Special Publication

Yak on the Move

Transboundary Challenges and Opportunities for Yak Raising in a Changing Hindu Kush Himalayan Region

ICIMOD

FOR MOUNTAINS AND PEOPLE

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The International Centre for Integrated Mountain Development, ICIMOD, is a regional knowledge development and learning centre serving the eight regional member countries of the Hindu Kush Himalayas – Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan – and based in Kathmandu, Nepal. Globalization and climate change have an increasing influence on the stability of fragile mountain ecosystems and the livelihoods of mountain people. ICIMOD aims to assist mountain people to understand these changes, adapt to them, and make the most of new opportunities, while addressing upstream-downstream issues. We support regional transboundary programmes through partnership with regional partner institutions, facilitate the exchange of experience, and serve as a regional knowledge hub. We strengthen networking among regional and global centres of excellence. Overall, we are working to develop an economically and environmentally sound mountain ecosystem to improve the living standards of mountain populations and to sustain vital ecosystem services for the billions of people living downstream – now, and for the future.

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Foreword

Yak is specially adapted to a high-altitude environment and is a flagship species for the Hindu Kush Himalayan (HKH) region. It plays a key role not only in agrobiodiversity conservation and maintaining the high rangeland ecosystem, but also in cultural traditions, livelihood strategies, and all aspects of socioeconomic development in the high mountain areas from the Hindu Kush Himalayas to the Tien Shan and Altay mountains. But yak are increasingly coming under pressure with closed borders and restrictions on grazing and movement. Furthermore, yak herders are facing immense livelihood challenges, not least due to climate change, and the younger generation is unwilling to continue with traditional yak herding, which poses a severe threat to this traditional occupation. Maintaining the number of yak, improving the condition of the pastures, and raising the living standards of the local yak herders is a growing challenge in the region.

The International Centre for Integrated Mountain Development (ICIMOD), as a regional knowledge-based institution with a programmatic emphasis on transboundary landscape management, has a long history of working on rangeland ecosystem management and pastoral development in the extended HKH region. Recognizing the importance of yak, ICIMOD has been co-organizing the International Conference on Yak since 1997, and has helped a large number of professionals, policy makers, and rangeland managers from the region to participate and share their knowledge and experience on yak husbandry and rangeland management with others. Recently, ICIMOD has been focusing on the conservation of transboundary landscapes through livelihood improvement, with a view of identifying equitable development strategies for people dependent on high-altitude ecosystems. Yak as a critical species for remote pastoral areas links the topics of conservation and development, and ICIMOD worked with the organizing committee of the 5th International Conference held in Lanzhou, China in the summer of 2014, to offer a special session on transboundary issues in yak husbandry. The main aim was to provide a platform for the exchange of experience and knowledge among scientists, policy makers, and local practitioners on the sustainable development of yak husbandry in transboundary landscapes of the Hindu Kush Himalayan region and other areas of yak distribution. Specifically, the session provided a forum for participants, especially those from ICIMOD member countries, to share knowledge and exchange views on such topics as the sustainable management of rangeland resources and yak husbandry in a transboundary context; traditional knowledge and practices on yak husbandry and related migratory grazing systems; traditional and innovative adaptations of yak-raising communities in response to change; conflicts between biodiversity conservation and socioeconomic development in yak-raising communities living in areas adjoining protected areas and along national borders; and options and opportunities to improve crossborder cooperation for the improved welfare of the yak-raising communities through enhancement of the value chains for yak products.

This special volume provides a selection of the presentations made by participants during the session, and provides some reviews of yak husbandry and genetic conservation in the high-altitude areas of the HKH region. The articles clearly indicate the need to develop a comprehensive understanding of the ecological, socioeconomic, and cultural role of yak, and its implications for biodiversity conservation and sustainable development at a local, regional, and even global scale.

My thanks and gratitude go to all the regional member country partners and other experts who contributed to this session and manuscript preparation. I hope that the volume will prove to be a valuable addition to the literature on yak and help in updating our knowledge of the conservation biology and ecology of this iconic animal.

David Molden, PhD
Director General
ICIMOD

Preface

The yak is a multipurpose semi-domesticated species raised by the people living at the limits in the high elevation areas of the Hindu Kush Himalayan (HKH) region. The major distribution of yak lies in the Qinghai-Tibetan Plateau in China, with relatively small populations present in the HKH countries of Afghanistan, Bhutan, India, Nepal, and Pakistan, and a few other places like the neighouring southern Altay region. During the last few decades, yak husbandry and the related traditional grazing systems – sedentary, semi-nomadic, and nomadic – have been facing a range of challenges and risks.

From very early times, yak herding, breeding, and management have formed an important part of traditional cultures, religions, and social life in the HKH region, with several ethnic communities and tribes highly dependent on yak for their day-to-day activities, livelihood options, and tourism. Yak production, we believe, will continue to be one of the major means of supporting pastoralists in the high-altitude areas of the HKH region in the future. Thus, there is a need to improve yak production, conserve yak genetic diversity and traditional breed selection systems, and improve the livelihoods of yak herders. Recognizing the importance of yak, the International Centre for Integrated Mountain Development (ICIMOD) assembled partners and experts from its regional member countries to participate in the 5th International Conference on Yak in Lanzhou, China on 27–31 August 2014, and shared their ideas at a special session on 'Transboundary Issues in Yak Husbandry in the HKH Region'. The participants included a diverse array of professionals, policy makers, and rangeland managers; contributions from the conference are presented to a wider audience in this book. This is the second publication on yak produced by ICIMOD, with the first one on 'Conservation and Management of Yak Genetic Diversity', jointly edited by ICIMOD and FAO, published 20 years ago in 1996.

Yak is a relatively insignificant species in national terms within the countries of the HKH region even in China (and perhaps except for Bhutan), but it is a critical livestock to the livelihood security of herders in the difficult environment of the high mountains. Compared to other livestock, relatively little attention has been given to yak by researchers and decision makers, but there have been a few reports from a number of the HKH countries. China has the largest yak population in the world and has also been the source of more scientific studies, with reports since the 1960s on topics such as yak biology, ecology, and management. The first book dedicated entirely to yaks was 'Sichuan Yak' by Cai Li, a small masterpiece published in 1989 in Chinese. This was followed by a second book – 'China Yak' – by the same author published in 1992, which was translated into English and published by FAO in 1995 as 'The Yak'. In 2003, a second extensively revised edition of this book was published. The discussion of yak in different regions was greatly enlarged and much more information was included on yak rearing and yak research in different countries in the HKH region, although information for

remote areas is still limited. The milestone work in Nepal was 'Yak and Chauri Husbandry in Nepal' by Durga Datt Joshi published in 1982, following publication of a few articles on yak in Nepal in scientific journals and reports. India established the National Research Centre for Yak in 1989, and the National Bureau of Animal Genetic Resources (Karnal, Haryana) carried out a pilot study in yak-raising areas. There have been only occasional scattered publications on yak in India, although a few articles on yak distribution and production systems can be traced back to the 1960s or earlier. Overall the scientific community has paid more attention to studies of reproduction and hybridization in yak compared to other topics, and there are many publications in this area in Asia and beyond. As early as 1946, Phillips et al. reported on yaks and yak-cattle hybrids in Asia in the *Journal of Heredity* (37: 163-170, 207-483). However, systematic work on breed selection and yak hybridization only started after the 1960s in China. The book on 'Heredity and Breeding of Yak', published in 1996, introduced up-to-date advances in breeding and crossbreeding of yak in China. A few years later (2004), another book on 'Yak Production in Central Asian Highlands' provided a broader introduction to the production and reproduction status of yak, not only in China but also in neighbouring countries. Only very limited information was available before the 1990s for the other yak raising countries (Afghanistan, Bhutan, Pakistan) in the HKH region, with the exception of a few papers with brief introductions to yak distribution and management systems.

Yak production will continue to be one of the major means of supporting pastoralists in the high elevation environments of the HKH region, as few other domestic animals can survive in these areas. However, yak herders are among the poorest of people and are marginalized from policies, access to services, and information. They face immense challenges from climatic and other changes and remain on the fringes of development. Notwithstanding the importance and significance of yak in the high-altitudes of the HKH region, there is a lack of up-to-date, empirical, and adequately documented scientific knowledge regarding the current status and management practices of yaks. This volume aims to enhance our understanding of yak in the region; it brings together 14 articles from the HKH regional countries of Afghanistan, Bhutan, China, India, Nepal, and Pakistan covering a wide range of subjects. It is divided into three sections. The first, with seven chapters, focuses on yak herding and challenges in the HKH region. It provides an overview of yak distribution together with reviews on yak husbandry in the high-altitude areas of the HKH region outside of China, with a focus on transboundary issues and the challenges of yak grazing along the high mountain ranges. The second is devoted to a discussion on policy and institutional arrangements related to yak grazing and breeding issues in the HKH countries. The papers mainly highlight policies on yak farming, integrated approaches to institutionalizing transboundary rangeland resource management, and management of animal disease and fodder shortages. The final section focuses on hybridization and crossbreeding of yak. Following an introduction to the indigenous system of yak selection in Pakistan, two papers describe the advances in yak breeding, and the use of molecular technology in China, where biological technologies applied to yak breed selection have greatly developed over the last two decades. The

successful experience and advanced knowledge can be shared with other yak raising areas to help alleviate the heavy pressures faced by yak herding dependent communities.

We are confident that this volume will provide valuable insights that will help in developing plans for yak genetic conservation, pastoral development, and management measures to enhance system resilience and the adaptive capacity of local communities to ongoing and potential changes.

Eklabya Sharma, PhD
Director of Programme Operations
ICIMODg

Acronyms and Abbreviations

AHD	Animal Husbandry Department
AFLP	amplified fragment length polymorphism
AKF	Aga Khan Foundation
AKRSP	Aga Khan Rural Support Programme
APP	Agriculture Perspective Plan
CBD	Convention on Biological Diversity
DoLP	Department of Livestock Production
DLS	Department of Livestock Services
EnS	environmental stratification
FAO	Food and Agriculture Organization
GB	Gilgit Baltistan
GDP	gross domestic product
GIS	geographical information system
GPS	global positioning system
HAADP	High-altitude Area Development Project
HLDP	Highland Livestock Development Project
HKH	Hindu Kush Himalayas/n
ICIMOD	International Centre for Integrated Mountain Development
KL	Kanchenjunga Landscape
KPL	Karakoram-Pamir Landscape
KSL	Kailash Sacred Landscape
masl	metres above sea level
NDVI	Normalized Difference Vegetation Index
NTFP	non-timber forest product
PRA	participatory rural appraisal
QTP	Qinghai-Tibetan Plateau
RAPD	random amplified polymorphic DNA
RCF	regional cooperation framework
RCP	representative concentration pathways
RRA	rapid rural appraisal
SAARC	South Asia Association for Regional Cooperation
SNP	single nucleotide polymorphisms
SRAP	sequence-related amplified polymorphism
SSR	simple sequence repeat
TAR	Tibet Autonomous Region
TMI	The Mountain Institute
UNEP	United Nations Environment Programme
WCS	Wildlife Conservation Society
WWF	World Wide Fund for Nature

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This book is a synthesis of existing knowledge and ongoing research work on yaks being done in the HKH region. The authors have developed their papers based on their research and the projects that they have been involved in with their respective organizations. We would like to acknowledge and thank those participants and presenters from the Hindu Kush Himalayan region who provided invaluable information on yaks during the conference held in 2014.

First and foremost we would like to extend our gratitude to the Lanzhou Institute of Husbandry and Pharmaceutical Sciences (CAAS) for organizing the 5th International Conference on Yaks in Lanzhou, China, from 27 to 31 August, 2014; co-organizers Yak and Camel Foundation of Germany. We would like to appreciate the support provided by David Molden, Director General of ICIMOD, for his encourgement and motivation to organize the special session in the International Conference on Yaks; Eklabya Sharma, Director of Programme Operations, ICIMOD, for his contributions and inputs during the special session and also giving key recommendations; Farid Ahmad, Ritu Meher Shrestha and Wang Jinniu for their support during the conference. We are thankful to Rajan Kotru, Regional Programme Manager, Transboundary Landscapes, ICIMOD, for his continuous support in organizing the special session and editing this book. The editors would also like to convey thanks to ICIMOD initiatives – Kangchenjunga Landscape, Karakoram-Pamir Landscape (now called Hindu Kush Karakoram Pamir Landscape), and Wakhan Landscape – for their support and providing a platform to the participants from the different landscape working areas to present their work.

We would like to extend our thanks to the external reviewers, Long Ruijun and Gopal Singh Rawat, for their valuable support and contribution, which substantially increased the value of this publication as well as A Beatrice Murray for editing the entire text. Special thanks goes to our colleagues in ICIMOD for making this publication possible: Faisal Mueen Qamer and Gauri Dangol for providing us with the maps and graphics being used throughout the book; Amy Sellmyer for her editorial inputs; Dharma R Maharjan for assisting and providing design and layout support; Nakul Chettri and Muhammad Ismail for providing data and references and Li Wei for her support is data collection and review.

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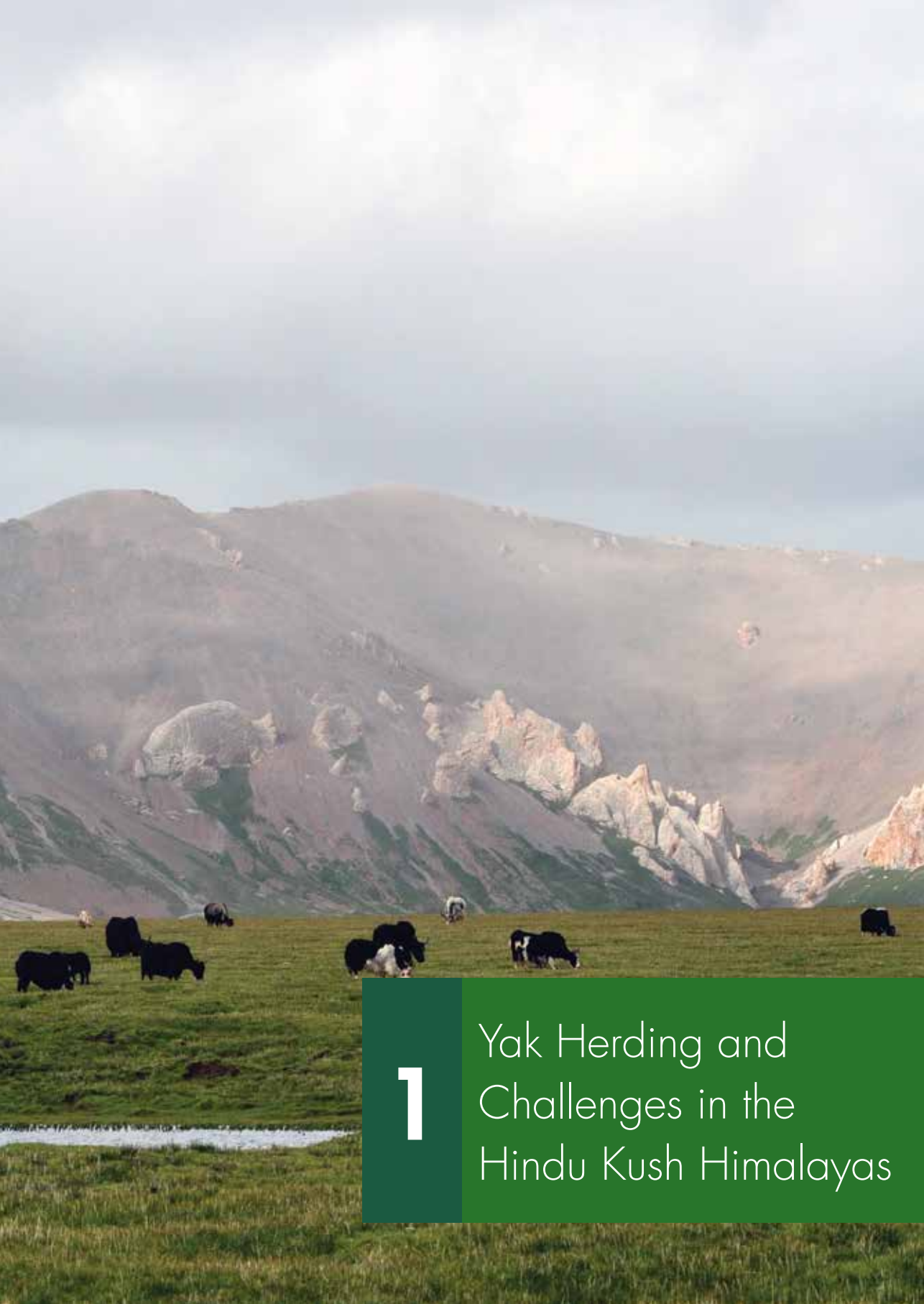


1 Yak Herding and Challenges in the Hindu Kush Himalayas

Coping with Borders: Yak raising in transboundary landscapes of the Hindu Kush Himalayan region

Wu Ning, Muhammad Ismail, Yi Shaoliang, Srijana Joshi, Faisal Mueen Qamer, and Neha Bisht
International Centre for Integrated Mountain Development, Nepal

Yak rearing in the Hindu Kush Himalayan (HKH) region is practised over a wide geographical area involving diverse groups of people, cultures, indigenous knowledge, ecological zones, migration patterns, crops, genetic resources, and socio-ecological interactions. The major yak distribution areas in the HKH lie in the high mountains in the border areas between China and neighbouring countries. In these places, yak rearing is still an important livelihood strategy for the local communities even though there has been a decline in the total yak population in some countries like India, Nepal, and particularly Bhutan. As in other places, yak rearing in the high mountains of the HKH is facing challenges and issues that vary from country to country and from case to case. The challenges posed by a shortage of winter fodder, a decline in the number of yaks as well as young herders, restrictions on mobility and exchange, and climate change are shared by all the landscapes identified by the International Centre for Integrated Mountain Development (ICIMOD) for transboundary conservation and development initiatives that have yaks. All these issues are crossborder in nature, and the strategies needed to address the challenges often go beyond local and national levels and can only be successful with regional cooperation. Meanwhile, yak rearing should be managed through a holistic, landscape approach integrating social, economic and cultural factors with the ecological aspects.

Keywords: crossborder, Hindu Kush Himalayan region, pastoral development, transboundary landscape, yak

Introduction

The extensive rangelands that occupy roughly 60% of the total land surface of the Hindu Kush Himalayan (HKH) region (Joshi et al. 2014) have been used for livestock grazing by pastoral societies for hundreds or even thousands of years. Even today over half of the regional population still lives directly or indirectly under nomadic or semi-nomadic livestock production systems (Miller and Craig 1997; Wu and Yan 2002). Most of the rangelands in this region lie in high-altitude areas, and people associate these high-cold pastures with yak (*Bos grunniens*), a well-adapted high-altitude multipurpose large mammal belonging to the Bovidae family (Wiener et al. 2003). In these harsh and remote high mountains, where other land uses are close to impossible without external input, rearing and breeding yaks together

with small ruminants such as sheep and goats is almost the only way for the diverse ethnic groups who live in the region to utilize the rangeland resources. As a flagship species of the HKH region, highly adapted to the high-altitude environment (cold winter, low oxygen content, high solar radiation, and cyclical nutrition with short growing seasons), yaks are inextricably linked to the local livelihood and socio-culture, playing a key role not only in conservation of agrobiodiversity but also in cultural heritage (e.g. Tibetan culture), livelihood strategies (e.g. yak products and value chains), and almost all aspects of socioeconomic development in the high mountain areas (Wu 2003).

Since ancient times, the transboundary frontiers in the high HKH region have been meeting places for different military, political, and cultural forces that have had multi-dimensional impacts on yak-raising communities and the rangeland resources they rely on. Many mountain passes or trading ports in the Himalayas, the Karakoram, and the Pamir became important channels through which yak-related knowledge, practices, and culture and yak breeds spread from their place of origin – the eastern Tibetan Plateau – to peripheral areas. In the last few decades, yak husbandry and the related traditional grazing system, including sedentary, semi-nomadic, and nomadic systems, have been facing various challenges due to climate change, population increase, socioeconomic reforms, geo-political dynamics, and the ubiquitous globalization occurring in all the HKH countries. Meanwhile new opportunities are unfolding for these previously remote yak-raising communities due to the rapid advancement of biotechnologies (e.g. molecular breeding), information technologies (i.e., increasing accessibility of information and creating new electronic business), and globalized markets (i.e., shortening the distance to markets and diversifying demands such as organic foods).

Learning from the successful experiences of transboundary approaches towards ecosystem management in several continents (UNEP 2011), the authors suggest that similar approaches should be adopted in the HKH region to address transboundary issues related to yak husbandry, such as genetic exchange, product trading, sustaining value chains, and cultural conservation. In the last 30 years, a lot of attention has been paid to the central area of yak rearing, i.e. the Qinghai-Tibetan Plateau region (or in short 'Tibetan Plateau') in China, home to over 90% of the world's yak population. But in the neighbouring regions where yaks are grazed in the high mountains following a migratory pattern (e.g. transhumance), studies on yak raising are still very limited, and the yak herding groups and yak-raising areas are often marginalized in national development plans. This paper focuses on the issues and challenges of yak raising along the high-altitude HKH crest outside China. We suggest that sustainable yak raising and rangeland ecosystem management can only be achieved through an integrated approach that takes full account of the transboundary nature of the issue and challenges and allows the free flow of services beyond the administrative boundaries.

Yak in the HKH region outside the Tibetan Plateau

Within the HKH region outside the Tibetan Plateau, yaks are found extensively in the alpine and subalpine belts and occasionally the temperate belt, at altitudes from 2,000 masl (e.g. in

Nepal) to over 5,000 masl (e.g. in the Karakoram-Pamir Landscape). Yak-raising areas outside of China lie along a narrow belt along the Himalayan arc from the Hindu Kush and Pamir in the west (Afghanistan and Pakistan), through the central Himalayan range, (India, Nepal, and Bhutan), to the southern end of the Hengduan Mountains where they meet with the eastern Himalayas in the transboundary landscape between China and Myanmar. The westernmost region of yak rearing within this belt is reported to be on the northeastern face of Tirich Mir (the main peak of the Hindu Kush) where about 500 yak and yak hybrids were found (Kreutzmann 2003). To the east, yak rearing (including hybrids) is practised all the way from Sikkim and Bhutan to the easternmost area where China and Myanmar meet. The southern border of this belt almost aligns with the contour of the southern slopes of the Himalayan range, clearly indicating the linkage between yak distribution and temperature. According to Cai (1989), yaks are distributed naturally in the area with the warmest monthly mean temperature below 13°C, but their hybrids can be found at much lower elevations. Roughly estimated, there are about 206,000–210,000 yaks and yak hybrids in the HKH region outside of China.

The western part of this arc is a contiguous region dominated by high mountain ranges, including the eastern Hindu Kush, Karakoram, the eastern Pamir, and the western Kunlun Shan mountains. This immense landscape is characterized by enormous levels of glaciation at high-altitudes contrasted with extremely arid valley systems, and provides substantial grazing grounds at high elevations, where yak still form a prominent part of animal husbandry alongside herds of sheep and goats. Although formal transborder trade of yaks may have ceased in the last few decades (Kreutzmann 2003), the yaks in the Pamir and its surrounding mountainous areas were believed to have dispersed from the Tibetan Plateau in ancient times (Wiener 2013).

In Afghanistan, yak keeping is restricted to Badakhshan province, i.e. Zebak and Wakhan, where Wakhi and Kyrgyz herders utilize the natural grazing area of the Pamir at 3,600–4,500 masl during the summer (Kreutzmann 2003). Wakhi people mostly inhabit the lowland areas but send their yaks to the pastures of Big Pamir. The Kyrgyz people live in the Pamir and graze their animals in both the Big Pamir and Little Pamir. According to recent studies by the Wildlife Conservation Society and Aga Khan Foundation, around 4,600 yaks use the Big Pamir and Little Pamir (see article by Ali et al. in this book).

In Pakistan, yaks are mainly distributed in the northern mountain ranges from the Hindu Kush through the Karakoram into the west Himalaya, i.e. from Chitral to Gilgit-Baltistan province, where mountain pastoralists dwelling at the upper limit of settlements are engaged in yak raising and breeding. A recent census indicated that there were 7,875 yaks in Chitral in 2014 (Livestock Department Chitral; Table 1) and that there had been a rapid increase in the yak population between 2010 and 2014. The exact number of yaks in Gilgit-Baltistan is still hard to establish. The statistics vary considerably across different reports (Cai and Wiener 1995; Khan 1997; Kreutzmann 2003; see Khan et al. in this book). The Provincial Livestock Department survey in 2006 reported that there were 16,319 yak in five districts (Figure 1)

Table 1: **Yak population in Chitral District, Pakistan**

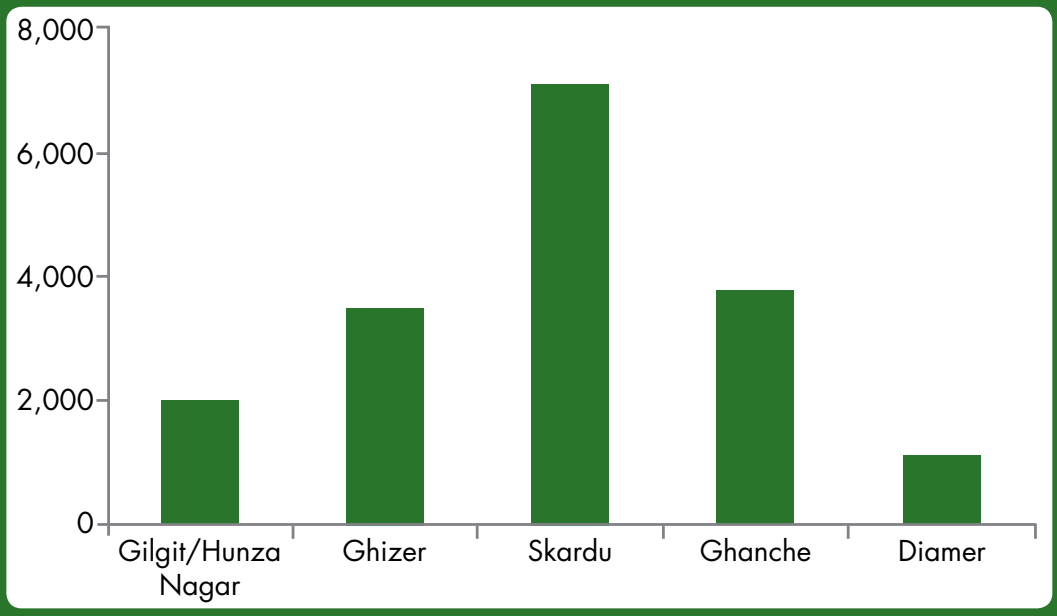
	Year				
	2010	2011	2012	2013	2014
Laspur valley	2,000	2,500	2,900	3,500	3,580
Yarkhoon valley	1,500	2300	3,000	NA	4,000
Torkhow valley	150	150	NA	210	230
Terich valley	35	40	50	50	65
Goboor valley	15	10	8	0	0
Total	**3,700**	**5,000**	**5,958**	**3,760**	**7,875**

NA = data not available
Source: Livestock Department Chitral, Pakistan

(Livestock Census Department 2006). A World Wide Fund for Nature (WWF) document from 2012 reported 35,430 yak and yak hybrids in the buffer zone of Central Karakoram National Park, which only involves four of the seven districts in Gilgit-Baltistan (WWF-Pakistan 2012). Thus, the total number of yaks in Pakistan still warrants a good study.

