) found that therophytes and chamaephytes were abundant. Kachroo et al (1970) & Sapru et al (1979) correlated the oastic, arid

and alpine type of vegetation with life forms of Ladakh. Gupta (1979) recorded thero-chamaephytic and thero-hemicryptophytic phytoclimate for temperate regions of Yusmarg meadows. Sharma et al (1993) reported thero-nanophanerophytic phytoclimate for the vegetation of Shahjahanpur district (UP). They also believed that dominance of therophytes appear due to grazing.Meher-Homji (1964a) described that chamaephytes were dominant in areas with arid and semi arid climates, and the life forms and biological spectra acts as epharmonic criterion for aridity and humidity. Thus dryness of climate leads to the preponderance of chamaephytic type of vegetation.

Billore (1978) argues that most of the workers simulate conditions to assess the grazing influences on grazing lands by "Clipping Techniques" but, these do not give realistic picture of the effect of treading, selective grazing and excretion by grazing animals on the grazing lands. Results of the studies conducted in most of the tropical grasslands in India both for its structural and functional dynamics are generally indicative. He further observed that no study in clear terms recommends the utilization capacity of these lands and number of cattle permissible for sustained

production of pasture lands, without any determination. Nevertheless, recent works carried out at Central Arid Zone Research Institute (CAZRI) and Indian Grassland and Fodder Research Institute (IGFRI) in India, clearly spell out this aspect of range management. In the present study also an attempt has been made to come out in clear terms the prescribed limits of stocking in alpine meadows of PirPanjal mountain range based on utilization or carrying capacity of pasture lands.

Coupland (1979) have summarized the biomass and productivity data of the world grasslands. He concluded that maximum green (live) shoot biomass ranged from 76 to 2088 gm/m^{-2}. The lowest values are typical of semi-arid temperate to tropical climates. Maximum production is associated with sub-humid tropical climate, maritime climate or temperate habitat receiving natural irrigation. Mean green shoot biomass ranged from 50 gm/m^{-2} in arid grasslands to a high of 827 gm/m^{-2} in dry sub humid climate. Dead shoot biomass ranged from 10 to 506 gm/m^{-2} with no trend evident in relation to habitat. Mean biomass of litter varied from 70 to 900 gm/m^{-2}. Underground biomass had a mean value of 700 gm/m^{-2} and

it ranged from 45 to 4707 gm/m^{-2}. The highest value of underground biomass was recorded in temperate than in tropical situations. Root/Shoot ratio ranged from 0.2 to 10.3. Ratio is smaller in tropical as compared to temperate grasslands.

In the present study at Rupri margs the mean aboveground live biomass ranged from 56.13 gm/m^{-2} to 146.10 gm/m^{-2} and in fenced sites it varied from 52.00 gm/m^{-2} to 170.83 gm/m^{-2}. The difference in production of peak biomass at different sites may be due to grazing effect, because in undisturbed areas the production goes on increasing gradually, but, in grazed area whatever is produced is consumed daily by the nomadic herds/flocks. At indivdual sites (Sewari, Badjari, Bela) values were fluctuating because of grazing behaviour of animals and the daily routes they follow for grazing. From above it is evident that the mean shoot biomass of 101.15 gm/m^{-2} falls well within the world average range of shoot production.

The mean standing dead biomass of Rupri margs ranged from 51.20 gm/m^{-2} to 137.23 gm/m^{-2} in grazed sites and 78.33 gm/m^{-2} to 122.24 gm/m^{-2} in fenced sites. This value is also within the world

average range of dead shoot biomass. Individual sites recorded no set pattern or trend, an observation also noticed in the analysis of data of world sites.

The mean litter biomass of Rupri margs in grazed sites ranged from 102.13 gm/m^{-2} to 259.7 gm/m^{-2} and in fenced sites it ranged from 48.33 gm/m^{-2} to 366.66 gm/m^{-2}. In both cases peak values were recorded on first recording just after snow melt from the meadows and showed a declining trend till snow fall. These values are also within the world averages. Grazing effects the litter production, since cattle (herbivores) remove the portion of green herbage as well as dead parts both of which contribute to litter. During the accumulation of aboveground live, biomass transition of live part tissue to standing dead also takes place, ultimately leading to litter formation. Transition from living to standing dead tissue can be attributed to the insect action or breakage through mechanical means caused by either biotic interference or environmental factors like wind and rain. Accumulation of standing dead biomass in the winter may be attributed to the maturity which decreases the metabolic activities of the plant tissue before the onset of winter. Larger root/shoot ratio

indicate an adoption for reducing transpiration surface while increasing the water absorbing surface.

The mean belowground biomass of Rupri margs indicated more production in fenced sites than in grazed sites. In grazed sites values ranged from 1215.24 gm/m^{-2} to 1842.5 gm/m^{-2} and in fenced sites it varied from 1443.3 gm/m^{-2} to 2175.6 gm/m^{-2}. In both cases one peak value was recorded. The difference of biomass production in grazed and fenced sites is indicative of more stress on belowground parts due to grazing. However, as observed in world averages higher values of belowground biomass at study site are in agreement with Coupland's (1979) observation that higher values are recorded in temperate grasslands than in tropics, probably, due in part to a slower rate of turnover associated with lower temperatures. Billore (1978) concluded that in heavy grazed lands the energy accumulated was higher in belowground parts. Lower values in growing season and higher values in the beginning of season i.e., July may be due to the accumulation of food material in winter and translocation of the same in growing season to aboveground parts. Numata (1979a) remarked that the absolute values of biomass depend on the latitude and altitude, soil fertility, weather and amount of soil

moisture. Table 56 indicates comparative mean aboveground live, standing dead, litter and maximum underground biomass for herbaceous ecosystems of the world.

Table 56 : Mean aboveground live, litter standing and maximum underground biomass for herbaceous ecosystems in gm^{-2}. (Modified after Jain & Mishra, 1972; Pandey, 1978; Gupta, 1979 & Koul, 198

Author	location	Vegetative Type	Biomass gm^{-2} Green top	Litter	Dead	Roots
Kelley et al. (1969)	Tennessee	Andropogon dominated.	219.1	181	650	804
	Tennessee	Festuca dominated	182.3	114	327	765
Haris (1966)	South Carolina	Andropogon dominated	-	258	382	-
	South Carolina	Festuca dominated	-	49	109	-
Golley (1965)	South Carolina	Andropogon dominated	46.3 to 135.6	135-250	335	-
Golley and Gentry (1966)	South Carolina	Field abundoned 1 Year	-	309	11	-
	South Carolina	12 yrs	-	480	189	-
Odum (1960)	South Carolina	Forb dominated	-	300	189	-
Ovington et al (1963)	Minnesota	Prairie	-	279	-	669.5
	Minnesota	Savanah	-	1365	-	1490.1
	Minnesota	Maize field	-	-	-	121.0

