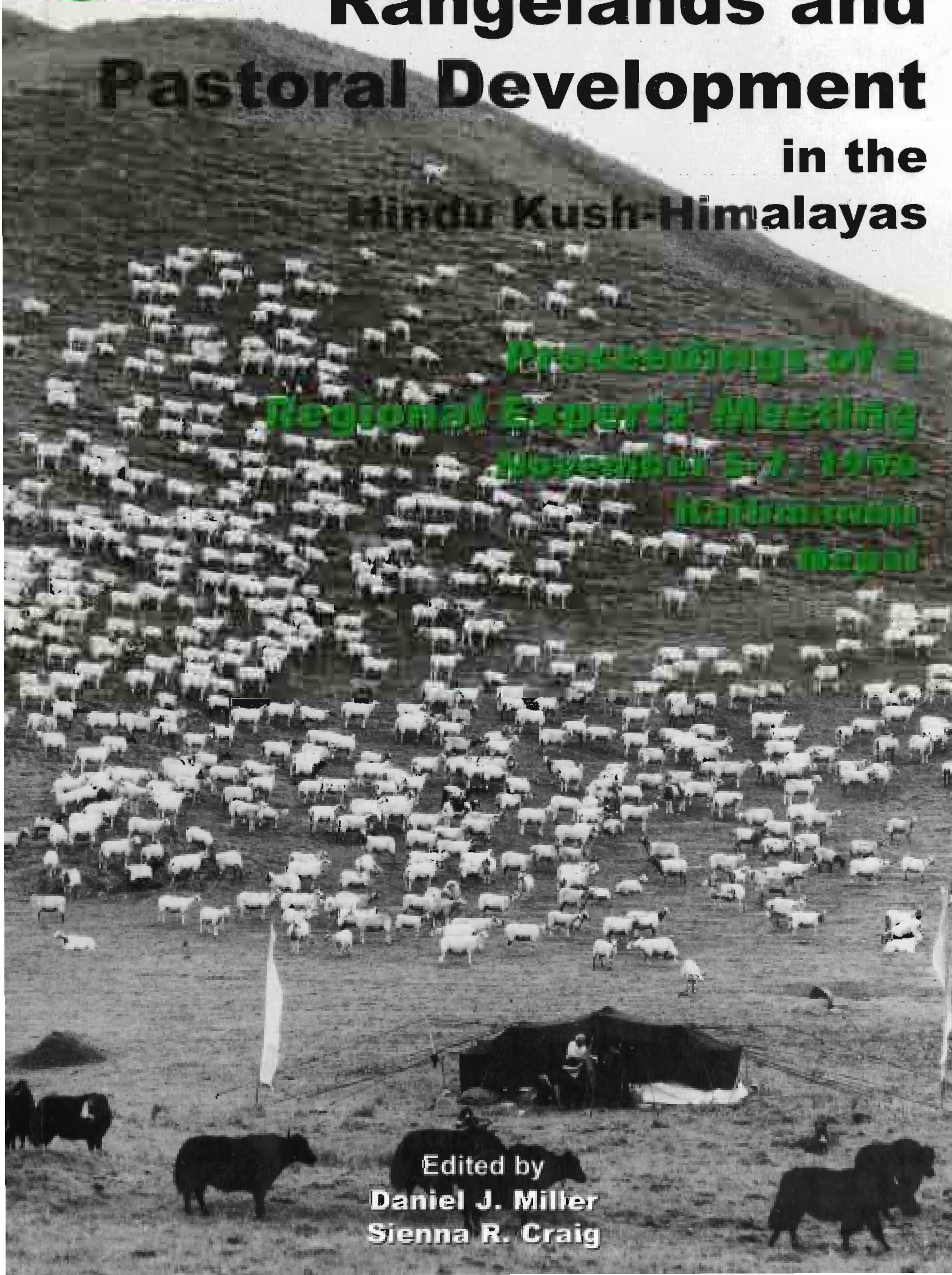
Rangelands and Pastoral Development in the Hindu Kush-Himalayas

Proceedings of a Regional Experts' Meeting
November 5-7, 1996
Kathmandu
Nepal



Edited by
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ISBN: 92 9115 158 0

Cover Plate:
Nomad Camp with Sheep and Yaks, Zoige, Sichuan, China

All plates in this publication are by Daniel J. Miller

Published by
International Centre for Integrated Mountain Development
GPO Box 3226
Kathmandu, Nepal

Typesetting at ICIMOD Publications' Unit

Layout by Sushil M. Joshi
Maps by Asha Kaji Thaku

Foreword

Rangelands cover two million square kilometres of the Hindu Kush-Himalayan Region; they include large parts of Pakistan and the vast expanses of the Tibetan Plateau, which reaches out into India, Nepal and Bhutan. As such it is the single largest land-use system within ICIMOD's realm. Yet it is also an area with the lowest population density in the HKH. This may very well have been the reason why rangelands and the largely nomadic people that inhabit them have not received similar attention from governments and development agencies as the more densely populated human settlements and agricultural systems of lower altitudes.

The fact is that rangelands present a vast, rich resource because of their diversity in terms of plant species, wildlife, and unique cultural groups. They are also important as the headwaters' environment of the major river systems of Asia; systems that are essential for hydropower development, irrigation, and as the basis for human survival. The situation in upland watersheds has a critical impact on the terrain below, but development interventions in this region have often neglected, if not marginalised, the pastoral peoples; the long-term custodians of this natural wealth.

Rangelands of the HKH are in transition and subject to change. On the one hand, modern market mechanisms have improved access and services to previously remote pastoral areas. This has provided pastoralists with opportunities, as well as constraints. While improved access increases marketing opportunities, it has also meant the expansion of agriculture on to rangelands, transformation of traditional pastoral systems-not always for the better, and disruption in traditional trans-Himalayan trade routes. Delineation of productive lands for agriculture and increased mobility are exerting higher growing pressures on the remaining lands, threatening the quality of forage and herds. Changes have also taken place due to natural causes. For example, alterations in climate have modified vegetation composition, reduced plant productivity and carrying capacity, and led to a general desiccation in Alpine-type rangeland.

The International Centre for Integrated Mountain Development, realising that, despite their extent and importance, rangelands in the Hindu Kush-Himalayas are still poorly understood, made sure that knowledge on the rangelands was an important and integral part of its first Regional Collaborative Programme (1995-1998).

As part of this process of increasing our knowledge of rangelands in the HKH, experts from five of its Regional Member Countries gathered in Kathmandu in November 1996 and brought together a wealth of experience and information that could be shared among themselves and with ICIMOD professional staff engaged in rangeland and natural resources' management.

Through publishing the proceedings of this regional consultation, ICIMOD hopes to stimulate reflection on and greater consideration of issues relevant to rangeland management, biodiversity conservation, forage improvement, and pastoral development in the Hindu Kush-Himalayan-Tibetan Plateau Region.

I am grateful to all the participants in the consultation for their contributions and commitment to bringing the issue of rangeland management higher on the agenda of work for ICIMOD and through that process hopefully also on the work agenda of institutions and organizations in its member countries. Mr. Daniel Miller, former rangeland management specialist at ICIMOD, and Mrs. Greta Rana, Senior Editor, deserve special thanks for making this publication not only technically more interesting but also pleasing to the eye.

Egbert Pelinck
Director General

Acknowledgements

The editors would like to thank Greta Rana and Anita Pandey of the Documentation, Information, and Training Service of ICIMOD for their continuing efforts to complete the language editing of this document and bring it out in published form despite the long absences of the technical editors in the field. We are also grateful to Sushil Joshi and Asha Kaji Thaku for their painstaking work on the formatting and layout of the document. Thanks are due to all those who shared their thoughts and papers on this subject with us, without them there would be nothing to publish. Finally, to the pastoralists of the high plateaus go our deepest gratitude for subjecting themselves, their lifestyles, their hopes and fears to so much scrutiny. We hope that, no matter in what small way, this document will ensure that their lifestyles continue, develop, and thrive into the next millenium.

Abstract

The papers in these proceedings seek to address three principal areas of concern: biodiversity, range resource management and pastoral development, and forage development. The workshop itself focussed on identifying crucial issues and determining prioties in order to address rangeland concerns, especially in the light of managing such remote areas at high elevation, sparsely populated, and subject to such harsh climates. Many of the papers demonstrate that there is a need to identify issues and set priorities for action to address rangeland concerns. The task of managing rangelands is challenging due to their altitude, harsh climates, and sparsely populated characteristics. However, over the centuries, pastoralists have developed animal husbandry skills and grazing practices adapted to these harsh environmental conditions and perturbations in the ecosystem; albeit that the efficacy of their systems is unacknowledged by development planners, hence leaving pastoralists out of the development process.

This unique collection of papers touches on the value of the unique flora and fauna of the rangelands and the need to preserve them in order to conserve biodiversity. Policies are also discussed in the context of their appropriateness to the rangeland systems and in the context of how poor perceptions have led to limited support for livestock husbandry. Strategies for range management are suggested to maintain productivity, rehabilitate degraded areas, improve biodiversity, promote sustainable livestock production, stimulate economic growth, and improve standards of living.

Welcome Address

Egbert Pelinck, Director General
International Centre for Integrated Mountain Development (ICIMOD)

Distinguished Participants and Colleagues:

On behalf of the International Centre for Integrated Mountain Development (ICIMOD), I welcome all of you to this Regional Experts' Meeting on Rangelands and Pastoral Development in the Hindu Kush-Himalayas. We are gathered here this week to deliberate on an important topic: the sustainable management of the rangeland resources of the Hindu Kush-Himalayas. I express sincere appreciation for the efforts you have made in coming to Kathmandu.

ICIMOD was established in December 1983 against the backdrop of a sharply growing concern about the alarming degradation of mountain environments and the increasing poverty of mountain people. This concern was for mountain areas of the world in general, but in particular for the Hindu Kush-Himalayas (HKH). This area is home to more than 120 million of the world's poorest people - trying to make a living in some of the world's harshest environments.

Poverty alleviation and environmental conservation in the HKH is ICIMOD's primary mandate. We pursue these objectives through documentation and information exchange, research and knowledge reviews, capacity building, and advisory services.

ICIMOD has worked on many different programmes over the years, but when I came to ICIMOD a little over two years ago, one area that I noted we had neglected to a great extent was the rangeland ecosystems of the HKH, despite the fact that rangelands cover about 40 per cent of the total land area of this region. Fortunately, ICIMOD has now begun to give greater consideration to rangelands and their inhabitants. The fact that ICIMOD has organized this regional expert meeting on rangelands and pastoral development is indicative of this trend.

Attention to rangelands is important for a number of reasons. First, they form the headwater environments of the HKH's major river systems. What takes place in these upper watersheds has important effects downstream for millions of people. Second, products obtained from rangelands — livestock and plants and their by-products — provide food and generate income for local people. Third, rangelands are home to millions of people who have, for the most part, been neglected by previous national development efforts which have historically focussed on the plains and lower hills; yet there is a great potential to improve the livelihood of people living in rangeland areas. Fourth, rangelands are important storehouses of biological diversity, providing habitats for numerous wild animals. Similarly, many of the protected areas in the HKH are dominated by rangeland vegetation.

Many issues regarding the sustainable management and development of rangelands need to be considered. While the ecology of these areas is still poorly understood by scientists, a wealth of indigenous knowledge exists that has been left largely untapped. Pastoralists have adapted animal husbandry skills and grazing practices to the harsh environmental conditions of the HKH over centuries. The efficacy of these traditional systems, however, is still poorly understood and not sufficiently acknowledged by development planners. We must deliberate on the tremendous local knowledge that herders possess and the unique strategies they have developed to survive — even thrive — in these difficult environments.

Furthermore, mountain rangelands contain a wealth of wildlife; yet we still know little about these wild animals and their interactions with other aspects of rangeland ecology, and I include domestic livestock in this knowledge gap also One of the major management issues facing national parks and protected areas located in the mountains is grazing related. Outside protected areas, wildlife is often thought to compete with domestic livestock for grassland resources. Management plans that consider the needs of both the wildlife and livestock that share rangelands both inside and outside reserves and protected areas should be developed.

Sustainable rangeland development requires appropriate policies. Development policies in the HKH have largely ignored mountain rangeland environments. Policies that do exist for pastoral areas have generally maintained that traditional pastoral systems need to be improved without any consideration for the practical or valuable implications of these existing systems. Agricultural and forestry policies have usually neglected the role of livestock in development and the potential positive contribution that domestic animals can make to economic growth.

ICIMOD is uniquely positioned to assist its member countries with developing policies and methodologies for sustainable development of rangeland ecosystems. By focussing greater attention on rangelands, ICIMOD expects to assist governments, NGOs, local people, and the international donor community in promoting the well-being of inhabitants and users of rangelands in the HKH; improving the conditions and management techniques for rangelands; and strengthening the capabilities of relevant institutions and organizations in ICIMOD's member countries.

This meeting has brought together rangeland specialists with various interests from five of our Regional Member Countries, as well as from ICARDA and Turkey. The participants' diverse knowledge and experiences give me hope that we can begin the process of addressing complex issues related to sustainable rangeland management in the HKH. ICIMOD expects that participants will be able to help us not only to clarify the major rangeland issues, but also to assist us in developing practical programmes for further work at national and regional levels. These may include directives for research priorities, policy reviews and options, and management options.

While the programme of this three-day consultation is fairly comprehensive, I am personally very interested in the issue of forage and fodder development as it relates to overcoming the scarcity of fodder during the long, harsh winters at high altitude. Tragedies like the one that killed thousands of yak on the Tibetan Plateau in the winter of 1994-95 should be prevented in future. The advice of those gathered for this meeting could be a first step in that direction.

Another issue that might be neglected in this highly male-dominated consultation — and of concern to ICIMOD — is the role women occupy in range management, particularly their increased workloads due to the seasonal or permanent outmigration of men in search of alternative income sources.

The challenges facing rangelands in the Hindu Kush-Himalayas are considerable, but I am confident that together we can have an impact.

I thank all of you for coming to this important meeting, and I look forward to hearing more about the discussions and recommendations arising from it.

Thankyou

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Rangelands and Pastoral Development: An Introduction

Daniel J. Miller

In terms of land area covered (about two million sq.km.), rangelands encompass more territory than any other ecosystem in the Hindu Kush-Himalayan-Tibetan Plateau region (Table 1). Rangelands are also unrivalled in terms of diversity. Extending from splendid, subtropical savannahs in the Siwalik foothills to lush, alpine meadows in the Himalayan mountains and stretching for 1,200 kilometres north across the spacious steppes of Tibet to the cold, dry deserts of the Kunlun mountains, rangelands of the Hindu Kush-Himalayan and Tibetan Plateau region display a diverse assortment of plant communities, wildlife species, and various, distinct human cultural groups.

Table 1: **Area of Rangelands in the Hindu Kush-Himalayan-Tibetan Plateau**

Country	Area (sq. km)	Per Cent of Total
China (Tibetan Plateau)	1,250,000	60.80
Pakistan	400,000	19.42
Afghanistan	200,000	9.71
India	180,000	8.71
Nepal	20,000	0.97
Bhutan	7,000	0.34
Myanmar	760	0.04
Bangladesh	290	0.01
Total	2,058,050	100.00

Rangelands in the Hindu Kush-Himalayan-Tibetan Plateau region are important for a number of reasons. First, rangeland ecosystems are the headwaters' environment for the major river systems in the region, and what takes place in these upper watersheds has far-reaching effects on downstream areas. The water from these rangelands will be of increasing importance for hydropower development in the future, as well as for agriculture at lower elevations, which is based on irrigation. Second, rangelands provide habitats for numerous wildlife species, many of which are endangered, and for a wealth of plant species. Many plants are of medicinal value and other species may provide important genetic material for future economic use. Most of the protected mountain areas in the region are dominated by rangeland vegetation. Conserving the rich biological diversity of these lands is crucial for sustainable economic development, yet grazing-related issues are often the major management concern in protected mountain areas. Third, these vast grazing lands provide forage for grazing livestock. Since cultivated agriculture is not possible on the rangelands, grazing by domestic animals enables herding communities to convert otherwise unusable plant biomass into valuable animal products that are either consumed by the pastoralists themselves or sold for income. Fourth, rangeland ecosystems in the mountains are becoming increasingly popular as tourist destinations. Tourism has the potential to not only improve the livelihoods of the local people, but also to contribute to overall economic development. Finally, the rangelands are home to millions of people who have been neglected by development efforts, to a great extent, due to their remoteness and to the fact that government policies failed to appreciate the importance and potential of mountain rangelands.

In recent decades, profound changes, with implications for the future of rangeland resources, pastoralists, and their production systems, have taken place on the rangelands of the Hindu Kush-Himalayan-Tibetan Plateau region. These changes include the modernisation process itself which has brought improved access and services to previously remote pastoral areas; the expansion of agriculture into rangelands; transformation of traditional pastoral production systems; disruption in traditional trans-Himalayan trade networks; and, what appears to be, a general desiccation of Alpine rangelands due to climatic changes which are modifying vegetation composition and reducing plant productivity and carrying capacity. These political, social, economic, and ecological transformations have altered previous, well-established links between the pastoral population and their rangeland environment.

The lack of concern for rangelands and misconceptions regarding pastoral ecosystems have led to a general downward spiral in the productivity of many rangeland areas, loss of biodiversity, and increased marginalisation of pastoral people. Reversing these trends should be a priority for governments and development agencies. Rangeland degradation can no longer be regarded solely as a localised problem since the implications are more widespread, affecting national, regional, and international interests.

Despite their extent and importance, the dynamics of the rangeland ecosystems in the Hindu Kush-Himalayan-Tibetan Plateau region are still poorly understood. Scientific data on ecological processes taking place throughout different types of rangeland are limited. Questions concerning how rangeland vegetation functions and the effect of grazing animals on the ecosystem in these mountain rangelands remain unanswered for the most part. The socioeconomic dimensions of the pastoral production systems are also not well known. This lack of information limits the proper management and sustainable development of rangelands. Where research information is available, it is seldom shared among other researchers in the region. As a result, there is often a duplication of research efforts, and this is a misuse of scarce resources.

Recognising the importance of rangelands in the Hindu Kush-Himalayan-Tibetan Plateau region and the lack of attention to rangelands, ICIMOD organized a workshop on rangelands and pastoral development in Kathmandu, Nepál, from November 5-7, 1996. The workshop brought together specialists from both the region and elsewhere to share their knowledge and experience. It would be hard to assemble a group of people from the region more knowledgeable about rangeland ecosystems and forage development. These proceedings are the outcome of that workshop and present case studies and research findings on rangeland resources, forage development, wildlife, and pastoralism. Most of the contributors are range and forage specialists, but also represented are specialists in wildlife, biology, sociology, and anthropology; as the papers show, all contributors have had extensive field experience in the Hindu Kush-Himalayan-Tibetan Plateau region and share a concern for the present situation on the rangelands. In compiling these proceedings, ICIMOD aims to stimulate reflection on and greater consideration for issues relevant to rangeland management, biodiversity conservation, forage improvement, and pastoral development in the Hindu Kush-Himalayan-Tibetan Plateau region.

The papers illustrate and address three main areas of concern on the rangelands: biodiversity, range resource management and pastoral development, and forage development. Discussions held during the workshop focussed on identifying important issues and determining priority actions that need to be taken to address rangeland concerns.

Managing rangelands and planning sustainable pastoral development in the Hindu Kush-Himalayan-Tibetan Plateau region are challenging tasks. Unfortunately, since these rangelands are often remote, at high elevations, subject to harsh climates, and sparsely settled, they have, to a great extent, been neglected by research and development agencies alike. As many of the papers show, however, there is ample opportunity to improve management practices on rangelands, maintain and also enrich biodiversity, increase livestock productivity, and improve the incomes and livelihoods of people dependent upon rangeland resources. Resolving rangeland degradation and pastoral development issues will, however, require modification in current strategies and approaches to development which will need to integrate the ecological processes of rangeland management and biodiversity conservation with the economic processes of pastoral production and integrated mountain development.

Pastoralists on the rangelands of the Hindu Kush-Himalayan-Tibetan Plateau have, over centuries, developed animal husbandry skills and grazing practices adapted to the harsh environmental conditions and perturbations in the ecosystem, but the efficacy of these traditional pastoral practices is not sufficiently acknowledged by development planners. There is also a lack of information on traditional pastoral production systems which makes informed decisions about altering traditional livestock production practices difficult. The 'mainstream view' regarding nomadic pastoralism, which maintains that traditional pastoral practices need to be improved, has largely shaped pastoral development in the Hindu Kush-Himalayan-Tibetan Plateau region, as elsewhere in the pastoral world. The result has been that the pastoralists themselves have been left out of the development process. Papers in these proceedings show that there are a number of researchers who are now giving much more attention to socioeconomic aspects of pastoral production systems. This is encouraging and gives rise to the hope that herders themselves will become more active participants in the pastoral development process in the future.

These mountain rangelands are comprised of a unique assemblage of flora and fauna. Human activities have resulted in the destruction of wildlife habitat and the loss of biodiversity. Numerous national parks and reserves exist in the region, but significant gaps in the protected area system remain, long-term ecological studies are lacking, and management of these valuable resources is inadequate. The preservation of mountain wild animals and management of their rangeland habitat are essential for conserving biodiversity in the Hindu Kush-Himalayan-Tibetan Plateau. This workshop has stimulated greater interest in biodiversity conservation in rangeland ecosystems and highlighted the need for range and livestock development specialists to work more closely with conservationists.

Sustainable development of rangelands requires appropriate policies. Development policies in the region have largely ignored mountain rangeland areas, and the policies that do exist for pastoral areas have generally maintained that traditional pastoral systems need to be 'improved upon' without any consideration of what may be practical or of value in the existing system. Agricultural and forestry development policies have usually neglected the role of livestock in development and the potential positive contribution that livestock can make to agricultural and economic growth has been overlooked. Rangeland development policies tend to centre on improving livestock production, rather than on multiple-use resource management, which considers uses other than livestock. It is clear that, if sustainable development of rangeland areas is going to take place, policies will need to give more attention to adopting an integrated, natural resource management approach.

The poor perception of rangeland environments and pastoralism and the limited support for pastoral development and rangeland resource management in the region in the past need to be counterbalanced by fresh perspectives and the new information emerging regarding the assessment of range ecosystem dynamics, pastoral production practices, and biodiversity conservation. These perceptions and innovative development paradigms suggest new possibilities for and fresh approaches to designing range management and pastoral development in the future.

Strategies for range management and pastoral development in the Hindu Kush-Himalayan-Tibetan Plateau should aim to maintain rangeland productivity, rehabilitate degraded areas, protect and improve biodiversity, promote sustainable livestock production, stimulate economic growth and create employment among the pastoral population, and improve people's livelihoods. Developing such strategies requires a much better understanding of rangeland ecosystem dynamics, increased knowledge of existing pastoral production practices, more thorough analysis of the issues and opportunities facing pastoralists, and adjustment of the existing policies for rangelands and pastoral areas.

Successfully implementing sustainable rangeland development interventions requires that ecological principles regulating rangeland ecosystem functions be linked to the economic principles governing livestock production and general development processes. However, most of the existing institutions and organizations involved in rangeland ecosystems in the region lack a suitable system for organizing and analysing range resource information relevant to the management of rangelands. Fortunately, there is growing awareness of the need to address rangeland resource issues which, when coupled with insights from fresh perspectives emerging on rangeland ecosystem processes and pastoral development and the new computer-assisted technology available for processing and analysing information on rangelands, provides good prospects for more sustainable development of rangeland areas in the Hindu Kush-Himalayan-Tibetan Plateau.

As part of ICIMOD's new Regional Collaborative Programme, the development of rangelands will receive high priority in the Centre's Mountain Natural Resources' Programme. ICIMOD's multidisciplinary team of professionals plan to work with rangeland specialists in the region to assess rangeland ecosystems, review traditional pastoral production systems, evaluate previous rangeland development experiences, and identify successful interventions for improving rangeland management practices. A major strength of ICIMOD's multidisciplinary approach is the identification of interdependence across spatial, ecological, sectoral, institutional, and disciplinary boundaries as an important requirement for promoting integrated approaches to sustainable mountain development. This workshop has made an important start towards this.

New Perspectives on Range Management & Pastoralism & Their Implications for HKH-Tibetan Plateau Rangelands

Daniel J. Miller

Pastoralism in the Hindu Kush-Himalayan-Tibetan Plateau region is thousands of years old. The fact that numerous unique and, in many cases, prosperous, pastoral groups remain to this day bears witness to the extraordinary diversity and resilience of Hindu Kush-Himalayan-Tibetan Plateau rangelands, as well as to the sustainability of its resources when used wisely. In recent decades, however, many profound changes with implications for the future of rangelands and pastoral production systems have taken place. These changes include the modernisation process itself, which has brought improved access and services to previously remote pastoral areas and also increased demand for livestock products; the expansion of agriculture into rangelands and decrease in the amount of grazing land available; disruption in trans-Himalayan trade networks which were often important parts of pastoral systems; and the expansion of the protected area system with increased regulation on the use of rangelands by livestock.

These changes are transforming traditional pastoral systems and grazing use patterns. Keeping pace with these changes requires that those responsible for managing rangelands remain informed about new management concepts and technologies, incorporating such information into the design of more appropriate strategies for sustainable development of rangeland resources.

This article discusses some of the basic principles behind range management and outlines new perspectives that are emerging for managing rangeland resources. Finally, the implications of these new perceptions for managing Hindu Kush-Himalayan rangelands are discussed.

Range Management Principles — Range Condition and Carrying Capacity

Since vegetation is the foundation for rangeland use, developing range management plans requires information on vegetation ecology and an understanding of rangeland ecosystem processes. Range science, which largely developed in North America, generated principles and methods to describe the state of rangelands upon which management was then based. One of the basic principles is *range condition* class, or interpretations of the 'health' of a particular range site. Determining condition is based on an assessment of vegetation composition both on its own and in relation to what the ideal climax plant community should be like.

The other major range management principle is carrying capacity. The predominant management concern about rangelands has usually been perceived as the need to control rangeland degradation by regulating livestock numbers. The scientific foundation for this concern is the concept of rangeland carrying capacity; the number of animals that can safely be allowed to graze without degrading the range. Carrying capacity estimates are normally based on assumptions about the impact of livestock on plants and plant succession. Heavy livestock grazing is thought to lead to a decline in range condition; reducing or removing grazing pressure assumed plant successional processes would restore the range to its previous state.

The conventional concept of carrying capacity in rangeland management is based on theories about plant succession, which is explained as the orderly and directional process by which one group or community of plant species replaces another over time. These theories to explain variation in vegetation types were developed in the early 1900s in the USA.

Successional theory assumed that a single, persistent and characteristic rangeland vegetation type, termed the climax, would eventually dominate a particular site. The theory postulated that, even if the climax vegetation was disturbed, by factors such as grazing or fire, it would still return through a successional cycle to the climax. The science of range management adapted these concepts to grazing systems. The responsibility of range managers was to try to balance livestock grazing pressure against the natural regenerative capacity of range plants. By knowing the range condition class, the proper use factor, or the amount of forage necessary to allow plant nutrients to be restored, and taking into account distance to water, slope steepness, and other factors, carrying capacities for a particular range or pasture could be determined. Livestock numbers and/or the time of year animals were allowed to graze were then manipulated to influence rangeland condition. Grazing practices normally tried to maintain or, ideally, improve range condition. This managerial approach is derived from the concepts of plant succession, rangeland condition, and carrying capacity.

New Perspectives

There are increasing questions about the relevance of these range management concepts, largely developed in North America, for planning livestock use on rangelands in pastoral systems in the developing world (Bartels et al. 1991, Ellis et al. 1991, Perrier 1990). The applicability of traditional approaches to range management in arid ecosystems, based largely on the concepts of equilibrium dynamics, plant succession, and carrying capacity, are being challenged and suggest that alternative management practices need to be designed. These concepts developed primarily in what is termed equilibrial ecosystems; areas where climatic variability is not very high and where it was believed livestock grazing was the major factor affecting vegetation.

Ecological research in the last decade in semi-arid rangelands, where climatic variability is high and ecosystem functions very dynamic, suggests that most arid and semi-arid range ecosystems function as non-equilibrial systems (Coughenour 1991, Ellis and Swift 1988). In these areas, plant growth and rangeland productivity were found to be more functions of climate than of livestock stocking rates and the effect of livestock on the range vegetation more sporadic than continuous.

In the semi-arid regions of pastoral areas of East Africa, where much of this seminal work was carried out, it was concluded that rangeland dynamics are largely controlled by frequent drought perturbances and that pastoral systems operate far from equilibrium most of the time (Ellis et al. 1991). Research in arid areas of Australia also determined that the range ecosystem was extremely dynamic and climate driven over time and that the system was better described in terms of its variability than some average value. Researchers here concluded that the concept of carrying capacity was not very useful (Walker 1993). Where ecosystems are highly dynamic, as is often the case in pastoral areas, accurately estimating carrying capacity is proving to be difficult.

Where, then, do non-equilibrial dynamics occur? Some researchers have indicated that, when the coefficient-of-variation of annual rainfall is greater than 30 per cent, the ecosystem will generate such non-equilibrial dynamics (Ellis et al. 1991). It has also been noted that areas that receive less than 300-400 mm of annual rainfall will operate as non-equilibrial systems. These are thought to be relevant estimates for the dry tropics, but it remains to be seen what rainfall levels determine non-equilibrial dynamics in dry temperate areas where diverse patterns of ecosystem behaviour may also occur. It has also been pointed out that, in dry, cold regions, where grazing lands are subject to severe blizzards (such as Tibet) rather than, or in addition to, droughts, non-equilibrial dynamics may occur (Ellis et al. 1991).

Another new perspective is the concept of relatively stable, multiple vegetation states with thresholds or transitions between these vegetation states (Laycock 1991, Westoby et al. 1989). The concept differs markedly from the traditional paradigm of plant succession. In this new view, plant succession does not proceed in an orderly, directional process whereby one group or community of plant species replaces another over time until the climax vegetation is reached. Rather, vegetation changes to a certain state and then stays there instead of moving to another successive stage, even without grazing. Only perturbation, such as fire or severe drought, will allow vegetation to proceed to another stable state. This concept provides a new framework for rangeland monitoring and management and offers promise for improved descriptions and measurements of range condition.

Pastoral development policy throughout the world has largely adopted the 'mainstream view', which maintains that traditional pastoral practices are backward and need to be improved. In recent decades, however, pastoral production systems have been viewed increasingly as highly efficient exploitation strategies to secure a livelihood in a harsh environment where cultivated agriculture is not possible. Many traditional pastoral production systems are being acknowledged as rational responses for using range resources available to herders (Coppock et al. 1986, Coughenour 1991, de Haan 1990, Ellis and Swift 1988).

Over hundreds of years, pastoralists in the Hindu Kush-Himalayan-Tibetan Plateau region acquired intricate ecological knowledge about the pastoral ecosystems in which they live and upon which their livestock production economies depend. Pastoralists' husbandry of land, water, plant, and livestock resources and their strategies are highly skilled, complex, and organized, reflecting generations of acute observation, experimentation, and adaptation to a harsh environment (Brower 1991, Cincotta et al.

1991, Goldstein et al. 1990). Local climatic patterns and key grazing areas were recognised, allowing herders to select favourable winter ranges that provided protection from storms and sufficient forage to bring animals through stressful times. Forage plants were identified that had special nutritive value. Other plant species were known for their medicinal properties or as plants to be avoided since they were poisonous. A wide diversity of livestock and grazing management techniques was employed which enabled herders to maintain the natural balance of the land upon which they were dependent. Complex forms of social organization within nomadic society developed that aided allocation of rangeland resources and, through trade networks with other societies, secured goods not available within pastoral systems.

This expanded appreciation for the complexity and ecological and economic efficacy of traditional pastoral systems is encouraging. It provides hope that the vast indigenous knowledge herders possess will be better understood and used in designing new interventions. Greater awareness of the need to understand existing pastoral systems should also help ensure that the goals and needs of pastoralists are incorporated into new programmes and that local herders become active participants in the development process.

Challenges for the Hindu Kush-Himalayan-Tibetan Plateau Region

New perspectives regarding the functioning of rangeland ecosystems raises interesting challenges for research and management in the Hindu Kush-Himalayan-Tibetan Plateau region. Such concepts provide a valuable framework for organizing range research programmes. Are Himalayan and Tibetan Plateau rangelands dynamic ecosystems? Do they function as non-equilibrial systems? In parts of the Himalayas and the eastern part of the Tibetan Plateau, annual rainfall is greater than 400 mm and equilibrial dynamics probably rule the system, but do the periodic snowstorms these areas are subjected to mean that non-equilibrial dynamics assert an influence? What about the drier, colder areas of northwest Tibet where rainfall is less and blizzards frequent? Will conventional methods of range management work there? Large expanses of Balochistan in Pakistan are semi-arid rangelands. Is vegetation here influenced more by variable climatic factors or livestock grazing? Can the carrying capacity concept really be adequately applied in these ecosystems?

In North America, range condition classes and carrying capacity estimates were generally derived from detailed measurements of soil types and range vegetation, combined with information on the proper use factor of key forage plants and livestock use of the range. In the Hindu Kush-Himalayan region, much of this information does not readily exist. Since it is difficult to accurately estimate carrying capacity in the highly dynamic ecosystems in which pastoralism takes place, there are increasing questions about the relevance of the carrying capacity concept for planning livestock stocking rates in such environments. How then should range managers tackle the problem of regulating livestock numbers in pastoral areas in the Himalayan region when such information does not exist?

The difficulty of applying carrying capacity concepts means the notion of 'opportunism' is gaining favour as a management approach for livestock production in pastoral systems (Behnke and Kerven

1994). An opportunistic approach, instead of considering 'average estimated carrying capacity', establishes the annual grazing strategy on that year's forage production. This allows pastoralists to make better adjustments of livestock numbers to the spatial variability of forage, establish a better distribution of livestock to forage availability, and enable increased production. Opportunism in this context requires herders to respond quickly to grazing opportunities and demands high herd mobility and timely destocking or restocking as grazing conditions change. Opportunistic strategies in pastoral systems, therefore, require that pastoralists capitalise on range resources available during good times and exploit outside resources during bad times (Ellis et al. 1991).

Researchers have noted that if non-equilibrium systems do operate in the above-mentioned manner, and if opportunism should be embraced, then the most important development intervention for pastoralists may be that of reducing isolationism and forging better links between the pastoralists and external resources (Ellis et al. 1991). This requires facilitation of the movement of goods and livestock through trade or marketing systems and external economies which can consume and distribute products to and from pastoral areas as they become available.

Opportunistic strategies for managing livestock and range resources are not a new idea to pastoralists. Traditional pastoral management systems in the Tibetan and Himalayan region were designed around mobility and the tracking of favourable forage conditions. Official endorsement of opportunism does not, therefore, require substantive changes in existing livestock production systems, but it does require improvements in marketing channels. By assisting in the movement of livestock and livestock products to markets, herders' incomes and access to goods can increase; their dependence upon the local pastoral environment for subsistence can, likewise, decrease.

A key challenge for researchers working in pastoral ecosystems will be to become more successful in explaining the ecological and social processes at work. Another important challenge will be to determine which aspects of indigenous knowledge systems and traditional pastoral strategies and techniques can be built upon when designing new interventions. Pastoral specialists will also have to try to ensure that research findings are incorporated into new policies and development programmes.

Conclusion

Rangeland ecosystems in the Hindu Kush-Himalayan-Tibetan Plateau region appear to be very dynamic systems. The modernisation process taking place, even in previously remote pastoral areas, is augmenting dynamic processes. Those involved with managing rangelands in the region, and they include herders, researchers, extensionists, and policy-makers, need to make the best use of available information and new ideas emerging about rangeland ecosystems. There is also growing acknowledgment of the need to explore beyond the conventional wisdom of many of the traditional range management concepts to more effectively manage rangeland resources. Some of the fresh perspectives on range ecology outlined above raise a whole new spectrum of enquiries about the functioning of Hindu Kush-Himalayan-Tibetan Plateau rangelands and traditional pastoral systems. They also suggest new, creative approaches for designing more sustainable pastoral development in the future.

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Status of Himalayan Rangelands in India and Their Sustainable Management

Panjab Singh

Introduction

India's climate, topography, flora, fauna, and land-use patterns are very diverse. Precipitation ranges from the lowest to the highest levels on earth. Altitudes vary from sea level to some of the highest peaks in the world. Temperatures range from sub-zero in the Himalayas to about 50°C in the central and western areas of the country.

India's diversity of environments has given rise to a spectrum of rangeland ecologies. Domestic animal husbandry remains a constant theme throughout India's diverse ranges. Rich grassland resources have sustained livestock very efficiently for centuries; however, the gradual increase in human population and related development activities, as well as the subsequent increase in livestock numbers and natural forces, such as soil erosion, has upset the balance of India's rangeland environments. Twelve million hectares of permanent pasture have been converted into wastelands with very meagre production.

Rangelands are not the only source of fodder for area livestock. Hill slopes, forests, and wastelands, as well as cultivated fodder resources, crop residues, and feed concentrates, all help meet the nutritional needs of India's livestock. Yet, in environments in which livestock depend entirely on grasslands, fodder availability is often low. The shortage and misuse of rangelands is critical. Without increasing the production levels of these resources, achieving optimum - or at least improved - levels of animal biomass remains impossible.

Background and Present Status

India's rangelands cover an area of about 121 million hectares, approximately 40 per cent of the country's geographical area, and are used in a variety of ways. Sedentary, semi-migratory, and migratory systems of grazing are all found throughout India. Due to extremities of climate, poor management, and constant grazing, these areas have degraded at an alarming rate. Some rangelands are becoming less productive than other well-managed grasslands, providing animals with less herbage and nutritional requirements. Yet, all of these ranges remain vital for rearing domestic animals.

In the Indian Himalayas, alpine grasses and meadows account for 114,250 sq. km. Permanent pastures and grasslands cover 123,000 hectares in Jammu and Kashmir, 158,000 hectares in Himachal Pradesh, and 299,000 hectares in Uttar Pradesh. These pastures and grasslands range from 300 to 4,500 masl, traversing sub-tropical, temperate, and alpine environments.

The change from subtropical to temperate conditions occurs around 1,800 metres. Both subtropical and temperate grasses occur at this altitude. These pastures are characterised by cool summers (15-20°C), followed by heavy monsoon rains (1,000-2,000mm) and cold winters (-8 to 8°C) with heavy snowfall (2-5m). The common sub-tropical species found in these areas are: *Arundinella setosa, Themeda anathera, Pennisetum orientala, Chrysopogon gryllus, C fullus, Apluda mutica, Heteropogon contortus,* and *Dichanthium annulatum*. Temperate species include *Deyeuxia scabrescena, Stipa spp, Poa pratensis, Festuca kashmiriana, Agropyron longe-aristatum,* and *A. semicostatum*. Subtropical grasses disappear around 2,650 metres and temperate types predominate. Common temperate genera include: *Deyeuxia, Helictotrichon, Brachypodium, Bromus, Dactylis, Festuca*, and *Trifolium*.

According to edaphic and microclimatic conditions, these temperate pastures can be categorised as dry rangelands (1,800-2,400m), humid rangelands (2,400-3,200m), semi-arid and arid rangelands in the inner Himalayas (2,800-3,200m), and sub-alpine and alpine pastures (above 3,200m). These different zones have distinct climatic conditions and different edaphic problems, requiring grass species and genotypes specifically suitable for each zone.

In the northwestern part of India, the high altitude sub-alpine and alpine pastures are grazed during the short summer by migratory herds who depend on other grazing resources the rest of the year — a period as long as eight months. Rangelands only cover 5.4 per cent and 3.5 per cent of Rajasthan and Gujarat, respectively. Yet these western regions maintain high livestock productivity levels as a result of alternative and supplementary grasslands. In the east, grasslands and pastures comprise less than one per cent of the total area, even though animal husbandry is an important source of livelihood for local people.

Singh and Misri (1993) determined that India's region with the highest rangeland carrying capacity is Kerala, where 1.47 adult cattle units (ACU) can be reared per hectare of grassland. India's grassland carrying capacity is lowest in Haryana, where only 0.20 ACU can be sustained per hectare of range. In semi-arid areas, grazing intensity ranges from 1.04 to 51.08 ACU per hectare (Shankar and Gupta 1992). In arid areas, grazing capacity is only 0.2 to 0.5 ACU ha^{-1} (Raheja 1966) — a situation mirrored throughout much of the country.

The increase of grazing pressure due to rising human and livestock populations, terrain, scanty vegetation cover, extremities of climate, erratic rainfall, constant neglect, and an ever-increasing livestock and human population have rendered India's grassland ecosystems fragile. Edible species have been replaced by noxious weeds. Plant regeneration levels remain low, leading to scanty vegetation cover which precipitates tremendous soil erosion and water loss. This degradation has occurred to such an extent that now the once productive grasslands are classified as wastelands. Gupta and Ambasht (1979) classified 80 per cent of the grasslands as 'poor'. Only an integrated approach to conservation can correct this situation. Proper stocking rates and management practices will help India's grasslands regain their ecological balance and also improve animal productivity.

Challenges

Various estimates have been made about the demand and supply of fodder throughout the country. Singh (1988) estimated that, by 2000 AD, India may require 822 tonnes of dry matter per year to maintain its animals. In order to increase productivity, at least 1,253 tonnes of dry matter will be required per year. Shankar and Gupta (1992) estimated that India is short of 69MT of dry forage annually. In addition to forage provided by rangelands, these areas produce fuel, timber, and other minor forest products. It is estimated that India is losing 1.5 million hectares of forest land every year due to various processes of degradation; yet 68 per cent of the rural and 45 per cent of the urban populations use wood as fuel (Qazi 1994). Fuel demands and the need for fodder production must be met from the same eco-regions. As such, it is necessary to reconsider how these rangelands are managed.

In addition to grassland herbage, agro-wastes play an important role in augmenting roughage supply. The animal pressure on one hectare of land providing agro-wastes ranges from 0.75 to 16.80 megatons; the demand for cultivated fodder is equally high. The states of Gujarat, Haryana, Punjab, and Rajasthan have started to cultivate fodder. However the animal pressure on one hectare of land that includes such fodder crops is 19.78, 11.07, 12.90, and 15.95, in these states, respectively (Singh and Misri 1993).

In spite of inherent limitations of animal rearing given rangeland production levels, the availability of animal products has increased considerably during the past few years. This demand will continue to rise in the future as human populations grow. Yet biomass production must be increased to balance animal product supply and demand. Likewise, grassland production must be sustainable. These are the greatest challenges facing users and researchers of India's rangelands.

Sustainable Rangeland Management

In the hills of India, farmer prosperity depends on animal husbandry, horticulture, and forestry; other sources of income are limited. Subsistence agriculture based on cereal and pulse cultivation is practised on about 10 per cent of the total geographical area, whereas rangelands and forests comprise 50-70 per cent of the entire region. These rangelands are the backbone of the hill farm economy and are fundamental to the rearing of sheep, goats, rabbits, cattle, and other animals for meat, milk, wool, hide, skin, and draught power. Medicinal plants are also harvested from local grasslands for profit.

The natural resources of the Himalayas have been haphazardly exploited for centuries. Reckless tree felling, overgrazing, and an absence of rehabilitation programmes have given rise to denuded hill slopes and rangelands, among other problems. Local hydroelectric projects, for instance, have often caused such degredation, resulting in flash floods and the heavy silting of reservoirs. The basic aim of sustainable rangeland management is to use the available biotic and abiotic resources, soil nutrients, and natural flora in a particular environment to produce maximum economic returns. Sustainable, scientific management of rangeland resources throughout India is needed to restore soil fertility, encourage regrowth of rare medicinal herbs and other grass species, support congenial climates for biological life, provide gainful employment to farmers, and improve the overall ecosystem.

Research undertaken on various aspects of grazing lands, animal husbandry systems, and the restoration of wastelands throughout India has generated methods and technologies aimed at restoring, regenerating, and improving area biomass production. Soil working, reseeding, fencing, and bush clearing are all sound methods of sustainable development. Rotational grazing systems, as well as water and soil conservation, destocking, and fertilizer application programmes, should be implemented. Similarly, legumes, trees, and bushes for fodder should be introduced. All of these suggestions are elements of sustainable rangeland management and are geared towards correcting the environmental imbalances afflicting India's grassland resources.

Introduction of Grass and Legume Species

Dry Rangelands

Dry rangeland areas consist of mixed sub-tropical and temperate vegetation. Heavy grazing pressure combined with water stress in the rhizosphere throughout most of the year and subsequent soil erosion have led to extreme degradation of these grasslands. White clover and other fine grasses do not grow well in these areas due to water stress.

In order to improve these rangelands, pasture plants with deep root systems, tolerant of drought and cold, should be planted. These types of plants can extract water and nutrients from deeper soil layers and provide good herbage yields. Suitable species include the following.

a. *Festuca arundinacea* - Hima- 1, Hima-2
b. *Trifolium pratense* - *UKU-5*
c. *T. ambiguum* - PCC-5
d. *Lotus corniculatus* - G-32
e. *T. repens* - PLP Comp.I

All of these cultivars meet the above criteria. *T. ambiguum,* for instance, has a strong tap root, as well as a rhizomatic root system, and binds soil well. The introduction of such cultivars in these pastures increases herbage yield by 30-40 per cent and raises quality by five to six per cent (13-14% CPDM). *Trifolium repens* is suitable for introduction into orchards. In addition to providing quality herbage, this plant fixes nitrogen in the soil at a rate of 200-300 kg per hectare.

Humid Rangelands

Humid rangelands are classified by temperate vegetation. A cool climate and adequate moisture in the rhizosphere help produce excellent vegetative growth. Such zones have lush, green pastures from May to September.

In order to improve rangelands in this climatic zone, high yielding grasses and legumes should be introduced into grasslands and orchards. Suitable species for this zone are as follow.

a. *Dactylis glomerara* (orchard grass) - Sumax, commet
b. *Festuca arundinacea* (Fescue grass) - Hima-2 and 3
c. *Phalaris raberosa* (Cannary grass) - Common
d. *Trifolium pratense* (Red clover) - PRC-3
e. T. *repens* (White Clover) -PWC-2,3,15, and PLP Comp.I
f. T. *ambiguum (Caucasian* clover) - PCC-5

Orchard grass can be introduced on northwest-facing wet slopes and in orchards. Hima 2 and 3 (Fescue grasses) are suitable for introduction on to drier slopes facing southeast, as well as on to field bunds and in orchards. These varieties are endophyte free and provide excellent nutritive herbage. The PRC 3 of red clover is collar rot resistant and, therefore, suitable for pastures, grasslands, and orchards. The introduction of these improved strains has been found to increase herbage yield by 60 per cent and quality by five to six per cent (14-15% CP on DM).

Semi-arid and Arid Pastures in the Inner Himalayas

The semi-arid and arid pastures in the Inner Himalayas are located in the rain shadow, receiving only 200-500mm of rain per year and one to two metres of snow in the winter. Private meadows are irrigated three to four times during the growing season (April-July) to encourage grass growth. Species found on dry hills in these areas include: *Agropyron repens, A. dentatum, A coqnatum, Dactylis glomerana, Medicago falcata, Lotus corniculatus*, and *Lespediza serica*. Common temperate type grasses are found throughout irrigated meadows.

On dry hill slopes, high-yielding strains such as *Agropyron, Medicago falcata, M. sativa, Lotus corniculalus, Lespediza serica*, and *Onobrychis viccifolia* should be introduced. Improved strains such as LS 1 of *Agropyron*, Anand 3 of *M. sativa*, and LL 1 of *Lespediza serica* have been developed. They are now in advanced testing stages and their seeds are being propagated.

High-yielding multicut varieties of grasses and legumes, such as the following varieties, should be introduced into irrigated meadows.

a. *Festuca arundinacea* 'Hima I'
b. *Dactylis glomerata* 'Sumax and Commet'
c. *Trifolium pratense* 'PLP Comp.I'
d. *T. respinatum* 'SH 18'
e. *Brassica oleracea* 'Kale'

The introduction of these strains of grass in meadows has increased forage yields by 60 per cent. Peas and barley are harvested by the end of July, leaving time and scope to cultivate a fodder crop. Oats and shaftal were tried for these purposes. Shaftal cultivation was very successful. Sown by the end of July, the shaftal remained green until December, providing nutritional fodder throughout the winter. Similarly, when kale is sown as border rows in potato, pea, and hop fields, this plant remains green through December and helps supply winter fodder.

Sub-Alpine and Alpine Pastures

Sub-Alpine and Alpine pastures remain snow-bound from November to April and are open for grazing by sheep, goats, and horses from May through September. Area shepherds move rotationally according to the growth and availability of grasses. Prominent forage species found in these pastures include *Poa alpinum, Agrostis stolonifera, Festuca alpinum, Dactylis alpinum, Trifolium repens, Andropogon ishaemum, Pennisetum flaccidum, Lotus corniculatus*, and *Artemisia vulgaris*.

Soil Water Conservation

Various moisture conservation techniques can help improve herbage availability on area grasslands. Ahuja (1977) found that contour furrowing, bunding, and trenching result in herbage increases of 638, 168 and 165 per cent, respectively.

Fertilizer Management

Fertilizer application is one of the most important management options for improving biomass yield. Investigations at the Indian Grassland and Fodder Research Institute (IFGRI) revealed that the annual forage yield from natural grasslands of *Sehima nervosum, Heteropogon contortus,* and *Iseilema laxum* can be increased from 4.13 to 7.56, 3.47 to 5.57, and 4.49 to 6.37 t/ha-', respectively by the application of 40 kg of nitrogen per hectare (Shankar and Gupta 1922). Himalayan grassland herbage production can be increased from 1.78 t/ha to 7.01 t/ha by the application of 60 kg each of nitrogen and phosporous ha^{-1} (Sharma and Koranne 1988).

The introduction of legumes to grasslands can improve the nutritional quality of herbage and can also compensate for nitrogen application. IGFRI scientists introduced 14 different legumes in a particular grassland. The presence of these legumes enriched the soil to the same extent as would introducing 40 kg N ha^{-1}. The herbage yield increases from 3.3 to 4.0 t ha^{-1}.

Burning and Weed Management

Controlled burning and weed eradication helps increase grassland biomass. Grazing land with high bush density (1300 bushes ha^{-1}) may yield only up to 0.8 t/ha; when all bushes are eradicated, the herbage yield can increase to 4.2 t/ha (Kaul and Ganguly 1963). However, it has been recommended that 14 per cent of the area should be covered with bushes for the sustained availability of grassland herbage.

Silvipastoral Approaches

The adoption of silvipastoral systems can help people meet fodder, fuel, and timber requirements from a single unit of land. Suitable tree species have been identified by Singh (1992) according to the country's various agroclimatic regions. IGFRI determined that planting *Leucaena leucocephala* on rangelands can provide additional biomass of 20 t/ha, while *Acacia tortilis* and *Albizzia amara* increase biomass by 14.6 and 9.5 t/ha, respectively.

A five-year study (1987-91) to critically assess resource depletion and soil degradation was undertaken in three diverse agroecological niches. Bare plot, natural grassland, improved grassland, and three-tier planting systems were grazed by mixed herds of sheep, goats, and cattle according to the carrying capacity of one ACU/ha. These systems were tried on a one hectare plot and replicated four times. Results revealed that total water runoff loss was minimum from sown pasture, followed by three-tier, improved natural grassland and bare plot treatment. The average per cent of total rainfall runoff was 8.6, 9.1, 11.6, and 38.3 from sown, three-tier, improved, natural, and bare plot grasslands, respectively. Soil lost as sediment was also minimal from sown pasture — 14 times lower than from bare plot pasture.

Nutrient loss was estimated according to total soluble salt, nitrogen, potassium, and phosphorus in the runoff water collected in multisot devices after storms. The minimum total soluble nutrient loss was recorded in sown pasture. Loss of nutrients increased by about 1.5 times in three-tier, improved and natural grasslands compared to sown pasture. Bare plot nutrient losses were 3.6 - 8.3 times higher than sown pastures.

Pasture production (grass and legume) varied in different blocks at different times. The average peak production was obtained from block I (4.36 t/ha/year), followed by block IV (3.89 t/ha/ v ear) and block 111 (3.89 t/ha/year). In the fourth year, grass contributed most towards dry matter production, followed by forbs and legumes.

Data pooled over five years revealed that sown pasture produced the maximum dry matter — 11 tonnes in 1988. This number decreased to 4.4 tonnes in 1990 and 3.7 tonnes in 1991, once this land was used for grazing. Improved heteropogon-dominated natural grassland reached a maximum of about 10 tonnes in 1988, decreasing to 3.7 t/ha in 1990 and 3.1 t/ha in 1991. A similar trend was also observed on natural grasslands. When protected, yields increase up to five times, with a maximum production of 6.83 t/ha in 1989. These numbers decreased to 3.8t in 1990 and 3.7t in 1991, once the pastures were grazed. The introduction of stylo on sown pasture increased biomass by 40 per cent in 1988. However, this increase became negligable after two years of grazing, necessitating the introduction of stylo every third year to maintain production levels.

Changing Traditional Grazing Practices

Most grassland production and regeneration in the Himalayas is highly sensitive to biotic interferences such as grazing. Therefore, traditional practices such as open grazing should be changed. Rotational grazing, exclosure, and/or stall feeding, should be introduced. Simple exclosure of grasslands for two to five years can increase herbage yield as much as four times (Sharma *et al.* 1988) and heighten biodiversity three times more than continuous grazing systems. Exclosure also improved nutrient content.

Alternative Land-use System for Forage Production

In order to provide green forage year-round, alternative land-use systems should be developed on private or community lands near villages. Energy plantations, coppice farming, agroforestry, and silvipastoral land-use systems could help meet forage and fuelwood needs, conserve the environment, and help maintain soil fertility through reduced erosion and nitrogen fixation. The species of trees, shrubs, legumes, and grasses chosen for such endeavours will vary according to local needs, elevation, and climatic conditions,.

Research and Development Issues

Grassland Utilisation

Rangeland herbage should be used carefully. In established or natural grasslands, deferrment of grazing schedules helps allow vegetation to reproduce and disperse seed. Rangelands re-seeded with perennial species should not be grazed for the first year. Grazing may be permitted after seed dispersal in the second year. Grazing should not exceed the carrying capacity of the grassland (predetermined in each situation) in subsequent years. Fences are a prerequisite for the introduction of controlled grazing in most dry areas. With effective fencing, pasture yield may increase three-fold in five years.

Stocking Rates and Herd Diversification

A suitable stocking rate should be determined and strictly adhered to, according to the type and strength of a herd and available rangeland biomass. Herd diversification is another important aspect of rangeland development. An area containing both grasses and shrubs may be best used by a combination of different ruminant species with diverse grazing habits.

Ecosystem Rehabilitation

Different management systems significantly influence rangeland and livestock health through their effect on soil, water, nutrients, and biomass yield. Rangeland rehabilitation needs to be initiated, wherever necessary, by planting suitable species, managing eroded grasslands, and controlling stock numbers.

Education

The most important factor in adhering to desired rangeland management practices is the creation of a cadre of sophisticated and educated range managers. Inclusion of range management as a subject in the curriculum of various universities should be prioritised.

Economics

Flexible credit systems, which allow farmers to borrow capital from financial institutions for herd development and improvement, should be established. Long-term repayment schedules and nominal interest rates should be maintained.

Marketing

Suitable marketing networks for livestock products should be created by the government. Subsidised prices for some exchange goods might also be appropriate.

Health Care

Animal health care, either completely or partially financed by the government, should be introduced throughout livestock-rearing communities in order to increase and maintain production levels.

Fodder Cultivation

Efforts should be made to increase overall forage availability. The number of areas under fodder cultivation and agroforestry systems should be increased. This will greatly reduce rangeland pressure. The creation of fodder banks in drought-prone and other potentially dry areas should be given priority.

People's Participation

Social and cultural factors are key elements of pastoral management. Local people's participation is vital to successful rangeland systems. Prevailing management practices have to be carefully studied and blended with other improved models. Only local people can ensure the successful implementation of rangeland improvement programmes.

Research Programmes

Research programmes geared towards rangeland production, management, and utilisation should stress the following points.

- Collection, evaluation, and introduction of suitable legume species with high palatability and drought resistance
- Breeding and biotechnological programmes to create palatable, high-yielding, and stress-resistant grasses, shrubs, and fodder trees
- Evaluation studies regarding the diversification of herds to enable livestock to survive under various ecological conditions

- Extensive rangeland surveys and ecological research about different habitats
- Soil and water conservation and utilization techniques employed under various land and climatic conditions
- Role of mycorrhizae and non-symbiotic nitrogen-fixing bacteria in relation to crop and grass productivity

Policy Recommendations

The following are policy recommendations for sustainable rangeland management in India.

- Most grasslands are openly grazed. Controlling grazing is a difficult problem. Public support for keeping livestock numbers and grazing controlled would be meaningful if some alternative arrangement to meet grazing requirements could be suggested. Adequate protective measures must be provided for farmers.
- There are many legislative acts for the preservation of forests and the regulation of forest products. Vast areas are under the control of government authorities who are not fully staffed or capable of managing these areas. Long-term leasing of such areas to appropriate institutions and individuals should be encouraged.
- Development projects on wastelands/ grasslands have great potential for employment and income generation. Once these lands are more productive, the earnings of small and marginal farmers who, otherwise, live below poverty line can be increased.
- Extension related to grass and tree farming and the protection of degraded grasslands should be implemented through schools, adult education centres, and voluntary organisations. Women's participation in protecting and rearing trees is critical and should be supported.
- In any rangeland development programme, a farming systems' approach should be adopted. As scientific experiments often require social scientific inquiry, a deep understanding of local needs and perceptions should be fostered. Research should be integrated accordingly.
- Availability of adequate funds (with appropriate timing) for afforestation programmes is very important since such work is largely controlled by time and season.
- Pastoralism should be recognised as important and adequately addressed by land management policies. Rangeland should be stratified into naturally defined and ecologically distinct management units for micro-level planning and management according to environmental settings and local needs.
- Ancient local and nomadic grazing practices should be stopped. A shift to new management systems should be encouraged by improving forage availability in such areas. Herders should be educated about the harmful effects of continuous grazing. The establishment of fodder banks in surplus zones will also be an important element of forage resource development.

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Rangeland Resources and Conditions in Western Sichuan

Wu Ning

Introduction

Due to the high altitude and the harsh environment of the Tibetan Plateau, cropping is not possible in most areas. The only way the land can be used is for livestock grazing (Goldstein et al. 1990). At present, there are 167 million hectares of natural rangeland resources on the Plateau, comprising 42 per cent of China's total area of grassland. These areas form the basis for pastoral lifestyles and have been used for centuries. Even now, more than half of the population depends on range-livestock production systems for their livelihood.

In regions like the Tibetan Plateau that are classified primarily by high-frigid environments and a dependence upon livestock production, information about rangeland resources is essential for sustainable development. Over the centuries, the pastoralists of the Tibetan Plateau have been immensely successful not only in using vast rangelands but also in conserving the grazing capacity of these areas. Wildlife has also co-existed with nomadic populations on the Plateau (Schaller and Gu 1994; Miller 1995). These pastoral communities have evolved migratory, semi-sedentary, and deferred grazing practices to produce ample quantities of animal products for private consumption and for sale (Wu 1996). Today, however, numerous demographic and economic changes are triggering adaptive changes that will, most likely, significantly transform these systems. Economic progress has brought pressures on the environment, especially on rangeland ecosystems, and has also influenced infrastructure and daily nomadic lifestyle (Clarke 1987, Wu 1995).

Range Resources in Western Sichuan

Western Sichuan is located on the eastern Tibetan Plateau. Elevations range from 3,000 to 5,000m and the area is located between 97°26' - 104°27' E and 27°57' - 34°21' N. Western Sichuan is an impoverished plateau area in need of development and has a long history of pastoral development with pronounced local economic characteristics. The total area is about 236,000 sq. km. and includes 13.9 million hectares of rangeland. These range resources not only play an important role in the national economy and environment, but are also related to the improvement of local livelihoods.

Land classification figures clearly indicate the importance of rangelands in western Sichuan. Some 58.9 per cent of the land in western Sichuan is rangeland, accounting for 3.5 per cent of China's rangelands. Of the 13.9 million hectares of rangeland in western Sichuan, 12.18 million hectares are available for grazing. This means that about 7.5 hectares of pasture are available per person and about nine hectares are designated for each rural person.

A number of factors determines the natural occurrence and extent of high-frigid rangelands in their various physiognomic forms. The most significant of these are: geomorphology, precipitation, temperature, and grazing. It is important to understand that these factors rarely operate independently of the others. Most often, the joint impact of several of these factors may have a cumulative effect upon a given ecosystem; occasionally such factors, alone or in combination, may have an entirely different effect.

Rangelands are primarily divided by grass type. Although trees and bushes are found in some places as woodland and bush meadows, these trees or shrubs are relegated to a secondary position as habitat indicators compared to grasses. The high-frigid rangelands that support Tibetan pastoralists (such as those of western Sichuan) have been divided into four kinds, 12 groups, and 22 types (Ni et al. 1984, Table 1).

High-frigid Meadows

High-frigid meadows are mainly composed of perennial and medium (eumesophytic) herbaceous plants and are formed under the Alpine and cold-humid climate of the Plateau. These meadows account for about eight million hectares of available area in western Sichuan, or 62.28 per cent of the area's total rangelands. They are distributed between 2,800 and 4,700 metres and extend across the northern part of the Province through Hongyvan, Zoige, Aba, northern Zamtang, Serta, Serqu, Garze, and Litang counties.

This rangeland's sod layer is one of its most important characteristics. The tightness and thickness of sod layers only diverge with variations in hydro-thermal conditions from place to place. Generally speaking, the colder the climate, the tighter and thicker the sod layer becomes. In frigid climates, more biomass accumulate in the underground parts of plants than in the aerial parts, and the decomposition of organic matter is slower. In addition, high altitude, cold climates, long winters, short growing periods, and substantial day-night temperature differences give rise to apparent similarities between grass species and definite distribution laws.

Cold-tolerant and perennial plants are the primary flora, represented by *Kobresia,* which grow thickly in clumps and cover about 80-90 per cent of the high-frigid meadows. Secondly, creepers, such as *Potentilla,* grow in the form of lotus fruits such as *Polygonum* and *Primula*. Plants growing in clumps, such as *Festuca, Poa,* and *Elymus,* are the main dominators or companions of creepers. The proportions of these representative plants always change regularly and with variations in latitude and altitude. The more northern the latitude, the higher the altitude and the colder the climate, the more important *Kobresia* becomes. At lower altitudes with warmer, more southern climates, more *Graminae* grasses are found in the vegetation. The height and productivity are also negatively correlated with latitude and altitude. The further north the latitude and the higher the altitude, the lower the plant yield.

Since high-frigid meadows are distributed extensively across great vertical difference, the characteristics and properties vary. These regions were formerly divided into Alpine meadow and sub-Alpine meadow

Table 1: Classification of High-frigid Rangelands in Western Sichuan

Kinds	Sub-kinds	Groups	Types
High-frigid Meadow	Subalpine Meadow	Gramineal grasses on the plains	1. *Arundinella chenii* 2. *Elymus nutans, Roegneria nutans*
		Sedges on slopes	3. *Kobresia setchwanensis, K. Capillifolia*
		Forbs on plains or slopes	4. *Anemone rivularis, Potentilla answeina* 5. *Polygonum viviparum, P. Sphaerostachyum*
	Alpine Meadow	Gramineal grasses on the tops of hills	6. *Festuca ovina*
		Sedges on plains or ridges	7. *Kobresia pygmaea*
		Forbs on plains or slopes	8. *Spenceria ramalana* 9. *Anaphalis flavescens, Leontopodium longifolium*
	Moist Meadow	Sedges on low temperature lands	10. *Kobresia humilis, K. Tibetica* 11. *Carex spp., Deschampsia caespitosa*
Swamp Meadow		Sedge on accumulated	12. *Carex muliensis*
Alpine Shrub Meadow		Shrub meadows on shady slopes	13. *Salix ernestii* 14. *Sibiraea angustata, Dasiphora fruicosa* 15. *Leaflet Rhododendron* 16. *Caragana jubata, C. Erinacea*
		Shrub meadows on sunny slopes	17. *Quercus monimotricha* 18. *Sabina pingii var. Wilsonii*
Subalpine Woodland Meadow		Open woodland meadows on shady slopes	19. Fir, spruce, open woodland 20. Alpine Oak (*Quercus* spp) Woodland
		Open woodland meadow on sunny slopes	21. *Sabina* spp open woodland 22. Pinus *densata*, open woodland

Source: Wei and Dong, 1984

because they moved vertically across sub-frigid and cold-temperate zones.

In the sub-frigid plateau and Alpine areas at altitudes above 4,000 metres, the annual mean temperature is generally below 0°C; the mean temperature in January drops below - 10°C, while the mean temperature in July does not exceed 10°C, and grasses only grow 60-120 days of the year. There is never an absolutely frost-free season. The tight sod layer is 8-15cm thick and the vegetation cover is easily impacted by drought. Given these climatic conditions, the composition of plants is simple and the grass layer is tight and low. The main species of plants are varieties of *Kobresia*, such as *K. pygmaea, K setchwanensis, K capillifolia, K humilis,* and *K kansuensis. Polygonum* spp and some species of *Potentilla* are also included, as are species of *Carex, Festuca, Poa, Saussurea, Gentiana, Ranunculus,* etc.