In India, yaks are mainly distributed in the mid-Himalayan zone at elevations below 5,000 masl, which extends from the bend in the Brahmaputra River to the east to the bend in the Indus River to the west (Pal and Madan 1997). Jammu and Kashmir and Himachal

Figure 1: **Yak population in Gilgit-Baltistan, Pakistan**



Source: Livestock Census Department (2006)

Pradesh, where the dominant vegetation is alpine steppe or desert due to the arid and cold climate, account for about 72% of the total yak population in India. The remaining yak areas in India are mostly located on the southern slopes of the central and eastern Himalayas and are characterized by a cold but humid climate. The yak population in these areas is very small and scattered over very isolated mountain pockets. During the cold season from October to May, yaks (including hybrids) may be driven downward to winter grazing areas in the forest belts. According to the government livestock census, the total number of yaks in India was 59,000 in 1997, 83,370 in 2007, and 76,662 in 2012 (GOI 1997, 2007, 2012). There was a significant increase in the yak population from 1997 to 2007 and a slight decrease after 2007 with a negative growth rate of 7.6%. The changes in the numbers of yak over the years seems to differ among the states, with some maintaining a constant number.

Nepal and Bhutan in the central Himalayas have relatively large yak populations. In Nepal, yak and its hybrids (chauri) are distributed in 28 northern districts. A survey conducted in 2009/10 by the Department of Livestock Services of Nepal reported 68,097 yaks and yak hybrids in 26 districts with an increase over the previous ten years. A recent survey by the Ministry of Agriculture Development (MOAD 2013) in all 28 districts with yak populations, reported a total of 65,980 yaks and their hybrids, with a slight decrease over the last three years (Table 2). Yak herding is transhumant in Nepal with a seasonal migration between elevations of 3,000 and 5,000 masl. Many Nepali pastoralists and agropastoralists raise yaks for crossbreeding purposes, and a large portion of the hybrid population (over two-thirds of the total) can be found in the temperate belt where better feed is available. Yaks are bred with hump cattle (*Bos indicus*) and humpless cattle (*Bos raurus*) to produce crossbreeds (chauri) for milk production, draught power, and transportation (Pal and Madan 1997).

Table 2: **Yak and yak hybrid population in Nepal (1999–2013)**

District	1999	2009/10	2012/13	District	1999	2009/10	2012/13
Bajhang		120	134	Manang	4,709	4,549	3,811
Bajura		67	80	Mugu	2,250	2,250	1,782
Bhojpur		648	854	Mustang	5,037	4,077	4,422
Darchula		660	697	Myagdi		287	228
Dhading		69	66	Nuwakot		768	903
Dolakha	4,470	4,470	3,551	Panchthar		1086	1092
Dolpa	6,605	10,168	7,450	Ramechhap	1,229	1,872	2,034
Gorkha	3,641	1,366	1,655	Rasuwa	5,027	2,493	3,007
Humla	2,029	11,999	12,747	Rukum			10
Ilam		162	180	Shankhuwasabha	3,024	3,945	3,950
Jumla	2,051	558	592	Sindhupalchok	321	1,032	1,032
Kalikot		47	55	Solukhumbu	12,059	12,097	12,033
Kaski			129	Taplejung	4,036	2,845	3,017
Khotang		123	150	**Total**	**56,488**	**67,758**	**65,661**

Source: DLSO 1999; DL 2012; MOAD 2013

Table 3: **Yak population in Bhutan (2006–2013)**

District	2006	2008	2010	2013
Bumthang	3,487	3,984	3,360	2,974
Gasa	11,910	9,511	7,545	5,787
Haa	7,520	3,583	4,895	5,857
Lhuentse	456	454	223	234
Paro	4,823	4,314	3,290	2,632
Samdrupjongkhar	0	0	0	28
Thimphu	9,645	11,073	10,223	10,984
Trashigang	11,863	11,093	7,094	7,153
TrashiYangtse	595	622	588	541
Trongsa		979	58	80
Wangdue Phodrang	2,612	2,787	3,098	3,273
Total	**52,911**	**48,400**	**40,374**	**39,543**

Source: DOL 2013

In Bhutan, yak rearing is the main source of livelihood for those living at high-altitudes. According to the livestock census in 2013, there were 39,543 yaks (including hybrids) in 11 districts (dzongkhags) across the country's northern belt, which extends from Haa district in the northwest to Merak Sakten in the extreme northeast of Trashigang district (Table 3). In 2008, around 2.2% of Bhutan's population was involved in yak herding with the herders distributed over 34 subdistricts in ten districts (Dorji et al. 2003; DOL 2008). Thus the yak production system has considerable national importance, unlike in many other yak-rearing countries. The western region has the highest density, with more than 50% of the total yak in Bhutan. Bhutan's climate is characterized by short wet summers and cold dry winters. Semi-nomadic yak herders graze their yaks on the high-altitude summer pastures but also have permanent settlements at lower belts in the form of village clusters which serve as the base of operations for yak rearing and other socioeconomic activities (Tshering et al. 1997). Over the last seven years there has been a marked decline in the yak population in Bhutan, which is believed to be due to the lack of quality pasture, limited access to social services, and outmigration of labourers seeking alternative economic opportunities (Derville and Bonnemaire 2010; Wangchuk et al 2013).

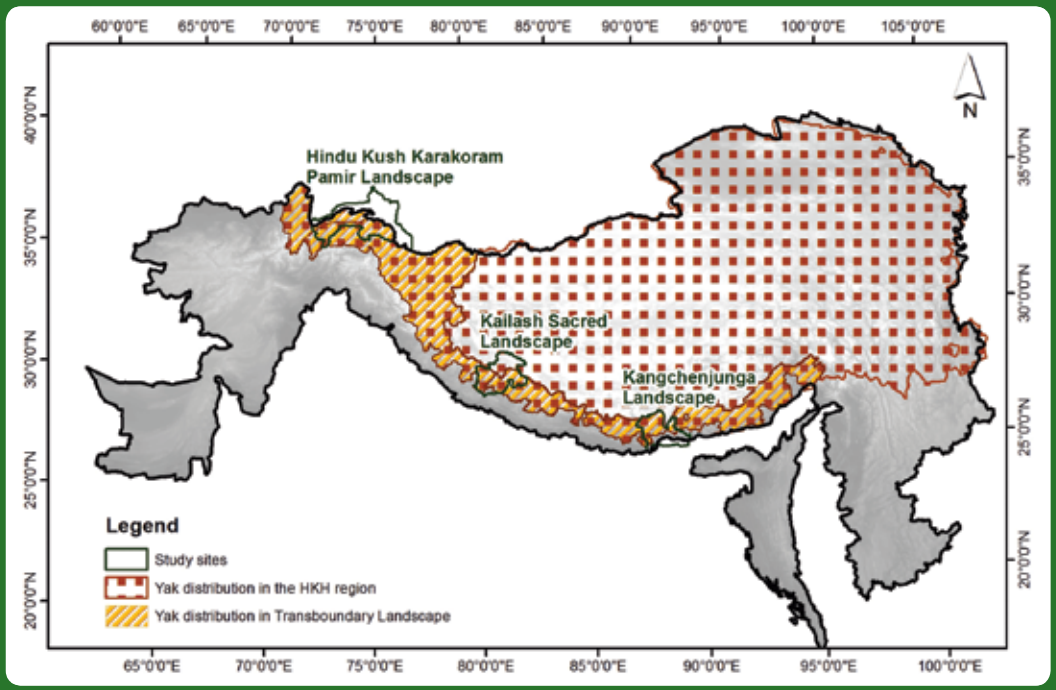
Yak raising in selected transboundary landscapes

Although the composition of livestock herds varies in different ecological regions, yaks are an important means of subsistence and productivity in all high-altitude pastoral societies in the HKH region, and contribute more than simply meat, milk, and clothing materials. Along the HKH range, local herders traditionally shared the summer pastures on the mountain crests, and it was very common for grazing yaks to cross the present-day administrative borders in the alpine belts. Such mobility was essential for the sustainable use of the rangeland resources

as well as for the survival of the livestock management system. Moreover, it created opportunities for communication and exchange among different ethnic groups. Thus, trading yaks for genetic improvement, exchanging animal products between herders and farmers, and using yaks to transport goods across Himalayan passes are traditional practices in the remote high mountains. The crossborder trade was accompanied by the exchange and sharing of different cultures, practices, and knowledge, which was the basis for traditionally diversifying livelihoods and enabling mountain communities to adapt to change.

Similarly, in the HKH region, the success of conservation measures in one country often depends heavily on what is happening across the political border. Biodiversity conservation approaches in transboundary areas need to be able to address the common concerns of all the related countries if they are to be effective. Over the last few years, ICIMOD and its partners have identified some specific transboundary landscapes of regional or global significance for programmatic cooperation. These landscapes are subsets of larger trans-Himalayan transects, where ICIMOD and its partner institutions plan to gather scientific information and strengthen interventions to promote conservation and management of landscapes with ecological and socio-cultural significance (Sharma et al. 2007; Chettri et al. 2009). Three of the identified transboundary landscapes have yak rearing (Figure 2) and are implementing ecosystem-based management to improve the livelihoods of the local communities and enhance the ecological integrity and socio-cultural resilience to environmental change.

Figure 2: **Three of the transboundary landscapes in the HKH region that have yak rearing**



Hindu Kush Karakoram Pamir Landscape (HKPL)

The Hindu Kush Karakoram Pamir region links Afghanistan, Pakistan, Tajikistan, and China. It lies at the convergence of several important bio-geographical regions and possesses a unique and rich assemblage of biodiversity. The region is also the source area or contains upper streams of three important international rivers – the Amu Darya, Tarim, and Indus – and thus has great conservation value. For millennia, the region has been an important corridor through which influential ethnic groups migrated across Eurasia, from east to west and north to south. It is a key link in the well-known Ancient Silk Road as well as an important arena for geopolitical struggle (Wu et al. 2014a). All of these have resulted in an extremely diverse cultural and regional history.

To conserve the biological diversity, preserve its ethnically traditional cultures, and promote sustainable socioeconomic development, the respective countries and governments have established protected areas in various categories (nature reserves, national parks, sanctuaries, and others) across the region. In March 2014, Wakhan District was officially declared by the Government of Afghanistan as Wakhan National Park. As a result, at least six protected areas in the region are now physically connected with each other. This connected complex of protected areas covers an area of over 33,000 km^2 with more than one million people within or in its adjacent watersheds.

The biggest population of yaks within this landscape is found on the China side. There were over 15,000 yaks in 2013 in Taxkorgan County (China), most of which are grazed nomadically by Tajik herders in the western part of the county among the Karakoram peaks with elevations above 4,200 masl. Many rangelands within the Taxkorgan Nature Reserve are important summer pastures for yak rearing, e.g. those near the Khunjerab Pass on the Pakistan-China border. Khan (1997) estimated that there were 6,000 yaks in Khunjerab National Park (KNP) on the Pakistan side in the area along the Pakistan-China border in the country's extreme north. There is one major distinction in yak breeding in northern Pakistan. Hybridization is practised more in eastern parts such as Baltistan (Kreutzmann 2003), however, a pure breed of yak is kept by herders in upper Hunza in Gilgit district, where there is no tradition of crossbreeding yak with local cows (Rasool et al. 2002). The trend in the eastern areas indicates the traditional influence on crossbreeding practices from the original area where yak were raised, in China; hybridization is practised by local communities to adapt the animals to lower elevations where local cattle are available and hybrids can provide more services and goods. Qi et al. (2008) used molecular genetic data to study the routes by which domesticated yaks dispersed from the original centre in the eastern Tibetan Plateau in ancient times, and concluded that one of the two dispersal routes was over the various passes in the Himalayan and Kunlun Mountains through which yaks and breeding practices spread westward into the Pamir Knot.

Many of the protected areas within the Hindu Kush Karakoram Pamir Landscape are adjacent to each other and have common protected species and ecosystems; while historically many of the high passes between different countries have been important biological corridors for the migration of animals, both important wildlife species and domesticated animals Thus, one of the key issues frequently mentioned by conservation managers and policy makers regarding protected area management in the region is human-wildlife conflict, especially the competitive use of domestic animals and wildlife on the same rangeland resources (Wu et al. 2014b). Rangelands in the protected areas are traditionally used by the local inhabitants and adjacent communities as summer or winter pastures. However, they are also important habitats for wildlife. To effectively manage this competitive use of rangeland resources by domestic animals and wildlife, we need to fully understand the seasonal demand for forage by the animals and the seasonal overlap of habitats.

Kangchenjunga Landscape (KL)

The Kangchenjunga Landscape (KL), shared by Bhutan, India, and Nepal, covers a vast area around the southern part of Mount Kangchenjunga. It is one of the richest of the HKH landscapes in terms of cultural and biological diversity and lies within one of the 34 global Biodiversity Hotspots (Mittermeier et al. 2004). The landscape has 15 protected areas, together covering an area of more than 15,000 km^2. Land cover data from 2010 indicate that about 20% of the KL is rangeland, and animal husbandry is an integral part of the whole farming system (Gurung et al. 2015). Yak rearing is the main source of livelihoods for local communities in the high elevation belts of the landscape in Bhutan, Sikkim in India, and

eastern Nepal. Local communities at high elevation practice transhumance, moving with their livestock between higher pastures in summer and lower valleys in winter. Movements of people and yak herds mixed with sheep and goats proceeds between previously used sites, which become more or less regular seasonal encampments or bases (Chettri 2008).

In KL-Bhutan, yak plays an important role not only in the livelihoods of the Bhutanese but also in their religious and cultural life. In 1997, Pal and Madan reported about 5,346 yaks in KL-India (Sikkim) with 46% lactating females and 19% calves, of which 90% were in the northern district (Pal and Madan 1997). Trading between Tibet Autonomous Region (TAR) and Sikkim is one of the main off-farm activities of the people in the high altitudinal belt (above 2,500 masl). A national survey in 2013 reported 4,289 yaks and yak hybrids in KL-Nepal distributed across Taplejung, Panchthar, and Ilam districts (MOAD 2013). Here, too, crossborder trade with TAR is an important factor in sustaining livelihoods, especially in the Upper Tamor area (mainly the upper parts of Taplejung district) (Gurung et al. 2015). Although there are several trading points in summer between TAR and KL-Nepal, in winter trade only takes place through Taplejung (Paudel 2010). Yaks and yak products are the main goods traded.

There are many factors impacting yak herding in the KL. Government restrictions on livestock numbers in the KL region and on movement in national parks were identified recently as a new challenge for pastoral development, which would inevitably lead to a change in livestock structure and migration routes (Gurung et al. 2015; see also the Border Closing section below). Although the development of community forestry in Nepal has resulted in the restoration of forests, it has also led to a shrinkage of winter grazing lands for livestock, and some forest owners have rejected yak grazing on their lands. Some traditional migration routes and trading routes for pastoral communities have been closed. The fragmentation of landscape has exacerbated the inbreeding of yak and other livestock, leading to further genetic degradation and poor performance. Recently, the impact of tourism and the attractions of other income-generating activities (e.g. medicinal plant collection, cardamom cultivation, and tea gardening) have also reduced the incentive for local people to pursue yak herding.

Kailash Sacred Landscape (KSL)

The Kailash Sacred Landscape (KSL) spreads over an area of about 31,000 km^2 in the remote southwestern portion of Tibet Autonomous Region (TAR) of China, adjacent districts in the Far Western region of Nepal, and the northeastern flank of Uttarakhand State in northern India, and represents a diverse, multi-cultural, and fragile landscape (Zomer and Oli 2011). The landscape is characterized by numerous sacred sites, including high-altitude lakes, snow peaks, and a fine network of religious places across the three countries. The local communities from the three countries have maintained cultural and socioeconomic linkages with one another, but the landscape is facing accelerated environmental changes due to drivers such as population increase, globalization, and outmigration, as well climate change. Livelihood options are limited, which adds to the harmful nexus of resource degradation and poverty.

The bioclimatic zone in the landscape ranges from 500 masl in the lower areas to 7,694 masl – the peak of Mount Kailash (known in different places as Gangrenboqi or Khang Rinpoche). The landscape includes hot and semi-arid regions in the southwest, as well as mountain forests, moist alpine meadows, high-altitude steppe, and extensive areas of permanent snow and ice. About 27% of the KSL area is classified as rangeland, i.e. various types of grasslands and open shrub (Zomer et al. 2013). Livestock rearing is one of the main land uses, especially in the higher altitude areas. In KSL-China the landscape is dominated by high-altitude steppe and meadows, which supported a yak population of about 4,600 in Burang (Pulan) County of TAR in 2013. The traditional trade between Burang and Khojamath in Nepal, which has operated for over 500 years, delivers the goods and products flowing from the pastoral area of TAR to downstream areas and vice versa. KSL-Nepal has a yak/yak hybrid population of 13,578 (mostly hybrids) located in Humla, Bhajang, and Darchula districts (MOAD 2013). The yak population in KSL-India is very limited (only about 200) due to the lower elevation (Pal and Madan 1997). Pal and Madan (1997) also attributed this low yak population to the fact that the inhabitants of the lower hill regions are ethnic Hindus who do not know about, or care to know about, yak husbandry techniques, as this animal does not fit into their social structure.

Trends towards degradation were reported in the whole landscape, with factors including 1) an increasing number of less productive livestock; 2) increasing demand for fodder and consequent seasonal shortage of green fodder; and 3) a decrease in available grazing land (Zomer and Oli 2011). Overgrazing in high-altitude areas has led to grassland degradation, soil erosion, water loss, and loss of biodiversity. The increase in goat rearing for cashmere production poses another severe threat to the alpine ecosystem, especially for steppe and sparse meadow types. In addition to human disturbance, climate change was considered as a new challenge for the vulnerable communities and fragile ecosystem in high-altitude areas.

To better understand the potential impacts of projected climate change in the KSL region, an environmental stratification based on geospatial tools was used by ICIMOD to simulate future trends (Zomer et al. 2013, 2014). The results showed that the projected mean annual temperature will increase from 2.2 to 3.3°C by 2050; while the average representative concentration pathways (RCP) predicted increases in precipitation ranging from 7.1 to 11.1%. Climate change will inevitably lead to boundary changes for the ecosystems. The study predicted that both the distribution and extent of bioclimatic zones will shift substantially by the year 2050 for all the RCP scenarios. Based on their average elevation, each of the bioclimatic zones will migrate upwards on average from 188 to 467 masl along the elevation gradient. At the eco-regional level, a large expansion will take place in the middle altitude classes (e.g., subalpine coniferous forests and alpine meadow), and a decrease in the highest altitude classes (nival zone, alpine tundra, and alpine steppe). However, the implications of climate change for pastoral livelihoods as a whole has yet to be fully understood (Zomer et al. 2013; see also Climate Change section below).

Common issues concerning yak grazing across the transboundary landscapes

Yak grazing remains an important livelihood strategy for rural inhabitants in the high elevation areas of the Hindu Kush Himalayan region. However, as in China, the main centre for yaks, yak rearing is facing a multitude of challenges and issues that vary from country to country and from case to case. In the following, we discuss some of the common issues faced by the yak-raising communities in the selected transboundary landscapes, with a special focus on the transboundary nature of these issues.

Insufficient feedstuff in winter

Yak production systems are often constrained by inadequate forage, especially in winter, and this leads to poor nutrition, slow growth, health-related problems, and reduced fertility. In many yak-raising areas, these problems are exacerbated by increasing livestock numbers which places greater pressure on rangelands and leads to overgrazing. In the high-altitude belts of the HKH region, the yak can gain substantial weight in the summer season grazing the rich and fertile pastures. However, lack of forage during the cold winter and early spring is a common issue impacting pastoral production. Livestock inevitably suffer hunger and cold on snowy and windy days and have a negative energy balance; many lose weight, emaciate, and die. Heavy snows are always followed by grievous losses among livestock and can even cause mass mortality as high as 50% percent (Wu and Yan 2002). The cycle of storing energy during the summer in preparation for the harsh winter conditions applies to all animals in the herds of pastoralists.

The cold winters in these high mountain ranges impact the production of alpine vegetation and thus the dependent livestock. The winter pastures in the pastoral areas of the HKH region are mainly located in the lower valleys; they account for around one-third of the total rangeland area but support two-thirds of the year's grazing time. This imbalance prevails from Pakistan and Afghanistan in the west to Nepal, Bhutan, and the Hengduan Mountains in the east. In the west, such as in the Pamir, Karakoram, and Kashmir, the extremely dry conditions mean that livestock cannot get sufficient extra feedstuff in winter, and yaks and sheep routinely lose up to 30% of their bodyweight. Fortunately, in the central Himalayan region (e.g. in Nepal) the situation is alleviated to a certain extent as yak herds can receive some supplementary feed (e.g. crop residues) as they are driven down to lower forests and even to villages during the winter period. However, this benefit is being reduced due to the conflicts between herders and farmers on land tenure following the development of community forestry (Chaudhary et al. 2014; Gurung et al. 2015).

Decline in yak populations and yak herders

The yak population in Bhutan, India, and Nepal has shown a declining trend in recent years. Pal (2003) reported a marked decline in the yak population in India from 132,000 in 1977 to

51,000 in 1997 (or 59,000 according to the Livestock Census of India, see above). In Nepal, the total number of yak and yak hybrids in 2013 was 65,980 (MOAD 2013), a marked decline from the estimated 200,000 yak and yak hybrids in 1961 (Joshi 2003).

The decline in yak populations is caused by complicated socioeconomic factors. In Nepal, the decline is at least partially related to government restrictions on livestock numbers and movement in Nepal's national parks, threats from predators and disease, and the reduction in availability of fodder (Pandey and Chettri 2005). The impact of tourism and the attraction of alternative opportunities have also reduced the incentive to pursue yak herding (Sherchand and Karki 1997; Joshi, 2003). More educated youth in the Sherpa community, for example, are unwilling to remain in traditional yak husbandry and have shifted their profession from yak husbandry to other types of employment (Shaha 2002).

The article by Wangda in this book describes the situation in Bhutan, where yaks and yak herding have been losing their importance as an important source of livelihood for the transhumant pastoralists in the high mountains. This trend is more evident in areas where there are other economic opportunities, such as collection of medicinal plants, small-scale tourism development, and cash crop cultivation. More and more yak herders have moved down to lower areas, and the seasonal migration routes have become shorter, which means a change from nomadic to more sedentary pastoralism.

Pal (1993) discussed the socioeconomic causes of yak decline in India, and suggested that the desire of the younger generation for an easier and more comfortable lifestyle is one of the major factors. The increasing outmigration in recent years from the HKH countries may indicate a change in mountain areas, where young people migrate to urban areas or even the Gulf countries for labour (Wu et al. 2014b). Outmigration is used by mountain pastoralists to mitigate economic hardship and deal with the seasonal constraints imposed by the harsh climate. Outmigration from pastoral to urban areas can not only provide financial assets for promoting livelihood diversification (Hoermann et al. 2010) but also reduce pressures on rangelands to some extent. With the impacts of globalization reaching previously remote yak-raising areas, people have begun to question whether this traditional lifestyle can be maintained.

Restricted mobility

Spatial mobility is the key feature of, and an adaptive strategy for, yak husbandry. The closure of political borders and establishment of protected areas over the past decades have greatly hampered yak mobility and weakened the adaptive capacities of yak-raising communities, as well as having a negative impact on the rangeland ecosystems across the region.

In the yak raising areas of the HKH region adjoining China, the yak population is thought to be suffering from inbreeding due to the lack of availability of new yak germplasm from the original yak area, the Tibetan Plateau, during the past few decades, and the resultant practice

of prolonged use of the same bull within herds (Miller et al. 1997). Current yak breeding practices in these countries have led to inbreeding, which lowers rates of survival and yak performance. Although access to many yak raising areas is improving with modernization, yak herders are often still marginalized. Social services are inadequate and outlets to markets for their animal products are limited. Crossborder access has not become any easier with the rapid globalization of the last few decades.

Looking back, it is clear that lack of new yak germplasm and reduced or ceased crossborder trade for yak and its products have become the norm not only between China and its adjoining countries, but also among other countries in the HKH region, since the 1950s. Over the past century, for example, yak herders in Little Pamir have been subjected to continuous spates of geopolitical changes that are completely beyond their control. In the 1890s, Badakhshan was divided into two by Russia and Great Britain, and the Kyrgyz people in Little Pamir were separated. This border was then strictly restricted after the 1930s by the Soviet Union. After the 1950s, the border between Afghanistan and China in the Wahkan Corridor was closed, leaving no possibility for the Wahki and Kyrgyz herders to get new yak germplasm from outside. The limited trade between Pakistan and Afghani Wakhan was also blocked after the 1990s due to terrorism concerns. The Wakhan corridor and the Afghan Pamir have thus become an isolated 'island' in terms of the exchange of yak genetic resources and the yak husbandry economy (see article by Ali et al. in this book).

As traditional exchange lines have been interrupted due to adverse political conditions on the Pakistan side, all forms of animal husbandry have been limited to subsistence survival strategies in recent years. Kreutzmann (2003) reported that the Kyrgyz in Afghanistan are engaged in yak breeding and limited barter trade with entrepreneurs from neighbouring Hunza in Pakistan. Between China and Pakistan, itinerant traders supply basic necessities in exchange for yak and yak products through the Sino-Pakistan Highway. However, in recent years this transborder trade has also ceased to exist due to terrorism concerns and frequent mountain hazards. In the western Himalayas, the disputed situation in Kashmir since the 1950s has also blocked most of the traditional crossborder trade routes across this yak raising plateau.

In the central Himalayan region, the livelihoods of pastoralists in the Kangchenjunga Landscape are threatened by various external forces from modernization to policy imperatives. Following the establishment of protected areas in the transborder areas between KL-Nepal and KL-India, livestock herders from both countries are facing problems in moving their herds to the traditional grazing sites (Chaudhary et al. 2014). In the northern transborder areas of Nepal, alpine pastures are traditionally opened (at least there is no strict control) to yak herders from both China and Nepal. After implementation of the agreement banning transborder use of pastureland in the 1980s, the previously accessible high mountains across the borders cannot be used as pasture (for more details see other article by Wu et al. in this book). This has led to overgrazing in the lower altitude rangelands due to the shortened

migration routes. Closing of the borders between China and Bhutan, and China and India after the 1960s also led to a shortage of the pure yak bulls needed for genetic improvement.

Climate change

Climate change, land use change, and population dynamics are the main drivers of environmental change in the HKH region (Singh et. al. 2011; Sharma 2012). Climate data available from the region suggest an increase in temperature which is greater at higher elevations. Climate change is known to have a significant impact on species distribution and diversity patterns. Warming temperatures in the high elevation region can have a negative impact on yak populations because of their lack of tolerance for heat, the reduction in habitat, and associated decline in yak survival and/or reproduction (Haynes et al. 2014). Maximum entropy studies have shown that an estimated average of 30–50% of the ungulates on the Tibetan Plateau may lose their distribution area, and may become endangered locally and globally (Luo et al. 2015).

Research also shows that climate change may increase the risk of occurrence of disease in yaks (Wangchuk et al. 2013). According to studies conducted in different parts of the Himalayan region, climate change is forcing communities to migrate to higher elevations in search of productive grazing lands, with an early start in the upward migration due to shortening of the winter period. Climate change is known to have a synergistic effect on the already existing challenges of dwindling yak populations, yak husbandry, degradation of high-altitude pastures, and shortage of feed and fodder, and even on changing social norms (Gyamtsho 2000; Maiti et al. 2014).

At the same time, a projection study in the KSL indicated that climate change could also lead to an increase in grass productivity and increase in pasture area. Considering the mobility of yak pastoralism and its ability to adapt to scarce and variable natural resources in a harsh environment, mobile pastoralism could show comparative advantages. With the upward encroachment of forests due to the warming effect, alpine pasture would also extend to up-slopes. However, the limitations posed by borders are a barrier to such adaptation, and increasing climatic variability means that we need to provide more space for mobility. Thus, it is not yet possible to reach a conclusion on whether the impacts of projected climate change on the pastoral system as a whole will be negative or positive. In the future, it will be essential to recognize and identify the impacts of climate change on yak species and their habitats scientifically in order to provide support for sustainable yak rearing in the region. Monitoring of yak habitats and associated species can also provide a good indication of the health of the ecosystem and of the dependent yak species.