Wieget and Evans(1964)	Michigon	Predominated Sevale		-	434	-	1018
	Michigon	Predominated upland		-	202	-	685
Dahlman and Kucera (1965)	Missouri	Prairie		-	-	-	1901
Porter (1967)	Florida	Muhlenberga dominated		119.4	-	-	-
Varshney (1972)	New Delhi	Heteropogon dominated		333.8	-	-	-
Jain (1971)	Sagar	-----		187.3 to 195.8	295	331	-
Chowdhary (1972)	Varanasi	Dichanthium dominated		149.1	93	129	1008
Singh (1973)	Ujjain	Sehima Chrysopogon		84.8	-	-	-
Misra (1973)	Ujjain	Dichanthium dominated.		159.2	225	164	925
Billore (1973)	Ratlam	Sehima dominated		104.1	168	190	873
Singh (1967)	Varanasi	-----		-	-	-	583.8
Jain & Mishra (1972)	Sagar	-----		-	-	-	1537.36
Numata (1978)	Lanzhot Czechoslovakia	Festuca sulcata		152	-	121.5	1556.00
	Hungry Csevharaszt	Festuca vaginata		155.5	-	181.0	863.0
	U.S.S.R Karachi	Phleum phleoides		130.5	-	313.5	2350.0
Koul (1981)	Nilnag (J&K)	Ground vegetation		488.17	58.38	164.03	565.05
Gupta (1979)	Yusmarg (J&K)	Meadow land	Fenced	482.00	353.78	604.00	2418.18
			Grazed	60.52	87.94	142.23	644.89
Present work	Rupri Marg	Alpine	Fenced	123.17	163.61	98.43	2175.6
			Grazed	95.05	159.04	96.15	1842.2

The productivity of various biotic ecosystems have been reviewed by Golley (1972); Golley and Lieth (1972); Golley and Misra (1972); Murphy (1975); Cooper (1975); Lieth and Whitaker (1975); Golley and Medina (1975), Billore (1978), Gupta (1979), Kaul (1981) and others.

Aboveground net production (ANP) values of grazed and fenced sites of the present study sites at Rupri margs are compared with some of the ANP values of India and the World (Table 57).

Table 57: Above ground Net production (ANP) values of Different grazing lands $gm\ yr^{-2}\ ^{-1}$. (Modified after Gupta et al., 1971; Gupta, 1979; Pandey, 1978)

Place	Year	ANP($gm/m/yr^{-2}\ ^{-1}$)	Author
North eastern Idaho	1958	92	Blaisdeff
Semi-arid Idaho	1949	165	Stewart & Hall
Eastern Idaho	1965	97.5 - 122.8	Pearson
Southwestern Africa	1955	120	Walter
South Dakota	1942	139 - 199	Larson & Whiteman
Louisiana	1962	295 - 329	Duvall
South Carolina U.S.A	1960	300-500 *	Odum.
Cedar Creak prairie U.S.A	1963	93	Ovington et al.
Kirigamine Japan	1964	270-380 *	Iwaski et al.
South Caroline U.S.A	1965	382-508	Golley.
South Florida U.S.A	1967	200	Poster

North America	1971	107-337 *	Sims & Singh.
Eruja Ghana	1960	1450 *	Nye & Greenland
Costa Rica	1972	2320	Daubenmire.
Varanasi India	1972	1358 *	Ambasht et al.
Varanasi Hills India	1975	4046 *	Singh & Ambasht
Chakla Forest India	1977	2255	Pandey
Varanasi India	1968	433-515	Singh
Varanasi India	1978	310-504	Chowdhry
Delhi India	1972	798	Varshney
Jodhpur India	1971	22-164.4	Gupta et al.
Ujjain India	1973	564	Misra
Ratlam India	1973	429	Billore
Kurukshetra India	1974	2407	Singh & Yadava
Ujjain India	1978	454-1408	Billore
Yusmarg kashmir	1979	476-3723	Gupta
Nilnag Kashmir	1981	635.5	Koul
World Average Tropics	1978	82 - 3396	Coupland
Temperate	1978	98 - 2430	Coupland
Rupri	1992	155.70 - 370.58	Present Study

* - includes belowground production also.

Net primary production of the study sites indicate more productivity in fenced sites than in grazed sites. Billore (1978) noticed that the tropical ecosystems are more productive than temperate systems on an annual basis. The annual net

primary production of tropical grazing lands, averaging 1080 gm/m^{-2} /yr^{-1} exceeds to that of temperate grazing lands averaging 500 gm/m^{-2} /yr^{-1}. Total annual net community production of shoots was quite low (635 gm yr^{-2} $^{-1}$) due to effect of biotic interference like grazing and trampling. Gupta (1979) also observed high N.C.P shoot in fenced areas than in open areas.Table 58 gives comparative productivity results of different grasslands of India and the World.

Table 58 : Net Primary Production (t/ha^{-1} /yr^{-1}) of Indian terrestrial vegetation. (Modified after Billore, 1978 and Gupta, 1979)

Vegatation	Type	Site	Production	Author
Grasslands	Hetropogon	Delhi	13.4	Varshney (1972)
	Hetropogon	Varanasi	42.3	Ambasht (1972)
	Dichanthium	Varanasi	22.1	Ambasht
	Dichanthium	Varanasi	10.5	Chowdhary (1972)
	Mixed	Kurukshetra	23.3	Singh (1974)
	Mixed	Udaipur	3.7	Vyas (1972)
	Mixed	Jodhpur	3.2	Gupta (1972)
	Dichanthium	Ujjain	9.8	Misra (1973)
	Dichanthium	Ujjain	20.3	Billore (1978)
	Sehima	Ratlam	8.4	Billore (1973)
	Sehima	Ujjain	13.3	Billore (1978)
	Iseilema	Ujjain	12.8	Billore (1978)
	Iseilema	Ujjain	11.6	Billore (1978)
	Fenced meadows	Yusmarg	61.12	Gupta (1979)
	Grazed meadow	Yusmarg	11.12	Gupta (1979)
	Grazed under story of forest	Nilnag	10.36	Koul (1981)
	Tropics	World average	2.39 to 45.57	Coupland (1978)
	Temperate	World average	7.02 to 34.70	Coupland (1978)
	Fenced	Rupri	24.52	Present study
	Grazed	Rupri	11.42	Present study

Lal and Melkania (1994) synthesised the biomass and net production of the eco-climatic zones of India and same is reproduced in table 59.

Table 59 : Plant biomass (gm/m^{-2}) and net production ($g/m^{-2}/yr^{-1}$) in Indian grasslands (After Lal and Melkania, 1994)

Parameters	Eco-climatic zones				
	Semi-arid to Arid	Dry sub-humid to humid	Himalaya Low alt	Himalaya Middle alt	Himalaya High alt
Plant biomass					
Live shoot (max)	76-1408	84-3296	228-706	128-724	217-623
(min)	7-498	1-1037	10-292	18-25	33-168
Dead shoot (max)	27-1086	42-1440	36-1239	55-65	103-309
(min)	1-140	2-239	9-352	9-16	22-286
Litter (max)	31-517	30-433	47-232	41-80	43-376
(min)	6-49	1-140	3-108	2-4	15-188
Belowground (max)	86-1145	174-2368	499-1614	577-698	1105-2026
(min)	16-801	28-875	114-1001	158-178	777-1568
Net Production					
Aboveground	38-1950	121-3396	279-1568	219-285	233-3724
Belowground	61-7788	146-1972	358-930	725-897	328-2388

Coupland (1979) observed that in a balanced system, the rate of turnover is determined by the relationship between standing crop and rate of production. The world averages indicate the turnover time of aboveground productivity ranged from 0.26 year to 1.64 years. Turnover time for underground

ranged from 0.36 to 4.18 years with values higher in temperate and less in tropics. He also recorded that no environmental trends are easily discernible probably because of variability in degree of use by the livestock and in the methods of estimating shoot production.

Mean turnover rates of Rupri marg study sites (Sewari, Badjari, Bela) indicated turnover rates of aboveground live productivity as 78% in grazed and 127% in fenced sites with turnover time of 1.28 years and 0.78 years, respectively. Turnover rate of aboveground dead was 72% in grazed and 131% in fenced with turnover times of 1.38 years and 0.76 years, respectively. Turnover rates of belowground parts was 53% in grazed and 79% in fenced sites with turnover times of 1.88 years and 1.26 years, respectively. The turnover rate of litter in grazed site was 56% and in fenced site was 57%.