Due to the heat deficit, grain crops cannot be grown in this area as it is always under stress from harmful frost and snow storms. Animal husbandry systems, particularly pastoral nomadism, meet the primary needs of the people of western Sichuan. Since solar radiation is strong and daily temperature range is great, the photosynthesis process is active and the ranges are highly productive. The utilization ratio, nutritive values, and palatability remain high. This kind of rangeland is prime summer grazing land. It should be mentioned that this rangeland is extensive enough in many areas to be used as summer grazing pasture, but it can only be used for a short period of the year due to the harsh climate and inaccessibility.

In the cold-temperate zone between 3,000 and 4,000 metres, the annual mean temperature is 06°C; the mean temperature in January is -10°C, while the mean temperature in July can be as high as 12-15°C. Annual precipitation totals 600-700mm and the growing period lasts about 120-180 days. Due to these improved hydro-thermal conditions and rich organic matter in the soil, plants grow luxuriantly and grass cover is high. Different sub-layers of grass can be identified and species' composition is more complex. Besides *Cyperaceae,* which often dominates, more species are taking on a predominant role in plant communities. Grasses and forbs are also abundant, giving rise to apparent seasons and inspiring the name 'colourful meadow' to refer to these grasslands.

Rangelands in these lower regions are mainly used as grazing land in winter, but parts of some pastures are fenced off and the grass is later harvested and dried as hay to supply winter fodder. Since pastoralists spend up to six or seven months in these areas, and since these pastures are generally smaller than others, overstocking and degradation can be seen, despite the area's higher yields. The condition of these pastures, therefore, varies greatly.

Sub-Alpine Open-woodland Meadow

Sub-Alpine open-woodland meadow occurs in open, park-like stands in areas where forests are sparsely distributed such as the edge of forests, clear-cut plots, or the belt near the timberline. A woodland has a well-developed, dominant yet open tree layer with a canopy cover of less than 50 per cent. On average, less than one-third of the crown canopy is either distinct or touching, but crowns are predominantly not interlocking. Shrubs may be scattered in the undergrowth. The ground layer consists of grasses, herbs, and forbs and is well-developed but usually not very dense.

Sub-Alpine, open woodland meadows are always found at elevations between 3,000 and 4,200 metres and mainly occur on valley slopes, particularly the north-facing slopes of wide valleys. The major trees on the north-facing slopes or in the shady valleys are species of spruce and firs such as *Picea likiangensis, P. balfouriana, P. asperata, P. purpurea, P. wilsonfi, Abies fabri, A. faxoniana, A squamata,* and *A. georgei*. Some xerophilous species, such as *Sabina* spp and *Pinus densata,* are common on sunny slopes. Understorey shrubs are dominated by species of *Rosa, Rhododendron, Lonicera, Spiraea, Cotoneaster, Ribes,* etc. Grasses, such as species of *Elymus, Poa, Deyeuxia, Roegneria, Ptilagrostis,* and *Avena,* are relatively abundant and are commonly associated with different sedges and forbs.

These rangelands cover 1.13 million hectares of western Sichuan, comprising 8.1 per cent of the Province's total rangeland. Mean yield per hectare is less than 1,500 kg/ha, with grasses accounting for three to eight per cent of the yield, sedges cover six-10 per cent, while forbs are found on more than 80 per cent of the sub-alpine open woodland pastures. Legumes are rare and are always used as natural cutting pastures and grazing land in winter and spring. The belt near the timberline is used occasionally in summer and autumn when nomads alternate between seasonal pastures.

Shrub Meadow

Shrub vegetation is mainly distributed on south-facing slopes of mountainous areas or in plateau valleys, with a wide altitude range of from 2,500 - 4,500 metres. This range is analogous to the altitudinal range from the sub-Alpine conifer forest belt to the seasonal snowline. Shrubs cover between 30 and 80 per cent of these meadows, but if coverage exceeds 50 per cent, livestock have a difficult time grazing or browsing on these ranges. The area of this meadow covers 3.17 million hectares and accounts for about 24.9 per cent of the natural rangelands, with a mean forage yield of 2,250 - 3,750 kg/ha.

Major bushes include species of *Rhododendron*. These plants cover the north-facing slopes in large areas on the gentle plateau, but they are not of important grazing value. The herbaceous layer, on the other hand, is highly grazed. More than 65 per cent of this layer consists of edible forbs which are highly palatable and of high nutritional value. *Gramineae* and *Cyperaceae* grasses each account for about nine per cent of shrub meadows. This meadow is mainly used as summer-autumn pasture and natural cutting pasture; yet lower elevation meadows are also used as winter-spring pasture.

Swamp Meadow

Swamp meadows are distributed in certain areas on the Plateau such as depression areas, areas with poor drainage or seasonal water accumulation, swamp margins, the bottoms of wide valleys, and foothills with springs. Most of them occur within the Hongyuan and Zoige counties of Aba Prefecture, at elevations of about 3,400 metres. The soil layer is composed of peat-grey soil and peat soil.

They are not many species in this meadow and they are mainly composed of moist-eumesophytic plants and moist plants, as well as a few swamp and aquatic plants. *Kobresia tibetica, K humilis, Carex atrofusca, C. moorcroftii,* and *G. muliensis* dominate. These plant communities cover an average of about 60-85 per cent of the ground cover with a height of about 20cm. The fresh grass yield is about 5,000 kg/ha, of which sedge yields account for 60-90 per cent, grasses comprise three per cent, and forbs cover seven-16 per cent.

As the grasses on swamp meadows become green very early, these ecosystems are important spring ranges. However, many parasites live on the water and on the surface of the soil, which means that animals that graze on these areas run the risk of disease. Generally speaking, the utilization ratio of this kind of pasture is low. Water accumulates easily during the rainy season; these meadows can only be used on the edges during summer.

Characteristics of Rangeland Ecosystems in Western Sichuan

Floral Composition and Quality of Rangelands

Given the short history of the formation of the Tibetan Plateau and the harsh ecological conditions under which it evolved, the development of the flora in this region has been restricted. According to Liu (1991), there are about 350 species of plants in these rangelands. Among these, grasses are extremely abundant. According to amount, yield, palatability, and feed value, grasses and sedges are the dominant plants. Restricted by natural conditions, the high-frigid rangelands produce a high quality of grass but low yields. In order to improve the development of animal husbandry, an estimation of the amount of primary production alone is insufficient, as livestock consume only a portion of this biomass. Another important factor is forage quality.

Grasses not only include a great number of species but are also widely distributed over the vast natural rangelands. Most species of grasses are plants with high permissible off-take because of their root structure or inferior propagation and, in addition, because of their rich foliage and soft texture. In comparison with other herbaceous plants, the nutrient values of grasses are lower, but they are still the main forage for domesticated animals due to their abundance, high palatability, and convenience in processing, carrying, and storing. These grasses are very important for fattening animals during autumn. They are also cut and dried as supplementary forage. However, the rangelands encompassing these grasses are small and their yields are lower than pastures dominated by sedges and forbs.

Species of sedges are not as numerous as those of the grasses, but they are very important for natural rangelands, especially species with low temperature resistance. *Kobresia* and *Carex* predominate most high-frigid meadows. In Garze and Aba Prefectures, pastures have a predominant abundance of species of *Cyperaceae*. These plants comprise 68 and 71 per cent of the total rangeland area; they have a high nutrient value and are also highly palatable, particularly for yaks. The species of *Kobresia* contain 13.49 per cent crude protein on average higher than that of other species in this family. This characteristic of *Kobresia* makes up for the deficit of legumes in the high-frigid meadows. Sedges have some shortcomings, such as high silicon content, changeable yields due to seasonal alternation, and their short bodies, which lead to yield disadvantages.

Legumes are also found throughout various rangelands of western Sichuan, but they are not as numerous as grasses. Since they contain more protein, minerals (especially in calcium), and vitamins, they are still very important for the growth of livestock. The mean nutrient contents in legumes such as *Medicago, Vicia, Hedysarum,* and *Astragalus* are as follow: crude protein, 20 per cent (varies from 10-20%); crude fat, 3.1 per cent, and calcium, 1.51 per cent. Among these, crude protein is the most important nutrient in all herbaceous plants. Because of the limits of natural conditions, large-scale introduction of improved species of legumes is difficult in this region. Therefore, initiatives to breed local wild species should be implemented.

In addition to grasses, sedges, and legumes, other forbs also are numerous and are widely distributed throughout the region. Their yields rank first among other herbage (usually above 50%). Edible forbs comprise one half or one third of the total forbs, some of which are palatable for animals. Thir crude protein content is always higher than that of grasses and sedges.

Seasonal Availability of Rangelands

Growing Phases of Plants

Within a single growing season, grasses show a fairly consistent growth pattern. Initiation of growth is largely determined by temperature and, in most cases, growth does not commence until air temperatures reach about 6 °C (Briggs and Courtney 1985). While temperatures are above that level, the rate of growth is closely related to the input of solar radiation.

1) Germination or Regrowth

Perennial plants, such as *Kobresia,* begin to grow at the end of April or the beginning of May when the daily mean temperature is about 4 - 5 °C. During this period, because of the low temperature, plants grow slowly and production is also low. For grasses reproducing by seeds, the herbaceous stratum which develops during the growing season is determined by the amount and distribution of rain at the beginning of the season, taking into account substration and seed supply. It is obvious that rainfall influences the nature of a germination flush by determining the period of wetness of the substration. The longer this period, the higher the proportion of slow-germinating species in the vegetation. On the highlands, germination is not successfully completed until the seedling is well established.

2) Vegetative Growth

Once growth begins, it tends to be rapid. Daily dry matter pasture production increases to a peak within six to eight weeks. Thus, this phase of vegetative growth sees an increase in both the mean height of the pasture and in its density. The total biomass produced during the growing season is determined by growth factors in short supply. For natural rangelands, this is first, soil fertility, and, secondly, water and heat availability. Tillering ability and plant establishment play an important role in the plant coverage by various species.

3) Reproductive Growth

Throughout the phase of vegetative growth, flowering stems of plants remain short and close to the ground; but, during late spring and early summer, vegetative growth gives way to reproductive growth and flowering stems extend and ultimately produce a flower. The beginning of the flowering phase varies from plant to plant. According to observation in Zamtang County (Wu 1996), *Kobresia setchwanensis, K. pygmaea,* and *Leontopodium nanum* begin to flower as early as June. These plants not only regreen and flower quickly, but also bear fruit and become dormant rapidly. Plants that flower in the middle of July include *Carex sp, Potentilla anserina,* and *Oxytropis kansuensis*. Others, such as *Elymus nutans, Festuca ovina, Poa sp,* etc, flower as late as the middle of August.

Reproductive growth is important for two reasons. First, the beginning of this phase (flowering) is the moment when growth rate decreases. Thus, flowering dates determine growing period length and, consequently, biomass production and its quality (dilution of nitrogen). Second, reproductive growth is the basis for each species for the following season. During vegetative growth, there is competition among species for light, nutrient elements, and water.

4) Senescence and Dormant Period

As the season progresses, senescence increases. Stresses upon the plants become greater due to lower radiation inputs and reduced ambient temperature. Plants cease to be able to compete as successfully, and new tillers fail to mature. In high altitude areas, various underground parts and seeds of plants are always dormant. Seeds and dead residues of plants undergo several processes. These processes, along with previous plant activity, determine the development of the quantity and quality of forage with time, thereby affecting the next season's growth. In northwestern Sichuan, grasses begin to wither and then become dormant in early November, though this can vary with climatic conditions.

Seasonal Pastoralism

Vertical climate changes caused by topographic variation lead to the formation of different seasonal pastures and seasonal grazing cycles. This implies that the seasonal variation of forage supplements is not of an equal proportion and pastoralists have to migrate in order to adapt to these variations. Meanwhile, since different grazing animals demand different fodder and ecological environments (e.g., temperature, water source) at various seasons, grazing practices and pasture resources are also seasonal. As seasons change, livestock often have to cover great distances in search of food and water. This strategy usually promotes sustained-yield resource exploitation whenever land becomes scarce and, in particular, when seasonal grazing sites are inaccessible by any other means.

In western Sichuan, the start of nomadic migration corresponds to the growth of grasses. Spring grazing only begins after grasses have been sprouting for between 12-18 days and have reached a height of 5-10 cm. This corresponds to late April for most semi-nomadic mountainous areas, where altitudes range from 2,500 to 3,500 metres, and from late May to the beginning of June in nomadic areas above 3,500 metres. This commencement of growth is marked by grass tillering and forbs dividing. Grass palability and nutrient value are both high at this time. Stored nutrients exhausted by the sprouting of regressing grasses have already recovered; consequently, grazing activity does not impact grass regrowth.

The time of autumn grazing termination will impact the coming year's grass yield. If termination occurs too late, the plants' pre-winter nutrient storage will not be sufficient and production will decrease. Therefore, autumn grazing usually stops 30 days before grasses stop growing. Nomads always drive their herds down to winter pastures from the end of September to the middle of October.

However, natural conditions, such as location and altitude, can restrict and alter the length of sprouting and withering periods. In northwestern Sichuan, where rangelands are usually located above 3,300m, the growing period only lasts about 100 days and never exceeds 170 days. The dormant period, however, can last as long as 250-270 days. This discrepancy leads to fodder shortages and high mortality rates among domestic animals. In more southern, lower altitude rangelands, the growing period lasts about five months, from May to September. In general, as altitude increases, growing seasons decrease, dormant periods become longer, and the utilization value of pasture also decreases.

Features of Rangeland Ecosystems

Rangeland ecosystems include three main components: vegetation, soil, and livestock. Each of these components interacts closely with the others. Soil fertility, for example, partially controls grass growth and herbage production, which, in turn, affects animal behaviour and development. Animal behaviour, in turn, influences pasture and soil. These three components of the ecosystem as a whole are also connected to external socioeconomic systems.

Vegetation is a central component of rangeland ecosystems. It receives inputs of energy from solar radiation, water, and nutrients from the soil. Vegetation provides energy and nutrients to livestock and, through the return of plant residues and the penetration of roots, has a marked effect on soil conditions. It also acts as a buffer between grazing animals and soil, absorbing some of the physical damage of grazing by propagatively regenerating. Pastures are, likewise, influenced by animal behaviour such as trampling, selective defoliation, and the return of faeces to the soil. All these processes affect the rate of growth and competitiveness of herbaceous plants, and thereby influence pasture composition. These, in turn, control rangeland productivity.

Under the natural conditions of western Sichuan, yaks and sheep act as the main consumers of rangeland vegetation. Grazing must be considered a natural influence in rangeland ecosystems. Rangelands grazed lightly or moderately by these animals remain stable and productive. Moderate grazing can stimulate productivity, with production of above-ground parts increasing to twice the size of ungrazed areas (Wu 1996). Furthermore, there are indications that light or moderate grazing can maintain the balance between plant species for very long periods (Pearse 1970). Total protection, on the other hand, leads to stagnation of growth and more or less complete dominance of a few species. Species' diversity decreases and productivity drops sharply (Singh and Misra 1969).

Whittaker (1977) drew similar conclusions based on fieldwork conducted in Israel. He suggested that grazing stress can prevent competitive exclusion and further suggested that many of the diminutive annuals which contributed a large portion of the species' richness in his study area coexist by inhabiting different micro-sites in the rocky, shallow-soil hillsides. More importantly, vegetation can adjust to long periods of stress, both through immigration of new species and evolutionary changes in those present. Thus, grazing should have a detrimental effect on communities with little history of grazing, whereas grazing might well be required to maintain species' density in communities with a long history of pastoral behaviour. The so-called 'sustainable development in pastoral society' means a rational use of rangelands rather than absolute protection.

The complex relationship between grazing animals and plant communities has long been recognised by rangeland workers. In most experimental work involving herbivores, it is virtually impossible to control more than a few variables at any one time. Grazing has three main effects on vegetation: a) the sward is defoliated; b) nutrients in the form of dung and urine are returned or removed from the rangeland ecosystem; and c) the plant life suffers physical damage from trampling.

The management of rangelands, in most cases, represents a loss of matter — and therefore energy — to the system. Under conditions of dynamic equilibrium, energy removed from rangelands as fodder or livestock is balanced by energy put into the system in the form of solar radiation. In the absence of management, matter accumulates in the system and tussocks are often produced, particularly by certain plants such as species of *Kobresia* and *Carex*. Under these circumstances, the nature of available plant material in the system changes from predominantly fresh, living foliage to old, dead material. The animal community changes from one consisting mainly of primary consumers to one in which saprophagous, decomposer species predominate. Even so, animals are unable to decompose all the plant litter. Dead plant material accumulates as succession proceeds.

The aim of the pastoral herdsmen is to control all three components - by migration, changing grazing routes, regulating the duration herds stay in one place, determining grazing seasons, and by controlling livestock. Thus, herders regulate inputs and outputs within the system, as well as its internal structure. It should also be remembered that herders are affected by this system — not always directly but through the economic implications of rangeland productivity.

While a certain amount of rangeland production is needed to maintain equilibrium, overuse is detrimental. Although there are various degrees of overuse, and although factors such as timing and duration are important, the destructive effects of overuse have been noted worldwide. Degradation proceeds faster than regeneration (Behnke 1992). Species that germinate slowly have resistant seeds, which are always present. The seeds of rapidly germinating species are less resistant to grazing pressures; they may survive in a viable form in the soil for a year. Seeds produced by these former species one year will determine the population of the following year. It takes a long time to build up a population of rapidly germinating species. If degradation has been caused by overgrazing, the regeneration process will be protracted, since the soil surface has been destroyed (Fig. 1).

Potentials and Constraints of Rangeland Ecosystems

Rangelands are fragile ecosystems. The basis of appropriate management lies in not exploiting their potential in the short term beyond their capacity to recover. The demand for increased production has to be carefully weighed against the need for preservation and balance in the natural environment. Available fodder resources have to be evaluated so that estimates of production potentials can be made.

Rangeland Degradation

Degradation of rangeland due to overgrazing is manifest in almost all pastoral areas (Scholtz 1995). No areas are found in which the current plant growth might be considered climax composition. What has been done so far to discover major causes of degradation, ways of combatting it, and producing an understanding of traditional pastoral systems of livestock and range management? Stiles (1981) reviewed the position usually espoused by social scientists (anthropologists, geographers, development experts, etc) that degradation or even desertification is caused by many factors: natural disasters such as long-term climatic deterioration, restriction of natural pastoral movement patterns, and artificial concentrations of high-density populations resulting from the creation of permanent dwellings. This position maintains that, under natural conditions, traditional pastoral practices are the most effective methods of exploiting and conserving marginal resources.

This position has gained popularity worldwide since the 1980s. Yet this author is of the opinion that, given the complexity of pastoral ecosystems, the causes of degradation should not be given such a simplistic explanation. Ecological factors, such as long-term climatic deterioration, global climatic change, and ecological fragility, are internal causes of degradation; artificial factors, such as overexploitation of environ-

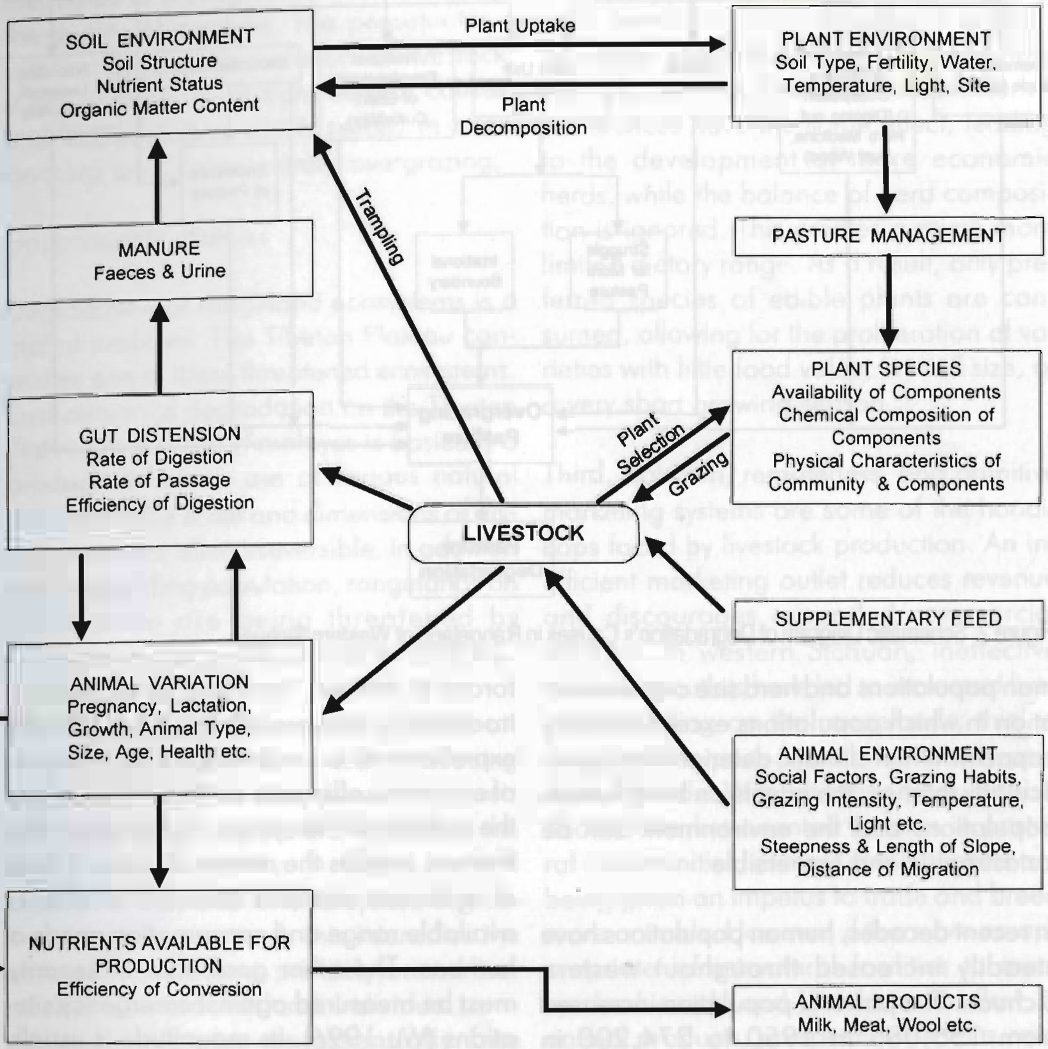

Figure 1: Schematic Complexity of Soil-Plant-Animal Relationships

mental resources by humans and their grazing animals, misjudgment of political decisions or economic policies, and so on, are external impetus for such depletion of grassland resources (Scholtz 1995; Wu 1996). To resolve this problem, data on the interrelationship of demographic, economic, and environmental change in relation to climatic change before and after the adoption of pastoralism as a subsistence base must be collected. It is not the author's intention, however, to give an overall explanation about the causes of degradation on rangelands. Such causes vary depending on location. Rather, this section has tried to simply outline and describe some forces affecting the study area (Fig. 2)

Pressures of Population

The principal causes of degradation derive from human beings' demands upon the environment that exceed the natural regenerative capacity of land. Increases in hu-

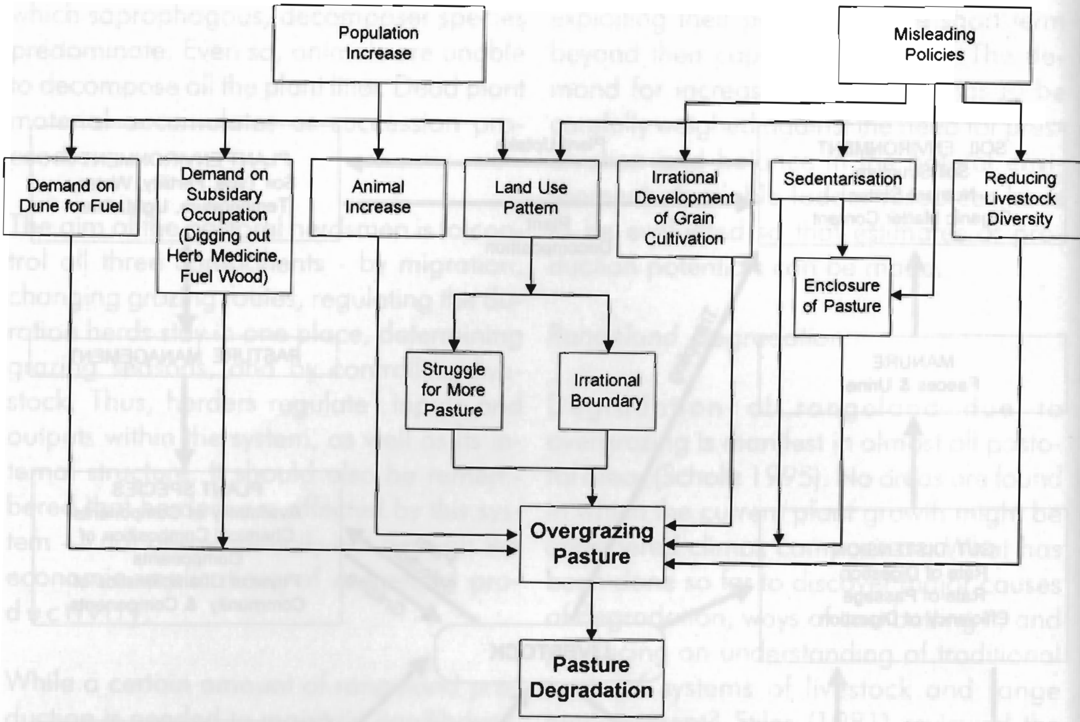

Figure 2: Schematic Diagram of Degradation's Causes in Rangeland of Western Sichuan

man populations and herd size create a situation in which populations exceed carrying capacity. When climatic deterioration is particularly intense, the effects on both human populations and the environment can be catastrophic and irreversible.

In recent decades, human populations have steadily increased throughout western Sichuan. The pastoral population increased from 155,085 in 1950 to 274,200 in 1990, an annual rise of 1.92 per cent. This indicates the population is no longer compatible with the land's capacity to support humans. In fact, most ranges that are used for extensive rearing of livestock already show many signs of degradation. In late autumn and early winter, rangelands are particularly denuded, giving forage grasses no chance to rehabilitate.

The availability of rangeland, together with the size of human populations, imposes limits within which livestock populations are forced to change. Variations consciously introduced by pastoralists are, as a rule, the expression of a conflict between the aims of economic efficiency on the one hand and the viability of the system on the other. The first aim implies the maintenance of a herd of optimum size and structure relative to available range and consumption needs of humans. The other goal, that of security, must be measured against emergency situations (Wu 1996). Its magnitude is usually based on vague empiricism, often revealing itself as a tendency to maximise animal populations.

Among pastoral nomads, the pattern which has emerged with modernisation is one of increasing pressure on pastures. As a result of successful attempts to reduce mortality rates, the human population is growing more quickly, as are livestock numbers. On the whole, efforts to increase the area of rangeland do not keep pace with changes in the two other variables.

Overgrazing in one area can be caused by an excessive density of livestock, which further leads to a progressive deterioration in the quality of pastures. This perpetuates a familiar cycle: accumulation of livestock; eventual decimation from natural causes; and accumulation which results in overstocking and, consequently, overgrazing.

Inappropriate Policies

Degradation of rangeland ecosystems is a global problem. The Tibetan Plateau constitutes one of these threatened ecosystems. Environmental degradation on the Tibetan Plateau and in the Himalayas is basically a product of human use of various natural resources. The scale and dimensions of disturbances are often irreversible. In addition to an expanding population, rangelands on the Plateau are being threatened by overgrazing due to inappropriate policies.

First, the problem of overgrazing can be attributed to a difference in incentives facing individual livestock owners and the costs and benefits of rangeland utilisation to the entire pastoral society. In many pastoral areas in China, a communal system of grazing is usually practised; this intensifies the contradiction between privately-owned livestock and communal land. Individual owners view pastures as essentially free comodities; if one person does not exploit the resource, then someone else will. This purportedly leads to a situation in which each herder maximises the number of animals grazed on the rangeland. Intense competition for the use of this scarce resource may ensue. This leads to deterioration and even rangeland destruction — consequences with many communal implications.

Second, many ecological changes occur in rangelands where extensive stock-rearing stems from low herd diversity. During periods of collective management, the composition of grazing animals was decided by the authorities concerned. Only certain animals were designated to graze in particular areas. This inevitably led to the simplified structure of livestock herds. Market preferences have the same effect, leading to the development of more economic herds, while the balance of herd composition is ignored. This creates a much more limited dietary range. As a result, only preferred species of edible plants are consumed, allowing for the proliferation of varieties with little food value, limited size, or a very short growing season.

Third, isolation, remoteness, and primitive marketing systems are some of the handicaps faced by livestock production. An inefficient marketing outlet reduces revenue and discourages expanded commercial off-take. In western Sichuan, ineffective marketing outlets have led to increased livestock stocking on the rangelands; this, in turn, creates price spirals for locally-produced goods. With changes from subsistence to market-oriented systems in pastoral communities, at least some herders are being given an impetus to trade and breed more animals. However, if there are no appropriate infrastructural facilities to meet herders' needs and distribute the flow of animal products, prospective benefits cannot be realised and overstocking is inevitable. This is the case in western Sichuan where the innovation of infrastructures has not yet been compatible with economic changes. Animal products have not become commodities; yet herders continue to increase herd size in the hope of benefiting from the sale of animal products. Without necessary infrastructure, however, pressure placed on grassland resources has intensified.

Finally, sedentarisation policies and initiatives aimed at enclosing large areas of rangeland have harmful effects on ecological conditions. Enclosed range areas, although their productive potentials are slightly higher than open range, are not immune to overgrazing. Stocking densities rarely match carrying capacity, but rather cater to the needs and demands of stock owners, and this often results in overstocking (Behnke, et al. 1993). Additionally, the changes from a long-ranging and highly mobile herding system to a short-range and sedentary or semi-sedentary one can have deleterious effects on range vegetation and soil. Grazing pressure on residual open range is increasing and migrations have to be rerouted. Some migration routes or water sources may be closed permanently, thus increasing pressure on others.

In addition to the factors mentioned above, it should be emphasised that there are also a number of other factors contributing to overstocking and degeneration of pastures, decline in livestock quality, and unstable productivity with poor economic returns. Yet these factors always exist in combination and affect the ecological situation of rangeland together. Under the *status quo* of rangeland management, productivity is decreasing, but excessive reclamation and grazing are continuing. In the mean time, numbers of grazing animals rise, but animal quality is not heeded. Thus, this problem of the relationship between livestock and forage is the basic contradiction of pastoral production in western Sichuan — a problem that is becoming more acute each year.

Rangeland Ecosystems' Responses to Pressures

Every ecosystem operates under the pressure of two kinds of factors, internal and external. Internal factors are due to the development of a plant community and associated changes in habitat conditions; external pressures are usually community-independent. Human population pressures are referred to as the anthropogenic factor and are also significant. The anthropogenic pressure acts as an internal factor when it predominates over a large landscape zone. This may be illustrated by pastoral ecosystems in which herding activities and exploitation are major agents in the system's economy.

High altitude rangeland ecosystems have developed in a climate displaying much seasonal variation. Therefore, fluctuations of a given environmental factor are much greater in an ecosystem associated with highland rather than lowland zones. Functioning under variable environmental conditions involves special ecological adaptations which permit ecosystems to survive through periods of strong pressure. Such adaptations are best known at the level of individual morphology and physiology. They are also found in the organization and management of ecosystems and are expressed both in terms of their structural properties and their response to environmental pressures.

Alongside the regular set of factors operating within a given geographical zone, there are also new agents which act upon ecosystems causing considerable deformations, both of the systems themselves and their surroundings. These agents will be referred to as *pressures*. It is not so easy to differentiate between pressures and normal environmental variations. It is assumed that pressures should be associated with the introduction of agents that have never before been encountered by ecosystems. Pressures cause so great a deformation of the requisites within an ecosystem that they begin to display a range of variations extending far beyond the regular limit. Anthropogenic pressure is a major type, affecting a system through a whole set of factors and fairly intense action. Thus, this pressure impedes the adaptive processes of the entire ecosystem.

To establish a new pattern of environmental relationships due to such a pressure usually entails a response of the ecosystem's components, i.e., rangeland, livestock, and pastoralists. This may evoke many concomitant reactions within a community, depending on the effect of a given pressure and a community's resistance to it. An obvious response is a change in the dominant structure of plant associations; species adjust to a new ecological situation resulting from different grazing pressures. Furthermore, community response also triggers ecological succession, thereby transforming the system so that it is better adapted to new environmental conditions.

Under strong pressure, some rangeland ecosystem components may be eliminated as a result of natural selection. Such pressures cause effective and directional natural selection in various species, producing changes in the genetic structure of populations. These phenomena have been found true of species on heavily overgrazed pastures. Changes in population structure are associated not only with diversity, but also with interspecific competition. Besides these changes in their genetic structure, populations display increased resistance to overstocked environments. The ways in which community organization respond to a given pressure must be determined. Its reaction to normal environmental factors chiefly consists of restructuring associations that compose different links of trophic chains. When pressures are strong, more profound changes in rangeland, in livestock, and in the related grazing system can be expected.

A plant community subject to heavy grazing pressure over a long period of time will undergo a process of change, eventually achieving a grazing climax which may be characterised as anti-pastoral. Plant adaptations to herbivores include escape in space and time as well as production of toxins, uncommon amino acids, and other digestibility-reducing substances (Nyerges 1979). Over time, dominant plant species will evolve toxicity specifically in response to new grazing pressure. In this case, toxicity is favoured in the plant community. Plant evolution occurs to such an extent that excessive foraging is prevented. Either plants and animals become closely co-adapted so that a sustained level of foraging is possible but overgrazing is prevented by toxicity or the relationship fluctuates in a cycle. At first, an increasing animal population overgrazes non-toxic species on the range until only toxic species remain. Animal starvation and poisoning ensue, causing a crash in the population of grazers. The eventual return of non-toxic species to the range follows.

The mediating role of stock in pastoralism depends largely on the evolved capacity of domesticated animals to forage successfully on available vegetation, which is generally scarce, of poor nutritive quality, and partly toxic. Thus, the capacity to forage must include adaptations to optimise nutrient intake and minimise or avoid consumption of toxins. Possible animal adaptations to plant poisons include detoxification of plant secondary compounds in the rumen and defensive foraging strategies essentially learned by individuals in infancy and specific to the local flora. In general, foraging by domesticated animals and control of foraging by humans are geared to optimise consumption; but these strategies must be understood in the context of plant adaptations to escape or minimise herbivore predation.

In addition, grazing impacts on the environment are strongly limited in space by the location of settlements and water sources. Grazing pressure approximates an inverse function of distance from the central water source or settlements. Vegetation response to grazing will, therefore, vary with distance from these sources, so that nearby vegetation is more strongly modified than vegetation further out. This is the reason why winter pastures experience uneven degradation. Optimisation strategies of rangeland ecosystem management are highly dependent on these factors. The study of pastoral ecology, therefore, becomes (at least partially) a study of spatial distribution and adaptive strategies adopted by pastoralists.

Perspectives and Conclusions

Rational utilisation of rangelands can retard degradation processes. Such rational utilisation of range could sustainably conserve rangeland resources. At the present stage of rangeland development, it is extremely necessary to collect more detailed regional and local information. This information base can serve as a starting point for detailed range management planning. The adaptation of animals to the natural environment and changes in seasonal fodder supply must be considered. Both of these factors may vary greatly within short distances as well as between different range or management units.

The aforementioned qualitative aspects of range utilisation should be taken into account for future development planning. The attraction of an increasing market economy has to be weighed against risks of land degradation. Today, systems of production in western Sichuan are more or less balanced; but ranges are already being used at close to their maximum intensity. These ecosystems are highly vulnerable. For this reason, rangelands should not be submitted to the uncontrolled and continually changing market interests arising from an increasing demand for animal products.

Rangeland developers should support the practice of mobility in traditional pastoral systems. As such, efforts to increase winter fodder resources should be encouraged, as this is the only way to use range resources adequately without immense financial investment. As a supporting measure, the re-establishment of degraded ranges and the establishment of protection areas for forage species should be prioritised.

At present, in pastoral areas of western Sichuan, the main development challenge is the articulation of a development strategy for nomadic areas that centres on rapid attainment of sustainability in all fields. Such a strategy must also consider regional, political, judicial, social, economic, and ecological circumstances. Pastoral economy or rangeland development cannot be treated as an isolated subject, but must be considered as an integrated part of a comprehensive regional development strategy based on basic needs and a 'self-help' philosophy.

It should be stressed that nomadism is the form of land use best adapted to these high-frigid ecosystems (Wu 1996). Various forms of nomadic living and economy, as described in the past, included - without question - optimal adaptation strategies. Furthermore, flexible, mobile stock- breeding based on the experiences of traditional nomadism and integrated into the entire regional economical, social, and ecologic system is the only way to use the poor and vast Tibetan Plateau adequately (Scholtz 1995).

The results of recent development trends cannot be clearly predicted. Nevertheless, a synthesis must be found between economic aspirations and environmental constraints. Traditions and new ideas have to be carefully combined to ensure the further existence of rangeland production systems. In order to achieve all of these aims, projects should be comprehensive, employing experts from different disciplines. A component that solely addresses range conditions and the development of range resources should be considered imperative for projects dealing with rangelands. Both modern technical means as well as target groups' traditional knowledge should be considered basic to constructive development.

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Status of Rangelands and Rangeland Development in Pakistan

Dr. Mirza Hakim Khan

INTRODUCTION

Pakistan is located between 24° and 37° north latitude and 61° and 75° east longitude, with a total land area of 87.98 million hectares. The country's diversified relief is rich in agricultural potential given its extensive canal irrigation system. In the southwest of the country, summer temperatures may soar to 45°C, while temperatures are often below freezing in the northern parts of the country. Precipitation also varies from about 100 to more than 1,500mm. Most of the country is classified by arid or semi-arid ecology.

The northwest, west, and southwest of the country are comprised of the large, fertile Indus Plains. The north includes the Karakoram and Himalayan mountain systems, as well as the Hindu Kush, and is one of the most significant mountainous tracts in the world. The unique Karakoram mountains host many glaciers and moraines and contain 100 peaks over 5,400 metres, including K2 (8,563m), the second highest mountain in the world. These mountains form a physical barrier between Pakistan and China, in the north, and Afghanistan and Iran in the southeast. They are also a barrier against westward penetration of the south-easterly monsoon and eastward movement of the northwesternly winds from Central Asia (Sheikh 1986).

The Indus Valley, like the Nile, Euphrates, and Tigris, was home to one of the world's first civilizations. Its fertile soil, plentiful water supply for irrigation, flat lands, and a dry climate creates little erosion and is ideal for cultivation. These hospitable ecological conditions led to a rise in the human population, resulting in deforestation throughout the Hindu Kush and Himalayas. Floods and siltation have also increased. These changes have, subsequently, negatively affected the overall economy and standard of living in the region (Rafi 1966).

STATUS OF RANGELANDS

Types of Rangelands in Pakistan

Five types of rangeland — Alpine pastures, sub-alpine pastures, temperate rangelands, foothill rangelands, and arid rangelands — are found in Pakistan. Alpine pastures are located between 3,500 and 5,200 metres and include continuous meadows that bear grasses, herbs, and forbs. Some bushy vegetation, including *Juniperus* sp, *Salix* sp, and *Betula* sp, can also be found in these areas. The grasses, forbs, and herbs include *Agropyron* sp, *Poa* sp, *Festuca* sp, *Artemisia martimia, Digitaria decumbans, Trifolium repens,* and *Thymus serpyllum*.

Sub-Alpine grazing lands range from 2,500 to 3,000 metres. In these areas, pastures are located within forests on either moderately level ground or steep slopes. These sub-Alpine grasslands are used during seasonal migration from lower valleys to Alpine pastures in early summer and fall. The rangelands extend from high elevation Alpine pastures in the north to fertile fields in the south (Mushtaq 1989). Common species found include: *Chrysopogon aucheri*, *Agropyrum* sp, *Potentilla sabaldi*, *Trifolium repens*, *Setaria pertusa*, and *Bothriochloa* sp. The introduction of potatoes as a cash crop in the Kalam Valley has considerably reduced the overall area of this pastureland.

Temperate rangelands occur between 1,300 and 3,500 metres. These potential forest lands have degenerated into grassland due to biotic interference. During summer, luxuriant grasses grow in these areas because of monsoon rainfall. The most common temperate grasses are: *Eragrostis* sp, *Aristida* sp, *Chrysopogon montanus*, *Heteropogon contortus*, *and Dicanthium annulatum*.

Foothill rangelands include areas below 1,300 metres. In these regions, pastures have been extensively grazed and carrying capacity has declined. These areas are now being converted to agricultural lands. The common grasses found in these pastures are *Desmostachya bipinnata*, *Saccharum spontaneum*, *Eulaliopsis binata*, and *Themeda anathera*.

Arid Rangelands

Arid rangelands are located in Punjab, Sindh, Balochistan, and the North West Frontier Province (NWFP). Shifting cultivation, unregulated grazing, and exploitation of woody vegetation for fuel have lead to increased wind erosion of sand in arid and semi-arid areas. Drifting sand disrupts communication lines, ports, and housing, particularly in Balochistan's Chagai-Kharan districts and on the Makran coast. Afforestation efforts, such as the introduction of mesquite, have been highly effective in counteracting these problems. Large areas can now be effectively treated to prevent further erosion.

Sindh's main rangeland areas are in the sandy Tharparkar region and the non-sandy Kohistan foothills, the latter supporting migratory livestock herds that descend from the Balochistan plateau during winter. The Forest Department has jurisdiction over 490,000 hectares of rangeland, distributed between Kohistan, Thar (Registan), and Nara. Most of this is in scattered desert areas, except for one large sub-mountainous block in Kohistan that includes part of Kirthar National Park. The Forest Department and the Sindh Arid Zone Development Authority (SAZDA) are the main agencies monitoring range management, while research is being carried out by the Pakistan Agricultural Research Council (PARC) and the Arid Zone Research Institute (AZRI).

In Punjab, rangelands cover 2.8 million hectares. Range management policies were introduced by the Forest Department in the 1960s under piecemeal development schemes. Work included reseeding small patches; constructing water ponds, wells and other water retaining devices; and small-scale tree and shrub plantations.

Some of the common species of these rangelands include: *Acacia arabica*, *Aerùa tomentosa*, *Alhagi camelorum*, *Albizzia lebbeck*, *Aristida depressa*, *Calligonum polygonoides*, *Leptadenia spartium*, *Prosopis spicigera*, and *Salvadora oleoides*. The following species should be introduced for rangeland improvement: *Tamarix* *aphylla, Zizyphus nummularia, Lasiurus hirsutus, Capparis aphylla, Cenchrus ciliaris, Azadirachta indica, and Melia azedarach* (Khan 1982).

Alpine Pastures in Kohistan (Dir, Swat, Kaghan Valley, Chitral and Northern Areas)

The Kohistan area is located between 3,500 and 5,500 metres. Rangelands extend over large areas of this land. When snow begins to melt in May, nomads who have spent the winter at lower elevations begin to travel north with their animal herds. These nomads, or *Gujar*(s) as they are locally called, give cheese, butter, or goats, to the tribal *Malik*(s) of these areas in payment for using their grasslands. Sometimes a fee (*qalang*) is levied by tribal heads for access to pasture.

The Alpine pastures in Kohistan include the following species: *Juniperus communis, Saxifraga ligulata, Hyoseyamus niger, Rumexhastatus, Betula utilis, Linum perenne, Chenopodium botrys, Silene moorcroftiana, Lotus corniculatus, Verbascum thapsus, Artemisia scoparia,* and *Linaria lanceolata*, as well as some tree species (*Ulmus wallichiana, Acer caesium, Quercus* spp). All of these species must be conserved. However, heavy grazing beyond carrying capacity has resulted in pasture deterioration. Unpalatable species are invading such areas. Soil erosion has also expanded. These areas should be rotationally grazed and the following species should be introduced to such areas: *Agropyron canaliculatum, Triticum schrenkianum, Agrostis canina, Bromus japonicus, Cenchrus eiliaris, Calamagrostis pseudophragmites* (Khan 1979). Some shrubs, such as *Salix* spp and *Rosa* spp, and Forbs, such as *Polygonum alpinum, Potentilla* spp, *Tamarix officinalis, Astragalus* spp, *Thymus* spp, *Geranium* spp, *Plantago* spp, *Saxifraga* spp, *Galium* spp, *Trifolium* spp, and *Vicia* spp, should also be introduced.

Pasture Utilisation in the Himalayan and Hindu Kush Region

Pakistan's provincial forest departments administer 6.4 million hectares of extensive range throughout the country. Over 60 per cent of the total land area of Pakistan is suitable for range management and plays a vital role in the country's economy (Table 1). Over 50 million hectares of land is classified as range, of which 18.5 million hectares are considered to be productive. Livestock rearing provides 28 per cent of the GNP and more than 75 per cent of the draught power for farm operations. Pakistan is home to more than 92 million head of livestock (54 million animal units), a number that is increasing by about one per cent each year. Goats and sheep are the most abundant domestic animals.

Table 1: Rangeland Distribution by Province (in '000 ha)

Province	All Rangelands	Range under forest control	% under Forest Dept. control
A.K.	600	195	32.5
Balochistan	27,400	787	2.9
Northern Areas	2,100	2,014	95.9
NWFP	6,100	150	2.4
Punjab	8,200	2,722	33.2
Sindh	7,800	490	6.3
Total	52,200	6,358	173.2

FSMP Report 1991

Rangeland degradation has severely limited productivity, specificially in Balochistan and in the Himalayan highlands. Presently, more than 60 per cent of all rangelands produce less than one-third of their potential. Over-stocking has damaged vegetation cover, which has, in turn, led to wind and water erosion and desertification — changes that are usually difficult to control. The effects of this mismanagement of rangeland resources have begun to show. Nearly half of the rangelands throughout Pakistan's Himalayan range are now gullies, unfit for any use. Hill slopes have generally lost their shallow mantle of soil, exposing infertile mountainous ranges.

The upland forests and rangelands of Pakistan have become severely depleted of many useful 'palatable species'. The principal problems which influence the depletion of Alpine grasslands are government agency, land administration methods and overgrazing. Although most high Alpine grasslands are controlled by provincial forest departments, these agencies do not have the interest, funds, or technical ability to manage these grasslands. Nature conservation, watershed, and commercial management issues are ignored.

In practical terms, local land owners have taken over control of these pastures, leasing out grazing and forest lands. Nomadic tribes with large flocks of domestic stock move into these areas as soon as the spring snow melts and remain there all summer, descending to lower pastures in autumn. This constant grazing pressure is leading to extreme resource depletion. Palatable herbs and grasses are becoming extinct and vegetation cover on highly erodible slopes continues to diminish (Wilkinson and Khan 1991).

As such, two conservation issues emerge. First, grazing royalties should be collected according to a specific range's carrying capacity. Currently, the number of animals on these ranges is unlimited. Second, in order to introduce land ownership concepts to local herders, appropriate technicians should be hired to explain management methods such as those being used in projects such as the Swiss/Pak Kalam Integrated Development Project in the upper Swat Valley, the Malakand Social Forestry Project in Dir and Swat, and the Aga Khan Rural Support Programme (AKRSP) in Gilgit and Chitral. These projects have illustrated that, in many cases, grasses regenerate above 3,000m within three years if grazing is controlled.

RECOMMENDATIONS

Range Management Agency

An independent agency responsible for managing and developing rangelands, as well as devising and implementing sound federal and provincial range policy, should be established (Khan 1972). Range management experts should also be given incentives to carry out their work, as technical expertise is in short supply.

Concept of Social Range Management

The Forest Department has tried to implement improvement activities without consulting range users. The concept of 'Social Range Management' has to be introduced and accepted much in the same way as the concept of 'Social Forestry'. Understanding herders' needs, encouraging their involvement in planning and decision-making, building trust, and encouraging herders to participate and benefit from programme interventions must be prioritised. Concomitantly, Forest Department field staff working on range management should be knowledgeable of elementary animal husbandry practices such as disease prevention.

Selection of Good Quality Animals

Local herders should be educated about the benefits of keeping quality animals in smaller numbers instead of overstocking their pastures with large numbers of unproductive herds. Suitable local and foreign breeds should also be made available for crossbreeding. Payment plans should be devised so the local people can afford to buy these improved breeds.

Grazing Associations

Range management is directly related to the interest and activities of the livestock owners. Their cooperation is essential for successful operation of such programmes. Therefore, grazing associations should be formed and given the responsibility for planning and implementing village-level range management projects.

Education and Training

Training in rangeland administration should be made available to government and non-government bodies. Similarly, training workshops should be provided for herders as a means of discussing issues and introducing services provided by the Forest Department and other line agencies.

Surveys and Analysis

Range surveys should be carried out to evaluate and properly classify area grasslands for sound range management planning. Range analysis should be systematically carried out on different sites in a variety of ranges. Permanent quadrat and line transects should be established. Periodically collected data would increase knowledge about the desirable palatable species and forage production. A livestock census, along with the collection of other needed data on range-dependent livestock should be carried out to ensure correct and scientific management of rangelands.

Links with Other Departments

Informal links with extension units of the Departments of Livestock and Agriculture should be established in order to determine joint approaches and provision of services. If forming these connections prove impossible, the Forest Department should recruit appropriate specialists to do the job. Connections should also be established with existing research and development agencies working on range management issues.

Fodder Banks

Fodder banks should be created for the production and distribution of seeds to farmers or user groups. Farmers should be encouraged to increase production of winter fodder on agricultural lands in order to enable herds to stay longer in the agricultural areas during spring, thereby giving upland ranges adequate time to regenerate.

Marketing

A livestock marketing system should be developed, possibly including market sites, distribution of market information, and the creation of marketing cooperatives. Livestock owners should be assisted in developing alternative sources of income in agriculture or other enterprises in order to decrease overall livestock numbers.

Reseeding Programme

Reseeding is an important range improvement operation and an effective tool to rehabilitate deteriorated rangelands. This specialised and useful operation should be carried out indiscriminately with local and exotic species.

Drought Compensation

Drought, often experienced in semi-arid rangelands, is probably the most difficult problem faced by herders. Droughts are quite common in Thal, Cholsitan, the desert ranges of Punjab, Nara, Tharparkar, and the Kohistan ranges in Sind, as well as the western arid mountain rangelands of Balochsistan and the NWFP. Government action to mitigate the effects of droughts and reserve money for the distribution of subsidised Tacavi loans will help offset local losses from drought. Drought emergency funds should be allocated in advance of the disasters themselves (Khan 1972).

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Conserving Biological Diversity in the HKH-Tibetan Plateau Rangelands

Daniel J. Miller

The Hindu Kush-Himalayan-Tibetan Plateau region, as elsewhere in the world, is experiencing a loss of species unprecedented in history. With each species lost, a part of the world's genetic heritage disappears. The innumerable species that make up the Hindu Kush-Himalayan-Tibetan Plateau's biological diversity construct an intricate life support system upon which humans rely.

These mountain rangelands and the biological resources found in them play a critical role in the region's overall economic development and people's well-being. Pastoralists rely directly on plants, water, animals and other natural resources found on the rangelands for their livelihoods. Other people, both those residing in rangeland environments and in adjacent areas, are also directly or indirectly dependent on rangeland resources. The conservation and management of the biological diversity of the Hindu Kush-Himalayan-Tibetan Plateau's rangelands is an essential element of sustainable mountain development.

Rangeland Biodiversity

Stretching for 3,500km from the desert mountain steppes of Afghanistan in the west to the lush, alpine meadows in Yunnan Province of China in the eastern Himalayas, the rangeland ecosystems of the Hindu Kush-Himalayas-Tibetan Plateau encompass an enormous area, estimated to cover about three million square kilometres. Within such a vast region, rangelands differ considerably in plant community structure depending on altitude, climate, rainfall, soil, and the uses they have been subjected to by humans and their animals. Each different range type has its own unique assemblage of plants and animals.

Situated at the confluence of five major biogeographical subregions — the Mediterranean and Siberian of the Palaeoarctic realm and the West Chinese, Indochinese, and Indian subregions of the Oriental realm — the rangeland ecosystems of the Hindu Kush-Himalayan-Tibetan Plateau are rich in biodiversity. In terms of plants, a number of floristic regions are found in the region and the percentage of endemics is large. In some rangelands, the floral diversity is very high. For example, in Alpine meadows of the central Himalayas of India and Nepal, it is not uncommon to find 30 plant species per square metre. These rangelands also possess remarkable resiliency. There are numerous examples where overgrazed ranges have recovered when just afforded some protection from grazing.

Rangelands also provide habitat for a wide variety of wildlife, especially ungulates, or large grazing mammals. From the Oriental realm came ungulate species such as takin, musk deer, goral, and serow. From the Palaeoarctic realm in Tibet came the Tibetan antelope, Tibetan gazelle, blue sheep, Tibetan wild ass, and wild yak. From the Mediterranean realm we find ungulates such as urial, markhor, argali, ibex, and red deer. The Himalayan tahr, which probably evolved in India, also inhabits these rangelands. A number of other species from the Oriental realm, more characteristic of subtropical grasslands, can also be found in low elevation rangelands: black buck, nilgai, swamp deer, hog deer, chital, gaur, sambar and muntjac. These ungulate species, of course, share the rangelands with a host of other birds and mammals and a number of the ungulates are important prey species for large predators such as snow leopards, which are endangered.

When considering rangeland biodiversity, one usually thinks of flowering plants and wild animals, yet an important aspect of biological diversity is also the domestic livestock species that are found on rangelands. These animals have evolved over centuries and adapted to the wide range of environmental conditions found there. They exhibit numerous, unique adaptive traits and resistance to diseases, which has enabled man to exploit the rangeland resources.

The genetic diversity of the wild and domesticated plants and animals found on the rangelands is a valuable resource. All of the food that human beings consume comes from wild and domesticated species of plants and animals. The wildlife found on the Hindu Kush-Himalayan rangelands includes the wild relatives of domestic animals that have fundamentally changed human civilization. The genetic pool of species found on the rangelands may hold important keys for improving livestock, developing new crop varieties, curing disease, and numerous other benefits as yet undiscovered. Certain traits found in domestic livestock breeds may be beneficial in increasing productivity of improved livestock. Finally, much of the tourist industry in the Hindu Kush-Himalayan region is based, in part, on the attraction of the rangeland's wildlife and magnificent mountain landscapes.

Major Issues

Conservation of biological diversity in the rangelands of the Hindu Kush-Himalayas-Tibetan Plateau is confronted with a number of issues.

- First, one of the major issues is loss of wildlife habitat. Habitat loss and degradation have been especially severe in the lower elevation rangelands where human population pressure is the greatest. Much of the original rangeland ecosystem in the subtropical zone has been replaced by agriculture. Where rangelands are still found in subtropical areas, they have been so disturbed by humans and livestock that much of the original vegetation is gone.

- Second, with the loss and degradation of habitat, wildlife populations have also declined. The land simply cannot support wildlife any longer.

- Third, overexploitation of medicinal plants, especially in the Alpine regions, is eroding the biological diversity. Although good data are not available, it is widely believed that in many areas the harvesting of medicinal plants is no longer sustainable.

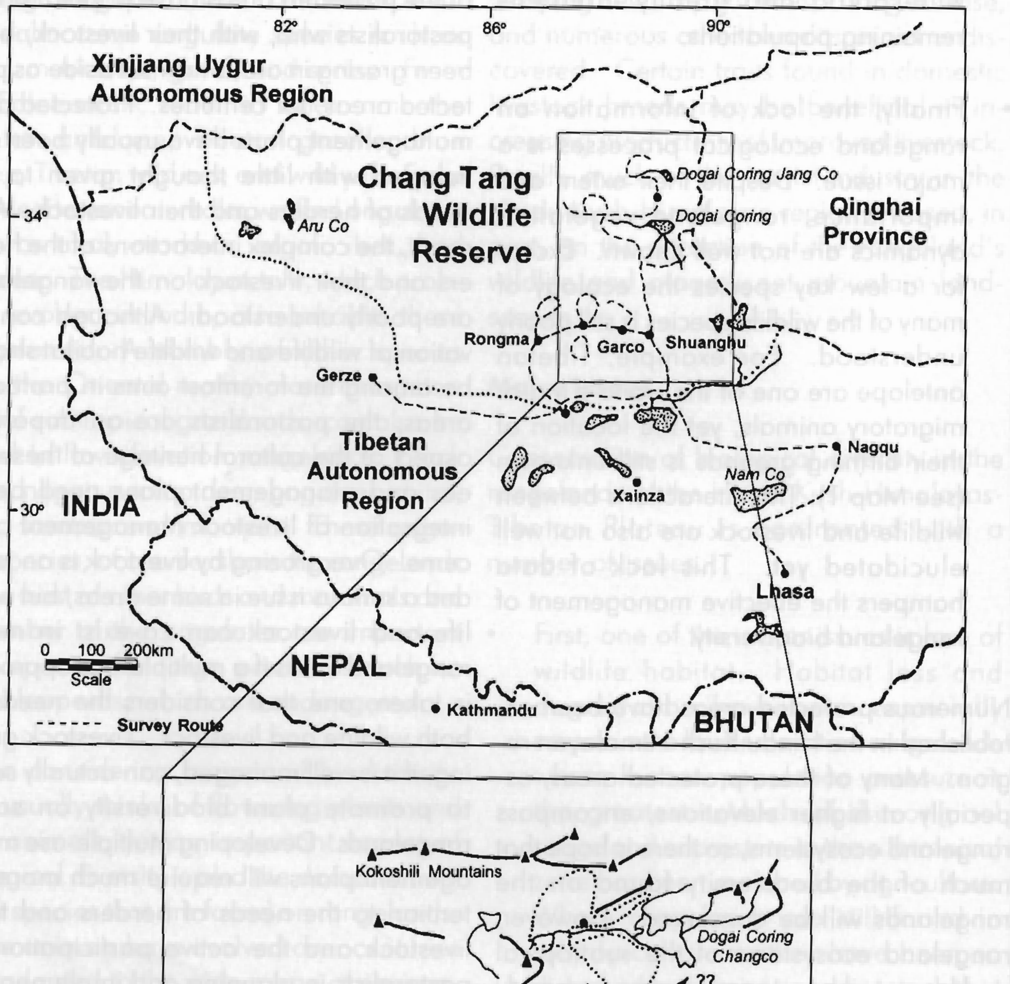
- Fourth, despite most wildlife being officially protected, illegal killing is still widespread and greatly threatens remaining populations.

- Finally, the lack of information on rangeland ecological processes is a major issue. Despite their extent and importance, rangeland vegetation dynamics are not well known. Except for a few key species the ecology of many of the wildlife species is still poorly understood. For example, Tibetan antelope are one of the world's major migratory animals, yet the location of their birthing grounds is still unknown (see Map 1). The interactions between wildlife and livestock are also not well elucidated yet. This lack of data hampers the effective management of rangeland biodiversity.

Numerous protected areas have been established in the Hindu Kush-Himalayan region. Many of these protected areas, especially at higher elevations, encompass rangeland ecosystems, so there is hope that much of the biodiversity found on the rangelands will be conserved. However, rangeland ecosystems of the subtropical and lower temperate zones are very poorly represented in the existing protected area network. These are the rangeland ecosystems that have been the most severely affected by human impact and yet, since they are centred where the greatest human populations and agriculture are located in the Hindu Kush-Himalayan region, they may possess some of the most valuable genetic resources for improving agriculture for the future. The inclusion of representatives of these lower elevation rangeland ecosystems within a protected area system is of paramount importance.

One of the major management concerns in protected areas in the Hindu Kush-Himalayan region is livestock grazing. Most of the protected areas have populations of pastoralists who, with their livestock, have been grazing in areas now set aside as protected areas, for centuries. Protected area management plans have usually been developed with little thought given to the needs of herders and their livestock. As a result, the complex interactions of the herders and their livestock on the rangelands are poorly understood. Although conservation of wildlife and wildlife habitat should be among the foremost aims in protected areas, the pastoralists are an important aspect of the cultural heritage of these areas and management plans need better integration of livestock management concerns. Overgrazing by livestock is an issue and a serious issue in some areas, but wildlife and livestock can co-exist in many rangeland areas if a multiple-use approach is taken, one that considers the needs of both wildlife and livestock. Livestock grazing, if it is well managed, can actually serve to promote plant biodiversity on some rangelands. Developing multiple-use management plans will require much more attention to the needs of herders and their livestock and the active participation of pastoralists in planning and implementing conservation programmes.

Conservation of biodiversity on the Hindu Kush-Himalayan rangelands has typically concentrated on efforts to save endangered species or to protect exceptional habitats. Too often, the important role that rangeland resources can play in raising the productivity of agricultural crops and livestock has been overlooked. Genetic resources of plants found in rangelands hold potential for improving grain yields and increasing forage productivity. Native breeds of domestic animals possess vast gene pools for improving livestock productivity. Conservationists need to take a more holistic approach to managing biodiversity of



Map 1: Tibetan Antelope Winter Range and Migration Routes

rangelands if the entire spectrum of biological diversity is to be adequately considered.

Challenges

Conserving the biodiversity of the rangelands of the Hindu Kush-Himalayas-Tibetan Plateau is a very challenging task. Many rangeland areas are remote and working in them is physically difficult. Information about basic rangelands ecology is limited, yet managers are still required to develop rangeland management plans. Throughout rangeland areas, efforts will need to concentrate on resolving-grazing related issues. This will require sociological skills that biologists often lack. Current policies and strategies for rangelands will also have to be refined as more information about rangeland ecology, biodiversity, and pastoral production systems becomes available.

Policies for more effective conservation of the biological diversity of the rangelands will need to do a better job of demonstrating, in economic terms, the contribution rangeland resources make to the region's overall social and economic development. Economic valuation of rangeland resources will require measurement of both direct and indirect values. Determining the economic value of rangeland biological diversity will require three different but related approaches:

- assessing the value of rangeland products — such as forage and meat, both from wildlife and livestock — that are consumed directly without passing through a market ('consumptive use value');
- assessing the value of products that are commercially harvested — such as livestock products, wildlife products, and medicinal plants ('productive use value'); and
- assessing indirect values of rangeland ecosystem functions — such as watershed protection, regulation of climate, production of soil, scientific research, and birdwatching ('non-consumptive use value'), as well as the intangible values of preserving options for the future ('option value') and simply knowing that certain species exist on the rangelands ('existence value').

Assessing the benefits and costs of preserving the biological resources of the rangelands provides a basis for determining the total value of rangeland ecosystems. Since the value of rangeland resources can often be considerable, conservation of rangeland biodiversity in the Hindu Kush-Himalayas-Tibetan Plateau should be regarded as a form of economic development.

Making the case for biodiversity conservation on the rangelands is complicated because of the subtle nature of the rangeland ecosystem. To the untrained eye, rangelands appear to just be dominated by an uninteresting cover of grasses. Yet, it is often the intricate differences in the rangelands that help explain ecosystemic processes. Learning to detect these subtle changes in the rangeland landscape requires acute observation and a willingness to spend considerable amounts of time in the field. Finding the time to be in the field observing ecosystemic processes, especially in the remote rangelands in the Hindu Kush-Himalayas-Tibetan Plateau, is a challenge in a day and age when sitting behind a computer working on GIS and remote-sensing analysis of the rangelands is often more interesting to many people.

Rangeland Biodiversity of the Chang Tang Wildlife Reserve in the Tibetan Autonomous Region, China

The Chang Tang Wildlife Reserve of Tibet, encompassing about 300,000 square kilometres, includes one of the last, largely undisturbed rangeland ecosystems in the world and provides habitat for numerous wildlife species, several of which are endangered and endemic to the Tibetan plateau. Rangelands in this Reserve can be categorised into three major types: alpine steppe, desert steppe, and alpine meadow. Rangelands are spatially heterogeneous ranging from patch to landscape scales in composition and productivity. Although limited in overall plant species' richness, the rangelands are nevertheless diverse and provide habitat for six wild ungulate species, as well as a variety of birds, small mammals, and large predators including the snow leopard and Tibetan brown bear. The six wild ungulates include: *chiru* or Tibetan antelope, Tibetan gazelle, Tibetan argali, blue sheep, the *kiang* or Tibetan wild ass, and wild yak. Tibetan gazelle are selective feeders, concentrating on forbs. Tibetan antelope, blue sheep, and argali are mixed feeders, consuming both graminoids and forbs while the wild yak and Tibetan wild ass consume mainly grasses and sedges. The Chang Tang is coming under increasing pressure from nomads and their livestock; illegal hunting, especially of Tibetan antelope; and the threat of oil-drilling and gold mining. Despite these pressures, the rangelands can continue to provide habitats for wildlife as well as pastures for livestock if properly managed. This will require innovative management plans that take into account the needs of the wildlife as well as the needs of the Tibetan herders and their livestock.

Conclusion

The fact that extraordinary wildlife populations still can be found on the rangelands of the Hindu Kush-Himalayas-Tibetan Plateau bears witness to the remarkable diversity and resilience of these ecosystems. Rangelands are coming under increasing pressure from an expanding human and livestock population, but, properly managed, they can continue to provide critical habitats for wild plants and animals as well as grazing land for livestock production. Conservation and development strategies for rangelands must aim to maintain the condition of the rangelands and protect biodiversity. To achieve this goal, it will be necessary to design development programmes that take into account the needs of wildlife as well as the aspirations of the local people who share the rangelands with wild animals. Developing such programmes requires a much better understanding of the dynamics of rangeland ecosystems, increased knowledge of pastoral production systems, more thorough analysis of the constraints and opportunities for improving rangeland biodiversity, and modifications in policies and current approaches to management. These actions are crucial for conserving biodiversity and ensuring sustainable pastoral development in the face of growing threats from modernisation.