Conclusion: Towards a transboundary landscape approach

The conservation of yak genetic resources, sustainable use of high-altitude rangelands, and development of yak-based food industry in the HKH region need regional cooperation based

on a transboundary landscape approach. This approach, as defined in CBD (2004), represents an important means for coordinating the efforts of countries that share important transborder ecosystems It is an evolving concept in the conservation of biological diversity, in which conservation means much more than simply protecting a species or an ecosystem within a confined area (Hamilton and McMillan 2004). The transboundary landscape approach implies using a landscape approach to conservation, with coordinated planning for a whole landscape rather than for a limited area defined in terms of political or other boundaries. It takes into account both the ecological interdependence across the international boundary, and the interdependence of the communities located along or close to the border. On the other hand, landscape management implies using an integrated approach in the management of extended landscapes, defined by ecosystems rather than political boundaries, in which both conservation and sustainable use of the components of biological diversity are considered, and in which people and their socio-cultural resources are placed at the centre of the conservation framework.

It has become increasingly clear over the years that in order to conserve yak genetic resources, conservation activities must look beyond protecting a particular population or a delimited area. The yak population is decreasing at an alarming rate, partly due to the low economic benefits derived from yak husbandry. Conservation and sustainable use of yak resources in the high mountains of the HKH region must thus take a holistic view, using a comprehensive and multi-scaled approach that not only considers a whole range of interlinked grassland, yak, and other animals, both wild and domesticated, but also includes both pastoral and farming areas, considers the needs and interests of the people who rely on these areas for their livelihoods, and even takes into account the entire global market and human demands outside this region.

The general belief that traditional pastoral practices need to be improved has largely shaped pasture development policy throughout the world. However, in the HKH countries, planners have generally ignored the role of livestock in development and failed to appreciate the efficacy of traditional pastoral systems In view of the adaptation of local communities to climate change, the advantages of seasonal pastoral migration should be integrated into development plans. There is an urgent need to develop policies and programmes that are sensitively attuned to and supportive of local people who are the prime actors at the interface of the man-nature relationship. Good progress can be seen in the development by Nepal and Pakistan, with the support of ICIMOD, of national or provincial rangeland policies that promote integrated approaches to rangeland ecosystem management. Sustainable innovations for economic enhancement or environmental improvement can only be introduced if there is a high degree of relevance to prevailing local cultural and production practices and traditions. Yak production systems, and especially their socioeconomic and cultural characteristics, are still poorly understood by researchers and livestock development planners due to the extreme marginalization of these groups. This lack of understanding often results in inappropriate yak development projects at a regional scale. All of these issues together combine to create considerable challenges to improving yak productivity and

enhancing the adaptation capacity of yak herders to change. Many of the challenges faced by yak raising in the transboundary landscapes are of crossborder nature. The strategies needed to address these challenges go beyond the local and national levels; they can only be successful with regional cooperation.

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Survival in the Frontiers: Yak husbandry of Kyrgyz communities in the Pamir region of Afghanistan

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In 2012, the Afghan Pamir had 331 Kyrgyz households with 1,545 people and 3,220 yaks. Yak husbandry is one of the pillars for the subsistence of these Kyrgyz communities who live in environmental extremes between geopolitical frontiers. Yaks are raised for meat, milk, fibre, and fuel and are also barter-traded for essential commodities, mostly with seasonal and occasional traders from distant lowland Wakhan and other places in Afghanistan, as well as from Tajikistan and Pakistan. The key issues faced by yak husbandry and the yak raising Kyrgyz communities in the Afghan Pamir are low productivity, shortage of energy, lack of veterinary services, lack of markets, low overall adaptability, and high social vulnerability. Increasing the energy supply and improving energy use efficiency will be a key entry point for any development intervention in the Afghan Pamir. Other recommended measures include promoting sustainable rangeland management technologies and practices, improving marketing conditions, strengthening veterinary services, improving breeds, setting up innovative insurance systems, and building the awareness and capacity of the herders. Closer collaboration between Afghanistan and its neighbouring countries, especially Tajikistan, to promote crossborder linkages between the confined Kyrgyz communities and the nearby communities across the border can create opportunities for the communities to change. If policy makers have the political will to put humanity before geopolitics, the remote communities in all the countries in the region can be turned into a frontier of economic cooperation for common prosperity.

Keywords: Afghan Pamir, crossborder collaboration, Kyrgyz, Wakhan Corridor, yak husbandry

Introduction

The Afghan Pamir is located in the south of the Pamir Mountains and includes part of both the so-called Big Pamir (Pamir-e-Khurd) and Little Pamir (Pamir-e-Buzorg) (Figure 3). The Big Pamir comprises the main block of high mountains and the plateau at the western end of the Pamir Knot, while the Little Pamir consists of two main mountain ranges at the eastern end of the Pamir Knot. The overall terrain of the Afghan Pamir lies above 4,000 masl, with ridges and peaks rising between 6,500 and 7,000 masl. This area constitutes the eastern part of the Wakhan Corridor, a narrow strip of northeast Afghanistan wedged between Pakistan and Tajikistan that stretches about 350 km from the Afghanistan town of Ishkashim to the China-

Figure 3: **The Wakhan Corridor, Big Pamir, and Little Pamir**

Afghanistan border. The area borders Tajikistan to the north, China to the east, and Pakistan to the south.

There are no climate data available specifically for the Afghan Pamir since there are no weather stations dedicated primarily to this area. People have to rely on surrounding stations in Tajikistan, Pakistan, and Afghanistan for estimations of climatic data. However, the great variability of micro-climates across the region in both temperature and rainfall makes such estimations difficult and not very accurate. According to the synthesis made by Vanselow (2011) using weather station data from the Tajik Pamir, the annual rainfall in the eastern Pamir mountains is generally less than 100 mm, and the annual average temperature is below 0°C. In July, the average temperature rises to between 8 and 12°C. There is an extremely short frost-free period of around 10 to 30 nights per year. Potential evaporation is estimated to be about 1,000 mm/yr and the relative humidity is 50 to 70% in winter and approximately 20% in summer.

The Afghan Pamir is the main pasture area for the Wakhi and Kyrgyz people. Wakhi people inhabit the lowlands and are engaged in both farming and pastoralism. They mainly graze on the Big Pamir and western end of the Little Pamir, while the Kyrgyz communities are pure pastoralists; they inhabit the Pamir Plateau and graze their animals, mainly yaks, sheep, and goats in both the Big Pamir and Little Pamir.

The Afghan Wakhi and Kyrgyz communities as victims of the erstwhile imperial geopolitical structure have been extensively studied by scholars at different times from different

perspectives (Shahrani 1979; Kreutzmann 2003). Shahrani (1979) used the term 'closed frontier nomadism' to describe the Kyrgyz pastoralism in the Afghan Pamir and describes the cultural and ecological adaptation of the nomadic Kyrgyz and agricultural Wakhi to high-altitudes and a frigid climate. A high degree of uncertainty of all types including geopolitical, ecological, and environmental variables is 'normal' for areas like the Afghan Pamir and is constantly testing the adaptive capacity of the inhabitants. Kreutzmann (2003) analysed the evolution of the survival strategies of the Kyrgyz and Wakhi communities and aptly concluded that "adapting to a changing social-political framework has affected the strategy of nomads and mountain farmers alike".

Recently the Wildlife Conservation Society (WCS) studied the socioeconomics and range use of the Wakhi households using the Afghan Pamir and generated very good information, but they deliberately paid little attention to the Kyrgyz communities (Mock et al. 2007).

With the objective of improving project intervention, the Aga Khan Foundation (Afghanistan) surveyed the pastoral economy and range use of the Kyrgyz households on the Afghan Pamirs in 2012 to collect information on range use and yak raising by these communities to provide a scientific and knowledge base for programme design. The aim was to use the results of the survey to help the Kyrgyz communities improve their livelihood. One of the major components of the study was yak husbandry, and this is the focus of this paper.

The survey was conducted in July–August 2012 in the Afghan Pamir; it covered 29 settlements with 36 households sampled for household interview. Semi-structured household interviews, key informant interviews, village meetings, and field observations were designed and used to collect information on per-household yak numbers, the prevailing grazing system, the contribution of yak raising to livelihoods, and major yak husbandry products and their marketing. Key problems and issues regarding yak rearing were also discussed with the herders during the survey. The questionnaires aimed to collect basic information on yak husbandry and livelihoods of the communities. A technical team composed of an agriculturist, veterinary doctors, and women officers were trained to conduct the field survey. The team also visited the key pasture areas in the surveyed area. This paper presents the key findings of the survey and aims to highlight the key issues and challenges faced by the Kyrgyz communities in yak husbandry and to identify potential areas for interventions. The section on rangelands and pastures is mainly based on a separate survey conducted in the same area by WCS and others.

Rangelands and pastures in the Afghan Pamir

The rangelands in the Afghan Pamir are an extension of the Central Highland rangelands of Afghanistan that extend all the way from Ghazni to the Little Pamir (Ali et al. 2013). They have formed over time under the influence of geology, soil, climate, animal use, and anthropogenic impacts. The potential value of the different rangelands is largely associated with their plant communities; at the same time, the productivity of the rangelands is often limited by water, cold temperature, and soil depth.

The most recent and detailed study on rangeland resources and its uses in the Afghan Pamir was carried out by WCS in 2006 and 2007 (Bedunah 2008). Using satellite images from late July and mid-August 1999, they analysed the Normalized Difference Vegetation Index (NDVI) of the rangelands used by the Kyrgyz communities in both the Big Pamir and Little Pamir (Table 4).

According to the analysis, only 52.4% of the total area is suitable for grazing, including about 16.8% of medium to high productivity sedge meadow, 16.7% of sagebrush steppe, 16.5% of cold desert low shrub, and 0.2% salt flat.

WCS further delineated the rangelands into six vegetation cover types, one further subdivided into four, using a systematically designed field survey and predominant vegetation characteristics, and measured the standing crop productivity of these types (Bedunah 2008). The results are summarized in Table 5.

In comparison to the vast areas covered by different types of dwarf shrub vegetation, meadows that offer high yield and quality forage are scarce and are limited to areas with good water conditions. However, these meadows are major grazing areas for yaks.

In another detailed study carried out in the nearby Tajikistan Pamir, Vanselow (2011) classified the rangelands into seven types/classes: desert, dwarf shrub desert, dwarf shrub cushion steppe (teresken type), dwarf shrub cushion steppe (wormwood type), spring turf, alpine mats, and screes. The overall phytomass (not forage) for all investigated plots was

Table 4: **Land cover in the Afghan Pamirs as defined by NDVI**

Land cover	Area (ha)	Description
Snow/glacier	36,161	Areas of 'clean' snow and ice
Glacier ice	42,491	Areas of snow/rock mix
Rock	108,644	Scree slopes, rock cliffs, non-vegetated mountainsides
Water (high sediment)	19,073	Mostly streams and some small ponds with high sediment; melting snow and ice around glaciers in the August image also show in this class
Carex meadow/alpine meadow (high productivity)	41,453	Areas of highest productivity; difficult to discern some types as often mixed; *Carex* meadows most common where site receives additional water
Carex and grassland (moderate productivity)	33,557	Areas of moderate productivity. Difficult to discern as some types are often mixed
Cold desert low shrub	73,549	Difficult to discern as mostly bare ground and low biomass
Sagebrush steppe	74,351	Includes a number of 'tall' *Artemisia* types
Salt flats	9,937	Areas of high salts with low vegetation cover
Water	5,080	Water, predominately lakes
Total	**444,272**	

Source: Bedunah (2008)

Table 5: **Rangeland community types and total standing crop in the Afghan Pamir**

Vegetation cover and community type	Key species	Standing crop (kg/ha)
***Artemisia* Steppe** 1.1 Artemisia/Festuca-Stipa community	*Artemisia rutaefolia, Festuca* spp., *Poa* spp., *Koeleria cristata., Potentila* sp., *Neptea* sp., *Astragalus* sp.	**Total: 475** Shrub: 228 Forb: 150 Grass: 120
1.2 Artemisia/ Acantholimon community	*Acantholimon erythraeum, Acantholimon gili, Acantholimon pamiricum, Ephedra* sp., *Artemisia rutaefolia, Stipa* sp., *Festuca* sp.	**Total: 207** Shrub: 119 Forb: 29 Dryland sedge: 8 Grass: 50
1.3 Festuca community	*Festuca alaica, Festuca pamirica, Festuca rubra, and/or Festuca valesiaca, Poa* sp., *Elymus nutans, Koeleria cristata*	**Total: 330** Grass: 321
1.4 Stipa community	*Stipa caucasica, Stipa trichoides, Pipthatherum* sp.	**Total: 177**
Low *Artemisia* Shrub	*Artemisia leucotricha, Artemisia vachanica; Stipa* sp., *Hordeum* sp., *Leymus* sp., *Krascheninnikovia lanata* (occasional)	**Total: 202** Shrubs: 131; Grass: 54; Forbs: 7 Dryland sedge: 11
Krascheninnikovia Shrub	*Krascheninnikovia lanata; Leymus* sp., *Stipa* sp.	**Total: 189** Shrub: 153 Grass: 35
Salt Grass	*Puccinellia* sp., *Leymus* sp., *and Hordeum* sp., *Chenopods* sp., *Achnatherumsplendens, Juncus* sp., *Carex* sp.	**Total: 836** (98–1690)
Sedge Wetlands Meadow	*Carex* sp., *Kobresia* spp	**Total: 1,226** Grass: 46 Forb: 52
Alpine Grassland	*Trisetumspp., Agrostisspp., Poa* spp., *Festucaspp., Phleum* spp., *Aloepecurus* spp., *Ranunculus* spp., *Delphinium* spp., *Anemone* spp., *Potentilla* spp., spp. *Pedicularis* spp., *Oxytropis* spp., *Gentiana* spp., *Primula* spp., *Allium* spp., *Waldhemia* spp., *Taraxacum* spp., *Polygonum* spp., *Papaver* spp., *Nepeta* spp., *Sedum* spp., *Primula* spp., spp. *Saxifraga* spp., *Geranium* spp., several *Asteraceae, Brassicaceae, and Neptea* spp., *Potentilla* sp.	600 (guesstimate)

Source: Summarized from Bedunah 2008

1,023.5 ± 128.8 kg/ha in summer and 953.1 ± 228.6 kg/ha in winter. The seasonal difference in the total forage supply is not very significant. Sedge-dominated meadows offer high quality and productive forage for yaks but are small in area. Shrub-dominated areas have low fodder quality and productivity, but due to their large area they are very important for pastoralism in the Pamir, especially in the winter months.

Yak population in the Pamir region

The Kyrgyz area in the Big Pamir includes the Bai Tibat, Tila Bai, Ilgonak, Beshkunak, Shaur, and Shaur Maqur watersheds and all watersheds south of Lake Zorkol (including the streams

Qara Jilga, Istiq, Maqur, and several smaller streams), while the Kyrgyz area in the Little Pamir includes the areas east of the Warm Zherav and Bai Qara watersheds. The total area for both is around 4,500 km^2.

There are altogether 14 Kyrgyz settlements in the Big Pamir and Little Pamir (eight in the Little Pamir and six in the Big Pamir) with 331 households (162 in the Little Pamir and 169 in the Big Pamir) and 1,545 people (743 males and 802 females). The households reported having a total of 3,220 yaks, just under 10 yaks per household (range 5.4 –18.5, with a median around 10.0). The yak number per household was 12.5 in the Little Pamir but only 7.0 in the Big Pamir (Table 6).

Two factors contributed to the big difference in yak numbers per household in the Big Pamir and Little Pamir. Firstly, the Little Pamir has more rangeland resources and the Kyrgyz pastoralists in the Little Pamir are wealthier with more animals; secondly, an 'amanat' (an Arabic word used in reference to any item/thing given to another person to use for a fixed period of time and then to be returned to the owner undamaged) system exists in the Big Pamir where Wakhi people with access to the Big Pamir 'lend' their animals, mostly yaks, to the Kyrgyz people to raise for them, especially during the winter months. In return, the Kyrgyz are paid in kind in calves or milk products. This system helps the poor Kyrgyz pastoralists who have no or few yaks to meet the livelihood needs of their families.

Table 6: **Yaks owned by the Kyrgyz households in the Afghan Pamir**

Settlement	Area	Total no. of households	Total no. of yaks	Yaks per household
Bazaygumbez	Little Pamir	28	300	10.7
Oqjilgha	Little Pamir	18	227	12.6
Uchjilgha	Little Pamir	15	166	11.1
Erghail	Little Pamir	25	270	10.8
Seki	Little Pamir	19	279	14.7
Qarajulghay	Little Pamir	19	154	8.1
Kokturuq	Little Pamir	13	171	13.2
Karademir	Little Pamir	25	463	18.5
Subtotal		**162**	**2,030**	**12.5**
Muguly Baytibut	Big Pamir	19	102	5.4
Saratosh	Big Pamir	29	164	5.7
Arghanak	Big Pamir	30	223	7.4
Dashti Mula	Big Pamir	24	241	10.0
Shawer	Big Pamir	28	250	8.9
Istiq	Big Pamir	39	210	5.4
Subtotal		**169**	**1,190**	**7.0**
Total		**331**	**3,220**	**9.8**

Mock et al. (2007) reported 1,380 yaks from Wakhi families using the Big Pamir and Little Pamir rangelands. This makes the total number of yaks in the Afghan Pamir to be around 4,600. Shahrani (1979) reported that 8% (3,360) of the 42,000 animals identified in 1979 were yaks, indicating that there has been a significant increase in the number of yaks using the pastures of the Afghan Pamir over the past decades.

The Krygyz people also keep sheep and goats. The WCS survey recorded a total of 10,607 sheep and goats owned by the Kyrgyz households with 44 per household in the Little Pamir and 20 per household in the Big Pamir. The Wakhi people sent more than 10,100 sheep and goats to graze in the Big Pamir and considerably fewer to the Little Pamir each year (Mock et al. 2007). Thus the total number of sheep and goats grazing the Afghan Pamir could be around 21,000.

Pastures and yak grazing patterns

As in many other places, the rangelands are divided into different seasons, mostly summer and winter pastures (called 'shiber' in Kyrgyz), based on the terrain and climatic conditions and availability of herbage for the animals. The summer pastures are extensive and the pastoralists use their traditional knowledge and experience to move the herds from one locality to another together with their family and belongings, including the local woollen tents (yurts). The winter pastures are mostly near the pastoralists' permanent settlements; the animals are allowed to graze freely and are cared for by the pastoralists' families. Table 7

Table 7: **Seasonal pastures and grazing period in selected surveyed villages**

Village/settlement	Summer and autumn pastures (used early June to late October)		Winter and spring pastures (used late October to early June)	
	Name	Length of use (months)	Name	Length of use (months)
Bozoygumbez	Qurshi	5–6	Bozoygumbez	6–7
	Qurshi bolo	5–6	Khashguz	6–7
	Qurshi poyon	5–6		
	Bog	5–6		
Oqjilga	Birgutya	5–6	Oqjilga	6–7
	Ochiktash	5–6		
	Ukchuray	5–6		
	Sarchitaq	5–6		
Uchjulga	Uchjuljayi bolo	5–6	Uchjulgay	6–7
	Uchjulgayi poyon	5–6	Chilop	6–7
			Okhsoy	6–7
Ergayl	Koshotuk	5–6	Ergayl	6–7
	Karatushutak	5–6		
	Muqir	5–6		
Andemin	Jarturuk	5–6	Andemini poyon	6–7
	Mechitutuk	5–6	Andemini bolo	6–7
	Chuqurturuk	5–6	Seki	6–7
	Garturuk	5–6		
	Chuqurutuk	5–6		
	Otoq	5–6		
Qarajulga	Qarasel	5–6	Qizilkurum	6–7
	Qarajulgay	5–6		
	Qaragarum	5–6		
Kokturuq	Kokturuk	5–6	Ermitak	6–7
	Saiting	5–6	Karatash	6–7
	Jergopchol	5–6		
	Zharguruk	5–6		
Karademir	Karademir	5–6	Ortobel	6–7
	Kalamazar	5–6	Tassery	6–7
	Mukul	5–6		
	Toshpuly	5–6		
	Sirt	5–6		

shows the number of pastures associated with some selected settlements. There are many more summer and autumn pastures than winter and spring pastures. Each group of households has specific areas for yak grazing. The time for grazing in each shiber is normally fixed; however, there is a flexibility in the timing and date depending upon fodder plant phenology and climatic conditions.

Yaks and other domestic animals range freely on the pastures for most of the year, although they are brought back to enclosures near the camping ground or settlement in the evening. In late winter to early spring, or when there is heavy snow or extreme weather conditions, they are stall fed with hay collected in summer. Late winter to early spring is often the most critical period in the year for the yaks. If a family fails to prepare enough hay or dry fodder, they may lose some yaks or be compelled to sell some at a low price. There is a social system among the surveyed communities, which ensures that families help each other by sharing the stored animal feed, but it works only if the adverse conditions do not last long.

Production and marketing of yak products

Milk

Milk is an important source of nutrition for the pastoralists of Pamir, and yaks are the major source of milk production and an important component of the pastoralist's livelihood system. Sixty per cent of the yaks are milk producing. In the surveyed villages, the average daily milk production for a female yak was 2–4 litres, but this can reach 10–15 litres immediately after calving in April to May. Milk production can last till late winter, but the peak is usually during July and August when the pastures are lush with grasses and forbs. Yaks are milked twice a day: once in the morning before they set out for the pastures and once in the evening when they return to the cattle sheds or enclosures near the yurts.

The common local milk products prepared by pastoralists are qurut, yogurt, sour cream, butter, and panir (paneer, a type of cheese). Shir rovoghan (milk and butter boiled together), shir chai (milk tea), and shir brinj (milk with rice) are common local dishes and drinks. Milk processing is mainly done by women.

Meat

Meat production is only a secondary objective for yak rearing in the Afghan Pamir and yak slaughtering is not very common. If slaughtered, a 5–6 year old yak produces an average of 250 kg of meat. Live animals are traded for essential commodities. According to the survey, around 500 head of yak are sold each year from the Big and Little Pamir. Yaks from the Little Pamir are mostly sold to Pakistan and Afghanistan, while those from the Big Pamir are sold only to Afghanistan.

Yak skins/hides

Yak skins/hides are used locally for flooring in the yurts after some local treatment. Some use the skin to cover and support yurts against wind and snow. Some Kyrgyz people make bridles for horses and maghsi – very soft socks made from yak skin after proper treatment (dehairing, felting, and rubbing).

Yak cashmere

Yak cashmere is usually collected in May and June. The fibres are often collected in a mixed manner and used mainly for rugs, yurts, and rope making. On average 500–600 g of cashmere is collected from a mature yak per season. There is no market for the fine cashmere, thus the combed fibre is not further sorted or processed for marketing.

Yak dung

Like pastoralists in other high-elevation areas, shortage of energy is a major concern for the Kyrgyz herders in the Afghan Pamir. Energy is needed all year round for cooking, water and space heating, and processing dairy products. Yak dung is collected, dried, and stored by the pastoralists for use during the year, especially in the long winter months. Collecting yak dung is quite a daunting job in summer as the yaks often range into far-flung areas of the plateau. Yak dung is also used as an alternative to stones or wood to make pens and winter enclosures for yaks and other animals and fresh dung is used for pasting fencing walls to stop wind from entering the houses.

Marketing

There is no regular, local market place for any products in either the Big Pamir or the Little Pamir. There is no road to the Pamir region from Afghan Badakhshan. Flour, rice, and other edible items are transported from Gazkhan in the Wakhan to Big Pamir on horseback or by donkey, a journey of seven days. Goods and edibles are transported to the Little Pamir on horses, yaks, and donkeys from Sarhad-e-Boroghil, a journey of eight days.

In theory, the nearest markets for Kyrgyz pastoralists would be Murgab in the Tajik Pamir and Khorog in Tajik Badakhshan as both are connected to the Little Pamir by metalled roads. However, border restrictions make this almost impossible. As a result, the Afghan Kyrgyz communities have to depend on seasonal or occasional traders from other parts of Afghanistan, or (illegal) traders from Pakistan and Tajikistan to sell their dairy products and exchange for commodities they need.

Live yaks are occasionally sold to traders from lowland Wakhan, Ishkashim, Takhar, Panjshir in Afghanistan, and Chipursan and Boroghil in Pakistan, often to the disadvantage of the local herders. Qurut, maska (butter), and paneer are also marketed. The field survey showed that 29 households in the Little Pamir were engaged in selling these products to traders from lowland Wakhi in Afghanistan, Chipursan in Gilgit (via the Ershad Pass), and Broghil in

Figure 4: **Origin of traders visiting the Little Pamir (borders approximate)**

Chitral, the latter both in northern Pakistan (Figure 4). Some local traders also take the local milk products to Chirpursan for sale or exchange for other essential household commodities, mainly wheat flour, rice, tea, sugar, and salt. Some households mentioned that some Tajik Pamiri traders visited them to exchange household commodities with local livestock products.

There is a crude traditional system for pricing yaks in the Pamir plateau. For example, a male yak (6–7 years) is considered to be equal to 9–10 fat-tailed sheep, while a female yak of the same age is equal to 5–6 fat-tailed sheep. Animals are bartered locally using this system. However, the price for outside traders is negotiated, with prices ranging from 25,000–40,000 AFN (400–600 USD at 2012 exchange rate) depending on the size of yak. (The price in 2014 had already increased to 35,000–45,000 AFN or 600–750 USD.) However, even then, the outside traders would insist on trading their commodities in kind using local animals or animal products so as to get maximum profit from the transaction. The survey found that many pastoralists had bartered their large animals for just two bags of wheat flour (approximately 100 kg, with each bag 50 kg). But 100 kg of flour cost only 48 USD in Faizabad market in 2012.

Yak breeding

There is no scientifically-designed scheme for yak breeding in this remote plateau. Awareness, information, and know-how on yak breeding are lacking among the Kyrgyz pastoralists, who depend totally on indigenous knowledge and practices. Free mating is common, but in some instances the pastoralists select the best vigorous bull for breeding and others are castrated. Little effort has been made to introduce new or improved breeds to the surveyed region.

Key issues and challenges faced by yak husbandry and the Kyrgyz communities

Low productivity

Yak productivity is naturally low due to the low primary productivity of the rangeland resources in high elevation areas. However, in the Afghan Pamir the following factors have particularly limited the productivity of yak husbandry.

Insufficient fodder supply especially during winter

The fodder supply for yak grazing in the Afghan Pamir is inadequate in both quality and quantity. Only around 53% of the total area can be grazed to some degree; the remainder is unusable due to a complete lack of fodder, difficult terrain, water bodies, snow cover, and so on. Fodder production in the part that can be grazed is generally very low. The high-quality sedge meadow that is suitable for yak grazing (with more than 1,000 kg/ha standing crop fodder production) only accounts for 9% of the total area; the bulk of the area is low-quality and low productivity desert or low-shrub desert dominated by *Stipa* sp., *Artemisia* spp., and *Krascheninnikovia* spp. with a fodder productivity barely reaching above 500 kg/ha. According to the survey, the total number of livestock (yaks, goats, and sheep) in the surveyed area had increased rapidly. The increasing demand for forage from domestic livestock has put a great pressure on the wildlife that shares the rangeland resources. Rangeland degradation, manifested as increasing bare ground and decreasing fodder productivity, has increased. The situation has been made worse by the droughts in recent years. Late winter and early spring is the most vulnerable period for yaks, particularly young animals, and the pastoralists lose many yaks every year during spring because of the scarcity of fodder and lack of alternatives or supplementary animal feed.

Poor breed of animals

The yaks in the Afghan Pamir have little genetic communication with yak populations in Tajikistan, China, or Pakistan due to the closed borders and natural barriers, and there is no local scientific breeding scheme either. As a result, the yak breeds in the Afghan Pamir are highly degraded with a small body size and slow growth rate.

High mortality rate due to disease and adverse weather conditions

The yaks have a high mortality rate (6–20%) due to disease, environmental adversity, and the lack of easily accessible services.