The turnover time (t) is the reciprocal of turnover rate (Rochow, 1975). The turnover rates at Nilnag forest Kashmir for the aboveground live, aboveground dead, belowground and litter were recorded as 82.31%, 73.45%, 70.09% and

115.4%, respectively (Koul, 1981). Singh and Krishnamurthy (1981) recorded turnover rates of canopy biomass from 44% to 155% and that of root biomass from 44% to 206%. They also observed that comparison with temperate grasslands of U.S.A indicated that in tropical grasslands production per unit of plant biomass is more. Concentration of biomass was recorded more in belowground in temperate than in tropics. They also recorded that all tropical grasslands have bimodial peaks in belowground biomass accumulation.

System transfer function is an expression of the amounts of inputs and outputs among the component blocks of any aspect of ecosystem. Golley (1965) regards it as the quantity by which the system block multiplies the input to generate the output. It reflects the orientation of functioning of an ecosystem in space and time (Sims and Singh. 1971). The system transfer function for some of the Indian grasslands have been summarized in Table 60.

Table 60 : System transfer function for Indian grasslands (Modified after Lal and Melkania, 1994).

Eco-climate Zone	Transfer function from TNP to Aboveground Net Production (ANP)	Belowground Net Production (BNP)
Semi arid to arid	0.03-0.88	0.22-0.97
Dry sub humid to humid	0.39-0.74	0.26-0.61
Low elevation Himalaya	0.32-0.70	0.30-0.68
Mid elevation Himalaya	0.24	0.76
High elevation Himalaya	0.38-0.61	0.39-0.62
Rupri marg	0.14-0.15	0.85-0.853

Rates of production of dry matter and its transfer through various compartments and its ultimate disappearance from the system has been shown in table 61.

Table 61 : Annual net flow rate into, and losses from compartments in terms of organic matter (in gm/m^{-2}) for three grasslands in India (Modified after Singh and Joshi, 1979).

Parameter	Pilani (semi-arid zone)	Kurukshtra (dry sub-humid zone)	Sagar (moist sub-humid zone)	Rupri Grazed	Rupri Fenced
Net Primary Production	239	3538	1851	1142.08	2452.4
Live shoots	84	2407	914	125.83	260.5
Dead shoots	24	2044	914	137.56	165.0
Litter	94	1728	990	212.78	298.3
Belowground	155	1131	937	986.38	2081.8
Disappearance from					
Aboveground litter	116	1666	594	332.52	564.5
Belowground	155	1185	841	626.99	1331.8
Total	271	2851	1435	959.51	1896.4

Above results of Rupri marg are not comparable to arid and humid zone grasslands of India, because of climatic, edaphic and altitudinal reasons. Singh and Joshi (1979) described greater output of litter and belowground parts than input because of excess carryover material in these compartments from the previous years. At Rupri average values indicate that there is a net surplus of material both in grazed and fenced sites which may

be because of the slower rate of disappearance than the rate of accumulation of dry matter except in one of the meadow (Badjari grazed) where total disappearance was slightly more than the total accumulation.

Recently, detailed anthropological studies on some of the nomadic communities of the state viz., Gujjars and Bakkerwals have been completed by Rao,et al (1988, 1990 & 1992); Casimir and Rao (1985, 1992) and Khatana (1992). In the past few studies were conducted by early European travellers and British officers. Notable among them are Moorecraft and Trebeck (1819-1825); Vigne (1880); Cunningham (1977); Lawerence (1967); Drew (1875); Wreford (1943), etc. Few studies of the grazing societies of the world have also been carried out by Harrington (1981) and William (1981).

Anthropologist and geographers have studied the primitive societies of the world under various categories but principal among them are 1. Nomadic, 2. Pastoral and 3. Transhumant.

Perpillou (1977) records that pastoral mode of life is defnitely a constituted type

that has arisen out of precise geographical conditions and was formed in very early times. Goldstein and Cynthia (1989) estimated that the pastoral nomadism infact developed relatively late in human history, about 8000 to 9000 years ago. Khatana (1992) however, describes pastoralism as a kind of management of a particular resource i.e., utilisation of pasture through domestication of animals. He also concluded that pastoralism is a process which is time and space bound and leads to the development of transhumance.

Encyclopaedia Britanica (Vol 10. No. 10. 1980) describes transhumance as a form of pastoralism or nomadism organized around the migration of livestock between mountain pastures in warm seasons and lower altitudes the rest of the year. It is infact vertical and horizontal nomadism involving seasonal migration from one ecological zone to the other and back. Extreme type of transhumance has been reported in practice by the Kohistanis of the Swat area of Pakistan and same is true of the Bakkerwals of Jammu and Kashmir state. Khatana (1992) is of the opinion that transhumance is a viable eco-social system mostly practised in the marginal lands of the globe, which involves regular and cyclic

seasonal movement of animal husbandsman alongwith their livestock between areas situated at different elevations and having different climatic and physical conditions.

The ecologists and agrostologists however, look these primitive societies from grassland management point of view. They identify four main ways by which the man exploits the rangelands with its stock. The evolution of these grazing systems indicate that the primitive societies started from true nomadism and finished with managed rangeland systems (Harrington ,1981 and Williams, 1981). The four grazing systems thus identified are :

1. True nomadism :- The stock moves wherever there is forage or herbage.
2. Transhumance :- It is a European term originally describing seasonal stock movement up and down the mountains. But now it is widely used for any cyclic movements of stock at the dictates of the season.
3. Semi-sedentary :- It is common in sub-Saharan

desert of Africa where whole villages move alongwith their herds from one pasture to another depending upon the availability of pasturage.

4. Sedentary :- It is a rangeland usuage common in developed economies of North America, Argentina, South Africa and Australia where pastures are fenced into paddocks.

Nomadism or transhumance are ecologically sound and compatible grazing systems but only if the number of stock are optimal. Based on grazing systems being adopted by different communities, the grazing communities of the state are thus categorised into three types viz., Nomadic, Pastoral and Transhumance, which includes both sedentary and semi-sedentary types also.

While studying nomadism various communities engaged in nomadic & semi-nomadic and sedentary and semi-sedentary pastoralist activities were studied. Their social groupings, herding pattern, cyclic movements, migratory routes, time of

stay at alpine meadows and areas of high altitude pasturing were studied from both primary and secondary sources. Detail study on the origin of principle nomadic herding community "Bakkerwals" have been particularly analyzed. During the course of present study it has been found that there are five grazing nomadic migratory communities in the state. These are :

1. Gujjars
2. Bakkerwals
3. Gaddis
4. Chaupans
5. Champas or Changpas

These communities have been engaged in three type of grazing systems discussed above since ancient times. Last three categories of migrating communities (Gaddis, Chaupans and Champas) are the original users of pastures in the state. Chaupans (the village graziers of Kashmir valley) used to bring cattle and flocks of valley on the PirPanjal meadows. Gaddis used to graze their flocks in Shiwaliks and mountain ranges of Kishtwar, Marwa, Wadwan and southern slopes of Pirpanjal, whereas, Changpas are the high altitude shepherds rearing

pashmina goat and Huniya sheep in Changthang plateau of state. Gujjars and Bakkerwals are the later entrants into the territories of state. Bakkerwals are the last to migrate into the state about one hundred fifty to two hundred years ago with the latest influx in 1947.