Rangeland Management and Wildlife Conservation in HKH

Joseph L. Fox

Rangelands comprise over two million km within the Hindu Kush-Himalayan region (Miller 1995, 1997), including a large portion of the sub-alpine, alpine, and steppe-vegetated high elevation environments. These lands provide extensive pasture for domestic livestock. In more marginal areas (dry, rugged, high elevation with low plant coverage), however, rangelands are relatively rarely exploited by man and continue to constitute important habitats for wildlife. In areas where pastures are not heavily overexploited, many rangelands of the world characteristically permit a combined management of both livestock and natural ecosystem values, including wildlife conservation. Thus, for example, mountainous rangelands in the cattle and sheep country of parts of western North and South America still support populations of various wild ungulates. Likewise, the mountain rangelands of central Europe continue to host populations of ibex, chamois, and deer. Vast rangelands of Australia continue to maintain populations of kangaroos and many other wild herbivores.

Nevertheless, the demise of wild animal populations in many areas that have undergone profound changes in livestock development suggest that some similar changes will take place in the more productive rangelands of the Hindu Kush-Himalayas. The virtual elimination of wolves and buffaloes and great reduction in the cougar, lynx, pronghorn antelope, and some wild sheep populations in western North America is a good example of this demise (Craighead 1991), as well as more recent changes in the dry African rangelands where Prins (1992) has argued for the incompatibility of livestock husbandry and wildlife. Thus, the directions in which governments and markets drive rangeland management and animal husbandry development in the Hindu Kush-Himalayas (Sabaerwal 1996) will have a profound effect on the continued existence and sustained viability of wild ungulates, other native herbivores, and their natural wild predators (Fox et al.1994, Miller and Jackson 1994).

It is likely that, whereas the more rugged mountain areas (marginal rangelands) will be able to maintain a compatible livestock industry and wildlife populations, livestock development in more open and productive mountain basin regions, however, will have a significant and detrimental effect on some wildlife populations. These areas are more easily exploited both by livestock and by humans for pest (e.g., predator) removal and for meat/sport hunting. The continued coexistence of wildlife and man in the Central Asian highlands will depend greatly on the type of development livestock industries undergo and the nature of national decisions regarding range management and biodiversity conservation.

The presence of wildlife on rangelands leads to several types of interaction between pastoral communities, domestic livestock, and the wild species of flora and fauna. Some of these interactions are listed below. Examples of significant species from the region are listed in Table 1.

The costs to animal husbandry due to wildlife include:

- Grazing competition (kiang, blue sheep, takin)
- Soil / pasture degradation (mouse-hare or 'rabbit rat', marmot)
- Predation (wolf, snow leopard, common leopard, *dhole*, brown bear, lynx)
- Disease transmission (spread of hoof and mouth disease via blue sheep)
- Fodder crop raiding (bear, wild boar, barking deer, goral, monkeys, blue sheep)

The economic uses of wildlife include:

- Fur industry (fox, martin, lynx; leopards and many small cats—now illegal)
- Skins for packing and floor rugs - not common today (all ungulates, cats)
- Wool industry (Tibetan antelope – 'shatoosh', currently significant illegal trade)
- Natural medicines (musk deer, leopard—bones, bear—bile, many other species)
- Meat (antelope, yaks, wild sheep & goats, most ungulates)
- Trophy hunting (most large-horned sheep and goats, some deer)
- Wildlife viewing (many species, but of limited use)

In Ladakh, India, livestock owners have received monetary compensation for grazing competition between the Tibetan wild ass or *kiang* and domestic livestock (Fox et al.1991, N. Kitchloo, Wildlife Warden, pers. comm.). Blue sheep and takin populations have been reported by Bhutanese officials (this workshop) to be so dense in some areas that these populations raise concerns with regard to food competition with domestic sheep and yak. The pika or mouse-hare (rabbit-rat) is the target of large-scale eradication programmes on the plateaus of western China. Their burrowing habits apparently cause soil degradation, and they compete with livestock for forage (this workshop). Similarly, compensation programmes to livestock owners for animals lost to predators have been introduced in Ladakh, India (N. Kitchloo, pers. comm.), and in Mongolia (R. Jackson, pers. comm) but are fraught with problems of verification and equitable distribution of available funds.

In general, areas of concern associated with the interaction between animal husbandry and biodiversity conservation include the following.

- Livestock mortality due to predation
- Grazing competition between livestock and wild herbivores
- Soil degradation by mouse-hare and marmots
- Transmission of disease between domestic and wild ungulate populations
- Maintenance of wild populations (e.g., yak) as potential sources of genetic diversity for domestic breeds

The Hindu Kush-Himalayan region, including the Tibetan highlands, is comprised of an area of substantial wild ungulate diversity, and the path of development for pastoralism and rangeland use will greatly in-

Table 1: Mammalian Herbivores of the Sub-alpine, Alpine, and Steppe Rangelands of the Hindu Kush-Himalayas

Common Name	Scientific Name	Body Mass (kg)	Location
Large Herbivores (ungulates)			
Wild yak	*Bos grunnien*	850	Cn
Tibetan wild ass, or Kiang	*Equus hemionus kiang*	350	Cn
Marco Polo sheep	*Ovis ammon polii*	95	Cn
Tibetan argali	*Ovis ammon hodgsoni*	85	Cn
Tibetan gazelle	*Procapra picticaudata*	30	Cn
Tibetan antelope	*Pantholops hodgsoni*	35	Cn
Blue sheep	*Pseudois nayaur*	50	Cn,Cs
Asiatic ibex	*Capra ibex sibirica*	65	Cn,Cs
Ladakh urial	*Ovis vignei*	45	Cn,Cs,B
Markhor	*Capra falconeri*	65	Cs,B
Himalayan tahr	*Hemitragus jemlahicus*	80	Cs,B
Musk deer	*Moschus moschiferus*	11	Cs,Cn,B
Red deer (*Shou*)	*Cervus elephus wallichi*	150	Cn,B
Hangul or Kashmir stag	*Cervus elaphus hanglu*	125	B,Cs
Takin	*Budorcas taxicolor*	240	B,Cs
Goral	*Nemorhaedus goral*	27	B,Cs
Serow	*Capricornis sumatraensis*	25	B
Wild boar	*Sus scrofa*	32	B
Barking deer	*Muntiacus muntjak*	14	B
Urial	*Ovis orientalis*	35	B
Small Herbivores			
Wooley hare	*Lepus oiostolus*	2	Cn
Cape hare	*Lepus capensis*	2	B
Himalayan mouse-hare	*Ochotona roylei*	1	Cs,Cn
Large mouse-hare	*Ochotona macrotis*	1	Cn
Ladakh mouse-hare	*Ochotona ladacensis*	1	Cn
Long-tailed marmot	*Marmota caudata*	5	Cs,Cn
Himalayan marmot	*Marmota bobak*	5	Cs,Cn
Sikkim vole	*Pitymys sikimensis*	1	Cs,Cn
Murree vole	*Hyperacrius wynnei*	1	Cs
Royle's vole	*Alticola roylei*	1	Cs
Field mouse	*Mus sp.*	1	B,Cs,Cn

Source: Nomenclature according to Nowak and Paradiso 1983

Location symbols refer to elevation ranges, as follows:

B = 500-3,000m;
Cs = 3,000-5,500m (south side of the Himalayas);
Cn = 3,000-5,500m (north side of the Himalayas).
Probably extinct on the southern side of the Himalayas

fluence the conservation of this great variety of species. In many cases, such species are in direct competition with domestic ungulate livestock. Both wild sheep and goat (*Caprinae*) and deer (*Cervidae*) groups of wild ungulates apparently evolved somewhere between the Himalayan region and the Middle East (Geist 1987), and a wide array of primitive (e.g., goral, musk deer) to advanced (e.g., argali, red deer) species still occur in the region. Today, the higher reaches of the Hindu Kush-Himalayan region support over 30 species of wild ungulates (Table 1), providing a diversity within relatively short cross-sectional distances similar to that found over comparable areas on the African savannas. Some of these species occur in the dense forests of the lower Himalayas; but most are, at least in part, associated with forest and sub-alpine rangelands or high, dry non-forested alpine and steppelands. In addition, various species of smaller mammalian herbivores (Table 1) also significantly contribute to the ecosystemic dynamics of these rangelands, sometimes with deleterious consequences for human exploitation of pasturelands.

Threatened wild species, indigenous to the rangelands of the Hindu Kush-Himalayas, include the wild yak, Tibetan argali, Ladakh urial, Tibetan antelope, snow leopard, wolf, and brown bear. Other species are affected by land-use patterns associated with pastoralism — some are considered a menace to livestock husbandry. These include small herbivores such as the pika, marmot, and hare, as well as large herbivores such as the Tibetan wild ass, Tibetan antelope, Tibetan gazelle, blue sheep, and Asiatic ibex and predators such as the wolf, wild dog (*dhole*), and lynx. Note that today, while large predator and wild ungulate numbers continue to dwindle in the Hindu Kush - Himalayas, they have been or are currently being re-established in the mountain rangelands of North America (e.g., the wolf in Yellowstone) and Europe (e.g., the ibex and lynx in the Alps). Timely efforts to maintain the existing, large mammal biodiversity can help avoid expensive re-establishment programmes in the future.

At present, some 10 per cent of the Hindu Kush-Himalayan region has been legally designated as protected areas for nature conservation (Green 1993; 1994). The vast majority of these parks and reserves are situated in mountain rangelands. The spectacular alpine scenery of mountain conservation areas does not generally constitute the most productive habitats and for that reason can be relatively more easy to protect from human alteration than tropical areas. However, because of their low productivity, these habitats often require large areas to maintain viable populations of wildlife.

The management of protected areas and their surrounding lands, both for wild species and the maintenance of pastoral systems, has recently become a major concern of conservationists in the Hindu Kush-Himalayan region. This shift represents an important advance in outlook that has taken place over the past several decades. Whereas the conservation management prescriptions for these areas are still being derived, especially with regard to traditional human land uses, it is clear that national imperatives associated with conservation and tourism will demand management to maintain some definition of 'natural' wild plant and animal communities in such protected rangeland areas, as well as in healthy rangelands outside legally designated protected areas. This requires a sound understanding of the interaction between livestock husbandry and both forage pastures (plant food species for livestock) and wild animal species to ensure effective management. Unfortunately, our knowledge of the functioning of these rangeland ecosystems and their likely reactions to imposed changes is quite limited. Specifically, such ecosystem questions have rarely been addressed when considering either proposed livestock development programmes or nature conservation programmes. In situations in which these concerns overlap, such questions are virtually non-existent. This needs to change.

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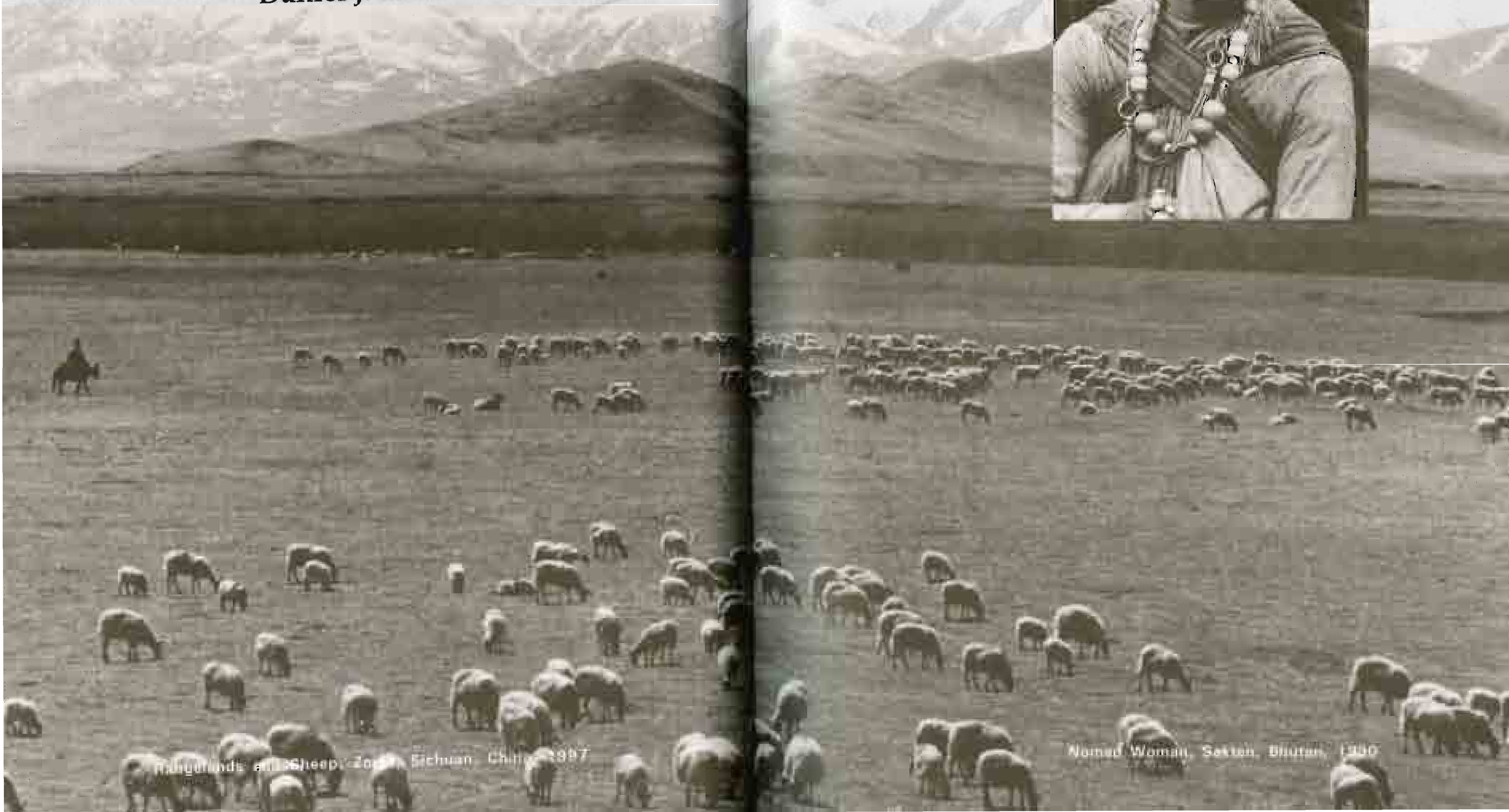
A Photo Essay of Himalayan and Tibetan Pastoralism

Daniel J. Miller



Rangelands and Sheep, Zo[illegible] Sichuan, China, 1997

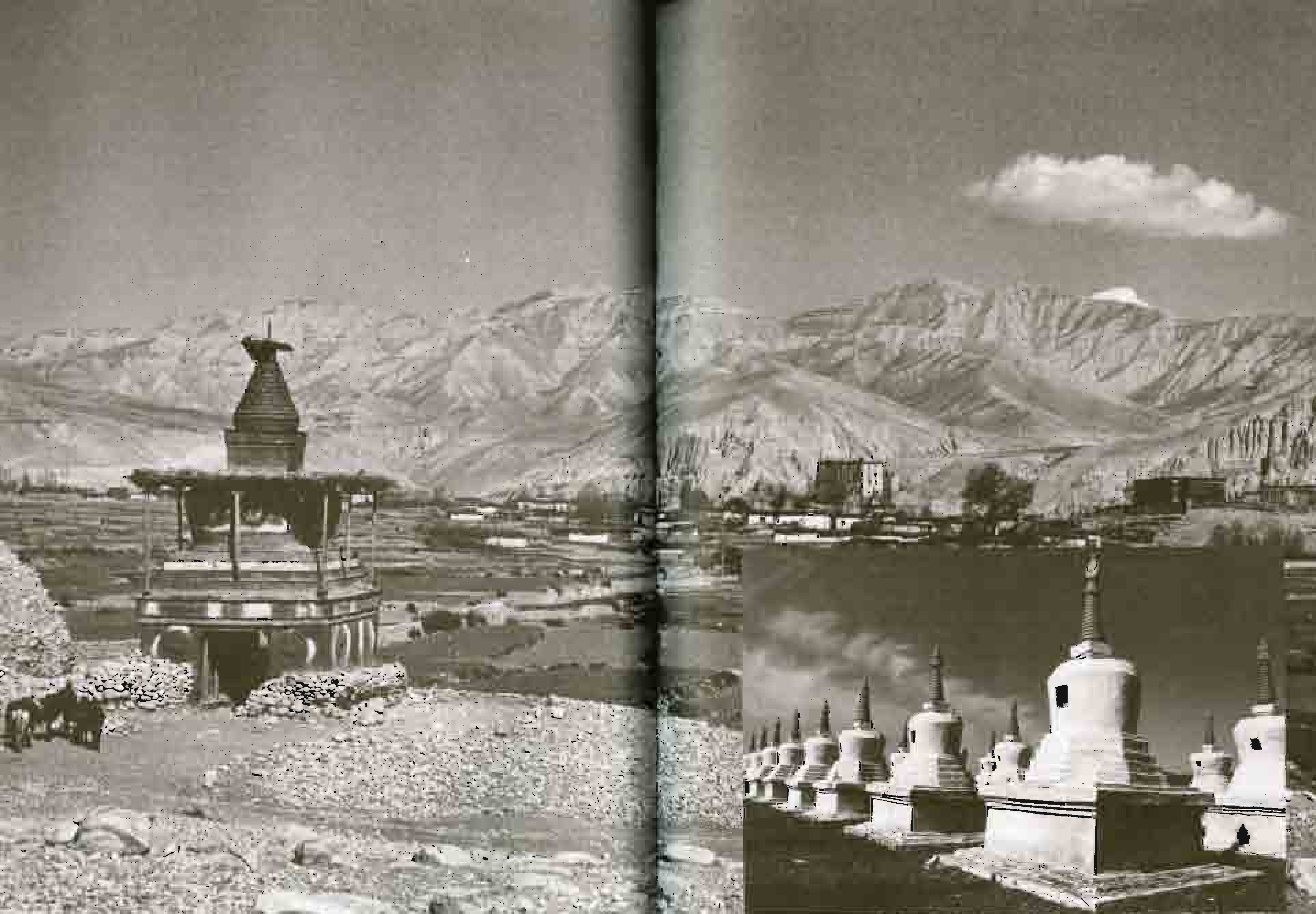
Nomad Woman, Sakten, Bhutan, 1990

Tibetan rangelands are at the heart of Asia. These grazing lands form the headwaters' environment where many major rivers have their beginnings. Here, the Yellow, Yangtze, Mekong, Salween, Brahmaputra, Ganges, Indus, and Sutlej rivers originate. The preservation and management of these river source environments have global implications, as the water from their watersheds will be of increasing importance in the future. Upsetting the ecological balance in these high-elevation rangelands will have a profound effect on millions of people living downstream. As such, these grazing lands demand respect and should be considered sacred ground.

Rangelands and Yaks, Madoi, Qinghai, China, 1988

The rangelands of the Tibetan Plateau and adjoining Himalayan region are one of the world's great grazing land ecosystems. Stretching for almost 3,000km from west to east and 1,500km from south to north, and encompassing about three million square kilometres, the region is one of the largest and most important pastoral areas on earth. The fact that these grazing lands have supported pastoral cultures for thousands of years while sustaining a varied and unique flora and fauna bears witness to the existence of a remarkably diverse and resilient rangeland ecosystem. Some of these rangelands, especially in northwestern Tibet, also represent one of the last notable examples of a grazing land ecosystem relatively undisturbed by man.

Yaks, river, and grazing land, Hongyuan, Sichuan, China, 1996



Stupas on the grasslands, Hongyuan, Sichuan, China

Across most of the pastoral region of the Tibetan Plateau, the land is too cold and arid t1o support cultivated agriculture. Here, fields of grass, green for only a few months of the year, clothe the rugged mountain ranges, extensive steppes, and broad valleys. Growing seasons are short and cool. Nevertheless, the grasslands nurture a rich wild fauna and a flourishing pastoral economy. The lives of pastoralists and animals, both wild and domestic, are tuned to the growth of the grass and the rhythms of the grazing lands. These fields of grass provide the theatre in which nomads and their animals interact and bring into force a unique pastoral culture - a remarkable nomadic way of life, thousands of years old, about which little is known.

Forest and rangelands, Maiwa, Sichuan, China, 1996

Nomad camp, Zoige, Sichuan, China, 1996

Rangelands of the Tibetan Plateau and the Himalayas are unique, as they are the highest elevation grazing lands in the world. Much of the Tibetan Plateau is above 4,000m; some nomads maintain permanent camps at elevations as high as 5,100m. Temperatures of minus 30°C are often reached in the winter and snowstorms are common even in the summer. As such, these grazing lands are one of the world's most extreme environments and, undoubtedly, the harshest pastoral areas on earth - still used extensively by nomads.

Hay fields and rangeland, Pheriche, Khumbu, Nepal, 1992

Rangelands, diverse in structure and composition, vary from cold deserts to semi-arid steppe and shrublands to lush alpine meadows. Forest areas in the eastern Tibetan Plateau and Himalayas also provide grazing land for wildlife and livestock. Vegetation differs considerably in plant community structure depending on altitude, temperature, rainfall, and the uses the land has been subjected to by man and his animals. Each rangeland type has its own unique assemblage of plants and animals. Vegetation variations define movements and foraging behaviour of both wildlife and livestock and influence the manner in which ungulates affect the ecosystem. Although often limited in overall plant species richness, especially in the cold, arid steppes of northern Tibet, the rangelands are still fertile environments, providing a habitat for numerous species of wild animals, as well as grazing for domestic animals.

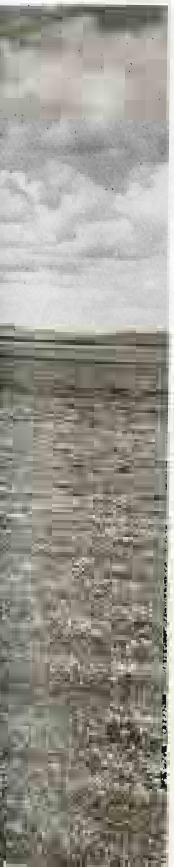
Mountain grazing land, Langtang Valley, Nepal, 1992

Rangelands, Mustang, Nepal, 1992

These high elevation rangelands are important for a number of reasons. First, they provide water and are the source for many major rivers. Second, rangelands provide habitats for a wealth of plant and wildlife species, many of which are endangered. Numerous plants are of medicinal value and other species may provide important genetic material for future economic use. Many of the protected areas in the Himalayas and Tibetan Plateau are dominated by rangeland vegetation. Conserving the rich biological diversity of these lands is crucial for sustainable development, yet grazing-related issues are often the major management concerns in protected areas. Third, these grazing lands provide forage for livestock. Since cultivated agriculture is not possible on the rangelands, grazing by livestock enables pastoralists to convert otherwise unusable plant biomass into valuable animal products. As economies in the region modernise and begin to demand more livestock products, it is the rangelands that are expected to be the source for this increased demand. Fourth, many mountain rangeland environments are becoming increasingly popular as recreational sites for tourists. Tourism has the potential to not only help improve livelihoods of pastoralists but also to contribute to overall economic development in pastoral areas.

Grasslands with flowers, Maiwa, Sichuan, China, 1996

Early summer nomad camp, Longri, Hongyuan, Sichuan, China, 1996



Factors such as geographical extent, watershed protection, biodiversity conservation, livestock production, and economic development suggest that the Himalayan and the Tibetan Plateau rangelands should be a priority area for development; but, unfortunately, they have not been given the attention they deserve. These pastoral areas are home to millions of people who have largely been ignored by previous development efforts due to remoteness and as a result of government policies that failed to appreciate the importance and potential of these grazing ecosystems. The lack of concern for pastoral areas and misconceptions regarding rangelands and pastoral production systems have led to a general downward spiral in the productivity of many areas, loss of biodiversity, and increased marginalisation of herders. Reversing these trends should be a priority for range researchers, policy-makers, range-livestock extension personnel, pastoral specialists, and herders.

Rangelands of the Tibetan Plateau and Himalayas provide habitats for a wide variety of wildlife, especially ungulates, or large-hoofed, grazing mammals. On the steppes of northern Tibet, wildlife such as the Tibetan wild ass (*kiang*), wild yak, Tibetan antelope, Tibetan gazelle, brown bear, and wolves are found. The mountains harbour blue sheep and *argali* along with the snow leopard and the lynx. In the mountain rangelands of eastern Tibet, where forests mix with grasslands, musk deer, red deer, white-lipped deer, roe deer, and *takin* are found. In the western Himalayas, ungulates like urial, ibex, and markhor appear along with the ubiquitous blue sheep and occasional *argali*. In the central Himalayas, Himalayan *tahr* and musk deer and, in lower elevation grasslands, *goral*, serow, and barking deer are seen. Some of these species are among the least known wild animals in the world. For example, Tibetan antelope are one of the earth's major migratory animals, yet the location of their birthing grounds is still unknown.

Tibetan wild ass (*kiang*), Chang Tang Wildlife Reserve, Tibet, China, 1993

Designing new and innovative conservation and development programmes for rangelands that will protect the remaining herds of wild yaks, Tibetan antelope, and other wild animals, requires a number of actions. First, there is a need to develop a much better understanding of rangeland ecosystem dynamics and animal-vegetation interactions. Second, more information on the ecology, status, and distribution of wildlife species is required. Regular monitoring of wildlife populations, especially antelope and wild ass, are also required. Third, there is a need for increased knowledge of pastoral production systems and nomads' use of important wildlife habitats. Such information is necessary in order to design management programmes that address the needs of both livestock and wildlife. Fourth, more thorough analysis of the constraints and opportunities for maintaining and improving rangeland biodiversity needs to be undertaken. Finally, modifications in policies and current approaches to management will have to be made. The illegal killing of wildlife, especially Tibetan antelope, must to be stopped. Wildlife authorities will require additional training and support for enforcing wildlife protection regulations and reorientation to more participatory approaches to working with herders on protected area conservation and development. These actions are crucial for conserving biodiversity and ensuring sustainable pastoral development in the face of growing threats from modernisation.

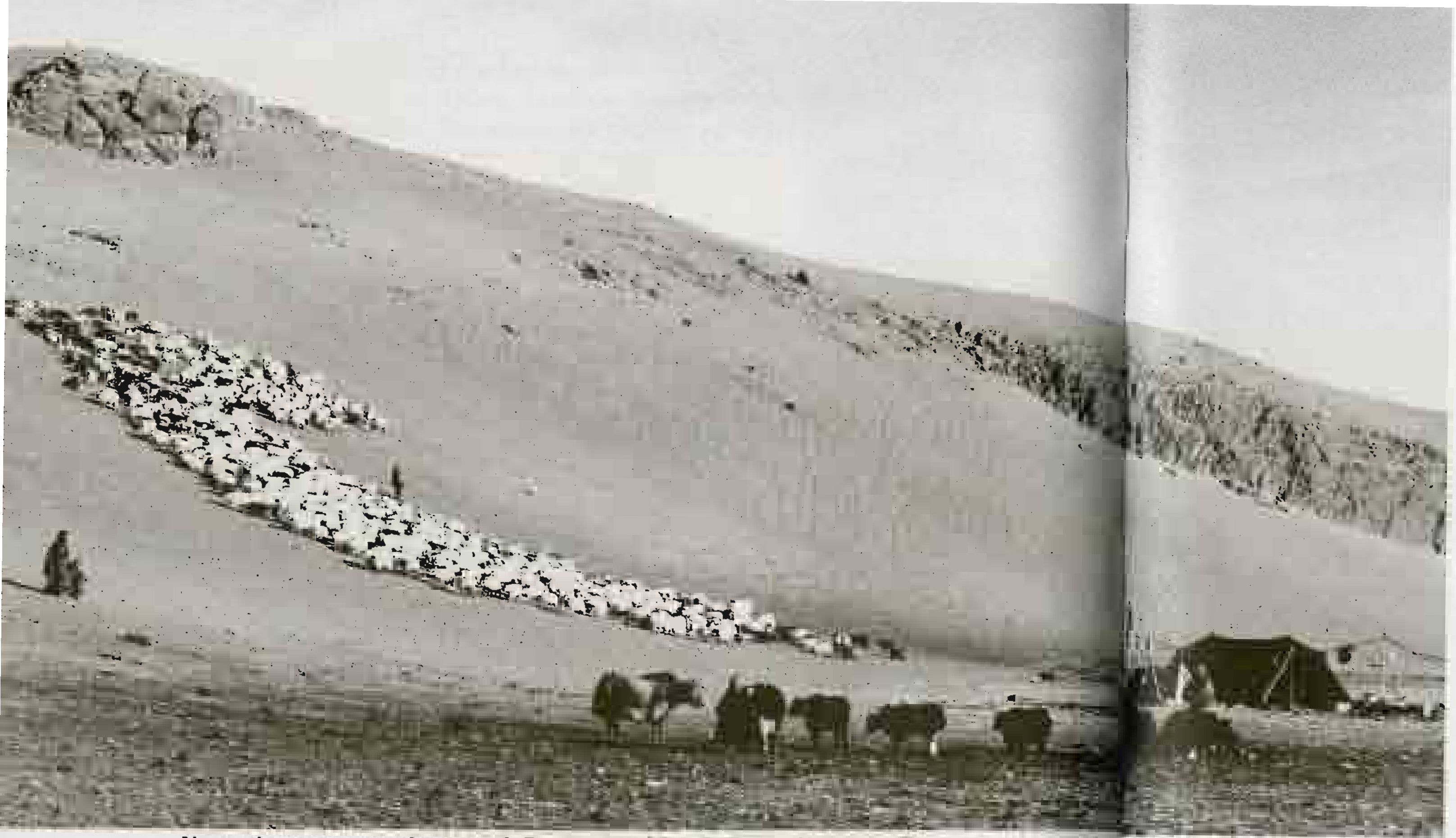
Shrine to endangered species, Lomanthang, Mustang, Nepal, 1992

Tibetan antelope define the vastness of the Tibetan wilderness. Like caribou in Alaska and wildebeest in Africa, antelope migrate long distances across the Tibetan steppes. The antelope's migratory habit indicates the need for an enormous territory or home range. Sadly, in spite of being fully protected under legislation, antelopes have been heavily hunted in recent decades for the luxurious wool they produce. Known as *shatoosh*, it is the finest wool in the world. With the establishment of the 300,000 sq. km. Chang Tang Wildlife Reserve in northern Tibet, much of the antelopes' habitat is now protected, but some antelope populations are known to migrate out of the Reserve into adjoining areas of Xinjiang and Qinghai to give birth. Protecting critical antelope habitats in these areas is vital if antelopes are to survive.

Tibetan antelope horns for sale, Zhongdian, Yunnan, China, 1996

Wild yak skull, Chang Tang Wildlife Reserve, Tibet, China, 1994

Wild yaks once numbered in the millions, now, only an estimated 14,000 are left in the wild on the Tibetan Plateau and these animals can only be found in the most remote areas, far from the hunter's guns. Preserving the remaining herds of wild yaks is crucial for biodiversity conservation. Wild yaks characterise the rugged wilderness of Tibet. No other animal so evokes the raw energy and wild beauty of the Tibetan landscape. The wild yak is a totem animal of the Tibetan wilderness and achieved mythic status long ago in Tibetan life. Superbly adapted to the rugged conditions of the highest plateau on earth, wild yaks are a keystone species: their presence identifies one of the last, great unspoiled ecosystems of Central Asia.



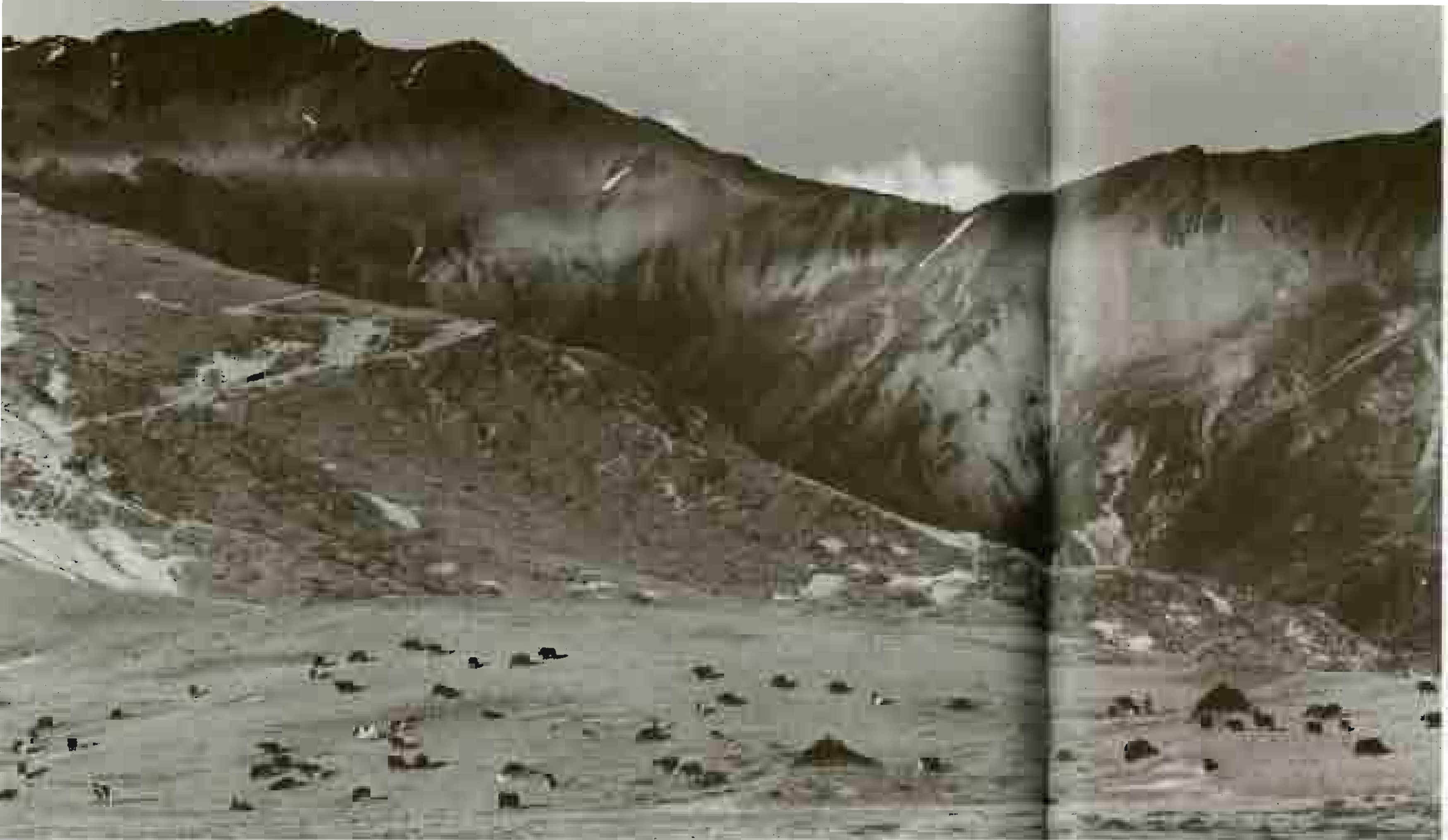
Nomad camp, northeast of Rongma, Chang Tang Wildlife Reserve, Tibet, China, 1993

Nomads have been herding livestock on the grazing lands of the Tibetan Plateau for probably 4,000 years. As early as the Chinese Hsia dynasty (2205-1766 BC), nomadic tribes called the Ch'iang, who were believed to be the early ancestors of Tibetans, were known for making a fine woven woollen material in their camps in the Kunlun Mountains. Even rugs made from the 'hair of animals' were recorded as one of the articles of tribute received by the Hsia Emperor from these early nomads. During the Chinese Shang dynasty (1766-1027 BC), these nomad tribes inhabiting the eastern Tibetan Plateau steppes were also renowned for their horses.

Pastoral production strategies and practices vary widely across the rangelands depending on altitude, environmental conditions, and rangeland types and, in recent years, on the influence of pastoral development policies, development interventions, and new markets for livestock and livestock products. Pastoralism in this environment has evolved through long-term persistence in one of the most inhospitable places on earth. As such, nomads have adjusted their production strategies to best suit the local environment and to take comparative advantage of the opportunities that are presented.

Female yak, above Thimphu, Bhutan, 1986

Nomad lady bundled up while herding, south of Shuanghu, Tibet, China, 1993



Nomad camp and yaks, Soi, Bhutan, 1987

The fact that nomads still populate Tibetan grazing lands today is proof of the rationality and efficacy of many aspects of traditional pastoral production as a means to convert forage from cold, arid rangelands into valuable animal products in an environment where cultivated agriculture is not possible. The survival of pastoral nomads indicates that many of the strategies of animal husbandry and range management developed centuries ago are well-adapted responses to the spectrum of environmental conditions found on the Tibetan steppes. Over thousands of years, nomads accommodated to their environment, learning to live with what it offered instead of changing and moulding the landscape to suit their needs, as farmers are wont to do. The endurance of pastoralism on the Tibetan Plateau also provides examples of nomadic practices that were once common throughout the pastoral world but are now increasingly hard to find. Tibetan pastoralists offer an opportunity to learn more about a way of life that is fast vanishing from the earth.

Nomad couple and tent, Phala, Tibet, China, 1997

Over the centuries, Tibetan nomads acquired complex knowledge about the environment in which they lived and upon which their lives depended. The fact that numerous, prosperous pastoral groups remain to this day, bears witness to the extraordinary knowledge and animal husbandry skills of the herders. Pastoral development specialists need to access this vast body of indigenous knowledge and incorporate such information in range-livestock development programmes. Nomads should be considered as 'experts' even though they may be illiterate. Some old Tibetan herders have probably already forgotten more details about rangelands and yaks than many young scientists will ever learn.

Young herder and horse, Namdo Valley, Dolpo, Nepal, 1978

Herders and horsemen,
Namdo, Dolpo, Nepal, 1978

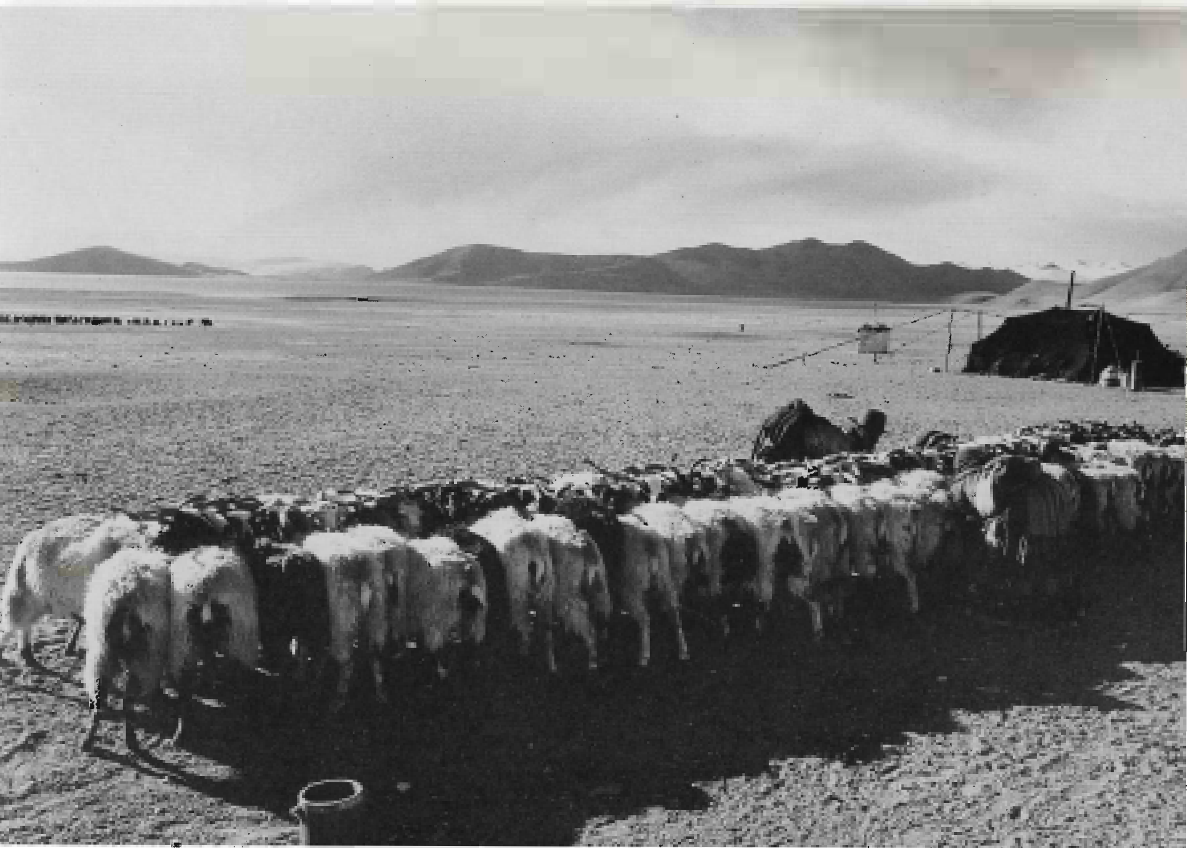
Happy nomad man, Dolpo, Nepal,
1978


Nomad woman, Phala, Tibet, China, 1997

Yak herd moving, Phala, Tibet, China, 1997


Pastoralists on the Tibetan Plateau often raise a mix of different animal species. Each species has its own specific characteristics and adaptations to the grazing environment. The multi-species grazing system – the raising of yaks, sheep, goats, and horses together, commonly practised by Tibetan nomads - maximises the use of rangeland resources. Different species of animals graze on different plants and, when herded together on the same range, make more efficient use of rangeland vegetation than a single species. Maintaining diverse herd compositions is also a strategy employed by herders to minimise the risk of losses. In the harsh environment in which pastoralism is practised, livestock are the only means by which people can subsist . Heavy snowstorms or outbreaks of livestock disease can devastate herds. Maintaining a mix of different species of animals provides some insurance that not all animals will be lost and herds can be rebuilt again. Different types of animals also have varied uses and provide different products for home consumption or for sale.

Sheep being milked, Phala, Tibet, China, 1997



Yaks are one of the most important domestic animals found in the pastoral areas of the Himalayan and Tibetan Plateau. Yaks provide milk and milk products, meat, hair and wool, and hides. Yaks are also used as pack as well as draught animals, for riding. Yak dung is an important source of fuel in an area where firewood is not available. Without the yak it is doubtful if man could live as well as he does in high altitude pastoral areas. The yak makes life possible for man in one of the world's harshest environments.

The wild yak is the progenitor of all yak populations. There is little doubt that the presence of wild yaks, and their later domestication, was the singlemost important factor in the adaptation of civilization on the Tibetan Plateau. Yaks still play an important role in many pastoral rituals and religious ceremonies. Events such as yak dances signify the vital role that yaks have in pastoral society, not only as a means of daily sustenance, but also for their cultural and spiritual value. Yak herd movements are often integrally linked to religious calendars and monitored by complex social structures.

Yaks tied up for milking, Hongyuan, Sichuan, China, 1996

White yak, Tianzhu, Gansu, China, 1996

Riding yak, Hongyuan, Sichuan, China, 1996

Milking yak-cattle hybrid (*dzo-mo*), Phijor, Dolpo, Nepal, 1978

Yak used for packing supplies, Namche Bazaar, Khumbu, Nepal, 1984

Yak production systems vary widely across the Tibetan Plateau. In some areas, herders maintain only yaks and, in other regions, both yaks and yak-cattle hybrids are raised. Complex systems for cross-breeding, with specific nomenclature for the different crosses, are also found in yak-raising areas. The wide range of yak production practices is a testimony to the diverse animal husbandry skills yak herders have acquired and the unique adaptations they have made for survival in a harsh environment. Despite these adaptations and skills, yak production today faces many problems. Improving yak productivity is often constrained by inadequate forage, especially in the winter. This leads to poor nutrition, health-related problems, and reduced fertility. Some of the current yak-breeding practices are thought to lead to inbreeding which lowers yak performance. Although access to pastoral areas is improving, yak herders are often still marginalised; social services are inadequate and outlets to markets for their livestock products are limited. Yak production systems, and especially their socioeconomic characteristics, are still poorly understood. As a result, many development interventions are often inappropriate. All of these issues combine to create considerable challenges to improving yak productivity.

Nomad camp, Longri, Hongyuan, Sichuan, China, 1996

Sheep and rangelands, Baingoin, Tibet, China, 1994

Sheep are very important animals on Tibetan Plateau and Himalayan rangelands. Although yaks characterise Tibetan pastoralism, sheep are often more important economically in many areas. Sheep provide wool, meat, hides and; in some areas of western Tibet, sheep are also milked. Sheep meat is the preferred meat among nomads and agricultural people throughout Tibet. The wool from Tibetan sheep ranks among the best carpet wools in the world. Tibetan wool is highly prized in the carpet industry for its great elasticity, deep lustre, and outstanding tensile strength. The fibres of Tibetan sheep wool have an exceptionally smooth surface, which reflects extra light, making them more lustrous than wool from other breeds of sheep. These factors help give Tibetan carpets their unique characteristics: the subtle, shaded abrash, supple resiliency, and a potentially radiant patina.

Fat Tibetan sheep, Zoige, Sichuan, China, 1996

Sheep tied up for milking, Phala, Tibet, China, 1997

Goats being milked, Phala, Tibet, China, 1997

Goats being milked, Phijor, Dolpo, Nepal, 1978

Combing out goat cashmere, Phala, Tibet, China, 1997

Tibetan goats are raised widely in western Tibet and parts of the western Himalayas. These animals are cashmere producing; some of the finest cashmere in the world comes from western Tibet. Kashmir shawls, made from the cashmere of Tibetan goats, became popular in Europe in the late 1700s. Kashmir had a monopoly on the supply of cashmere at the time. The British were eager to enter this profitable business. Early British interests in the northwest Himalayas and Tibet in the late 1700s and early 1800s were often linked with the trade in shawl wool. The fine cashmere from Tibetan goats enjoys a strong reputation even today, as much of Tibet's cashmere is exported to Europe. Goats are also milked by nomads and actually produce milk for a longer period of time than sheep.

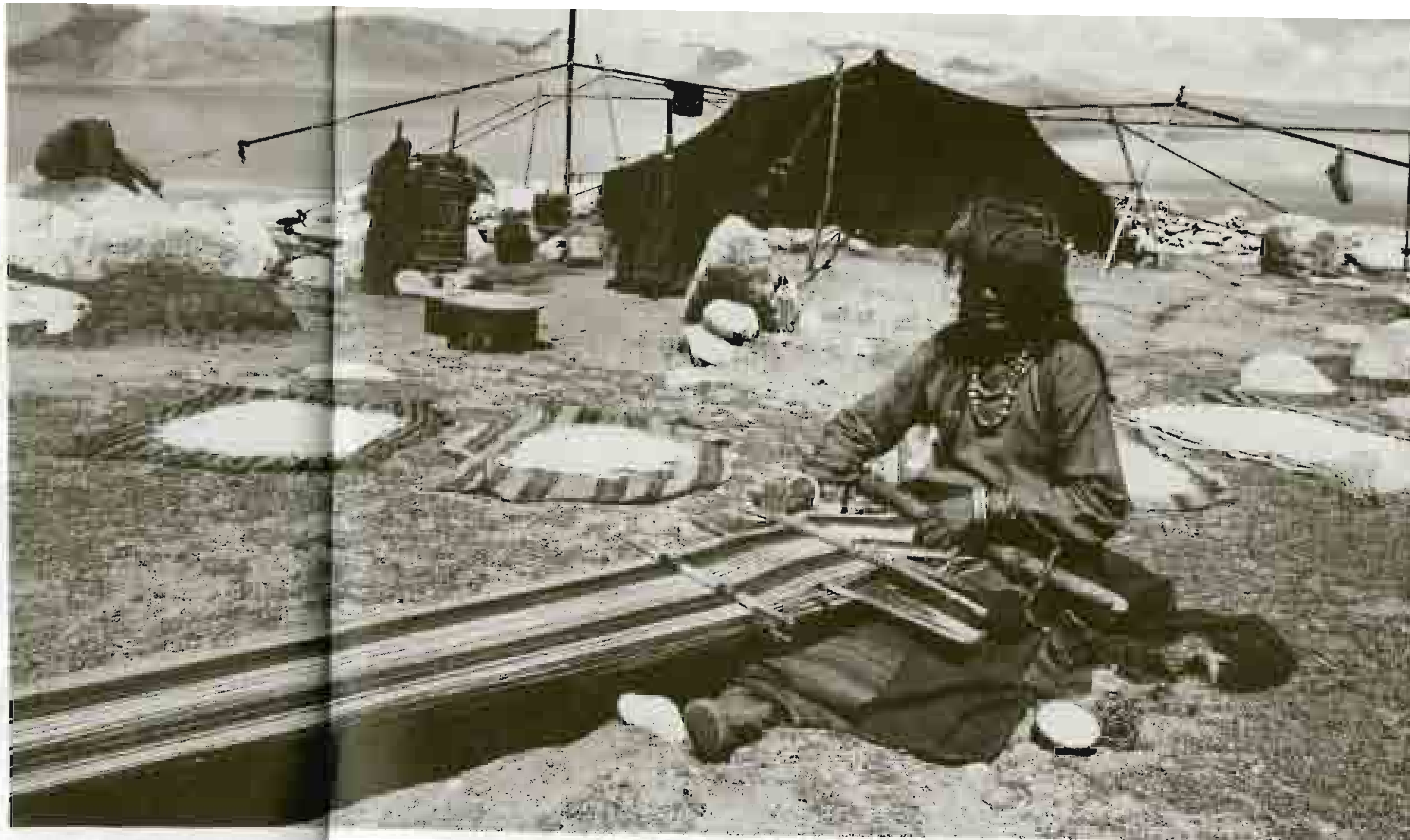
Horsemen, Nagqu, Tibet, China, 1984

Horse and saddle carpet, Namdo, Dolpo, Nepal, 1978

Tibetan Khampa horseman, Kangding, Sichuan, China, 1996

Horses were believed to have been first domesticated on the steppes of southern Russia about 5,000 years ago. Whenever the horse was first domesticated, it probably appeared on the steppes of the northeastern Tibetan Plateau soon afterwards. Horses would have been quite easily brought down to Tibet through what is now Xinjiang and Gansu on trails that later became the Silk Road. The grasslands of present day western Gansu, eastern Qinghai, and northwestern Sichuan Provinces, the Tibetan area known as Amdo, has long been renowned for producing good horses. Horses bred from around Qinghai Lake were supposed to be able to run 1,000 *li* (500km) in a day. This area is also the home of the legendary Golok tribes, excellent horsemen who are descended from ancestral nomads who considered it bad manners to walk even when exchanging greetings between one tent and another. The sport of polo is even thought to have originated in Tibet over 1,000 years ago.

Lady spinning wool, Tarap, Dolpo, Nepal, 1978



Weaving yak hair, Phala, Tibet, China, 1997

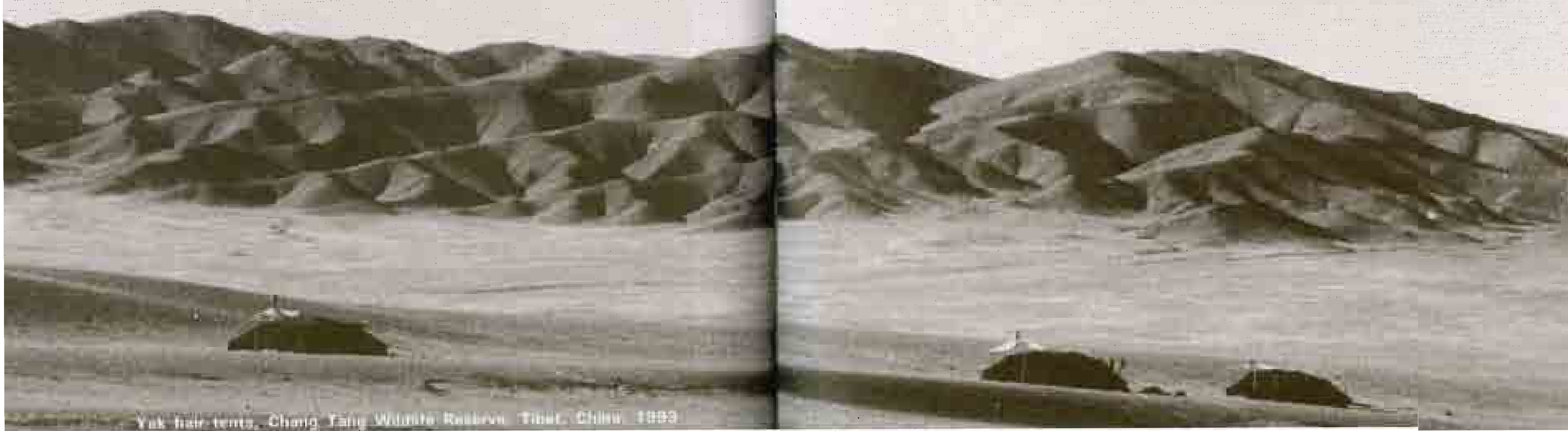
Detail of a yak hair tent, Lugu, Gansu, China, 1996

Since the first nomads ventured on to the Tibetan steppes and began raising sheep and yaks, perhaps 4,000 years ago, their very existence has depended on spinning and weaving skills. Since the beginning of Tibetan civilization, Tibetans were exposed to various Central Asian weaving centres. In the eighth century AD, the Tibetan Empire controlled the Silk Route oasis-city states where carpets were known to be made. Spinning and weaving techniques moved along the Tibetan frontier linking cultures, spinners, and weavers. Over time, various ethnic influences and trends were absorbed by Tibetans and incorporated into the formation of their own unique aesthetic styles. Old Tibetan carpets exhibit an elegance that is finally starting to be better appreciated. These ancient spinning and weaving talents continue, in an intact legacy, even now. Nomad men still spin sheep and yak wool and yak hair. Women weave wool into material for tents, blankets, bags, and clothing. Men braid ropes. These items are still used in everyday nomadic life.

Inside a yak hair tent, headwaters of Yangtze River, Qinghai, China,1993

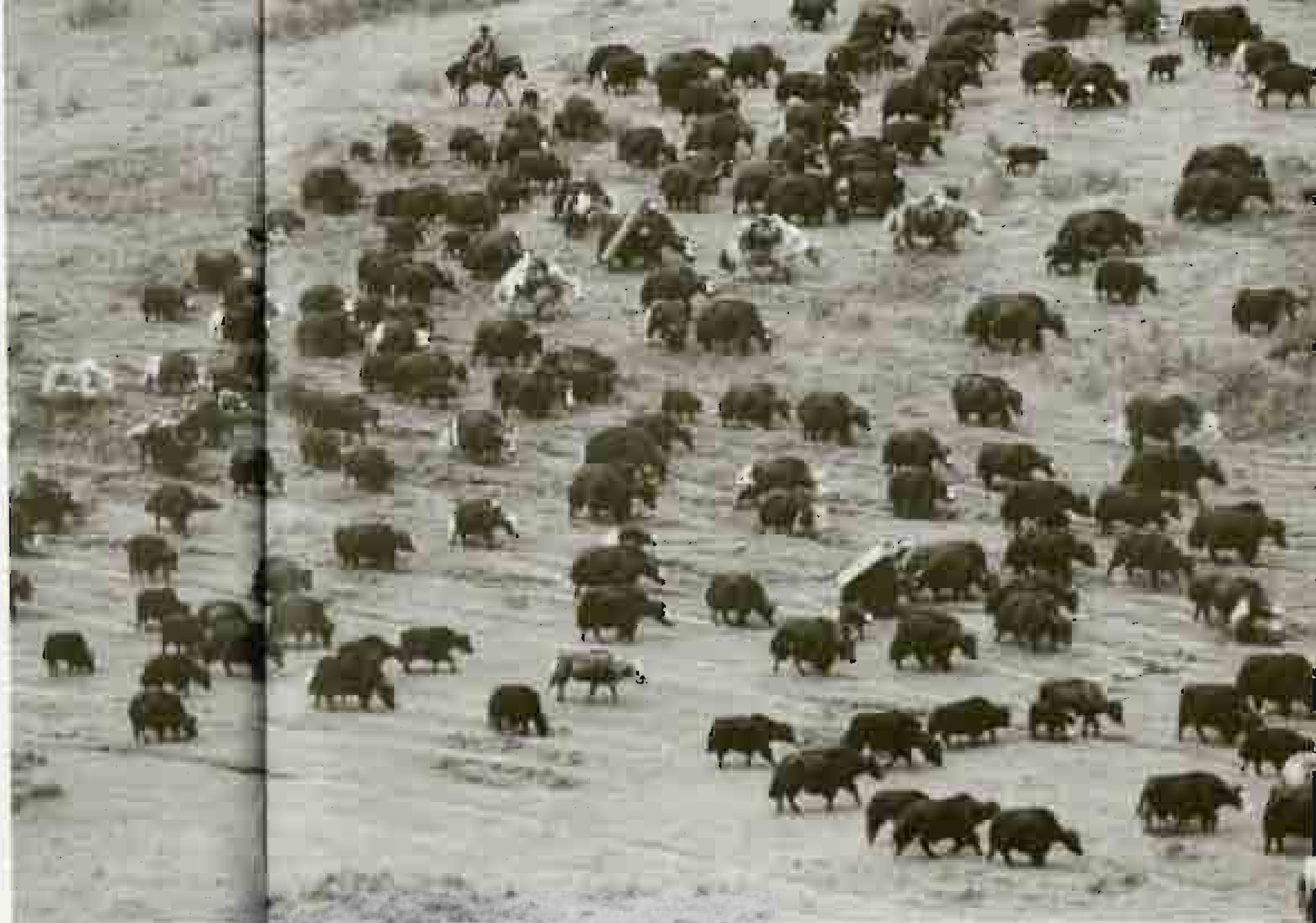
Yak hair tents are a prime example of the Tibetan nomads' skill in adapting to life on the vast, windswept plains of the Tibetan Plateau. Locally made from the long, coarse hair of the yak, Tibetan tents are very suitable to a nomadic lifestyle. They can be easily taken down and packed on yaks when moving camp. They keep out the rain, yet let in light. Sections of the tent that become old and frayed can be easily replaced with new strips of woven yak hair. Tents have been perfected to stand up in the fierce winds that blow across the Tibetan plains in winter.

Pastoral development policies on the Tibetan Plateau, as elsewhere in much of the pastoral world, often maintain that nomads are 'backward' and that their traditional practices need to be 'improved'. Policies also often dictate that herds need to be restructured to contain an optimum, or economically efficient, composition of livestock species and age classes of animals. Such policies are often prescribed by people with limited understanding of pastoral production systems and with little appreciation of the fact that nomads have been herding animals for thousands of years and, in many instances, already had or possess quite sophisticated systems for managing rangelands and livestock. Nomads have, after all, been raising animals on these grasslands for thousands of years and over time have figured out how best to use grazing land resources. Fortunately, many aspects of traditional Tibetan nomadic practices are being increasingly viewed by some researchers as highly efficient strategies for range management and livestock production.



Yak hair tents, Chang Tang Wildlife Reserve, Tibet, China, 1993

Nomad moving to summer camp, Aba, Sichuan, China, 1996



Yak herd on the move, Maiwa, Sichuan, China, 1996

Mobility is an important feature of pastoralism on the Tibetan Plateau. Traditional pastoral management systems were designed around the movement of herds to various pastures during different seasons of the year and the tracking of favourable forage conditions. Livestock are regularly moved between pastures to maintain rangeland condition and animal productivity. Herders do not randomly move across the landscape; rather, their movements are often well prescribed by complex social organizations and are highly regulated. Rotation of livestock between different ranges helps to conserve the grass and takes advantage of topography and climatic factors to make the best use of the rangeland.

The expanded appreciation for the complexity and ecological and economic efficacy of many aspects of Tibetan pastoral production systems is encouraging. It provides hope that the vast wealth of knowledge that herders possess will be better appreciated and understood and used in designing more appropriate development interventions for pastoral areas. It also provides promise that the herders will be listened to and involved in the planning and implementation of development programmes in the future.

The walled city of Lomanthang, Mustang, Nepal, 1992

Village of Saldang, Dolpo, Nepal, 1978

Pastoralist trader, Namdo, Dolpo, Nepal, 1978

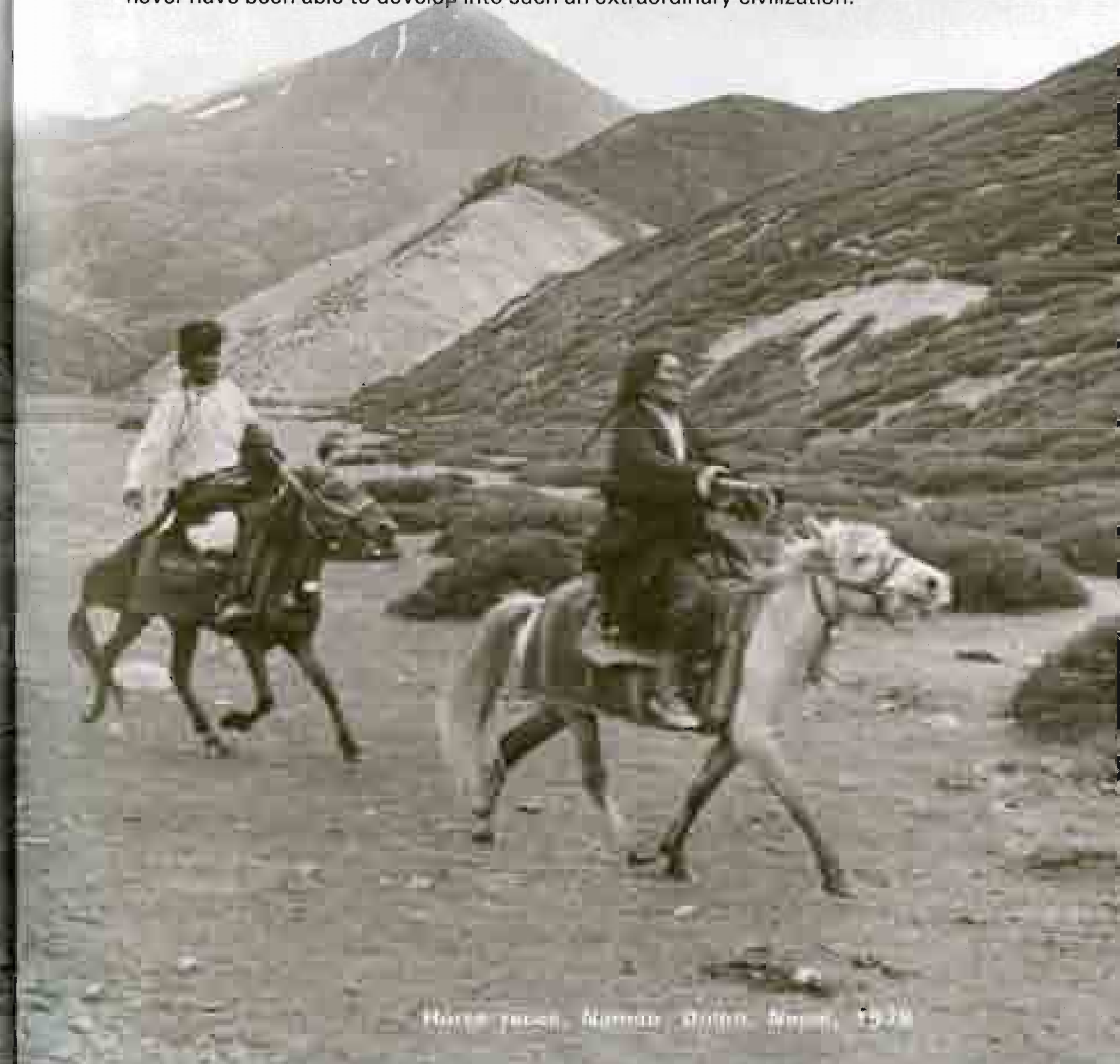
Trade and links with agricultural communities have always been an important feature of pastoralism in the Himalayas and on the Tibetan Plateau. Trade represented an essential element in the pastoral economy in most areas and, for some pastoral groups, defined the structure of their herding operations as well. Various factors, such as ethnicity, religion, subsistence patterns, and environment, played key causal roles in the development of trading enterprises within each community. For centuries, this trade linked pastoral regions with grain producing areas and both the means of transport and the basic characteristics of this trade remained constant over long periods of time. In much of the Himalayas, trade was based on the exchange of grain for salt and wool in Tibet and the subsequent bartering of Tibetan salt for grain.

It is unclear when trade across Tibet and through the Himalayas began, but it must have been flourishing when the Central Asian city-state of Khotan was founded in 250 BC. The opening of the Silk Road in the first century BC ushered in a period of rapidly expanding trade across Central Asia and across Tibet to India. Pastoralists must have contributed to, and been a part of, much of this trade.

Tibetan saddles and saddle carpet
[illegible], China, [illegible]

When analysing rangeland ecology and current pastoral production practices on Tibetan rangelands, it is important to keep in mind the region's long pastoral history. The movements of early hunters, herders, traders, and troops across the grazing lands had a major effect on the later historical development of dynasties and kingdoms throughout the region. They, in turn, affected how pastoral areas were used. Understanding the historical developments that took place in the grasslands is invaluable in comprehending the present ecology of the landscape. It also helps to inculcate a greater appreciation for present day nomads and their long experience with herding livestock across these vast fields of grass.