Because of isolation, lack of infrastructure, and poor accessibility, only very limited extension services have reached the pastoralists in the Afghan Pamir. Before the Aga Khan Foundation's programme intervention in 2010, there was no vaccination system for yaks or other animals and no paravet or extension services were available from the relevant government

departments or any NGOs. Kyrgyz pastoralists do not have access to, and could not afford to pay for, vaccination services for large flocks of animals.

Yaks in the Afghan Pamir are particularly vulnerable to foot and mouth disease (FMD, locally called oqsil), brucellosis, and anthrax. The calves frequently contract contagious bovine pleura-pneumonia disease. Another main cause for the high mortality rate is the lack of enough winter fodder, which makes the animals very weak in late winter and early spring and extremely vulnerable to cold weather events.

During the survey, local herders reported that in 2011, 106 yaks died in the Big Pamir and 22 in the Little Pamir because of disease, heavy snowfall, shortage of feed, and low temperatures. This high rate of mortality often causes big economic losses to the already impoverished pastoralists.

Energy shortage

Due to the cold weather in the Pamir, the energy demand of the Kyrgyz communities is very high. They need energy for cooking, processing milk products, preparing hot water, and even lighting. And they need energy for space heating all year round. There are no exact data available on the energy demand of Afghan Kyrgyz families. However, studies carried out by the Aga Khan Foundation in the Tajik Pamir indicated that on average each household annually consumes about 3,331 kg of cow dung, 3,462 kg of fuelwood (mainly bushes collected by uprooting from the pastures), and 1,300 kg of coal. In the Afghan Pamir, there is no access to coal and this part has to be made up through the use of vegetation phytomass or cow dung. The negative environmental consequences of this heavy dependence on animal dung and phytomass for energy is apparent. Uprooting of woody plants has reduced the vegetation cover of the rangelands and decreased the supply of forage for the animals (both wildlife and domestic animals). Teresken shrubs are the main fodder sources for goats and sheep in winter, but they are also the major shrubs collected for use as fuelwood. The excessive collection of animal dung for energy has also depleted the rangelands of its fertility, making it more difficult to recover from heavy use. The Tajik Pamir survey estimated that the animal dung used by each household annually could cause a loss of 440 USD (2012 exchange rate) worth of fertility to the pastures. Furthermore, each household must spend 4–8 labourer/hours per day collecting fuelwood, and poor hygienic conditions related to the use of animal dung and fuelwood pose a great hazard to people's health. Energy shortage is becoming a key factor in the sustainable use of rangeland resources as well as the quality of life of the Kyrgyz communities in the Afghan Pamir.

Distance from service centres and markets

People suffer enormously from the lack of a proper health care system. The communities reported high mortality rates related to giving birth, malnutrition, cold weather, and other factors. During the survey, people clearly mentioned that there was a high mortality rate

among women and children, particularly during pregnancy and in the neonatal period, because of the lack of medical health facilities, poor nutrition, and harsh climate. This was reflected in the average family size of only 4.8 in the Kyrgyz communities, compared to 11.3 for the whole of Wakhan District and 7.3 in Afghanistan overall.

Lack of proper markets and information makes it hard for the Kyrgyz pastoralists in the Afghan Pamir to sell their pastoral products such as yak meat, milk, and milk products on a regular basis and at the right prices, and meanwhile they are forced by circumstances to purchase essential commodities from outside traders at exploitative prices. Having to transport goods from far distances by horses adds to the huge cost of essential commodities such as wheat flour and oil. Poor accessibility and lack of regular markets and information makes it difficult for local herders to organize their pastoral activities according to external market demand, while they have to depend on external market goods for their livelihoods. This renders them prey to unfair trading leading to further poverty.

High social vulnerability

The yak-raising Kyrgyz communities in the Afghan Pamir are highly exposed and sensitive to a multitude of shocks and disruptions including unexpected climate extremes, animal and

human disease, food insecurity, domestic politics, and regional instability. At the same time, economic poverty, insufficient external inputs, poor education, lack of alternative livelihoods, opportunities and a social insurance system, and lack of social networks means that the adaptability and transformability of the communities are very low. All these have resulted in high social vulnerability.

Recommended areas of intervention

The following recommendations are made for practical interventions through development programmes based on the analysis of key issues and challenges.

Increasing the energy supply and improving energy use efficiency

Energy will be an important entry point for any conservation and development initiative in the Afghan Pamir; the aim should be to increase the supply of alternative energy sources and increase energy use efficiency in order to reduce dependence on phytomass and dung for fuel. This can result in multiple benefits of leaving more fodder for animals, reducing the exploitative use of rangeland resources, and improving the quality of life of the households.

The energy supply can be increased through the promotion of alternative energy sources such as solar and wind energy, which have great potential in the Pamir. Importing energy such as electricity or coal from Tajikistan through bilateral cooperation is another option. This is not unlikely; during the Soviet Union time, electricity was supplied to Little Pamir communities from Tajikistan. Coal is not an ideal choice, but could definitely help to ease the energy crisis. At the same time, more efficient stoves and passive solar-heating house construction technologies can be introduced into the Pamir to increase energy use efficiency and reduce energy demand.

Promoting sustainable grazing management

Existing data such as the latest rangeland assessment data from Bedunah (2008) or data from an additional survey should be used to calculate the seasonal carrying capacities of different rangeland types and determine the proper stocking rate. Such calculations can be used to guide local pastoral development and design proper grazing schemes. Since the per capita holdings of livestock are already low, it seems very hard to reduce the number of animals owned by each household. External inputs in the form of hay or supplementary feed are needed, and this will only be economically viable if the nearby border trade between Tajikistan and Afghanistan is allowed.

Improving marketing conditions

Improving marketing conditions means both increasing the access of the pastoral products to markets and enhancing the capacity of herders to benefit from market exchange.

To the extent possible, regular crossborder trade between Afghanistan and Tajikistan should be facilitated at points nearest to the communities on both sides. With the facilitation of the Aga Khan Foundation, crossborder trade ports have already been established in many places like Ishkashim, Nusai, and Mai Mai/Vanji to facilitate trade between Afghanistan and Tajik communities with the consent of the governments of both countries. Therefore, having similar arrangements in the Pamir is also feasible.

Providing market information to the herders, helping them to improve the quality of yak products, introducing collective bargaining systems, and setting up mutual-help institutions to prevent herders from despair selling, can enhance the capacity of herders to benefit from market exchange.

Strengthening veterinary services and improving yak breeds

The Aga Khan Foundation (Afghanistan) is already working to provide veterinary services to the Kyrgyz communities in the Afghan Pamir from the Tajik side by engaging Tajik veterinarians (see Nazarbekov et al. in this book). This model should be institutionalized through bilateral arrangements between Afghanistan and Tajikistan. At the same time, capacities within the Kyrgyz communities should be developed to carry out vaccination campaigns, monitoring and reporting of epidemic outbreaks, and emergency treatment of animal diseases. Activities are also needed to raise the awareness of pastoralists on the importance of vaccination. Efforts should be made to introduce new breeds or good-performance yak individuals (or sperm) from neighbouring areas such as Tajikistan or China to improve the quality of the local yak population.

Establishing fodder reserves and an animal insurance mechanism

A community-based self-sustaining system like fodder banks needs to be established in each settlement/shura. Linking Afghani communities with the nearby Tajik communities can help them cope with emergencies such as extreme climatic events. An innovative livestock insurance system can also help the farmers to buffer losses from animal mortality.

Capacity and awareness building

In the short term, capacity building should focus on areas like pasture management, livestock product processing, storage and marketing, animal health and nutrition, disease control and treatment, and the adoption of new technologies such as alternative energy products. In the long run, capacity building should aim at increasing the capacity of the local people in taking up alternative livelihoods so as to increase their overall adaptive capacity. Awareness building efforts are often needed for local people to accept new technologies and approaches such as new grazing schemes, animal vaccination, artificial insemination, alternative energy products, and new ways of dairy product processing.

Conclusions

Yaks are extremely important for the subsistence of the Kyrgyz communities of the Afghan Pamir. Both yak raising and the Kyrgyz communities are faced with many challenges and are highly vulnerable to both environmental and socio-political shocks. The development of the Kyrgyz communities in the Afghan Pamir cannot be achieved without the overall development of Afghanistan. However, since many of the problems and challenges faced by the local communities are the result of geopolitics, the true solution to these problems also lies in political cooperation to re-link these Kyrgyz communities with nearby communities and service centres across the political border. If the policy makers have the political will to put humanity before geopolitics, the remote communities in all the countries in the region can be turned into a frontier of economic cooperation for common prosperity.

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Traditional Yak Herding in High-Altitude Areas of Gilgit-Baltistan, Pakistan: Transboundary and biodiversity conservation challenges

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Yak pastoralism in Pakistan is confined to the higher elevations (3,500–4,500 masl) of Gilgit-Baltistan and Chitral, extending over parts of the Karakoram-Pamir Landscape (KPL). It is practised in six of the seven districts in Gilgit-Baltistan, where yaks occupy an important cultural and livelihood niche. Yak benefits include dairy products, meat, and wool, as well as their use as pack animals. There is considerable variation in the reports of the number of yak in Gilgit-Baltistan, from an estimate of 25,000 yak and 100,000 yak-cattle hybrids in 1995 to one of only 6,000 yak in 1996. Transhumance based on seasonal migration of herds across the KPL has been a strategic herding practice in the Upper Indus basin. The migration routes have been disrupted by the demarcation and closure of international borders, and this has closed the access to traditional summer pastures and increased the grazing pressure on land within Gilgit-Baltistan. It has also resulted in increased inbreeding and a decline in the genetic health of the yak population. Social and infrastructure development supported by the Aga Khan Rural Support Programme (AKRSP) has attracted local people (Passu, Shimshal, Sost, and others) away from yak pastoralism towards other forms of community development. The increased movement of people facilitated by the improved road network is also having a pronounced negative impact on traditional yak herding practices, which have become less attractive to the youth. Biodiversity conservation through protected areas needs to be re-assessed and transboundary collaboration explored for the conservation and development of yak in Gilgit-Baltistan.

Keywords: Karakoram-Pamir Landscape, Pakistan, transboundary collaboration, yak pastoralism

Introduction

Gilgit-Baltistan covers an area of 725,000 km^2 in Pakistan. It is surrounded by Afghanistan and China to the north and east, and India to the southeast and south (Jianlin et al. 2002; Ochiai 2009). This area is one of the most mountainous regions in the world, with more than half lying above 4,500 masl (Rasool et al. 2000). In the valley bottoms, temperatures range from +45°C in summer to -10°C in winter. Annual rainfall rarely exceeds 200 mm in areas below 3,000 masl, but at higher elevations, where most of the mountain slopes are without

vegetation, precipitation in the form of snow can reach levels as high as 2,000 mm water equivalent per annum (Kreutzmann 1986).

The Hindu Kush Himalayas (HKH) and Pamir mountains are key yak habitat. FAO (2003) reported a global yak population of 14.2 million, of which 93% was in China. In Pakistan, yak herding is confined to the higher elevations (3,500–4,500 masl) in the high mountain ranges of the Hindu Kush, Pamir, Hamadans, and Karakoram – the Karakoram-Pamir Landscape (KPL) – in Gilgit-Baltistan and Chitral (Ali 2013). Yak is locally called 'dong' in Baltistan, 'bapoo' in Gilgit, Astore, Hunza, and Nagar, and 'terminy' in Gojal (Rasool et al. 2000). In Baltistan, part of Gilgit-Baltistan, the male is popularly known as yak and the female as yakmo. The word yak is of Tibetan origin and word mo is used to indicate feminine in the language of Baltistan (Shafiullah 2012).

Yak products make a significant contribution to the household diet as well as having a cash value in the markets of Hunza and Gilgit (Ali 2013). Despite accessibility issues, livestock, including yak, are sold to other parts of the Hunza valley where livestock rearing has been reduced as a result of the diversification of sources of local livelihoods (Ali 2013). Yak herding can potentially fulfil the regional meat demand (Khan and Rahman 2010). Yak milk can be used for dairy products such as butter, cheese, and yogurt; yak blood can be used to produce high quality plasma and insulin; and yak horns, hooves, and internal organs can be used to produce various medicines (Jianlin et al. 2002). Handmade Sharma carpets woven from goat and yak hair with attractive indigenous designs are a cultural pride in most parts of the KPL. Yak safaris are key cultural attractions for tourists (Ali 2013). Mules, horses, and pack yak were major means of transportation along the historically famous Silk Road trade route, which originated in Kashmir and passed through Gilgit-Baltistan towards Kashgar in China. Following the implementation of international boundaries, the Silk Road trade was closed and the pack yak, indispensable for high-altitude trade, were confined to pastures and specific mountain ranges in individual territories like Gilgit-Baltistan (Ali 2013).

There is a considerable lack of clarity on the number of yak in Pakistan, with few and differing estimates. Cai and Wiener (1995) reported a total of 25,000 yak and 100,000 yak-cattle hybrids in Gilgit-Baltistan, but Khan (1996) estimated only 6,000 yak in all of Pakistan, and later reports are similarly variable (Table 8). These big differences indicate the lack of reliable baseline data on yak in Pakistan and the need for a detailed survey of the yak population. Overall, yaks have received little research and development attention from either the private or public sector, and this lack is one reason for the low level of local interest in improved yak production.

Table 8: **Yak population reported by different authors**

Year	Yak number	Reference
1995	25,000	Cai and Wiener (1995)
1996	6,000	Khan (1996)
1998	14,900	Agricultural Census Organization (1998)
2000	16,300	Rasool et al. (2000)
2006	16,320	Livestock Census Department (2006)
2013	25,900	Ali (2013)

The aim of the present study was 1) to assess the current status of yak in Gilgit-Baltistan, 2) to evaluate the implications of the current transboundary restrictions on the traditional migration of yak herds, and 3) to identify issues/challenges which can be addressed to enhance the livelihood role of yak at higher elevations.

Methodology

Rapid rural appraisal (RRA) techniques were used to make an informal and exploratory survey of yak producers in Gilgit-Baltistan to obtain information on the characteristics of local yak production and husbandry.

Survey locations

In consultation with the Livestock and Agriculture Department of Gilgit-Baltistan and local veterinary service providers, a list of key villages of yak producers in higher altitudes of each district was prepared. A survey was conducted in 19 villages in six of the seven districts in Gilgit-Baltistan between March and June 2014 (Table 9).

Table 9: **Surveyed villages and number of respondents**

Village	District	No. of respondents/village
Bubin	Astore	1
Chongra	Astore	1
Parishnug	Astore	1
Golmagoh	Ghizer	2
Tero	Ghizer	3
Thalay	Ghanche	2
Bagrote	Gilgit	1
Hanuchal	Gilgit	1
Kaltaro	Gilgit	5
Hispur	Hunza Nagar	5
Hoper	Hunza Nagar	2
Shimshal	Hunza Nagar	5
Basho	Skardu	2
Ganokh	Skardu	2
Giltari	Skardu	3
Gharis	Skardu	1
Ghirak	Skardu	4
Kindrik	Skardu	4
Sadpara	Skardu	5

Data collection

Data was collected on various aspects of yak husbandry, including population, pastures used, breeding and inbreeding issues, disease, and other farming practices, using a systematic, semi-structured interview process as follows:

- Interviews with key informants/yak herders in each village; elites and livestock activists were interviewed in villages with no yak herders
- Some group interviews including focus group discussions
- Wherever possible, cross-checking information with local veterinary service providers, i.e. vet dispensary/hospital
- Direct observation in the villages
- Quantitative estimates of yak population in each village
- Close to 50 yak herders and others were interviewed in 19 villages

Results and discussion

Yak population in Gilgit-Baltistan

The estimated yak population in the selected villages is shown in Table 10. The highest yak population was found in the districts of Skardu and Hunza-Nagar. Although yaks are found in many villages in the Upper Indus basin, the high numbers in some villages indicate that in these high-altitude areas it is a key livelihood animal due to its better adaptation to the harsh conditions.

Table 10: **Number of households and yak population in selected villages in Gilgit-Baltistan**

Village	District	Households	Yak population
Bubin	Astore	180	970
Chongra	Astore	250	830
Parishnug	Astore	180	430
Golmagoh	Ghizer	220	660
Tero	Ghizer	180	315
Thalay	Ghanche	250	1,250
Bagrote	Gilgit	180	590
Hanuchal	Gilgit	100	650
Kaltaro	Gilgit	200	250
Hispur	Hunza Nagar	150	4,000
Hoper	Hunza Nagar	450	2,650
Shimshal	Hunza Nagar	150	2,513
Basho	Skardu	1,200	3,000
Ganokh	Skardu	350	4,981
Giltari	Skardu	25	163
Gharis	Skardu	170	1,190
Ghirak	Skardu	200	300
Kindrik	Skardu	120	580
Sadpara	Skardu	80	480
Total		**4,635**	**25,802**

Transhumance

Ali (2013) described the centuries old practice of yak transhumance originating from Gilgit-Baltistan. In the past, the yak herders' seasonal migration extended to Srinagar/Kashmir/Ladakh in the east, to the People's Republic of China in the northeast, and Tajikistan and Afghanistan in the KPL to the northwest. Khan and Rahman (2009) also mentioned that traditionally the yak herders from Gilgit-Baltistan were able to graze their yaks in summer in areas of Afghanistan, China, and India, where the herders would also sell dairy products like qurut (similar to yogurt) and butter through barter trade. The annual transboundary migration was also synchronized with the breeding cycle and facilitated crossbreeding among herds (Ali and Butz 2003).

The pattern followed by herders from Gojal in the Shimshal valley illustrates the way in which transhumance functioned (Khan and Rahman 2009). The yak producers in Shimshal were largely dependent on summer pastures across the national border to feed their livestock, especially due to the limited land resources in the Shimshal valley. The timing of movements was determined by a village level decision. The group of herders, including women, left the village by the 1st week in May moving first to Shujerab, the closest accessible summer pasture, and then on to Sher Lakhsh, Furzin-i-Dasht, Gorjerav, Sher Bulak, Ghrsar, and Sher-a-lik, to reach their final destination in the Pamir mountain range which extends across parts of Afghanistan, China, Kyrgyzstan, and Tajikistan. The length of grazing at each pasture site depended on the weather conditions and availability of forage. The summer months were peak milk processing days with plenty of forage available for the yaks. Milk was processed into products like butter and cheese. The yak herders return to Gojal by mid-September

carrying milk products as winter supplies. The herders spent the winter around Gojal where they could protect the livestock from predators like wolves and snow leopards using indigenous herding practices to graze and feed the animals (Khan and Rahman 2010).

The international demarcation of borders together with closures and restrictions on transboundary travel over the past six decades has led to a paradigm shift in yak herding practices in Gilgit-Baltistan. The historical pre-partition yak herding corridors are shown in Figure 5; the present day routes are primarily restricted to within Gilgit-Baltistan as shown in Figure 6. The focus group discussions showed that this relocation of routes not only led to drastic and adverse changes in the husbandry of yak, but also affected the whole role of yaks in farmers' livelihoods. The barter trade in yak dairy products ceased abruptly as soon as the transboundary grazing corridors were blocked, while the role of yak as a pack animal was reduced over time (Ali 2013).

Crossbreeding and inbreeding

Yak crossbreeding with local cattle has been popular in Pakistan since historic times. Systematic crossing and backcrossing was introduced in Gilgit-Baltistan in the early nineties by the Aga Khan Rural Support Programme (AKRSP) and Gilgit-Baltistan Livestock and Dairy Development Department (GBLDD) as shown in Table 11. Breeding yak-cow hybrids has several advantages over maintaining pure yaks.

Figure 5: **Pre-partition transboundary yak herding corridors**

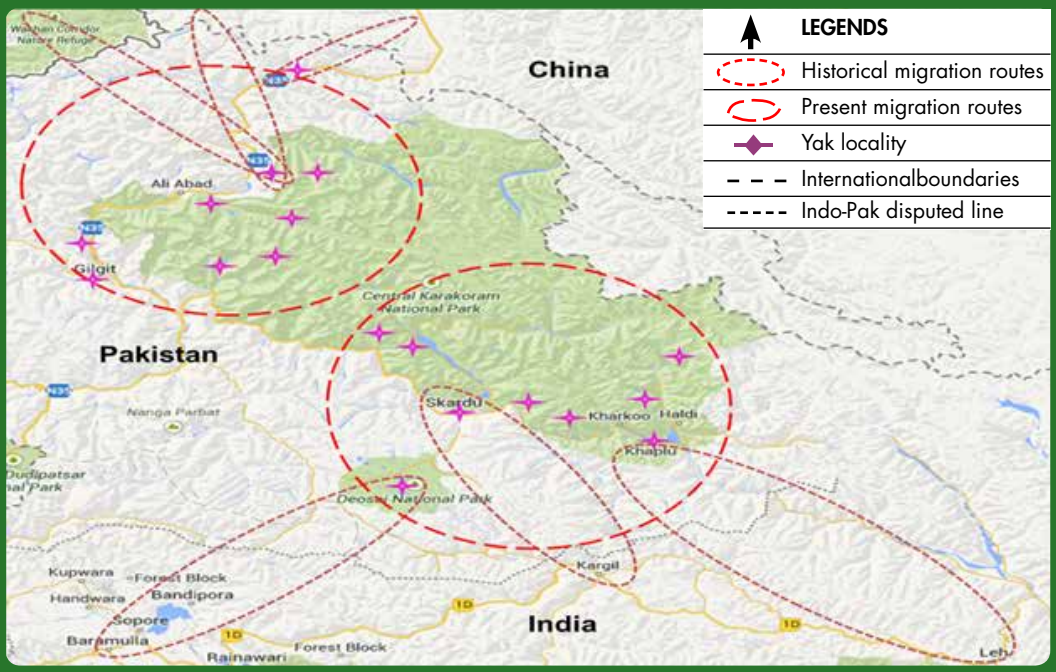
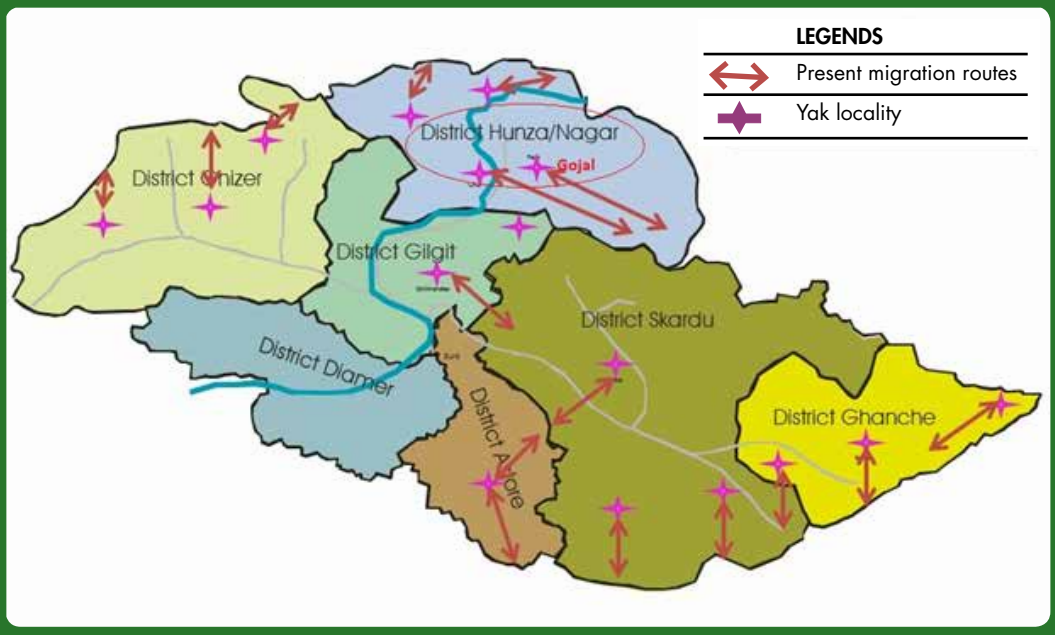


Figure 6: **Post-partition migration routes of yak herders**



- Hybrids are docile, non-aggressive, and easier to handle for use in farming practices like ploughing and threshing.
- Hybrids produce more milk than pure yak.
- Meat from hybrids is preferred as it is more tender and less fibrous.
- Hybrids are more tolerant of warmer conditions and can adapt better to lower elevations and graze in areas near villages.

Table 11: **Crossbreeding of yak with cow in Gilgit-Baltistan**

Sire	Dam	Male/Female	Generations
Yak	Cow	Zo/Zomo	F1
Yak	Zomo	Gar/Garmo	F2
Yak	Garmo	Gir/Girmo	F3
Yak	Germo	Bre/Bremo	F4
Yak	Gremo	Hlok/Hlokmo	F5
Yak	Hlokmo	Yak/Yakmo	F6

Source: Shafiullah (2012)
Note: Male progeny of F1 to F5 are infertile; F6 is considered 100% pure yak.

The yak farmers discussed the problems of inbreeding in their yak herds. At present a single breeding bull in a village or cluster of yak households is used for at least eight years. In earlier times they had used breeding bulls from other herds in the areas that they migrated to in summer. They suspected that this inbreeding had led to their yaks becoming smaller than yaks in Chitral and that this had also encouraged local farmers to focus on crossbreeding with cattle to transform yak herds into hybrid offspring. Other authors have reported problems of yak inbreeding. Cai and Wiener (1995) reported inbreeding as being a problem in Bhutan, India, and Nepal, but thought herds were less inbred in Gilgit-Baltistan and remote areas of Afghanistan. Miller and Steane (1997) recognized that inbreeding also existed in certain yak populations in Pakistan.

Livestock holdings

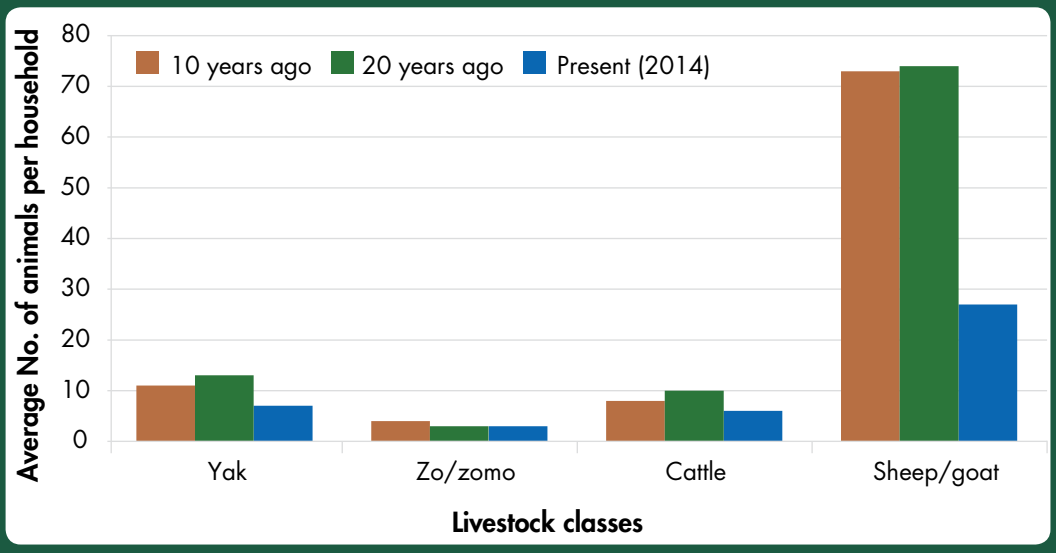
Figure 7 shows the trend in average number of different livestock kept by individual households over the past 20 years as reported by the yak farmers in Gilgit-Baltistan. Although the survey indicated that the total yak population had increased, the number of yaks per household has declined, which may reflect an increase in the total number of yak households. The population of small ruminants was reported to have drastically declined, but further investigations need to be carried out in the yak areas to confirm this. The reduction in numbers of animals per household indicates a big shift in farmers' livelihood strategies.