The All India Enquiry Nomadic tribes report (1960) has classified all the Indian nomadic groups into three categories viz., pastoral nomads, wandering tribes and semi-nomadic tribes. Drew (1875-) identified only four races in the region of middle mountain ranges of Jammu viz., 1. Pahari 2. Gaddis 3. Dogras and 4. Chibbalis. Lawerence (1967) however, mentions Gujjars, Chaupans and Bakkerwals as grazing communities of the Kashmir valley. Kango and Dhar (1981) identified four nomadic tribes in state viz., Gujjars, Bakkerwals, Gaddis and Chaupans. Their study however, did not concentrate on the grazing societies of Ladakh. Casimir & Rao (1985) identified five mobile pastoral communities in the state viz., Gujar, Banihara, Bakrwal, Pohol and Gaddi. In another study Rao and Casimir (1987) classified pastoral communities of J&K state into eight categories viz., Bakkerwals, Banihara, Valley Gujjar, Gujjar Bakkerwal, Pathan, Syed, Pohol/Choupan, Pohol/Gaddi.

Khatana (1992) however, adopted different yardsticks and norms to group the nomadic societies of the state. He infact believed that Gujjar and Bakkerwals represent one group and clubbed them as Gujjar Bakkerwals. On the basis of sedenterization or migration, he again classified them as 1. Gujjar Bakkerwal nomadic population 2. Gujjar Bakkerwal sedentary population.On the basis of their occupation and sedenterization, he named them as 1. Cultivators and 2. Transhumance Gujjars which he further classified as a) Banihara or Dodhi Gujjars and b) Bakkerwal Gujjars. On the basis of their origin, he classified them as 1. Kunhari Gujjar Bakkerwals and 2. Illihiwal Gujjar Bakkerwals.

Infact Gujjars and Bakkerwals in the state are the result of two distinct historical migrations. Gujjars in this state have entered much earlier from the areas of Gujarat and Kathiawad (Wreford, 1943) whereas Bakkerwals have entered much later in this state as recently as about 200 years ago from the Hazara district of North West Frontier Province (Mc Donell, 1894-1896 ; Blunt, 1904-1907 ; Lovegrove, 1908-1909 ; Milward, 1910; Wright, 1914; Coventry, 1917-1920 ; Lambert, 1927-1929 ; Hoon, 1930-1931 ; Clutterbuck, 1933-1943 ; Pathania, 1947-1952).

So to club both as one group will be a misnomer and may not be justifiable on several historical and anthropological counts. Even their type of herding of animals is all together different. Bakkerwal, the name refers to the herder of goats (locally the goat is known as Bakri). The gujjar, name derived from the herder of cattle particularly the cow. But these days Gujjars mainly keep herds of buffaloes besides other cattle. Rao (1988) also is of the opinion that Bakkerwals are not to be confused as the Gojar-Bakkerwals, although the community have developed due to the conglomeration of different ethenic and territorial communities in the past. Even the census of tribes of Jammu and Kashmir state recognises them as two distinct groups. Gujjar population is estimated as **547149** and Bakkerwal population as **34899** (Table 36).

At present, Chaupans and Gaddis are considerably reduced in number and their pasturing areas had been occupied earlier by Gujjars and now Bakkerwals. No encroachments have been made into the domain of Changra shepherds so far, except in Rangdum region of Suru watershed and upper reaches of Drass watershed.

During the study it has been observed that migratory or Dodhi or Bunyara Gujjars oscillate between plains of Jammu and hills of Udhampur, Kathua and Bhaderwah districts. But sedentary Gujjars of Rajouri, Poonch, Doda and Kashmir valley oscillate between their habitations and temperate or sub-alpine meadows, located at one or two days journey distance. Majority of the Gujjars are sedentary except Buniyaras who still engage themselves in seasonal migration for pasturage of their herds.

Gaddis who once grazed most of the areas have now been restricted to eastern part of the state in Kathua, parts of Udhampur and Doda districts. They have almost become sedentary, livestock population has reduced and their younger generations have switched over to other occupations. Population of Gaddis have been estimated as 18039 (Table 36). Till 1956 they used to migrate upto Nandi Marg in Kashmir (Raina, 1956).

Chaupans and village Pohols have also been considerably reduced and are only found in some parts of the valley.

Changpas are still true nomads who

are always moving in search of pastures in Rupshu valley, Pugga valley and areas around Tsokar and Tso-moriri lakes of Changthang plateau of Ladakh. Although their number have reduced due to annexation of the majority of pasturing areas of eastern portion of Ladhak with China. Drew (1875) estimated population of Changpas or Khimaposh (Wearers of tents) to about 500 souls spread in 4000 sq miles of Rupshu. Webber (1902) described these shepherds of Tibetan plateau as Hunias or "Khampa Log" (the people of tents) and also observed of Bhotia transhumance between Indian sub-tropics and the Tibetan plateau across great Himalayan range. Goldstein and Cynthia Beall (1989) believe that they are the inhabitants of Changthang region of Ladakh and areas of central and northern plateaus of Tibet. There total population has been estimated by them as about 4 to 5 lacs. But in Jammu and Kashmir they are not more than 3510, at present (Table 36).

Bakkerwals "The goat herders" are now the principal community who have occupied almost every inch of Shiwalik bush forests and high altitude alpine meadows. Bakkerwals, infact constitute a group of migrated people from Hazarazat, Kohistan, Swat, Kunhar and Kagan valleys. Their first groups

or Deras made entery about 200 years ago. At present, they have developed a close relationship between herding and pasturing. To meet the requirements of herbage these Bakkerwals move in Deras with their flocks in summer to trans-Himalayan areas and in winter to Shiwaliks hills. During the study it has been observed that their seasonal movements are closely related with temperature, rainfall and availability / scarcity of pastures. During the course of time some of the Bakkerwals have settled along the migratory routes very near to alpine meadows of PirPanjal, whereas others still transhumance between subtropical Shiwaliks and dry arid areas of Tilel, Drass and Rongo valley.

In the study it was observed that majority of Bakkerwals have their lands and houses in summer pasturing areas in southern districts of the state, very few have settled in Kashmir valley and none in transhimalayan region.

During seasonal migration all Bakkerwal Deras leave their houses on any of the auspicious day as decided in their Jirga or by the Lambardar or Muqadum. The date of departure from winter pastures is by and large round about first of

Baisakh (10 to 15 April). Generally groups of same clan get together and also move in groups to the pastures of their ancestors. But due to the reduction of pasture areas in 1947 around Mitsel and Deosai in transhimalaya and Mirpur, Kotli, Bhimber and Muzffrabad districts, many "Deras" got themselves adjusted with other herding groups or purchased new pastures in the state.