The foundation for the rise of strong nomad tribal federations, kingdoms and empires on the Tibetan Plateau were the rangelands. The boundless, fertile grazing lands, and the livestock grazed on them, helped create prosperous, pastoral-based cultures. Tibet's vast grasslands nurtured a prolific livestock industry. Tibet was rich with animals, wool, and butter. The pastoral landscape also assembled nomads accustomed to taking care of animals. This legacy enabled troops on horseback to be easily organized and for cavalry to travel swiftly and conquer far-flung territories. Without such a pastoral setting, people residing on the Tibetan Plateau would never have been able to develop into such an extraordinary civilization.



Horse race, [illegible], Nepal, [illegible]

Tibetan nomad Women, Phala, Tibet, China, 1997

Nomad dancers, Namdo, Dolpo, Nepal, 1978

Nomads possess a great body of indigenous knowledge about the environment in which they live and the animals they herd. Unfortunately, nomads' vast ecological knowledge and animal husbandry skills are often not well recognised or appreciated by scientists and development planners working in pastoral areas. As a result, herders have often been left out of the development process, with neither their knowledge nor their needs and desires being considered by many governments and development agencies in introducing more 'modern' and 'scientific' methods of livestock production. The key to sustainable pastoral development in the Himalayan and Tibetan Plateau lies in incorporating and building upon the indigenous knowledge and skills that herders already possess when designing new interventions.

Old pastoralists, Zhongdian, Yunnan, China, 1996

Tibetan nomad women, Phala, Tibet, China, 1997

Women play a very important role in pastoral society. Since they bear and rear children, women directly influence future human resources. As managers of the household and tent, pastoral women make vital decisions about the use of natural resources (fuel and water). As herders, women are responsible for many of the activities regarding livestock production. Their decisions and actions have effects on range resources and livestock. Efforts to improve livestock productivity, conserve and manage rangeland resources, reduce population growth, and improve pastoral peoples' livelihoods will, therefore, have to focus on pastoral women. These efforts will have to try and reduce women's time constraints; remove barriers to women's access to credit and extension advice; introduce technologies useable by and beneficial to women; and improve women's educational levels. Women are key actors in the sustainable development of pastoral economies in the Himalayas and on the Tibetan Plateau. Governments, donors, researchers, and pastoral specialists need to better acknowledge women's critical roles.

[illegible] woman, [illegible]hala[illegible], Tibet, China, 199[illegible]

Pastoral women, Phala, Tibet, China, 1997

Pastoral women, Phala, Tibet, China, 1997

The White River, Hongyuan, Sichuan, China, 1997

The management of Tibetan rangelands is both a science and an art. It tries to augment the returns from rangeland resources (water, plants, animals) in ways that are desired by the herders who raise livestock on the grazing lands, other people who also make use of the rangelands, and the wider society through the proper use of rangeland ecosystems. Proper management of rangelands combines practices from the physical, biological, and social science disciplines. Since climatic, topographic, soil, and hydrologic factors affect rangelands, physical science skills are necessary. Biological science is required because range management deals with plants and the response of animals (both wild and domestic) that consume vegetation. Social science skills are necessary because the needs and desires of society determine how rangelands are used.

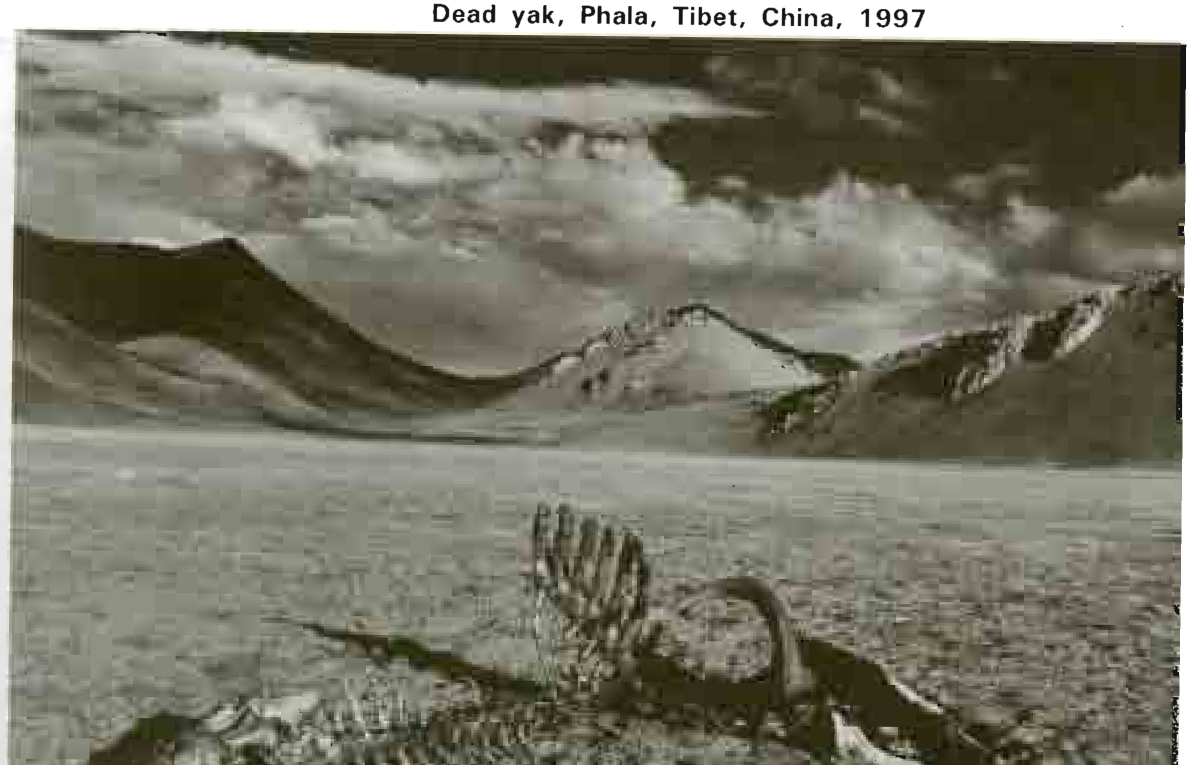
Scientific knowledge of rangeland ecosystems and technical skills are vital to managing rangelands, but range management and pastoral development are more than just a science. They are also an art. The scientific information available on rangelands needs to be synthesised and fabricated into practical and implementable management plans. Creating such plans requires the talents and perception to detect changes in rangeland vegetation that have taken place in the past, how different uses are currently affecting the rangelands, and then the ability to fashion plans to present range use and future demands. This 'feel' for the rangelands can only be achieved by spending considerable time in such areas looking and listening.

Tibetan wild ass (*kiang*), Phala, Tibet, China, 1997

Early summer snow storm, Phala, Tibet, China, 1997

Tibetan pastoral areas are complex environments and appear to function as highly dynamic ecosystems. Over much of the Tibetan Plateau, there is considerable variation in forage production from one year to another due to different precipitation patterns. There are even remarkable differences in grass growth in a small geographic area within one year due to local climatic patterns. Severe winter blizzards can bury forage for livestock under snow, often resulting in large livestock losses. These periodic snowstorms add to the complexity and non-equilibrial nature of the pastoral system, making pastoral production a high risk enterprise. Nomads cope with the uncertainties of the environment by adopting a number of flexible production strategies that minimise risk and make optimal use of the resources available to them. One such strategy is to diversify herds and maintain a high degree of mobility. Social arrangements with neighbours and neighbouring groups of nomads have also been established to enable herders to gain access to additional resources or assistance during times of stress. Although not as important now in many areas, hunting and gathering were also strategies engaged in by pastoralists to supplement subsistence livestock production. All of these strategies aimed to minimise risk, stabilise production, diversify food and livestock product sources and income, and maximise returns to household labour.

Dead yak, Phala, Tibet, China, 1997



Old beach lines of Mun Tso lake, Phala, Tibet, China, 1997

Many of the large lakes on the Tibetan Plateau are much smaller than they were thousands of years ago. Old beach lines, in some cases 40 metres above the present shore lines, indicate the degree to which lakes have dried up. This general desiccation that is taking place is also affecting vegetation and is especially apparent in the alpine *Kobresia* sedge meadow communities. Researchers have noted that, in many of these plant communities, the environment can no longer support sedges and the vegetation is changing to a grass steppe type. These vegetational changes have important implications for the future of the Tibetan Plateau rangeland ecosystem, as these sedge meadows provide vital grazing for livestock and wildlife. Reduced plant productivity in these areas could have serious repercussions for livestock production and pastoralism over a wide area, with critical implications for wildlife as well. These climate-induced vegetation dynamics need to be better understood and vegetation changes should be monitored to detect changes and to develop appropriate pastoral management plans.

Since Tibetan Plateau rangelands have been subjected to livestock grazing for thousands of years, livestock have probably affected rangeland vegetation composition in many areas. Analysing the nature of these man-induced changes will help to explain ecosystem processes and the impact of livestock on the rangelands. New perspectives about non-equilibrial ecosystems such as are often found in pastoral areas, provide fresh paradigms for analysing the Tibetan rangelands and pastoral systems. The new concept of relatively stable, multiple vegetation states with thresholds or transitions between these vegetation states is also emerging as a new framework for analysing rangeland vegetation. These perspectives differ markedly from the Clementsian Paradigm of plant succession and plant climax communities, offering promise for improved descriptions and measurements of rangeland conditions. Exploring the relevance of these new concepts for Tibetan and Himalayan rangelands could have important implications for the future management of these pastoral areas.

Rangelands and mountains, Phala, Tibet, China, 1997

Rangelands with *Caragana* shrubs, Mustang, Nepal, 1992

The conventional concept of carrying capacity in range management is grounded in theories of plant succession and climax plant communities. Range management was built around the concept of range condition class, determining carrying capacities, and the manipulation of livestock numbers and grazing patterns to influence range condition. The relevance of the carrying capacity concept for planning livestock grazing in pastoral systems is being challenged, since it is often difficult to estimate carrying capacity in the highly dynamic ecosystems where pastoralism occurs. The difficulty of applying carrying capacity concepts means the notion of 'opportunism' is gaining favour as a management approach for livestock production in pastoral areas. Instead of considering 'average estimated carrying capacity', an opportunistic approach bases the grazing strategy on that year's forage production. Such an approach allows herders to better adjust livestock numbers to the wide spatial variability found in forage production, establish better distribution of livestock to forage availability, and enable increased livestock production. The optimal strategy for herders in highly dynamic environments where pastoralism is commonly practised, therefore, may be to exploit range resources during 'good times' when climatic conditions promote better forage growth and to capitalise on outside resources during 'bad times' as the need arises. Opportunism is not new to pastoralists; many aspects of traditional pastoral systems embraced such opportunistic strategies. However, the adoption of opportunistic range management strategies on the Tibetan Plateau today has implications for the redesign of pastoral policies, most of which are currently based on carrying capacity concepts. Range research on Tibetan grazing lands needs to further investigate the usefulness of carrying capacity practices and the practicability of new models, such as opportunism, for managing livestock grazing.


Herders returning home, Garco, Tibet, China, 1993


Yak herder, Langtang, Nepal, 1975

Nomads with little to do, Shuanghu, Tibet, China, 1993

Faster than a horse, Lugu, Gansu, China, 1996

Sheep being brought to market, Lugu, Gansu, China, 1996

In recent decades, many changes have taken place on the rangelands that are transforming traditional rangeland use and conditions, pastoral systems, and the lives of herders dependent on rangeland resources. Nomads and their pastoral systems have always been confronted with events that change their lives – droughts that wither grass, winter storms and livestock epidemics that wipe out herds, and tribal wars that displace people and their animals – but the changes nomads are facing today on Himalayan and Tibetan rangelands are more profound and likely to have more significant, long-term implications on their way of life and the ecosystems in which they reside than any previous changes.

Modern nomad way to travel, Damxung, Tibet, China, 1993

Road, truck and fences - Near Zeku, Qinghai, China, 1997

Tibetan herder's house and barn. Henan Mongol, Qinghai, China, 1997

Such new changes include the modernisation process itself, which has brought improved access and services to previously remote nomadic areas and increased demand for livestock products; the expansion of agriculture onto rangelands, and decrease in the amount of grazing land available to nomads' herds; disruption in traditional trade networks, which were often an important part of pastoral systems; the expansion of the protected area system with increased regulation limiting livestock grazing; and, more recently, policies to settle nomads and divide rangelands into individual family parcels. In many cases, the changes have altered previous, often stable, relationships between pastoralists and their environment. Pastoral systems are still in a state of transition and it is not yet clear what patterns will eventually emerge.

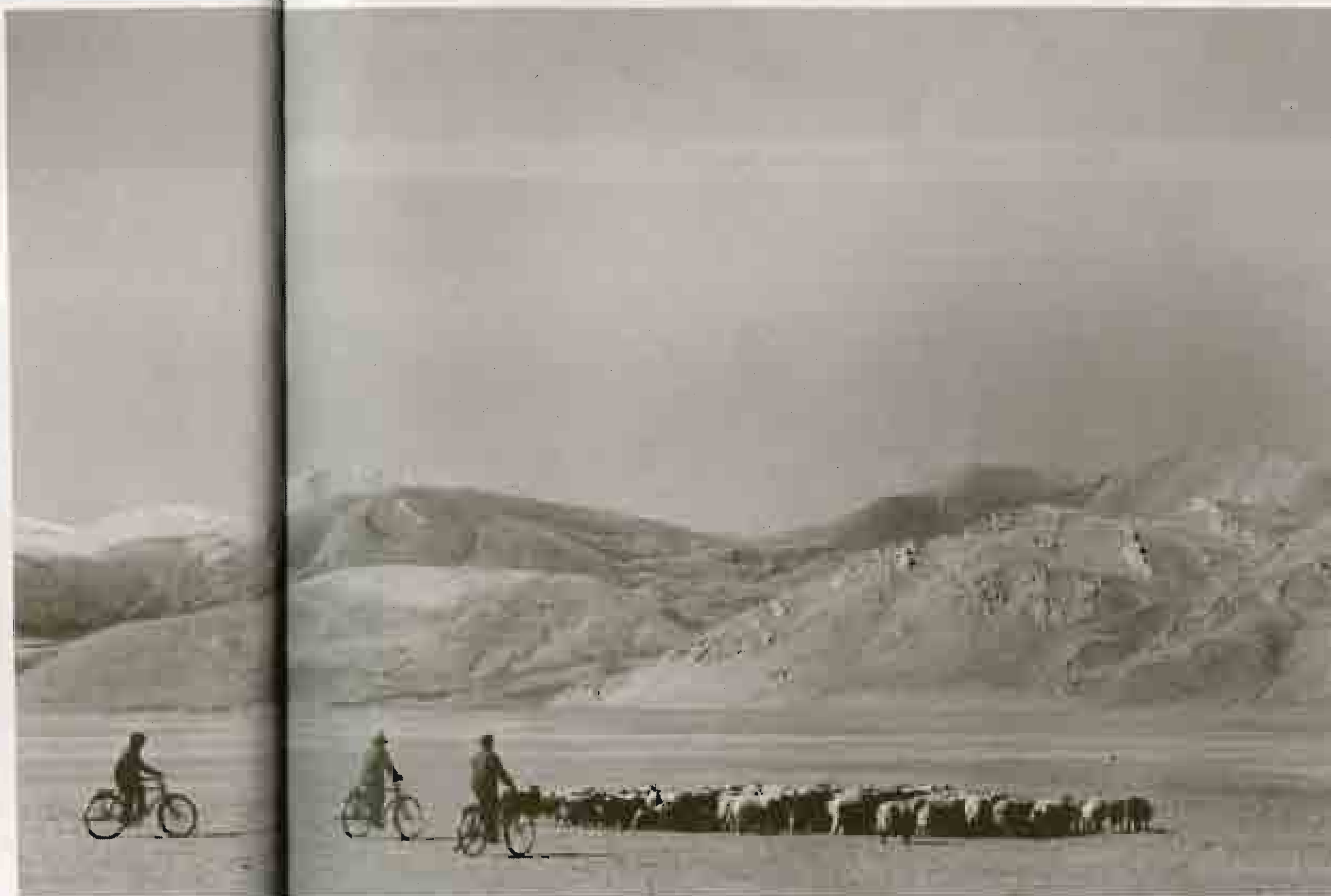
Street scene. Henan Mongol, Qinghai, China, 1997

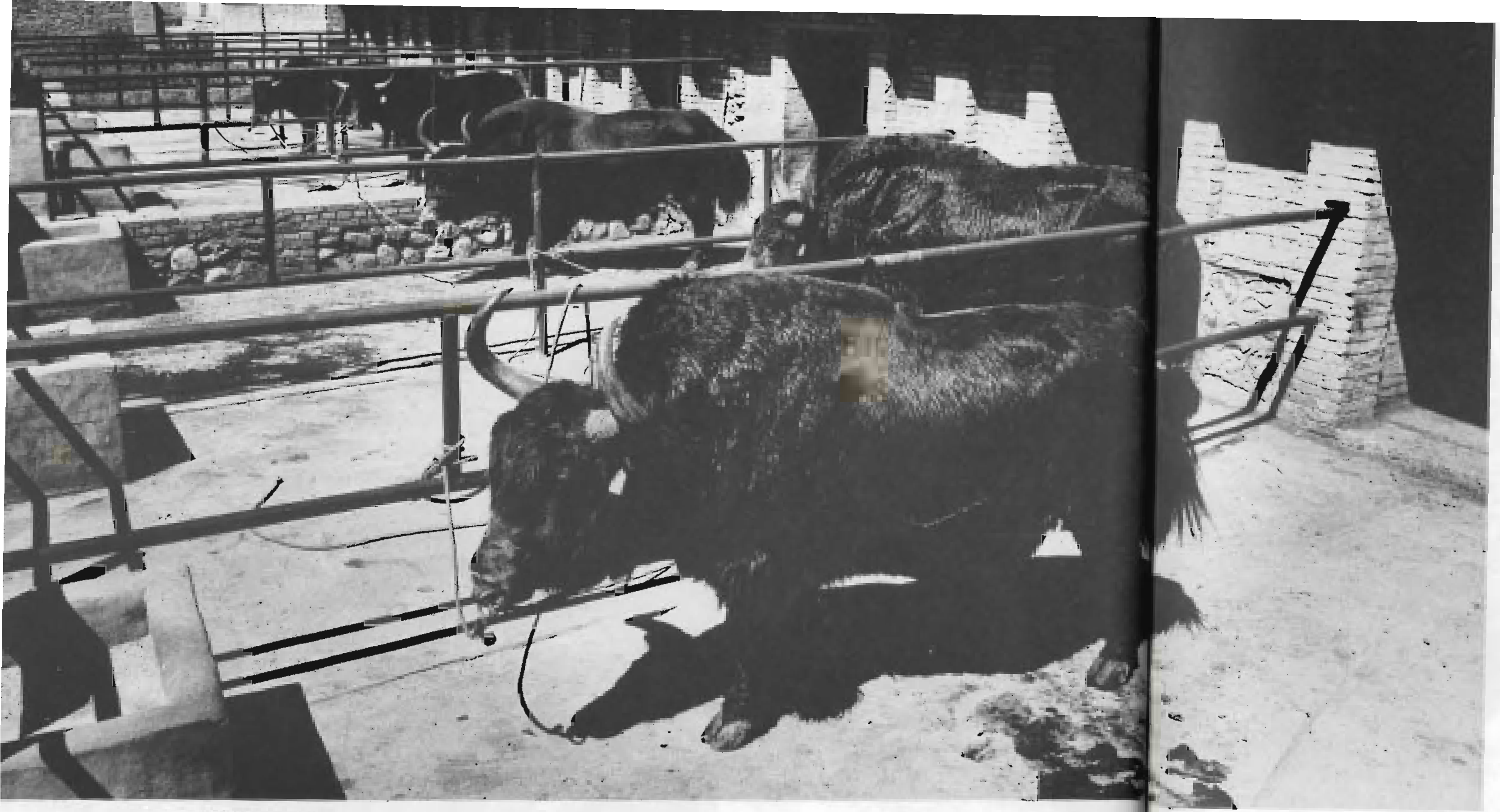
Yak milk being collected for market, Hongyuan, Sichuan, China, 1996

With the increase in human population in the region, along with a rise in peoples' incomes, there is an increasing demand for livestock products from pastoral areas. Many nomads have now entered the market economy, selling their livestock products and purchasing goods they require, in contrast to traditional barter systems. Many pastoral families have greatly improved their standards of living. Nomads throughout the Tibetan pastoral areas of western China, who until a few years ago still lived in tents the year-round, have now built houses and barns and have erected fences around private winter pastures, although most herders continue to live in tents in the summer. Herders are also demanding improved social services (schools, health clinics, etc.), as well as improved veterinary services and market outlets for livestock products. Keeping abreast of the changes taking place on the grasslands is an important task for pastoral researchers. These changes and the effects they have had - and are having - on the rangelands, livestock production, and socioeconomic dynamics of pastoral societies need to be analysed.

Nomads returning home from town, Hongyuan, Sichuan, China, 1997

Modern way to herd sheep, Phala, Tibet, China, 1997





Wild yak stud bulls, Datong Yak Farm, Qinghai, China, 1997

Wild yak bulls are now being used for cross-breeding programmes with domestic yaks to improve yak productivity in China. Semen is collected from wild yak bulls that were captured as calves and now raised on government farms. Wild yak semen is frozen and used in artificial insemination with domestic yak cows. The male F1 crosses from these matings are also used as breeding yak bulls to improve yak productivity. Domestic yak calves sired from wild yak bulls (and bulls that are 50% wild yak) are much bigger and more productive than pure domestic yaks. These programmes highlight the need to conserve and manage the remaining herds of wild yaks still found on the Tibetan Plateau of China.

Deer, such as white-lipped deer which are native to the Tibetan Plateau, are being raised on government farms in China. Their antlers are harvested for medicinal purposes. When considering management of rangelands and pastoral development in the Himalayas and on the Tibetan Plateau, greater attention needs to be directed towards animal resources other than livestock that could be raised by pastoralists to earn additional sources of income.

White-lipped deer, Datong Yak Farm, Qinghai, China, 1997

Yak roundup, Hongyuan, Sichuan, China, 1997

The challenges facing the sustainable development of rangelands in the Himalayan and Tibetan Plateau are considerable. These grazing lands, however, do offer numerous opportunities for achieving the twin objectives of conservation and development of rangeland resources. Programmes stressing multiple use, participatory development, sustainability, economics, and biodiversity could be realised through complementary activities in range resource management, wildlife conservation, and pastoral development and livestock production. Properly managed, rangelands can continue to be sources for water, provide habitat for wild animals and grazing land for livestock, and contribute to overall economic development. Rangeland strategies must aim to maintain the condition of the range and to protect biological diversity. Designing more effective pastoral policies and rangeland development strategies requires improved knowledge of range ecosystem processes, better understanding of pastoral production systems, and more thorough analyses of the constraints and opportunities for improving the management of grazing lands.

Resolving rangeland management and pastoral development issues will require policies and approaches that integrate ecological processes of the rangelands with the economic processes of livestock production and biodiversity conservation. Economic valuation of rangeland resources requires consideration of both direct and indirect values. New policies for rangelands will also have to better demonstrate, in economic terms, the contribution grazing land resources make to overall economic development.

Those involved with managing rangeland resources and setting pastoral policies need to make the best use of the latest data available and any new ideas or emerging concepts on rangeland ecosystems and pastoral development. There is also a need to explore beyond the conventional thinking of many of the traditional range management concepts, developed largely in North America, in order to manage rangelands in the pastoral areas of the Himalayan and Tibetan Plateau where the pastoral history is thousands of years old, more effectively.

Fences on the rangelands, Zoige, Sichuan, China, 1997

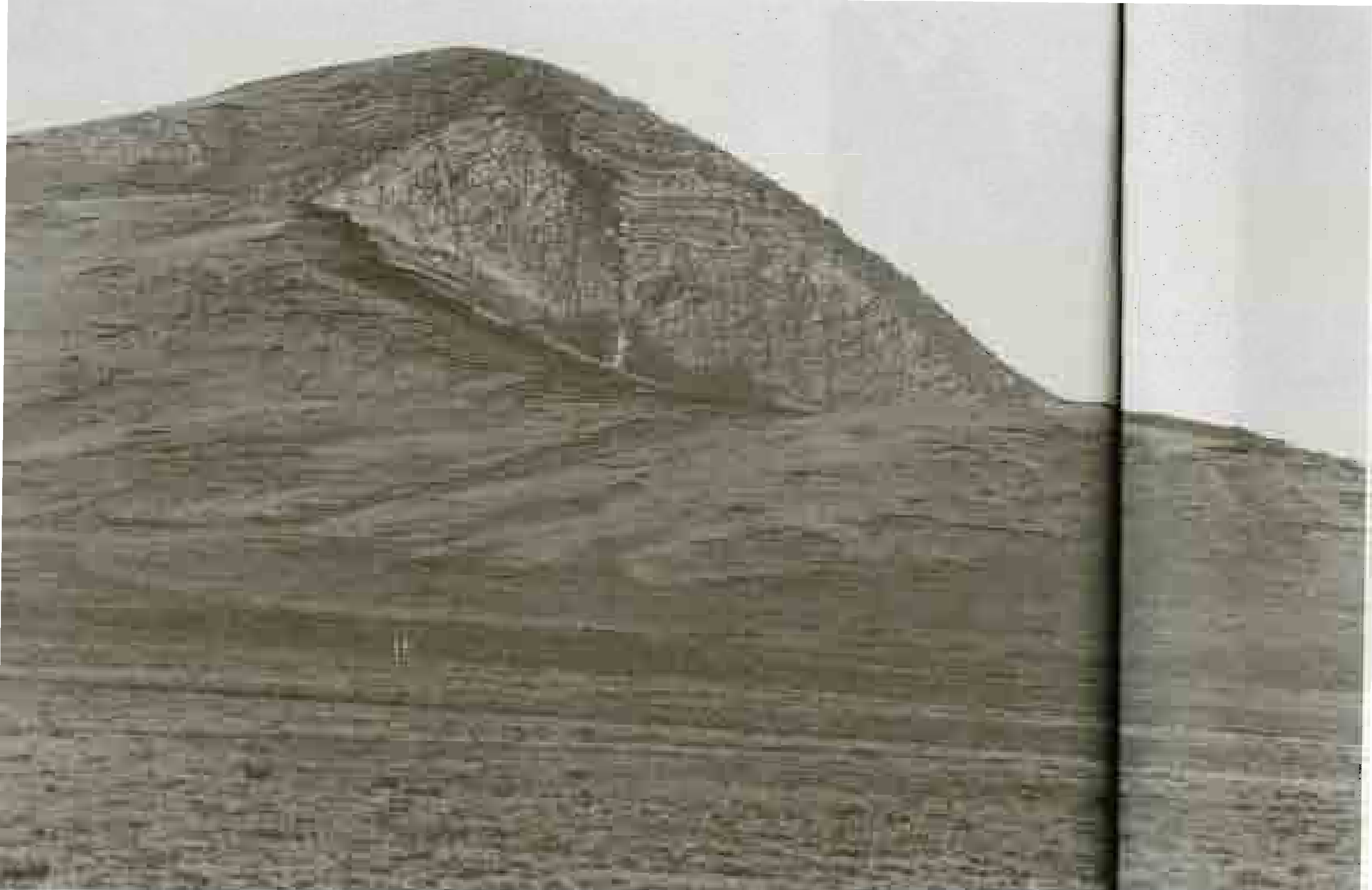
Rangelands, forest and log trucks, Zhongdian, Yunnan, China, 1996

Rangeland degradation, loss of biodiversity, and increased marginalisation of pastoralists result from mismangement of rangeland resources. The general lack of concern for rangelands in the Himalayas and on the Tibetan Plateau means that not enough, good ecological research has been carried out in these grazing land ecosystems and, therefore, rangeland dynamics are not well understood. This complicates proper assessments of the causes of rangeland degradation and decline in rangeland productivity and biodiversity. While overgrazing by livestock is a problem in many areas, livestock are often wrongly blamed for vegetation changes and rangeland degradation. There is increasing evidence that a general climatic trend of desiccation may be responsible for much of the vegetation change and apparent degradation that is taking place. When the actual causes of perceived rangeland problems are misinterpreted, as is often the case on the Tibetan Plateau when the ecology of the rangelands is not well understood, efforts to address the problems are often frustrating and unsuccessful.

Successful efforts to conserve and manage rangeland resources must address the full range of causes of rangeland degradation, loss of biodiversity, low livestock productivity, and marginalisation of pastoralists and embrace the opportunities that rangeland ecosystems and pastoral people offer for sustainable development.

Yaks and sand dunes, Zoige, Sichuan, China, 1996

Eroded landscape, Mustang, Nepal, 1992



Degraded rangelands ("black beach"), Zeku, Qinghai, China, 1997

Rangeland degradation, illustrated by areas of rangeland that have lost their vegetative cover (known as 'black beach' in China) is an issue on the Tibetan Plateau. Large areas of this 'black beach' are found in the eastern parts of the Tibetan Plateau in *Kobresia* sedge meadows. While the causes of this degradation are still not well understood, it is believed by some researchers that the general desiccation, or drying up, taking place on the Tibetan Plateau may be responsible. The rangeland environment can no longer support *Kobresia* plant communities and the rangeland is going through changes to a plant community dominated more by drought tolerant grasses and forbs. Livestock grazing, often perceived as the cause of 'black beach', may actually just accentuate natural ecological processes taking place on the landscape. Small rodents such as pikas ('rabbit-rats') and zokers ('mole-rats') also cause considerable rangeland degradation.

Mole-rat mounds destroying the grasslands, Zeku, Qinghai, China, 1997

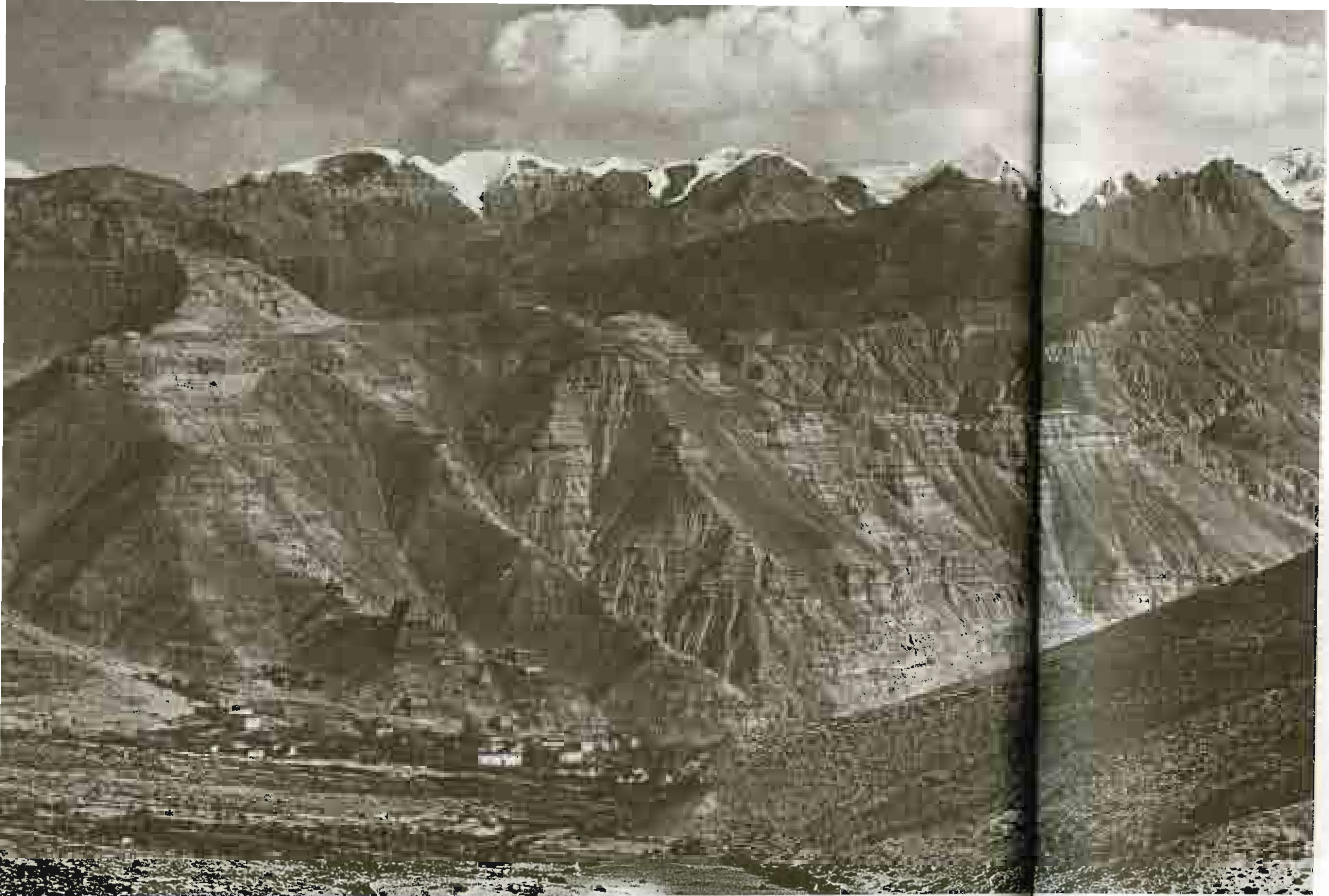
Milking goats, north of Rongma, Chang Tang Reserve, Tibet, China, 1993

Nomad camp, Mustang, Nepal, 1992

Animal husbandry will continue to be the main land use in this high plateau environment. Livestock will be the primary source of livelihood for people residing in these pastoral ecosystems for many years to come. As such, much greater effort needs to be directed towards rangeland research and pastoral development. Many of the new perspectives emerging on rangeland ecosystem dynamics and pastoral production systems from other pastoral areas of the world provide fresh approaches and interesting challenges for analysing rangelands and pastoralism in the Himalayas and on the Tibetan Plateau. They also offer valuable, fresh frameworks for designing new, exciting range and pastoral research, suggesting possibilities for more sustainable development and conservation of these unique grazing lands.

Many pastoral areas in the Himalayas and on the Tibetan Plateau are now included in a greatly expanded protected area system. Balancing biodiversity conservation and pastoral development in these parks and reserves is a major challenge. Innovative models for conservation that promote an integrated development approach offer new opportunities for protecting wildlife while, at the same time, improving people's livelihoods. However, in some key wildlife habitats there may have to be restrictions placed on livestock if wildlife is to survive.

Nomad family, headwaters of Yangtze River, Qinghai, China, 1993



Mountain rangeland, Mustang, Nepal, 1992

There are no simple solutions for addressing range resource management, biodiversity conservation, and pastoral development issues in the Himalayas and on the Tibetan Plateau. Due to the multifaceted dimensions of the problems, action will have to be taken on several levels. Policy dialogue will be necessary to establish appropriate range-livestock development programmes and incentive structures for pastoral areas. Mechanisms for increasing pastoralists' participation in the development process need to be improved. Human resource training and institutional development for organizations working in pastoral development need to be supported. Many of the tools are already available – the knowledge and skills of the herders, scientific data on rangeland resources, new technologies, and information systems – and new information, ideas, and technologies are being generated, but all of this must be integrated into a practical long-term strategy that includes saving rangelands, analysing them, and using rangeland resources sustainably and equitably.

Tibetan sheep, Hongyuan, Sichuan, China, 1996

Tibetan nomad women, Zamtang, Sichuan, China, 1996

Nomad camp with sheep and yaks, Zoige, Sichuan, China, 1996

Pastoral development programmes must involve herders themselves in the initial design of interventions. Herders' needs and desires must be heard and the vast body of indigenous knowledge pastoralists possess about rangeland resources must be put to use when designing new range-livestock development projects. An important message for pastoral policy-makers and planners is the need for active participation by the herders in all aspects of the development process and for empowered herders to manage their own development. New mechanisms for discussion, negotiation, and common action by all concerned about rangelands may be required in order to realise sustainable development goals in pastoral areas.

Rangeland resources must continue to be available for future generations, as much as they should be used to improve people's livelihoods now. Without such provisions, rangelands are not being used in an equitable, sustainable manner.

Milking sheep, Phala, Tibet, China, 1997

Horse festival, Zhongdian, Yunnan, China, 1996

Tibetan saddle, Zoige, Sichuan, China,1997

72-Year old Tibetan nomad, Zoige, Sichuan, China, 1997

The fact that many prosperous nomadic groups remain to this day on Tibetan rangelands bears witness to the extraordinary capacity of these grazing lands, as well as to the sustainability of their resources if used wisely. Maintaining rangeland productivity and biodiversity and, at the same time, increasing livestock offtake to meet growing demands and improve the livelihoods of nomads who depend on the rangelands for existence are challenging tasks.

Sustainable development of the pastoral areas of the Tibetan Plateau and those of the Himalayas requires a better understanding of the complex nature of the rangelands, greater appreciation for nomads and their way of life, and consideration of new information and ideas emerging about rangeland ecosystems and pastoral production systems. It may also require rethinking of some existing pastoral polices in light of new information about rangelands, nomads, and range-livestock production practices.

Yak breeding bull, Merak, Bhutan, 1990

The remarkable rangelands of the Himalayas and on the Tibetan Plateau will experience a great and tragic emptiness if the productivity and biological diversity of these grasslands diminish. Unique pastoral cultures will be forced into transformation beyond recognition, while wildlife populations will be severely threatened. These consequences can be avoided if timely action is taken to evaluate the rangeland resources, to acknowledge the efficiency of many traditional pastoral strategies, and to realistically appraise development alternatives for conserving and managing the Tibetan rangeland ecosystem. These actions are crucial for ensuring sustainable economic development and environmental protection in the face of growing threats from modernisation. Only then will the long-term viability of the Tibetan fields of grass be secured for future generations.

Stupa and prayer wall, Saldang, Dolpo, Nepal, 1978

Pastoral mother and child, Sakten, Bhutan, 1990

Pastoral Issues of the Central and Eastern Indian Himalaya: Prospects & Constraints

Nehal A. Farooquee

INTRODUCTION

This paper presents a survey of livestock management systems and grazing resources affected by the process of modernisation in the Darma and Byans Valleys of Pithoragarh district in Uttar Pradesh, and the Tawang Valley in the district of Arunachal Pradesh, India. *Shauka Bhotia*(s) inhabit the Darma and Byans valleys, while *Monpa*(s) are found in Tawang. In the Darma and Byans valleys of the Indian central Himalayas, the *Shauka Bhotia*(s) use alpine pastures for transhumant grazing of their livestock. The ecological potential and limitations of winter pastures, the extremely inhospitable conditions present at such high altitude settlements, and shifting regional socioeconomic impacts all affect land use.

The overexploitation and mismanagement of alpine pastures have been the focus of much environmental discussion. A number of studies (Melkhania and Singh 1989; Ram et al, 1989; Rekhari et al, 1992; Bawa 1995; Sundriyal 1995) have estimated the dynamics of Alpine grazing resources, composition, growth rate, consumption pattern, and a number of other parameters. However, there is a remarkable gap in knowledge between human activities and the biosphere and impacts of modernisation and development on these traditional resource practices. Concomitantly, much of the available information about Alpine regions in India have been based on false assumptions and inaccurate estimates due to insufficient knowledge of local conditions (Ives and Messerli 1989; Kreutzmann 1993). Likewise, the social aspects of high pastures have received very little attention.

Throughout the Hindu-Kush Himalayas, starting from the Karakoram range in the west to the Tawang Valley of Arunachal Pradesh in the Eastern Himalayas, there is a general decline in animal husbandry and high altitude postoral activities, although populations continue to grow. According to Snoy (1993), in the Hindu-Kush, Karakoram, and northwest Himalayas, the work force is no longer large enough to fulfill the demands of Alpine animal husbandry because of the convenience and economic advantage of non-agrarian income opportunities. Similarly, among pastoral communities of the Indian Himalayas such as the *Bakarwal*(s) and *Gaddi*(s) in Jammu and Kashmir, the *Gaddi*(s) in Himachal Pradesh, the *Mercha Bhotiya*(s) and *Shauka Bhotia*(s) in Uttar Pradesh, the *Lepcha*(s) in Sikkim, and the *Monpa*(s) in Arunachal Pradesh, the actual number of families using Alpine pastures has declined substantially. As a result of his study in Darma and Byans Valleys, Farooquee (1994) regards this decline as a result of development, market-oriented cash economy, and modernisation. High altitude pasture management has also changed; the responsibility for pasture management and herding is shifting from actual livestock owners to hired labourers.

The linking of remote areas with motorable roads and the increased levels of communication between peripheral societies and large market economies has, in turn, changed the priorities in production even among remote transhumant communities. Population pressure and external socioeconomic innovations have influenced the production process, as have new income avenues from off-farm employment. Transhumant pastoralists such as *Shauka Bhotia*(s) have historically employed flexible methods of rangeland management. Whereas they were once trans-border traders linking India with Tibet, they are now finding employment in the tourism sector and altering trading strategies to adapt to changing sociopolitical circumstances.

PASTORAL OWNERSHIP AND PRODUCTION

In the case of the *Shauka Bhotia*(s), environmental uncertainties have changed their production processes. The major production processes are agriculture, pastoralism, livestock production, the sale of woollen garments, and trade in minor agro-based and medicinal herbs. These production processes, as well as compulsory biannual migration between summer and winter settlements, have substantially influenced livestock ownership. The general characteristics of four out of nineteen *Shauka Bhotia* villages are presented in (Table 1).

The *Shauka Bhotia*(s) raise a mixed bovine and ovine population consisting of cattle, sheep, and goats. The relative contribution of each species to household income is important. Cattle provide manure and milk, while sheep and goats provide wool, manure, and meat. Cattle are also well suited for ploughing on the small terraced fields. Though both bovines and ovines are used as pack animals, sheep and goats are easier to maintain than cattle due to the fragility of the resource base and the rugged terrain.

The mean livestock holdings of the four villages of *Shauka Bhotia*(s) studied are given in Table 2. This table indicates that ovine holdings are seven to eight times higher than bovine and equine numbers. This difference is due, primarily, to the fact that sheep are more suitable to the geographical environment than are, for instance, cattle and horses. The sizes of ovine holdings are given in Table 3. It is interesting to

Table 1: Geographical and Socioeconomic Features of the Studied *Shauka Bhotia* Villages

Variable	Dantu	Nabi	Boondi	Sela
Altitude (m)	3220	3566	3000	2438
Total geog. area (ha)	289.62	240.04	241.543	176.24
Total cultivable land (ha)	47.43	2.59	.22	26.59
Cultivable land (% of total)	16.9	17.6	17.8	15.0
Civil and comm. forest (ha)	25.07	5.05	4.95	119.63
Total population	203	315	250	147
Total cows and bullocks	63	133	103	61
Total sheep and goat	859	873	702	429
Total horses	10	18	12	19
Average land holding size (ha)	0.651	0.514	0.755	0.515

Source: Land Revenue Office, Dharchula (Pithoragarh) Primary Survey (1992)

Table 2: Mean of Livestock Holdings of Four *Shauka Bhotia* Villages Studied				
Village	Bovine	Ovine	Equine	Canine
Dantu	6.47 + 2.19	31.6 + 19.2	1.5 + 0.83	1.11 + 0.33
Sela	4.47 + 1.67	28.5 + 33.7	2.7 + 1.73	1.13 + 0.51
Nabi	4.32 + 1.24	26 + 16.42	1.5 + 1.08	1 + 0
Boondi	4.39 + 1.34	41.3 + 43.1	1.7 + 1.57	1.16 + 0.38

note that more than 50 per cent of the pastoralists in all four villages have sheep and goat holdings ranging between 10 to 50, and around 10 per cent of them have herds of more than 50 sheep and goats. The sizes of ovine holdings have reduced drastically in the last decade; earlier, each household had more than a 100.

Table 3 : Size of Sheep and Goat Holdings in the Four *Shauka Bhotia* Villages Studied		
Villages	Flock Size	% of Families
Dantu	No holdings	15.8
	1 to 10	10.5
	10 to 50	63.2
	Over 50	10.5
Sela	No holdings	31.5
	1 to 10	10.5
	10 to 50	52.6
	Over 50	5.4
Nabi	No holdings	17.5
	1 to 10	7.5
	10 to 50	65.0
	Over 50	10.0
Boondi	No holdings	30.3
	1 to 10	9.1
	10 to 50	51.5
	Over 50	9

These migratory pastoralists receive consistent income from sources such as agriculture, woollen products from livestock, and the sale of medicinal herbs (Table 4). Income from agriculture varied from 32 to 36 per cent of their total income; woollen products contributed 18 to 24 per cent; sale of livestock provided 28 to 38 per cent of overall income; and sale of medicinal herbs accounted for 12 to 13 per cent. Thus, livestock forms a regular source of income for

Table 4: Average Income from Various Sources in the Studied Villages of Dantu and Sela		
Income	Dantu	Sela
Agricultural produce	5537 (32%)	5773 (36%)
Woolen products	3178 (18%)	3738 (24%)
Sale of Livestock	6450 (38%)	4400 (28%)
Sale of Medicinal Herbs	2018 (12%)	1994 (13%)

Note: Income (Rs per year) with % of total income in parenthesis in the village
(Rs. 35 = 1 US$ in 1996)

these pastoralists and hence needs to be viewed as a land-based production system. Thus, agriculture, livestock, and natural vegetation are interlinked subsystems of the total pastoral production system (Farooquee and Saxena 1996). The nature and magnitude of the linkages between various subsystems differ from place to place, depending upon environmental conditions and sociocultural traditions.

CHANGING CHARACTERISTICS OF TRADITIONAL PASTORALISM

Livestock Management

The extreme geographical conditions of high altitude rangelands and the meagre resource base available have forced pastoralists to evolve strategies for optimal management of their available resources. The dependence of *Shauka Bhotia*(s) on livestock for their sustenance in an environment characteristically fragile, and the migration of these tribal people twice a year between their high altitude summer settlements and winter settlements in the valleys, have compelled them to develop management strategies well adapted to their tenuous resource base.

As true for any nomadic, transhumant, or pastoralist society, the complex and variable patterns of animal husbandry depend on herders' ingenious orchestration of grazing resources and livestock. These indigenous management systems help balance resource use with subsistence needs. Random fluctuations in grazing resource availability, unpredictable climatic conditions, and wildlife predation are thought to condition pastoral behaviour in this society. Like pastoralists of the High Sierra in the South Central Andes, Central and Eastern Himalayan pastoralists respond to opportunities and limitations presented by the availability of forage, the growth potential of their flocks, and random fluctuations in herd size due to environmental and social hazards (Kuznar 1991).

Management of sheep and goats is required for the survival of Himalayan pastoralists. In order to produce improved herds, sheep and goats are divided into three categories depending on the functions they serve: sheep and goats used for breeding are managed differently than those used for wool production and those that function as porter animals.

Breeding animals receive the utmost care. They are generally kept indoors during rain and snow. They are also fed with the most nutritive grasses and are the first flocks to visit the pastures after winter snows melt when the best nutritive grasses and aromatic plants grow. Herders also try to ensure that these livestock are not confined to one place so they don't miss diversified grazing resources available in summer. This emphasis on nutrition helps encourage healthy offspring and overall breed improvement.

Wool producers receive less care and attention. Their breeds are also different, with some of Tibetan origin bearing high quality wool similar to 'pashmina' varieties. These sheep and goats are very hairy and hence are sheltered from high intensity sun to avoid excessive sweating and energy loss. They are sheared twice a year, in summer and winter.

Flocks used as pack animals are generally local breeds of sheep and goats. Just as camels in deserts, they are extensively used for transportation of food grains from lower settlements to summer encampments. This category of sheep and goats outnumbers the other two groups. These animals can carry up to 30kg each.

The *Monpa*(s) of Tawang primarily keep yaks *(Bos grunniens);* their cross-breeds are not classified like the sheep and goats of the *Shauka Bhotia*(s). Yet, only male yaks are used to carry fuelwood. Pregnant female yaks are fed properly and given a regular supply of salt for better digestion and appetite. Yaks provide these pastoralists with milk, meat, wool, and hides; dairy products, in particular, are a staple of the *Monpa* diet. Selling milk and its by-products provides a a primary source of *Monpa* income. However, instead of cash, *Monpa* pastoralists prefer barter exchange of grains and other food items for their dairy products.

Community Regulation of Resource Use

Evidence suggests that community regulation of resource use and livestock movements evolved to stop conflicts and encourage the equal sharing of resources by the entire community. The ceremonial exclusion of livestock from particular areas for a specified period of time is a crucial component of their resource management system. A similar system has also been reported among the *Sherpa*(s) of Khumbu (Brower 1991). This practice protects village crops and also creates a *de facto* deferred grazing system which distributes livestock impact through space and time.

Though most of their agricultural fields have a wall-fencing, the growth of potato and buckwheat plants determine the date on which livestock are moved towards the '*bughiyal*' or Alpine pasture. Defaulters are fined by the community for each day their livestock remain on the restricted side. Other restrictions are also imposed on entry into village fields and similar activities considered to jeopardise crops and village welfare. Thus, villages have instituted protection methods for both their rangelands and their cultivated areas. A similar ban is also imposed on any land providing cereal grasses, or any plant or vegetation promising seed, nutrient storage, or floral diversity. Sometimes these restrictions are also imposed on the growing of good grazing resources; occasionally, a particular day is fixed for grazing in a particular area so that grazing resources are shared between all villagers. In most of Darma and Byans, the bans on various grazing resources are removed sequentially and grass cutting is permitted just before crops are harvested.

These regulations protect wild grasses for most of the growing season, and hence provide good grazing resources to pastoralists. They also promote efficient labour use during the year's busiest season and, thus, are a good example of indigenous management systems which strive to synchronise human and natural resource use. The institution of community regulation of resource use and livestock movement is an example of self control, discipline, and community cohesion — all of which help sustain these pastoral lifestyles.

CONCLUSIONS

Over the centuries, pastoralists have developed adept grassland management and animal husbandry systems so that they may survive in their inhospitable, high altitude environments. The presence and continuity of transhumant pastoralism in places like the Central and Eastern Indian Himalayas attest to this. Yet, these pastoral communities are now witnessing tremendous pressure as a result of their integration into market-oriented cash economies, on the one hand, and their rapidly changing social structures on the other. Hence, it is very important for local social and cultural institutions to strike a balance between these two opposite forces. Questions concerning traditional knowledge and evaluation of natural environment in such societies have gained more importance in the recent literature (Sandford 1983; Fisher 1987; Miller 1990; Brower 1991). However, new perspectives regarding the assessment of changing pastoral production practices in light of the increasingly cash-oriented Indian economy, as well as changing local values, provide a valuable framework for studying Himalayan pastoral societies.

ACKNOWLEDGEMENTS

The author is thankful to Dr. L.M.S. Palni, Director of the G.B. Pant Institute of Himalayan Environment and Development, for facilities and to Dr. S.K. Nandi for his comments on this paper.

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Pasture Management, Indigenous Veterinary Care and the Role of the Horse in Mustang, Nepal

Sinna Craig

INTRODUCTION

Once a major thoroughfare for the trade of salt and grain between Tibet and Nepal's southern hills, the Mustang District in Nepal's western Himalayas remains a trading route to this day. This boot-like piece of land jutting north into western Tibet is cold, high-altitude steppe, caught in the rain shadow of Dhaulagiri Himal to the west and the Annapurna massif to the east. Much of the district lies above 2,500m, coming to a peak at 8,167m — the summit of Dhaulagiri. The Kali Gandaki River is the backbone of this district; its source is located near the Tibetan border, flowing south towards the northern Indian plains. Mustang is flanked by the Nepalese districts of Manang to the east and Dolpa to the west; the Tibetan frontier stretches north from Mustang's borders.

Mustang is one of the most remote areas in Nepal and is second in terms of the sparsity of population (Thakali 1994: 45). The district covers an area of over 3,500 sq. km. and is divided into 16 Village Development Committees (VDCs), which function as local political units. According to the 1992 Census, the total population of the district was 14,319, not including area residents such as government and army officials, police, development workers, and Tibetan refugees (Thakali 1994: 45). Mustang can be socially and geographically divided into four regions: Lo (the northern, restricted area); Baragaon (villages of ethnically Tibetan people who live in and around the Muktinath Valley); Panchgaon; and Thak Sat Sae (villages clustered around Jomsom, the district headquarters and settlements along the Thak *Khola*, a segment of the Kali Gandaki located south of Jomsom).

Though the people of Mustang live within the geographic boundaries of Nepal, their history is also tied to Tibetan religion and culture, geography, and politics. Until 1769, when the Ghorka King, Prithivi Narayan Shah, and his army 'unified' what was a land of many small kingdoms and created the kingdom of Nepal, much of present-day Mustang was ruled by independent kings and feudal lords. These regions were, at times, closely linked to adjoining kingdoms of Western Tibet and, during other periods of history, politically linked to Lhasa, the capital of Central Tibet.[1] Before the unification of Nepal by

[1] The Raja of Lo, for instance, continued to pay tithes to Lhasa until the 1950s. For more information about the historical connections between Tibet and Mustang, see Jackson 1978, Vinding 1988, and Ramble 1993 a and b.

the Gorkha king, areas of Mustang were ruled by kings from Jumla, a region to the southwest. The only remnant of these kingdoms is the still-intact kingdom of Lo, an area corresponding to the northern third of Mustang District.

Although Lo is now open on a restricted basis to foreign travellers, the kingdom was closed to foreigners, with rare exceptions, until 1992. The lower Mustang areas (much of Baragaon, Panchgaon, and Thak Sat Sae) lie along the Annapurna Circuit, the most heavily trekked route in Nepal. The entire district lies within the Annapurna Conservation Area — the largest protected area in Nepal. Development programmes, tourism management, and so on are primarily overseen by the Annapurna Conservation Area Project (ACAP), a division of the King Mahendra Trust for Nature Conservation (KMTNC).

This paper describes traditional grazing practices in Mustang and indigenous veterinary techniques, specifically as they relate to horses. Although horses only comprise a small fraction of the total domestic livestock kept by Mustang residents, they are the fulcrum of social status and one of the most significant measures of wealth. Similarly, equine care is the most intricate and developed of all local veterinary practices. Adequate pasture land, sustainable management of these resources, productive animal husbandry, and access to effective and reliable veterinary care are integral to local subsistence in Mustang.

MUSTANG'S PASTORAL MANAGEMENT SYSTEMS

Agro-Pastoralism

The people of Mustang survive through a combination of animal husbandry, agriculture, and trade — a lifestyle similar to the nomadic and semi-nomadic pastoralists of the Tibetan frontier and the Central Asian plains. In general, pastoralism refers to the way of life of pastoralists, their socioeconomic institutions, and their land-use systems. This includes communities of nomads (so-called 'pure' pastoralists), as well as communities who live by various systems of transhumance; other forms of animal husbandry in which the pastoral component is a dominant feature are also a factor in their survival mechanisms (Miller 1995:2). This latter definition encompasses the agro-pastoralists of Mustang.

Variations in altitude, geography, and climate throughout Mustang give rise to a range of agricultural practices and growing seasons; in general, however, sustaining oneself through land cultivation alone is nearly impossible in most places throughout the district. The people of Mustang rely heavily on animal husbandry to survive. As such, access to sufficient and good-quality grazing lands is indivisible from a viable agro-pastoral lifestyle. Just as maintaining the health of one's stock is of primary concern (as healthy and/or malnourished animals are unproductive), the quality and quantity of an area's pastures, as well as the methods for managing these vital resources, determine the wealth and define the futures of agro-pastoralist communities such as those in Mustang.

The status of grasslands and the number of pastures, as well as cultivation cycles and practices, vary greatly within Mustang. A harsh climate and high altitude, as well as lack of cultivable land, dung for fertilizer, water for irrigation, and labour sharply limit cultivation (Jackson 1994:3). The villages of upper Mustang[2] only cultivate their fields once a year, planting in late winter (February-March) and harvesting in late fall (October). Barley (naked and husked varieties)[3], wheat, buckwheat (bitter and sweet varieties), sweet peas, and mustard comprise the bulk of the year's yield. Some families grow green vegetables and radishes as well as apples and peaches in private fields and orchards. Settlements in lower Mustang plant and harvest twice a year, sowing in mid-February, reaping in May, and planting again in late May/early June for harvest in October. Settlements from Taye to Marpha (villages in Baragaon and Panchgaon, respectively) are famous for their apples. Large orchards line fields and nudge up against homes. These apples are locally consumed, as well as dried, distilled, and marketed in Pokhara and Kathmandu.

Despite their relative wealth, even the villagers of lower Mustang offset their income and low-yielding fields by keeping domestic livestock. Yet, the further north one travels, the more dependent these communities become on animal husbandry. The area's geography also changes dramatically as one moves up the Kali Gandaki towards Lo. Clusters of Alpine forest (particularly Juniper, Spruce, and Fir) and jagged, rocky trails segue into rolling hills and plains cross-hatched by cavernous valleys of cadmium, ochre, and vermilion-coloured earth. Pasture lands virtually devoid of trees surround villages and stretch towards the snow line. The trail to the Tibetan border is a ribbon of road that seems arbitrarily fashioned along this western stretch of the Tibetan Plateau. Although cultivated fodder (grains and grasses) helps offset free-range grazing for horses, donkeys, mules, cows, and yak crossbreeds to varying degrees, all of these animals depend on area pasture resources for survival. Yak, sheep, and goats rely exclusively on free range for fodder.

External Perspectives

In *People's Participation in Range Management: The Case of Mustang, Nepal*, Thapa (1990:6) describes the rangelands of upper Mustang as part of a bleak, dry landscape in which the majority of land is barren, uncultivable, and used for natural grazing. Despite local reliance on animal husbandry, the range is "*denuded due to overuse and lack of proper management practices.*" The livestock population is double the carrying capacity of the rangeland (Rajbhandari and Shah 1981 in Thapa 1990:7). Brown (1983:19) describes a similar situation in his *Recommendations for Revegetation and Management of Denuded Lands in Mustang, Nepal*. Upper Mustang's range is scattered with spiny bushes, not all of which are palatable; few fodder trees

2 For the purposes of this paper, I will refer to 'upper' and 'lower' Mustang. In contrast to the border drawn at Kagbeni which equates 'upper' Mustang with the restricted area, I draw this border between the villages of Samar and Tsele; whereas all villages from Samar north cultivate their fields only once annually, settlements from Tsele south cultivate twice a year (with several exceptions). The religious, geo-political, and linguistic divisions of settlements in Mustang District are much more complicated (see Schuh 1990 and Ramble 1994, 1995).

3 According to Manzardo, when the people of Thak Khola reduced their production of hulled barley, a localised cost spiral began in the area. It soon became the local equivalent of an 'oil shortage', as the lack of this grain began to drive up transportation costs and with it, the cost of all other goods in the area. One can conclude that the heavy production of hulled barley in this area is directly linked to the needs of animal husbandry (1994:24). Without this fodder, the extensive and lucrative Thakali (people from Thak *Khola*) mule trains would be much less efficient and profitable.

exist in the area. As dung and low bushes are collected for fuel, the fertility of rangeland soil has suffered. These practices also accelerate soil erosion (Thapa: 1990:7).

Shortages of fodder, particularly free-range grasses, are becoming more acute due to the declining status of area pastures and Mustang residents' lack of access to Tibetan pasture land in winter. The Chinese invasion of Tibet gave rise to political changes between the governments of Nepal and China, eventually disrupting the centuries' old transhumance patterns. In 1983, the two governments enacted an agreement which stipulated that the movement of animals from both countries would be completely stopped by April 1988, a policy affecting about 21,000 head of livestock in Mustang alone (Thapa 1990:15). Whereas people from upper Mustang once moved their herds (particularly yaks, sheep, and goats) to pastures on the Tibetan Plateau for winter, this practice was essentially stopped.

His Majesty's Government of Nepal (HMG) realised that the closing of Tibet for grazing purposes would have a severely effect on pasture land and fodder availability in regions like Mustang. In response, the government introduced the Northern Area Pasture Development Programme (NAPDP), in collaboration with the Department of Livestock Services (DLS). This programme was particularly geared towards range management and fodder development in four 'critical' and six 'emerging' forest/feed crisis districts (Thapa 1990: 17). DLS, in conjunction with UNDP/FAO, also launched a similar programme in these four districts, including Mustang. Although the status of grasslands in lower Mustang is generally considered better than the status of those to the north, the entire district retains a reputation as an area in dire need of grassland and pasture management assistance.

Thapa (1990: 49) isolated several indigenous rangeland management activities practised in upper Mustang, most of which were connected to rotational grazing, with additions such as altering the number of animals per range at different seasons, weeding pasture lands, and *"asking China to help"* alleviate winter pasture problems. The other primary pasture management practice mentioned by Thapa's informants was the levying of fines for herders caught grazing outside their designated village grazing areas. Forage needs in lower Mustang are primarily met by buying hay from lower Mustang, harvesting fodder from private fields, and moving animals south for the winter (Thapa 1990: 51). When asked about pasture management issues, ACAP programme officers based in lower Mustang have said that indigenous pasture management systems are limited to rotational grazing and charging fines to those who graze their animals outside their home range. Changes in property distribution and shifts in marriage structures (from polyandry to monogamy) might also be affecting overall range management throughout the district, according to ACAP.

The informants in both Thapa's thesis and Brown's report trace their management practices to those of their parents and ancestors. Likewise, ACAP and CARE Nepal field staff in Mustang mentioned that pasture management systems, like farming techniques, are integral to the overall social, cultural, and historical framework of Mustang and have been practised for generations. Thapa (1987), CARE Nepal, and ACAP personnel all mention, however, that locals are 'unaware' of problems caused by overgrazing and their roles in contributing to these problems. *"Villagers are prac-*

tising the traditional system of management, but that alone is not adequate to produce more forage in such an overgrazed and overpopulated rangeland" (Thapa 1990: 24).

According to such assessments, the people of Mustang are marginally conscious of the critical state of their ranges, as well as their roles in contributing to these problems. Indigenous systems are seen as too weak and inadequate to face the challenges of effective and sustainable resource management. Although there is value in such statements, these assertions leave one with an incomplete — and, therefore, inaccurate — picture of the status of grasslands and pasture management in Mustang. In addition to examining the workings of indigenous management systems externally, one must — as much as is possible – glimpse the internal perspectives of these systems.

Internal Perspectives, Historical Precedents and Political Change

Local responses to questions like *"Do you have enough pastureland to sustain your animals?", "(How) has the quantity and quality of wild and cultivated fodder changed within your lifetime?"*, or *"How do you look after your pastures?"* vary substantially throughout Mustang. The 'upper'/'lower' Mustang divide, intricacies of social stratification, and educational levels of informants all have a bearing on local awareness of such issues and, therefore, answers given. Nevertheless, it is possible to isolate trends and general assumptions regarding local perceptions of the status of area grasslands.

On the whole, the people of lower Mustang say that they are less pressed for rangelands than their northern neighbours. Glacial runoff forms relatively lush valleys near the base of the Nilgiri Himal; the Muktinath Valley and other areas of lower Mustang harbour clusters of Alpine forests and grasslands. In upper Mustang, a virtually treeless landscape and stretches of sandy plains frame dry, difficult local realities. Whereas a Thakali living in Thini (a village across the Kali Gandaki from Jomsom) might reveal that the availability and quality of pasture land has declined in his lifetime, he is hard pressed to say his livelihood has significantly changed due to these shifts. A *Loba* (person from Lo) from Samzong village, for instance, would most likely say that the problem of inadequate pasture land has caused him much loss of livelihood in recent years. He might point to problems such as rivers and other water supplies drying up and insufficient winter pastures as the sources of such changes in pasture quantity and quality.

Throughout Mustang, weather patterns, fluctuating numbers of livestock, lack of access to Tibetan pasture land in winter and, to a lesser extent, fear of ghosts of Khampa guerrilla forces who occupied Mustang during the 1960s and 70s are some of the primary factors shaping local perceptions of rangeland resources.

First, weather patterns — particularly fluctuations in rain and snowfall — have direct implications for rangeland quality, and therefore, local perceptions of this quality. Adequate snow and rainfall leave pastures green, grasses long, and water sufficient according to Mustang residents from Monthang in the north to Marpha in the south. Likewise, either extreme (e.g., lack of rain or particularly heavy and/or early snow) produces devastating effects on pasture land and, consequently, livestock. Such shifts in weather also directly correlate to the amount of water available for irrigation: cultivated grasses and grains for fodder and human consumption become less sufficient and more expensive when water is in short supply. Massive, quick climatic changes resulting in disasters such as floods and landslides can also have instant and devastating effects on local grazing land. For example, Chhoser (a VDC north of Monthang) was ravished by floods in 1986; this event destroyed a significant amount of the area's cultivated land as well as free ranges.