Livelihood diversification

Commercial farming

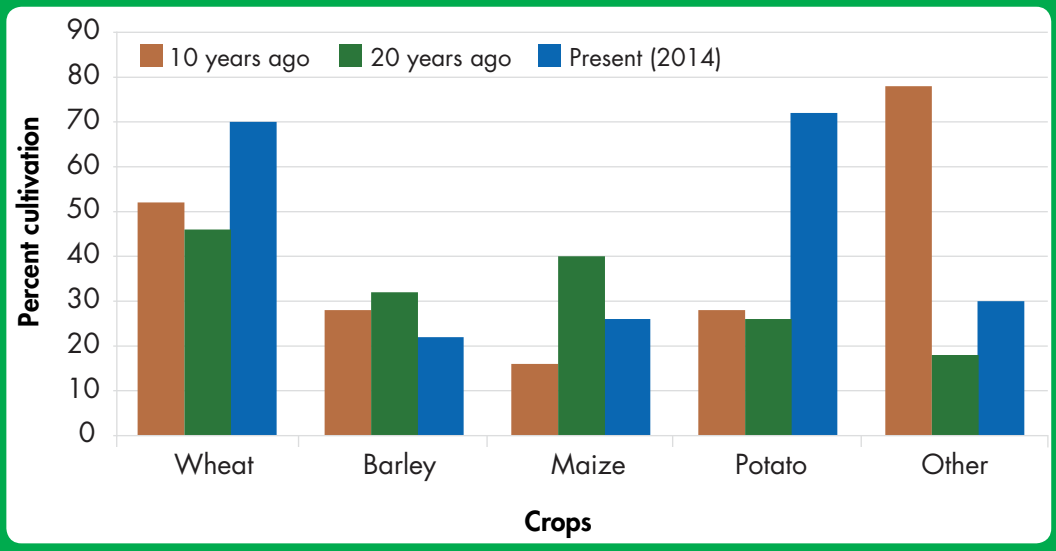
The yak pastoralists need to adapt to the changes happening around them. While some changes exacerbate the challenges they face, others provide opportunities. Increased access to inland markets for agricultural produce is one such opportunity. Figure 8 shows the change in crops cultivated by farmers in yak herding areas over the past 20 years. Wheat is still the main cereal crop, although barley and maize are increasing. Ten years ago, farmers in this single cropping high elevation area were testing various crops including various vegetables, but potato has now emerged as the single most important cash crop in irrigated fields. The

Figure 7: **Estimated average livestock holdings of individual households in Gilgit-Baltistan over the past two decades**



Source: RRA survey

Figure 8: **Trends in crop cultivation in the yak areas of Gilgit-Baltistan**



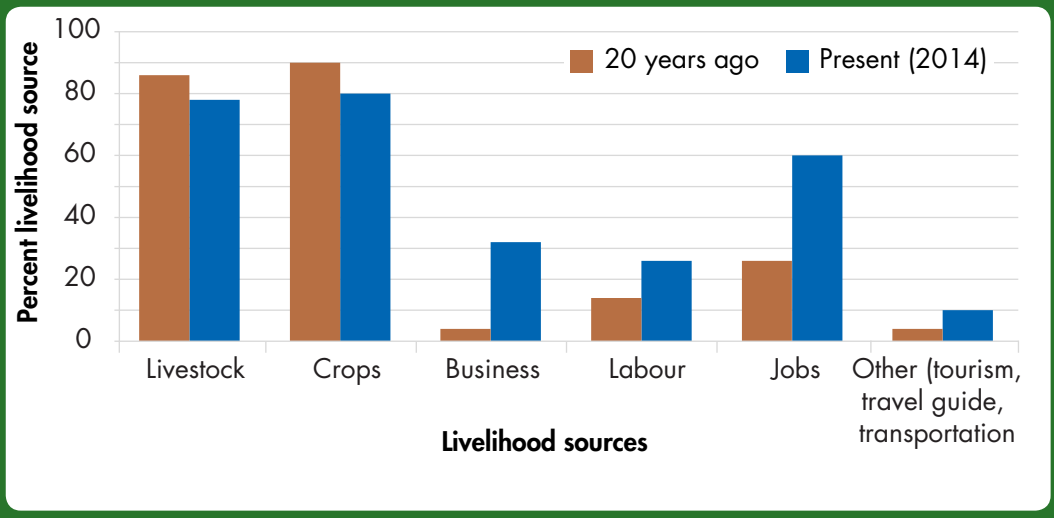
survey showed that 80% of farmers were growing cash crops like potato and tomato in place of staple crops, and it is possible that over the next ten years wheat fields will be replaced by potato and tomato to increase cash income, while farmers purchase subsidized wheat from the market (Ali 2014). Although the farmers benefit from the increased income, the loss of traditional wheat cultivation poses a strategic challenge for local food security, both for government agencies and for social organizations (Ali 2014).

At the same time, community-based value chain development for yak products like milk, cheese, butter, and meat would help make yak-based livelihoods sustainable and help provide alternative income opportunities.

Other opportunities

Various livelihood opportunities for yak farmers were discussed during the focus group discussions. Although livestock and crop production remain the mainstay of local livelihoods, other occupations have become more prominent over the past 20 years as shown in Figure 9. Various factors are contributing to this change, including the impact of social organizations like the Aga Khan Rural Support Programme (AKRSP) and WWF-Pakistan, which is leading to increased literacy and a shift in youth behaviour, and the low returns, lack of stability, and insecurity associated with agropastoral livelihoods. The proclivity of youth is towards employment opportunities instead of laborious farming. Increased infrastructure development, particularly the improving road network, is creating business opportunities, and the creation of jobs in the private/public sector has increased.

Figure 9: **Livelihood opportunities in Gilgit-Baltistan**



Transboundary issues

One of the most severe consequences of the restrictions on transboundary migration has been the degradation of high-altitude rangeland ecosystems because of overstocking as the yak farmers redefined their summer pastures within Gilgit-Baltistan, where the yaks have to compete for available forage with other livestock. The overgrazing in summer is also increasing the forage stress in winter (Ali 2014). In Shimshal, for example, in northern Pakistan, yaks are central to household survival, providing dairy products and meat as well as income. The people of Shimshal – especially the poor – have limited landholdings and rely on common lands as grazing pastures to feed their yaks and other livestock, which are under severe pressure as a result (Habib 2007). Shafiullah (2010) has reported similar issues in Gilgit-Baltistan with even further overstocking due to refugees from Afghanistan and downstream areas moving in with their flocks.

The loss of access to a diversified yak population, and resultant inbreeding and weakening of the yak herds, is a further result of the closures of international transhumance routes. Wildlife management, for example of snow leopard, is another transboundary issue. Yak pastoralists were very concerned about the loss of animals due to avalanches and predators like snow leopard in winter, and noted that the state had not put any compensatory mechanisms in place.

Outmigration of youth from Gilgit-Baltistan

According to the population Census of Pakistan (1998), 53% of the total 1.3 million population of Gilgit-Baltistan at the time of the census was aged 15–35, while the overall literacy rate was 38%. The government has so far failed to attract the investments in natural resource management that could generate employment opportunities for the young people in the district. Youth migration out of the district to destinations in Pakistan and abroad is becoming a challenge, both as a labour and as a brain drain.

Recommendations

There are a number of recommendations for action to address the issues related to the current yak-herding scenario in Gilgit-Baltistan as indicated by the results of the survey and discussions.

- There is huge gap in the availability of consistent data and information about the yak population. The latest available livestock census in Gilgit-Baltistan is from 2006 and lacks any information on the population of yak-cattle hybrids. The responsible government departments should promote and conduct studies on the current status of yaks in the area to provide clear information on the present situation and to serve as a baseline for future research to assess changes resulting from management practices and socioeconomic and environmental change.
- The traditional approach to conserving mountain biodiversity by demarcating protected areas restricts local yak herders in terms of resource use and is in direct conflict with pastoral livelihoods. The approach should be re-examined to allow participation of local communities in decision making and to integrate conservation with local livelihoods.
- The negative impact of continued inbreeding of yak should be addressed through transnational crossbreeding cooperation on yaks between China and Pakistan. The national governments should establish rules, policies, and schemes that promote and facilitate the exchange of yaks. Gilgit-Baltistan can benefit from the excellent research being done at the yak breeding centres on the Tibetan Plateau (Ali 2014).
- Proper planning is required for skills development amongst the local youth in the area. Vocational training at community level for value chain development and transboundary outreach could be tested as an innovative approach for involving youth in local social development and increasing livelihood opportunities.
- The potential for promoting yak ecotourism, for example yak safari, yak polo, and similar, should be explored and built in through consultations with the local communities in various transboundary corridors. Special markets for local value added yak products could be established at centres like Khunjerab zero point and Attabad lake, and could have a very positive commercial impact.

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Yak Raising Challenges: Transboundary issues in Far Eastern Nepal

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Yak herding practices remain one of the most important livelihood options in the high-altitude mountain region of Nepal. The study was conducted to assess the impacts of border closure or movement restriction on traditional yak husbandry and the livelihoods of the yak herding communities in the three easternmost districts of Nepal (Taplejung, Panchthar, and Ilam) and neighbouring areas in India and China. The information was collected using rapid rural appraisal (RRA) techniques, field visits, a key informant survey, and a literature review. The yak population in the case study area shows a decreasing trend over recent decades. As a result of loss of access to some seasonal pastures due to border closures and movement restriction, local herders faced several problems and have had to adjust their livestock structure in order to utilize the limited forage resources more intensively. The restrictions on grazing on the Tibetan side and in Sikkim state of India have led to increased grazing competition which has become a serious issue in eastern Nepal. Prolonged and heavy grazing of domestic animals is causing substantial changes in wildlife habitats. The yak-raising system is ecologically, culturally, and socioeconomically important in the high-altitude areas of the HKH region and the study highlights the need for transborder cooperation for better management of pasture and livestock and to accomplish mutual economic benefit for the yak herder communities in the transborder region.

Keywords: high-altitude, movement restriction, transboundary landscape, yak herding

Introduction

During the last few decades, the fundamental problem reported for yak husbandry in the Hindu Kush Himalayan (HKH) region has been lack of fodder resources and grazing space such as pasturelands leading to poor nutrition (Miller et al. 1997). Many studies have also discussed the decline of pastoral migration and impact of pasture enclosure for restoration and/or rotational pasture management (Scoones 1994; Wu and Richard 1999; Yan et al. 2005; Wu et al. 2012), but as yet there have been few studies focusing on transboundary issues such as the impact on dependent societies of border restrictions and the legal prevention of the natural seasonal movement of animals to their traditional (crossborder) grazing lands.

The yak is a multipurpose animal raised by high-altitude mountain communities in the HKH region. Yak husbandry following seasonal migratory patterns is a traditional, and one of the most important, livelihoods in these harsh mountain regions. When winter snowfall begins,

yaks are brought down to lower winter pastures, as the weather grows warmer, yak herds return to higher summer grasslands. This transhumant system can be found across the entire high-altitude rangelands of the HKH region (Kreutzmann 2004, Dong et al. 2009). A wide range of seasonal pastures along altitudinal belts is a fundamental primary requirement for mobile yak grazing and traditionally these pastures have been distributed in a natural realm beyond administrative borders. The closure and enforcing of national border laws due to geopolitical changes since the 1950s among the Himalayan countries has had a huge impact on yak grazing in the transboundary landscapes, as well as on the large number of pastoral societies dependent upon it.

In this paper, the authors investigate this issue with a case study in the Himalayas in far eastern Nepal. The study primarily assesses the impacts of movement restriction due to border closure and grazing bans upon the traditional yak herding system and related livelihoods in three eastern districts in Nepal (Taplejung, Panchthar, and Ilam) and their neighbouring areas.

Methodology

Field survey

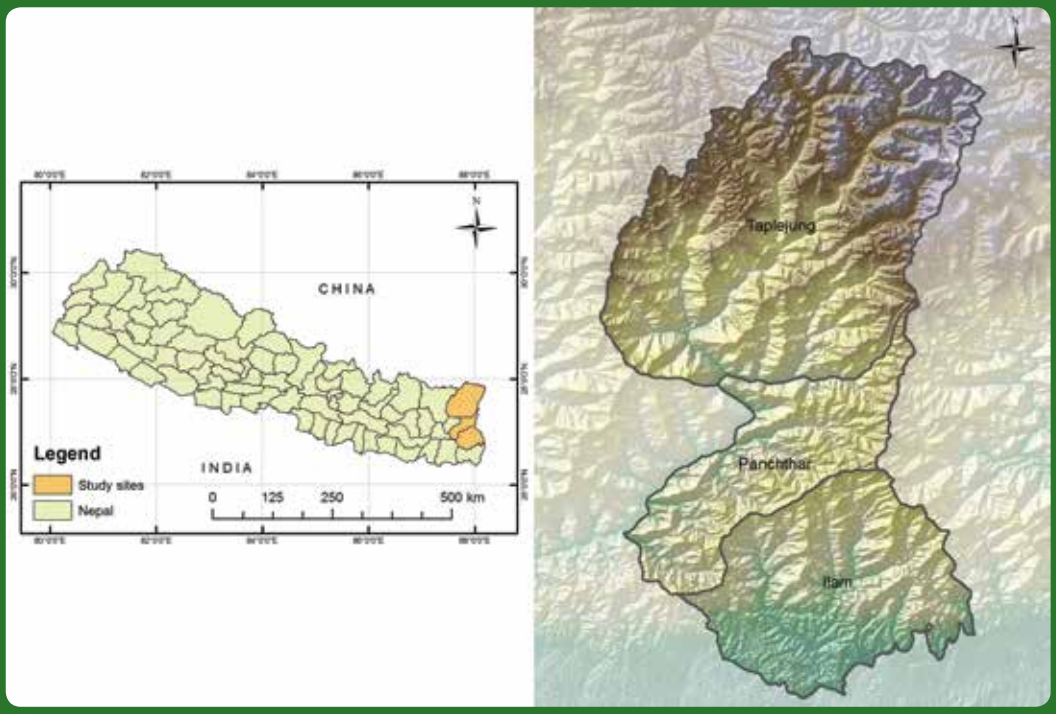
The study was carried out in three districts inside Nepal within 10 km of the international border in the eastern hills using rapid rural appraisal (RRA) techniques, field visits, and a key informant survey with structured and semi-structured interviews and group discussions, as well as subjective assessment. Prior to the field visit, a checklist was prepared and discussed with natural resource management personnel. District-level consultations were carried out with government officials involved in the planning and management of natural resources, facilitated by the district livestock/veterinary officer. Information on different aspects of pasture/livestock management statistics was also collected through secondary sources. Along with the discussions with local people, assessments were also made of the systems used for management of pasture/animal fodder and animals. The field study was complemented with a literature review.

Case study area

The three districts Taplejung, Panchthar, and Ilam (TPI) – the case-study area – are situated in the eastern part of Nepal, bordering the western part of Darjeeling district and Sikkim state of India to the east and the Tibetan Autonomous Region (TAR) of China to the north (Figure 10). Administratively, TPI is situated in the hills of the Eastern Development Region of Nepal, the total household number is 113,050. The transborder area within Nepal is a strip about 8 km wide extending 135 km from west to east and then north to south along the international border, with a total area of 2,892 km^2, about 44% of the total area of the three districts.

The topography within the transborder area is quite diverse, from areas in the Ilam Siwaliks that are almost level with the tropical plains to the world's third highest peak – Mount

Figure 10: **Location of the transborder area in the far-eastern Himalayan region of Nepal**



Kangchenjunga. The mountainous terrain is a continuum of the terrain of the Himalayas, with diverse climates from sub-tropical and warm temperate in the lower elevations to alpine and tundra in the upper mountain slopes determining overall biodiversity and development activities. The temperature decreases with increasing elevation, resulting in different climatic zones within a short vertical distance. The temperature recorded at Taplejung meteorological station shows a variation from <0°C minimum in winter to +30°C in summer. The monsoon wind causes rainfall from June to September. In some years, there is some scanty rainfall during the mid-winter months. The annual precipitation varies from 1,440 mm to 2,660 mm with average annual rainfall of 1,650 mm, almost 70% falling between June and September. Usually, the southern facing slopes receive more rainfall than the northern ones.

Yak is confined to the northern and northeastern parts of this landscape at the higher elevations. Many hybrids of yak with domestic cattle (Siri and Nepalese hill Zebu cattle) are kept on neighbouring, somewhat lower, land and sometimes alongside the yak. The Ministry of Agriculture Development reported 3,017 heads of yak and yak hybrids in Taplejung, 1,092 in Panchthar, and 180 in Ilam (MOAD 2013).

Results and discussion

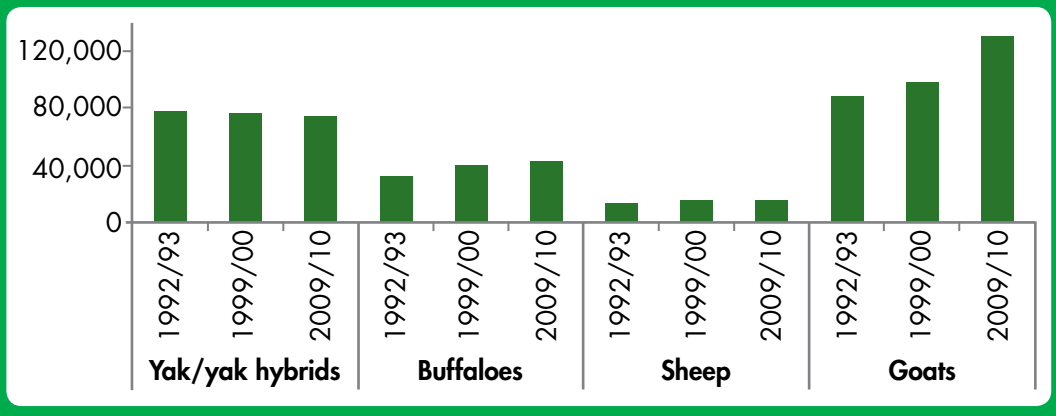
Yak husbandry

Yaks are found in all the northern districts of Nepal. According to recent estimates, there are 65,980 heads of yak and yak hybrids in Nepal, distributed across 28 northern districts (MOAD 2013). The livestock trends in Taplejung district between 1992/93 and 2012/13 are shown in Figure 11. Taplejung district is a typical pastoral area with most of the pastures in the high mountains, and bordering both TAR, China, and Sikkim in India. The livestock population that used to be grazed at higher elevation, like sheep, did not increase greatly, or even decreased (cattle/yak), but the number of goats and buffalo, which are well adapted to the temperate climate at lower elevations, increased significantly. The trends indicate a change in the overall livestock structure. The number of yak went down from a reported 4,036 in 1999 (DLSO 1999) to 3,017 in 2013 (MOAD 2013), in line with the trend in Nepal overall (Wiener et al. 2003). Sherchand and Karki (1997) reported that the yak population in Taplejung decreased by about 60% from 1981 to 1991. In the other two districts of Panchthar and Ilam, yak is not a dominant animal species in the domestic livestock, but yak hybrids still play an important role in arable farming, animal husbandry, and trading of by-products. The main reasons for the reduction in the yak/chauri population in Nepal are analysed in other articles in this book.

Seasonal migration system

In eastern Nepal and the surrounding transboundary area, transhumance grazing of yak and other domesticated animals has evolved over a long time. The most common form of traditional pastoralism on the upper mountain slopes of the transborder area is extensive rearing of sheep, yaks, chauris (yak hybrid with the native Zebu cattle), and hill cattle for wool,

Figure 11: **Livestock trends in Taplejung district in eastern Nepal**



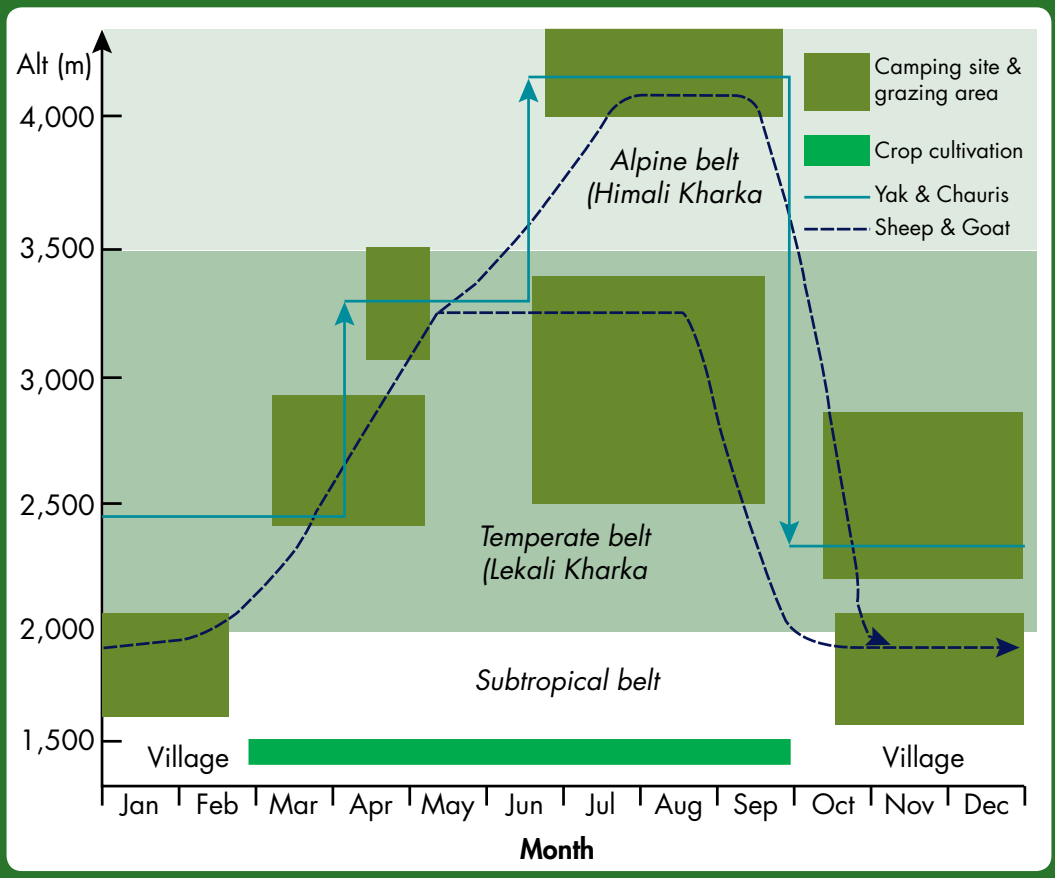
Source: DOL 2011; MOAD 2013

meat, pack, and draught purposes, with the livestock often herded in mixed flocks. This system covers much of the grazing land in the high-altitude areas of Taplejung and other districts and is especially significant for nature conservation in the hill and mountain areas. In Taplejung, transhumant systems follow a vertical pattern where stock overwinter in warmer zones in the foothills, and move upwards as the weather warms reaching alpine pastures in the summer (Figure 12). Between June and September, sheep, yaks, and chauris (and occasionally a few goats) are grazed on the higher pastures (Himali kharka) and are then gradually brought down from early October. Yaks are wintered in the temperate belt (Lekali kharka), while other animals are driven down further to the subtropical areas where they have access to supplementary feedstuffs such as crop stubble, crop residues, and shrubs.

Traditional transboundary grazing

The international border of Nepal with TAR, China to the north and Sikkim, India to the east is located in the high mountains and along the mountain ridges where the traditional summer pastures lie for all herders, regardless of their citizenship. The people living on different sides

Figure 12: **Time-space diagram for yak migration in the transboundary landscape of Taplejung, Nepal**



of the border are often from the same clan, and transborder marriage plays a vital role in establishing strong family bonds (Oli 2003). Due to dual citizenship, access permits for much of the transborder population, and property ownership and transfer, are easy for many people. The same person or family owns land on either side of the border and thus has access and rights over the use of land resources and for yak grazing. Traditionally, herders from the transborder areas were allowed to graze their animals within pasturelands of either country within 10 km of the border. If animals from either country were lost and found within 20 km of either country, they needed to be handed over to the owner. Transboundary cooperation is therefore an established norm for the local communities. Although there are some local conflicts, the system is practised everywhere except within protected areas, where modern governance systems have impacted the traditional system.

Border closures and grazing restrictions

In the northern transborder areas of Nepal, alpine pastures were traditionally opened (at least there was no strict control) to local herders from both sides. In 1978, an agreement banning the transborder use of pastureland was reached between the Chinese and Nepalese government. In 1988/89, a five-year grace period was given by the Chinese government for pasturing animals from Nepal in high-altitude areas on the Chinese side. After implementation of the agreement, the ban on pasturing animals on the Tibetan side forced more high-altitude grazing sites to be opened for animal grazing in Nepali districts (Joshi 2000). This meant that the previously poorly accessible high mountains on the Nepalese side had to absorb more domesticated animals and were subjected to overgrazing and over-browsing (Suttie and Reynolds 2003). In the eastern transboundary region, animal grazing was restricted within protected areas following the notification of Kangchenjunga Biosphere Reserve at the end of the 1970s and Singhalila National Park in 1990 by the Indian Government (Chaudhary et al. 2014). On the Nepalese side, this arrangement especially impacted Taplejung district and some parts of Panchthar where, for example, Nepali people had traditionally used Singhalila Park resources for grazing and these were now closed. With the increase in conservation areas in Sikkim after the 1990s, the options for yak grazing became even more limited. Herders used to make their migratory arrangements taking into account the pasture situation on both sides of the border, or even rented pastureland from the traditional pasture owners. After the demarcation and enforcement of the border of protected areas, yaks and other domesticated animals were only brought for wintering to Lekali kharka in Nepal (Oli 1985, 1986). The already over-stocked grazing sites between 2,000 and 4,000 masl received even more grazing pressure from both the Nepalese and Sikkimese sides. The increase in livestock often leads to local conflicts, which are now heightened in the transborder areas between Nepal and Sikkim (Tambe and Rawat 2009).

Impacts on transboundary movement

Traditionally, the eastern districts of Nepal bordering India and China also benefited from the livestock development occurring in Sikkim and Tibet. Transborder herders and farmers sharing

common grazing lands and visiting relatives across the borders brought improved yak bulls back for breeding purposes. At the same time, pasture and forage seeds and saplings were also introduced from early times in the border villages of Taplejung, Panchther, and Ilam districts. These were farmer-to-farmer efforts in the exchange of genetic material for improving the forage base and genetic improvement of their livestock, essentially 'transborder cooperation'. The local communities in the case study areas reported that after the restriction of crossborder movement there was a reduction in the transfer of superior yak bulls from the Tibetan side which has led to serious problems of inbreeding in the local yak population, resulting in a decline in productivity and population due to the reduced hybrid vigour.

Transboundary movement between Nepal and India is an age-old practice that was important for socioeconomic purposes (Chaudhary et al. 2014). Eastern Nepal (Taplejung, Panchthar, and Ilam districts) is separated from India (Darjeeling and Sikkim) by a long stretch of the Kangchenjunga-Singhalila complex. This is an open border crossed by people from both sides as well as livestock. The people living on either side of this Nepal-India border are mostly from the same families, and some even possess dual citizenship, as a result of which they own land on both sides of the border while also enjoying rights over the use of natural resources, including pasturelands. Thus if the use of a natural resource is regulated on one side of the border, they are able to extract resources from the other side. Law enforcement in Singhalila National Park in India is stringent, while there is weak law enforcement on the Nepal side of the border (Chaudhary et al. 2014). As a result, the natural resources on the Nepal side are more prone to unsustainable extraction and poaching.

Crossborder dissemination of yak herding practices

Tibetan people started to settle in the transboundary landscape in Nepal and neighbouring Sikkim and Darjeeling from the late 1950s (Chettri 2008, 2009). Many of the early migrants became mobile within the areas and large numbers were also involved in various other businesses. With them, they brought Tibetan culture and a knowledge base on rearing yaks, hunting of high-altitude wildlife, and collection of medicinal herbs. With the coming of new migrants after the end of the 1960s, the earlier settlers invested in the newcomers for settlement along the transborder areas, where they again started to rear yak. The increasing population of Tibetan origin in the following decades also led to a growing demand for yak butter, cheese, meat (including veal), and other body parts, which further promoted a stable increase in the yak population in the Kanchenjunga transboundary area.