In the study it was also noticed that almost all Bakkerwal Deras located in Rajouri and Poonch districts upto the right banks of river Chenab oscillate between grazing grounds of Metsil, Gurez, Tilel and Drass in northern Kashmir and bush forests upto river Chenab in Akhnoor Tehsil, but all Bakkerwals located in Kathua and Jammu districts upto left bank of river Chenab migrate upto Rongo valley of Zanskar mountains via., Marwa-Wadwan. Few Deras from Paouni and Bharakh located across river Chenab also migrate to these areas (Table 48, 49). In summer as the temperature starts rising in April and May, flocks take 180° turn and start moving to high altitudes. They spend about one month enroute and by June/July reach summer grazing grounds. Whole of July and August they stay at high altitude pastures and start their journey back in

last week of August. Whole of September they spend in journey and by October reach in their winter grazing grounds. Rao and Casimir (1987) observed that Bakkerwal migration started from middle of April shortly after the festival of Baisakhi, July and August was spent in summer pasture and in late August left the summer pasture. In the present study also same observations have been recorded. Khatana (1992) observed that the daily mode of march of a migratory Dera depends on the work timings on each day, which has a direct bearing on the decisions as to wheather to move or to stay on at a place during migration. The time can be consumed for rising, cooking, packing, departure, arival, unloading and tenting. To understand migrartion behaviour he worked on graphs based on timing of daily schedule, including journey and Parao or halts. He also introduced the concept of Dhiyara to study the migration behaviour equivalent to several days journeys in particular topographic zones. But Dhiyara word of Bakkerwals has been derived from Dhiyari or Dhiyadi word of Dogri meaning a day consisting of one day journey and one night halt. On this basis he classified migration journey (PirPanjal Pass route) into nine Dhiyaras and Banihal Pass route into 12 Dhiyaras. A return journey was completed in seven Dhiyaras (PirPanjal route) and eight Dhiyaras

(Banihal Pass route).

The Jammu and Kashmir Gazetteer of 1890 (cf. Lal & Melkania 1994) listed 74 routes and Lal et al (1994) believes that most of these form the present day network of nomadic routes. Present day J&K state is half of the area than what it was prior to 1947. Some of these routes and passes adjoining Central Asia and N.W.F.P have now come under POK. Vigne (1880) and Cunningham (1977) identified twenty seven and twenty five mountain passes, respectively, which were used as corridors of oscillation by foot travellers and the graziers. Kango and Dhar (1981) have identified and listed seven nomadic routes. These are :

1. Riasi - Margan - Krishnai route
2. Paoni - Barakh - Zazimarg - Kolahoi route
3. Lamberi - Budhal - Sonmarg route
4. Chingus - Dubjan - Tilel route
5. Poonch - Khag - Gurez route
6. Poonch - Tangmarg - Lolab route
7. Mansar - Doda - Marwah route

They however, missed some of the routes located on eastern side of the state. Casimir and Rao (1985) and Rao and Casimir (1987) studied migratory routes of two families from Jammu to Drass and Kathua to

North of Anantnag. They also conducted detailed anthropological studies on the Bakkerwals of the state. They described these Bakkerwal migration as "Constricted Oscillatory Nomadism". Khatana (1992) identified ten main passes in the PirPanjal mountain and studied two routes in detail viz., 1. Banihal pass route 2. PirPanjal pass route, the seasonal migrations (both spring and autumn) and periods of stay. He estimated only 167 Kafilas moving through these routes every year. He also somehow left the passes and routes located on the eastern side of J&K state and Ladakh.

Present study on the basis of oscillation corridors in PirPanjal mountain range, Greater Himalayas and middle mountain ranges have identified twenty four main corridors (Table 47). Between these corridors nomads undertake several routes depending on availability of pastures, locality through which they pass, their settled kins, etc. Infact during the study it was observed that nomads by and large follow the river valleys and mountain passes for their seasonal migrations. There are as many migratory routes as are mountain passes. During the study it was found that there used to exist well organised nomadic grazing system encouraged by

the rulers of the state, about 100 years ago when the routes were identified, Gojjar-ghas (tax collection points) were fixed, pasturing areas were identified and the whole grazing system was legally controled under the "Kahcharai Act" of Samvat 1994, which was later on modified in 1997 and 2011 (Khan, 1981). Unfortunately, this whole system with the development of sheep husbandry in the state after 1947 had become null and void, and the Government having no control on the herding communities, their flocks, migrating routes and pasturing areas. Infact Bakkerwal graziers have become the de-facto owners of alpine pastures in the state.

At the study site sedentary population of Ans catchment, Rajouri and Jamola were engaged in local migrations to their Bandobasti pasturelands of PirPanjal at Rupri marg. These sedentary to semi-sedentary grazing communities of the area cover an average distance of 10 to 100 Kms on one side during their seasonal migration to alpine pastures (Table 46).

At microlevel, effect of grazing and trampling was studied at Rupri. It was observed that

meadows where only sheep and goats graze are better in conditions than where heavy cattle like cows, Buffaloes and horses graze. It was observed that lowest altitude grazing ground Sewari carried 1899.5 H.S.U, Badjari carried 1714.5 H.S.U and highest located Bela marg carried 2680 H.S.U. On basis of area it was noticed that the grazing intensity of study sites at Sewari was 4.74 H.S.U/Ha, Badjari 2.86 H.S.U/Ha and Bela 3.35 H.S.U/Ha against permissible pasture utilization and carrying capacity of the areas of Sewari 2.63, Badjari 2.01 and Bela 2.86 H.S.U/ha, respectively (Tables 51 & 53,Plate).

The study revealed that sheep and goats are first to reach in these margs and move alongwith melting snowline, followed by cattle & horses. While leaving these pastures reverse is the case . Cattle moves first and sheep goats are the last to leave the margs. Most of the families reached to these margs between 24th of June to 28th of July 1992. Stayed for only one month and started moving down from 26th of August 1992 and completely vacated the margs upto 30th of August 1992 and few extended their stay upto 5th of September 1992. Arnold (1981) observed that the interactions between the behaviour

of the grazing animals and the environment in which it lives can have a profound effect on both the environment and the productivity of the animals. These interactions dominate the animal's daily activities. The wise husbandsman always knows these interactions and manages his animals and pastures accordingly.

The grazing behavior of livestock indicated that Sheep & Goats genarally leave their pens before sunrise between 6 to 7 A.M and return back to pens between 6 to 7 P.M before sunset. Buffaloes, cows & Horses graze all the 24 hrs. Sewari & Badjari margs had mixed grazing of cattle & sheep, goat, wheras Bela marg & high up only sheep & Goats graze. Perpillou (1977) records that in French Alps there is more careful organized type of grazing. Cows are given best pastures found in hollows and on level ground where the grass is richer and softer. The steeper parts where grass is less luscious are reserved for calves and heifers that are destined to slaughtered. Sheep which are often left unattended spend the summer on steep slopes near the mountains. Almost similar type of pattern is followed on the PirPanjal margs also with certain local modifications.

Here except horses none of the cattle or other livestock is left unattended. With all type of herds and flocks,the herder or one of his family members moves as a shepherd with the flocks. Here also the heavy cattle is kept at lower altitude margs in the valley bottom meadows and mountain slopes and higher reaches are kept for sheep and goat grazing. At lower altitude margs the mixed grazing is quite common. The daily routine of the animal is determined by the diurnal pattern of grazing, with rumination, periods of rest, and drinking being fitted into the intervals when the animals are not grazing. Major grazing periods begin near dawn and again in late afternoon, ending close to sunset in both northern and southern hemispheres. As the days get shorter the breaks between grazing also decrease in mid winter or may continue during day light throughout. There are very less evidences to prove that herbage preferences are primarily motivated by the nutritional wisdom of animals. Sharma (1984) while working on the grazing behaviour of the livestock in Rajasthan recorded proper grazing hours for cattle, sheep and goat as 5 A.M to 12 Noon from April to June, 3.0 P.M to 7.0 P.M from July to September and 8.0 A.M to 12.00 Noon and 3.0 P.M to 5 P.M from November to March. In order to have best

utilisation of rangeland products it was recommended that sheep and goats should follow cattle. Same observations were recorded in the present study also in their seasonal movements to and fro the margs. Thus it shows that the grazing communities in the study area already practice the system of aforementioned type of migration to and from the pastures. It seems that even the management of pastures has also been properly organised in the past related with the elevation and productivity of pasturelands. But due to increase in livestock population of the nomads and other grazing communities of the area there seems to be an increased tendency of encrochment of higher altitude margs with the heavy cattle and increasingly leading to mixed type of grazing with lesser number of sheep and goat flocks. Thus ultimately leading to the increased grazing pressure and overall deterioration of alpine pastures with increased soil erosion and degradation of herbage cover. The wise husbandman of yester years have become the most unwise graziers of today.