The number and kinds of livestock kept by Mustang residents vary both from village to village and from household to household, depending on overall community wealth, individual family income, and available range and fodder resources. This availability, however, is inextricably tied to weather patterns. Death from cold and/or starvation, during particularly harsh winters is not uncommon. Similarly, if rain and snowfall have been good for several seasons, locals tend to increase their herds, maximising profit when conditions are good and guarding against future losses. As such, the pasture management systems practised by the people of Mustang tend to fall outside the concept of 'carrying capacity' and function instead on an opportunistic model of rangeland use.[4] This is particularly true of sheep and goat herds, and is further exemplified by the rapidly decreasing number of yaks and their crossbreeds raised in Mustang since the closing of the Tibetan border to migrant herds in winter (Blumont 1996). In the last twenty years, however, the number of horses kept by people in Mustang has continued to increase. Fifteen years ago, the Muktinath Valley had very few horses. Only wealthy families could afford to own these animals. Although *Thakali*(s) living between Jomsom and Tukche have a long history of keeping mules, the number and quality of horses in this area have also increased in the last two decades. Twenty years ago, the village of Monthang was home to, at most, 150 horses; now the village keeps over four hundred. The reasons for this increase are primarily tied to the wealth generated by tourism (in Mustang's unrestricted area), the hope of generating such wealth in the future (in the northern, restricted territory), and the social status connected to horses themselves.

Thakali(s) and Tibetan-speaking people who live in the unrestricted area of Mustang have augmented their herds of both horses and mules, renting riding horses and supplying trekking companies or individual trekkers with horses or mules to porter goods. Each riding horse earns owners between Nepali Rs 300 and 700* per day; porter horses and mules earn between Rs 200 and Rs 350 per day.[5] Age-old *Thakali* mule trains now not only deal in Tibetan salt and Nepalese grains; they also carry expedition gear, beer, sodas, and choco-

4 For more information on these concepts, and their implications for future range management strategies in the Himalayas and Tibetan Plateau, see Miller 1997.

5 The rental price of both porter horses and riding horses are subject to change depending on season and the availability and price of fodder. Ironically, the prices for these services are more expensive in the unrestricted areas (particularly Jomsom) than they are in the restricted areas of Mustang. Whereas the former continues to become more expensive, and more 'luxurious', for independent trekkers, the latter continues to scrape what little benefit they can from 'organised group' trekking tours. Competition induced by trekking companies looking for the best bargain on porter animals has created fierce price wars in upper Mustang, particularly for porter horses. Trekking companies rent from the lowest bidder; locals are desperate to make what little profit they can, instead of having their animals sit idle in the village. Even though fodder is more expensive in upper Mustang, locals are renting pack animals for as low as Rs 180 per day. A porter horse consumes at least Rs. 100 per day in feed costs, if not Rs 150 or more, rendering the profit margin virtually nil.

* There are 63 Nepalese rupees to one US $.

lates to sell to trekkers. Although *Thakali*(s) are known as savvy traders and middlemen, they have increased their wealth by fortifying herds of porter animals.

Now that upper Mustang is open to foreigners on a restricted basis, *Loba*(s) have increased the number of horses kept in the hopes of benefiting from tourism. Trekkers in this and other restricted areas of Nepal are required by government regulation to porter in all food and fuel, thereby minimising environmental impact. Given such stipulations, one of the only ways that locals reap some benefit from tourism is to rent horses for riding and portering. As such, those who can afford to keep more horses (particularly in Monthang) have begun to do so.

Horses in Mustang, as with other nomadic and semi-nomadic communities across Tibet and the Central Asian plains, denote wealth and prosperity. To increase one's holdings of these animals directly correlates to one's social status. This simple fact has a bearing on the intriguing relationship to Mustang's pastures. The people of both upper and lower Mustang recognise that the increase in horses has direct negative effects on the availability of adequate pasture land for other domestic animals. Horses also consume cultivated fodder and grains at an alarming rate, compared to other livestock. And yet, because of the wealth and status this increase implies, locals have been reluctant to reduce horse herds.

Political changes in Tibet have brought about economic upheaval among pastoralists throughout northern Nepal, disrupting traditional trading patterns. These events have also had vast effects on local rangeland and livestock production systems (Miller 1995:7). In the wake of the Dalai Lama's flight from Tibet in 1959, Tibetan pastoralists fled (with their livestock, when possible) into Nepal. Mustang's relatively easy access to Tibet, as well as its historical ties to pastoral communities on the other side of the border, precipitated the entry of large numbers of refugees to Nepal across Mustang's border. This dramatically increased environmental pressures on rangelands, leading to heavy grazing and declines in rangeland productivity. Similarly, the Sino-Nepali agreement of 1983 changed the lives of Mustang people, particularly those from Lo. This political sanction increased demands on scarce winter rangelands within Mustang's borders. The closing of the Nepal/Tibet border to winter transhumance has caused *Loba*(s) to shift their winter migration patterns; they now move south to Pokhara with horses, mules, donkeys, sheep, and goats. Yaks, however, cannot live in the lowland heat of Nepal's middle hills. Consequently, very few yaks and their crossbreeds are currently raised in Lo. What yaks remain must survive on greatly reduced areas of winter pasture in upper Mustang — areas that, according to locals, are becoming increasingly less productive. These negative trends are attributed both to a general feeling that the area is drying up (see Blumont 1996), and to competition between sheep and goat herds and yaks for limited high-altitude winter range.

Finally, when asked about the status of their grasslands, the people of Mustang often refer to *Khampa* occupation of Mustang in the 1960s and 70s. The *Khampa*(s) were Tibetans (primarily, though not exclusively, from Kham in eastern Tibet) who engaged in guerrilla warfare against China's People's Liberation Army. The *Khampas* — fierce warriors and reputed horsemen — based themselves in Mustang from the early 1960s until 1974. They established camps, monopolised trade along the Kali Gandaki, set up supply posts, and instituted rotating credit systems for Mustang residents. Their troops' demands for firewood, building materials, food, and animal fodder, however, greatly increased human impact on local resources.[6] Given the nature of the *Khampa*'s plight, and the fact that they were regarded as both heroes and bandits, it was difficult for locals to enforce community regulations on firewood use and pasture exploitation on these guerrilla warriors. Today, the *Khampas* are often blamed for deforestation and the depletion of precious grassland resources throughout Mustang.[7]

In contrast to external perspectives on pasture management, as exemplified by reports like those of Thapa, the people of Mustang have engaged in complex systems of grazing management for centuries. Historically, management of Mustang's grasslands is primarily in the hands of the village headman (*rgan-pa*). In the case of Monthang and the surrounding villages, the Rajah of Lo often handled such responsibilities. The headman position, chosen from among a village's noblemen, rotates every few years. The headman's responsibilities include mitigating disagreements over grazing and irrigation rights, as well as setting and collecting fines for those villagers caught breaking rotational grazing rules. The *rgan-pa* also played an integral role in determining herd size and local prices for domestic animals (Schuh 1990:5). Village constables (*rol-po*) were traditionally in charge of enforcing community regulations regarding the use of natural resources.[8]

"*Enquiries in all the settlements of Baragaon and Panchgaon*," writes anthropologist Charles Ramble in 'Rule by Play in Southern Mustang', "*suggest that...the position of headman (rgan-pa) has altogether ceased to exist, apparently in consequence of the introduction of the Panchayat System in the 1960s. While it is clear that there has been more or less rapid political change in most of these communities, it is not always clear what the change has been from*" (1993:228).

In some lower Mustang communities, village *rgan-pa*(s) have been replaced by VDC heads, or *mukhiya*(s). Enquiries into the status of these posts in upper Mustang yield different results; although the positions of *rgan-pa* and *rol-po* throughout Lo have changed, they have not disappeared. Sometimes *rgan-pa* and *mukhyia* or VDC chairman sit side by side and share decision-making; at other times, they are the same person. The situation is also complicated by the presence of the Rajah of Lo. The Rajah spends, on average, half his time mediating conflicts, i.e., inheritance dis-

[6] For more information on the *Khampa*(s), see John Avendon's *In Exile from the Land of Snows*, Michel Peissel's, *Mustang: The Forbidden Kingdom*, Thakali 1994, Balestracci 1989.

[7] In the villages of Chuksang (Tshug), for example, there is evidence of trees that were felled by *Khampa*(s). Ironically, an old *Khampa* is currently in charge of protecting the area from wood poachers (Ramble and Seeber 1995:115).

[8] Ramble's article *Civic Authority and Agrarian Management in Southern Mustang* also outlines complex systems of local resource management, the shadows of which only are referred to in accounts such as Thapa's and Brown's reports. Topics from seed planting and practices to irrigation rosters, in addition to grazing patterns and rights are referred to in the primary sources discussed in Ramble's piece. Also see Vinding and Ramble 1987 and Schuh 1990.

putes, irrigation disputes, grazing disputes, and so on. Though Nepalese justice is available a few days' walk south in Jomsom, the *Loba*(s) often prefer the Rajah to mitigate their disagreements (Laird 1992:86).

Although grazing rights and pasture management systems vary throughout Mustang's history, these systems generally contain the following components: rotational grazing according to season, type, and number of animals; the levying of fines for outsiders who use community resources, as well as for community members who violate set grazing rules; and a system of shepherding which varies across the spectrum of domestic stock. As Manzardo writes, "*The Thakali(s) developed an efficient management programme for their pasture areas, controlling access and charging outsiders for its use...Their example could be applied to other areas of Nepal*" (1984:30).

Likewise, the people of upper Mustang continue to regulate the use of their pastures. A look at the specifics of horse grazing provides a window into these systems.

The Specifics of Horse Grazing and Relevant Migration Patterns

Although horses are less of a luxury item in Mustang than they are in purely nomadic areas across the Tibetan frontier (Goldstein and Beall 1990:72), these animals are generally not as productive as other livestock such as mules, yaks, or yak-cow crossbreeds — particularly when comparing levels of productivity to overall fodder consumption. Horses must be stabled, shod (in the case of riding horses), and given supplementory feed most of the year. As horses are pivotal indicators of social status, they are often kept (relatively) fat at the expense of the health and nutrition of other animals, or even humans.[9] The price of horses in Mustang has also risen in recent years. Whereas one could buy a good riding horse for Rs 3,500 in 1974 (Manzardo 1984:25), people now routinely pay between Rs. 60,000 and Rs. 150,000 for an animal of comparable quality.[10] After accounting for national inflation in the last 20 years, this is still a significant increase.

Manzardo suggests that because "*horses are neither strong nor economical...they need to be replaced on a systematic basis*" (1984:31). Though this assertion is valid in strictly economic terms, it does not account for the social and cultural roles that horses fill in Mustang, the historical niche they occupy in upper Mustang during harvest,[11] or the increasingly productive role that horses are playing in Mustang.[12] Likewise, one cannot discount the fact that the equine presence creates attitudes and value judgments that are part of what Robert Ekvall in *Fields on the Hoof*, his book on Tibetan pastoralism, called a "*horse-culture modal personality*" (Miller 1995:5).

Unlike yaks, which spend their entire lives

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9 In Monthang, horses are often fed much of the sweet pea crop each year. These legumes are one of the major sources of protein (in addition to mutton, yak meat, and dairy products) that comprise local diet. People who want to appear wealthier than they are tend to use a good portion of their sweet pea yield to keep horses healthy. Eggs and mustard oil, a luxury in most of upper Mustang, are also given to horses. If alternative sources of horse fodder were available (such as subsidised oat or barley grains, or increased production of alfalfa), or if the number of horses decreased, nutritional standards of the people of Lo might improve (Wandgu, pers. com. 10/96).

10 In equivalent $US, this is a price increase from approximately $65 to between $1,200 and $2,300.

on free ranges, horses move between free ranges and private homes as much as they travel up and down the Kali Gandaki to earn their keep. The management of horses differs across community lines as well as across Mustang's variegated geography. Two communities' pasture management systems in relation to horses — those of Jomsom and Monthang — will be presented and compared to illustrate this point.

In Jomsom, most households own at least one horse. Many families (particularly those directly involved with tourism or trade) own three or more horses. During the winter, grazing one's horses is an individual responsibility. These animals are usually let out to drink in the morning and are then led by a family member to nearby winter pastures (usually fields of spiny bushes on ridges directly above Jomsom, or along the Kali Gandaki river bed) where they roam freely throughout the day, returning home at night. Horses' diets are supplemented by green hay and grasses collected from fields and dried during the fall; if a horse is ridden, it is often given between four and eight *manna* (ca. 2 manna/kg) of grain in addition to grass each day.

Before fields are planted in early spring, and once they have been harvested in fall, horses (as well as other domestic animals) are allowed to forage for roots and grass in fallow fields. However, once fields have been planted, owners of horses caught grazing in fields pay Rs 20 per animal per day and double at night. This rule is strictly enforced. Funds collected are given as compensation to owners of violated fields. During the spring, horses continue to move between lower winter pastures and private stables. Responsibility for care remains in the hands of individual horse owners, though the distances travelled to reach grazing pastures increase as snow melts; a gradual transition between the use of winter and summer grazing pastures begins. Grazing land is considered communal property. Villagers tend to keep their horses away from high altitude pastures until summer to maximise regeneration. Borders of local pasture are based on centuries' old village relations, are recorded in village documents (*bem-chag*), and are primarily enforced by the village *mukhyia*.

From approximately mid-June to late September, horses are grazed on high altitude pasture land surrounding Jomsom. At this time, the care of horses and pastoral management become a community responsibility. Horses are often released for weeks at a time to graze high in the mountains surrounding Jomsom. Informal groups are formed among friends and relations in which one person is chosen to be the *rta-dzi*, or 'horse shepherd' on a rotational basis. Approximately every week, one of these people will travel to the high pas-

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[11] In lower Mustang, people thresh newly reaped harvest. In Lo, however, horses almost exclusively supply this labour. Horses carry sheaves from the fields and are then driven in circles to thresh grains, particularly wheat and peas. Incidentally, the Rajah still drives his own team of horses during harvest (Laird 1992:86). Cultural taboo prevents mules from doing this work.

[12] Given the increasing difficulties in keeping yaks due to lack of winter pasture, and given the general increase in the number of horses throughout the District, it might be economical to keep yak herds at a minimum and rely on horses to a greater extent (Blumont, pers. com. 10/96). Now, economic reality is expressing this idea. Lo Monthang's VDC Chairman, one of the few people who owns yak in Monthang, just sold his herd to Tibetans because he can no longer afford to keep them given the lack of winter pastures. The Rajah of Lo is now contemplating a similar move (Bista, J. pers. com. 11/96)

tures and check on his group's horses, bringing down any horses that are needed for work. *Rta-dzi*(s) discuss grassland conditions with each other and determine rotational grazing schedules. Unlike geldings, stallions, and unpregnant mares, pregnant mares and foals are kept closer to the village, and staked near fields to graze on their perimeters.

This pattern continues during the fall, though people begin to move progressively lower in altitude as the weather turns cold. Once this happens, the *rta-dzi* system shifts again. Instead of leaving horses unattended for days, animals are brought home to the village each night. As such, the rotational responsibilities of horse owners increase. If a person owns three horses, for example, he will be responsible for watching all the horses belonging to his group for three days. This pattern continues until fall harvest is complete, at which time horse grazing becomes an individual responsibility once again.

This system used to operate without the exchange of money; horse watchers were paid in kind (i.e., given grain, alcohol, etc) by other members of their collective when it was their turn to check on the horses. With the influx of cash to the local economy and increasing wealth generated by tourism, however, Jomsom residents have begun hiring lower status villagers or migrant labourers to watch their horses. This shift has generated local income for poorer community members. However, some Jomsom residents believe this change is having deleterious effects on local pastures because the hired help do not have a vested interest in — nor knowledgeable about — practising sustainable and traditional rotational grazing since they do not own many horses, or, in the case of migrant workers, are not familiar with the terrain.

Horse grazing methods in Monthang are markedly different from those in Jomsom. Due to the frigid, barren winter climate of Lo, lack of winter pasture land, and the insufficiency of both animal fodder and food for human consumption, many people from Monthang migrate to Pokhara, a village in the middle hills below Mustang, for about three months each winter. *Loba* take well over a hundred porters and about as many mules and donkeys combined when they make this move.[13] This exodus serves several purposes: it allows the 'best' horses to remain in Mustang, their health and feeding patterns relatively undisrupted by the journey south, difference in climate and food, and the burden of carrying supplies north again in the spring; this migration also helps offset the price of stores such as corn, rice, and sugar for *Loba*(s). Such lowland commodities are otherwise very expensive for *Loba*(s) because they are either flown to Jomsom from Pokhara or portered north by other people's pack animals. This migration pattern is based on both the fodder needs of Mustang's horses, mules, and donkeys and on their capacity for work. Horses that are not taken to Pokhara survive on measly stores of grain and hay and spend most of their time in family stables during the snow-covered winter. They are cared for by family members or locally-hired hands.

During this winter migration, poorer families become the caretakers of other people's animals as well as their own. The same rotational system (e.g., three horses equal three days shepherding duty) applied in

[13] Many people from Mustang also migrate in the winter to India — particularly Assam and Benares — where they trade in sweaters.

Jomsom during late fall is used by *Loba*(s) during the winter. After reaching Pokhara, *Loba*(s) establish temporary residences on the southern edge of town and are allowed to graze their horses, mules, and donkeys in empty fields. Although *Loba*(s) are given free access to this grazing land, they must rent living quarters nearby. If a *Loba* animal is caught in a cultivated field, however, the animal's owner must pay about Rs 100 per animal, per day. Usually, if one horse wanders into a field, several others follow. Available fallow grazing land is insufficient and of poor quality. Fences dividing cultivated and fallow land are often flimsy. Two *Loba*(s) are often responsible for watching between one and two hundred animals at one time.[14] Consequently, the grazing fines incurred by *Loba* in a given year is significant and often more than *Loba*(s) can afford to pay.

After *Losar* (Tibetan New Year), *Loba*(s) slowly begin to migrate north, usually reaching Monthang in March. During spring, horses graze in pasture areas near the village. If a horse is caught in a field during the day, the charge is Rs 10-20 per animal; if a horse is caught grazing in a field at night, the fine is Rs 500. This dramatic increase is said to be levied because owners of such horses are suspected of deliberately placing their horses in someone else's field. This increase, compared to the Rs 40 charged in Jomsom for the same offense, is also a testament to the shortage of cultivated land in upper Mustang. Fines are managed by the *mukhyia* and help offset the violated field owner's losses.

The *rta-dzi* system in Monthang begins with the first signs of summer and continues until the beginning of harvest in late September/early October. Unlike in Jomsom, poor villagers apply for this work and are selected by the *mukhyia* based on their knowledge of horse care and previous shepherding experience. Monthang employs three *rta-dzi*(s) each year, even though only two *rta-dzi*(s) are on duty at any one time; in smaller villages in Lo, two people are employed for this job. These shepherds are paid in kind: seven *phaktin* (approx. 14 manna or 8kg) of grain per horse for the three to four months they work each year. Once *rta-dzi*(s) are chosen they have the option of continuing this job until they want to 'retire'. Usually, people spend about three years employed in this capacity — enough time for poorer families to build up some surplus grain to offset difficulties incurred because they have small fields.

During the first month of summer, horses are led at dawn to pastures within about four hours of Monthang. They return to the village at dusk. Although it is generally said that *rta-dzi*(s) have full range over where they choose to graze, local convention holds that *rta-dzi*(s) are reprimanded by fellow villagers if they go to the same pasture more than one day in a row (Wangdu, pers. com 10/96). At this time, a third of the village horses (about 150 animals) are shepherded each day; others that are either being used for work or riding, as well as pregnant mares, remain close to the village.

From early July to early September, horse shepherding takes on a dual role. *Rta-dzi*(s) split their time between bringing about 150 horses in and out of the village each day and watching another 150-200 animals who are left to graze on high pastures for several weeks at a time. Horse herders tend to move about 12 hours a day in the lower pastures. Every three days, one of the *rta-*

[14] As many of the men go to India for trading, women often take on extra shepherding responsibilities in addition to household and child care duties.

dzi(s) walks up to the high pastures to check on the other horses, shift pasture areas, and report any deaths or injuries due to snow leopard or wolf attacks; this regular human presence is also locally regarded as a deterrent against such attacks.

Harvest work begins in mid-to late September with grass cutting — first of the Rajah's fields and then of individual family plots. At this time, horses are brought down from high summer pastures for the winter. A large portion of village horses are busy hauling bundles of grass, barley, wheat, mustard, and sweet peas from family fields to threshing grounds outside Monthang's walls at this time. Once harvest work begins, *rta-dzi*(s)' contracts end until the next summer. It is not unusual for shepherds to spend time working the Rajah's fields — labour for which they are paid.[15]

Although there is some discussion among villagers in Monthang that the current *rta-dzi*(s) are 'lazier' than their predecessors (Wandgu, pers. com 10/96) — or that, since the coming of democracy to Nepal in 1990, shepherds are less compelled to adhere to traditional rotational grazing patterns (Bista, G. pers. com 8-9/96) — many villagers believe their horse grazing systems are efficient.

Contradictions, Communication Gaps, and Need for Further Study

Internal perspectives on the status and management of Mustang's grasslands vary greatly from external perspectives. Pasture management as it relates to horses is just one example of this divide. Assessments of Mustang's grasslands as overgrazed or denuded resources in a state of crisis — or assertions that indigenous pasture management systems should be altered in order to be effective rather than harmful — might be accurate. However, dismissing local practices as inadequate and uninformed disregards the efficacy of systems that are highly refined and often centuries in the making. This emphasis on local 'mismanagement' also dismisses effects on grazing lands caused by climatic changes occurring throughout the Himalayas and the Tibetan Plateau (Blumont 1996). Although such changes might necessitate the people of Mustang altering aspects of their agro-pastoral lifestyles, disregarding existing resource management systems renders useless viable templates which, if used as a model for development strategies, might provide insight into successful management of the area's scarce grassland resources.

Despite theoretical efforts to 'improve' the quality of pasture lands and range management in Mustang by programmes such as the NAPDP, very little has actually been done. As the village *mukhyia* of Monthang recalls, *"About ten years ago, there was some talk of the government giving us money and guidance to help us improve our pastures and increase fodder production. But we never saw anybody come to help. About five years later,"* he continued, *"I found out that the money we were supposed to receive for this purpose ended up going to the District Development Committee in Jomsom"* (Bista, G. pers. com. 5/96)

The Department of Livestock Services (DLS) tried to start an alfalfa (N. *khote*) and fodder tree plantation outside the village of Gemi in Lo. Though there are still some trees and clusters of grasses in this walled compound, the management of this project

15 In 1956, the *Loba* were emancipated from supplying the Rajah with a certain amount of 'coryee' or forced labour by a decree passed by the Nepal Congress Party during the time of the current Rajah of Lo's father (Laird 1992:86)

has fallen apart. DLS officials maintain that they have handed the project over to the villagers; nobody from the DLS office in Jomsom has visited the site in years. Some Gemi villagers maintain that it is a 'government' plantation and they are not sure how to deal with management issues because of the ambiguity of ownership. Other locals view the plantation as community property, yet because they were only marginally involved in the planning and implementation of this venture, they are not compelled to maintain the plantation compound. According to ACAP's Project Manager for Upper Mustang, ACAP has contemplated revitalising this 'dead' project, though nothing towards this end has been introduced to date.

Concomitantly, a $32 million venture funded by USAID in 1980, called the 'Resource Utilisation and Conservation Project' was implemented in three districts, including Mustang. Among other things, this project was supposed to address forage and fodder needs. Although the capital injected into Mustang through petty contract work, construction, and transport during this project should not be discounted, the programme's long-term prognosis was largely deemed a failure (Thakali 1994:73). Although both ACAP and CARE Nepal have done some work on fodder development and community forestry in Mustang — with a certain amount of success — little research has been conducted to understand and incorporate indigenous practices into these development programmes.

Efforts to combine research carried out on historical, cultural, and religious knowledge about Mustang by Ramble, Vinding, etc. with development feasibility studies or actual work plans are virtually non-existent. Yet indigenous systems can neither be comprehended nor constructively built upon with only shallow historical understanding. Linguistic and cultural divides make bridging the gap between 'external' and 'internal' views precarious, though this is not an impossible task. If these gaps in understanding are left untouched, however, a host of contradictions arise which makes creating development programmes and making valid recommendations about pasture management and other issues very difficult.

Development workers are quick to assert that community-based grass roots' programmes involving 'people's participation' should be the mould into which development ventures are cast. However, promoting people's participation, as such, is not only a matter of getting locals to elucidate their needs, but also requires that one understands how these needs are conceptualised, where motivation and a sense of civic duty reside. Real dialogue over a long period of time between development workers and locals remains a rare occurrence. Planners must recognise that local people are not simply users but managers of their environments. Subsistence farmers and herders need to be perceived as part of the solution to grassland management rather than the problem if current rhetoric regarding people's participation is ever to be translated into practice (McVeigh 1994:2).

In their description of Pala nomads from Western Tibet, Goldstein and Beall write, *"As one Tibetan county official commented, 'The nomads have to be educated to understand that just rearing more and more animals is not the answer'. This attitude, which appears pervasive among government officials, dismisses the traditional local system as destructive, and rejects a priori the possibility that it might allow the nomads a decent livelihood over the long-term without exponential growth in herds and the* *destruction of their resource base. Our findings, in fact, suggest that the traditional pastoral system was sophisticated and may have done just what the nomads claim, allowing them to thrive on the harsh Tibetan Changtang for centuries" (1990:177).*

Although lack of access to Tibetan pasture and increasing numbers of horses kept by Mustang residents are both placing extra pressure on area grasslands, few studies have been conducted — with or without people's participation — in an attempt to determine just how degraded Mustang's pastures are. Likewise, study of historical records of weather patterns (which, in the case of Lo, date back to the 14th century), as well as extensive, thorough study of the area's climatic shifts with the use of available computer technology and satellite imagery have not been conducted. Further study is required if the choreography of people, animals, and pasture in Mustang are to be accurately understood.

MUSTANG'S TRADITIONAL VETERINARIANS

Historical Context

Indigenous pasture management systems and the status of rangelands are interconnected with local veterinary care which, in turn, affects the productivity and health of Mustang's domestic livestock. Unproductivity dovetails from lack of fodder and insufficient grasslands, Similarly, without reliable methods for dealing with disease among their animals, agro-pastoralists are faced with the prospect of regularly losing income and wealth.

In Mustang, as in other Himalayan areas, responsibility for the sick (both humans and animals) is primarily the responsibility of the village doctor (*amchi*). These people are also generally householder-priests (*sngags-pa*), married religious practitioners whose principal teachers are often their own fathers. *Amchi*(s) do not practice medicine full-time; like everyone else in a society of subsistence farmers and pastoralists, they have their own fields to plant and animals to tend.

Although Tibetan veterinary science is a discipline in and of itself, animal care finds its roots within the larger traditions of Tibetan medicine. Likewise, though specialists in veterinary care do exist throughout Tibet and the Himalayas, village *amchi*(s) often double as local veterinarians. In Mustang, village *amchi*(s) might also treat animals, particularly horses.

Much of the knowledge about equine care in Mustang finds its theoretical roots within a corpus of Tibetan texts devoted to hippology and hippiatry. These books, some of which are believed to be translations of Sanskrit treatises, exist in a variety of extant forms.[16] Some of these works are beautifully illustrated. These texts are generally referred to as *tap-sho*. One book that contains several folios has been compiled and republished in China. In addition to this popular reprinted work (on sale in bookstores in Lhasa, Dharamsala, and Kathmandu), many *tap-sho* are found in Mustang. The personal libraries and family archives of the Rajah of Lo, local *amchi*(s), village *lama*(s) (priests), and other families house many a horse text. Many of the books found in Mustang seem to be hand copies of texts from other sources in Central Tibet, as they are written in classi-

16 The most significant contribution to the study of these literary sources to date has been made by Anne-Marie Blondeau (1972). Her work on the subject draws on both Indian and Tibetan sources, including sources found in the Dung Huang caves, Gansu Province, PRC.

cal Tibetan. (Mauer, pers. com. 3/97). Some of these texts are complete, while others exist in fragments. None of the sources catalogued to date[17] contain a colophyn, rendering questions about dates, origins, and ownership difficult to answer (Mauer 1995). Yet, given similarities between the content of Dung Huang texts and Mustang folios, *"the available texts have kept alive a continuous written record of Tibetan veterinary medicine"* (Mauer 1995).

Veterinary care in Mustang has also been greatly influenced by the presence of the *Khampa*(s). Excellent horsemen, the *Khampa*(s) are often credited with introducing practices such as horse-shoeing and a variety of training techniques to Mustang residents. The *Khampa*(s) quite successfully instilled the notion that horses imported from the Tibetan plains were stronger, more beautiful, and more valuable than their local counterparts — a socioeconomic gauge that remains valid to this day. In addition to this more general knowledge, the *Khampa*(s) were said to have brought veterinary texts with them. This literary background, in addition to their practical expertise regarding things equine, aroused local interest. Many of Mustang's aging veterinarians were trained, at least in part, by *Khampa*(s).

Training: The Oral - Literary Divide

Although a substantial number of *tap-sho* exist in the private libraries and village monasteries of Mustang, much of the knowledge about veterinary practice and general horse care is an oral tradition. Though methodological parallels exist between what is written and what is practised, much of the veterinary care actually performed in Mustang is only tangentially derived from these theoretical sources. Local veterinarians often view these texts as the basis for their knowledge about hippiatry and hippology; however, very few of these practitioners actively refer to such documents in the course of treatment. Rather, the veterinarian's mere possession of a *tap-sho* — the theoretical ability to consult these books — is more often an affirmation of the practitioner's legitimacy than a medical guide.

Unlike Mustang's *amchi* tradition — in which medical and religious knowledge is passed from father to son through structured study and rigorous meditation retreats — and although some *amchis* double as veterinarians, many of the area's most renowned horse doctors have learned their craft by observation and out of necessity. Only some of these practitioners are literate in Tibetan. One noted exception is the current Rajah of Lo. A skilled equestrian and horse doctor, Jigme Palbar Bista has spent many years studying his *tap-sho*(s) and has passed this knowledge on to a select few. However, his expertise — an understanding grounded as much in theory as in practice — is rare.

Diagnosis and Treatment

Two of the primary healing techniques employed by Mustang's local veterinarians are moxibustion or cauterization (*me-btŝa'*) and blood-letting (*grag-rgyab*). These methods are shared by Mustang's neighbours; other peoples of the Himalayas and Tibet practise similar procedures on their horses and mules, yaks, *dzo*(s) (yak-cow crossbreed), and cattle. Moxibustion and blood-letting are also practised in the treatment of human ailments within Tibetan medical tradi-

[17] Photographing and cataloguing these texts on microfilm has been conducted by the Nepal German Project in High Mountain Archaeology and the Nepal German Research Centre, Tibetan Manuscript Division.

tions. Benefits of these treatments include healing broken 'wind' (*rlung*), decreasing oedema, and lowering the possibility of infection.

For horses in particular, the application of fire to the skin and the letting of blood are used as preventative measures against disease and for curing various ailments. If one horse in a village catches a cold, for example, the owners of neighbouring horses might ask a local veterinarian to apply the tip of a hot iron rod to five places on the horse's face: at the base of each ear, on the outside of each nostril, and at the centre of the upper lip. This treatment is said to prevent the spread of a cold. Respiratory problems, particularly pneumonia, are quite common in Mustang. Brisk winter winds, lack of sufficient winter grazing lands, and time spent in poorly ventilated, dirty stalls give rise to such problems — many of which begin as common colds. As such, lowering the risk of contagion is a vital component of indigenous preventative care systems.

At the end of the fifth Tibetan month (mid-late July), horses are bled from the veins on their nostrils. This blood is collected, mixed with grains, and then fed back to the horse. Along with this treatment, horses are also bathed in cold water. This combination of the letting of 'bad' or 'old' blood and then restoring this blood to the body as food, as well as shivers induced by the cold bath, is said to replenish a horse's strength and cleanse all impurities from the animal's system. This blood-letting — more common in upper than in lower Mustang — is also believed to hasten the formation of new blood which helps animals adjust to changes in altitude encountered during the shift from winter to summer pastures. After this annual regimen is completed, horses are given a week to a month's rest. Interestingly, this down-time corresponds to the shift from one grazing system to another. After this blood-letting period (*smal*), most horses are no longer brought back and forth between the village and summer pastures daily. Instead, they move to high altitude pastures where they graze virtually unattended for weeks at a time. This illuminates the relationship between indigenous pasture management systems and traditional veterinary care. In this case, *Loba*(s) are practising rotational grazing on the one hand and taking care of their horses on the other. These two vital practices do not passively coexist; rather, each facilitates the other. Such an example provides new insights into concepts of resource management.

Although moxibustion and blood-letting are often used independently of each other, these techniques are also used in combination to cure a variety of lamenesses. For instance, if a horse or mule moves downhill carrying too heavy a load, or if a horse is being ridden quickly and then trips on a stone — common occurrences in these mountains and on the flats of Mustang's river valleys — the animal can injure either its shoulder or hip, causing instant lameness. Though there exists much variation on both the causes of such problems and their treatment, one of the most common methods for curing lameness includes letting blood around the irritated area and then applying heat points in a protective circle around the region. This problem is often diagnosed as a separation of skin from muscle and bone, causing bad wind and blood to collect in the affected area. Blood is let in small amounts with the tip of a pointed metal instrument (*gtsag-bu*). After blood is let, the local veterinarian will sometimes insert a hollow tube into the wound, blow 'new' wind into the space between skin and muscle, and then prick this inflated area with his *gtsag-bu*, deflating the now 'cleansed' area. A hot stone is then rubbed over the area to re-bind skin, muscle, and bone. Other times, blood-letting wounds are sutured closed with hair from the horse's own mane or tail; this, along with cauterisation around the wounds, helps cure the lameness. Occasionally, local veterinarians carefully pierce around tendons and ligaments with a needle and let out fluid in order to cure a lameness. This technique bears an uncanny resemblance to the allopathic method of needle-point firing.[18]

Like its allopathic counterparts, Tibetan veterinary medicine describes several different types of colic, a gastro-intestinal and digestive problem that can be fatal.[19] However, unlike western medicine which primarily relies on enemas, walking the horse, administering drugs which stop intestinal contractions, and surgery to cure this problem, Mustang's veterinarians treat various forms of colic with a combination of blood-letting and herbal remedies. A newly diagnosed case of *hre*, or what western medicine calls 'gastric dilation', is treated by piercing the vein on the underside of the horse's tongue in several places, massaging out the build-up of black, foul-smelling blood, and then rubbing salt across the tongue. Local veterinarians explain that this disease is caused by horses eating mouldy or dirty fodder, particularly grasses that have been infected by human waste. Horses tend to paw at the ground, roll, pick at their food, and stop urinating when this disease is in its early stages. A horse's stomach also tends to bloat. If caught at this stage, the blood-letting alone cures *hre*; horses are eating, drinking, and urinating regularly within an hour. If the disease remains untreated for some time, other methods of treatment are used. Herbal medicines are administered. Sometimes a piece of wool is saturated with a foul smelling mixture of fermented sheep dung, water, and '*khimo*' (a blue mineral used to make dye) and this is then swabbed on to a horse's bit. The horse is then ridden slowly for several hours. The author has witnessed several severely ill horses recover from advanced *hre* within a day. Other types of colic are diagnosed by observing slight differences in the temperature of a horse's breath. Treatments, as well as the causes of these divergent kinds of colic, significantly vary by local standards.

Such examples only hint at the diversity and viability of local veterinary techniques. As Dr. Punel, Jomsom's head veterinarian and a *bhotia*[20] from the Manang District, commented, *"The traditional doctors here have isolated many subtle, highly effective treatments for lameness, infections, and the gastro-intestinal problems from which horses often suffer. Although these local practitioners could benefit from the use of things like penicillin and regular de-worming, I think I have as much to learn from them about*

18 Needle-point firing involves the insertion of needles into various deep tissues including tendons, ligaments, and bones (O'Connor 1980:252)

19 For general definitions of the different kinds of colic, see Hawcroft (1990:177-181).

20 *Bhotia* is a Nepali term for ethnically Tibetan people. The word is often used with pejorative overtones, denoting those who practice Buddhism, eat meat, and drink alcohol. The fact that Dr. Punel is a *bhotia* is significant, as he is not as biased against local veterinary techniques as some other government veterinary workers who cannot relate culturally to the communities in which they are working.

treating horses as they can learn from me" (pers. com. 9/96).

Current Occupational Status

Cultural conventions surrounding *amchi* (and Tibetan veterinary) traditions dictate that these practitioners never ask for money in exchange for their services. Patients (or animal owners, as the case may be), offer payment in kind. Sometimes cash is given, but grain, alcohol, or other foodstuffs more often serve as compensation. Although this system was once viable, it no longer is, according to Mustang's local healers. Now that Mustang is largely a cash-oriented economy (due to tourism and changes in trade and migration patterns), and given the high national inflation rate, local *amchi*(s) and veterinarians cannot afford to provide adequate care. Similarly, the lack of economic incentive involved in such work has dissuaded the sons of aging local veterinarians to continue this work. The son of one of Mustang's most renowned horse doctors, for example, is an engineer.

Integrally related to this decline in the occupational status and overall tradition of local veterinarians is the poor quality of schooling available in Mustang. Like other ethnically Tibetan hinterland areas of Nepal, most of Mustang's schools (with the possible exception of schools in Jomsom) do not maintain national — let alone international — levels of instruction. Teachers are generally under-supported by the government and are often cultural outsiders. In addition, courses are taught in Nepali or Nepali and English medium, despite the fact that many local children have a very limited comprehension of the national language. Teaching literary and/or colloquial Tibetan is not sanctioned. As a result, children who come from prosperous families, or those who find sponsors, are sent to school in Pokhara, Kathmandu, or places like Darjeeling and Kalimpong in India. Although many of these children will grow up literate in Nepali, Tibetan, and English, few will return to settle in their villages. Poorer children who remain in rural schools receive marginal formal education and rarely become literate in Tibetan — the language which records their history and culture, including *tap-sho*(s) and other medical texts. Youngsters who are both capable and interested in maintaining such healing traditions are rare.

Not surprisingly, the number of locals who doctor animals has declined in recent years. Forces like those mentioned above have changed the relationship of people to their animals in Mustang, particularly in their ability to care for domestic livestock. Despite all this, the majority of people in Mustang, when asked about maintaining the health of their animals, prefer local systems of care derived from Tibetan medicine.

In contrast, HMG's veterinary offices (located throughout Mustang) are rarely used by locals. Aside from the rare visit to purchase saddle sore ointment or antibiotics (two items in whose efficacy locals have come to believe), these clinics are viewed with skepticism by Mustang residents. Though inexpensive (almost all procedures only cost a five-rupee registration fee) and equipped (at least half the year) with anesthesia, sterile needles, worming medicine, etc, these clinics tend to go unused, particularly for equine care. Locals view veterinary technicians as people who might know how to cure a sheep of parasites, but who don't know much about the subtleties of horse care. Nevertheless, as the number of local practitioners decreases, livestock owners often find themselves with little option besides trusting their animal's health to Nepali clinic workers.

One prime example of this phenomenon is castration. According to *Loba*(s) and Mustang's other Tibetan-speaking inhabitants, this operation should be conducted by a person specifically trained in equine castration — often a person of lower caste according to Tibetan social stratification. Before this procedure, the owner should consult the lunar astrological calendar to determine an auspicious day on which the operation should occur. Tibetan cultural frameworks include a litany of stipulations regarding the details of this operation; above all, conducting a proper castration demands that the practitioner know the locations of a stallion's three channels (*rtsa*). These channels, or 'veins' as they can be literally translated, each correspond to different aspects of a horse's vital energy. Of these, one is directly linked to the horse's ability to move at the *dru*, a fast, four-beat trot that is the most revered of all gaits. A horse's performance at the *dru* is one of the determining factors in the horse's value. If a castration is performed without carefully severing and then separating this vein, the horse's *dru* can be easily 'broken', leaving the owner with a very expensive beast of burden — a fate considered worse than death for a fancy mount.

Several skilled castraters once lived in Mustang; none remain. Before the closing of the Tibet/Nepal border, many people from Mustang took their stallions across the border to Tibet where this operation was performed. This is no longer an option for most people, save *Loba* elite who can sometimes move across the border with a touch of impunity. As a result, people of Mustang now hand over their uncut studs to the Nepali veterinary clinicians. According to these Jomsom-based veterinarians, no horse has ever died as a result of their work. Nevertheless, locals often scoff at the skills of these practitioners. And yet these same people are leading their stallions with more regularity into Jomsom's whitewashed veterinary compound, their expressions slightly pained.

CONCLUSION: THE CASE FOR INDIGENOUS KNOWLEDGE

In his introduction to *The Mollas of Mustang*, David Jackson writes, "*Five hundred years ago, a diverse and colourful stream of travellers made their way along the roads that lead to Lo Mustang. In those days, a person standing at the gates of the capital city might see Indian pundit(s) and yogi(s), Tibetan traders with their trains of donkeys and sheep, pilgrims bound for Mount Kailash. Today, however, it is hard to imagine that Lo Mustang was ever such a thriving centre, for it is now one of the most remote, backwards, and inaccessible valleys in the Nepal Himalayas*" (1984:ix).

In many ways, Jackson's assessment of Mustang is depressingly accurate, especially in relation to the restricted area of this district. Nevertheless, as much as Mustang might be classified as 'backwards' and 'undeveloped', as much as this region is defined by crumbling ruins and the ghosts of cave dwellers and kings, the area's living culture continues to change, evolve, and struggle to subsist. The people of Mustang are ever aware that they exist at a crossroads between modern and medieval lifestyles. Though frontier environments such as Mustang are just coming under the influence of the modern world (Miller 1995:3), theirs is a history as rich and as capable, as intricate and as eccentric as the next enclave of civilisation.

Local people like those from Mustang are often labelled 'victims' of failed development schemes or categorised as unenlightened masses who hinder the progress 'development' implies. While there are elements of truth to both ends of this spectrum, a more accurate picture exists somewhere in the middle. To assume that local people have no idea what is happening to them — and no control over the course that their own culture takes — as well as to assume that cultural changes would not naturally occur is naive, ahistorical, and ethnocentric. Such reasoning can have devastating effects on the integrity and viability of pastoral lifestyles.

Influences such as tourism, development, national and international trade, politics, and ensuing shifts in culture and economy are having profound effects on indigenous knowledge in Mustang. The status of pasture management and traditional veterinary care exemplify such trends: Mustang, an area on the periphery of national consciousness for centuries, is now gaining international attention. There is interest in preserving the area's unique and fragile ecosystems. The World Wildlife Fund for Nature (WWF), for example, recently identified 200 ecoregions with an inherent biodiversity that sustains life on earth. Among the critical, endangered, and vulnerable categories of these ecoregions are Nepal's eastern and western Himalayan Alpine grasslands and steppes (such as Mustang). Yet the ways locals have been managing and caring for their resources for centuries are largely misunderstood or not addressed.

Thapa writes, *"The traditional bias of the veterinary approach in the Department of Livestock Services contributes to the pasture and fodder problems of Nepal"* (1990:24).

This statement can be applied to Mustang. Without adequate access to trustworthy animal care, livestock production levels decline and the number of unproductive animals can increase, thereby stepping up pressure on local grasslands. Since HMG has not made it a priority to train or support their DLS staff in remote places like Mustang, such agencies often do more harm than good, while indigenous traditions continue to decline. Likewise, HMG has not considered supporting local veterinary practitioners, or traditional medicine as a whole, in areas like Mustang.[21] Similarly, *rta-dzi*(s) are storehouses of information about the quality of area pastures and their management. These shepherds (particularly in Lo) also keep scrupulous oral records of the number, colour, sex, health, and habits of village animals. This detailed knowledge remains untapped.

The continued ability of Mustang people to care for their horses and other animals with a sense of confidence in their own traditions depends on the transmission — be it literary, oral, or a combination of the two — of this knowledge to younger generations. Ironically, though the number of horses in Mustang has increased in recent years, the number of local veterinarians and *amchi*(s) continues to decline, primarily for economic reasons. Although 'culture' is never a stagnant entity, how will coming generations care for their horses? To whom will they turn? Learning requires the pres-

[21] One notable exception involves Dr. Punel. This Jomsom-based veterinarian hired a local *amchi* from Monthang to be the HMG veterinary office representative in Monthang VDC. This relationship continued for several months before the Monthang-based *amchi* had to quit the job due to the death of his father (who was the Rajah's physician and astrologer) and his subsequent additional responsibilities. Both Punel and the local *amchi* viewed this arrangement as a means of combining local knowledge with allopathic care and were disappointed when this relationship terminated. Punel hopes to foster similar relationships in the future. Such actions have not been encouraged by his superiors (pers. com. 9.96).

ence of an adept teacher and a motivated student. Skills honed by observation become hollow skills when younger eyes turn towards other disciplines. Several highly skilled local veterinarians and *amchi*(s) are willing to pass on the science and art of this practice. Unless younger people view this occupation as economically viable (even part time), however, they will not be compelled to maintain these traditions.

The conservation of grassland resources and indigenous pastoral systems are integrally linked to the perpetuation of local veterinary practices and, therefore, the overall health and productivity of Mustang's herds. Without access to adequate pasture and fodder, animals will not be productive. Without sustainable and effective mechanisms for combating disease, herds risk death and people face devastating loss of livelihoods. Support from both within and without a given community is necessary to carry these valuable and viable systems of animal care into the future.

There is an old Tibetan adage that likens the Buddhist concept of 'mind' to a horse: a powerful vehicle rendered useless if undisciplined and untrained. This saying can be taken as a metaphor for the important role indigenous knowledge should play in addressing pastoral concerns. Respecting and building upon such knowledge, as well as supporting local healers and traditional medicine, should be a top priority in Himalayan and Tibetan rangeland environments like Mustang.

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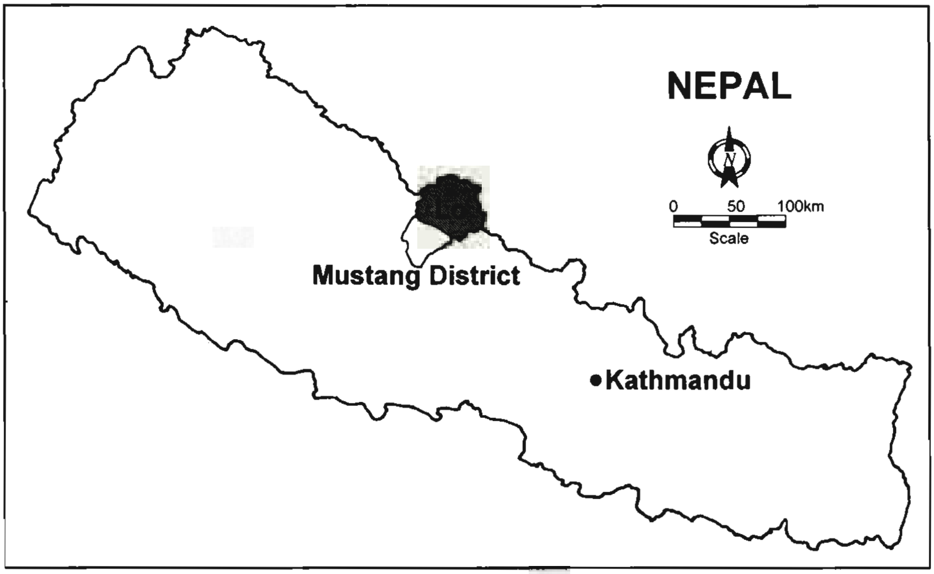
Upper Mustang's Shifting Animal Husbandry Practices

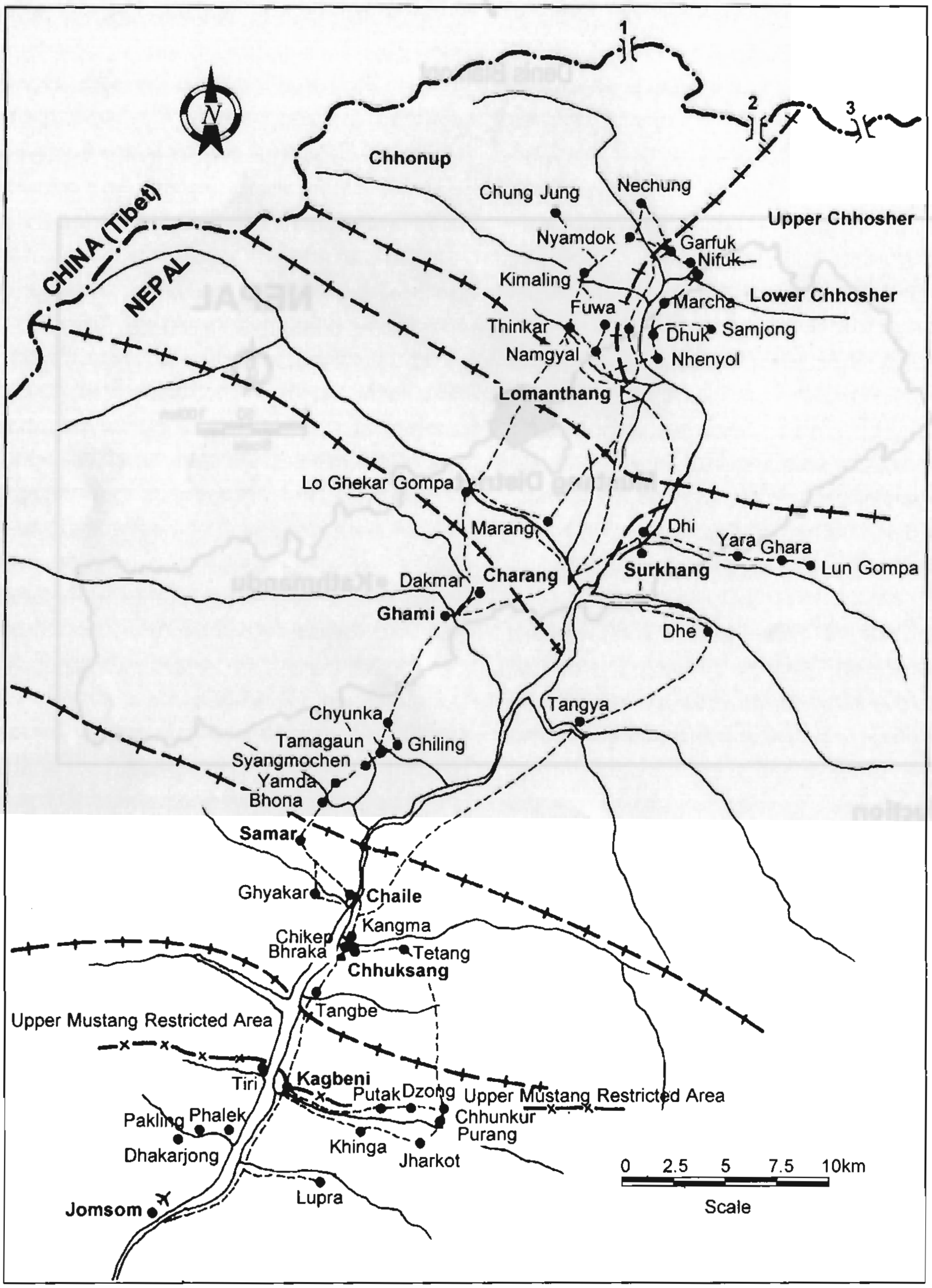
Denis Blamont



Introduction

The Upper Kali Gandaki Basin, or Upper Mustang[1], situated on the southern face of the Tibetan Plateau, north from the Annapurnas and Daulagiri, has one of the highest population densities in Nepal — 1,508 per cultivated square kilometre, whereas the national average is only 455 people per sq. km. How can one explain that striking figure in such a high, arid area where cultivated land accounts for between 3,000 and 3,900 metres and where only one crop is harvested per year above 3,300 metres. Yields are also scanty (about 17 q/ha in a good year)? The paradox becomes even more striking when one realises that, on average, local production of food meets only 55 per cent of subsistence needs and that only eight per cent of the 5,700 inhabitants of Upper Mustang are self sufficient in terms of grain (Thakali 1994).

1 Following the Nepalese administration, by Upper Mustang we shall improperly mean not only the historical 'kingdom' of Lo, composed nowadays of six VDCs (Chhosher, Chhonup, Lomanthang, Charang, Surkhang and Ghami), but also the upper part of Baragaon, as is called the area situated just to the south of Lo, Chhuksang VDC, comprising the villages of Samar, Gyakar, Chaile, Tetang and the different hamlets of Chhuksang (see map in fine). The inhabitants of Lo are called *Loba*(s). A VDC (Village Development Committee) is the smallest administrative unit in Nepal. It is further subdivided into 9 wards.



Upper Mustang Conservation and Development Project Area

Actually, only 0.3 per cent of the district area is cultivated, while five per cent is covered by forest. More than 40 per cent of Mustang's area is rangelands and pastures[2] at altitudes ranging from 3,000m to higher than 5,000m. Animal husbandry is, by far, the main source of income, above agriculture and trade, and accounts for this population density. In 1992, according to the National Research Council, animal husbandry accounted for 53 per cent of the total annual income of the *Loba*(s) (people from Lo). Man Bahadur Thapa estimates that livestock activities produced an average income of NRs. 10,118.10 per household in 1990, whereas agriculture produced only NRs 7,665.60 — a ratio of 4:3.

Recent evolutions in the animal husbandry systems in Upper Mustang are of great concern. If the *Loba*(s) have long been used to short cycles of prosperity and hardship, it seems that, for the last 30 years at least, they have been experiencing a trend of slowly but surely deteriorating conditions, as well as geological, climatic, social, and political changes.

After having reviewed the spatial distribution and the present situation of animal husbandry in the area, this paper relates them to some of their possible causes, especially the ones concerning changing ecological conditions of pastures and rangelands. Finally, some of the possible consequences of this degradation and changes in animal husbandry practices are discussed. Suggestions as to how to counteract these trends are suggested.

Spatial Distribution of Livestock in Upper Mustang

As in all high elevation communities of the Himalayas, *Loba*(s) rear a wide variety of domestic animals of Tibetan origin. The historical structure of their society not only allowed them to maintain the size of their land tenures and herds over generations, but also allowed one family to indulge in many activities such as rearing different types of domestic animals, cultivating fields, and engaging in long distance trade. These inseparable three activities were key components of their economic life. Generally, the eldest son inherited all his father's fields and animals after marriage. The second son was often sent to a monastery. Subsequent sons were either adopted by an uncle with no son or, more often, married to the older brother's wife. This system of polyandry is found throughout other areas of the Tibetan-speaking world and requires that the younger brother ask the permission from his brother's wife. The third son could also be 'adopted' by a family with only daughters, one or several of whom he would marry. This *'magpa'* could then inherit his father-in-law's possessions. Ordinary families, therefore, were often comprised of two or three brothers and their wife, parents, children, and unmarried sisters; or, one woman, her sister(s), their parents, and her/their husbands.

Although Lo is one of the rare regions where Tibetan culture is still living and active, Lo has been a part of Nepal since its unification at the end of the eighteenth century. The people of Mustang are becoming in-

[2] 1991 Census. According to ACAP, the three northernmost VDCs (Chhosher, Chhonup, Lomanthang) cover 21 per cent of the district area and 2.3 per cent of their area is cultivated. In Lomanthang, 1.53 per cent of the land is cultivable, 1.3 per cent is cultivated, 41.5 per cent is under pastures and rangelands, and 5.2 per cent is forested.

creasingly more integrated into Nepalese lifestyle, culture, etc. It is not surprising that Mustang's own customs tend to give way to Nepalese laws. Younger sons are practising polyandry less and less with their elder brothers[3], who are, in turn, giving them a small share of paternal lands and herds — unless the younger brother is 'adopted' as a *magpa*. Although the average family size is only four (with basically an equal number of families of one to six members[4]), the variety of domestic animals is still high. Several households often group their animals together by types and graze them by turn. Family size, therefore, cannot explain the wide differences in the spatial distribution, numbers, and different types of domestic animals found in Mustang.

Spatial Distribution of Animals

The Tables in Annex 1 show that the distribution of the different types of reared animals is not uniform in Lo. First, means computed from data collected by the Veterinary Office in Jomsom, Mustang's District headquarters, from 1993 to 1995 will be analysed. (The utilisation of means is justified by high annual variations, which will be described and analysed later.

Goats (*Capra hirtus*) are by far the most numerous of all domestic animals in Upper Mustang. They are present everywhere, especially throughout eastern Lo (Chhosher and Surkhang VDCs). Goats, like sheep and yaks, are reared for their meat, milk, skin, wool, and packing capacities. They, as well as sheep, are used to carry salt from Tibet[5] (8).

Horses (actually Tibetan ponies) and bovines (*Bos taurus*) are found throughout Mustang; proportions are greatest in Lomanthang. Bovines are reared mainly for milk whereas horses are used on trade routes like yaks, mules, and donkeys.

3 Only 11 per cent of the families were polyandrous in Lomanthang in 1987, following Navin K. Ray

4 1991 Census. In this paper many statistics will be used. As anyone knows, statistics are generally not available and, when they are, they are neither reliable nor comparable for many reasons. Data might not have been correctly recorded when collected or incorrectly copied during their many transfers; some misunderstanding might have occurred between the interviewer and the interviewee; the interviewer could also see some advantage in over or understating his declarations. They are not comparable because, from one census or one survey to another, either the administrative boundaries or the categories used have been changed, or data have not been collected in comparable conditions. In Nepal, for example, as far as goats or sheep are concerned, there is a very significant difference in their number if they are counted before or after Dasain. Some exceptional event such as a bad winter might have occurred the very year of data collection and comparison with a census from ten years ago, or from another area, might lead to very erroneous conclusions. Let us cite an example: in 1994, the Veterinary Branch Office of Jomsom counted 121 sheep and 616 goats at Samjong, while the staff of ACAP counted respectively 700 and 600.

Having said that, statistical information must be justified. One justification could be that very few people can resist the temptation to use statistics; in fact, papers are not taken seriously unless they use such figures. Likewise, the figures used in this paper fit what the *Loba*(s) declare to any person who asks them about the evolution of animal husbandry in Upper Mustang. Statistics generated by the Jomsom Veterinary Office about Upper Mustang are even less reliable than the author's. These figures should definitely not be taken literally but used as an illustration of the points underlined by the author.

5 Local goats and sheep are considered to be stronger than those from Tibet, which are reputed not to be able to perform this task.

Horses also work locally, carrying fuelwood, dung, and harvested crops, which they also thresh.

All the other animals have a specific spatial distribution. Mules and donkeys are found mainly in Lomanthang and in the south. Sheep (*Ovis aries*), very surprisingly, are nearly absent in the whole southern part of Lo (the VDCs of Ghami Charang, Surkhang) and in Chhuksang; but they are very numerous in Lomanthang, Chhonup, and Chhosher, especially in Chung Jung, one of the northern-most villages, where sheep are sometimes even more numerous than goats. Yaks (*Poephagus grunniens* or *Bos grunniens*) are also not found, or seen only in a very limited number in the north-east (Chhosher), the south-west (Ghami and Charang), and in Chhuksang. *Dzo*(s) (yak-cow crossbreeds) are used mainly for ploughing and transporting goods. Their spatial distribution is limited throughout northern Lo (Chhosher, Chhonup, and Lomanthang). These animals are not produced in Lo[6] where the crossbreeding of yaks and other bovines is ritually forbidden, as is crossing horses with donkeys to produce mules (although it has successfully been practised in Samar).

All animals are found in the northwestern part of Lo (Chhonup) in standard numbers, though *dzo* numbers are fewer than in the south. Within Chhonup, there is a definite difference between the village of Chung Jung and the rest of the area. Chung Jung, one of the northern most villages, has 75 per cent of the yaks and 45 per cent of the sheep of Chhonup VDC. In northeastern Lo (Chhosher), sheep and goats are the primary reared livestock. The yak pastures of the Rajah[7] of Lo are also located in Chhonup.

Lomanthang's relatively small territory hosts a comparatively high number of yaks, horses, and donkeys, as well as goats. The number of sheep in Lomanthang is less than in other areas. The rajah is the only inhabitant of Lomanthang who owns *dzo*(s).

Western-central Lo (Charang and Ghami) rears few yaks, a fair amount of *dzo*(s) and goats, but, most surprisingly, no sheep. Southeastern Lo (Surkhang) has by far the highest number of goats in proportion to the number of households as well as in absolute figures in all Lo. Few yaks and *dzo*(s) are found in the villages of this district; and there are hardly any sheep. Finally, Chhuksang, the VDC bordering Lo to the south, has no yaks and, once again, no sheep but a high number of goats, mules, donkeys, and *dzo*(s).

In Lomanthang and Chhonup, yaks are reared for their milk, meat, and portage abilities. The number of females is generally higher (between five to 10 times, depending on the village and the year) than male populations. Sometimes, however, the proportion is reversed when yaks are reared only for meat, as is the case for at least one yak owner in Dhi.

6 Some say that the cows *(lulu)* are too small and either would be afraid of the yak or die while giving birth and that the female yaks (*brimo*) would not allow the cow bull to come near them.

7 Today, Lo belongs to Nepal and is only part of one district. Lo's 'Rajah', or king, has no real political power any more. However, he is the biggest land, pasture, and herd owner in the area and plays a very important role as a symbol of unity, identity, survival, and security of Lo. He is also a mediator in the majority of conflicts over land or water ownership or grazing rights. As such, he has been able to maintain some of his privileges: his grass and crops are the first to be harvested and *Loba*(s) do this work for him, though today they are paid for this labour.

Table 1: **Mean Numbers of Animals Per Farm, 1991-92**

	cattle	buffaloes	yak & hyb.	sheep	goats
Nepal (*)	3,5	2		4	7
Mustang District (*)	4		15	35	32
Upper Mustang (1994**)	3		2	6	37

Sources: * National Sample Census of Agriculture. Central Bureau of Statistics. Kathmandu.
** Agricultural Development Office of Mustang District. Jomsom.

The figures in Table 1 show that, if the number of goats stays more or less the same in the whole district, the number of sheep is much higher in the southern part of the district, as are the numbers of yaks and *dzo*(s). These figures reiterate the point that the absolute number of reared animals in Upper Mustang is quite low, compared with the lower part of the district.

Annual Variations in Herd Size

Wide differences occur in herd size if one analyses this data according to annual figures instead of by means (for example, between 1994 and 1995.) Yet care must be used when handling these figures because the numbers are highly variable. In 1993, for instance, *dzo*(s) were not counted in Lomanthang.

The number of yaks totalled 1,660, 1,937, and 1,145 in 1993, 1994, and 1995, respectively, creating a variation of 41 per cent between 1994 and 1995. Goat populations were 27,808, 27,935, and 22,340, in these three years, an overall decrease of 20 per cent. Horse populations were 1,431, 1,731, and 1,429 in the same years, decreasing by 17 per cent from 1994 to 1995, after similar increase the previous year. In contrast to these decreases, the number of sheep increased by 35.5 per cent during the same period; the population rose from 7,529 to 11,679 during the same period. Chhonup's sheep population rose by 88 per cent — the sharpest overall increase in Upper Mustang. Chhosher, which already had the largest number of sheep rose by 44 per cent, while Lomanthang's sheep population rose by 23 per cent. The *dzo* population varied widely, dropping by 37 per cent between 1994 and 1995.

Shifts in Relative Importance of Domestic Livestock

It is very difficult to measure exact changes in livestock populations. According to *Loba*(s), the number of horses has been steadily increasing in recent years, while the number of yaks is decreasing. Although these animals have slightly different uses[8], horses are tending to replace male yaks more and more both for local use and for trade between Tibet, Lo, and southern areas.

As for sheep and goats, between 1994 and 1995 their respective proportions seem to have risen from 2/3 to 6/5 in northern Lo, indicating a tremendous change in herd composition and husbandry strategies, if this change is permanent and not just a temporary shift — a distinction which is not possible to make at this time.

[8] Horses bear no wool and cannot be eaten, but they are used for transporting harvests and for threshing, while yaks provide meat, dairy, and wool products, as well as draught power, but they are not used for threshing.

Drastic and Steady Reduction in Yaks and Other Livestock

All *Loba*(s) complain that they cannot rear as many animals as they did in previous decades. Five years ago, for example, three farmers owned yaks in Lomanthang; last year only two *Loba*(s) had yak herds. One of these farmers has just sold all his remaining yaks in Tibet. The Rajah of Lo is also earnestly considering a similar move. The Rajah used to keep more than 800 sheep ten years ago; in 1996 he had only 284 (Sienna Craig, personal communication). (This figure contradicts census and Jomsom Veterinary Office statistics for Upper Mustang, once again revealing the unreliable nature of such figures.) In Dhe (Surkhang), the rearing of yaks has been abandoned by all but one farmer. Fifteen years ago in Samar, Gyakar, and Chaile (Chhuksang), yaks were also quite numerous; none are left. Samjong (Chhosher) keeps only one-third of the livestock it used to rear 20 years ago and has also lost half of its cultivated fields. Considered to have once been one of the richest villages of the area, it is now one of the poorest.

Natural and Human Causes of these Shifts

The causes of all these shifts in livestock numbers are accidental as well as structural. Some causes are not new to Lo, but have been seen throughout Lo's history. Yet the combination of historical patterns and natural, unexpected changes in combination might have long-term, definitive consequences for the ecology — human and otherwise — of Upper Mustang.

Lack of Suitable Slopes

The river beds throughout Lo are very rarely suitable for green meadows and the lower versants are often too steep to be used as pastures; the rivers have dug very steep ravines throughout Mustang. It is doubtful whether *dzo*(s), who cannot stand as cold temperatures as yaks and, therefore, need to move to lower elevations in winter, could find sufficient grazing land around Lomanthang. The fact that *dzo*(s) are less hardy than yaks is one of the primary reasons *Loba*(s) give when asked why they do not rear *dzo*(s). In Samjong, people also correlate the absence of *dzo*(s) with the scarcity of favourable slopes. *Dzo*(s) are mainly bought from Samjong's eastern neighbours, people from Manang District, who barter *dzo*(s) for yaks throughout Lo.