To ensure the continued flow of yak products, wealthy people from urban centres have invested in yaks, while handing over the responsibility for rearing and breeding to an intermediary person on fixed terms and conditions. The middlemen act as quasi hidden yak herd owners; they make contracts with the traditional pasture owners along the transborder areas between Nepal and Darjeeling and the western districts of Sikkim State, but the arrangements are confidential and only known to the persons involved in the business. Payment for the grazing rental is made in kind or in cash. In agreement between the two

parties, a reliable Nepali herder is hired who seems to be the owner of the yaks. He/she will be given specific responsibilities for the supply of products, veal, and live animals to a fixed destination. The middleman collects the products and hands them over to the owner, who distributes them to a wide range of larger consumers including in TAR. The business of transborder rearing of animals has been maintained continuously and has shown no decline over the years.

The Tibetan migrants also introduced hybridization to the southern slopes of the Himalayas. According to Chettri (2009), the number of yak and especially yak hybrids (locally called dzo) increased very quickly in Sikkim after the new Tibetan settlers came. The mountaineering trails which flourished in the Mount Kanchenjunga area after the 1960s provided livelihood options for these new settlers. The people living in this isolated forested area brought a few yak hybrids from Holung in Nepal in 1971 to cater to the needs of mountaineering agencies for carrying goods and trekking equipment. Soon after, people started hybridizing their local cows with yaks to produce their own hybrids. Yak hybrids are used as pack animals for tourism purposes in most parts of Nepal, especially for mountaineering and trekking in the Himalayas. Those mountain people who have very limited options for making a living can take advantage of the economic benefits provided from tourism through increased yak raising or crossbreeding (Watanbe and Ikeda 1999; Sherpa and Kayastha 2009).

Impact on conservation

Pastureland management is a major issue of concern in eastern Nepal and throughout the Kangchenjunga Landscape (Chaudhary et al. 2014). Yaks are an integral part of the pastoral system and domestic biodiversity in high-altitude pasturelands. In eastern Nepal, free range grazing, where large numbers of livestock are left out in the forests and pastures to graze freely, is practised in some places. Habitat degradation in pasture lands is common throughout the Kangchenjunga Landscape (Chaudhary et al. 2014). In the case study area, the problems associated with intensified pastoral activities in the landscape due to the shortened migration include removal of trees to increase the grazing area, harvesting of trees and scrub vegetation for fuelwood, depredation of ground-dwelling birds and their nests by herders' dogs and humans, and poaching of rangeland wildlife.

Many studies have highlighted the degradation of pastoral areas as a result of closure of the transborder movement of animals (Bauer 2002). Following the closure to access some summer pastures due to border closure or grazing restrictions, local herders adjusted their livestock structure in order to utilize forage resources at lower elevations. The change in mix of livestock breeds led to a further decline in traditional transhumance, with a transformation from long-distance migration to a short-distance migration or even sedentary pastoralism, which inevitably leads to overgrazing in the limited space. Furthermore, there is grazing competition between wild herbivores (such as Himalayan tahr, blue sheep, musk deer, and barking deer) and domestic livestock (Oli 1985, 1986). Herbivores are forced to survive in areas grazed by livestock, negatively affecting their survival. One of the indicators of reduced

wild ungulates as observed by the local people is that wildlife such as the leopard, fox, and Jackal are predating more on yak calves, sheep, and goats for food. The off-take in this pathway has increased by up to 12% causing economic loss to the local people (Oli 2003). Around 65% of the respondents reported that domestic animal depredation has increased compared to the previous two decades (Watanabe and Ikeda 1999). This has profoundly increased human-wildlife conflict in the high-altitude region and is creating a serious threat to mountain biodiversity.

Another major transboundary issue in this landscape is the illegal trade of wildlife and plants. A lucrative market and insufficient patrolling are among the factors that promote illegal trade in the crossborder areas (Chettri et al. 2011; Chaudhary et al. 2014). The porous borders in eastern Nepal are transit routes for the illegal trade of forest products. Reports from eastern Nepal include the collection of butterflies and rhino beetles from Ilam district, collection of pangolin scale from Taplejung and Panchthar districts, trade of tiger skin, and arrest of Tibetan poachers in Taplejung District (NCDC 2010). The formal institutions are unable to deliver adequate services for conservation and development (Chaudhary et al. 2014). There is inadequate infrastructure in some of the protected areas within the landscape, and lack of adequate personnel, staff, gear, and insufficient capacity hampers the delivery of services and coordination between conservation and pastoral development in the landscape.

Conclusion

The traditional transboundary resource sharing system which evolved in the transboundary pastureland areas was an important management tool, but is currently weakened, leading to demands for appropriate guidelines and awareness raising both in the community and among the concerned authorities. For the sustainable development of yak husbandry, the transboundary area needs to be brought under some form of pasture conservation with an appropriate legislative framework. Under the present management regime, further erosion of pasture biodiversity is a foregone conclusion. The fundamental starting point for transboundary cooperation in yak husbandry and pasture management, including forage supplements, will be the traditional local level institutions that have managed the resources over centuries.

Since historic times, the transhumance yak rearing system (highland/lowland) has been part of an ecosystem management tool in the high-altitude trans-Himalayan areas. The system plays an important role in the transfer and spread of genetic resources from one place to another, including various domesticated animals and pasture species, and converting them into valuable meat, milk, and other products. This system is in decline, but the consequences for the entire mountain ecosystem are not clearly understood. Yak pastoralism is a complex form of natural resource management which maintains an ecological balance between pastures, livestock, and people and is also an adaptive strategy for a stressful environment (Chettri 2008). The yak raising system has regional ecological, cultural, and socioeconomic significance. An integrated transboundary yak herding management plan needs to be

introduced in the transboundary landscapes as one of most important components for conservation and development strategies in the HKH region.

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Yaks and Yak Herding: Challenges and opportunities in the Bhutanese Himalayas

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Yak rearing has been practised by the transhumant pastoralists of Bhutan for generations. Yaks are found at elevations of 2,800 to 5,000 masl, and benefit approximately 1,100 nomadic households in the high-altitude northern areas of the country. In recent years, yaks and yak herding have become less important as the main source of livelihood for these nomadic communities due to the numerous challenges they face. The challenges include inequitable access to basic social amenities, shrinking grazing grounds, shortage of household labour, unhygienic yak product processing practices, lack of facilities and technical capacity in yak breeding, and poor yak health care coverage. The livestock census data for the past five years do not show an alarming decrease in the yak population overall, nevertheless many yak herding households appear to be giving up or reducing yak rearing. Notwithstanding the numerous challenges, there are many opportunities available to support the yak herding communities and ensure that a critical population of yaks is maintained. The opportunities fall into three broad categories: policy innovations, technological interventions, and development of cottage industry yak products. Immediate attention should be paid to strategic planning and innovative interventions aimed at protecting and preserving yaks.

Keywords: livelihoods, rangelands, transhumant, yaks, yak husbandry

Introduction

Bhutan is surrounded by China to the north and India to the west, south, and east. It is home to about 39,500 yaks and 6,300 zo-zoms (a hybrid between yak and local cattle), which together constitute 12.2% of the (non-poultry) livestock population in the country (DOL 2013). Bhutan is mostly mountainous; yaks are found in the northern areas at elevations ranging from 2,800 to 5,000 masl (Roder et al. 2001). Yak herding is one of the most important activities for nomadic communities, who lead a transhumant lifestyle with yaks as their main source of livelihood. The ethnic nomadic communities are known by different names such as Brokpas in central and eastern Bhutan, Bjops in western Bhutan, and Lakhaps in west-central region, all of which basically mean 'pastoralists' (Gyamtsho 2000).

Alpine meadows at an elevation of 4,000–5,000 masl, commonly known as tsamdro, provide the main summer grazing grounds for the yaks (Roder et al. 2001). The winter grazing grounds are located near villages, and the spring and autumn grazing areas lie along the transit routes used for the seasonal movement of yaks, as well as sheep, cattle, and horses. The tradition of yak rearing is an old practice in Bhutan. Yaks provide food and fabric, as well

as draught power for haulage in the high-altitude areas. The cold climatic conditions and rugged terrain at high-altitude are only suited to yak rearing, which helps to optimize the use of available land for animal-based food production in the mountain agricultural production system through vertical zonation and exploitation of the seasonal supply of fodder. Yaks are also closely associated with unique traditions and culture, which strengthens the social bonding among communities. In addition to the yaks providing basic needs for the herders and defining a distinct culture and tradition, the yak herders also serve as important custodians of the rich natural resources in the remote high-altitude areas.

Yak rearing in Bhutan

Yaks are reared in 11 of Bhutan's 20 dzongkhags (districts) (Figure 13). Table 12 shows the yak population and number of yak rearing households in these dzongkhags from 2009 to 2013. In 2013, Thimphu had the highest yak population and Samdrupjongkhar Dzongkhag the lowest.

Although overall numbers have not gone down drastically, there was a sharp decline in the yak population in 2012 (Figure 14), which is attributed to the neglect of yak herding communities in mainstream development plans and the meagre support for yak husbandry provided by government agencies. Yaks and yak herding are losing their importance as the main source of livelihood for transhumant pastoralists in high-altitude mountain areas. The

Figure 13: **Yak rearing dzongkhags**

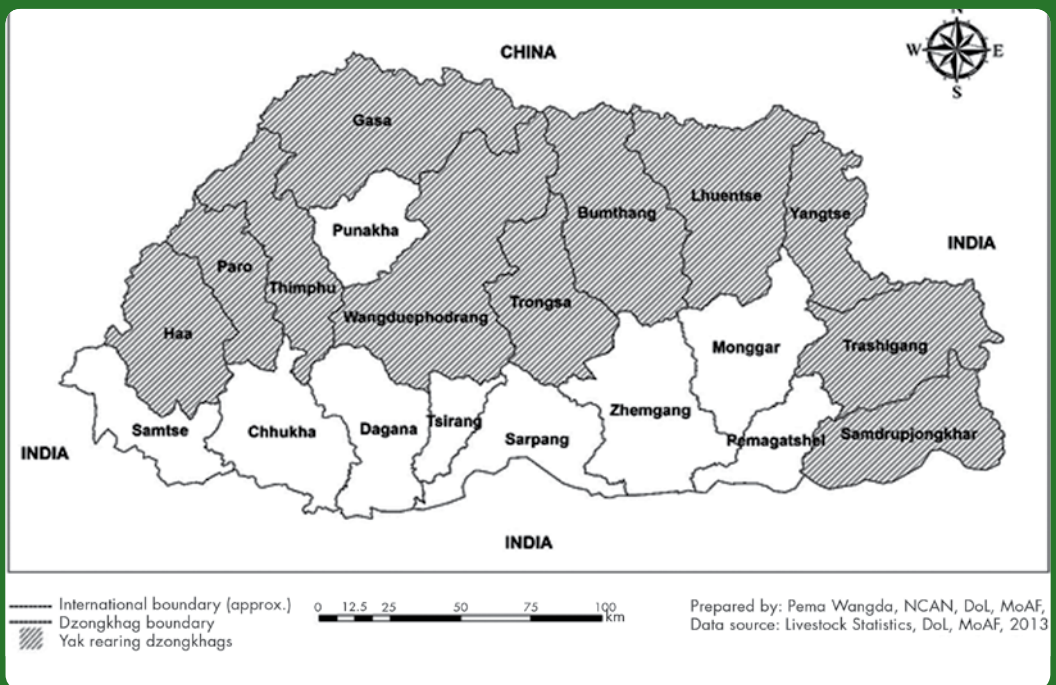
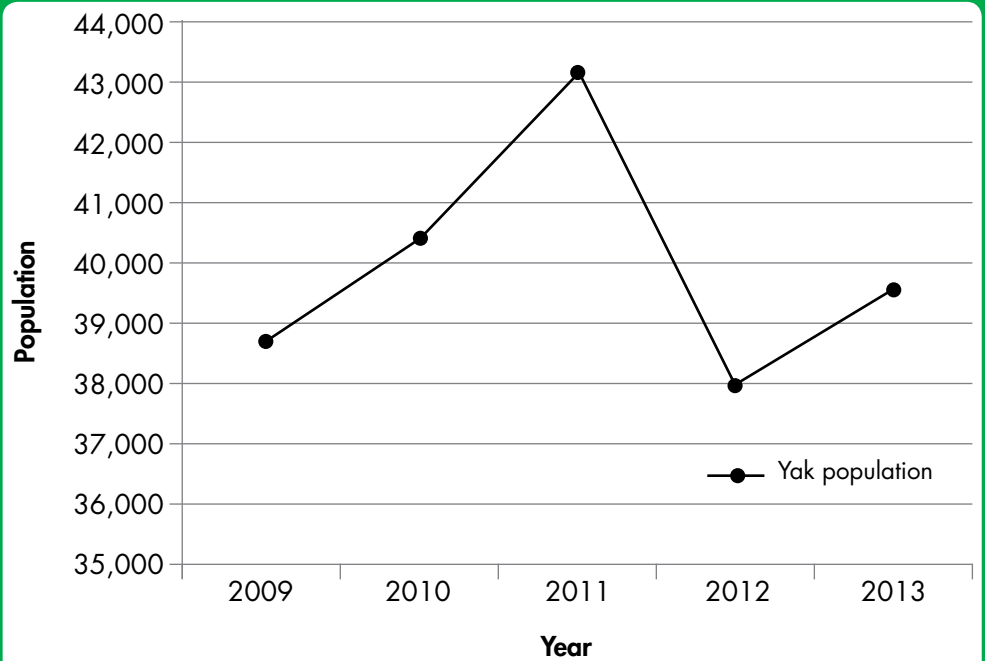


Table 12: **Yak population and number of yak rearing households in Bhutan from 2009 to 2013**

Dzongkhag	Yak population					No. of yak rearing households				
	2009	2010	2011	2012	2013	2009	2010	2011	2012	2013
Bumthang	3,103	3,360	3,501	3,232	2,974	80	92	75	82	58
Gasa	6,590	7,545	7,640	6,313	5,787	192	233	229	223	216
Haa	5,552	4,895	4,763	5,226	5,857	104	89	80	82	99
Lhuentse	322	223	216	241	234	6	5	5	5	4
Paro	3,572	3,290	3,217	1,535	2,632	180	42	42	25	42
Samdrupjongkhar	NA	NA	50	25	28	NA	NA	4	7	6
Thimphu	10,395	10,223	11,154	10,442	10,984	152	141	151	148	156
Trashigang	5,981	7,094	8,724	7,312	7,153	284	381	390	366	375
Tashiyangtse	572	588	591	589	541	6	6	6	6	9
Trongsa	72	58	73	71	80	3	3	3	3	3
Wangdue	2,531	3,098	3,215	3,025	3,273	97	117	111	103	114
Total	**38,690**	**40,374**	**43,144**	**38,011**	**39,543**	**1,104**	**1,109**	**1,096**	**1,050**	**1,082**

Source: DOL (2013)

Figure 14: **Yak population (2009–2013)**



Source: Livestock Statistics, Department of Livestock, MOAF, RGOB, 2013

trend is more evident in areas where there are alternative avenues for economic development, such as tourism and the collection of *Ophiocordyceps sinensis*.

Challenges in yak husbandry

The yak herding communities in Bhutan face a number of challenges, and there are a number of needs that require immediate attention to protect yaks and the interests of the yak herders.

Poor access to basic social amenities

The approximately 1,100 yak herder households (Table 12, DOL 2013) are scattered across the northern parts of the country, which makes it difficult to implement a specific development programme to support them. Planned economic development started in Bhutan about six decades ago, but development interventions are limited in the remote and far flung high elevation areas. The yak herding communities have benefited only minimally from the planned development process compared to the downstream valleys. Some of the differences in access to basic social amenities are shown in Table 13 in a comparison between a yak rearing gewog (block) and a non-yak rearing gewog (Sakten Gewog in Trashigang Dzongkhag and Mongar Gewog in Mongar Dzongkhag).

Unbalanced development activities have resulted in inequity in access to basic amenities for high-altitude nomads, triggering a rural-urban migration in search of better livelihood options. As elsewhere in the developing world, the impacts of modernization have not spared these nomadic communities and the younger generation are unenthusiastic about yak herding and the hardships of this way of life. The development interventions that have been carried out to support enhancement of yak communities' livelihoods, for example fodder development and supply of inputs such as fencing materials and milking and milk processing equipment, have been widely dispersed and unequally distributed and have had little or no impact.

Shrinkage of grazing areas

Rangelands are the main source of grazing for yaks, but they are subject to various forms of degradation due to lack of management interventions. Rangelands are used on a free-for-all

Table 13: **Access to basic social amenities in a yak rearing and a non-yak rearing gewog**

Basic social amenities	Sakten Gewog – yak rearing[a]	Mongar Gewogb – non-yak rearing[b]
No. of households	336	617
Farm road connectivity (km)	0	79.5
Access to electricity	0%	100%
No. of high schools	0	4
No. of health facilities	3	7

Source: [a] Tashigang Dzongkhag (2014); [b] Mongar Dzongkhag (2014)

basis without any management practices or regulations (Roder et al. 2001). Moreover, the strong environment conservation policies of the country have prohibited the traditional management practice of rangeland burning since the 1970s. Prior to this, local yak herders used rangeland burning as the main rangeland management tool, and cessation has resulted in the proliferation of unpalatable shrub species over a considerable area, reducing the amount of grazing land available for yaks (Chophyel 2009). The decrease in grazing area, low productivity of the rangeland, and competition for the limited grazing resources from wild ungulates – mainly takin (*Budorcas taxicolor*) and blue sheep (*Pseudois nayaur*) (Gyamtsho 1996) – mean that availability of adequate grazing resources has become a serious challenge for yak herding.

Changes in the educational system and seasonal shortage of household labour

In the past, yak herding practices and traditions were passed from generation to generation. Now with the introduction of a western education system and modernization of the country, yak herding families prefer to send their children to school, leaving only the elderly to tend the yaks. Most young people are not willing to take up yak herding. The yak herders seem to be giving up yak rearing faster in areas where the extended family have agricultural land, like Bumthang or Haa; about 60% of the yak herders who reared yaks in the past have left yak rearing over the past ten years (Dervillé 2010). A shortage of household labour at the time of

the *Ophiocordyceps sinensis* harvest in May, June, and July has also become a common phenomenon. Most of the younger members of herders' families devote their time to collection of *Ophiocordyceps sinensis* because of the high income from its sale.

Unhygienic yak product processing practices and poor marketing opportunities

Herders still process yak milk and milk products using age-old traditional knowledge and equipment. These are not only laborious and time consuming, they also lead to unhygienic products, which poses difficulties in marketing. Yak meat and meat products are rarely available in the market because of the difficulties in transporting them from the mountains to the nearest markets. In the past, yak products such as butter and hardened cheese (locally chugo) were bartered for food grain in the valleys, but now yak products are mostly sold for cash. Challenges to the sale of yak products include the poor infrastructure, inefficient traditional equipment for processing, unhygienic products, and lack of a proper marketing strategy. Thus, yak herding is no longer attractive as a main source of income for herders.

Lack of facilities and technical capacity in yak breeding practices

Lack of facilities and technical capacity for yak breeding are also contributing to the decline in yak herding. The most common breeding practice is the frequent exchange of male breeding

yaks with neighbouring herds to reduce inbreeding (Dorji 2002). However, the scattered nature of the yak herds coupled with a lack of quality yak bulls are major constraints to improving breeding quality.

Improving yak herds through artificial insemination on a large scale is impractical and difficult to implement due to the rugged terrain, scattered nature of yak herds, and seasonal movement of yaks (Tshering 2000). Yak breeding through artificial insemination with semen imported from China did achieve limited success (Tshering et al. 2000), but the technology remains to be tested in Bhutan on a larger scale.

Poor animal health care coverage

Gid is the most common disease causing high mortality among yaks (Dorji 2002); around 70% of cases are reported in young animals 1–2 years old (Tenzin 1979). Poisoning by plants such as *Senecio* species, which contain the highly toxic chemical pyrrolizidine alkaloid (Dahal 2000), and by contaminated water (locally known as baduk and chuduk), is also reported to be a major cause of yak mortality. There are no known successful treatments for such cases and the yaks are left at the mercy of nature for a cure.

Veterinary health care services are provided free of cost by the government through the dzongkhag and gewog clinics throughout the country. However, due to the remoteness and scattered nature of yak herds, these animals rarely receive even the basic veterinary services on time.

Livelihood opportunities from yak rearing

Enhance income from yak-based food products

There is a rising demand for animal-based food products in Bhutan and a deficit in the supply of such products at the national level. Yak rearing and production can play a crucial role in achieving national self-sufficiency in livestock-based food products. Yak rearing offers a good opportunity to produce animal-based food products while enhancing the livelihoods of nomadic communities. The yak products are primarily based on natural grasses grown in a pristine environment, and fetch relatively high prices compared to other livestock products. There are opportunities for marketing the yak products to high-end hotels as 'niche organic products'.

Yak based ecotourism activities

High-altitude landscapes, a pristine environment, and unique communities are key features for tourism. Well-organized tourism in yak-based regions can offer an avenue to enhance income generation in yak herding communities. Possibilities exist for building eco-lodges for homestays and promoting ecotourism. Emphasis could also be given to riding and using pack yaks for trekkers, because most of the trekking routes in the country pass through the yak

rearing areas in northern Bhutan. Moreover, yaks are emblematic animals and could attract tourists who are interested in simply watching them. These initiatives, if well planned, can bring more income, generate employment, and encourage the younger generation to continue rearing yaks, in addition to preserving Bhutan's culture and tradition.

Legalization of *Ophiocordyceps sinensis* harvest and trade

The harvest and trade of *Ophiocordyceps sinensis* was legalized in Bhutan in 2004 with the aim of enhancing the living conditions of nomadic communities. The harvest permits are only allotted to highlanders (Dervillé 2010), and with the huge demand and good prices in the international market, this legalization has provided an important source of income for herders and the herders' communities. This income could be invested to support yak rearing and increase its sustainability.

Future actions

Policy innovations for sustainability

Formulation and implementation of direct policies and innovations for sustainable yak rearing will be crucial for maintaining a critical number of yaks and yak herders in Bhutan. There is a need to contribute to the sustainable development of yak production through enhanced development of basic amenities and improved service delivery to yak herding communities. Although construction of roads to connect the remote highlands with the rest of the country is underway, it is likely that some remote areas will still have no road network for some years to come (DOA 2011). Therefore the issues faced by herding communities will still take some time to improve. A shift in the development paradigm is needed to balance and develop basic infrastructure and facilities in the highlands; this will be vital to curb rural-urban migration.

One of the reasons herders are giving up yak herding is the low production from yaks due to poor breed quality, which is the result of the lack of a sound breeding policy and practice. The Livestock Breeding Policy of Bhutan is still in the draft stage, and there are concerns about whether the policy will mention yak breeding aspects. It is important to recognize the need to improve yak breeds, as one of the main sources of ruminant-based animal foods in the country. This can be achieved by providing free or highly subsidized yak breed improvement schemes through selective breeding for a number of years. The technical capacity of the technicians and the development of facilities for yak breeding need to be strengthened.

The ban on burning of rangelands as a management tool should be revisited because prescribed burning is the most practical and cost-effective tool for reducing the invasion of rangelands by unpalatable shrubs and bushy species (Wangchuk et al. 2013). Environmental conservation policies should be reviewed with a view to lifting the ban on traditional burning of rangelands and allowing prescribed burning on a limited scale as a major management tool.

Currently, there are no policy directives that require establishing a nodal agency responsible for yaks and yak herders and their development, unlike other commodity programmes such as dairy, poultry, and piggery. The responsibility for yaks and yak herders is shared among different government ministries and departments, which means that there is limited or no impact. Establishment of a nodal agency at national level is critical for ensuring reliable support and implementation of planned activities for the sustainability of yak husbandry.

Technical interventions and capacity building

Sound rangeland management tools and practices need to be instituted by balancing and blending policy directives, societal needs, and scientific rangeland management principles. Yak grazing needs to be regulated by preparing and implementing grazing management plans. At present, grazing in the rangelands is mostly unregulated and there are no management practices in place, which not only leads to low productivity as a result of overgrazing and encroachment by shrubs and bushes, but also leads to negative environmental impacts such as losing species biodiversity and drying up of water sources, which will ultimately expose the rangelands to further forms of degradation.
Other important activities include intensifying the production of fodder crops by introducing high yielding fodder species, and developing pasture in high-altitude areas with appropriate fodder species to supplement the nutritional requirement of yaks and enhance yak production. During winter, initiatives focused on fodder conservation such as promotion of feed blocks and urea molasses mineral blocks (UMMB) will also make yak herding more attractive.

Initiation of free or highly subsidized yak breed improvement schemes through selective breeding will be crucial to improve yak quality and contribute to sustaining yak husbandry. Animal health care and veterinary services also need to be improved. Animal health outposts should be established in strategic locations to help minimize the loss of animals from disease and other health issues.

Subject matter specialists need to be trained in yak husbandry and rangeland management. Small scale interventions for enhancing yak herders' livelihoods, such as treatment of yaks and development of pasture and fodder, are being undertaken by extension workers who have little or no knowledge of either yak husbandry or rangeland management. Prioritizing the training needs and capacity building for subject matter specialists will be the key to rejuvenating recognition of the significance of yak populations and yak herding. Similarly, capacity building of the herders in handling modern processing equipment and in rangeland management will also have a positive impact on herders' livelihoods and rangeland conservation.

Yak products cottage industry development

The recent advances in dairy development initiatives in Bhutan's downstream valleys have overtaken the markets for traditionally produced yak dairy products such as yak butter and

chogo (hardened cheese). Basic milk and meat product processing infrastructure needs to be established in yak herding areas with modern yak product processing equipment to improve the quality and hygiene of yak products.

Payment for environmental services

The yak herding communities act as custodians of the environmental services provided by the challenging high-altitude terrain, while at the same time being deprived of developmental incentives and benefits. The environmental services benefit communities in the lower lying areas. Institutionalization of environmental incentive schemes such as payment for ecosystem services (PES) for the highland communities is another as yet unexplored avenue for improving yak herders' livelihoods and yak herding in Bhutan.

Conclusion

Yaks and yak herding are important to Bhutan from a social, environmental, and economic perspective, but they are facing numerous challenges. A holistic, well planned, and target-oriented approach must be adopted to sustain yak herding in Bhutan and retain yak herding as an important livelihood source for the herders' communities. The relationship between yaks, yak herders, and the rangelands is synergistic, and the importance of yaks and yak husbandry needs to be more widely recognized. If the trend away from yak herding is not reversed, yaks and yak herders will become a past memory, which will have serious long-term negative social, environmental, and economic repercussions.

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Recent Changes in Yak Herding Practices in Eastern Ladakh and Implications for Local Livelihoods

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Yak have been an integral part of pastoral livelihoods in Ladakh and the adjacent areas in Central Asia for centuries. Yaks not only provide pastoralists with their basic needs such as food, transport, and clothing, they also help sustain the rural environment in the cold deserts by leaving a low ecological footprint. In recent decades, the dependence on yaks has declined as a result of several factors including lack of superior breeds, insufficient pastureland, and socioeconomic development. In-depth information on these factors will help maximize the benefits of yak rearing. This paper describes the historical and recent trends in yak husbandry practices in the Ladakh region of Jammu and Kashmir state, India. The current status of yak husbandry and factors leading to the decline of such practices in eastern Ladakh was assessed using a semi-structured questionnaire. Nomadic herders, village heads, and local people in the Changthang areas of Nyoma block were consulted. Strategies for the better management of rangelands, improvement of the fodder supply chain during winter, improvement of breeds, introduction of insurance policies, and value addition of yak products are discussed. Policy level interventions to improve the livelihoods of pastoral communities are recommended.