In the present study it was observed that all fenced sites had more production as compared to grazed sites, a clear reflection of grazing pressure on these meadows. Jain and Mishra (1972) opined that the aboveground production in grasslands is of great

significance to the ecologists and dairy scientists and underground production is of great importance to soil development, its conservation and organic matter.

On the basis of aboveground net production, it was noticed that against the available requirement of 31472.5 qtls of herbage (Dry matter) only 22918 qtls is available. Hence a net shortfall of 8554.5 qtls of Dry matter (Table 52). So to meet this shortfall following alternatives singularly or in combination can be adopted.

1. Reduce the number of livestock preferably cattle.
2. Increase the productivity of Margs by imposing limited enclosures.
3. Increase the productivity of sub-tropical and temperate pastures along the migratory routes with the help of various agronomic and silvi-pastoral technologies.

Option number (2) has limited scope, as productivity of alpine meadows as compared to subtropical and tropical grasslands cannot be increased beyond certain limits. But option number (1) can be implemented either by providing stall feeding to cattle and stop their migration and in their place

increase number of sheep and goat or in case of mixed grazing reduce the number of livestock to 27% straight way by motivating the herdsmen that their flocks at present level are only 73% fed and 27% starved. In case the numbers are reduced to 27% level, the herbage of surplus livestock can be made available to left over animals who will be 100% fed with better health and high wool, meat and milk production. In case option number (2) is also implemented at limited scale in highly degraded pastures of the state, there is a potential to increase the productivity by atleast 27% more. Dass et al (1963) recorded 70% utilization should be considered adequate to maintain the grassland in the same status. Encyclopaedia Brittanica (Vol 6. 1980) while explaining system models in ecosystem approach recommended that if more than 40% of annual net primary production is grazed the future productivity of the grassland may be jeopardized. A large part of each years production must be left in the system if moisture retention and nutrient cycling capacity are to be maintained. Gupta et al (1993) recommended average grazing capacity of 6 to 7 sheep/ha on the basis of 70% utilization, and for maintenance above 2.5 sheep/ha in case of poor grasslands on year long basis,

but in case of migratory systems more than 8 sheep/ha have been recommended in the Shiwaliks where fodder is available from the three tier vegetation. The recommendations are, however, not based on any research findings but only on the basis of ration recommended else where in other countries. The prescription may not be applicable to the local conditions both for primary producers and the secondary producers of the grassland ecosystem. It is as such proposed to carry out further indepth studies for the inter-relationships of primary and secondary producers for the sustainable development of pastures as well as the livestock and for the upliftment of the nomadic economy of the Jammu and Kashmir state.

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CHAPTER 6

SUMMARY

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In depth ecological studies have been carried out by various workers, to understand structural and functional parameters of tropical grasslands of India (Billore, 1978). Few attempts have however, been made to study the temperate grasslands in India (Gupta 1978, Lal & Melkania 1994). But very few attempts have been made to study the alpine and subalpine meadows of India, particularly, Jammu and Kashmir Himalayas, due to inaccessibility, limited working period of two to three months and poor communication. In the present study an attempt has been made to fillup this gap of vital ecological information. The present study has been carried out in Rupri alpine pasture (Marg) of west PirPanjal mountain range located in Rajouri district about 300 kms from Jammu.

Rupri alpine meadow is located at an average height of 3400 mts a.s.l. Three contiguous margs located at different altitudes were selected for the purpose. Sewari was located at an average height of 3200 mts, Badjari was slightly higher at an average height of 3400 mts and Bela marg was highest at an average height of 3600 mts. All margs were facing southern slopes of PirPanjal, experiencing effect of monsoon rains in summer.

In the present study, ecological

studies of grassland alongwith the socio-geographical studies of some of the nomadic grazing communities of the state were carried out, in order to find out their impact on the ecology of alpine grasslands.

The physico-chemical analysis of soils of study sites indicated higher percentage of organic matter from 14.4 to 20.69 %. This indicated slow process of decomposition due to low temperature. In fact in some cases where trampling effect is low, bog like conditions prevail in the margs. High ph value of 5.25 also indicate slow process of leeching hence acidic reaction is noticed. Due to weathering of rocks soils are rich in minerals like phosphorous, calcium ,potassium and Magnessium . But whether these nutrients are available to plants or not is worth studying. But may be this is one of the reason that natural alpine pasture compensate the requirement of mineral's ration in pasturing livestock, more than what is required. This has also been observed in several other studies that natural pastures are best source of nutrients and minerals in daily ration of livestock than concentrates & salts.

The phyto-sociological studies revealed that grazed pastures are more open than fenced sites which tend to improve by improving the herbage cover percentage. The herbage cover of fenced sites varied from 24.22% to 32.17% as compared to grazed sites with herbage cover varied from 22.26% to

23.84%, at different study sites. The number of species was more in grazed sites than in fenced sites (tables 9-14), establishing that the grazing stimulates species diversity and protection leads to uniformity. In grazed sites the number of species varied from 15 to 20 and in fenced sites from 8 to 12. The index of species diversity varied from 1.91 to 2.35 in grazed sites as compared to 1.34 to 1.86 in fenced sites in reverse order of meadows, altitudinally. Grazed sites recorded high diversity but low dominance and fenced sites recorded low diversity but high dominance, an observation made in similar studies elsewhere in India. Jaccard's Index of Similarity established that the alpine meadows are climatic climax type of vegetation with very little variation in species composition between grazed and fenced sites and both recorded homogenous species composition at different altitude sites.

An analysis of life forms indicated Hemicryptophytic type of phytoclimate . In grazed sites there were more hemicryptophytic elements followed by Chamaephytes but in fenced enclosures hemicryptophytes were followed by chamaephytes in Sewari and geophytes & therophytes in Badjari & Bela enclosures. It also supports the concept that alpine meadows are hemicryptophytic in nature and are climatic climax as compared to tropical and temperate grasslands which with the protection change into high forests and

are seral in succession.

The Importance Value Index (IVI) analysis revealed that present status of alpine meadows contain more graminoids and forb species with characteristic rosette and cushion type of habits, which is ideally suited to withstand the impact of grazing and trampling by the livestock. In fenced sites more tender species try to colonise which otherwise take refuge in scree slopes or protected niches of glacial moraines. In all the grazed sites IVI value of grasses ranged from 48.92 to 87.65 and value of Sibbaldia cuneata ranged from 42.27 to 81.56. In fenced sites IVI value of grasses ranged from 78.16 to 88.99 and that of Taraxacum officinale from 27.99 to 42.47. At Bela Rhodiola himalensis and Thalictrum alpinum were unique species with IVI value of 76.02 and 15.30 in fenced site and 56.61 and 16.52 in grazed site, respectively.

Since biomass productivity in the grasslands have direct bearing on the feeding of livestock and their health, an assessment of productivity potential was carried out in both grazed and enclosed areas. The values for biomass production (gm/m^{-2}) in respect to aboveground live, belowground, litter and standing dead for both grazed and fenced sites, on oven dry weight basis, were estimated from July to September 1992 corresponding to the actual growing period at the Rupri study sites. The results have been

recorded in tables 25 to 29. During the study it was recorded that there was more production of biomass in belowground parts as compared to aboveground live parts. There was more biomass production in fenced areas than the grazed sites, an indication of more stress due to grazing on the belowground parts.