With the exception of Lomanthang, *Loba*(s) rarely mention female crossbreeds (*dzomo*) and their milking capacities[9]. When reared at all, *dzomo* appear smaller in numbers than males. The Rajah of Lo sold his females once he was no longer able to keep their young caves Tsinam Jya of Gyakar tried to cross yaks with *dzo*(s) when he was still rearing yaks, but failed. Dorje of Chung Jung successfully reared two *dzo*(s) after two of his cows 'accidentally' met a yak; all his attempts at planned crossbreeding, however, failed because, *"The cows are afraid of the yak."*

Unlike *dzo*, goats thrive on steep slopes and, therefore, appear to be more adapted to the Upper Mustang topography. Yet these grazing slopes are not always present near villages. Goat and sheep shepherding patterns also impact population fluctuations. Goats are taken back to villages every evening; after a day of grazing, sheep stay on rangelands at night. The difference between the number of sheep and goats, and, perhaps, the sharp increase in the number of sheep and decrease in the number of goats in Chhosher between 1994 and

[9] *Loba*(s) say the fat content of *dzo* milk is lower than the female yak's, therefore yielding unsatisfactory butter.

1995, might be attributed in part to the distance from villages to winter pastures (when flocks must cross one crest line to reach rangelands). If rangelands are affected by a scarcity of grasses in summer or excess snow in winter, sheep are more autonomous and can be driven further in search of rich and/or snow-free grazing areas. Poor slope quality is, most importantly, of little concern for sheep.

Inadequate grazing areas due to poor slopes can also bear consequences on agricultural cycles. In Dhe, for example, dzo(s) are taken to higher pastures immediately after wheat is sown, as is the custom in the rest of Lo. Yet in Dhe, due to the lack of pasture land, the dzo(s) cannot be taken down later to sow mustard; this crop is, therefore, not cultivated.

Floods

The rarity of river bed meadows is further increased by floods. In 1984 and 1987, two floods of the Kali Gandaki River were caused by earthquakes which had provoked landslides and caused glacial lakes to burst. At least 14 people and many animals were killed in Chhoser during these floods. Houses, watermills, bridges, half the fields, and all the low pastures (used from mid-October to mid-April) were washed away. The destruction of winter pasture by this flood forced the people of Chhosher to sell their *dzo*(s). As a result of this flood, the number of *dzo*(s) in the VDC was reduced from 200 to 12 in 1993 and four by 1995.

Aridity, Snow, and Low Temperatures

As one can see in Figures 1, 2, 5 and 6 (Source: Dept. of Irrigation, Hydrology and Meteorology and Ministry of Food Agriculture and Irrigation, Kathmandu) in Annex 4, Upper Mustang's climate is arid and cold. Mean annual rainfall was 161mm between 1974 and 1990 (Figure 1) and 191 mm in Ghami between 1973 and 1984 (Figure 2). Mean temperatures do not exceed 28° Celsius in July and are negative three months per year. Yet mean monthly maximum temperatures are rarely below zero, indicating that, even in winter, temperatures generally become positive during the day in Lomanthang (3,700m). On average, however, only seven months of the year can be considered dry (in spring and in autumn, when $R < 2t2$ [see Figure 1]). In winter, snowfall covers high pastures, preventing access to animals other than yaks. In Ghami, where temperatures have not been recorded, it seems that snowfalls are more abundant than in Lomanthang. This could be one of the reasons why sheep are absent from southeastern Lo. On the other hand, shepherds of villages around the Kali Gandaki in Chhosher say that snow cover generally does not prevent their sheep from grazing, even though winter temperatures can be colder there than in Samjong, east of Lomanthang.

Forests are scarce in Lo, and cultivation is impossible without irrigation. One crop is cultivated per year in Upper Mustang, with the exception of Dhi, Tangye, and most of Chhuksang, where two crops are grown yearly. According to Shrestha, Grela, and Joshi, lower forests are populated by *Juniperus squamata*, *Cupressus forulosa*, *Betula spp*, *Betula utilis*, *Pinus roxburghii*, *Pinus wallichiana*, *Populus ciliata*, and *Salix spp* between 3,300 and 3,500 metres. The 'forest' in Samar has a ground cover hardly exceeding 60 per cent and is mainly populated by *Juniperus* and *Cupressus*, with *Betula utilis* on the north-facing slopes. Higher up towards Ghami, forest density decreases to 40 per cent; it is only 20 per cent in Charang. On rangelands and pas-

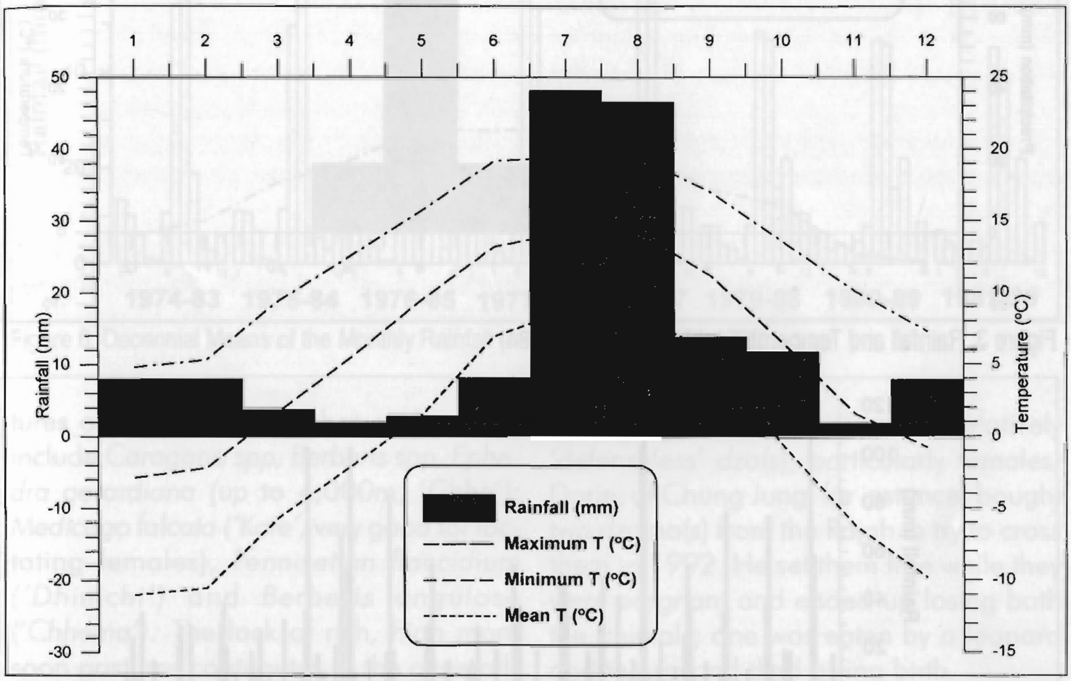


Figure 1: Mean Rainfall and Temperature at Lomanthang from 1974 to 1990

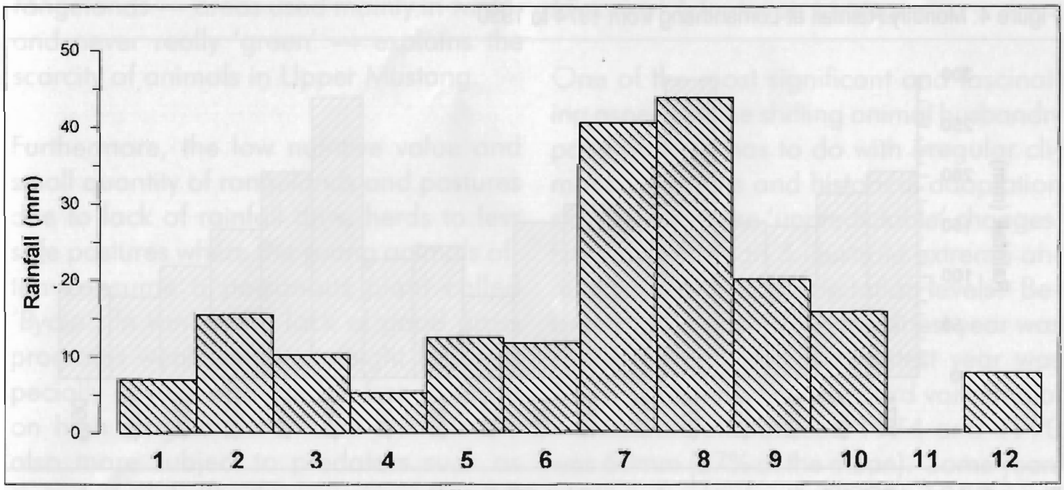


Figure 2: Mean Rainfall at Ghami between 1973 to 1984

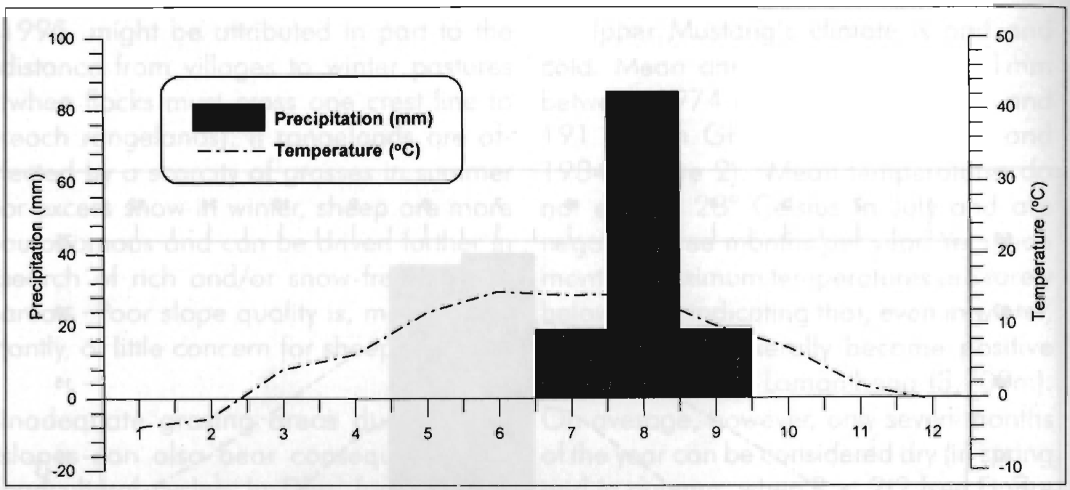


Figure 3: Rainfall and Temperature at Lomanthang (1984)

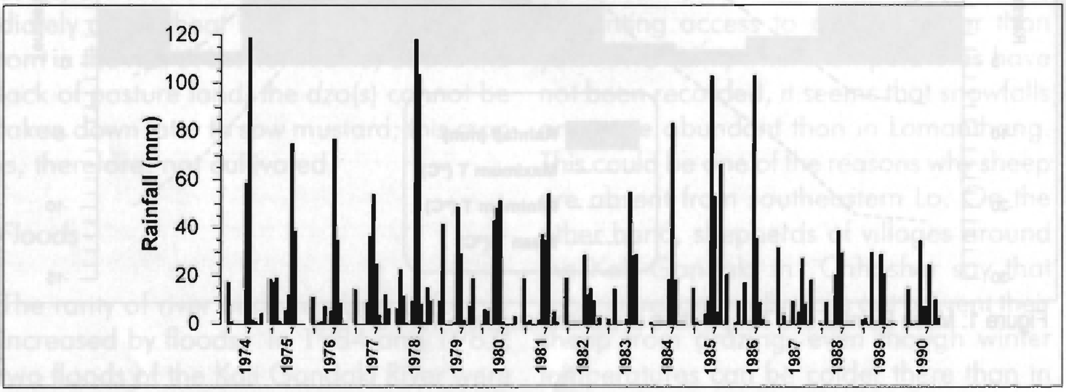


Figure 4: Monthly Rainfall at Lomanthang from 1974 to 1990

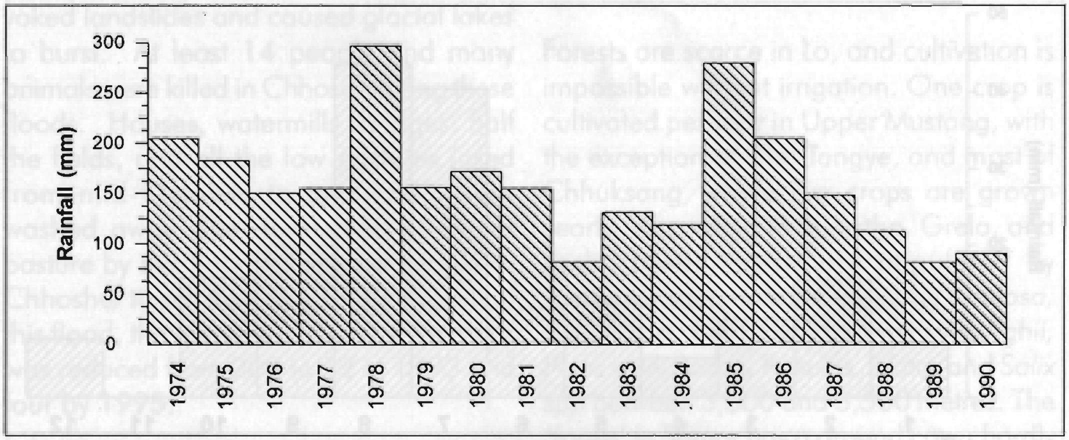


Figure 5: Annual Rainfall at Lomanthang from 1974 to 1990

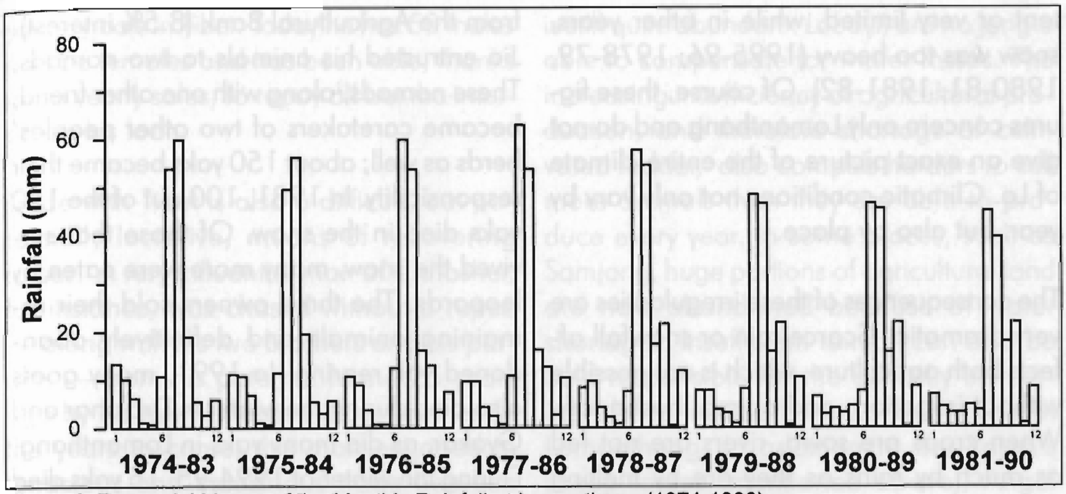


Figure 6: Decennial Means of the Monthly Rainfall at Lomanthang (1974-1990)

tures of northern Lo, bushes and grasses include *Caragana spp, Berberis spp, Ephedra gerardiana (up to 4,000m, 'Chhe'); Medicago falcata ('Kote'*, very good for lactating females), *Pennisetum flaccidium ('Dhimchi')* and *Berberis angulosa ('Chhema')*. The lack of rich, high monsoon pastures contributes to the generally low numbers of livestock in Lo. Yet the low density and feeding capacity of these rangelands — areas used mainly in winter and never really 'green' — explains the scarcity of animals in Upper Mustang.

Furthermore, the low nutritive value and small quantity of rangelands and pastures due to lack of rainfall drive herds to less safe pastures where the young animals often consume a poisonous plant called *'Byoja'*. In winter, the lack of good grass promotes weakness and weight loss, especially in yaks who are left free to graze on high rangelands. These animals are also more subject to predators such as snow leopards (*Panthera uncia* or *'Sanje'*) or wolves (*Canis lupus; 'sau'*). Villagers routinely lose between one and five head of livestock per winter. One can easily assume, also, that the presence of these wolves or wild leopards is definitely not encouraging to the *Loba*(s) to rear relatively 'defenseless' *dzo*(s), particularly females. Dorje, of Chung Jung, for instance, bought two *dzomo*(s) from the Rajah to try to cross them in 1992. He set them free while they were pregnant and ended up losing both the animals; one was eaten by a leopard and the second died giving birth.

Highly Irregular Rain and Snowfalls and Historical Adaptation Strategies

One of the most significant and fascinating aspects of the shifting animal husbandry patterns in Lo has to do with irregular climatic variations and historical adaptation strategies to these 'unpredictable' changes. Figures 3 through 6 illustrate extreme annual variability in precipitation levels. Between 1974 and 1990, the driest year was 1982 (85mm) and the wettest year was 1978 (296mm). The standard variation of annual rainfall between 1974 and 1990 was 60mm (37% of the mean). Some years are extremely dry. In 1982, 1988, and 1989, only four months were considered 'not dry' ($R > 2t$; see Figure 3). In 1982, 1989, and 1990, monsoon rainfall was scanty or came too late. In some years, snowfall in winter was virtually non-existent or very limited, while in other years, snow was too heavy (1995-96; 1978-79, 1980-81, 1981-82). Of course, these figures concern only Lomanthang and do not give an exact picture of the entire climate of Lo. Climatic conditions not only vary by year, but also by place.

The consequences of these irregularities are very dramatic. Scarce rain or snowfall affects both agriculture, which is not possible without irrigation, and animal husbandry. When crops are sown, rivers are not fed as much by rains as they are by melting snow; a dry winter will compromise summer cultivation. Snow is also very important for pastures and rangelands since summer melt provides water for these areas. During years of insufficient rain or snowfall, many animals die or are sold in anticipation of fodder shortages. The sharp decrease in the number of goats between 1994 and 1995 resulted from rain shortages in 1994. For example, Pemba of Samjong lost 100 out of 120 goats and Ningma of Ghara lost 50 out of 54 of his newly born goats. Angyel from Thinkar saved only nine young goats of his 55 females; only four survived. He has been obliged to sell half his adult animals to meet his expenses.

Excessive winter snowfall also has profound effects on herd size. Tsinam Jia of Gyakar owned about 100 yaks which he bought from the *Khampa*(s)[11] when they left Mustang. He made this purchase with a loan from the Agricultural Bank (8.5% interest). Jia entrusted his animals to two nomads. These nomads, along with one other friend, became caretakers of two other peoples' herds as well; about 150 yaks became their responsibility. In 1981, 100 out of the 150 yaks died in the snow. Of those that survived the snow, many more were eaten by leopards. The three owners sold their remaining animals and definitively abandoned yak rearing. In 1991, many goats also died during the winter in Drakmar and Gyakar, as did many yaks in Lomanthang. During the winter of 1994-95, 15 yaks died in Dhe, at least 20 in Drakmar, and many more in Lomanthang.

The combination of poor monsoon rains and a snowy winter in 1994-95 jointly contributed to the current demise of yak rearing and the decline in livestock populations throughout Lo. Yet such climatic fluctuations and the subsequent death of animals, are frequent occurrences in Lo's history. One can even find mention of them in ancient texts (see below). Yearly fluctuations in herd size are not surprising. Animal husbandry in Mustang, as in other parts of Nepal or different mountainous areas of the world, is a precarious endeavour. *Loba*(s) are used to the risks they must take and have generally been able to overcome them by anticipated sales, personal savings, or by borrowing money to restock herds when conditions improve. Ten years ago, Ningma of Ghara borrowed Rs 17,000 (at the rate of 2.5% per month) with which he bought 60

10 One has to be careful handling the available climatic data. The climatic stations at Lomanthang and Ghami opened in 1974 and 1973, respectively. Twenty-six years is to0 short a period to be able to draw reliable, long-term conclusions. Furthermore, data for the years after 1990 were either not available or too incomplete to use. These stations are also situated in low areas; surrounding crest lines receive more rain and snowfall than villages or fields. The data collected at Lomanthang and Ghami greatly underestimate actual rainfall.

11 One can consider a month as dry when the amount R of rainfall (expressed in mm) is lower than the double of the mean temperature (t) expressed in °Celcius. This clearly appears on figures where scales have been designed so R=2t.

young goats in Tibet. Today he has 50 males and 56 females and has been able, thanks to his yearly sales, to repay all but the interest on his loan.

Trade with Tibet is also a difficult, but potentially lucrative, means of recovering losses. A very influential man of Chhosher, for instance, was chased without a rupee — along with his two brothers and his parents — from his paternal home 25 years ago by his newly married elder brother. In the years to come, this man engaged in tenacious and industrious trade between Tibet, Lo, and the mid-hills. (This trade included Tibetan salt for Nepali grains, goats and yaks from Tibet, edible oil, kerosene, lighters, watches, cloth, etc) The ousted brother and his family were able to buy fields and animals with the profits from this trade and are now one of the wealthiest families in the area — much richer than their elder brother who, incidentally, lost his house twice and nearly all his fields and animals during the two Chhosher floods.

Constant Decrease in Average Rainfall

Although stories like the one above are not anomalies, it is also common for people to fail to recover their losses. The main reason for these failures and also for the generally diminishing number of animals reared in Lo is not only the recent succession of climatically unfavourable years, but also the steady decrease of monsoon rain during the last 25 to 35 years, according to local residents. The shifting means shown in Figure 6 do illustrate a definite declining trend, although data are not sufficient either in number or in quality to make a definitive statement. Mean rainfalls have dropped from 169mm in 1974-83 to 142mm in 1981-1990 (negative 16%). This indicates that it is mainly monsoon rainfall which fails, since snowfall in winter is still quite abundant. *Loba*(s) are no longer able to compensate for winter losses. The increasing insufficiency of agricultural production, and therefore shortage of cultivated fodder, also compels herders to sell more animals than they are able to produce every year. In some places, such as Samjong, huge portions of agricultural land are now abandoned because of water shortages. Insufficient rainfall can also be held responsible for the difficulty in rearing sheep in southern Lo and even in Lomanthang. In addition to the Rajah's sheep losses (mentioned above), Angel Bista now keeps only 80 of the 500 sheep and goats he owned four years ago.

The lack of grazing areas, especially in winter, further contributes to declining livestock numbers. Sheep, for example, can no longer be kept in Dhe (3,835m). Even goats cannot be kept in the village but must be sent down to the neighbouring village of Tangye (3,280m) (Snellgrove 1992). Tangye itself has been particularly affected by drought. After the death of 15 yaks in the winter of 1994-95, only one herd of yaks remains out of the three which used to graze the high pastures of Dhe. Ten years ago, Suram Siri of Dhe was rearing up to 30 yaks; he has none today. After losing many head of goats during the dry monsoon of 1993, Suram kept around 90 goats in a common flock with two other people who each had 60 animals. These villagers shepherded the animals in turn (1 day for 5 head). The lack of rain is so extreme in Dhe that, two years ago, the entire village was thinking about abandoning their settlement. The last two relatively abundant monsoons, and the impossibility of finding new sites on which to settle, caused them to change their minds.

Contrary to other sources, according to Thapa (1991), if the rangelands and pastures are overgrazed, it is not because *Loba*(s) have increased the number of animals they rear, but because rangelands have been deteriorating these 25-35 years due to adverse climatic conditions.

Increasing Winter Migration

Another factor contributing to shifts in livestock numbers, especially after losses are incurred, is the deterioration of trade with Tibet. The introduction of Indian salt in the lower areas of Nepal has had a drastic impact on the once lucrative trans-Himalayan trade of Tibetan salt[12] for Himalayan grains. Some *Loba*(s) and other people in neighbouring regions continue this trade on a small scale. The taste of Tibetan salt is still preferred to Indian salt. However, merchants have had to diversify their items and places of trade. Very few people can earn enough income from local trade with Tibet to survive. Some *Loba*(s) now travel as far as Lhasa, Bangkok, Singapore, and Nagaland to trade, backed by big investors.

These international traders and businessmen are the exception rather than the norm. Yet the diminishing local resources have driven more and more *Loba*(s) (particularly men) to leave Lo during the winter. Some go to India to sell 'handmade' Tibetan sweaters. Actually, these sweaters are purchased wholesale in Ludhiana, Punjab (India), and then resold. Each village has its privileged trading area (Varanasi or Lucknow for Lomanthang or Charang-Marang, Assam for Ghami or Baragaon.). Others go to Pokhara where they barter wild garlic (*'jim-bu; Allium fasciculatum*) harvested during monsoon on the rangelands and high pastures of eastern Lo or in Tibet, receiving rice as compensation. Then, these *Loba*(s) travel from one village to another in the mid-hills or *Terai*, bartering rice for vegetables or finger-millet with which they prepare and sell alcohol. During these journeys, *Loba*(s) also look for antiques and precious stones which they can sell for a high profit in Pokhara or Kathmandu.

During the winter of 1992-93, out of the 170 houses in Lomanthang, 41 homes were totally deserted[13]. Nearly two-thirds of the population of the 109 households investigated by ACAP had left Lomanthang. One-fourth had gone trading between Tibet and the Nepalese lowlands, while one-tenth were in India. These statistics indicate a trend in which fewer and fewer people stay in villages to take care of animals during the winter. Thus, the cycle of keeping less domestic animals and increasing seasonal migrations continues. In some villages of Lo, particularly Chung Jung, Nyamdok, and Samjong, people migrate less because of language barriers. Most of these villagers are not fluent in Hindi or even Nepali. They prefer to stay in Lo and are more available in winter to look after animals. This unfurls another aspect of differences in the livestock numbers discussed earlier. The comparatively higher number of sheep and goats encountered in these

[12] It seems, following the appearance of the vegetation, the economy and other factors I have observed over the last four years, that eastern Lo receives even less rainfall than the west.

[13] Annapurna Conservation Area Project (ACAP) is a branch of the King Mahendra Trust for Nature Conservation, a Nepalese NGO which has been entrusted with the supervision of tourism and development around the Annapurna region. Upper Mustang was opened for tourism on a restricted basis in limited numbers in November 1992. The ACAP office in charge of Upper Mustang is the Upper Mustang Conservation and Development Project (UMCDP) which has been operating in Lomanthang since November 1993.

villages is due, in part, to the presence of good shepherds throughout the winter.

Lack of Competent, Reliable Shepherds

The shepherding situation mentioned above is, however, not the norm. Reliable shepherds are becoming harder and harder to find. Indeed, harsh winters make the lives of these shepherds very hard. In Samjong, for example, the two flocks of sheep have to stay on crest lines surrounding the village at altitudes higher than 4,500m, from December to April, because snow blown down by winds accumulates in valley bottoms. Sheep flocks come down near villages in early May and then go up again to high pastures in the middle of June, this time to escape high temperatures. From mid-October to mid-December, sheep graze in valley bottoms at around 3,900m. One of the shepherds of Chhosher has to travel as far as Ghami, a one-day walk, the entire winter.

Nowadays, few people choose to live the life of a shepherd. Winter trade and migration are also more lucrative than the compensation — often in kind — given for shepherding. Although the constant insufficient monsoon rainfall or the occasional excess of snow in winter affect livestock numbers, the main reason why so few sheep are raised in Charang, Surkhang, or Ghami is lack of good shepherds. Similarly, this lack of qualified manpower is why some farmers in Dhi are not rearing yaks for milk. Villagers are not willing to stay at high altitudes to milk female yaks every day. As such, people prefer to rear goats or horses which can be kept in the village every night during winter[14]. Goats and cattle herds can be looked after by young children, members of a community to whom it would be unthinkable to entrust herds staying over night in high pastures. Some of the 'one-day shepherds' are no more than eight or nine year olds, though they generally begin work at twelve. In the case of goats and horses, community members form common herds and their children take turns to miss school and watch these animals. The length of these turns are in proportion to the number of animals their parents possess. In Kimaling (Chhonup), for example, five goats equal one day's shepherding responsibility; and in Garfuk (Chhosher), the ratio is ten to one (Craig 1996). These practices allow elders to devote themselves to other activities such as trade or to leave Lo for longer periods in search of seasonal employment. Still, in Lomanthang, a majority (51% in 1990) (Thapa 1991) entrust their animals to 'professional' shepherds.

Although keeping less animals limits the amount of profit earned from animal husbandry, having less animals means that losses incurred from predator attacks are less severe and less common. It is possible to keep only a few goats, cattle, or only one horse, while it is difficult to have only a few sheep or yaks. These circumstances further contribute to the high number of cattle (2-4 per household). Dairy requirements are often met by rearing cows.

14 It seems the tendency to restrict the number and change type of reared animals and keep them nearer farms is becoming a common occurrence in many Nepalese villages, even ones with large pastures and forest areas. Instead of driving animals to the forest during the day and grazing them over a large area, people prefer to reduce their numbers and fodder from neighbouring forests. Since villagers do not have the time to diversify the places where they harvest fodder, however they plunder the same place until resources are depleted. Even in areas where the total production of biomass is higher than human consumption levels, deforestation is still a reality (Wairt 1983).

Exceptions do exist. The villages of Chung Jung and Phua (Chhonup) and of Niphu and Seikang (Chhosher) do rear more sheep than goats. In Chung Jung (29 households) as many as 742 sheep and as few as 22 goats were recorded in 1991[15]by the Veterinary Office in Jomsom. In Phua (25 households), 415 sheep and 323 goats were counted. In Niphu (19 households), 1,782 sheep and 963 goats were counted, while 1,013 sheep and 1,001 goats are kept in Seikang (15 households). In Chhosher and Chhonup, the VDCs in which these villages are located, the highest number of sheep per household in Niphu was found to be 94; 67 being the highest number of goats in Seikang [16].

Chung Jung (3,930m) is by far the best example of the importance of 'tradition' and indigenous pastoral knowledge as far as animal husbandry is concerned. Its inhabitants are *nagagpa*(s), former pastoral nomads of Lo who used to take their herds from Lo to Tibet and back again, but settled in higher Lo about 45 to 50 years ago. After that time, they had to flee from Tibet and were given land by the father of the current Lo Raja. The fact that Chung Jung rears more yak and sheep than do other villages indicates that they not only manage sufficient pasture land, but that they are also competent and devoted shepherds, as these animals require herders to be competent and willing to endure difficult conditions for the sake of their livestock.

The neighboring village of Kimaling, in comparison, is inhabited by 'true *Loba*(s)[17]. As Kimaling belongs to the same VDC as Chung Jung, the villagers of both areas have access to the same pastures. Yet the villagers of Kimaling only rear an average of three yaks, eight sheep, 13 goats, and three cattle per household compared to 20, 26, one, and one head reared in Chung Jung, respectively. Villagers of Kimaling argue that since goats have recently been more appreciated than sheep for their meat, skin, and wool, raising goats has become more lucrative than rearing sheep. But one must not deny the question of willing or non-willing shepherds.

The few families of *drokpa*(s) (*'brogpa*), Tibetan pastoral nomads who claim to be from this side of the border, still raise animals as their primary means of livelihood and are skilled shepherds. They live in tents and rear numerous yaks and goats, mainly on the high, western versants of Lo, in Ghami, Lomanthang, and Chhonup. Some of them are the Rajah's shepherds or work for other wealthy *Loba*(s). Although they do not go any more to Tibet and stay all year round in the same area, they still live under their tents and rear numerous yaks and goats, mainly on the western high versants of Lo, in Ghami, Lomanthang and Chhonup.

Increased Depletion of Fuelwood and Dung Collection

Another reason for shifting pasture use and livestock numbers in Lo is a result of the decrease in fuelwood and the collection of dung for fuel. According to an ACAP report from 1993-94, one family in Lomanthang was consuming between 1.04 and 1.24kg of fuel per person per day

15 Detailed data were not available for the year 1995.

16 In contrast, Surkhang VDC supports no sheep, though there are 86 goats per household in Tangye, 73 in Dhe and Yara, and 68 in Ghara.

17 Following local legends, the *Loba*(s), former nomads, settled as early as the seventh century AD (Ray 1987).

during the winter — an average of 3.92kg per family/day. Three houses randomly selected in the villages of Thinkar, Dhi, Charang, Ghiling, and Samar were burning an average of 2.9kg of dried dung per head/day. A large quantity of these fuel sources are collected from area rangelands, thus depriving them of a much-needed source of fertilizer and compost material.

Harvesting bushes for fuel also negatively effects the quality of rangelands Caragana, a grass that grows long roots, helps prevent soil erosion, while bushes themselves protect soil surfaces from desiccating winds. ACAP estimated that between 300 and 600ha lose their vegetation cover every year from villagers collecting firewood.

One historical source of this depletion of rangeland and forest resources is said to tie back to the *Khampa* occupation of Mustang. These Tibetan refugees settled down in Upper Mustang from 1959 to 1974 in order to fight the Chinese annexation of Tibet. The *Khampa*(s) might be responsible for impoverishing rangelands and pastures and destroying many forests, thereby adding to the fuel shortages felt today; yet they do not seem to have had a long lasting influence on the number of domestic animals kept in Lo. When the *Khampa*(s) arrived, they stole many animals from villagers and occupied a larger portion of summer pastures. (Yet, according to the Raja and other sources, the *Khampa*(s) did not forbid locals' access to their own pastures; rather, they limited access in the vicinity of their camps and areas they used to graze their animals.)

Ghami, a settlement that had no more than 100 houses at the time of the *Khampa*(s), claimed to have lost 600 yaks and many hundreds of other animals (Bista 1976). The people of Dhe also complain that many of their yaks died and that the 500 to 600 *Khampa*(s) who settled near their forest destroyed it while building their homes[18]. But when the *Khampa*(s) left Mustang, they also left their animals behind[19], selling them at ridiculously low prices to the *Loba*(s), to whom the Agricultural Development Bank provided loans at low rates of interest (8.5% per year instead of 2.5-3% per month).

The Tourist Trade

As Craig rightly points out, *Loba*(s) want to harvest more benefits from newly authorised tourism. Currently, 1,000 visitors per year are allowed to visit Lo, but they must be accompanied by a government liaison officer, porters, guides, cooks, etc. The fee for a visit to this 'restricted area' is $70 per day for a minimum of 10 days. Riding a horse on these beautiful plateaus is a pleasure which tourists often enjoy. Renting horses as pack or riding animals to tourists is one of the few ways *Loba*(s) are 'allowed' to benefit from tourism. Horses are advised as pack animals, since they are (wrongly) considered to consume less of the already rare food grains than porters. The increase in the number of horses and the decrease in the number of yaks are thus further explained by tourism.

The Closure of the Tibetan Border

The worst event in the recent history of Lo animal husbandry has been the signing of

[18] In Dhe it is also said that when the *Khampa*(s) left, the people of Charang and Chhosher, particularly, following instructions from the Rajah, came and took logs to build their own schools and monasteries.

[19] According to one old *Khampa*, they left more than 600 yaks and 1,000 horses in Lo. In Ghami alone, they sold or abandoned between 400 to 600 goats, 70 *dzo*(s), and 30 horses.

an agreement in April 1983 between Nepal and China forbidding traditional transhumance patterns. According to Basnyat and Netra, between 1987 and 1988, the year these new regulations took full effect, and 1988-89, the number of reared animals in Lo decreased by 19 and 24 percent, respectively. Tchokya of Chung Jung is now only able to keep 20 out of the 100 yaks and 30 out of the 400 sheep and goats he reared before 1988. It is also significant that he had many more sheep than goats prior to this agreement, whereas he now keeps them in more or less equal proportions. This closure affects both *Loba*(s) and Tibetans. While the *Loba*(s) used to travel to Tibet in winter, the Tibetans once took their yaks south to Lo's high pastures during the summer.

Although summer pastures have suffered from this closure, it is the lack of winter pastures that has particularly impacted livestock numbers in Lo, especially the number of yaks. The only alternative for yak herders is to bring their animals south in the winter. ACAP counted that 20 per cent of the *Loba*(s) in Lomanthang, Chhosher, and Chhonup take their yaks to Chhuksang and as far as Jomsom (2,600m). Yet winter pastures in these areas are not in excess; the *Loba*(s) are not always welcome. As a result, there are almost no yaks left in Chhosher.

Although Pema Huangdi from Lomanthang lost 70 yaks during the winter of 1991, he rebuilt his herd. During the winter of 1994-95, however, he again lost 228 of his 280 yaks. Pema had sent his yak to Dolpa District in the hope that there would be less snow there than in Lo. The Rajah of Lo lost 70 out of his 160 yaks the same winter. Pema Huangdi sold his 52 remaining yaks last year; the Rajah considered a similar move. The consequences of this catastrophic treaty and the decrease in the number of yaks and their replacement by horses are having a drastic impact on the lives of the *Loba*(s).

Horses can travel to lower areas during winter (Craig 1996) and, thus, escape the harsh conditions of this season and the shortage of grains and fodder. Some of them stop at Jomsom but a number of Lo's horses travel to Pokhara in the winter, bringing down goods such as *jim-bu* and portering necessary oil, kerosene, grains, dresses, etc and back to Lo in the Spring. This ability to be used as pack animals all the way from Lo to Pokhara and back gives horses a definite superiority over yaks who cannot travel lower than Thak *Khola* (south of Jomsom). At this point, they must be replaced by other people's mules.

Conclusion and Possible Solutions

The conjunction of geological, climatic, social, and political events has induced long lasting changes in the animal husbandry practices and overall economy of Upper Mustang. Local alternative sources of income, such as trade and agriculture, are also changing. The long-term consequences of these overall shifts could be a waste of local resources. Replacing the rearing of yaks or sheep with horses, mules, and goats will lead to an under utilisation of the high pastures and rangelands, contributing to probable overgrazing in the vicinity of villages, even if horses which are not used for transporting goods or riding are grazed on high pastures during monsoons. These changes will also lower the resilience of indigenous management systems which could, historically, always overcome a bad year in one sector thanks to the variety of activities in which locals engaged. By using all available rangelands, *Loba*(s) guarded against natural and man-made hardships. With the decrease in the variety and numbers of animals kept, *Loba*(s) face greater risks and potential losses in livelihood.

At the same time, the growing number of horses in Upper Mustang (1,574 in 1995) introduces competition for food grains between men and animals. When at work, a horse can consume up to four kg of cereals daily. At rest, horses still need one kg of sweet peas or grains each day from October to March. Yet only 55 per cent of local food grain needs are met by local agricultural production. The remaining 45 per cent must be imported. Import levels, particularly of wheat and barley, must now increase to feed horses, so much so that the difference in prices between rice and these two cereals has significantly dropped. In Samjong, for example, the price of grain has risen by three times in the last four years, since the opening of Lo to tourism. Currently, rice, barley, and wheat are sold for basically equal prices.

These changes bring a greater dependence on lower areas in terms of both grains and pasture land. One must ask the question: How long will the *Loba*(s) be allowed to graze their horses for free in Jomsom and Pokhara?

In order to counteract these trends, some urgent measures could be investigated and taken. First, and most difficult, Nepal should engage in negotiations with Chinese authorities regarding mutual access to pasture land.

Second, facilities should be constructed and fodder raised so yaks and sheep can be fed and sheltered during winter.

Third, high pastures and rangelands should be improved by reactivating traditional rangeland management and introducing productive grasses and shrubs. One should also keep in mind, however, that this area is remote (one week's walk from the nearest road in Nepal). When introducing improved varieties of grasses, the possibilities of making the best use of local manure should be investigated. In this regard, replacing the use of dung and bushes for fuel with solar energy devices would allow manure to stay on pastures and in fields. Pastoral shepherds could also be equipped with such devices to help improve their living conditions.

Fourth, fodder crops should be cultivated inside irrigated areas between fields. They could also be introduced into the crop rotation cycles and/or planted on fields abandoned due to insufficient yields or irrigation. Since yields and production of staple crops are already low, this would require a shift towards an even more decidedly pastoral economy. This shift has already occurred in a certain way, however, since horses are fed with imported grains.

Actually, Lo boasts a long tradition of harvesting grass within cultivated areas for winter fodder. Fields are often quite distant from one another and a large area is thus left for grass to grow within irrigated areas. Two months before harvesting food grains, cutting this grass is strictly forbidden, even to field owners. Grass is cut just before the harvest. Since the water a farmer puts in his field is also supposed to irrigate most of the grass growing around his field's terrace wall, he is entitled to three-quarters of this grass; the farmer whose field lies below the wall receives the remaining one-fourth.

Fifth, the introduction of mobile veterinary units should be implemented to help improve animal health. Currently, villagers must travel to Jomsom if they want to receive decent veterinary care from the government clinic.

Finally, low interest rates and insurance systems should be devised in order to allow *Loba*(s) to rebuild their herds after losses from climate or predators. Such schemes often fail because it is very difficult to regulate misuses or false claims. In order to guard against such problems, credit organizations should be run on a community basis in order to allow for local control of these resources.

Tourism has been introduced in Upper Mustang, in part, to counterbalance the decrease in agropastoral and trade production levels. Tourism offers some very limited employment opportunities to *Loba*(s), but it cannot be considered as the only solution or even the main source of local income generation. Unless *Loba*(s) can produce enough on their fields and pastures or with their trade to support themselves, the few tourists allowed to visit Lo will behold a desert and ruins, hopefully with some doorkeepers.

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Annex 1: The number of Animals Reared in Upper Mustang between 1993 and 1995

	Houses	Cattle	*	Yaks	*Dzos*	Sheep	*	Goats	*	Horses	*	Mules	onkey	Poultry	*
1993															
Lomanthang	5262	471	3	534	0	1609	12	4196	30	394	3	29	223	0	0
Chhonup	295	554	2	715	102	1692	6	2084	7	366	1	2	0	0	0
Chhosher	146	316	2	0	12	3232	22	6545	45	165	1	0	0	0	0
Charang	112	489	4	42	129	2	0	2800	25	197	2	6	22	36	0
Ghami	139	537	4	34	218	0	0	3909	28	214	2	6	23	122	1
Surkhang	118	207	2	303	65	160	1	7908	67	86	1	0	0	53	0
Lo	839	2583	3	1660	529	6885	8	27808	33	1431	2	43	268	211	0
Chhuksang	239	302	1	0	342	25	0	8069	34	151	1	313	34	443	2
Upper Mustang	1078	2885	3	1660	868	6910	6	35877	33	1582	1	356	302	654	1
1994															
Lomanthang	139	502	4	848	130	1744	13	4057	29	694	5	68	452	0	0
Chhonup	185	582	3	762	102	1820	10	2060	11	366	2	2	0	0	0
Chhosher	146	360	2	10	0	4051	28	5904	40	166	1	0	0	0	0
Charang	112	488	4	45	117	0	0	3412	30	178	2	6	17	49	0
Ghami	139	502	4	42	184	0	0	4547	33	205	1	6	27	117	0
Surkhang	118	358	3	230	78	0	0	7955	67	122	1	0	0	104	1
Lo	839	2792	3	1937	611	7529	9	27935	33	1731	2	84	82	270	0
Chhuksang	239	377	2	0	311	0	0	7450	31	135	1	254	254	636	3
Upper Mustang	1078	3169	3	1937	922	7529	7	35385	33	1866	2	336	336	906	1
1995															
Lomanthang	139	381	3	365	65	2144	16	3658	3	390	3	29	0	0	0
Chhonup	185	328	2	485	52	3423	19	2060	2	381	2	2	0	0	0
Chhosher	146	251	2	0	0	5852	40	4903	1	168	1	0	29	0	0
Charang	112	282	3	45	124	0	0	3799	2	178	2	0	27	48	0
Ghami	139	301	2	39	95	26	0	3538	1	190	1	6	0	118	1
Surkhang	118	271	2	211	48	234	2	4382	1	122	1	0	266	115	1
Lo	839	1814	2	1145	384	11679	14	22340	2	1429	2	37302	50	281	0
Chhuksang	239	230	1	0	155	0	0	7994	1	145	1	339	316	536	2
Upper Mustang	1078	2044	2	1145	539	11679	11	30334	1	1574	1	210	0	817	1
Mean 93-95															
Lomanthang	139	451	3	582	65	1832	13	3970	29	493	4	42	295	0	0
Chhonup	185	488	3	654	85	2312	12	2068	11	371	2	2	0	0	0
Chhosher	146	309	2	3	4	4378	30	5784	40	166	1	0	0	0	0
Charang	112	420	4	44	123	1		3337	30	184	2	4	23	44	0
Ghami	139	447	3	38	166	9		3998	29	203	1	6	26	119	1
Surkhang	118	279	2	248	64	131	1	6748	57	110	1	0	0	91	1
Lo	839	2396	3	1581	507	8698	10	26028	31	1530	2	54	205	254	0
Chhuksang	239	303	1	0	269	8	0	7838	33	144	1	290	113	538	2
Upper Mustang	1078	2699	3	1581	776	8706	8	33865	31	1674	2	344	318	792	1

Source: Veterinary Office, Jomsom

* Number of animals reared per household

Pastoralism and Its Development in Balochistan, Pakistan

Dr. Muhammad Saleem

Abstract

Although Pakistan is primarily an agricultural country, many of the rural poor and mountain dwellers rely on animal husbandry for their livelihood. Pastoralists of Balochistan, like other nomadic and semi-nomadic peoples throughout the world, have developed complex strategies to cope with the harsh environments in which they live and raise livestock. However, dwindling range resources and increasing human and livestock populations have strained area rangelands. Although the people of Balochistan were once pure pastoralists, they are now shifting towards agro-pastoral lifestyles. No pure form of pastoralism currently exists in Pakistan, however, with the exception of Afghan nomads who spend their winters in Balochistan and parts of other similar provinces. Likewise, traditional methods of management have become less viable.

In order to sustain life in the mountainous regions of Pakistan such as Balochistan's uplands, it is imperative to devise sound rangeland resource improvement and development models. Advanced technologies should be utilised, as long as they are compatable with social frameworks of the region's pastoralists and agro-pastoralists. In addition to being socially acceptable, such models must also endorse community land legislation, particularly when addressing common land pasture management issues.

Pastoralism in Pakistan

Background

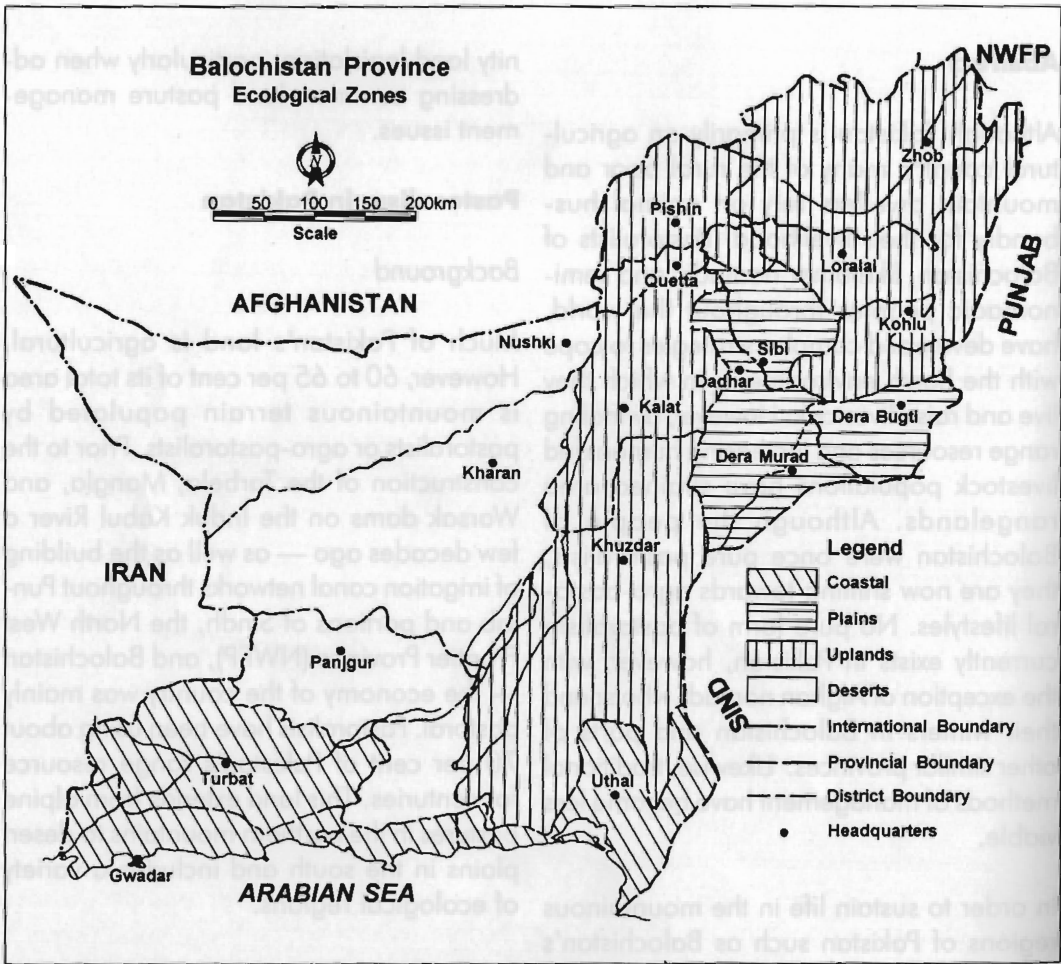
Much of Pakistan's land is agricultural. However, 60 to 65 per cent of its total area is mountainous terrain populated by pastoralists or agro-pastoralists. Prior to the construction of the Tarbela, Mangla, and Warsak dams on the Induk Kabul River a few decades ago — as well as the building of irrigation canal networks throughout Punjab and portions of Sindh, the North West Frontier Province (NWFP), and Balochistan — the economy of the country was mainly pastoral. Pastoralists have been using about 70 per cent of Pakistan's range resource for centuries. This land extends from alpine pastures in the northern mountains to desert plains in the south and includes a variety of ecological regions.

Range Resources and Ecology in Balochistan

Balochistan is the largest province of Pakistan, covering about 43 per cent of the country's total area. Balochistan's topography is diverse. Mountains cover 9.6 per cent of the total area, while uplands comprise 19 per cent of this region. The rest of Balochistan's geography includes piedmont, deserts, flood plains, and coastal plains. The annual rainfall varies from 50mm in the west to 400mm in the east. Because of its aridity and erratic rainfall, about 93 per cent of the area is considered rangeland. Climatically, the entire province could be divided into four ecological zones: coastal, plains, deserts, and uplands (Map 1).

social and linguistic groups. These pastoralists live in four provinces, including Azad Kashmir and the Northern Areas.

Pure pastoralists hardly exist in Balochistan. Only the Afghan nomads who travel from Afghanistan into Balochistan in the winter can be classified as such. These nomads trace traditional migratory routes year after year, entering Balochistan at Chaghai,

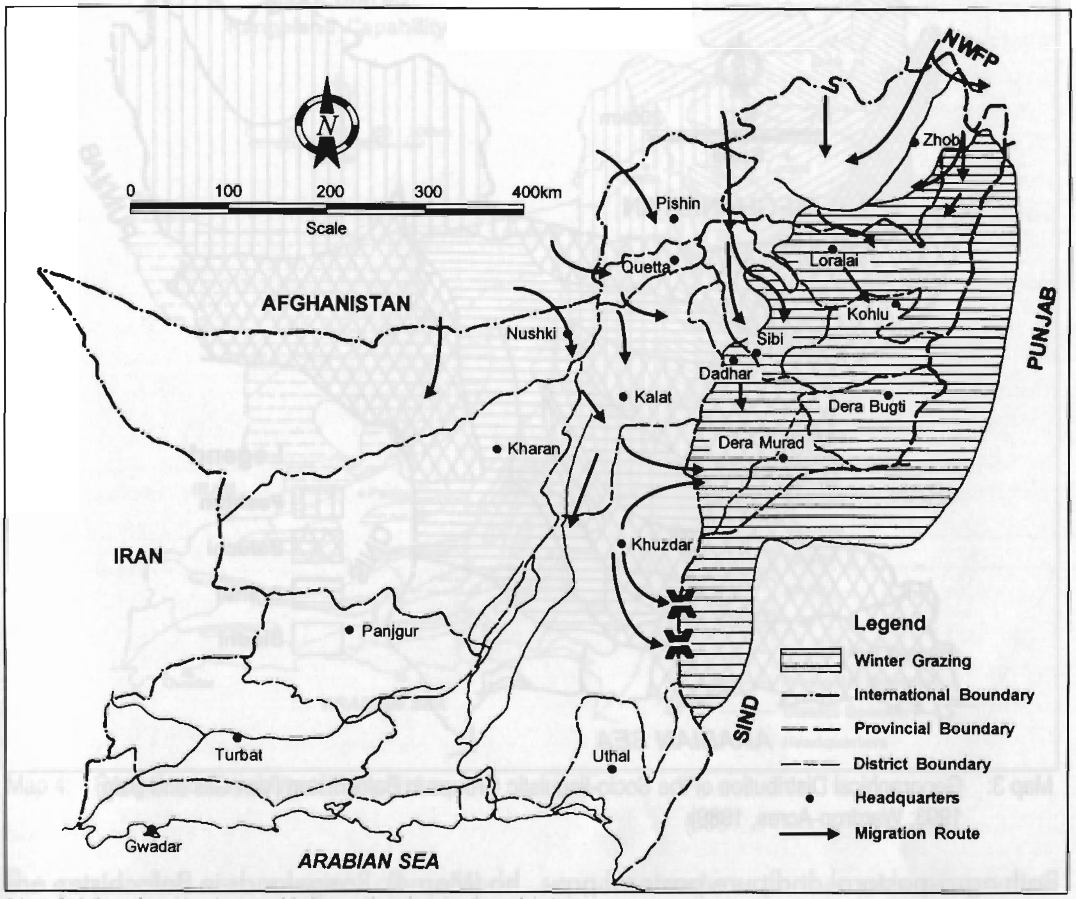


Map 1: Ecological Zonation of Balochistan Province

Major Types of Pastoralists

Pakistan's pastoralists can be grouped into two main types: local pastoralists and non-local pastoralists (Afghan *Pawinda*). Local pastoralists include people from different

Nushki, Quetta, Chaman, Pishin, Qamar Din Karez, and Zhob (Map 2). They then settle throughout the entire province for the winter. Some of these migrants also conduct trade at this time, while others work as hired labourers on Balochistan's or-



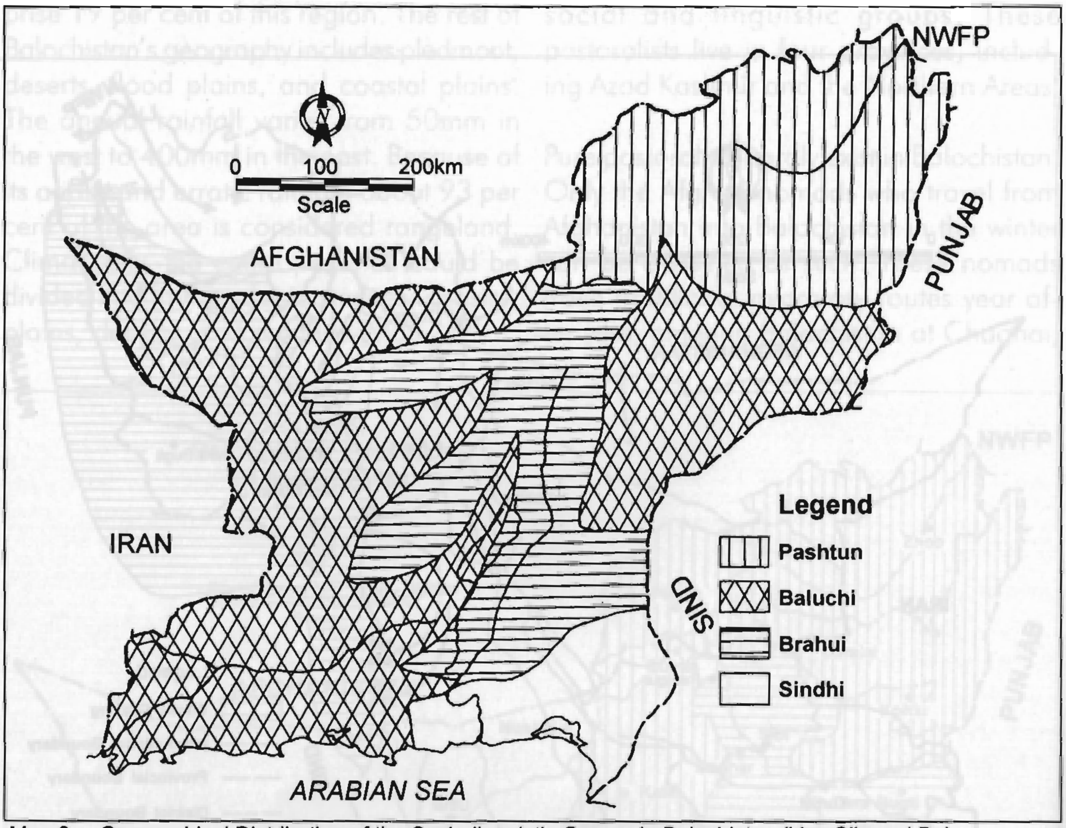
Map 2: Migration Routes and Winter Grazing in Balochistan

chards and farms and in the cities. Local herders are primarily agro-pastoralists who travel a variety of routes between summer and winter pasture lands.

The indigenous pastoralists of Balochistan are ethnically diverse and composed of three main socio-linguistic groups: Baloch, Brahvi, and Pashtun. Small populations of other groups, such as Sindhi and Siraiki, also exist in Balochistan (Map 3). Each group retains its own traditions and social organization. Yet some mutual transformation among different groups has occurred over time. For example, people who were once pure pastoralists are now agro-pastoralists. Likewise, agro-pastoralists have shifted towards more sedentary, overwhelmingly agriculturally-based lifestyles.

Pastoral Production Systems

Most local and non-local pastoralists move their herds in accordance with indigenous grassland management policies. These people usually make two major moves a year: from winter to summer pastures and vice versa. Occasionally, pastoralists change pastures every quarter in order to provide their animals with enough fodder — particularly during extreme weather. On the basis of their movement patterns these pastoralists can be divided into nomadic, transhumant, and sedentary herders.



Map 3: Geographical Distribution of the Socio-linguistic Groups in Balochistan (Van Gils and Baig, 1993; Wardrop-Acres, 1989)

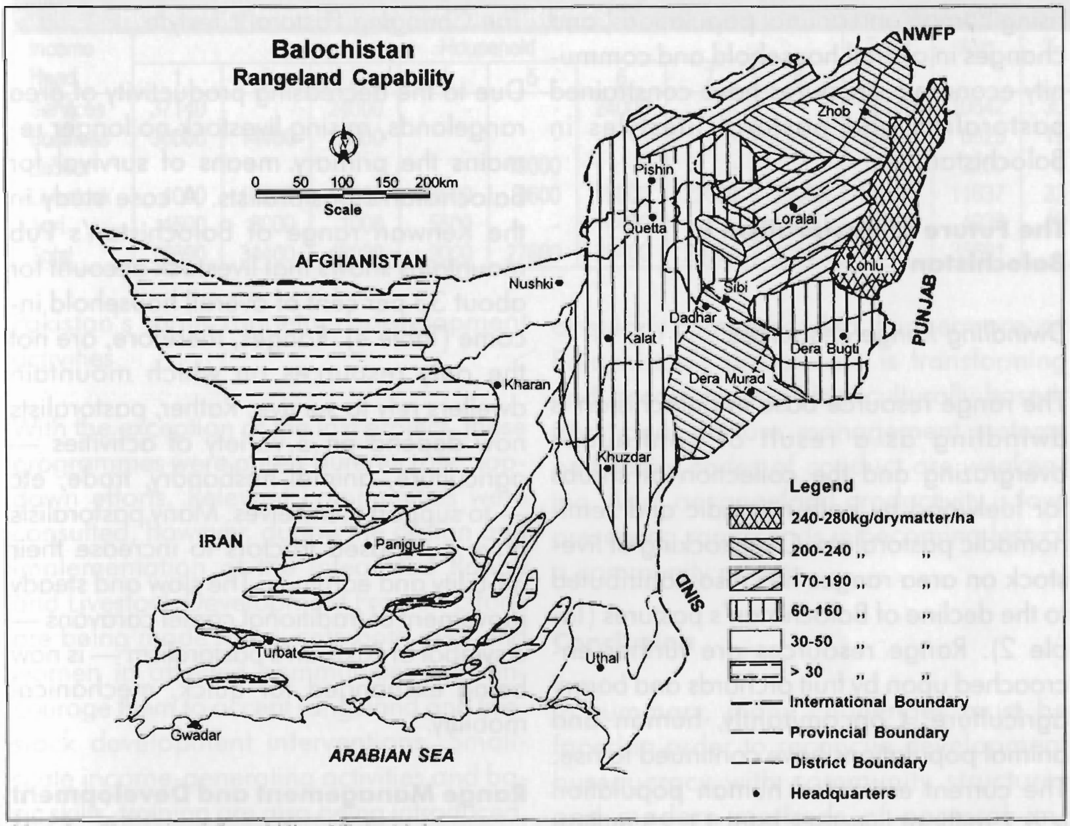
Both agro-pastoral and pure pastoral production systems operate in Pakistan. In the latter production system, 50 per cent or more of a household's gross revenue comes from livestock or livestock oriented activities. Agro-pastoralists, on the other hand, earn more than 50 per cent of their livelihood from agricultural activities, while 10-15 per cent comes from animal husbandry. Agro-pastoralists can be further divided into those who irrigate fields and those who depend on rain to water their crops.

Rangeland Capability

Balochistan's rangelands can be classified into one to six capability classes. Grassland productivity ranges from 280 kg/dry matter/ha to less than 30 kg/dry matter/ha (Map 4). Rangelands in Balochistan are continuously grazed and commonly owned by area pastoralists. As such, the 'tragedy of the commons' may apply to this area. Potential production is approximately three times current production levels. Although resources are available, the means of improving the potential of the resource base's potential is needed (Table 1).

Survival Strategies

The pastoralists and agro-pastoralists of Balochistan rely on many coping strategies to exist in their high mountain environments. Such strategies include herd mobility, moisture security, livelihood linked with overall biomass availability, diversification of pastoral activities, flexibility, and collective sustenance.



Map 4: Rangeland Capability of Balochistan

The pastoralists use a variety of methods to actualise the above strategies. Combining agricultural and pastoral activities helps secure and strengthen the local economic base. Herders also practice folk agronomy, planting a variety of crops with different maturation cycles. Ethno-engineering and indigenous agroforestry practices (shelter belts, crop bush fallow rotation, etc) are also used to secure local livelihood. Traditional credit and other community-based support structures further aids pastoralists of Balochistan.

When range resources are productive and human and livestock populations remain low, pastoral norms stay intact. Traditional pastoral strategies work well. Even today, under more challenging environmental conditions, many indigenous pasture management practices are viable. However, the increasing amount of degraded pasture,

Table 1. **Estimated Annual Forage Production from the Rangelands of Balochistan**

Rangeland	Area (m.h)	Current Production DM (t/h)	Current Production Total DM (mt)	Improvement Potential DM (t/h)	Improvement Potential Total DM (mt)
Central Balochistan	8.00	0.5	4.00	1.00	8.00
Eastern Balochistan Range	5.00	0.4	2.00	1.50	7.50
Western Balochistan Range	18.50	0.3	5.55	0.80	14.80
Suliman Mountain Range	1.50	0.3	0.45	2.00	3.00
Total	33.00		12.00		33.30

rising human and animal populations, and changes in overall household and community economic structures have constrained pastoralists and pastoral lifestyles in Balochistan.

The Future of Pastoralism in Balochistan

Dwindling Range Resources

The range resource base in Balochistan is dwindling as a result of continuous overgrazing and the collection of shrubs for fuelwood by both nomadic and semi-nomadic pastoralists. Overstocking of livestock on area ranges has also contributed to the decline of Balochistan's pastures (Table 2). Range resources are further encroached upon by fruit orchards and *barani* agriculture. Concomitantly, human and animal populations have continued to rise. The current estimated human population is 6.7 million; livestock total 11.25 million head (Table 3). All of these factors are contributing to the desertification of Balochistan's ranges.

Table 2: **Stocking Rate of Balochistan Rangeland Area**

Year	Total Ran. Ar. ('000 ha)	Population ('000)	E/E (000)	ha/EE
1972	22,500	7,977	11,567	1.9
1980	22,500	7,945	13,032	1.7
1983	22,500	8,240	15,232	1.5
1996	22,500	8,240	18,053	1.2

FAO 1983/84

The overstocking since 1972 to date has increased by about 36%.

The Changing Pastoral Lifestyle

Due to the decreasing productivity of area rangelands, raising livestock no longer remains the primary means of survival for Balochistan's pastoralists. A case study in the Kenwari range of Balochistan's Pub mountains shows that livestock account for about 33 per cent of overall household income (Table 4). Ranges, therefore, are not the only resources on which mountain dwellers rely to survive. Rather, pastoralists now depend on a variety of activities — agriculture, animal husbandry, trade, etc — to support themselves. Many pastoralists have purchased tractors to increase their mobility and earnings. The slow and steady movement of traditional camel caravans — a symbol of Pakistan's pastoralism — is now being exchanged for quick, mechanical mobility.