Keywords: Changthang, livelihoods, pastoralists, rangelands, yak

Introduction

Domestic livestock, especially yak (*Bos grunniens*), have been a vital resource for sustaining the livelihoods of the people of Ladakh and adjoining areas in Central Asia. Yak has been very closely associated with the culture, religion, and social fabric of the pastoral people in these areas due to its ability to survive in extremely harsh climatic and resource scarce conditions. Yak forms a major source of food (milk and meat), clothing (hair), shelter (hides), and fuel (dung). As agriculture is unsustainable in the cold high deserts (above 4,000 masl), people have adapted to a pastoral mode of life, rearing sheep, goats, and yaks for their survival. Pastoralism has been the only means of subsistence for these people, who have been managing the pastures by using defined movement, tracking spatio-temporal changes and pasture quality, and predicting uncertainty and risks of drought, predation, and avalanches (Hagalia 2004; Walker and Meyers 2004; Walker et al. 2004). Despite harsh climatic conditions and scarcity of resources, pastoralists have been able to manage the environment until recently (Miehe et al. 2009), but the scenario is now changing rapidly in response to

socioeconomic changes. For example, in Ladakh in the Indian trans-Himalaya, only 1,200 nomads in three distinct communities – Kharnak, Samad, and Korzok – remain in their original habitat, around 1% of the total population in Leh district (Dollfus 2013).

A study of the literature on the recent changes in pastoral practices in the Ladakh region reveals a drastic change in the mode of pastoral lifestyle from nomadic to sedentary, resulting in increased grazing pressure on the available rangelands in the area surrounding the settlements (Singh et al. 2013). Overgrazing has resulted in a change in the plant community composition with reduced plant cover and threat of extinction to valuable fodder species (Bagchi and Ritchie 2010a, b). With the degradation of pastureland, a decline in the survival rate of calves has been reported in some areas (Dollfus 2013).

The eastern part of Ladakh, popularly known as Changthang, is undergoing rapid socioeconomic change. With the increasing population of other livestock (sheep and goats) and decrease in the area of available pasture due to border issues between India and China, yak numbers have decreased considerably over the last few decades. The decreased economic potential of yak and increasing competition for grazing land, coupled with the increasing opportunity for employment especially in the tourism sector, has changed the livelihood pattern of nomads. This, along with other anthropogenic pressures such as population growth, increasing demands for goods and services, and education, has led to a rapid change in the pastoralist lifestyle (Singh et al. 2013).

In this paper, we present the results of a rapid survey carried out in eastern Ladakh on the current status of yak herding practices, recent trends in the yak population, and breeding and pasture management. Future strategies to revive yak husbandry practices are discussed.

Study area and methodology

The study was conducted in Nyoma administrative block in Leh district in the Indian state of Jammu and Kashmir. Nyoma block contains more than 80% of Indian Changthang, which is well known for its extensive high-altitude rangelands, traditional use of the rangelands by nomadic Changpa herders, and production of Pashmina wool. This area lies in the Indian cold desert and has extremely harsh winters with temperatures reaching below -30°C. There are 17 villages in Nyoma block, of which eight were selected for sampling due to the remoteness.

The survey was conducted in autumn 2012 (September–October) when herders are preparing to move to the winter pastures. We collected information on yak herding practices using semi-structured questionnaires and personal interviews with nomads and village heads. Representatives from 150 families (48 female and 102 male) were interviewed for information on livestock holdings, demography, socioeconomic conditions (landholdings, income, agricultural and animal husbandry practices). Census data collected from the Animal Husbandry and Sheep Husbandry Departments in Nyoma and Leh were used to analyse

temporal changes in the population. Data for land use and socioeconomic changes were obtained from the District Statistical Department Leh, and were complemented by interviews with elderly people in the villages. Information on available livelihood alternatives, causes of changes in pastoral life, and problems associated with animal husbandry were collected by interviewing people in the village, including the headmen, as well as migrants working in Leh, using an open-ended questionnaire. Data were interpreted using qualitative analysis methods. Changes in animal husbandry practices were compared with the change in socioeconomic conditions and resource use patterns.

Results and discussion

Trends in the yak population

Data collected from the Animal Husbandry Department (AHD), Government of Jammu and Kashmir, indicate a total yak population in Leh district of 13,000 in 2010, compared to 132,000 in 1977, and 30,000 in 1991, a reduction by more than 85% since 1977. According to official figures, there were 18,877 yaks in the district in 2012, of which 9,103 were in Nyoma block (Table 14).

Table 14: **Livestock population in different administrative blocks in Leh district in 2012**

Block	Yak	Sheep	Goats
Nubra	2,351	7,723	15,104
Kharu	864	3,119	4,067
Khaltse	2,060	11,255	9,703
Nyoma	9,103	46,230	132,581
Durbuk	4,272	7,757	36,172
Leh	227	6,493	2,816
Total	**18,877**	**82,577**	**200,443**

Source: Animal Husbandry Department Leh

Official records show that the total livestock population in Leh district increased from 141,541 in 1972 to 360,314 in 2012. Between 1977 and 2012, the number of livestock (yak, sheep, goat, and horses) in Samad-Rogchen increased from 14,700 to 28, 450, and in Korzok-Chumur from 26,250 to 45,100 (data from AHD Nyoma).

Figure 15 shows the average number of yak, goats, and sheep per household in the selected study villages in 2000 and 2012. Kharnak had the most yak, goats, and sheep on average per household: 30, 242, and 166, respectively in 2000, and 14, 352, and 170, respectively in 2012 (Figure 15). The herd size in the majority of households varied from 100 to 350 for goats and 50 to 170 for sheep. The number of goats increased in most of the villages between 2000 and 2012.

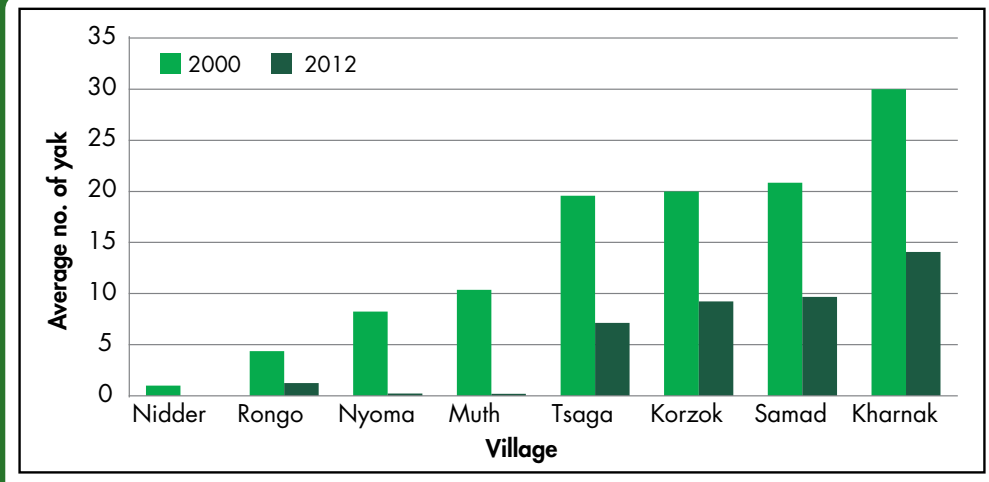
Table 15 shows the number of goats and sheep and household numbers in the study villages of Kharnak and Korzok in 1970 and 2010. According to the Animal Husbandary Department (AHD) Leh, the livestock population in eastern

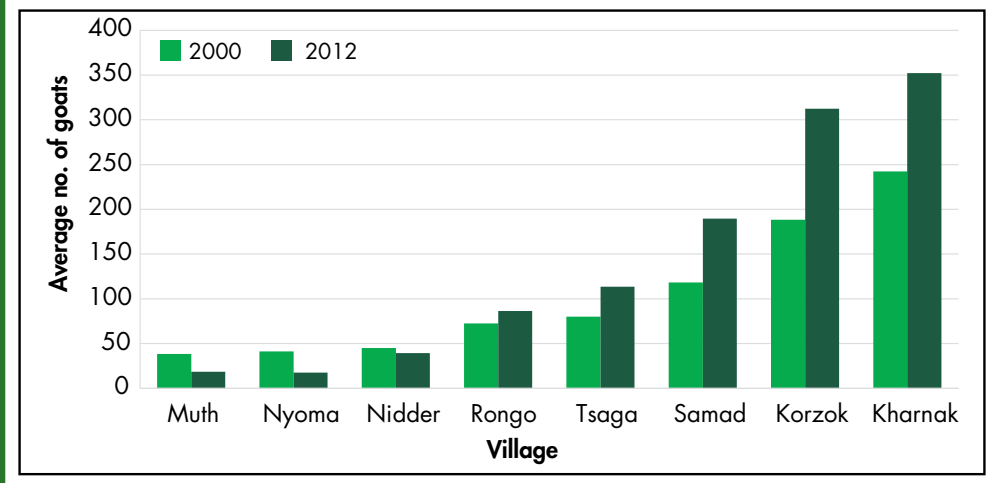
Table 15: **Livestock population in 1970 and 2010 in two villages in eastern Ladakh**

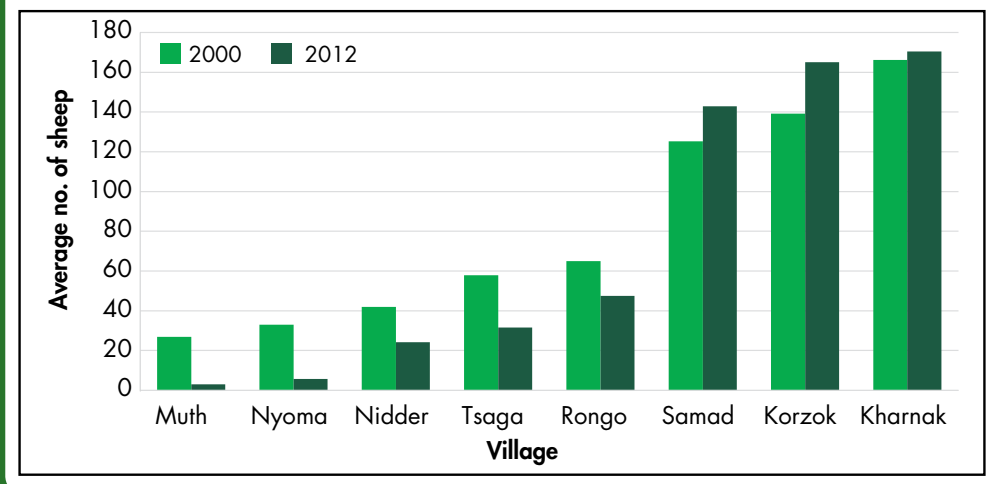
Year	Village	Households (HHs)	Pashmina goats	Sheep
1970	Kharnak	70	5,200	10,500
	Korzok	70	4,600	9,100
2010	Kharnak	30	5,500	2,000
	Korzok	150	25,000	12,500

Source: AHD Ladakh

Figure 15: **Average number of yak, goats, and sheep per household in different villages in eastern Ladakh**







Ladakh has increased considerably, nearly doubling since 1970/80. The greatest increase has been in goats, which could be due to the increasing demand for cashmere wool. A similar trend has been found in other parts of Ladakh (Namgail et al. 2007b).

The yak population decreased from 25,662 in 1997 to only 18,877 in 2012, and the remaining herds are suffering from inbreeding due to the absence of superior germplasm, which has resulted in a decline in milk production. The increase in the number of Pashmina goats has led to further degradation of the pastures.

Breeding status

The genetic diversity within the yak population in Ladakh has not yet been investigated. However, there are major physical differences between the yaks of Kargil and those of eastern Ladakh (Changthang) in terms of body size. The yaks from Kargil are larger and heavier (500–600 kg) than the yaks from Leh district, but the difference is attributed to better quality and quantity of forage in Kargil. All the respondents reported that they still follow natural breeding; there has been no effort to improve the breed through selective breeding. Breeding occurs from July to October when most of the nomads are away from the villages, where breeding facilities would be available. Generally, the first calf is born when yaks are 5–6 years old. The survival rate of yak is very low; only 1–2 calves survive more than 4–5 years out of 3–4 born. Males with the desired characteristics are kept for breeding. Most of the village clusters maintain male yaks with different physical attributes, and they rarely exchange yaks with villages at distant locations for breeding. Most of the nomads keep yak for milk and carrying heavy loads; slaughtering of yak is very rare. There are two yak farms in Ladakh, one in Nubra and the other in Budhkharboo, but there is no breeding farm in the Ladakh region. There have also been no efforts to discover the actual extent of inbreeding in yak. However, the National Research Centre for Yak (NRCY) in Arunachal Pradesh has provided frozen semen for artificial insemination to the Department of Animal Husbandry Leh and has also provided male yaks, one each in Nyoma, Hanley, and Samad (Rockchen) villages, on a community basis to reduce inbreeding. The results of these efforts are still awaited.

Most of the respondents (68%) considered that yak productivity (both milk and meat production) had declined considerably during recent years, which is attributed to inbreeding within very small herds. While artificial insemination facilities are available for cows, yak owners have difficulty in arranging breeding of yaks. None of the respondents had adopted artificial insemination for yak.

The hybridization of yak with cattle, which is a common practice in different parts of India, is not practised in Ladakh. According to the Animal Husbandry Department Nyoma, lack of expertise and facilities are the major constraints for hybridization of yak with cattle. The hybrid yak require more attention and resources (care for diseases and dietary requirements), and most nomads think that hybrids may not be able to survive at the altitudes where they spend the greater part of the year.

Status of rangelands and their management

Eastern Ladakh (Changthang) has a total area of around 21,000 km^2, of which less than 15% is under vegetation (Namgail et al. 2007b). Good pastures are restricted to those in close proximity to the river; pastures at higher altitude are characterized by poor vegetative cover. The pasturelands face immense pressure from a large population of livestock (more than 200,000), most of which are Pashmina producing goats (Namgail et al. 2007a). In 2008, Nyoma block alone had more than 171,376 sheep and goats (Sheep Husbandry Department Leh).

In recent years, reallocation of pastures for year-round use further reduced the area of rangeland from 1,500 km^2 to 500 km^2 for Samad and from 2,000 km^2 to 1,500 km^2 for Korzok groups (Singh et al. 2013). This decrease in the area of pasture and increase in the number of livestock, coupled with the lack of separate pastures for different seasons (winter and summer) has created immense grazing pressure (Table 16). Pastures have come to the state of exhaustion in many areas such as Skagjung (AHD Leh).

Table 16: **Grazing pressure by different livestock on the pasturelands of selected villages in eastern Ladakh**

Village	Pasture	Approx area (km^2)	Yak	Sheep	Goats	Other	Total livestock
Samad-Rokchen	Sta-sa-Phuk, Thukjay, Polokhangkha, Rokchen, Rina, Nuruchen, Dipring, Bongkanu	1,500	1,052	8,597	9,649	121	19,419
Korzok-Chumur	Khaldo, Luplung,Paldoh, Phirtseri, keyley, Yulungmarlung, Labjo,Lamye, UngtiTekajong, Aerong, Chumikshaltey, Kiangdam, Jabjay	2,000	1,646	14,100	15,746	921	32,413
Nyoma TR, Nidder	Kakjung, Thangka, Kyam-phu-tsuri , Nyan-ru, Kung Tso, Takjung, nebo-cheyspung, Tsegu-ringmo-lungung, Takpochey, Bowolay, Sagra, Khargay, Lewochey, RichikPhiwa, Tum-Tum, Dungti, Changlung, Nichung,	-	121	2,625	2,746	607	6,099
Kharnak	Lungmoche, Zara Pangchen, Gyagang, Tsermatse	-	3,491	1,921	5,412	82	10,906
Tsaga, Rongo, Muth	Kakjung, Pilungkong,PilungYokma, Dungsum, Lung Maru, Riya,Yulung, Trulung, Taro, Dudling, Zao, Diplung, Nyanlung, Lhaphur, Kyakchat, Pakra, Panjumglungba, Parma Spangling, Taklung, Kungdingnala, MuchongLungba, NuchungLungba, LadumTaba, Na-you, Khurul,Tseyoringmo, BonakLhatsey	-	249	4,751	5,000	475	10,475

Source: AHD Leh

Overgrazing in eastern Ladakh has resulted in a reduction in the density of good quality forage species such as *Eurotia ceratoides* (Uniyal et. al. 2005). *E. ceratoides* is one of the most important forage and fuelwood species in the region (Uniyal et. al. 2005). The impact of grazing pressure can also be seen in the prominence of graminoids (Rawat and Adhikari 2005), and decline in leguminous plants to only 3% of all vegetation; a good pasture should contain at least 33% leguminous plants.

Efforts to improve the quality of pastureland were initiated by establishing a forage farm at 4,600 masl. Although the results of the experiment were encouraging, it could not be implemented at a large scale due to the constraints of human resources for maintaining the farm (Pal et al. 1994). Considering the magnitude of the problem, improving the quality of pasture alone is not sufficient to tackle the problem of fodder shortages during winter. Hence a more comprehensive approach such as cultivation and use of other locally available resources as fodder is needed (Pal et al. 1994).

A community system of pastureland management prevails in the area, in which almost every village has its own summer and winter pastureland whose use by people from other villages is restricted. The nomads in eastern Ladakh are mainly divided into three groups: Kharnak, Samad, and Korzok. Until now, their traditional rangeland management system, involving continuous moving and use of pastures depending on season and quality, has been effective. In this system, the pastures at the highest altitude are used during the warmest period of the year (June to October); the middle altitude pastures during March to May; and the pastures at lowest altitude during the winter (October to March). This migratory grazing pattern, intended to avoid scarcity of fodder, is no longer practised intensively.

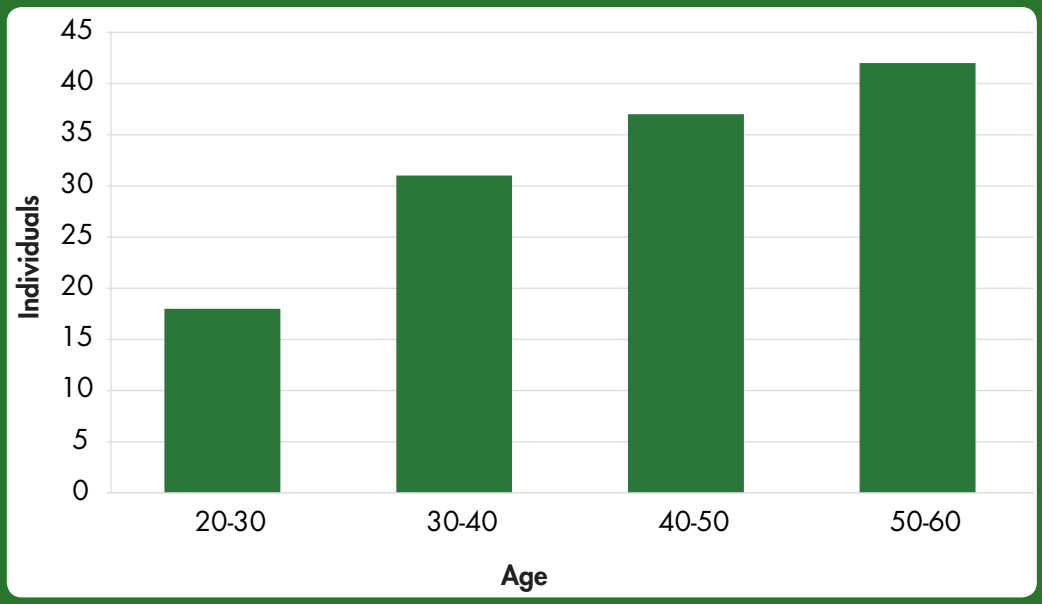
Originally, the nomadic groups had no specific rights to the use of pastureland. However, they possess traditional grazing rights in certain areas with well-defined boundaries, where they use some regulatory decisions to avoid conflicts with other nomadic groups. Currently, the pastureland of eastern Ladakh (Changthang) is state owned; there is no strict rule regarding its use by nomads and it is considered as common property with open access. Earlier, the government used to levy a nominal amount as grazing tax, but the system is not effective due to the lack of a policy for pastureland development.

Demography and socioeconomic status

Demography and literacy

The human population in Nyoma block increased from 7,320 in 1981 to 11,103 in 2010. In Kharnak and Korzok, the number of households increased from 140 in 1970 to 180 in 2010, while the number of people decreased from 1,000 to 950, suggesting migration from these villages primary health care nyoma. The majority of the interviewed herders were older than 40 (Figure 16).

Figure 16: **Age structure of interviewed herders**



Of the 150 people interviewed, 75 were non-literate and only two had completed pre-university education (Figure 17). The population census data shows 67% of the population to be non-literate and only 9% to have completed Grade 10 and above. Despite the availability of a primary school in most of the villages, the dropout rate is very high. A mobile school programme has been successful in many parts of Ladakh and efforts are being made to improve it further. However, it has limitations as the teacher has to move with the nomads with limited logistic support. Despite being interested, very few nomads have had an opportunity to continue their education.

Livelihood alternatives and economic status

The opening of tourism in Ladakh in 1974 created thousands of jobs and now contributes around 50% of the region's gross income (Pelliciardi 2010). The number of tourists in Kharnak and Korzog increased from 20,000 in 1990 to 78,000 in 2010 (District Statistical Department Leh). Notwithstanding the continuous growth in the tourism sector, animal husbandry remains the backbone of Ladakh's economy and the interviewed families were still herding livestock. However, only 27% were totally dependent on livestock and led a nomadic life, while the remainder were semi-nomadic. This is a recent trend; 42% of the families reported that they had only adopted other livelihood alternatives recently. Besides pastoral activities, most people in the surveyed villages also worked as porters, labourers, or farmers (Figure 18). People are also opting for government jobs, small business, and other

Figure 17: **Educational level among interviewed herders**

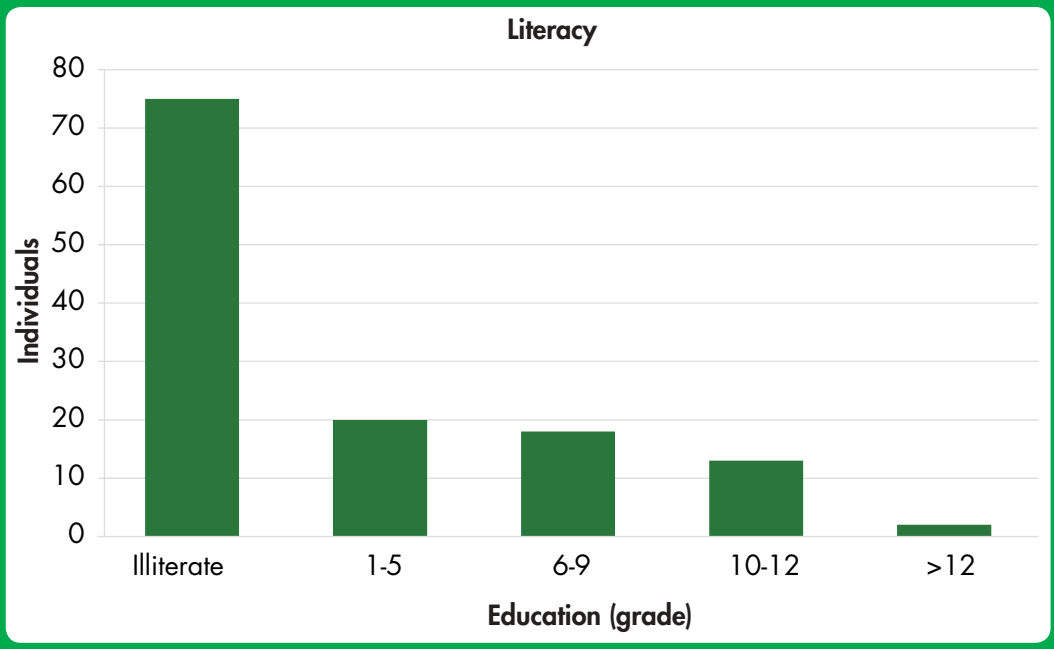
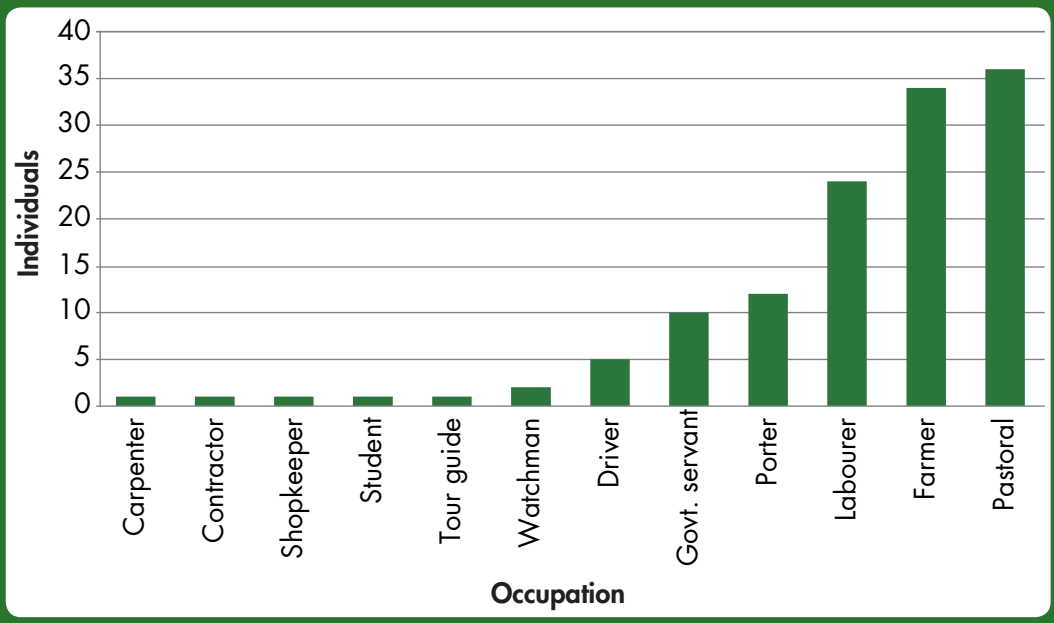


Figure 18: **Occupation of herders in addition to animal husbandry practices**



miscellaneous work such as driving private vehicles, tour operator, and trafficking of contraband. Of the 150 people interviewed, very few had opted to work as tour guides or shopkeepers, which could be due to the lack of proper education.

The majority of the respondents were landholders, but only 7% had more than 1 ha of land (Table 17); 18% of respondents were landless, while 40% had less than 0.4 ha of land. Only 18% had mixed farming (cereal and fodder production).

Table 17: **Landholdings among herders**

Landholdings (ha)[a]	No. of people	%
0	27	18
<0.4	61	41
0.4–0.6	32	21
0.6–1.0	19	13
>1.0	11	7

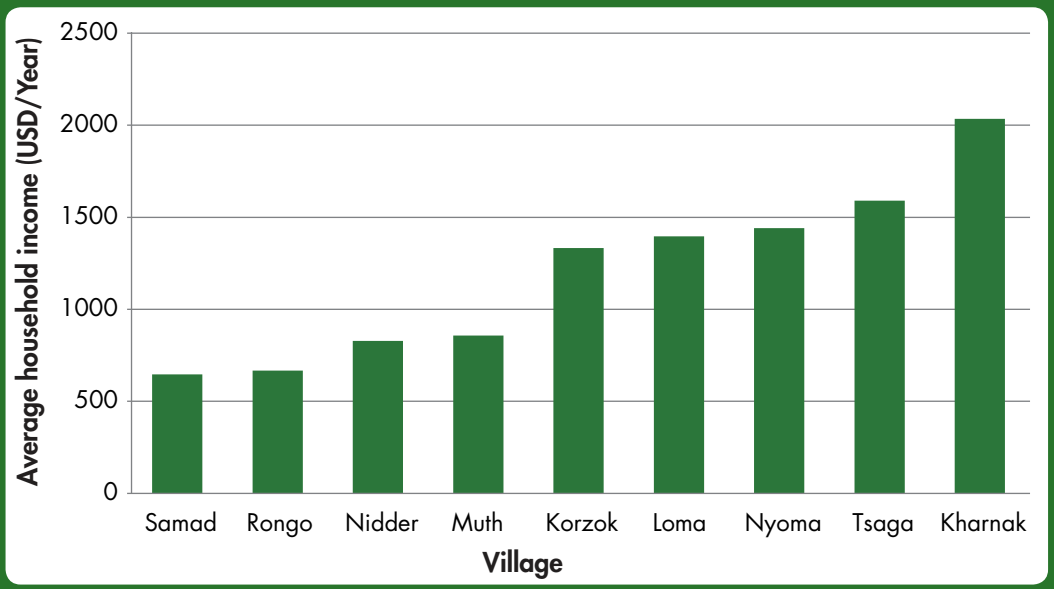
[a] 1.0 ha = 2.5 acres approx

Among the surveyed villages, Kharnak had the highest annual average household income at more than USD 2,000, followed by Tsaga, Nyoma, Loma, and Korzok with more than USD 1,300 (Figure 19). One of the reasons for the high household income in these areas is the higher number of tourists compared to the other villages.