Aboveground live production (dry wt.) in grazed sites varied from 100.90 $gm/m^{-2}/yr^{-1}$ to 145.00 $gm/m^{-2}/yr^{-1}$ whereas in fenced sites it varied from 163.00 $gm/m^{-2}/yr^{-1}$ to 353 $gm/m^{-2}/yr^{-1}$. Thus indicating that grazing sites are producing far less as compared to fenced sites, due to more number of animals on these pastures than what are required to be permitted for grazing. There was more concentration of belowground production as compared to aboveground production due to biotic and climatic factors. Average belowground production in fenced sites was 2081.85 $gm/m^{-2}/yr^{-1}$ and in grazed sites the production was 986.38 $gm/m^{-2}/yr^{-1}$. The mean root/shoot ratio in grazed sites was recorded as 15.66 as compared to 15.81 in fenced sites.

Total net production varied from 891.96 $gm/m^{-2}/yr^{-1}$ to 1578.98 $gm/m^{-2}/yr^{-1}$ on grazed sites and 2055 $gm/m^{-2}/yr^{-1}$ to 3026.25 $gm/m^{-2}/yr^{-1}$ on fenced sites. Turnover rates of biomass in aboveground live varied from 0.75 to 0.85 in grazed and 0.93 to 1.68 in fenced sites. Turnover rates of standing dead varied from 0.60 to 0.89 in graged sites and 0.69 to 1.89 in fenced

sites . Turnover rates of roots / belowground varied from 0.36 to 0.73 in fenced sites. Turnover rates of litter varied from 0.26 to 0.78 in grazed site and 0.25 to 0.80 in fenced sites.

System transfer function of dry matter dynamics indicated transfer from TNP to AGNP varied from 0.11 to 0.22 in grazed sites and 0.12 to 0.22 in fenced sites. TNP to BGNP varied from 0.78 0.89 in grazed sites and 0.78 to 0.88 in fenced sites. TNP to total disapperance varied from 0.68 to 1.03 in grazed sites and 0.68 to 0.87 in fenced sites.

While studying nomadism, various communities engaged in nomadic, semi-nomadic and semi-sedentary pastoralist activity were analyzed. Their social groupings, herding pattern, cyclic movements, migratory routes, time of stay at alpine meadows and areas of high altitude pasturing were studied from both primary and secondary sources. Detail study on the origin of principle nomadic herding community "Bakkerwal" have been analyzed. In the present study it has been recorded that there are five nomadic migratory grazing communities in the state viz., 1. Gujjars, 2. Bakkerwals, 3. Gaddis, 4. Chaupans and 5. Champas or Changpas. During the course of study it was also recorded that three main grazing systems exist at present in the state viz., 1. Nomadic, 2. Pastoral and 3. Transhumance. In the study an attempt has been made

to find out the pasturing patterns of nomadic herdsmen and their migration behaviours. Most of the sedentary families migrate to PirPanjal pastures in summer covering distances from 10 to 100 Kms. but transhumance migrations involve seasonal movements of herdsmen between Shiwaliks and transhimalayas covering a distance of more than 600 Kms. on one side.

All the herding families and their flocks were analyzed at the study sites. Communitywise pattern of various herding groups indicated that in Sewari 22 Deras of sedentary Bakkerwals,3 deras of Kashmiri and 11 Deras of Thakar herdsmen come for pasturage. In Badjari 16 Deras of sedentary Bakkerwals and 4 of Kashmiri come for herding. Bela contains only 21 Deras of sedentary Bakkerwals and one Kashmiri Dera. The pattern indicates that most of the alpine meadows of PirPanjal are under use either by the pastoralist communities located in villages at a distance of about 10 to 100 Km away from Bandobasti Dhoks (Hindu and Muslim Thakurs) or in course of time the Bakkerwals who have settled in these valleys had become semisedentary also, bring their flocks in summer months. It is evident that Bakkerwals who were once pure nomads and use to transhumant over long distances over the period have become settled and sedentarized, also practice short distance migration to alpine meadows of PirPanjal.

At present, the study reveals that

Bakkerwals occupy maximum grazing rights in PirPanjal mountain range which ranges from 61% to 95%. Other communities have either stopped the practice of pastoralism or don't come to these pastures due to unfriendly behaviour of these Bakkerwals towards other communities for their competition for grazing rights. Aparna Rao (1992) while analyzing their territorial behaviour has very well quoted. "He sat like a servant then he became master". This may be due to the result of "individuated territorial behaviour" of nomads. She also observed that they are more of " Nature's subjects" than "Nature's objects".

Since most of the Margs are located at one or two days distance away from the villages, families do not move out of their villages till snow starts melting in these margs. The study revealed that sheep and goats are first to reach in these margs and move with the melting of snowline in these margs. In time of the retreat, reverse is the case.

In another macrolevel study of transhumant Bakkerwals of Nowshera areas revealed that out of 1788 families (Deras) 206 families take their flocks to 25 meadows of pirpanjal, 192 families migrate to 17 meadows of Kashmir valley hills, 324 families cross Kashmir valley and take herds to 17 margs of Gurej, 221 families enter transhimalayan regions of Drass, 266 families stay at Sonmarg, 279

families take their flocks to Pahalgam Amarnath meadows and only 50 herding families enter into Marwa Wadwan meadows of Kishtwar . None of the family from Rajouri Nowshera districts enter Tethys Himalayas of Zanskar valley in Ladakh. 119 families are scattered with other herding groups and only 131 families were recorded as sedentary who do not migrate but has adopted settled and agricultural mode of life (Tables 44 & 45).

The herding pattern at study site revealed that 21 families had Buffaloes and other cattle, 19 families had only sheep & Goat and 38 families had mixed livestock. In Sewari and Badjari marg 17 families reared Buffaloes and 11 families sheep & Goat only and 25 families had both cattle & other livestock. In Bela 8 families possessed only sheep and goat, 4 families reared cattle and 14 families possessed mixed livestock. In Bela marg none of the herdsmen took cattle to highest pastures except horses & Mules, and the cattle was grazed at the lower elevation. It indicated that sedentary & semisendentary families generally have tendency to rear Buffaloes & prefer lower altitude Margs which are close to high altitude Oak forests (Quercus semicarpifolia) to supplement feed of leaf fodder to milking cattle. Since sheep & Goat are not fed on Oak leaves , they move very high as in present case of Bela Marg. The transhumant Bakkerwals only keep sheep & goat, preferably goat are

more in number for speed in covering long distances .In the present study it has also been found that alpine pastures which are grazed by sheep & goat are more healthy more productive and can carry more numbers of H.S.U than a mixed grazed pasture or which carry only cattle. On cattle grazed pastures there is more damage by trampling and grazing due to their continuous mode of nibbling herbage, non-stop, except milking & resting hours.

Schedule of migration, period of stay and migration routes of nomadic herdsmen were also studied. During the present study twenty four migratory routes have been identified between Shiwaliks and Cis and Trans Himalayan pastures. The schedule of migration indicated that the nomads start their seasonal migration from Ist of Baisakh every year and is completed by about 30th of Baisakh. May and June is spent in journey. July and August are spent in summer pastures. In last week of August nomads start their retreat and by about October reach to their winter pasturing areas in Shiwaliks. The study of migratory routes indicated that there are definite pattern of seasonal movements based on Kabila and Kafila of nomadic herdsmen.