Range Management and Development

Rangeland Development Approaches

Until recently, rangeland development in Balochistan has been confined to government forests and rangelands. Not only have rangeland users had little or no involvement in the planning or executing of these activities, but such programmes have been rarely introduced. The Maslakh Rangelands Development project (1954-1965); the 'Assistance to Rangeland and Livestock Development Survey', UNDP/FAO (1983-84); and the Integrated Range and Livestock Development Project, UNDP/FAO (1992-97) comprise

Table 3. **Balochistan Livestock Projected Population 1996 (base year 1983 FAO Report 1983/84)**

Livestock (all species)	Base year 1983	1988	1993	1994	1995	1996	E/E
Local	8,034	8,652	9,097	9,204	9,290	9,388	1,531
Refugees	1,554	1,654	773	1,803	1,834	1,867	2,922
Total	9,588	10,306	9,870	11,007	10,124	11,255	18,053

Table 4. **Household Annual Average Income (Rupees)**

Income Head	Household 1	2	3	4	5	6	7	8	Total	Avg	%
Services	37140	-	24000	-	-	24000	-	-	85140	10642	30
Business	30000	14400	11000	-	-	-	-	-	55400	6925	19
Labour	-	-	-	-	18000	-	-	-	18000	2250	6
Livestock	4000	12000	12000	3500	9600	10000	22000	20000	93100	11637	33
Agri.	4500	8000	1000	5500	-	4400	-	10500	33900	4237	12
Total	75690	34400	48000	9000	27600	38400	22000	30500		35691	

Pakistan's main rangeland development activities.

With the exception of the last project, these programmes were purely bureaucratic, top-down efforts. Relevant communities were consulted, however, during the design and implementation of the Integrated Range and Livestock Development Project. Efforts are being made to educate both men and women in affected communities and encourage them to accept rangeland and livestock development interventions. Small-scale income-generating activities and basic skills' training are also being introduced.

Range Management and Traditional Pastoral Lifestyles

Although simply involving local pastoralists in decision-making processes of development projects is highly beneficial, other complications arise when trying to reconcile traditional lifestyles with modern development techniques and expectations. Rangelands are common property with no single owner or user. This creates problems for development workers, as the uses and limitations of community land are not specifically addressed by local legislation. Quite often, it is difficult to implement mutually agreed upon projects that rely on communal property.

As pastoral communities often are uneducated, collective community losses and the value of common resources are not easily or quickly comprehended. Furthermore, as Balochistan's pastoralism is transforming and becoming more agriculturally-based, traditional pasture management systems and social codes of conduct are weakening. Also, as rangeland productivity is low, preserving rangelands is becoming less of a community priority.

Conclusion

In summary, many challenges must be faced in order to reconcile development bureaucracy with community structures and modern methods of pastoral improvement with traditional management systems. During this transitional stage of pastoralism and agro-pastoralism in Pakistan, natural resources, such as rangelands, suffer greatly. Efforts must be made to bridge cultural, practical, and ideological differences in order to improve and sustain quality pastoralism in Balochistan.

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Small Ruminant Production and Pastoral Development in the Dry Mountains of Pakistan

Abdul Wahid Jasra

Introduction

Mountain areas constitute 60-65 per cent of Pakistan's total area, with high mountains accounting for 22-25 per cent and low mountains covering 38-40 per cent of the country's land mass (Siddiqui 1995). Rugged mountainous terrain, narrow valleys, and foothills total approximately 0.4 million sq. km. (Abbasi 1987). These mountainous zones may be divided into two categories: dry mountains and wet mountains. The dry mountains can further be classified into the following two geographical sub-divisions: northern dry mountains and western dry mountains. This paper mainly addresses small ruminant production and pastoral development in these dry mountain regions.

Northern Dry Mountains

The federally-administered Northern Areas (Gilgit and Baltistan) now include five districts and comprise the largest part of the northern dry mountains. These mountains are located between 35°-37°N and 72°-75°E, with a total area extending over 72,500 sq. km. (Mohammad 1995). Land use is dominated by mountains (34%) and rangeland (52%) with a small area of natural forest (4%). Less than one per cent of the land is cultivated (Archer 1992). The entire region receives an average of 100-200mm precipitation annually, though precipitation generally exceeds 400mm at elevations above 3,000 metres (Mohammad 1995). Native vegetation can be grouped into four distinct types: foothill ranges, dry temperate ranges, valley grazing lands, and alpine pastures.

Western Dry Mountains

Balochistan, the largest province of Pakistan, is one of the best examples of the western Dry Mountains. This region covers an area of 0.35 million sq. km. (Archer 1992) and extends between the northern latitudes of 24°-32° and the tropics. The climate is Mediterranean. Annual precipitation ranges from 200-300mm with 60-80 per cent occurring during winter and early spring (Khan 1988). However, the precipitation gradient increases from 50mm in the west to 400mm in the eastern mountains bordering the Punjab. Rangelands account for the majority of this land, about 93 per cent of the total area. Vegetation is divided between shrublands in the south and grasslands in the north.

The Role of Small Ruminants

Livestock grazing is the most important activity undertaken by the subsistence farming and pastoralist communities of these regions. In Pakistan, almost 50 per cent of

Table 1: Small Ruminant Populations in Pakistan (million head)

Province	1955	1960	1972	1976	1986	1993	*
Punjab							
Sheep	4.19	5.58	6.28	8.04	6.69	7.03	1.8
Goats	2.60	2.97	2.97	7.77	0.76	15.47	13.0
Sindh							
Sheep	1.05	1.59	0.84	1.83	2.62	3.09	5.1
Goats	1.98	2.20	2.28	4.24	6.76	9.33	9.7
NWFP							
Sheep	1.56	2.43	2.46	3.68	2.23	2.28	1.2
Goats	2.10	3.04	3.74	4.69	4.20	4.49	2.9
Balochistan							
Sheep	1.16	2.56	3.86	5.08	11.11	15.10	31.6
Goats	0.70	1.60	3.24	4.44	7.30	11.28	39.7
Northern Areas							
Sheep	0.14	0.21	0.23	0.32	0.64	0.86	13.5
Goats	0.19	0.24	0.39	0.56	0.94	1.39	16.6
Pakistan							
Sheep	8.10	12.38	13.67	18.94	23.29	28.36	6.6
Goats	7.56	10.05	15.58	21.69	29.95	41.96	11.9

* Per cent annual increase over 38 years (Nawaz and Khan 1995)

the meat supply comes from small ruminants (Nawaz and Khan 1995). The majority of small ruminants are raised by flock owners with little or no land resources.

According to recent statistical estimates, Balochistan has 37.5 per cent of Pakistan's total sheep and goats, while the Northern Areas account for only three per cent. Presumably, Balochistan would soon be supporting as much as 50 per cent of the total small ruminant populations. Goats have increased tremendously in the last few years, indicating significant shifts in the structures of native plant communities (e.g., shrubs etc).

Sheep and goat-raising contribute 25 per cent of Balochistan's Gross Agricultural Product. Small ruminants directly or indirectly aid the income of about 80 per cent of the population of this province (Nagy et al. 1987).

Fiduciary Pastoral Development

Based on statistical indicators, it may be concluded that pastoralism in dry and cold mountainous regions of Pakistan is heading in a positive direction. The following sections examine the fallacy of such pastoral development claims and addresses pertinent rangeland issues.

Nutrition

Small ruminant production has always adhered to traditional systems of pastoral manangement. However, this reality is changing. Sheep and goats used to obtain 90-95 per cent of their nutritional requirements from grazing resources in Balochistan (FAO 1983). Buzdar (1989) concluded that traditional small ruminant production was suffering from severe pressures due to overstocking and declining fodder supplies which, in turn, hinder production. Estimates by Archer (1992) reflect the magnitude of nutritional stress upon sheep and goats (Table 2). For example, in both Balochistan and the Northern Areas, feed supplies and grazing resources have dropped to about 60 per cent of their previous levels. These examples illustrate that feed deficits are perhaps the biggest issue facing sustain-

Table 2: **Feed Budget Deficits in Dry Mountainous Regions** (million tons)	TDN	DCP
Balochistan		
Total availability	2.58	0.234
Total required	4.16	0.504
Per cent deficit	38.0	54.0
Northern Areas		
Total availability	0.49	0.042
Total required	0.71	0.077
Per cent deficit	31.0	45.0

TDN: Total Digestible Nutrients (Archer 1992)
DCP: Digestible Crude Protein

able small ruminant pastoral development in Pakistan. All other issues are connected to this basic lack of feed.

Wahid (1990) determined the mechanism by which sheep and goat nutritional deficiencies were operating on grasslands and shrublands of Balochistan. His explanation places emphasis on understanding this lambing/kidding calendar in order to mitigate nutritional deficits. According to this lambing/kidding calendar (Table 3) the year is divided into four periods and explains a flock's nutrient requirements based on the physiological state of females. The first period begins in the late summer and early fall and includes all months when the females are dry and their nutrient needs remain at a maintenance level. Breeding is normally included in this first period and begins during the second half of September. The second period lasts from October through December when females are in early to mid-gestation. After December, ewes/does enter the most critical third period, when 70-80 per cent of the foetal growth occurs. Nutritional requirements are high at this time. Since sheep and goats depend entirely upon rangelands to meet their nutrient requirements, winters are always difficult for them, as vegetation becomes coarse, dry, and dormant until the first week of March. Females experience severe nutritional stress at this time. Productivity, conception rates, lambing percentages, birth weights, and live weights are significantly affected by the harsh conditions during this period.

Management interventions which improve winter feed availability would increase overall production benefits at least twofold (Rafique *et al.* 1990). Wahid (1990) concluded that small ruminants are se-

Table 3: Lambing/Kidding Calendar and Nutrient Requirements of Sheep and Goats on Balochi Rangeland

Month	Physiological state	DM (%)	TDN (%)	CP (%)	P (%)
June	Maintenance	2.0	55	9.4	0.2
July	Maintenance	2.0	55	9.4	0.2
August	Maintenance	2.0	55	9.4	0.2
September	Maintenance	2.0	55	9.4	0.2
October	Early gestation	2.4	55	9.4	0.2
November	Early gestation	2.4	55	9.4	0.2
December	Mid gestation	2.4	55	9.4	0.2
January	Late gestation	3.2	59	10.7	0.23
February	Late gestation	3.2	59	10.7	0.23
March	Lactation	4.2	65	13.4	0.26
April	Lactation	4.2	65	13.4	0.26
May	Lactation	4.2	65	13.4	0.26

Note: **DM**: DryMatter-per cent of bodyweight (Wahid 1990)
TDN: Total Digestible Nutrients - per cent of ration
CP: Crude Protein - per cent of ration
P: Phosphorus - per cent of ration

verely phosporus deficient year round throughout both the shrublands and grasslands of Balochistan. The crude protein availability on rangelands does not meet nutritional requirements during fall and winter.

Lambing/kidding commonly occurs in early spring on Balochi ranges. Rapid spring growth commences as the climate grows warmer. Forage is generally considered nutritionally adequate for all ruminants at this time. Lactation may end in May as offspring are weaned, though this process is often delayed so that milk production levels remain high. After lactation ends, animals exist at maintenance nutrition levels until breeding begins again in September.

Meanwhile, considerable production losses occur in young stock. Range vegetation reaches maturity in July when newly-weaned young stock are only 3-5 months old. Young lambs/kids must survive seven months of nutritional stress (August through February). During this period, grazing resources fail to meet their growing nutritional needs. Results of such nutritional deficits include death, poor weight gain, and delayed puberty — all of which have negative effects on the herding economy.

As illustrated above, the traditional lambing/kidding calendar does not correspond with existing seasonal feed supplies. Thoughtful breeding plans that coincide with seasonal vegetation cycles are required to increase the productivity of small ruminant pastoralism. The role of small ruminants in pastoral development can be greatly improved and intensified by introducing management interventions that improve feed availability, particularly during winter.

Diet

It is imperative to understand the current modified structures of vegetation and their relationship to grazing livestock. Not all forage species on rangelands are equally palatable. Similarly, the quantities of various available forage do not indicate the amounts of each in animal diets. In general, most of the rangelands in dry mountains have been overstocked. Consequently, many of the highly desirable plant species are becoming rare. For example, retrogression of climax plant communities, such as *Chrysopogon aucheri,* is widespread throughout Balochistan's grasslands. Presently, *Cymbopogon shoenanthus* constitutes 75 per cent of all plant biomass on grasslands (Wahid 1990), whereas *Artemisia* spp and *Haloxylon* spp dominate on shrublands, averaging 54 per cent and 60 per cent of the total plant composition, respectively.

Dietary preferences of sheep and goats on grasslands and shrublands of Balochistan were determined by Wahid (1990). Sheep diets were consistently low in *C. shoenanthus* — ironically the most abundant plant species on the grasslands. Goats also neglected this grass species throughout the year. Similarly, even though *Artemisia* spp and *Halaxylon* spp are abundant on shrublands, *Convolvulus iexocalycinus* appeared to be the most preferred species by both sheep and goats. Wahid concludes that special management techniques are required to bring basic changes into plant communities, introducing preferred, palatable species. If this is not made a pastoral development priority, small ruminants productivity will continue to decline.

The results of Wahid's study (1990) are equally valuable for both individual farmers and pastoral development policy-mak-

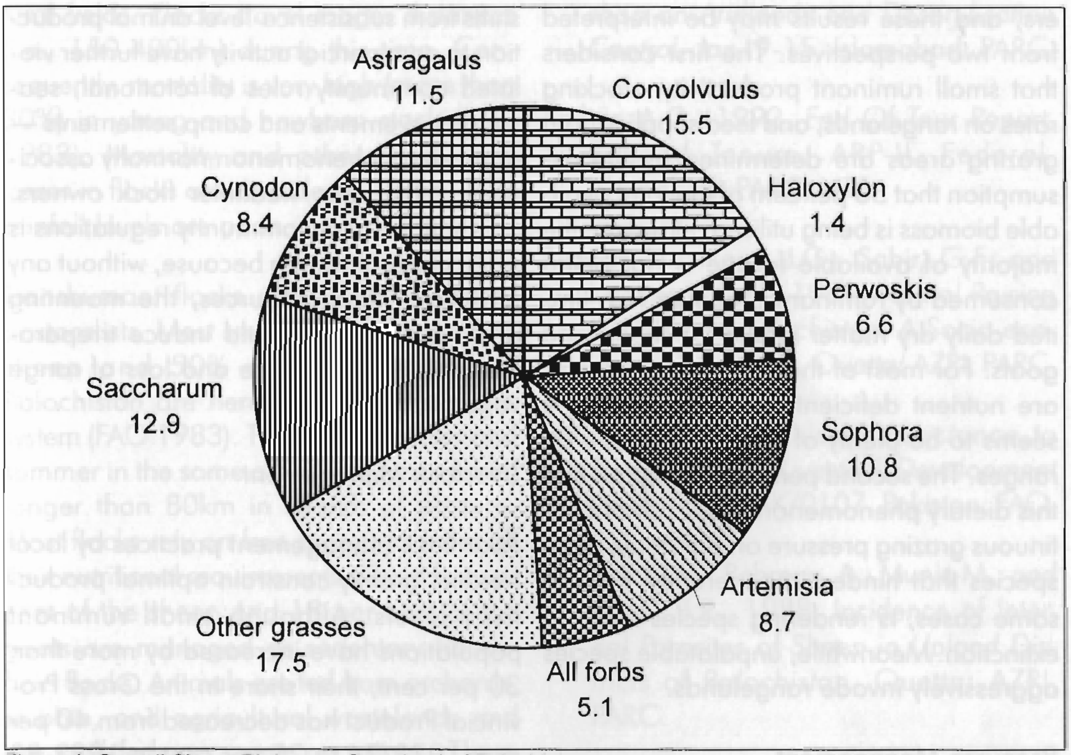

Figure 1: Overall Sheep Diets on a Grassland of Balochistan

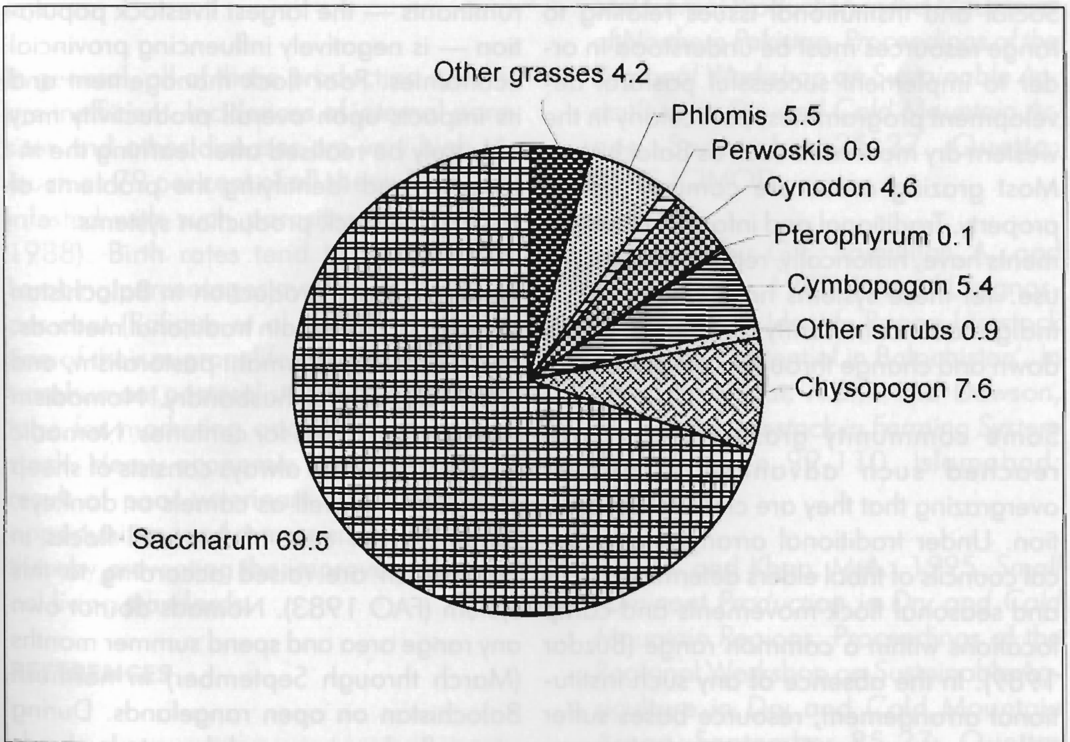

Figure 2: Overall Goat Diets on a Shrubland of Balochistan

ers, and these results may be interpreted from two perspectives. The first considers that small ruminant productivity, stocking rates on rangelands, and feed supplies from grazing areas are determined by the assumption that 50 per cent of the total available biomass is being utilised. However, the majority of available forage is not being consumed by ruminants, leading to a limited daily dry matter intake for sheep and goats. For most of the year, these animals are nutrient deficient, even though there seems to be plenty of forage available on ranges. The second perspective implies that this dietary phenomenon is a result of continuous grazing pressure on palatable plant species that hinders regeneration and, in some cases, is rendering species close to extinction. Meanwhile, unpalatable species aggressively invade rangelands.

Resource Management

Social and institutional issues relating to range resources must be understood in order to implement successful pastoral development programmes, particularly in the western dry mountains such as Balochistan. Most grazing areas are common, tribal property. Traditional and informal arrangements have, historically, regulated resource use. Yet these systems have weakened as indigenous community structures break down and change throughout Balochistan.

Some community grazing lands have reached such advanced stages of overgrazing that they are close to devastation. Under traditional arrangements, local councils of tribal elders determined daily and seasonal flock movements and camp locations within a common range (Buzdar 1989). In the absence of any such institutional arrangement, resource bases suffer from the 'tragedy of commons' phenomenon. Buzdar (1989) mentions that gradual shifts from subsistence-level animal production to commercial activity have further violated community rules of rotational, seasonal movements and camp settlements — a 'modern' phenomenon normally associated with larger, wealthier flock owners. This shift in local community regulations is particularly alarming because, without any additional feed resources, the mounting grazing pressures could induce irreparable biological damage and loss of range vegetation.

Livestock Management

Poor flock management practices by local herders greatly constrain optimal productivity levels. Although small ruminant populations have increased by more than 30 per cent, their share in the Gross Provincial Product has decreased from 40 per cent 1973/74 to 25 per cent in 1982-83 (FAO 1983). The diminishing role of small ruminants — the largest livestock population — is negatively influencing provincial economies. Poor flock management and its impacts upon overall productivity may only truly be realised after learning the intricacies and identifying the problems of existing livestock production systems.

Small ruminant production in Balochistan still follows three main traditional methods: nomadism, transhumant pastoralism, and sedentary animal husbandry. Nomadism has been practised for centuries. Nomadic flock composition always consists of sheep and goats, as well as camels or donkeys. About 30 per cent of the total flocks in Balochistan are raised according to this system (FAO 1983). Nomads do not own any range area and spend summer months (March through September) in northern Balochistan on open rangelands. During winter, flocks are moved down to lowlands where they graze on abandoned agricultural fields. Flocks travel longer distances (i.e., 150-400km) during this time. Consequently, mortality is very high (more than 30%) in young and newborn stock (FAO 1983). Mortality and other production losses in flocks are considerably high when rainfall levels are poor.

Transhumant flocks are owned by agro-pastoralists. Most small ruminants (65% of sheep and 50% of goats) raised in Balochistan are herded according to this system (FAO 1983). These flocks winter and summer in the same areas and never travel longer than 80km in search of pasture. Most flocks rely on free ranges to meet all their nutritional requirements. About five per cent of the sheep and 18 per cent of the goats are managed as sedentary household flocks. Animals are fed from orchards, stubble, and agricultural wastelands and are stall-fed, on some occasions. These flocks are generally found in cultivated valleys.

In general, all of these production systems are inefficient. Incidences of internal parasites and other diseases are very high. As much as 79 per cent of all sheep flocks are infested with such parasites (Khan et al. 1988). Birth rates tend to be very low. Lambing percentages may be as low as 23 per cent (Rafique et al. 1990). By definition of their migrant lifestyles, nomads and transhumant pastoralists are at a disadvantage for marketing and selling their livestock. Heavy economic losses occur as a result of poor veterinary care, marketing opportunities, and management practices, thereby preventing the improvement of local living standards.

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Pastoral Development & Its Relevance to Large Ruminants' Production in Pakistan

Abdul Wahid Jasra
Amjad Saleem

Introduction

Seventy per cent of all farmers in Pakistan are considered 'small farmers', people characterised not only by the size of their land and animal holdings but also by a host of factors that influence their productive potential and income-generating capacity. Livestock raising is an integral component of small farming systems. Large ruminants raised by small farmers in Pakistan include cattle, buffaloes, and camels. Animal husbandry is integrally linked to local cropping systems. Fodder production, for example, is one portion of the annual crop rotation cycle. Large ruminant production systems depend on crop residues, cultivated fodder, fallow, and wastelands to meet animals' nutritional and grazing requirements.

Any rural poverty alleviation programme in Pakistan should focus on improving small farmer livestock holdings and production levels. Some minor progress has been made in this regard, primarily with large ruminant populations. Intensive selection and crossbreeding programmes, the development of cheap feed supplements, and efforts to broaden the gene pools of large ruminants by introducing exotic breeds has significantly altered — and helped improve — traditional production systems. Although a National Breeding Policy for cattle and buffaloes has been outlined, detailed analysis of previous crossbreeding experiments in different agro-ecological regions of Pakistan need to be analysed. The gap between actual and potential productivity levels of native animals remains wide. Interventions intent on closing this gap are required if economic development in Pakistan's farming communities is to be realised.

Profile

Quraishi et al. (1993) reported that about 50 per cent of Pakistan's total livestock lived in Punjab province. Sindh, the North West Frontier Province (NWFP), and Balochistan host 21, 11, and 13 per cent of this total, respectively. The highest populations of cattle (45%) and buffaloes (66%) are found in Punjab, although Balochistan boasts the highest camel population (42% of the country's total).

Tables 1 and 2 illustrate that cattle and buffaloes are the most abundant large ruminants in Pakistan. They are mainly raised in the irrigated flood plains of Punjab and Sindh, rendering their dependence on dry mountain grazing lands negligible. Pakistan's most significant camel population, on the other hand, is found in the dry mountain regions of Balochistan. Effects on agricultural activity and grasslands are significant.

Table 1: Large Ruminant Populations in Pakistan

Province/Unit	1976	1986	1992
Pakistan			
Cattle	14.8	17.5	17.8
Buffaloes	10.6	15.7	18.7
Camels	0.8	0.9	1.01
Punjab			
Cattle	8.1	8.8	
Buffaloes	7.9	11.1	
Camels	0.34	0.32	
Sindh			
Cattle	2.8	3.9	
Buffaloes	1.8	3.2	
Camels	0.14	0.22	
NWFP			
Cattle	3.0	3.3	
Buffaloes	0.8	1.3	
Camels	0.09	0.07	
Balochistan			
Cattle	0.7	1.2	
Buffaloes	0.03	0.06	
Camels	0.2	0.35	
Northern Areas			
Cattle	0.21	0.41	
Buffaloes	0.003	0.003	
Camels	-	-	

Table 2: Large Ruminant Distribution According to Province

Province	Cattle (%)	Buffaloes (%)	Camel (%)
Punjab	50	71	34
Sindh	22	20	23
NWFP	19	08	07
Balochistan	07	01	36
Northern Area	02	-	-

GOP 1988

According to available quantitative data, Pakistan's cattle population is decreasing, while the buffalo population continues to rise. This trend could be partially explained by the fact that cattle used to be bred primarily for draught purposes in cultivated areas. The mechanisation of farming has contributed to the declining cattle population. Similarly, the people of Pakistan tend to prefer buffalo milk to cow's milk. Buffaloes are also more adaptable to riverain land tracts where only coarse fodder is available.

It is estimated that buffaloes and cattle will increase at the rate of 4.0 and 1.8 per cent a year, respectively. Given these growth rates, the buffalo population will reach 27.1 million and the number of cows will total 22.46 million by the year 2000. At present, buffaloes and cows combined are producing 803,000 tons of beef and 16.3 million tons of milk annually. Yet Pakistan's milk and meat products are not sufficient to meet the human population's daily nutritional needs. The daily per capita availability of milk (290ml) and meat (35g) only satisfy about 50 per cent of the total demand. This situation is further aggravated when human and livestock populations are forced to compete for food, given the country's static land resources.

Quraishi et. al. (1993) reported that there were about 4,000 grazing families in Pakistan — eight per cent of the total farming families in the country. About 45 per cent of all families depend on agro-grazing (crop residues etc) to subsist. The remaining 55 per cent rely on rangelands and forest grasslands to feed their animals. Most of the grazing families (40.5%) live in Punjab. Balochistan, and Sindh; each host about 20 per cent of the remaining grazing-oriented families. The majority of these pastoralists is very poor.

Large Ruminants in Pakistan's Mountains

Cattle

Although sheep and goats are the most common livestock kept by pastoralists in the NWFP, Northern Areas, and Balochistan, cattle are common throughout Punjab and Sindh, predominating along river banks and uncultivated plains. Pakistan's plateaus, riverain belts, and deserts all possess distinct cattle breeds. Eight breeds predominate. 'Red Sindhi' and 'Sahiwal' are world-famous dairy breeds that live in irrigated tracts of the Sindh and Punjab provinces, respectively. The *Tharparkar* breed is a dual purpose (dairy and draught) animal found in and around the sandy Thar desert. The *'Bhargnari'* is an excellent heavy draught breed found in Jacobabad district of Sindh and is also a famous breed in the foothills of Balochistan bordering Sindh province. The provincial Government of Balochistan has established a *Bhargnari* cattle farm at Sibi for the development and improvement of this breed. Crossbreeding of this breed with exotic breeds is also being carried out with the aim of creating a superior beef breed in Pakistan. Any significant outcome of this breeding programme may increase the role of *Bhargnari* cattle in traditional economies of poor, rural pastoralist communities in the dry western mountains.

The *Dajal* breed is considered to be an offshoot of the *Bhargnari* breed. These animals are relatively smaller in size and lighter in colour. This breed is found in the southern part of Rod Kohi area (Sulaiman foothills in the districts of D.G. Khan and Rajanpur). Rojhan cattle are medium-sized draught animals commonly found in hilly areas of the Dera Ismail Khan, Kohat, and Bannu districts and in Waziri territory (northern Sulaiman mountain ranges). *Lohani* is a light draught breed found in the Loralai district in Balochistan and D.I. Khan in the NWFP province. *Dhanni* cattle are famous medium-sized draught animals from the Pathowar Plateau (Attock, Rawalpindi, Chakwal, and Jhelum districts, Punjab).

All these mountain breeds are suitable for light draught work typical of mountainous agricultural activities and can survive under harsh environments and poor feeding and management conditions. About 12.6 per cent of the country's cattle depend on agro-grazing. Agro-grazing refers to herding livestock on cultivated lands as well as along water channels, farm roads, canal banks, river banks, etc (Quraishi *et al.* 1993). About 33.4 per cent of the country's cattle depend on range grazing to meet their fodder requirements. Due to increasing mechanisation of farming in Pakistan, draught breed populations are gradually decreasing. Yet this genetic pool should be conserved and their potential for beef production should be explored.

Buffaloes

There are two important buffalo breeds in Pakistan: *Kundi* and *Nili Ravi*. *Nili Ravi* are found in Punjab's irrigated areas, whereas *Kundi* buffaloes dominate the Indus flood plains. Both are very good dairy breeds, contributing more than 70 per cent of the total milk supply to the country's human population. The role of buffaloes in Pakistan's mountainous regions is negligible.

Camels

Camels are found throughout Pakistan, except in high altitude mountain regions. They constitute about two per cent of the country's total livestock. Most camels are found in Balochistan (42%), whereas Punjab and Sindh maintain 27 and 25 per cent of the total population, respectively. The Thal and Cholistan sandy deserts are the largest camel habitats in Punjab. *Tharparkar* and *Nawab Shah* sandy deserts are major camel-producing regions in Sindh.

As many as fifteen breeds of camel have been recognised in Pakistan. These animals are either riding camels or loading camels. *Mahra (Bekaneri)* camels are excellent for riding and found in the sandy desert of Cholistan. *Booja* varieties are racing camels found in Cholistan and Thal. *Brela* camels are common in the cultivated plains of Punjab. *Sindhi* camels are named for the Sindh province. *Kacchi, Mekrani, Brohi* and *Pashin* camels are found in Balochistan.

All of Pakistan's camels are single-humped (*C. dromedarius*). Camels are economical and efficient animals on the arid and semi-arid rangelands of tropical and subtropical Pakistan. A camel is an integral component of most nomadic families in Balochistan and is used for ploughing, drilling, transportation, etc. Unfortunately, very few livestock research and development efforts have focussed on this most useful large ruminant.

Very recently, the National Aridland Development and Research Institute (NADRI) and the Ministry of Food, Agriculture and Livestock (MINFAL) in Islamabad have collaborated with the Arab Centre for the Studies of Arid Zones and Drylands (ACSAD) in Damascus, Syria, in order to establish a Camel Research and Development Network in Pakistan. A workshop was held at Islamabad on November 3, 1996, to assess the status of camel research and development in Pakistan. Experts outlined strategies and recommendations for future courses of action.

Issues and Challenges

The production of large ruminants in Pakistan remains a traditional, subsistence level activity. Major issues and challenges relating to large ruminant development are summarised below.

Low Animal Productivity

Pakistan's livestock produce considerably less than their genetic potential. Numerous factors handicap their productivity. The dairy potential of local cattle and buffalo breeds is much lower than exotic breeds, primarily due to insufficient fodder. The majority of Pakistan's native cattle population (76%) is made up of non-descript draught animals born as a result of unplanned breeding practices. Lactation yields do not exceed 600-800 litres per cow. A lactating buffalo may produce 2,000-2,200 litres of milk per lactation cycle, but the buffalo's total lifetime production levels are very low due to their sub-optimal reproductive efficiency.

Fodder Shortages

The present nutritional state of Pakistan's indigenous breeds indicates that there is acute shortage of animal feed in the country. Animals are suffering from energy and protein deficiencies of up to 40 and 60 per cent, respectively. Animals are getting about 40 per cent less green fodder from pastures and rangelands than they once did; fodder is also as much as 19 per cent deficient in dry roughage. Concentrate deficiencies are far worse, as high as 80 per cent in some farming communities. These fodder and nutrient shortages have a great negative impact on milk production and work performance.

Poor Reproductive Efficiency

The low reproductive efficiency of Pakistan's livestock has precipitated great economic losses for the country's farmers. Late sexual maturity and long calving intervals are two major constraints on reproductive rates. These problems are particularly serious for the dairy industry and for those who are involved in buffalo production. Modern technology aimed at improving productivity and methods of genetic improvement of local breeds remain scarce.

Disorganised Marketing System

Pakistan's cities are becoming overcrowded as a result of large-scale migration from rural areas to urban environments. Consequently, urban demand for livestock products is increasing. In contrast, due to poor communication, transport facilities, and the lack of proper marketing systems, most livestock and livestock products from rural areas are locally consumed, never reaching big cities. More than 90 per cent of the country's livestock are maintained in rural areas. Yet it is estimated that only 25-30 per cent of the milk produced in rural areas of Punjab, for example, is supplied to urban markets. The situation in other provinces is presumed to be similar.

Dairy production and marketing research is marginal, as is training in the proper handling, preservation, and efficient use of milk and meat products. At present, there is no exclusive beef breed of cattle raised in Pakistan. Lack of livestock production extension systems, and demonstrations of new technologies to small farmers further weakens marketing potential.

Improper Veterinary Care

Veterinary services in Pakistan are limited to the public sector and have not been able to effectively protect livestock against various infectious diseases and parasites. Common diseases like Foot and Mouth Disease, Hemorrhagic Septicaemia, Rinderpest, and Enterotoxemia contribute to the low productivity of indigenous livestock. No regular monitoring system for the surveillance of livestock diseases exists in Pakistan.

Lack of Incentives for Improvement

Pakistan's livestock industry has been neglected by the government. Raisers of livestock are unable to shift from primitive techniques to modern livestock production technologies due to lack of incentives, particularly at the small farmer level. The governmental agricultural loan policy does not include loans for establishing village chilling centres to check conversion of surplus milk into *ghee* (clarified butter), nor does it provide economic incentives for small farmers to become involved in feed lot operations or to establish rural livestock farms and veterinary clinics.

All of these problems contribute to the low production levels and poor economic realities of large ruminant pastoral systems in Pakistan.

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Forage and Fodder Development on Rangelands of the Indian Himalayas

Bhag Mal

Introduction

The Himalayas are one of the greatest geographical entities on earth. This diverse mountain range extends over 3,200km from east to west. In the east, the Himalayas begin from the southward bend of the Brahamputra River, extending to the Indus river to the west of Nanga Parbat. Though the width of this mountain system varies at different points, it extends over an axis from the Indo-Gangetic plains to the Kunlun mountains in China. It is believed that the Himalayan system is not restricted to the Indian sub-continent but actually extends further into the European Alpines through the Hindu Kush and the Caucasus (Mani 1994).

The Himalayas have been described as the 'saviour' of the Indian subcontinent. The northern parts of the sub-continent lie along the Tropic of Cancer and, climatically, should be a desert. Due to the Himalayas' influence on temperature and precipitation, however, this area's climate is mild and highly productive. The Himalayas also give rise to monsoon rains. The origin and trajectory of a number of perennial rivers are the major water sources for a large number of people living in India's mountains and adjoining plains.

The Himalayas also support an enormously diverse resource base. However, in recent years the unsystematic overexploitation of these resources has created vast environmental imbalances, disturbing fragile ecosystems and causing ecological degradation, throughout the Himalayan region, including India's rangelands.

Present Status of Forage and Fodder Resources

Animal husbandry is the most important pursuit of India's Himalayan communities. Pastoralism was introduced into these areas centuries ago by Aryan settlers. Gradually, terrace farming came into being and the net area of pastures and other grazing lands began to decline. In many Himalayan communities, climatic constraints only allow farmers to grow a single crop per year. The agricultural products yielded from this one harvest are almost exclusively used for human consumption. Forage cultivation is the farmer's last priority. They have historically depended on free ranges to feed their animals. Such pasture still provides most of the herbage required for raising livestock; crop residues, aquatic vegetation, and tree fodder supplement grasslands and help meet livestock nutritional needs. The lack of cultivated forage and the decline in pasture productivity, however, has resulted in critically low livestock biomass throughout the entire Himalayas.

Eastern Himalayas

The eastern Himalayan region is comprised of nine states: Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, Nagaland, Sikkim, Tripura, and the hilly regions of West Bengal. Out of the total geographic area of 275,000 sq. km., 212,000 sq. km. are located in the hills where arable agriculture is not possible. Agricultural activity is mostly confined to valley basins, plains, and terraced foothills. Thick rain forests cover 63 per cent of the eastern Himalayas. Areas of *jhum* or shifting cultivation occupy about 35 per cent of the hills.

According to one estimate, the east Himalayan states require 22.8 million tonnes of green fodder per year to maintain optimum feeding levels; available fodder meets less than half of this need (Chatterjee and Maiti 1988). Livestock graze on free ranges in forest areas. This activity, over time, has caused heavy forest degradation. Available crop residues exist in inadequate quantities to supplement free grazing. From October to March, forest vegetation dries up. Animal nutritional requirements, particularly for lactating animals, cannot be met by grazing alone.

Native fodder trees are another major source of livestock forage. Rations are substantially supplemented with fodder from trees like *Acer, Aescuwus, Albizzia, Anogeissus, Ailanthus, Bauhinia, Betula, Cedrala, Dalbergia , Erythrina, Ficus, Grewia, Puercus, Ulmus,* and so on. Grasses found in forests at this time are nutritionally poor and may contain only 2-18 per cent of crude protein (Verma 1988). Nevertheless, this is the most common source of fibre and is often collected by pastoralists. On the contrary, high altitude herbage is very nutritious and may contain 17 per cent crude protein.

Central Himalayas

The Central Himalayas is comprised of the Kumaun and Gharwal regions of Uttar Pradesh and occupies an area of 5.15 million hectares. Eighty per cent of the hill population is engaged in agriculture or livestock-rearing. These occupations are complementary to each other, as arable agricultural systems require draught animals for farm labour. Domesticated animals are reared according to sedentary, semi-migatory, or migratory pasture management systems. Fodder cultivation is confined to the outer hills — areas in which a farmer may be able to spare some of his land for forage cultivation. In the middle and higher hills, fodder cultivation is negligible. Livestock graze on sub-Alpine and Alpine pastures during summer and are stall-fed on crop residues during winter. Grassland vegetation in the middle hills is poor becuase of the area's ecology and has been further degraded due to intense grazing pressure. Such pressures have also encouraged soil erosion at a rate of 0.8-1.7 mm per year in the Kumaun Hills (Bartarya and Valdiya 1988).

The total annual fodder availability in the central Himalayas is 8.3 million tonnes (Table 1). Yet the total annual requirement is 22.4 million tonnes (Singh 1995). This huge gap between actual and required fodder levels has led to considerable decline in livestock productivity, thereby questioning the sustainability of local animal husbandry and pastoral management systems. A number of pastoral communities inhabits this area, among whom the *Kumauni(s), Jadha(s), Marchya(s), Kha(s), Bhotia(s), and Khadwal(s)* are the most common. These pastoralists migrate both horizontally and vertically throughout these areas with their herds. Lack of adequate fodder and healthy pasture is threatening the maintenance of such lifestyles.

Table 1: Biomass Availability and Nutritive Value of Sub-Alpine and Alpine Pastures				
Site	Altitude (m)	Green fodder (t/ha)	Dry matter (t/ha)	Crude protein (t/ha)
Himachal Pradesh				
Nurpur	500	20.4	5.1	4.5
Hamirpur	675	20.0	5.0	4.1
Simtoli	1000	15.4	4.8	5.5
Holta	1345	17.8	4.7	5.1
Bundla	1675	13.4	4.9	6.8
Mashobra	2360	8.7	2.9	6.1
Chharabra	2685	8.8	2.5	7.1
Kufri	2915	9.3	2.9	8.9
Kaylong	3515	18.6	5.1	9.8
Jammu and Kashmir				
Dachigam	1900	20.5	6.15	-
Gaobal	2000	10.8	2.7	-
Duksum	2500	29.1	9.3	-
Kralpathri	2500	14.6	3.6	-
Gaomarg	3000	14.7	3.6	-
Drobmarg	3200	10.8	2.1	-
Dagwan	3400	14.0	4.2	-
Uttar Pradesh				
Nainital	1350	28.3	7.2	-
Almora	1550	15.7	4.5	6.5
Sunderdhung	3200	29.3	8.2	-
Gordon	3600	22.6	7.3	9.8
Tungnath	3200-3700	1.6	0.32	-
Baideni Ali	3300-4000	2.5	0.57	-
Rudranath	3250-4200	3.9	1.01	-
Panwalihanthe	3800-4000	2.2	0.44	-

Northwestern Himalayas

The states of Jammu and Kashmir (J&K) and Himachal Pradesh (H.P.) comprise the northwestern Indian Himalayas. This area exhibits a tremendous diversity in topography, climate, soil types, vegetation, and farming practices. The outer hills or 'Siwaliks' support scrub vegetation and the climate is subtropical with harsh summers. The middle hills are the true temperate regions and support predominantly temperate vegetation. Agricultural activity only occurs below 2,000 metres, after which land becomes agriculturally unproductive and rugged. Given these conditions, livestock rearing plays a major role in the local socio-economy. Above the middle Himalayas lie the cold, arid deserts of Lahul, Spiti, and Ladakh. The total area of the J&K state is 138,124 sq. km., of which 4,164 sq. km. is classified as pasture/grazing land. Himachal Pradesh's total area of 145, 000 sq. km. includes 55,600 sq. km. of pastureland.

Complex transhumant grazing systems pervade in these areas and are a means of supplying domestic livestock with enough fodder to survive and be productive. Generally, pastoralists and their herds migrate from the plains and outer hills to alpine areas during the summer, returning to the plains during winter when high pastures are covered with snow. In the entire temperate region, cultivation only occurs from April to September. Winters are harsh. Due to snow cover, it is not always possible to produce a winter crop, even at significantly lower altitudes. As land holdings are very small, farmers tend to only propagate food crops. Fodder is not cultivated at all in the temperate zone, although it is sometimes grown in small quantities at lower altitude temperate regions.

Forest areas and community sub-Alpine and Alpine pastures are the major source of area fodder. These pastures are known by a variety of names throughout the north-western Himalayas. Called *Marg(s)*, *Bahak(s)* or *Dhok(s)* in the J&K regions, such grasslands are known as *Thach* or *Bhugiyals* in H.P. Alpine and sub-Alpine pastures are used by semi-migratory and migratory herders throughout the summer. Under the semi-migratory system, villagers living around 2,000 metres hire a few herders *(chaupan)* who gather village animals and take them to area pastures while animal owners harvest rice husks and dry them for hay. In autumn, fodder trees, such as *Celix, Celtis, Robinia* etc, are lopped and tree leaves are stored for animal consumption during winter. Crop residues (primarily paddy straw) are stacked indoors, generally in the attics of houses, and used as supplementary winter fodder.

Cold-Arid Deserts

The cold arid deserts lie above the middle Himalayas in the Greater Himalayan system and are unique biological entities. This complex geography of large valleys, high mountains, and elaborate plateaus encompasses Ladakh and Lahul Spiti. Both precipitation and vegetation cover are low, the latter not exceeding five per cent of the total area (Misri 1988). Agricultural land is limited to the cultivation of *alfalfa*, naked barley, wheat, buckwheat, and some millet on the banks of lower altitude rivers near Kargil and Leh. The winters are very severe here. In January, temperatures may drop to -40°C. Yet animal husbandry pervades local livelihood systems and is practised up to 5,200 metres (Misri 1994).

Medicago sativa and *M. falcata* are extensively cultivated on small landholdings during summer. Traditionally, farmers only cut crops for fodder once, drying this hay and using it for their livestock during winter. Crop residues are also used extensively to supplement free-range fodder. At areas above 4,000 metres where nomads rear *Pashmina* goats, the herbage production ranges between 12.0 - 18.7 t/ha on area pastures during summer and fall, and becomes more bleak as winter moves in (Misri 1994). The situation gets worse during winter. These grazing areas are treeless and the bushy vegetation is either too thorny or too noxious to be grazed. About 50 species of edible grasses and legumes are found in such regions, but their frequency of occurrence is very low (Misri 1982).

Forage Resource Improvement Prospects

Forage availability throughout the Himalayas is, generally speaking, quite poor. However, research on these topics has been carried out at the Indian Grassland and Fodder Research Institute's Regional Centre in Srinagar, Kashmir, as well as at other research institutions and universities. The results of these investigations have provided answers for most of the existing problems. If the recommendations indicated by such studies are adopted by farmers, pastoralists, and development agencies, the Himalayas could become a highly productive region for livestock.

The improvement of forage resources in the Himalayas implies a simultaneous development of both pastures and cultivated fodder, as both of these resources are used continuously or sequentially across the spectrum of animal husbandry systems. Proposed scientific interventions are listed below.

Pastures

Pastures in the Indian Himalayas are in urgent need of improvement, both in terms of management and quality control. Migration patterns should be shifted to increase time for pastures to regenerate. Drilling or dabbling seeds in existing pastures during the fall has been a successful means of improving free-range fodder and should be encouraged (Misri 1988). Productive species of grass for all regions of the Himalayas have been identified (Singh 1995; Sood *et al.* 1995; and Misri 1988). Proper pasture management would require regular monitoring of pasture health, as well as fertilizer application and resowing, wherever necessary. Before resowing is started, however, it is essential to improve forage resources along migration routes, thereby delaying the arrival of livestock by 30-45 days. This time period will be sufficient for new seedlings to establish themselves. An adequate quantity of legumes (50%) should be sown on pastures to control weeds (Misri 1988).

Pastures and other grazing lands at lower elevations of the lower and middle hills can also be improved in order to substantially increase forage resources. By the adoption of agri-silvipastoral systems in lower altitudes of the eastern Himalayas, financial returns can reach Rs 48,960 per hectare (Anonymous 1984; see Table 2.) Similarly, by adopting proposed scientific interventions to develop forage resources on different kinds of wastelands, production can be increased to up to 72 t/ha (Table 3).

Most farmers in the lower hills enclose their grasslands and harvest grass at the onset of winter when grasses are almost dry. Yet these grasslands should be harvested earlier when vegetation is nutritious and palatable. Such areas should also be fertilized with nitrogen (80 kg/ha). This application can increase production from 1.04 to 1.96 t/ha (Table 4). If fertilizer is applied twice, production can be increased by 2.02 t/ha. Production can be further increased from

Table 2: Economics of Microshed Based Forage Production Systems in the Eastern Himalayas

Economic parameters (Rs/ha)	Dairy farming	Agro-pastoral system	Agri-horti-silvipasture system
1990-91			
Input	23,184	29,675	10,604
Output	37,384	50,882	20,943
Net returns	14,200	21,207	10,339
1993-94			
Input			
- with livestock	45,030	38,201	11,406
- without livestock	-	17,366	9,197
Output			
- with livestock	93,992	78,692	24,468
- without livestock	-	31,942	13,120
Net returns			
- with livestock	48,960	40,490	13,061
- without livestock	-	14,575	3,922

Source: Anonymous (1984-94)

Table 3: Forage Production Potential from Different Land-use Systems in the Low and Middle Hills of the Eastern Himalayas

	Land Use	Forage production system	Green forage yield (t/ha)
1	Permanaent pastures/ wastelands/ degraded lands	Silvi-pasture grassland	15.6-51.6 42.1-74.6
2	Current fallow	Seasonal forage crops	25.0-54.0
3	Alternative land, i.e., terrace risers/terrace bunds	Perennial grasses and legumes stylos Fodder trees grasses	40.4-60.0 2.8-5.0 5.7-8.3 c/1000 rm
4	Horti-pasture	Seasonal forage crops/ perennial grasses and legumes	12.5-15.7
5	Watersheds	Perennial grasses	40.0-65.0
6	Dairy farms in watersheds	Silvi-pasture	3.7-72.0
7	Bamboo plantations	Orchard, Nandi, Deenanath grass and Stylo	3.3-38.3

Source: Singh et al. 1993

Table 4: Effect of Fertilizer Management on the Productivity of Mid-Hill Grassland in the Central Himalayas

Treatment	Fresh forage yield (t/ha)
Fertilizer application (N kg/ha)	
- 0	1.04
- 40	1.52
- 80	1.96
N application pattern	
- Basal	1.47
- Two splits	2.02

Source: Singh, V 1995

Table 5: Effect of Fertilizer Application on the Green Herbage Production of Natural Grasslands in the Central Himalayas (t/ha)

Nitrogen	Phosphorus			Average
	P_0	P_{30}	P_{60}	
N_0	1.77	2.31	3.22	2.43
N_{30}	3.42	4.27	5.26	4.32
N_{60}	4.69	5.51	7.02	5.74

Source: Melkania 1995

1.77 to 7.02 t/ha by applying 60 kg/ha of both nitrogen and phosporous (Table 5).

Wastelands can be turned into very productive ranges by introducing and establishing new species. Yield potentials of various species have been documented by Melkania and Tandon (1989) and are presented in Table 6. Between 13.10 and 53.29 t/ha, fresh fodder can be obtained from these wastelands. Similarly, studies of the introduction of pigeon peas on natural grasslands (Sharma and Sood 1994) indicate that green fodder yields decrease slightly from 10.4 to 9.6 t/ha, while dry matter yields increase from 3.1 to 3.2 t/ha with the addition of 0.62 t/ha of local pigeon peas (Table 7).

Table 6: Yield Potential of Established Grasslands in the Middle Hills of the Central Himalayas

Grassland type	One cut/yr green T/ha	Two cuts/yr green T/ha
Panicum coloratum	50.62	53.29
Digitaria sp	25.76	35.97
D. decumbens	26.64	33.21
Brachiaria mutica	39.08	28.41
Cynodon plectostachys	19.54	21.76
Panicum repens	32.86	20.41
Chloris gayana	15.10	13.10

Souce: Melkania and Tandon 1989

System	Green fodder yield (t/ha)	Dry fodder yield (t/ha)	Grain yield (t/ha)
Natural grassland	10.4	3.1	-
Natural grassland + pigeon pea	9.6	3.2	0.62

Table 7: **Yield Increase in a Natural Grassland by the Introduction of a Food Crop in the Western Himalayas (average: 3 years)**

Source: Sharma and Sood 1994

Forage Crops

A number of intensive forage production rotations yielding year-round fodder has been established (Table 8). These rotations can provide 79.2 to 129.9 t/ha of green matter and 15.3 to 25.3 t/ha of dry matter. The economic returns from these rotations range between Rs 14,754 and Rs 26,995. Similarly, by growing berseem, oats, or these two crops in combination and on a rotational basis with *Kharif* crops, crops can yield 52.8 - 89.2 t/ha green forage and 12.0 - 17.5 t/ha dry matter, while protein yields range between 1.75 - 270 t/ha (Table 9). Production can be greatly increased by scientifically managing a *Kharif* crop such as maize, grain, green forage, and stover. Traditional maize cultivation systems, however, provide only 4.6 t/ha of grain and 9.8 t/ha of stover. With the application of nitrogen fertilizers, a green forage cut can be imposed 60 or 75 days after sowing; later, the crop can be harvested for grain. Nitrogen application also maintains stover availability (Table 10). Similar findings have been found in relation to a number of other crops like *Sorghum*, *Pennisetum*, *Cowpea*, etc. Tremendous potential exists throughout the entire Himalayan belt for the cultivation of forage; but farmers must be motivated to integrate forage production into present cropping systems.

Table 9: **Forage and Crude Protein Yield under Intensive Forage Production in the Western Himalayas**

Crop	Fodder yield (t/ha)		Crude protein yield (t/ha)
	Fresh	Dry	
Berseem	58.6	12.0	2.32
Oat	52.8	12.9	1.75
Oat + Berseem	89.2	17.5	2.70

Source: Sood and Dahal 1993

Alternative Land Use for Forage Cultivation

In India's hill areas, shortages of cultivable land always limit fodder production potential. Efforts have been made to grow fodder on land such as the barren spaces between orchards. These are excellent sites for forage production — particularly in re-

Table 8: **Forage Yield and Economics of Different Intensive Forage Crop Rotations in the Western Himalayas (average: 5 years)**

Crop rotation	Forage yield (t/ha)		Economic returns (Rs/ha)
	Fresh	Dry	
Maize + Cowpea - Berseem + Oat	94.2	20.1	18,252
Teosinte + Velvet bean + Oat + Peas	79.2	15.3	14,754
NB Hybrid + Velvet bean – Berseem + Mustard	129.9	25.3	26,995
NB Hybrid - Turnip - Oat + Vetch	86.1	17.4	15,212
Setaria + Soyabean – Berseem	83.6	17.8	17,778
Maize + Velvet bean - Lucerne + Berseem	85.4	15.8	16,537
Sorghum + Cowpea - Berseem + Mustard	86.3	17.8	17,124

Source: Sood and Bhandari 1987

Table 10: **Grain, Fresh Fodder, and Stover Yield of the Maize Crop System in the Western Himalayas**

Treatment	Grain yield	Fresh fodder yield (t/ha)	Stover yield
Nitrogen application (kg/ha)			
90	3.4	18.9	8.8
112	3.9	21.2	9.5
135	4.2	22.6	9.9
Harvesting stages			
60 DAS	3.8	18.9	9.4
75 DAS	3.2	22.9	9.0
Traditional System	4.6	-	9.8

Source: Sood 1991

gions where cultivable land is in short supply. Green forage yields can reach 1.148 t/ha by planting various perennial grasses and legumes in orchards (Tables 11 and 12). Terrace risers occupy a lot of space in hill farming. Up to 15.04 t/ha of forage can be produced on these sites with active cultivation efforts. Under natural conditions, these terraces provide only 1.23 t/ha of biomass (Table 13).

Table 11: **Fodder Production Under Horti-pasture System in the Western Himalayas**

System	Green forage yield (t/ha)
Orchard grass + Red clover	42
Rye grass + Red clover	48
Brome grass + Red clover	39
Timothy + Sub clover	35
Fescne	6.7
Orchard	3.1
Rye	2.1
Natural vegetation	1.1

Source: Misri 1986, Sharma and Jindal 1989

Table 12: **Production Potential of Hortipasture in the Central Himalayas (Apple Orchards)**

Pasture sp	Green forage yield (t/ha)
Red clover	2.6
White clover	2.4
Lucerne	2.5
Perennial rye grass	3.1
Orchard grass	2.7
Canary grass	2.1
Barren orchards	1.8

Source: Singh 1995

Table 13: **Terrace Risers: A Potential Site for Forage Production in the Central Himalayas**

Species planted on terrace risers	Grain yield t/ha)		Forage yield (t/ha)
	Rice	Wheat	
Nandi grass	1.04	1.14	10.8
Guinea grass	1.01	1.16	10.3
Hybrid napier	1.08	1.21	15.04
Rhode grass	0.98	1.04	9.88
Indian couch grass	0.85	1.02	8.62
Natural vegetation	0.56	0.98	1.23

Source: Bhatnagar and Kundu 1992

Hill farmers generally believe that nothing can be grown under the canopy of coniferous trees. Studies undertaken in Almora, however, suggest that various forage species can be grown under both pine and deodar trees providing green forage yields between 14.0 and 13.66 t/ha, respectively (Table 14). Fallow winter lands are another potential source of land for forage cultivation. Green forage yields up to 69 t/ha can be obtained from these areas (Table 15).

Conclusion

The ecology and agricultural potential in the Indian Himalayas are unique onto themselves. Natural factors, such as altitude, cli-

Table 14: Yield Performance of Perennial Grasses Grown under Coniferous Tree Canopy in the Western Himalayas

Grass species	Green forage yield (t/ha)	
	Pine trees	Deodar trees
Pangola	14.01	13.66
Rhodes	4.78	3.06
Para	0.4	2.06
Guinea	0.41	2.04
Kikyu	-	6.42
Natural veg.	0.25	0.22

Source: Koranne and Singh 1989

Table 15: Forage Production Potential of Winter Fodder Crops in the Westen Himalayas

Crop	Fertilizer requirements (kg/ha)	Green forage yield (t/ha)
Berseem	90 P	50
Triticale	90 N	37
Vetch	120	45
Barley	90	35
Oats	90	52
Turnips	60 N + 60 P	69

Source: Misri 1988

mate, soil, and others, are dynamic throughout the entire Himalayan system, thereby affecting production and sustainability of agricultural systems. Pastures, particularly in sub-Alpine and Alpine regions, are areas of climatic climax. Production in these areas can be sustainable only if management and overall rangeland quality are improved. Efficient grazing systems should be established. Areas should be constantly monitored and maintained. Appropriate stocking rates should be determined. Herd size could be reduced substantially if the forage resource base at lower altitudes is strengthened, thereby making individual animals more productive.

Technologies for achieving higher biomass from natural and cultivated forage resources are available in India and should be adopted by communities living in the Indian Himalayas. In order to facilitate the adoption of such technologies and further increase forage production levels, suitable grazing systems need to be developed. Appropriate grass-legume mixtures should be determined and a variety of high-yielding trees and bushes should be introduced. Likewise, improved varieties of pasture and grass species should be bred. Technology transfers and on-farm adaptive trials should be executed. Adequate quality grass and legume seed should be produced and made available to local people. Finally, the socioeconomic components of India's pastoralists should be studied, understood, and incorporated into development programmes.

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Forage and Pasture Development and Forage Seed Production in Nepal

Rameshwar Singh Pande
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Introduction

Forage and pasture development is a new intervention for rural communities in Nepal. Before 1980, forage cultivation was confined to government farms and only 36 hectares of crop land were under forage cultivation. The primary limiting factor for forage and pasture development in Nepal is the conventional belief that livestock thrive on natural vegetation and crop residues. Yet the rising human population and improved living standards have increased the demand for various livestock products and high-yielding animals that require a high quality and quantity of fodder and sustainable management systems.

Currently, cultivated forage and pasture lands are the major sources of inexpensive, good quality feed for livestock. With the improvement in livestock breeds and farming systems, forage cultivation and pasture land improvement initiatives have significantly increased in Nepal. Presently, over 2,000 hectares of crop land are cultivated annually for forage production. Despite this significant achievement, pastoral development continues to occur slowly, hardly offsetting the severity of the country's feed deficit situation. One of the major limiting factors for the development of fodder and pasture production in Nepal is the availability of quality seed.

Forage and Pasture Development Activities in Nepal

Nepal's national forage and pasture development records date back more than 150 years. Forage and pasture development programmes were first initiated by the Rana Prime Minister in 1860. He introduced white clover seed into the Kathmandu Valley after visiting England. Now, white clover is well-naturalised and growing as a weed throughout Kathmandu Valley. In 1952, FAO conducted a study on forage and pasture development which formed the basis for development activities. During this time, several cheese factories were established in high altitude regions such as Rasuwa and Dolkha districts. Forage and pasture development programmes were carried out in the vicinity of these cheese factories.

In 1970, the Ministry of Agriculture established the Fodder and Pasture Centre at Khumaltar and Rasuwa. The FAO-funded Trisuli Watershed Project in Rasuwa and Nuwakot and the Swiss Aid Multipurpose Agricultural Centre Programme were simultaneously established. The ADB-assisted Livestock Development Project (LDP) commenced in 1980 and continued until 1994. This project aimed to develop forage crops specifically for the *Terai* and mid-hills. The project is now entering a third phase.

In 1983, the governments of Nepal and the People's Republic of China signed a treaty regarding the trans-frontier pasture areas in Mustang, Dolpo, Langtang, Humla, Khumbu, and Walangchung Gola. This project aimed to slowly phase out the transhumant movement of livestock herds from Nepal to Tibet (China) and vice versa. In order to help local people adjust to this change in migration patterns, Nepal implemented a 10-year 'Northern Belt Pasture Development Programme' (NBPDP) in high altitude districts bordering the Tibetan Autonomous Region, China. During this same period, FAO-funded a project to strengthen the Northern Pasture Programme. Similarly, the FAO Himalayan Pasture and Fodder Research Network was implemented throughout the Hindu-Kush Himalayas.

The Department of Livestock Services (DLS) is the sole government institution responsible for implementing forage and pasture development activities in Nepal. In 1994, a Pasture and Animal Nutrition Development section of DLS was established to plan, implement, and monitor forage and pasture development activities.

Forage and Pasture Development Trends

A few years ago, most of the seed required for domestic use was imported from India, the United Kingdom, U.S.A., New Zealand, Australia, Canada, Egypt, and Bhutan. Over 12 tonnes of forage and pasture seed were procured between 1980 and 1992, primarily by the above-mentioned FAO-funded projects and the ADB-funded Local Development Programme (LDP). These seeds were distributed to farmers and used for pasture development. Over 162 species and 371 cultivars of grasses and legume species were introduced and tested in Nepal through this initiative (Pande 1993).

Forage and pasture development activities have gradually increased since the 1980s. In 1980-81, only 36 hectares were under forage crop cultivation — most of which were located within government farms. Another 177 hectares of rangelands were improved by various means such as oversowing with exotic pasture species, constructing pasture paths, and building drinking water facilities for livestock, particularly around cheese factories. Since then, over 2,000 hectares of land have been transformed into different forage crops each year. Similarly, over 7,242 hectares of high altitude pastureland have been developed. Presently, the area under forage crop cultivation on private land is negligible. Only 0.05 per cent of all agricultural land in Nepal is used for forage cultivation. Similarly, only 0.4 per cent of native pastureland is developed for forage. Forage crop cultivation and pasture land improvement trends are presented in Table 1.

Role of Government Organizations, NGOs, and INGOs

At present, nine government farms (under DLS) are directly or indirectly involved in forage and pasture development activities.

Table 1: Area Under Forage and Improved Pasturelands

Fiscal Year	Forage Crop Cultivation (ha)	Pasturelands Improvements (ha)
1980/81	36	177
1981/82	139	175
1982/83	532	289
1983/84	407	371
1984/85	446	250
1985/86	329	898
1986/87	415	73
1987/88	330	898
1988/89	697	919
1989/90	880	853
1990/91	1061	1025
1991/92	1000	652

Four farms are located in the *Terai*; two farms are located in the hills, and three are situated in the mountains (Table 2). These specific farms are involved in forage and pasture development activities, producing a small amount of forage and pasture seed for their own consumption, whereas other farms are carrying out forage and pasture development as secondary programmes. Only surplus seed is sold to farmers.

In addition to DLS farms, different Forage and Pasture Research Stations exist under the auspices of the Nepal Agricultural Research Council. These include the National Pasture and Grassland Research Centre, Khumaltar, Lalitpur; the Regional Pasture Research Centre, Dhunche, Rasuwa; the National Sheep Research Centre, Jumla; the Agricultural Research Centre, Pakhribas; and the Agricultural Research Centre, Lumle. A reasonable amount of forage and pasture seeds is produced in these locations and available for distribution. In 1994-95, a total of 54 tonnes of forage seeds was produced in Nepal, 45 per cent of which are produced by farmers, and 52 per cent by government farms (Tables 3, 4 and 5).

Although the DLS is the primary governmental institution involved in pasture and forage development, many government and non-government organizations are involved in such activities in Nepal. The Nepal Agricultural Research Council is responsible for carrying out and studies on forage and pastures. The Institute of Agriculture and Animal Science, Rampur, the Institute of Forests, and the Department of Forestry and Soil and Water Conservation are all involved in forage and pasture development. NGOs and INGOs participating in such work include ICIMOD, King Mahendra Trust, ACAP, and SNV.

Role of the Private Sector

Forage and pasture development programmes in Nepal have tended to be successful when run in conjunction with dairy industries. In the milk shed areas around Janakpur, Bhairahawa, and Chitwan, forage cultivation (particularly during winter) is widely practised. In certain areas of Janakpur, Palpa, and Dang, forage seed production has become quite popular.

The primary forage crops cultivated by farmers are oats, vetch, berseem, stylo, and molasses. A reasonable amount of teosinte and lab-lab are also grown as summer crops. Similarly, perennial crops like napier, para, and broom are widely grown in the

Table 2. **DLS Government Farms Involved in Forage/Pasture Seed Production**

Region	Name	Major forage species
Terai		
1	Forage Development Farm, Janakpur	Berseem, Saftal, Oats Toesinte, Napier, Para Oats,
2	Forage Development Farm, Ranjitpur	Maize, Stylo Centro, Seratro, Kudzu Teosinte, MP
3	Forage Development Farm, Gaughat, Banke	Chari, Oat Joint Vetch
4	Forage Development Farm, Geta, Dhangadhi	Oats, Napier
Mid Hills		
1	Livestock Dev. Farm, Pokhara	Teosinte, Oats
2	Seed Dev. Farm Chitlang, Makwanpur	Oats, Paspalum
Mountains		
1	Livestock Dev. Farm, Jiri	Oats, Paspalum, Rye grass
2	Livestock Dev. Farm, Solukhumbu	Local grass, Phurcha
3	Livestock Dev. Farm, Panchasaya Khola	Oats, Paspalum

Table 3: **Seed Production at Government Farms, 1994/95 (2051/52)** (in kgs)

Name of the Farms	Oat		Vetch	Berseem	Kudzu	Lab-lab	Teosinte	Saftal	Joint vetch	Rye grass	Paspalum	Stylo	White-clove	Centro	Seratro	Des-modium
	Kent	Swan														
Fodder Dev. Farm, Janakpur	3250	-	300	3630	-	-	-	100	50	-	-	-	-	-	-	-
Fodder Dev. Farm	3339	3314	317	-	337	329	1610	-	-	-	-	400	-	50	50	-
Livestock Dev. Farm	1200	-	-	-	-	-	1750	-	-	-	-	-	-	-	-	-
Livestock Dev. Farm	2080	-	-	-	-	-	-	-	-	292	203	-	-	-	-	-
Livestock Dev. Farm	1700	-	-	-	50	-	1500	-	200	-	-	50	-	-	-	50
Sheep Dev. Farm, Chitlang	400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sheep Dev. Farm, Panchasay	400	-	-	-	-	-	-	-	-	-	100	-	-	-	-	-
Yak Farm, Solukhumbu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sheep Dev. Farm, Dhangadhi	1000	-	-	-	-	-	200	-	-	-	-	-	-	-	-	-
NARC, Rasuwa	300		-	-	-	-	-	-	-	-	-	-	10	-	-	-
NARC, Khumaltar	300	-	-	-	-	-	-	-	-	150	-	-	-	-	-	-
Sub-total	13969	3314	617	3630	387	329	5060	100	250	442	303	450	10	50	50	50

Table 4: **Seed Production at PFDP (FY 1986/87 to 1994/95)** (in kg)

FY	Stylo	Molasses	Desmodium	Total
1986/87	92.0	5.0	5.0	102.0
1987/88	194.0	44.0	83.5	321.0
1988/89	176.0	38.0	11.0	225.0
1989/90	386.5	166.5	15.3	568.3
1990/91	228.0	115.0	30.0	373.0
1991/92	181.8	152.3	24.3	358.4
1992/93	210.0	180.0	-	390.0
1993/94	350.0	250.0	-	600.0
1994/95	700.0	500.0	-	1200.0

Terai and the Middle Hills. Seeds are produced by private farmers, primarily for individual family consumption. Traditionally, seeds are only sold if surplus exists. However, due to increased demand for forage seed and the high profit it yields, many farmers are now beginning to cultivate seed. At present, over 20 districts are emerging as sources of different forage and pasture seeds.

Table 5: **Seed Production Record 1994/95 (2053/53)** (in kg)

Species	Govt. Farm (kg)	Private Sector (kg)*	Total
Winter Crop			
Oat	17,283	19,464	36,747
Vetch	617	305	922
Berseem	3,630	3,200	6,830
Saftal	100	-	100
Summer Crop			
Teosinte	5,060	654	5,714
Lab-lab	329	-	329
Velvet bean	-	25	25
Pasture			
Rye grass	442	-	442
Paspalum	303	-	303
wt clover	10	-	10
Stylo	450	824	1,274
Molasses	-	516	516
Perennial A			
Kudzu	387	-	387
J. vetch	250	-	250
Centro	50	-	50
Seratro	50	-	50
Desmodium	50	-	50
Perennial B			
Napier	NA	NA	-
Para	NA	NA	-
Broom	NA	NA	-
Fodder Tree			
Ipil-ipil	210	NA	210
Total kg	29,221	24,988	54,209
Per cent	53.9	46.1	100

Contribution of Farmers' Associations

In order to effectively implement their fodder development programmes, DLS has launched a Users' Group (UG) campaign throughout the country. Various UGs have been formed in response to local interest and motivation. Some of these include Forage Development Groups (*Ghans Bikas Samuha*) and Forage Seed Production Groups (*Biu Utpadan Samuha*). These UGs have emerged as potential seed producers, particularly in Palpa and Dang.

The Forage Development Group in Palpa has formed the Palpa Forage Development Association - 2050, a registered local NGO. The farmers have been involved in stylo and molasses' grass seed production since 1984. Presently, the Palpa Forage Development Association is producing over 700kg of stylo seed and 500kg of molasses' seed annually. In addition to seed, stylo and molasses are a good source of fodder for livestock and are sold to the members of the Association.

Forage cultivation and seed production in Palpa is relatively new. Stylo and molasses' production began in 1980-81 through the Department of Livestock Services under the Tinau Watershed Project funded by HELVETAS. Seed was brought from Australia and about seven hectares of community land from Pokharathok

Village Development Committee were cultivated with stylo and molasses. Cultivation was successful and gradually expanded. Presently, over 175 hectares of afforested land are being cultivated with stylo and molasses. About 50 hectares of this land are used for stylo and molasses' seed production. This project is managed by 17 Farmers' Groups comprised of more than 541 farm families.

Stylo and molasses are not only good forage crops, but are also excellent for soil conservation. Stylo, a leguminous crop, fixes nitrogen and improves soil fertility; it is also hardy and performs well in unfertile soil and afforested areas. As stylo is perennial, once it establishes itself, it thrives. Stylo and molasses can be successfully grown at altitudes of up to 2,000 metres. Under Palpa's ecological conditions, these crops produce 20 tonnes of green matter/ha and up to 66kg seed per hectare. When management practices are optimised, however, 33 tonnes of green matter and up to 230kg of seed can be produced per hectare.

Forage and pasture seeds are expensive. The price of stylo seeds ranges from Rs 250 (threshed) to Rs 350 per kg (picked), molasses' seeds cost Rs 200 per kg. The Department of Livestock Services fixes prices in consultation with the UGs, respective farms, and Chief District Officers (CDOs). The Palpa Forage Development Association is earning over three hundred thousand* rupees each year from the sale of seeds alone. Last year, stylo was being sold on the black market for up to Rs 1,200 per kg.

The present stylo and molasses' seed production programmes are good sources of income generation, particularly for women and young children as they do most of the planting, harvesting, and threshing work. Earnings from the sale of seeds provide women with their own funds, called '*pewa*'. The plantation of stylo and molasses has also significantly reduced female workloads. Time previously spent collecting fodder can now be devoted to other activities. The Association deducts about 10 per cent of the profits earned from seed sales and deposits this money into a revolving fund. These pooled resources are then used for the construction of drinking water tanks, school building maintenance, trail construction, and other community activities.

Palpa's success has begun to be replicated in other areas. For example, stylo production was introduced into Dang in 1990-91, particularly to aid soil and water conservation. Presently, various Farmers' Group are involved in fodder cultivation and seed production in Dang. Similarly, in the *Terai*, successful berseem seed production has begun. Over eight megatons of berseem seed is now produced annually in Dhanusha, Mahottari, Sarlahi, Banke, and Dang districts. The government price of berseem seed is Rs 65 per kg. Oats, vetch, and teosinte are also grown for seed production.

Scope of Forage and Pasture Seed Production in Nepal

Many fodder seeds have potential for cultivation in Nepal. Berseem is suitable for the southern belt of the country, including the Dhanusha, Mahottari, Sarlahi, Banke and Dang districts — areas with adequate irrigation facilities. It is estimated that about 0.2 million hectares of paddy land could be used for berseem seed production in these districts, thereby producing a mini-

* There are currently approximately 63 Nepalese rupees to the US Dollar

mum of 40,000MT of seed per year (Pande 1995). Stylo seed has been successfully produced in Palpa, Dang, and Makwanpur up to altitudes of 1,500m. Seed production of oats, vetch, and teosinte has been successful in the *Terai* and middle hills. Temperate pasture species such as white clover, rye grass, cocksfoot, and paspalum grow well in Rasuwa, Mustang, Jiri, and Dolpa. Some native species found in temperate mountainous zones (*Elymus nutans, Pennisetum flaccidum*, and *Medicago falcata*) have potential for seed production.

Nepal is now trying to become self-sufficient in tropical forage seed production, particularly for berseem, oats, stylo, and molasses. Yet production levels of temperate pasture seeds are far lower than domestic demands. In 1994-95, forage seed production reached 54 tonnes, 54 per cent of which was produced on government farms; farmers only contributed 46 per cent. Twenty species of forage and pasture seeds are produced on government farms. In contrast, farmers only grow six species for seed: oats, vetch, berseem, teosinte, stylo, and molasses. Oats and beerseem are the most popular seeds, contributing 68 and 13 per cent, respectively, to overall private seed production. In addition to these plants, a wide range of perennial forage species (napier, para, broom, setaria etc) is grown both on government farms and by private farmers.

Nepal has a forage and pasture seed deficiency of 38 per cent according to the DLS. If demands for seed dictated by INGOs and NGOs working in Nepal are included, this deficit percentage would significantly increase. Currently, the winter fodder seeds available meet only 57 per cent of the seed necessary to implement activities proposed by the DLS for 1995-96. Similarly, there is a 40 per cent deficiency of temperate pasture seeds (Table 6). Despite these deficiencies, stylo and molasses seeds are, ironically, in surplus. Old stock of these seeds is stored in the PFDP at Palpa.

The DLS target for Forage 'Mini-kit' Distribution in 1995-96 is 24,110 metric tonnes. It is assumed that about 25 per cent (6,027 packets) of the mini-kits will be berseem,

Table 6: Demand and Supply Situation of Forage Seed 1995/96: (2053/54) (kg)

Species	Available	Demand	Balance
Winter Crop			
Oats	36,747	54,431	-17,684
Vetch	922	16,937	-16,015
Berseem	6,830	6,407	+423
Saftal	100	-	+100
Sub-total	44,599	77,775	-33,176
Summer Crop			
Teosinte	5,714	5,714	0
lab-lab	329	329	0
Velvet bean	25	25	0
Sub-total	6,068	6,068	0
Pasture A			
Rye grass	442	570	-128
Paspalum	303	570	-267
White clover	10	760	-750
Sub-total	755	1,900	-1,145
Pasture B			
Stylo	1,274	760	+514
Molasses	516	380	+136
Sub-total	1,690	1,140	+550
Perennial			
J. vetch	250	250	0
Kudzu	387	387	0
Centro	50	50	0
Seratro	50	50	0
Desmodium	50	50	0
Sub-total	787	787	0
Perennial B			
Napier	NA	-	-
Para	NA	-	
Broom	NA	-	
Ipil-ipil	210	-	
Total kg	54,209	87,670	-33,461

70 per cent (16,877 packets) will be comprised of oat and vetch, and the remaining five per cent (1,206 packets) will be made up of other crops. The berseem mini-kit contain one kg of berseem seed with rhizobium. The oat mini-kit contains three kg of oats and one kg of vetch seed. Other mini-kit packages contain one kg of seed. The total seed requirements to produce these mini-kits is as follows: 6,027kg of berseem; 50,631kgs of oats; 16,877kg of vetch; and 1,206 kgs of other seed varieties - including joint vetch (*kudzu*), centro, seratro, desmodium, etc.

DLS has decided to target 353 hectares of farmers' land as potential winter forage development sites. Twenty-five per cent of this land will be covered with berseem and 75 per cent will be sown with oats and vetch. Similarly, the DLS has planned to develop about 379 hectares of native pasturelands for fodder development. About 50 per cent of this land will be located at high altitudes, while the remaining land will be cultivated at lower elevations. Seven hundred and sixty kg of white clover and 1,140kg of rye grass or paspalum will be needed to seed high pastures. Lower altitude pastures will require 760kg of stylo and 380kg of molasses.

To meet Nepal's growing demand for forage seeds, various private agencies are importing seeds from India. Yet they are generally poor in quality and not suitable for Nepal's growing conditions. Domestic forage and pasture seed production is increasing, however, especially in the milk-shed areas of the *Terai* and middle hills where dairy farming has been successfully adopted by farmers. Similarly, awareness of rangeland improvement issues is increasing in higher altitude areas near cheese factories.

Government Policies and Programmes

The Government of Nepal has been promoting forage and pasture development in a variety of ways. Government agencies such as DLS have helped with the production of forage crops and seeds, as well as the supply of planting materials, quality control, and facilitating marketing and distribution of seeds and planting materials. The DLS and other agencies have been promoting forage and pasture production by distributing forage mini-kits and fodder trees to farmers, supplying vegetative materials for perennial forage crops, implementing native pasture improvement projects, developing silvi-pastoral and agro-forestry incentives, and establishing forage nurseries and forage seed production resource centres. The government has also been organizing training for farmers and supplying technical staff in relevant fields, as well as publishing leaflets, booklets, and extension materials related to rangeland development.

DLS has also been registering forage seed producers and establishing rural seed banks. Farmers who could potentially produce fodder seed are registered through this orgainzation. These farmers are then given the necessary technology and resources for quality seed production. Similarly, Users' Groups help establish rural forage seed banks for which DLS provides technical and financial support of up to Rs 3,000 (US$ 50). This money, once matched by local UGs, is deposited in a revolving fund. Such endeavors have encouraged the successful propagation of berseem and oat crops. However, in temperate environments, pasture crops are limited by the availability of land for pasture seed cultivation. The implementation of all of these programmes depends on strong people's participation

DLS has fixed the minimum germination percentage of different types of seeds and their purity standards through HMG's Nepal Seed Board in order to control seed quality. DLS has fixed prices of these items after consulting respective government farms, farmers' representatives, and Chief District Officers in order to regulate seed prices and the costs of planting materials (see Annex 2).

Major Limitations and Constraints

Subsistence-oriented Production

Most of Nepal's farmers are subsistence-oriented producers. Farmers grow a variety of crops in relatively small amounts to support their families. Specialisation or commercial production of crops, especially forage seeds, is not part of traditional farming systems. Farmers involved in forage production grow some seeds for future use and only sell their surplus when available.

Farmers are primarily concerned with growing crops for domestic consumption. Any changes in traditional farming systems affect food supply. Many winter and summer forage crops compete with food crops such as wheat and maize. Consequently, most farmers are reticent to grow fodder on valuable and scarce cultivable land.

Seed Quality

Most of the seed produced on government farms and by individual farmers is of poor quality. Similarly, berseem seed imported from India has been reported to include many weed seeds.

Training and Skills

Forage and seed production is highly specialised and requires trained manpower — skills that are lacking at both government and private, local levels. Government staff need to be trained in quality founder-seed production, breeding, and processing, while farmers should be trained in the production of grower seeds, quality control, harvesting, processing, and proper seed storage.

Forage Seed Production and Distribution

There is no organized programme in Nepal for the production and distribution of forage seed. DLS and other organizations involved in the promotion of fodder and pasture development activities are more concerned with promoting production levels than the marketing aspects of such endeavours.

A large quantity of forage seeds is imported from India, particularly from Sitamathi, Bihar, and Gorakhapur, U.P. It is estimated that about 800-1,000kg of berseem and 300-5,000kg of oat seeds are brought from India and sold throughout Nepal. These seeds are less expensive than locally produced seed, though the quality is low.

Recommendations

Forage seed production programmes should be well organized. A national-level institute responsible for the production, processing, quality control, and marketing mechanisms of fodder seed should be established. Forage production (including seed/planting materials) should be promoted as a potential source of income generation, particularly for rural farmers. Export possibilities, particularly to other SAARC countries, should be explored. A specialised farmers' association should be formed for this purpose. Old seed stocks at government farms should be immediately replaced with high-quality seeds supplied by registered seed growers in order to maintain variety, purity, and high seed production levels.

Government and non-government efforts should be directed towards the extensive use of fallow crop lands for forage cultivation to solve winter feed deficits and improve soil fertility. Farmers involved in forage seed production should be trained in quality seed production and processing. Farmers in seed production districts should be provided with the necessary equipment for seed processing and quality control. Rules and regulations to control the quality of seeds produced should be amended by the agencies concerned.

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Forage Resource Development on Degraded Land in Nepal: A New Approach

Dinesh Pariyar

Introduction

Rangeland development was introduced into Nepal in the late 1950s with the establishment of yak and yak hybrid cheese factories in several mountainous regions of the country. At that time, research and development efforts stemmed from species' evaluation and forage production programmes carried out at the Singha Durbar Livestock Farm between 1953-1959. Perennial, short rotational rye grasses were studied in combination with white clover imported from New Zealand particularly for pasture improvement.

Pastoral development programmes brought in by INGOs, NGOs, and government agencies began in 1970. In the early 1980s, the government also introduced the Northern Areas' Pasture Development Programme (NAPDP). This project attempted to offset the fodder crisis facing most of Nepal's northern districts after access to the Tibetan pasture — part of traditional transhumance patterns — was curtailed and the Nepal/Tibet border was closed. The NAPDP concluded in 1992, however, and forage/pasture development became the responsibility of District Agricultural Development Offices. In 1995, the Department of Agriculture and Livestock Services was created and pasture development activities again shifted hands. They are now under the jurisdiction of District Livestock Offices and the Department of Livestock Services (DLS). These frequent organizational changes have weakened forage and rangeland development activities and research and development networking has been inconsistent.

A comprehensive range of fodder and pasture improvement materials (seed, rootstock, etc) has been imported from various countries over the last 35 years and has been used both for research and extension purposes on a sporadic, *ad hoc* basic. Technical support and additional information, however, are very limited. Initiatives need to be expanded in order to improve livestock productivity and, therefore, the socioeconomic status of many Nepalese.

Nepal's Fodder Situation

Over the last 30 years, the human and animal populations have increased at a much faster rate than have food and forage resources. Fifty-six per cent of the 20 million inhabitants of Nepal live in the mid- and high hills. Over 50 per cent of households in these areas have average land holdings of 0.18 hectares. This amount of cultivable land can hardly produce half of the staple foods required to maintain nutritional standards within individual families (FAO 1992), let alone adequately feed livestock.

Nepal's fodder shortage is estimated at 36.25 per cent (Pariyar 1992). This lack of domestic animal forage further limits the availability of manure and other livestock products needed to sustain increased population pressure. Cereal yields are also decreasing (Table 1). Meanwhile, forests and shrublands — the traditional and primary source of livestock fodder — have substantially decreased in area (Table 2). During the 1960s, Nepal's forests covered 6.5 million hectares; in the 1990s, forests only accounted for 5.5 million hectares of the country's land mass.

Nepal's overall socioeconomic and environmental situation has continued to deteriorate as a result of a continuous reduction in landholding sizes. Likewise, shortages of traditionally-used forest and animal fertilizer products have resulted in declining crop yields. Off-farm income generation activities and real wage rates have also declined in recent years. Given these adverse circumstances, the poor have become increasingly dependent on exploiting government land as well as community forests and rangelands for the sake of sup-

Table 1: Trends in Human Population, Animal Population, and Forest Coverage in Nepal

Decade	Human Population ('000)	Animal Population ('000 head)	Forest Area ('000 ha)
1960s	9413	-	6500
1980s	15023	8226	6000
1990s	18600	8783	5500

Source: DFAMS (1986), MPFS (1988); LMP (1990); Rajbhandari and Shah (1981)

Table 2: Yield Per Hectare and Growth Rates of Important Crops in Nepal and Other South Asian Countries in 1961-63 and 1991-93

Country	Cereals			Potatoes	Sugarcane
	All	Paddy	Wheat		
1961-63					
Nepal yield (kg/ha)	1854	1940	1230	-	1979
Nepal as % of					
India	198	129	146		46
Bangladesh	111	116	198		53
Pakistan	212	140	150		61
Sri Lanka	108	101	-		119
1991-93					
Nepal Yield (kg/ha)	1817	2277	1340	9639	3467
Nepal as % of					
India	92	86	57	73	53
Bangladesh	70	86	75	92	86
Pakistan	84	93	69	85	82
Sri Lanka	61	74		89	101
Annual Growth Rates (%) 1961-63 to 1991 - 93					
Nepal	-0.07	0.54	0.29	-	1.89
India	2.71	1.92	3.46		1.39
Bangladesh	1.59	1.55	3.59		0.27
Pakistan	3.27	1.92	2.89		0.92
Sri Lanka	1.75	1.57	-		2.45

Source: Adapted from Agricultural Perspective Plan (1995)
* 1961-65

plying their livestock with fodder (HLFFDP 1996).

New Approaches to Forage and Pasture Development

The Hills' Leasehold Forestry and Forage Development Project (HLFFDP) aims to correct these ecological and socioeconomic imbalances. Its two broad objectives are to raise family incomes of those living below the poverty line, and to help improve the country's ecological conditions. This project is being implemented jointly by four line agencies: the Department of Forests (DOF), the Department of Livestock Services (DLS), the Agricultural Development Bank of Nepal (ADB/N), and Nepal Agricultural Research Council (NARC). During the project's eight-year tenure, HLFFDP aims to involve 14,224 families and in doing so rehabilitate and develop 13,513ha of degraded land by planting timber, multipurpose, and fodder trees. The project also hopes to instigate grassland development activities, as well as comparable activities on adjacent farms (IFAD 1990). Each group involved in this project includes between five and seven families, all of whom own less than 0.5ha of land and whose per capita annual earnings are at most NRs 2,168 ($US 38). These groups will obtain lease rights to one hectare of degraded forest land for 40 years. They have the right to renew this lease.

An Integrated Research Development and Extension Training Programme (IRDET) has now been developed and implemented as part of the HLFFDP in order to further assist poverty alleviation, environmental protection, and sustainable development.

Basic Principles of IRDET

IRDET has been developed as a pilot activity aimed at addressing and resolving constraints faced within HLFFDP. IRDET activities are being conducted with farmers' participation and are focussed on the rehabilitation, management, and development of degraded lands. It is the project's assumption that such activities, with the support of local institutions, will continue well beyond the actual duration of IRDET (HLFFDP 1995, 1996).

IRDET strategies and procedures target individual families as a means of empowering communities at large. This project aims to increase the quality, quantity, and seasonal availability of forage and animal products. IRDET also hopes to develop an environmentally-sound and socioeconomically-viable management structure for the rehabilitation of degraded land.

IRDET Methodology

IRDET plans to realise these goals through the following methodologies: group formation and land sanctioning; group discussion and programme formulation; loan availability for land development; household surveys; site identification; classification; and description. Training on seed treatment, basal fertilizer, inoculation and lime pelleting, line planting of pasture legumes, and the planting and use of fertilizer for nitrogen-fixing trees and shrubs will be offered to both leasehold farmers and JT/JTA of DLS by NARC staff. In addition, the formulation and monitoring of a workplan for leasehold groups will include an initial site questionnaire, botanical descriptions, analysis of land availability, and farmer preference for common fodder species. Description and analysis of farmland and soil quality, as well as a list of inputs and outputs geared towards economic analysis of the project's impact, will also be included. A socioeconomic survey and analysis of locally-perceived constraints and preferences for developing livestock fodder on area farmland are also included in IRDET's methodology.

Forage and Pasture Interventions

Since 1995, a new non-traditional approach has been used to facilitate poverty alleviation through the rehabilitation of degraded forest land and the development of adjacent arable lands. This two-tiered approach is being led jointly by HLFFDP's Technical Assistance component and NARC as part of the IRDET programme. This initiative includes a farmer-based field network that integrates research, development, and extension work. Training plots for seed and fodder production have been established. A research-based farmer support network has been founded and national and international connections have been fostered to bridge the gap between existing institutional frameworks and the specific needs of the project.

Protection from Grazing to Facilitate Natural Regeneration of Indigenous and Naturalised Exotic Fodder and Pasture Species

Previous project experiences and examples gleaned elsewhere indicate that protecting a degraded area from grazing provides ample opportunity for indigenous vegetation (including naturalised exotic species) to regenerate. Paudel and Tiwari (1992) reported that protection of 19.2 hectares of community plantation land produced 24MT of dry matter and could potentially produce 30MT of grass as well as 100MT of wood biomass annually. On this basis, the project strongly suggested that degraded land not be grazed at all in order to promote rehabilitation and development of indigenous and natural exotic species (HLFFDP 1996).

Site Identification, Classification, and Description

To begin any kind of intervention programme, detailed information about local preferences for common fodder species, land formation and soils composition, vegetation analysis, and socioeconomic conditions must be collected. Farmers' perceived constraints and preferences for developing livestock fodder on their leasehold farmland should also be analysed.

In this context, 128 soil samples, 125 plant samples, and 1,789 farmer interviews have been collected and conducted. Soil status analysis indicates that soils are acidic and nitrogen and phosphate deficient. A large number of plant species has low nutritional status; their productivity is estimated at 0.5-1MT of green matter/ha. However, some species that are present in sample plots, such as *Heteropogon Contortus, Pogonatherum* spp *Desmodium* sp, *Crysopogon gryllus,* and *Flemingia* sp have been said to increase milk and ghee production, therefore indicating that they have substantial nutritional value.

Households were large, consisting of five to ten members. Ruminant livestock populations were also very high (4-19.5 head per household). Landholding sizes varied from 0.28 to 0.92 hectares per family. These land characteristics and socioeconomic structures indicate that project areas suffer from increased pressure on fodder and fuel resources, particularly in areas near forests and on some cultivated areas. Malnutrition is also a problem, as annual area cereal production only meets nutritional requirements for between one and 2.5 members of a household.

Strategic Use of Naturalised Exotic Fodder and Pasture Species on Degraded Land

For the last 10 years, Stylo (*Stylosanthes guianesis*) and Molasses (*Melinis minutiflora*) have proven successful fodder species on degraded land in warmer climates. White clover (*Trifolium repens*), cocksfoot (*Dactylis glomeratai*), and perennial grass (*Lolium perenne*) have shown limited potential in cooler climates. Stylo was used in the low to transitional belt (400-1,800m), while white clover was introduced on high altitude pastures (1,800-2,500m) in areas of minimum tillage. White clover seeding was also combined with line planting inoculation, pelleting, and the use of starter fertilizer. The pasture legume seeds were seeded at three kg/ha after inoculation and lime pelleting with the use of starter fertilizer ($N_{45}P_2O_{5\,115}$ S_{30} kg/ha /DAP 250 kg/ha and Gysum 150 kg/ha).

Primary turf skimming was not deeper than three cm and covered 30cm bands along hill contours at 75cm intervals. Fur was placed on downhill slopes to control runoff. Starter fertilizer was applied on the downhill side and inoculated and pelleted pasture legume seeds were sprinkled on the upper hillside. Care was taken to separate seed from fertilizer and gypsum and to selectively incorporate seed and fertilizer with soil. Local grasses were occasionally cut from between five and ten inches on both sides of the turf in order to increase green fodder production and control competition. This procedure was repeated three to four times each year. Productivity data collected in August 1996 revealed that Stylo had produced 18 to 36MT of green matter/ha in low altitudes and 9 to 15 MT/ha in the transitional belt; white clover harvested in December 1995, under occasional grazing conditions, produced 3 to 4MT green matter/ha in high altitude areas.

Strategic Use of Nitrogen-Fixing Tree Plantations on Degraded Land

The proper establishment of nitrogen-fixing trees in combination with other multipurpose/fodder trees has been the basis of IRDET's silvipastoral programme. For all species, planting holes of 3 X 50cm were combined with starter fertilizer (DAP 250 gm and Gypsum 150 gm/pt or N_{15}, P_2O_{546}, S_{12} kg/ha). Trees were space planted at 400 ha/ha, and undersown with pasture species. *Bauhinia purpurea*, *Lencaena diversifolia*, and *lencocephala* have been planted in low and transitional belts while *Robinia Pseudocasi*, *B. variegata*, and *Alnus nepalensis* have been established at high altitude locations. *B. purpurea* seedlings planted according to this method have a 52 to 95 per cent survival rate, reaching an average height of 10 feet in 14 months. *L. diversifolia*'s survival rate was 50 to 92 per cent with an average plant height of 4.5 feet in 14 months. *L. pallida* had a survival rate of between 20 and 60 per cent with an average plant height of 2.5 feet in 14 months. These plants are found in low, transitional, and high altitude areas, respectively.

Problems Encountered

White clover (*Trifolium repens* cv. Khumaltar) has not been successfully established on many sites. Mono-species' evaluation has to be combined with other species such as *Lotonomis bainesii cv* miles, *Lotus pedunculatus* Maku, etc. *Anthracnose* might effect stylo cultivation in the future. Resistant cultivars such as CIAT-184 and Graham should be introduced on a large scale.

Occasional conflicts between leasehold forestry and community forestry groups have resulted in the grazing of established plots at two or three high altitude sites. More training and institutional commitment is necessary to remedy these problems. Likewise, although four institutions are working together on this project, determining norms based on research recommendations, particularly by the DLS, has been difficult. Such activities aim at extending IRDET activities to a number of key locations. More backup support is required for proper research funding, hiring international consultants, and establishing networks with national, regional, and international institutions.

Recommendations and Conclusions

Present degraded land development projects have relied on simple, affordable, and sustainable technological packages. This approach could be replicated — or at least tested — on rangeland ecosystems. Although ranges are fragile environments, improving their productivity is a fundamental component of alleviating Nepal's fodder shortages (Basnyat 1995).

The methodology developed under IRDET can be replicated and tested throughout the Hindu Kush-Himalayas, provided that appropriate institutional support is given. Institutions such as ICIMOD should formulate and support a location-specific demonstration plot. Such a programme could set an example for the ways in which management, institutional, technical, and socioeconomic factors affect the improvement of degraded land. Fodder development and rangeland improvement strategies will only be successful with national, regional, and international cooperation and support.

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Fodder Development Initiatives and Hill Conservation in Nepal

Surya Bahadur Singh

Introduction

Nepal is a country situated between the southern slopes of the Himalayas to the north and the upper parts of the Ganges plain in the south. Altitude ranges from more than 8,000 metres above sea level in the high mountains to about 150 metres in the southern *Terai*. In between these extremes are the Mahabharat and the Siwalik Mountain ranges. Characterised by deep valleys and flat uplands, these hills cover lands between 300 and 3,000 metres in altitude. In the mid- and the lower areas of the zone, extensive terracing, deforestation, and overgrazing has reduced formerly forested lands to wastelands and over cultivated fields. Landslide scars and eroded areas are common. All valleys are cultivated. The expansion of terracing on ridges is accompanied by increased soil erosion.

Soil erosion, a continuous washing away of the hill slopes in Nepal, has become a serious problem. Billions of cubic metres of soil are subject to erosion every year. The Siwalik and mid-hills, occupying about 61,345 sq. km. (41.7% of the country's total area) have been most affected by this problem. Soil erosion is continuously taking place throughout the middle hills, 0.856 million hectares of cultivated lands and 4.465 million hectares of deforested lands (LRMP 1985) as a result of forest clearing and overgrazing. Consequently, most of these lands have seriously been degraded, able to meet just over 60 per cent of the total annual feed requirements (in terms of Total Digestible Nutrients) for existing livestock populations (approximately 3.4 million cattle, 1.9 million buffalo, 0.41 million sheep, and 3.24 million goats (ASI/AMAO 1995). The degradation of these lands has also resulted in considerable decline in crop productivity due to reduced soil fertility. This has adversely affected many subsistence farm economies in the hills.

The government of Nepal has undertaken a number of conservation initiatives in response to these problems. These initiatives encompass both government and community degraded lands and include sloping terraces for increasing vegetation coverage and fodder supply. The experiments undertaken in the last three to four decades have provided specific lessons which should be considered when formulating future conservation strategies for the hills of Nepal and other hill regions of the Hindu Kush-Himalayas.

Initiatives

In Nepal, pasture development work started in 1952, after FAO conducted a study towards the implementation of a systematic approach to pasture and fodder production to support the Nepalese dairy industry in the hills. Structural orientation and the provision of a Pasture Development Officer occurred in 1965, within the establishment of the Livestock development Section, Department of Agriculture. In 1975, an extensive pasture development programme was launched. White clover was oversown on high altitude pastures as part of the 'Agriculture Year 2032/1975'. However, this initiative was not successful because it did not focus on gathering local support and encouraging people's participation. The technicians in charge of the project were often inexperienced as well.

In the 1980s, however, the Department of Livestock Services (DLS) had remarkable success in planting napier on bunds and risers of private sloping terraces to increase vegetation cover and thereby livestock fodder supply. At this same time, the Swiss were supporting the Tinau Watershed Project in Palpa District. This project successfully sowed degraded forest lands with *Stylosanthes, Gaynensis,* cv. Cook, and molasses grass (*Melinus minutiflora)* in fenced areas. These lands were eventually handed over to communities who used them for forage cultivation and to help protect timber and fuelwood plants.

In 1982, the Government of Nepal enforced a Soil Conservation and Watershed Management Act, empowering the Government to declare any area to be a protected watershed in which the harvesting of trees, plants, and other forest products is prohibited without official permission and where aforestation and forest protection are required. This initiative also marked the establishment of the Department of Soil Conservation. This Department is responsible for maintaining land structures through appropriate use of soil and water resources, as well as proper watershed maintenance. This Department's work has significantly aided the rehabilitation of degraded lands, primarily by sowing stylo, planting fodder and timber/fuel trees, and propagating medicinal plants.

Similarly, the Department of Forests has made significant contributions towards the rehabilitation of degraded lands since the introduction of the Amendments to the Forest Act in 1977. Community forestry and leasehold forestry programmes resulting from this Act have had tremendous positive effects on restoring natural cover on degraded forests in recent years.

Both the Department of Soil Conservation and the Department of Forests work with user groups. The Department of Forests conducts afforestation programmes in government forests through District Forest Offices or through Community Forestry Programmes. The latter empowers and mobilises user groups, helping them to create management plans and establish fuel and fodder tree plantations. Ground forage development programmes have also been established by leasing degraded forest lands to a group of farm families under the Leasehold Forestry and Forage Development Project (HMG-IFAD).

The Department of Livestock Services works at the district level for forage intervention on community lands. User groups organized by the District Forest Office or those working with the District Soil Conservation Office are involved in these forage intervention efforts. Forage intervention on private land is accomplished through livestock commodity groups or Milk Producers' Cooperative Societies. These Societies supply milk to the Dairy Development Corporation of Nepal.

Successes and Failures of Hill Conservation Initiatives

Past efforts to rehabilitate degraded lands have succeeded or failed depending on a variety of circumstances. Hence, an attempt has been made to present both positive and negative experiences in order to help shape future development and conservation planning in Nepal.

Fodder Enrichment Through Chir Pine Plantation

The physical success of chir pine plantation both in the mid-hills and the high mountains has been attributed to the fact that pine plant leaves are unpalatable to all livestock. Yet this success has not been appreciated by most users at the village/ household level. Local people continue to be resentful of this intervention. They do not like the restriction from grazing during the initial stage of plantation establishment. Restriction of traditional grazing patterns is unpopular because livestock keeping is a common practice of most farm houses in the rural areas. In some areas, it is the sole or major source of cash income after non-farm activities. Restriction of the use of traditional grazing lands means decreased forage supplies for existing livestock, which eventually leads to lower livestock productivity and decreased household cash income.

Fodder cultivation on cultivable land is not a traditional practice for most rural households, unlike the practice of raising livestock by free grazing. Moreover, most rural households keep more head of livestock to reduce the risk of natural disaster or disease, as well as for fertilization of crops, irrespective of livestock productivity levels. But, with the decrease in forage supply, farmers cannot kill or easily sell their unproductive animals, thereby adversely affecting overall herd productivity. At the same time, decreases in livestock intake or livestock number will adversely affect crop productivity.

The absence of forage growth after canopy closure further contributes to village disdain for chir pine plantations Canopy closure is so dense in mature chir pine plantations that there is no undergrowth. This is associated mainly with the planting system, as plants are only 5 X 5 feet from each other. The adoption of such a planting distance was arranged to account for probable plant mortality due to livestock grazing, as well as to achieve physical success. As mentioned earlier, however, pine is not palatable to livestock and natural mortality is negligible, as planting is done during monsoon. As a result, plantations become so dense within 12-21 years that virtually no ground cover remains.

The Rapti Development Project had taken two steps to examine the possibility of overcoming these problems. First, the introduction of napier in bunds and risers of *bari* lands and, second, the introduction of Cook stylo, molasses grass, velvet beans, siratro, and centro under five to seven year-old chir pine plantations to provide understorey fodder. As expected, both interventions were successful. Community complaints about chir pine plantations are virtually nil. It is expected that the undergrowth of the above introduced species will continue to supply forage until the canopy is totally closed, i.e., at least for another five to seven years. By this time, farmers will have developed enough cultivated forage on their own homesteads that they will no longer be dependent on forests for forage supply.

The above discussion implies that forage development programmes on the private, sloping terraces and utilization of unused space under new plantations on community lands should be given due attention while organizing community forestry programmes. Such an approach will help improve additional vegetation cover and increase or maintain forage supply, thus maintaining livestock productivity.

Introduction of Stylo and Molasses on Degraded Land

Stylo sowing has become the most favoured practice for all agencies involved in rehabilitating degraded forests in the Siwaliks and mid-hills of Nepal. Stylo can be grown in very poor to very fertile soil. Stylo does not require land preparation; seeds can just be thrown on the ground. The luxurious green stand of stylo appears within two to three years and stands so thick within three to four years of sowing that it virtually prevents sheet or reel erosion by thickly covering the top soil. As a legume, stylo fed to livestock in combination with straw during the winter or early spring is ideal for maintaining animal nutrition.

Molasses grass is also favoured for improving vegetation of degraded lands and increasing green forage supply during winter when straw is the only source of fodder in most of Nepal's hill regions. However, sowing molasses and stylo together in Palpa has demonstrated that molasses grass completely destroys stylo within five to seven years. It is possible that the favourable nutrient supply of stylo declines, but there is a constant supply of nitrogen to the molasses grass, thereby giving it more opportunity to dominate stylo.

The above experiences indicate that both stylo and molasses grass can be excellent materials to achieve quick ground cover in degraded lands in the hills of Nepal. Yet they should not be planted together.

Napier Plantation on Sloping Terraces and Community Land

Napier plantation on bunds and risers of sloping terraces will increase on-farm forage supply resulting in reduced pressure on forests. It will also decrease the time women spend collecting forage, thereby creating greater opportunities for other productive work (housekeeping, child-care, income-generating activities, literacy). If napier is planted for fodder, it will become less necessary for children to act as shepherds for the family's herds — an activity that often takes precedence over going to school. Napier plantations also create a barrier against soil erosion, thereby improving soil and nutrient conservation for improved crop productivity. Napier plantations on risers and bunds have been the most successful technology of on-farm forage development and soil and water resource conservation practices in such areas.

As such, napier plantations have become well accepted in most dairy-producing areas of the hills and *Terai* of Nepal (Ilam, Dang, Palpa, Tanahu, Chitwan, etc.). Napier provides sufficient green forage to livestock except during January-February. This plant does not require extra fertilization; it grows with the nutrients that leach along slopes or the terrace edges due to gradient differences. Napier provides enough forage that women and children no longer have to collect forest forage, thereby decreasing the assault of forest resources to sustain livestock.

Yet napier plantation programmes have not been heartily accepted by farmers in non-milk market access areas. Moreover, napier plantations, as the main crop on *bari* or as a mono-crop on degraded community lands did not win the confidence of hill farmers. Thus, the initiative/demonstration did not continue in Chitwan, Madan Pokhara, and Palpa. Farmers contested that they needed this land to grow subsistence crops. They also found it difficult to uproot established sward if they wanted some other crops to grow on that patch of land; napier needed to be removed manually. Farmers also cited rat problems in and around the napier plots. Napier planted on large plots as a mono-crop (Narayanpur, Dang) did not last long; the artificial fertilization (napier is a heavy nutrient eater) of the crop was not practical according to members of the community.

Fodder Tree Plantation Programme

Combined fodder tree and timber/ fuelwood plantations have become a common practice of the Soil Conservation Department in community forest afforestation programmes throughout Nepal. Fodder tree plantation is also carried out by the Department of Livestock Services on a massive scale. Overall performance of fodder tree plantation programmes, however, is poor. Most indigenous fodder tree species grow slowly and require fertile land. Propagation procedures are also complicated. The seedlings supplied for plantations are often too small and improper pittings are dug in which to place these seedlings. Concomitantly, in most rural areas, farm animals are free grazed and do not rely on cultivated fodder.

The fodder grass, *amriso (Thysanolaena maxima)*, however, has been successfully cultivated in the hills of Ilam. *Amriso* provides green fodder almost year round and is easily propagated. Growing *Amriso* is a direct source of cash income because its inflorescences are sold to make brooms. The non-edible overstalks are used as fuelwood for household cooking or for fencing kitchen gardens. *Amriso* cultivation has not been as successful in the western regions of the country due to drier climatic conditions in these regions.

All the above discussions clearly indicate that farmers' interest and initiatives are guided from their awareness and social understanding of natural resource conservation and their economic realities. Economic activities are the driving force behind the structuring and adoption of such interventions and their sustainability. Likewise, economic activities are driven by market opportunities and structural development. Therefore, past initiatives have succeeded or failed depending upon whether the fodder development programmes were implemented in the milk market access areas or the non-milk market areas and whether the people were aware of the importance of conservation practices. In most non-milk market access areas, fodder programmes have been unsuccessful. When there have been any successes or a few adoptions at initial stages, all have collapsed after subsidies have been withdrawn or other interests of farmers left unfulfilled.

Local Hill Conservation Organizations

Farmers' organizations are directly concerned with livestock management, as well as land and water conservation. Livestock production organizations are commodity groups such as buffalo, cattle, sheep, and goat groups or Milk Producers' Cooperative Societies. These organizations are primarily involved in improving forage production on private cultivated or non-cultivated lands. Local organizations involved in community land enrichment through forage and tree plantations are larger groups organized as forest managers and soil and water conservation user groups. The user groups in Dang and Palpa Districts have organized themselves into district level associations known as District Pasture Development Associations.

These local organizations are formed on democratic principles. Each of them have their own by-laws with specific objectives. Members of the executive bodies are elected. Each month, the executives hold a meeting to discuss pertinent issues that concern themselves and/or line agencies. The capacities of these local organizations have not been fully used by local governments or line agencies. These organizations can perform a number of jobs at the local level. In fact, they could be excellent development partners.

The Palpa District Forage Development Association (PFDA) provides a good example of these organizations' functions and potentials. The PFDA represents 11 forest/ soil and water conservation user groups of the Palpa district. The major objectives of the association include the collection of forage seed from user groups which they then market at reasonable prices. PFDA uses the money earned to implement socioeconomic activities at the village level, implement drinking water and village toilet projects, construct school buildings, pay the monthly salaries of school teachers, fence community lands, pay the monthly salaries of community plantation guards, etc. This Association also implements programmes on environmental rehabilitation and supports nutrition programmes. They also try to improve forage seed production practices with the introduction of new technologies and to establish inter-group and inter-agency coordination for rural development.

By implementing the above programmes, this Association has gained the faith of its member user groups. As a result, this association helps prepare and implement annual member user group programmes.

In 1996, the Dairy Enterprise Support Component of the Agro-enterprise and Technology Systems' Project (DESC/ATSP, HMG-USAID) trained members of PFDA, along with some other seed producers from selected places, in management of stylo seed production on cultivated or community lands in order to test the ability of farmers' organizations to work as development partners. These line agencies then invited PFDA to undertake action research on 'Farmer-to-Farmer Training in Stylo Seed Production and Organization of a Forage Seed Production Association in the Dang District of the Mid-Western Region of Nepal'. This Association was also responsible for sowing stylo on 40ha of degraded community lands in Dang and Palpa districts by mobilising the user groups; PFDA was also required to manage preliminary variety and fertilizer trails introduced by ATSP and conduct preliminary cutting trials on their own.

The farmer-to-farmer training component of this programme involved discussions with farmer groups about the training programme, its objectives and methodology of teaching, and the actual on-site training by following an experiential teaching-learning process. The groups selected farmers interested in training and provided a training site. Trainers were basically leading farmers of Palpa and Dang. In total, 879 farmers of 25 user groups were trained over three months. Women's participation was 67 per cent.

Similarly, the organization of the district level association by PFDA in Dang involved bringing 12 users' groups together into the district level association, preparing bye-laws, registering this association with the

District Administrative Office, electing the Executive Committee, and preparing an Annual Plan.

With seeds from DESC/ATSP, 24ha of community lands in Dang and Palpa have been sown with stylo. The communities provided labour for sowing and contributed towards temporary fencing and hiring watchmen in many community plantation areas. Moreover, fourteen farmers in Palpa and eleven farmers in Dang have planted stylo on private lands (covering about 15ha) for commercial seed production.

PFDA, with technical support from the District Livestock Services' Office and DESC/ATSP, also conducted cutting trials in Palpa in 1994 and 1995. It was found that taking forage cuttings once in the month of Shrawan (late July or early August) produced more seeds (66-230kg/ha) compared to two cuttings in the month of Shrawan (July) and Bhadra (August) or Aswin (September) (25-130kg of seed/ha). Taking no forage cuttings but harvesting for seed collection only produced 60-218kg of seed). A similar trend was observed in forage supply (Basnet and BC, 1996). The association was also involved in fertilizer and variety at Palpa and Dang.

The DESC/ATSP concluded that PFDA was cost-effective and had sufficient knowledge/skills in carrying out: farmer-to-farmer training, conducting preliminary field trials, establishing district-level farmers' associations, and extending stylo sowing to community levels through mobilization of user groups.

The above discussion clearly indicates that local organizations like PFDA can be effective partners in many development programmes if they are trained and given opportunities to participate.

Conclusions and Recommendations

Forage development programmes on private sloping terraces and use of unused space under new plantations on community lands should be given due attention when organizing community forestry programmes. Such an approach will help improve additional vegetation cover and increase or maintain forage supply, thus maintaining livestock productivity. Similarly, both stylo and molasses grass can be excellent materials to achieve quick ground cover in the degraded hills.

Farmers' interests and initiatives are guided by their awareness and social understanding of the conservation of natural resources, as well as economic activities. The above-mentioned successes or failures of fodder development schemes in milk access areas and non-milk access areas, as well as other such economic factors, should not be underestimated when developing conservation and development programmes in Nepal. Community awareness of conservation practices are also fundamental to creating sustainable programmes.

Local organizations should be recognised by local government and line agencies as potential partners in development programmes. Local users' groups are excellent social mobilisers capable of conducting farmer-to-farmer training and action research in specific areas. Yet efforts are required to improve their capacities and capabilities through training so that they may provide paid services at the village level.

Alternative fast growing, nutritious fodder tree and shrub species need to be tested for private plantation on sloping terraces and community lands. Improved napier varieties should be used for private plantation on such terraces, particularly in the dairy pockets.

The Soil Conservation and Forestry Departments should take prime responsibility to encourage community stylo sowing on degraded local lands. The Department of Livestock Services should promote competitive seed production by defining the most potential forage seed production sites by type and by providing the necessary technical support to seed producers. Research institutions should support local farmers.

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Conclusions and Recommendations from the Workshop

Daniel J. Miller

Background

This Regional Expert Meeting on Rangelands and Pastoral Development in the Hindu Kush-Himalayas was organized by ICIMOD to bring together rangeland, forage, livestock, and wildlife specialists from ICIMOD's member countries to: (1) discuss issues related to the sustainable management of rangeland resources and pastoral development in the Hindu Kush-Himalayan (HKH) mountain region; (2) identify opportunities that exist for improving the management of rangelands; and (3) formulate specific recommendations on technologies, management systems, and policies to promote more sustainable use of rangeland resources.

Topics covered during the paper presentations and discussions included country rangeland status reports from the major countries (Bhutan, China, India, Nepal and Pakistan), rangeland ecology, socioeconomic aspects of pastoral production, livestock production, rangeland biodiversity and wildlife conservation, forage and fodder development, major issues, and priorities for action. The Meeting provided an excellent opportunity for specialists from the region to share information and ideas related to rangelands.

Based on the discussions that took place, and the interest shown among all participants, it is anticipated that one eventual outcome of the Meeting will be that greater attention and resources will be directed to rangeland management and pastoral development by national governments and development agencies. It is also expected that the Meeting will lead to greater collaboration and exchange of information between rangeland specialists, conservationists, and development workers in the HKH region and outside the HKH region in the future.

Despite the fact that rangeland environments have not received the attention they deserve from governments and development agencies, there are specialists committed to rangelands and actively working out in the remote rangeland regions of the HKH. Many of those specialists were present at this Meeting. The papers in this proceedings are a testimony to the excellent work on rangelands, forages, and pastoralism being conducted by these people.

This workshop has made a significant contribution to the expansion of knowledge on rangeland environments in the HKH. Programmes now need to be introduced that will address the many issues highlighted in this proceedings in order to promote more sustainable use and management of rangeland resources. Recognising the limited funding resources available for range and pastoral development and the lack of trained range specialists, the Meeting sought to prioritise development actions that should be taken. Although opinions varied depending on participants interests and specialities, broad consensus was reached on the major issues facing rangelands and priority actions needed to conserve rangeland biodiversity, improve rangeland management and pastoral development programmes, and to promote forage and fodder development (see Boxes).

Rangeland Biodiversity

Conservation of biodiversity on the HKH rangelands is facing numerous issues (Box 1). Major issues include the loss of species and decrease in biodiversity, wildlife habitat degradation and loss of habitat, lack of knowledge about the biodiversity in rangeland environments, uncontrolled hunting, and competition between wildlife and livestock for forage. Inadequate government policies and lack of trained staff to monitor biodiversity on the rangelands are also issues facing biodiversity conservation in rangeland environments.

Actions need to be taken on a number of fronts to protect and conserve biodiversity, but priority actions include research on wildlife habitat, wildlife ecology, and wildlife-livestock interactions; control of illegal hunting; creation of additional reserves to protect biodiversity not included in the existing protected area network; and conservation

Box 1
Major Issues Concerning and Priority Actions for Rangeland Biodiversity

Rangeland Biodiversity

Major Issues

- decrease of biodiversity/loss of species
- habitat loss
- illegal hunting
- lack of data/knowledge/awareness
- overgrazing
- wildlife-livestock competition
- climatic changes
- cultural diversity problems
- medicinal plants — lack of knowledge
- inappropriate government policies
- lack of monitoring

Priority Actions

- research on:
  - wildlife movements/grazing systems
  - wildlife habitat
  - wildlife and range ecology
  - wildlife-livestock interactions (monitoring diets, etc.)
  - indigenous pastoral management systems
- awareness campaigns, education
- establish biosphere reserves
- create monitoring teams
- control illegal hunting
- manage stocking rates/sell unproductive animals
- establish a biodiversity database
- rehabilitate overgrazed ranges
- introduce improved forages
- incorporate indigenous knowledge into development plans
- create off-farm and alternative employment opportunities
- promote appropriate land ownership rights/legislation for tenure

Box 2
Major Issues Concerning and Priority Actions for Rangeland Management and Pastoral Development

Rangeland Management/Pastoral Development

Major Issues

- fodder shortages, especially in winter
- lack of information on range ecosystem processes
- lack of technical support
- lack of trained manpower
- agricultural encroachment on ranges
- rangeland degradation
- land tenure problems
- settling of pastoralists
- lack of community participation in development efforts
- lack of herder education
- lack of knowledge of traditional systems and pastoralists' indigenous knowledge
- lack of accurate socioeconomic data on pastoral systems
- lack of data on flora-fauna interactions
- large herds
- climatic hazards (aridity, poor soil, erosion)
- lack of adequate winter grazing
- overgrazing
- local management systems no longer viable
- lack of alternative income activities
- lack of economic incentives to adopt new technologies
- poor government commitment to pastoral communities
- exclusion of women from involvement in pastoral development programmes

Priority Actions

- train professionals and locals
- create opportunities for two-way exchange of information between pastoralists and professionals
- develop programmes to study traditional systems and perceptions of pastoralists' problems
- improve forage/fodder resources, especially in winter
- improve people's participation and community organization
- conduct applied rangeland research
- determine extent and severity of rangeland degradation
- develop appropriate land tenure legislation and policies
- distribute available technologies to pastoral areas
- develop seed and gene banks
- develop snowmelt water collecting techniques

education and biodiversity awareness campaigns.

Rangeland Management and Pastoral Development

Major issues associated with rangeland management and pastoral development (Box 2) include rangeland degradation, lack of forage in winter and spring, overgrazing, lack of information on pastoral systems, lack of information on range ecosystem processes, lack of trained rangeland and pastoral development specialists, and poor commitment on the part of governments for pastoral areas. The lack of pastoralists' participation in planning development programmes is also a major issue, especially with respect to the involvement of women since they play a major role in pastoral pro-

Box 3

Major Issues Concerning and Priority Actions for Forage and Fodder Development

Forage and Fodder Development

Major Issues	*Priority Actions*
• shortage of feed/fodder in winter and early spring • lack of fertilizer to establish legume forages • lack of land for forage cultivation and pasture establishment • high cost of inputs • lack of dedicated extension staff • lack of appropriate varieties of production systems • lack of improved forage seed • lack of appropriate, sustainable technology and related support • poor communication between herders/farmers and technicians • lack of methods for hay production and conservation • native forage species for improvement not identified • lack of forage distribution system in remote pastoral areas • poor genetic characteristics of livestock • limited markets for livestock products • lack of fodder banks • competition between food and fodder crops	• establish improved forages and hay crops • develop appropriate technologies for fodder conservation • use fallow and marginal land for forage cultivation • establish hay meadows • improve profitability of livestock rearing vis-a-vis crops • support seed production of forages • integrate food-forage crop systems • conserve forage for winter and spring • establish forage and forage seed banks • promote silage technology • conduct improved feeding demonstrations • test winter period forage species • organize training on forage conservation • establish forage production user groups • emphasise year-round forage production • introduce forages with low water and mineral requirements • create agencies to distribute forage seeds to pastoralists • promote stall feeding • research to identify forages for high altitude zones

duction. With changes arising from modernisation processes, many traditional management systems are no longer viable. The lack of alternative employment opportunities in pastoral areas is also of concern, especially with increasing human populations. Finally, the poor quality of education among pastoralists is a factor limiting their access to new technologies.

Actions required to improve rangeland management practices and promote more sustainable pastoral development are numerous, but priority actions include improving forage and feed supplies in the winter, the need for applied rangeland research on numerous aspects, encouragement of greater participation by local pastoralists in development planning, training rangeland technicians, dissemination of new technologies, and developing appropriate land tenure legislation and rangeland policies.

Forage and Fodder Development

Forage and fodder development is the key to improving livestock productivity on the rangelands. Major issues regarding forage development include lack of suitable improved forage species for many rangeland areas, lack of technologies for low-cost forage establishment, high cost of forage seeds and fertilizers, lack of dedicated extension staff, and poor communications between forage specialists and pastoralists.

Priority actions for forage and fodder development include development of appropriate forage technologies for different agro-ecosystems, especially for higher elevations; promote forage seed production; organize forage production user groups; promote stall feeding; and identify native forages for rangeland rehabilitation.

Designing Development Strategies for Rangelands in the HKH

Strategies for improved management of rangeland resources and sustainable pastoral development in the HKH should strive to protect and enhance rangeland biodiversity, promote more sustainable livestock production systems, rehabilitate degraded rangelands, improve people's incomes and well-being, and contribute to overall economic development in rangeland areas. Developing such strategies requires a much better understanding of range ecosystem dynamics and animal-plant interactions, increased knowledge of pastoral production systems, more thorough analyses of the issues and opportunities facing rangelands and pastoralists, and modifications in current policies and approaches to development. The following paragraphs outline some of the factors that should be considered in developing strategies for rangelands and in preparing development programmes.

Adopt a Systems' Approach

Since rangelands encompass diverse resources and land uses, an integrated systems' approach is needed to acquire a better understanding of rangeland ecosystem processes and to identify the opportunities that exist for more sustainable development. Pastoral development needs to take place in the context of integrated natural resource management and overall economic development. For this to happen, pastoral sociologists, livestock and natural resource economists, and biodiversity specialists need to work closely with range, forage, livestock production, and watershed management specialists.

Develop a Better Understanding of Range Ecosystem Dynamics

There is good descriptive information about many of the rangeland ecosystems in the HKH (plant and wildlife species list, vegetation types, etc), but our understanding of how the various rangeland ecosystems function is still limited. Strategies for rangelands need to develop a better understanding of rangeland processes and ecosystem functioning. Rangelands are complex environments and proper management of these grazing lands requires more detailed information about soil-water-plant processes, plant-animal interactions, and wildlife-livestock interactions. Many semi-arid pastoral areas of the world are increasingly being viewed as non-equilibrial systems. Such views postulate that climatic factors are more of a driving force in determining vegetation growth patterns instead of the more traditional view that livestock are the primary factor affecting rangeland vegetation. These new concepts need to be explored in the context of HKH rangeland systems as they could help in developing a better understanding of range ecosystem dynamics.

Develop a Better Understanding of Pastoral Production Systems

Resolving many of the pastoral development issues in rangeland environments requires better information on pastoral production systems. Understanding the aims, purposes and goals of the pastoralists is the key to sustainable pastoral development. This requires more information on livestock production parameters, including population trends, herd movements, livestock grazing behaviour and food habits, calving and lambing rates, etc. Since women are important players in livestock management, the role of women in pastoral systems needs to be given greater attention. Development programmes for pastoral areas must be socially as well as ecologically appropriate, and this calls for a much better understanding of the social dimensions of rangeland ecosystems, including the social values attached to livestock and livestock management practices, land tenure, and community interactions. With modernisation, pastoral areas are undergoing rapid changes. How pastoralists are adapting to these changes is an important research area.

Give Greater Consideration to Rangeland Biodiversity

As wildlife is a valuable resource in rangeland areas of the HKH, greater attention needs to be given to conserving and managing wildlife. The distribution, status, and ecology of many species found in the high elevation rangelands of the HKH are poorly known at the present time. Interactions between wildlife and livestock also need to be better understood in order to assist pastoral development planning and biodiversity conservation. Conservation of wildlife cannot be considered without including the attitudes of local people to wildlife. Conservation programmes need to encourage greater participation from local people and allow for local resource use from pastoralists living in the vicinity of protected areas.

Rangelands not only provide plants used as forage by livestock and wildlife; numerous plants found in the rangelands have medicinal or economic value. The multiple-use aspects of rangelands must be given greater consideration.

In considering the biodiversity of the rangelands, emphasis also needs to be placed on conserving the genetic diversity of domestic livestock. Most of these local breeds are well adapted to local conditions and any strategies for biodiversity conservation should consider conserving these valuable genetic resources.

Make Use of New Tools for Integrating and Updating Information

Recent technological advances in computer data processing, geographic information systems (GIS), decision support systems, and remote sensing have valuable applications for range resource management. Their use needs to be encouraged when planning rangeland and pastoral development.

Develop More Appropriate Range and Pastoral Policies

Policies for pastoral areas should acknowledge the efficacy of many traditional pastoral production practices and seek to understand range resource dynamics and current land use practices before advocating substantial changes in the name of 'development'. Proper incentive frameworks also need to be established for pastoral areas to encourage herders to adopt new technologies and practices that they find appropriate. Livestock development in many countries has been undermined by inappropriate input and output pricing, subsidies, interest rates, and cost recovery policies which have discouraged destocking and investments in rangeland management. In order to better integrate biodiversity conservation with range-livestock development, policies for rangelands should also emphasise multiple-use management practices.

Innovative Roles for Donor Agencies

Since rangeland ecosystem dynamics and pastoral production practices are still poorly understood in the HKH, donors and development agencies need to adopt a more flexible approach towards range and pastoral development. The diverse range ecosystems and pastoral systems found on the HKH rangelands require rather localised interventions and research in pilot areas combined with long-term institutional building efforts. The design of projects, as well as funding arrangements, should be flexible and allow for adjustments as more knowledge becomes available. Within projects, decision-making should be decentralised to local levels to enable managers in the field to respond to local conditions. Since the emphasis should be shifting from capital investments to institution building, investment requirements for many range and pastoral projects will be low and donors will need to accept that projects, which need a lot of manpower in their design and supervision, require only limited funding and thus do not show well on the balance sheet. Donors may need to shift from detailed project agreements covering short time periods to flexible programme approaches covering a longer time span.

Conclusion

The fact that numerous, prosperous pastoral cultures and wildlife remain to this day on the HKH rangelands bears witness to the remarkable diversity and productivity of these unique ecosystems, as well as the sustainability of their resources if used wisely. Pastoral areas throughout the HKH are coming under increasing pressure from an expanding human population but, if properly managed, they should be able to sustain watersheds, supply much of the projected increased demand for livestock products, provide critical habitat for wildlife (including many endangered species), and continue to provide livelihoods for millions of people. New perspectives that are emerging about rangeland ecosystems and pastoral production practices provide valuable frameworks for assessing HKH rangeland ecosystems and suggest fresh approaches for designing pastoral development in ways that complement environmental conservation. Pastoral development programmes will need to take into account local resource possibilities and constraints and the sensitivities of pastoralists. Development programmes should be flexible enough to take into account new information as it emerges and to support activities based on technologically and socially accepted options. Only thus will the long-term viability of the rangelands of the Hindu Kush-Himalayas be protected and enhanced.

Timely action needs to be taken to acknowledge the efficacy of many traditional pastoral strategies and practices, to evaluate the rangeland resources, and to realistically appraise development alternatives for the HKH rangelands. These actions are crucial in order to ensure sustainable economic development and environmental protection in the face of growing threats from modernisation. Such action requires a concerted effort on the part of range ecologists, livestock specialists, forage agronomists, wildlife biologists, sociologists, economists, and development planners to devise development programmes sensitive to the range resources and the needs of the local pastoralists. The rangelands of the Hindu Kush-Himalayas and Tibetan Plateau are remarkable ecosystems. Sensitive ecosystems such as these grazing lands demand sensitive approaches.

ANNEXES

Annex 1
Workshop Shedule

TUESDAY, NOVEMBER 5, 1996

Opening Session

0900	Registration
0930	Welcome Address, Mr. Egbert Pelinck, Director General, ICIMOD
0950	Purpose & Outline of the Workshop, Mr. Daniel Miller, ICIMOD Rangeland Specialist
1000	Overview of Rangelands in the Hindu Kush-Himalayas, Mr. Daniel Miller, ICIMOD Rangeland Specialist
1045	Tea/Coffee/Refreshments

Paper Session: Rangeland Status Reports

Chairperson: Daniel Miller
Rapporteur: Dr. Shaheena Malik

1115	Bhutan, Dr. Pema Gymatsho
1145	Nepal, Mr. Dala Ram Pradhan and Mr. Rameshore Pande
1215	India, Dr. Panjab Singh
1300	Lunch
1415	Pakistan, Dr. Abdul Wahid Jasra
1445	Tibetan Plateau of China, Mr. Daniel Miller
1515	Discussion
1530	Tea/Coffee/Refreshments

Paper Session: Socioeconomic Aspects/Ethnobiology

Chairperson: Dr. Onur Erkan
Rapporteur: Dr. Joe Fox

1545 Ms. Sienna Craig
1615 Mr. Denis Lamont
1645 Dr. Nehal Farooquee

WEDNESDAY, NOVEMBER 6, 1996

Paper Session: Rangeland Biodiversity

Chairperson: Dr. R.C. Sundriyal
Rapporteur: Mr. Devendra Amataya

0900 Dr. Joe Fox
0930 Dr. Pralad Yonzen
1000 Cai Guiquan and Daniel Miller
1030 Tea/Coffee/Refreshments

Paper Session
Rangeland Ecology/Management & Pastoral Development

Chairperson: Daniel Miller
Rapporteur: Dr. Pema Gyamtsho

1045 Dr. Sundriyal
1115 Dr. Wu Ning
1145 Mr. Mirza Myhammad Hakeem
1215 Dr. Mohammad Saleem
1245 Mr. Ze Bai

1315 Lunch

Paper Session: Forage and Fodder Development

Chairperson: Dr. Panjab Singh
Rapporteur: Dr. Abdul Wahid Jasra

1415 Dr. Bhag Mal
1445 Mr. Amjad Saleem
1515 Discussion

1530 Tea/Coffee/Refreshments

1545 Dr. Pema Gyamtsho & Tsering Gyaltshen
1615 Mr. Dinesh Pariyar
1645 Discussion

THURSDAY, NOVEMBER 7, 1996

Paper Session: Special Reports

Chairperson: Daniel Miller
Rapporteur: Dr. Bhagmal

0900	Report from Turkey, Dr. Onur Erkan
0930	Report from Turkey Dr. S.P.S. Beniwal
1000	Discussion
1030	Tea/Coffee/Refreshments

Discussion Session: Major Issues

Chairperson: Daniel Miller
Rapporteur: Dr. Panjab Singh

1100-1300	Discussion on Major Issues
1300	Lunch

Discussion Session: Priorities for Action

Chairperson: Daniel Miller
Rapporteur: Dr. Pema Gyamtsho

1415-1530	Discussion
1530	Tea/Coffee/Refreshemnts

Discussion Session: Conclusions

Chairperson: Daniel Miller
Rapporteur: Dr. Abdul Wahid Jasra

1545-1645	
1645	Closing Comments
1800	Dinner at ICIMOD Guest House

Annex 2
List of Participants

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ICIMOD

Founded out of widespread recognition of degradation of mountain environments and the increasing poverty of mountain communities, ICIMOD is concerned with the search for more effective development responses to promote the sustained well being of mountain people.

The Centre was established in 1983 and commenced professional activities in 1984. Though international in its concerns, ICIMOD focusses on the specific, complex, and practical problems of the Hindu Kush-Himalayan Region which covers all or part of eight Sovereign States.

ICIMOD serves as a multidisciplinary documentation centre on integrated mountain development; a focal point for the mobilisation, conduct, and coordination of applied and problem-solving research activities; a focal point for training on integrated mountain development, with special emphasis on the assessment of training needs and the development of relevant training materials based directly on field case studies; and a consultative centre providing expert services on mountain development and resource management.

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ICIMOD Workshops are attended by experts from the countries of the Region, in addition to concerned professionals and representatives of international agencies. Professional papers and research studies are presented and discussed in detail.

Workshop Reports are intended to represent the discussions and conclusions reached at the Workshop and do not necessarily reflect the views of ICIMOD or other participating institutions. Copies of the reports, as well as a Catalogue of all of ICIMOD's Publications, are available upon request from:

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Nepal	Pakistan

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