Since livestock of different catagories graze on alpine pastures, they have different consumption pattern as per category. In order to assess the grazing pressure due to nomadism, a

uniform Himalayan stock Unit was computed for all types of animals. It was found that in Sewari marg 1879.5 HSU were grazing, in Badjari marg 1714.5 HSU were grazing and in Bela 2680 HSU were grazing. It is estimated that one HSU requires about 500 kg of herbage on dry matter basis annually for optimum feeding. While analyzing the total productivity of above ground biomass and availability to consumers (livestock) it was found that against 9497 qtls, 8572 qtls, and 13402 qtls requirements of dry matter in Sewari, Badjari & Bela margs respectively, the himalayan stock units (H.S.U) pasturing in these meadows at present, are getting only 5264, 6054 and 11600 qtls of dry matter. Thus there is a net shortfall of about 8554 qlts of herbage on dry matter basis. The study thus conclusively proves that in all the studied alpine pastures, livestock pasturing on these meadows are almost 73 % fed and 27 % starved. Present study also indicates the serious aftermath of livestock population growth in the state. Whatever grows in these alpine meadows, especially in PirPanjal range from the time of melting of snow upto first snowfall is nibbled and nothing is left on ground for recycling of productivity into the ecosystem for sustained production of pastures, both quantitatively & qualitatively. Pastures should not only produce more but whatever is produced should be nutritious also. In the study it was also concluded that against the present grazing intensity level of 4.74, 2.86 and 3.35

PLATE 48 : Permissible carrying capacity / utilization capacity of Rupri margs.

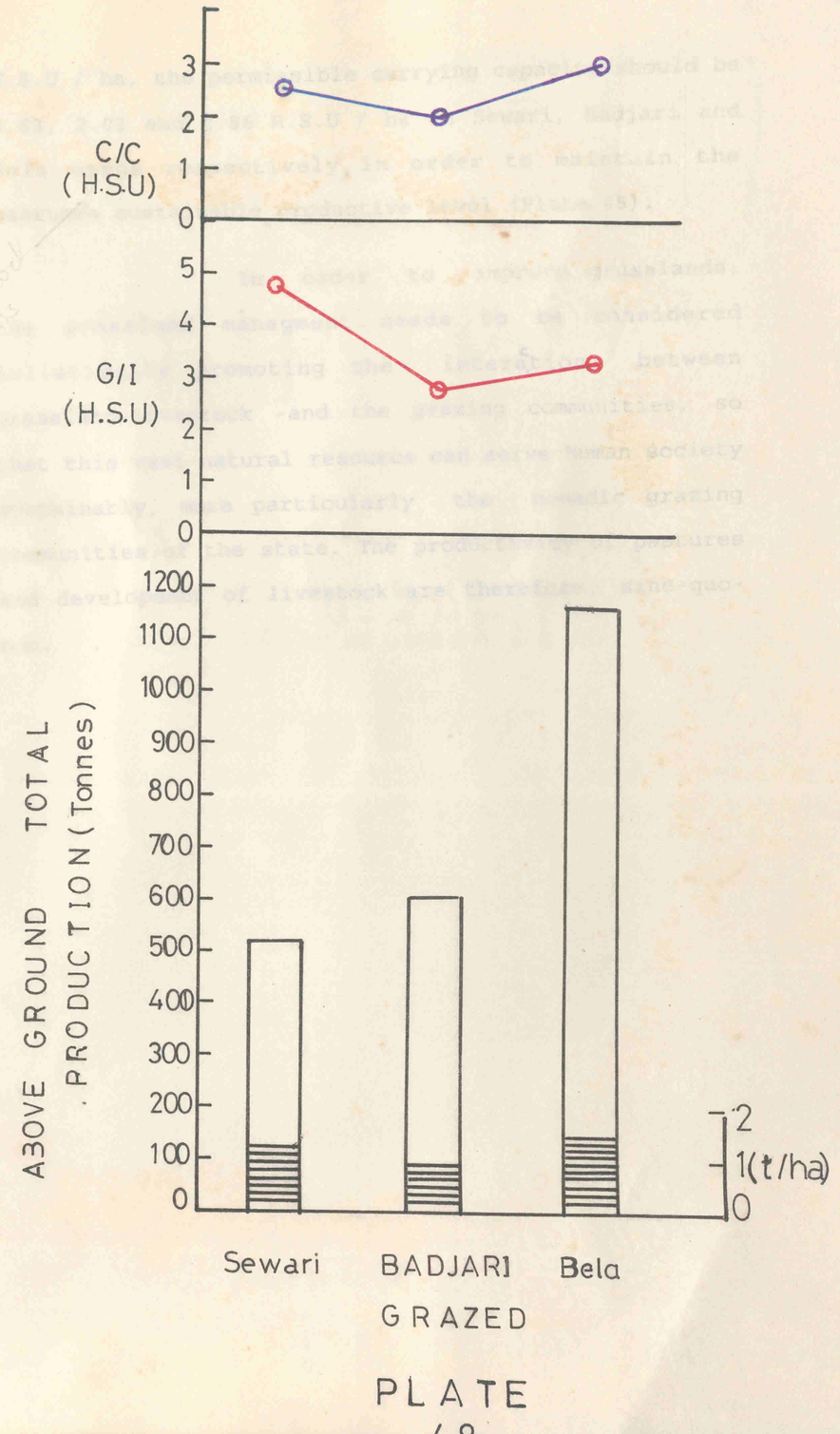

PLATE 48

H.S.U / ha, the permissible carrying capacity should be 2.63, 2.01 and 2.86 H.S.U / ha in Sewari, Badjari and Bela margs respectively, in order to maintain the pastures sustainable productive level (Plate 48).

In order to improve grasslands, the grassland managment needs to be considered holistically promoting the interaction between grassland-Livestock -and the grazing communities, so that this vast natural resource can serve human society sustainably, more particularly the nomadic grazing communities of the state. The productivity of pastures and development of livestock are therefore sine-quo-non.

CHAPTER 7

BIBLIOGRAPHY

BIBLIOGRAPHY

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ANNEXURE I

PROFORMA FOR SOCIOLOGICAL SURVEY OF NOMADS

Information required for Ph.D work

1. NAME OF HEAD OF FAMILY : ----------

2. KUMBHA / JAT / DERA NAME : ----------

3. BIRADERI : ----------

4. MARRIAGE SYSTEM : ----------

5. NAME OF PLACE / VILLAGE / DISTRICT : ----------

6. LIVESTOCK

	MALE	FEMALE	KIDS
SHEEP			
GOATS			
COWS			
OX			
HORSES			
BUFFALOES			
MULES			
OTHERS			

7. AGRICULTURAL LAND : ----------

8. SUMMER PASTURE USED : ----------

9. WINTER PASTURE USED : ----------

10. NAME OF PLACES ALONG THE MIGRATORY ROUTE : ----------

11. PERIOD OF STAY AT EACH PARAO : ----------

12. PERIOD OF START OF JOURNEY FROM WINTER GRAZING GROUNDS : ----------

13. PERIOD OF START OF JOURNEY FROM SUMMER PASTURES : ----------

14. TYPE OF HOUSES AT SUMMER AND WINTER PLACES : ----------

15. NO. OF SERVANTS (AJRIS) : ----------

16. SOURCES OF INCOME : ----------

17. PRODUCTION LEVELS : ----------

18. SOURCES OF FODDER : ----------

19. PLACE OF ORIGIN : ----------

20. ANY OTHER INFORMATION : ----------

DATE :

SIGNATURE