Socioeconomic change and migration

Nomads were able to survive in the harsh climate of eastern Ladakh because of their ability to utilize the scarce resources while maintaining the ecological balance (Pal 1993). With the increasing pressure on pastureland following the border issues between India and China, the nomads have been forced to search for livelihood alternatives.

Figure 19: **Average household income of herders**



Migration towards the major cities has increased in recent years. Out of the 150 families interviewed, 26 reported that 1–4 members of the family, 58 people in total, had migrated recently. Approximately 1,000 people had already migrated to Leh and its surrounding areas between 1962 and 2013. According to the respondents, lack of employment is the major reason for migration, followed by lack of facilities for children's education and lack of health care services in the area. Lack of other basic amenities such as shortage of water during winter, electricity, and transportation is also influencing the decision to migrate to major cities.

The government's efforts to provide subsidized feed, fodder, and medication for livestock has not proved effective in stopping migration. The rapid development in the area indicates that the continuous efforts of the government to provide all basic amenities such as food, education, and health care services has not been sufficient to improve the traditional life of nomads. Many nomadic settlements in the surveyed areas still have no electricity, most experience a shortage of potable water, and most lack good educational institutions in nearby areas.

Current animal husbandry practices

Fodder availability

Animal rearing was mostly based on grazing in the pastures, and feeding systems utilized only locally available resources. However, with the improvement in transportation, people now have the option to purchase fodder from the Leh market. The practice of stocking feed for winter has now become essential for most of the nomads as the death of livestock due to the scarcity of fodder during heavy snowfall and in winter has become a serious issue over the last few years. In 2013, more than 22,000 Pashmina goats, yak, and other livestock were killed during unprecedented snowfall in eastern Ladakh due to lack of fodder. Since very few families have irrigated land to grow fodder, most must purchase from the open market. None of the respondents used a mineral mixture as a dietary supplement. However, most were aware of the frequent use of salt and regularly provided it as a supplement. Stall feeding is with wheat straw and local grass and only very rarely with oil cake.

Problems of animal husbandry

Lack of feed and shelter, severe cold, and lack of human resources during winter were the most severe problems for yak husbandry mentioned by the 150 respondents; while shortage of water in pasturelands and disease were also reported as contributing factors affecting animal husbandry (Figure 20). The problem of obtaining winter feed was exacerbated by the cost in the market of USD 15 per kg and many herders purchased none or only a small quantity (Figure 21).

There was no insurance scheme for yak husbandry in the region. An insurance scheme has been initiated in some parts of Ladakh in which INR 50 per month is collected for each adult yak, supported by an annual contribution from NGOs involved in natural resource

Figure 20: **Factors affecting animal husbandry practices**

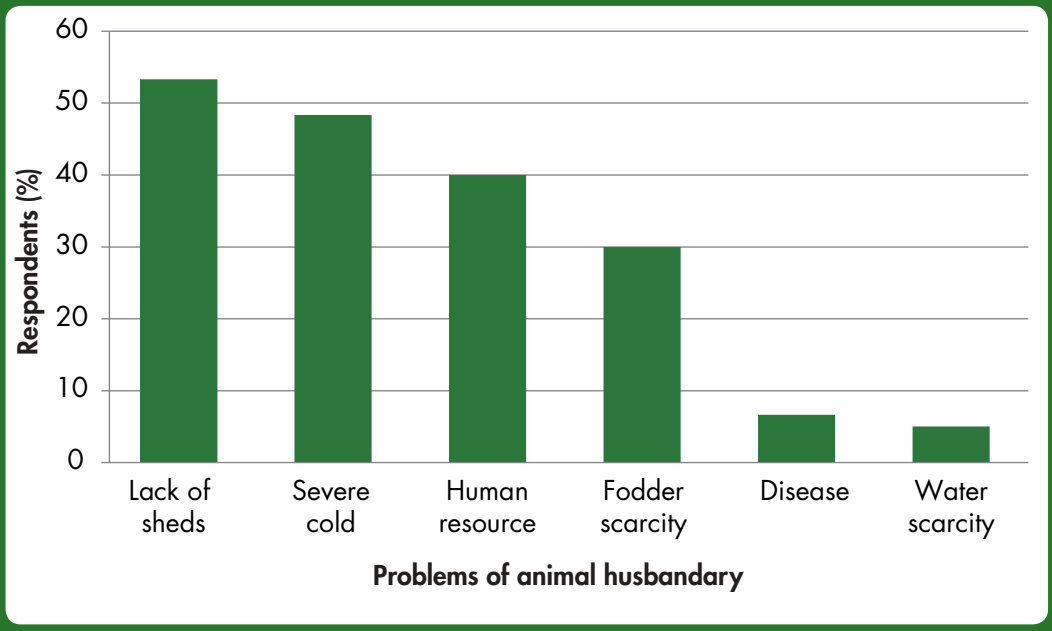
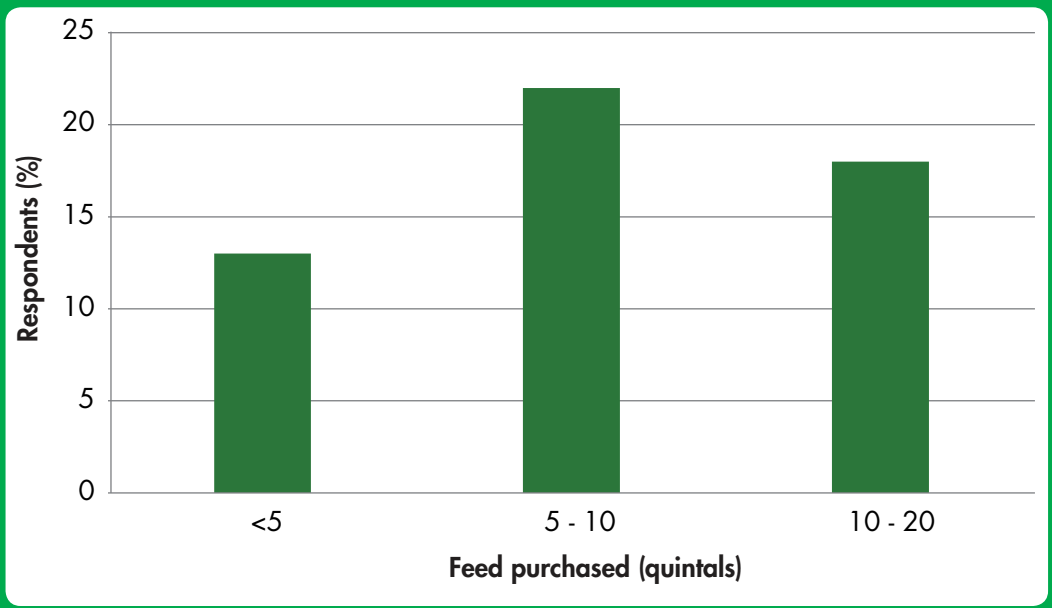


Figure 21: **Quantity of feed purchased annually by herders**



management and wildlife conservation (Singh et al. 2013). The scheme includes avoiding certain areas for conservation purposes, with the village committee provided with a fee equivalent to the fair market rent for that grazing land.

Yak utilization

Yak is used as a multipurpose animal in eastern Ladakh. Although milk contributes a major part of the herder's economy, only 3–5% of total milk production is obtained from yak. In Ladakh, the demand for yak meat is high and the price of yak meat varies from USD 4–6 per kilograme depending upon the locality and quality of meat. The average weight of a mature yak is 200–320 kg depending on breed and location.

All the respondents used yak milk for household purposes but there was no record of using the milk for commercial purposes. The yield of milk from yak varied from 0.9 to 2.4 kg/day/yak in different villages with an average of 1.38 kg/day/yak (Table 18). The lowest yield was recorded in Tsaga and the highest in Kharnak. The reason for the difference was unclear, as most of the families had poor feeding and management practices. The nomads said that one demo (female yak) gives approximately 110–120 litres of milk annually, which is very low compared to the yield in China of 200–400 litres in the months following calving (Wiener et al. 2003). Three litres of milk gives 250 grams of butter. The nomads said that they buy a lot of butter from the stores in Leh. Milk is rarely used in making tea, as 68% of respondents used it for making butter.

Sale of animals for meat, mostly castrated males, is the major source of income for nomads. Only 12% of respondents had a regular income from the sale of yak, while most had insufficient to maintain the herd. None of the respondents had income from the sale of yak hide, hair, or pelt as these were mostly used locally or for household purposes. Despite the immense scope to use yak milk for the commercial production of cheese, as in Nepal (Joshi et al. 1999), there has been no effort in this direction.

None of the respondents used the yak pelt, but the majority (84%) used dung for household purposes. There is no value addition of yak products in Ladakh, and no expanded market for raw or value added products for sale. The potential to commercialize yak cheese, fleece (for good quality fibre), and hides has not been adequately exploited.

Table 18: **Yield of milk in different villages of Changthang**

Village	No. of households	No. of female yaks	Total milk (kg)	Average yield (kg/day/yak)
Samad	21	65	104	1.6
Korzok	13	49	58	1.2
Tsaga	14	32	29	0.9
Kharnak	15	81	146	1.8

Conclusion

The yak population in the surveyed villages in eastern Ladakh has declined considerably, which can be attributed to the Changpa herders switching to the relatively more lucrative rearing of Pashmina goats. Traditional yak husbandry depended more on the advantages of having multiple uses and brought relatively less cash. However, the lack of superior breeds of yak is probably also a major factor affecting the yak rearing practice. Intensive research and extension practices are needed to successfully implement a yak breeding programme. The deteriorating condition of pasture can be improved through the introduction of selected plant species. Providing fodder and shelter during winter and introduction of insurance policies has the potential to improve the deteriorating practice of yak husbandry in Ladakh. Value addition through processing has a potential to establish market chains for a range of yak-derived products.

The rate of outmigration has been increasing over the last few decades. Tourism is a major factor that has affected the nomadic life of people in the study area. The increase in human and livestock populations and decrease in pastureland, along with changes in society are probably the main factors affecting yak husbandry practices in eastern Ladakh (Changthang). Given that the change from a nomadic to a sedentary lifestyle appears to be more or less inevitable in the modern context, providing better opportunities for marketing of yaks and yak

products is likely to be the most viable option for sustaining a healthy population of yak in the Ladakh region. Initiatives by the government and NGOs to improve livelihoods need to be implemented in remote areas.

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Yak Herding and Associated Transboundary Issues in the Sikkim Himalaya, India

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The Sikkim Himalaya lies within one of 34 globally significant biodiversity hotspots and forms part of an important transboundary landscape. More than half of the geographical area of Sikkim (4,187 km^2, 59%) lies above 3,000 masl, in the greater and trans-Himalaya. The region is inhabited by diverse livestock-dependent ethnic groups, with different and unique rangeland management systems Two multi-disciplinary studies of pastoral practices were conducted in 2006 to 2012 with a special focus on yak herding. Extensive field surveys were carried out using geospatial and scientific tools to assess the spatial extent of yak herding, movement patterns, and the challenges faced by the indigenous ethnic communities. In the greater Himalaya (3,000–4,300 masl) of western Sikkim, the traditional Banpala breed of sheep were increasingly replaced by yaks and their crossbreeds, which graze on the alpine meadows during summer and descend to the multilayered temperate and subalpine forests during winter, and this was leading to degradation of habitats. Major transboundary issues included forest degradation due to human interference and grazing, human-wildlife conflict, and illegal collection and trade of species along the Indo-Nepal border. In the trans-Himalaya (4,300–6,000 masl), there has been a decline in grazing area and population (sheep and yak breeds) over the past 20 years. Here, the nomadic Dokpas, Lachungpas, and Lachenpas practice a unique form of pastoralism, moving to the high elevation in the cold desert during winter and returning to lower moist alpine ranges during spring. A traditional governance system for rotational grazing is followed to manage the herds and grazing area under Dzumsa, an indigenous institution. High stocking densities can lead to habitat degradation and competition with wild ungulates for forage and space. Management of the high-altitude rangelands in Sikkim requires an integrated conservation and development policy based on principles of equitable sharing of ecosystem goods and services, and transboundary cooperation.

Keywords: conservation, high-altitude rangelands, indigenous ethnic communities, transboundary landscape, yak herding

Introduction

Sikkim, one of the smallest states in India, lies at the tri-junction of Nepal, the Tibet Autonomous Region of China (TAR), and Bhutan within one of 34 global biodiversity hotspots

(WWF and ICIMOD 2001; Mittermeier et al. 2004). The primary reasons for the astounding biodiversity are the biogeographic location, wide altitudinal variation within a short distance from 300 to over 8,000 masl, heavy seasonal rainfall during the monsoon, and the conservation ethos of the local communities. Close to 31% of the geographical area of the state has been set aside as protected area, the highest proportion in any Indian state and far above the national average (4.7%), while the adjacent areas are generally covered by natural vegetation (Acharya and Sharma 2013).The state provides contiguous habitat corridors for the dispersal and evolution of flora and fauna, and provides connectivity with the far eastern districts of Nepal to the west, the Darjeeling and Jalpaiguri districts of West Bengal (India) to the south, and the Toorsa Strict Nature Reserve in Bhutan to the east. This compact landmass – the greater Kangchenjunga Landscape (KL) – has immense potential to strengthen conservation and development through transboundary cooperation (Sherpa 2003; Chettri et al. 2000; WWF India 2013).

The local communities in the KL rely on traditional farming activities for their livelihoods. There are five major farming systems in this landscape and other parts of northeast India – pastoralism, agropastoralism, mixed-farming systems, shifting cultivation, and cultivation of commercial cash-crops – with different systems practised according to the agroclimatic zone (Sharma and Kerkhoff 2004). In the Sikkim Himalaya, pastoralism/agropastoralism is largely practised in the subalpine and alpine zones of the greater and trans-Himalayan ranges between 4,000–5,500 masl; mixed farming in the temperate zone (2,500–4,000 masl); traditional agroforestry in the subtropical to warm temperate zones (600–2,500 masl); and terraced rice cultivation-based farming in the sub-tropical zone (above 300 masl) (Sharma and Dhakal 2011; Sharma 2014). Pastoralism and agropastoralism have been the primary livelihoods of the Gurungs and Magars (mainly shepherds), Bhutias (traders and yak herders), Lepchas and Limbus (hunter-gatherers and shifting cultivators), Chettris and Bahuns (agro-pastoralists), and Tibetan Dokpas (nomadic yak/sheep herders in the trans-Himalaya) (Tambe and Rawat 2009; Sharma and Dhakal 2011).

Pastoral practices in the KL evolved and spread over several centuries at a time when the political boundaries were not clear. Short and long distance migration in search of appropriate seasonal and better pastures, and exchange of livestock products with food grain and other commodities, were characteristic features in the past and ensured socio-cultural exchange among the local communities. During past decades, lack of effective governance and mutual distrust along the transboundary areas have facilitated poaching and illegal collection and trade of wildlife parts, including non-timber forest products (NTFPs). There has been a realization of the need to resolve transboundary issues in the KL, and this means a need to assess the dependence of pastoral communities on livestock grazing and to understand recent trends in pastoral practices and related issues in the transboundary areas (Shakya and Joshi 2008; TMI India 2010a; WWF India 2011a; Phuntsho et al. 2012; SBAP 2012).

Transboundary cooperation for conservation has received greater attention in recent decades due to the overarching issues across borders and the shared concerns for recognizing

environmental security (Oli 2003; Griffin and Linde 2000; Sharma 1997; Shengji and Sharma 1998). The Singalila Range along the Indo-Nepal border, the Pangolakha Range along the Indo-Bhutan border, and the trans-Himalayan range along the Indo-Chinese border are all important transboundary areas in the context of the KL. In line with the directives of the Eighth Conference of the Parties to the Convention on Biological Diversity (CBD), Nepal, India, and Bhutan have agreed to develop long-term conservation and development strategies for this region, together with a regional cooperation framework to be facilitated by the International Centre for Integrated Mountain Development (Sharma et al. 2007). The need for transboundary cooperation is particularly high in light of the persistent poverty that exists in the communities located in the remote and poorly accessible areas along or close to the international boundaries (Chettri et al. 2007a, b, 2008a, b; TMI 2010b), as well as unregulated tourism, the illegal trade in wildlife and NTFPs, and the degradation of forests due to crossborder grazing (FAR 2014).

The Mountain Institute India (TMI India), which has its headquarters in Sikkim, has been actively engaged in applied research on contemporary issues of conservation and development in the eastern Himalayas for the past one and a half decades. TMI India conducted a detailed ecological study in the alpine landscape of Khangchendzonga National Park with special reference to livestock grazing during 2005–2009 (Tambe 2007; Tambe and Rawat 2009), and a detailed study of the ecology, economy, and equity of pastoral systems in greater and trans-Himalayan Sikkim in 2008–2012. The main objectives of the studies were to 1) assess the challenges of conservation and resource use in the high elevation areas of Sikkim; 2) assess dynamic grazing practices, livestock movement patterns, grazing competition, and stocking density in the greater and trans-Himalayan areas (2,500–5,000 masl); 3) assess the challenges faced by indigenous ethnic communities, and resource governance by the indigenous Dzumsa system; and 4) identify transboundary issues in the region. Dzumsa is a traditional institution, and the local self-governance system of the Lachengpas and Lachungpas in the villages of Lachen and Lachung in North Sikkim, which is recognized by the Government of Sikkim.

This article synthesizes the key findings of the two studies and is based on a decade long assessment of pastoral practices in the region with a special focus on yak herding, the challenges faced by herders, the results of participatory action research on rotational grazing, changes in herd composition, and an analysis of associated transboundary issues in the region.

Materials and methods

We conducted baseline studies during 2005/06 on the land use, land cover, and tenure rights related to livestock grazing in the region. The geographical area under different categories of pasture and associated livestock populations were obtained from the records of the Sikkim State Forest Department. Extensive field surveys were conducted to ascertain the availability and use of various bioresources around villages in the buffer zone of protected areas. Key informants from the sample villages (200 individuals) and from government departments (25

field officials) were interviewed using a semi-structured questionnaire. In addition, focus group discussions (20) were held to collect information on grazing regimes, seasonal rotation and management, the role of informal institutions (e.g. Dzumsa, the traditional community-based resource management structure), challenges to sustainable pasture management, and benefit sharing from the available resources. The informants were interviewed periodically. They included herders, ex-herders, ex-hunters/poachers, women, community panchayats, Dzumsa members, school teachers, police personnel, staff from the forest department on the frontline, traditional healers, porters, cooks, and tourist guides.

After 2006, TMI India and the Sikkim State Government identified around 40 knowledgeable ex-herders and ex-hunters who could act as community-based conservation volunteers (Himal Rakshaks) in the high elevation alpine and trans-Himalayan areas. Himal Rakshaks accompanied the TMI teams in the field and served as an important source of information, as well as carrying out occasional patrols and regular high elevation wildlife monitoring, and raising community awareness (GOS 2006).

A combination of remote sensing data, Survey of India topographical sheets, and geographical information system (GIS) tools were used to categorize the ecological zones. Groundtruthing of major land use and land cover classes and habitat areas was done with the help of the Himal Rakshaks. Consultative workshops were organized from time to time with local communities in the east, west, and north districts involving herders, members of community institutions, Dzumsa members, defence personnel, and field staff from the Forest Department. The information gathered from the primary informants was used to identify grazing locations and wildlife habitats; these were then visited and the coordinates recorded using a global positioning system (GPS; Garmin+). The critical wildlife habitats and grazing areas within and outside the protected areas were identified.

The traditional herding practices and spatio-temporal use of high-altitude pastures were studied in Lashar valley, Tsho-Lhamu plateau, and Muguthang districts in North Sikkim, Dzongri-Goechala, Narsing, and Yambong districts in West Sikkim, and Kupup-Gnathang district in East Sikkim.

We calculated the stocking density of yaks at 85 locations and of sheep at 22 locations. The size of pastures was further confirmed through field surveys, community consultations, and groundtruthing, enabling 85 polygons to be defined for yaks and 22 for sheep. Participatory rural appraisal (PRA) tools, a line transect method, and informal interviews were used to ascertain the movement patterns of livestock over a calendar year and the number of grazing days at a particular location. The stocking density was calculated separately for yaks and sheep using the following formula:

$$\text{Stocking density} = \frac{\text{No. of grazing animals x No. of grazing days (per season)}}{\text{Area of grazing pasture}}$$

Where,

- Number of grazing animals means the total number of animal heads grazing in a particular location;
- Number of grazing days means the number of days the given number of animal heads graze in that particular location;
- Area of grazing pasture relates to the area of grazing land utilized by the animals in a given period of time.

This formula is used for calculating stocking density in rotational grazing. Stocking density of the same grazing location of different seasons differ, and the animals mostly graze in the same location for two seasons in a year during their movement.

Results and discussion

Trends in yak and sheep populations

Nomadic pastoralism is the major livelihood practice in the Sikkim trans-Himalaya and agropastoralism in the greater Himalaya. There are three distinct breeds of yak in Sikkim: a Tibetan breed in the north, a breed from southern Tibet and Bhutan in Lachen valley, and a Nepalese breed in the west. According to the official statistics, the total population of yaks in 1977 was 3,955, which increased to about 6,470 in 2007, and then decreased to 4,213 in 2009, with 69% in North Sikkim, 18% in East Sikkim, and 11% in West Sikkim (Table 19). In 1977 there were more than 70,000 sheep, but by 2009 the number had gone down to 2,311 (54% in North Sikkim and 45% in West Sikkim, Table 19). In 2014, there were 1,200 sheep on the Tsho-Lhamu plateau in North Sikkim (Bhyang-lung breed of Tibetan origin), and 1,071 in West Sikkim (Ban-pale breed of local origin). Analysis of the historical trends showed that an outbreak of epidemic disease followed by heavy snowfall, decimated the sheep population in the Lhonak valley, North Sikkim in 1995/96.

Table 19: **Population of yak and sheep in alpine, greater, and trans-Himalayan Sikkim**

Livestock type (districts)	Population over 32 years			
	1977	1987	2007	2009
Yak				
North	2,340	4,865	3,877	2,934
East	1,337	40	1,449	790
West	278	441	1,142	489
Total	**3,955**	**5,346**	**6,470**	**4,213**
Sheep				
North	12,841	15,498	2,139	1,240
East	33,309	36,313	158	-
West	24,445	26,682	1,894	1,071
Total	**70,595**	**78,493**	**4,191**	**2,311**

Source: TMI India (2010a)

Rotational grazing in the trans-Himalaya

The Muguthang area of Lhonak valley, Lasher valley, and the Tsho-Lhamu plateau have been home to the nomadic pastoral Dokpa community and the traditional agropastoral Lachenpa community for centuries. The Dokpas have remained socioeconomically marginalized, and continue the practice of herding yak (*Bos grunniens*), sheep (*Ovis aries*), and pashmina-type goats (*Capra hircus*).

Grazing regimes in the entire greater Himalaya, the transition zones, and the trans-Himalayan meadows in the northern parts of Sikkim are strictly regulated and managed through the Dzumsa, which fixes the dates of movement from one area to another for all herders according to the lunar calendar. The Dzumsa actively controls the rotational grazing practices for rangeland resource management and regeneration. Irregular herding or shifting of livestock from one pasture to another, other than on the specified dates, is unlawful and results in fines levied by the Dzumsa. The grazing regimes and pasture movement depend upon forage availability, pasture area, number of grazing animals, snowfall events, and season.

The yak herders migrate to the higher elevations around the south facing slopes of the Gurudongmar and Tsho-Lhamu plateau in winter (November through March) to find snow free slopes for grazing, and move down to the lush, moist valleys during summer in search of good foraging ground. The yak herders follow the Tibetan Lunar calendar when specifying the dates of movement of animals (Table 20).

Once the new Pipon (head) of the Lachen Dzumsa takes over his seat after the poll, he declares the kya (specified dates for movement of herds). The yaks on the Tsho-Lhamu plateau

Table 20: **Yak grazing and pasture movement at different locations over a calendar year in Tsho-Lhamu and Lasher valley, North Sikkim (4,000–5,000 masl)**

Location	Grazing month	Approx. no of days
Damboche	August end	25
Byamzay	September 1st week	20
Leten	mid-September	57
Tsho-Lhamu	November end	76
Yumcho	February end	32
Leten	March end	35
Yakthang, Byamzay, and Yangdi	April end	30
Byamzay	May end	30
Damboche	June 3rd week	30
Sebu-Gechang and Phalung	August end	30

Source: TMI India (2010a)

are never brought down below Thangu (4,100 m), because these 'phe' yaks (original Tibetan breeds) cannot adapt to lower elevations. Similarly, the local cattle (mostly cows) are never shifted to the higher elevations, owing to the extremely harsh and cold environment. Each year, the Lachen Dzumsa specifies the dates of movement of the herds depending on the Tsechik of Dawa Sum (first day of the third month of the lunar calendar). The first move starts from Damboche and Byamzay where almost all herders congregate during the end of August or in the first week of September.

The grazing locations and movements during subsequent months are also notified by the Dzumsa depending upon the availability of good pasture. The herders move until they reach their final destination on the Gurudongmar and Tsho-Lhamu plateau, returning after the winter. The movement of herds and the number of days at both higher and lower elevations are strictly regulated by the Dzumsa.

The yaks in the Lasher valley and Tsho-Lhamu plateau belong to 21 families; only three families rear sheep. Most of the herds are managed by Dokpas. Over the last two decades, the younger generations of Lachenpas and Dokpas have started migrating to Gangtok and other big cities in India in search of better education and employment and the owners of yaks and sheep have started employing herders from other parts of Sikkim.

Rotational grazing in Yumesamdong-Lachung

The Lachung Dzumsa regulates grazing in a similar manner in the lower elevation Lachung area. The lho-yak found here are said to come from the southern parts of TAR and Bhutan. They mainly graze at lower elevations in winter (November through February) and gradually move upwards in spring to graze for around three months, then shift towards the mid-elevation zone (3,000–3,600 masl) to graze from June to October (Table 21).

Table 21: **Yak grazing and seasonal movement at different locations during a calendar year in Yumesamdung and Lachung valley, North Sikkim (3,000–5,000 masl)**

Location	Grazing month	Approx. no. of days
Zadong	August	30
Samdong	September	30
Yumthang	October	30
Singba	November	30
Techen	December	30
Sola (Yakdhum/Sola /Palung/Chudeten)	Jan–Feb; Nov–Dec	60
Techen	March–May	90
Yumthang	June	30
Samdong	July	30
Source: TMI India (2010a)		

In contrast to the yak movements in Tsho-Lhamu and the Lhonak valley, the yaks of Lachung valley climb up to Yumesamdong (4,500 masl) and further upward to Zadong (4,886 masl) during the summer months in search of higher quality forage and pasture, and migrate down to the temperate region below Lachung village during the winter months. The Yumesamdong and Zadong region are mostly snow covered from October to May, and grazing there at that time is practically impossible. A total of ten herds of yaks (~500 animals) move up to Yumthang (3,612 m) during the summer months and gradually migrate down during winter after the snowfall.

The herds in Lachung valley are mostly taken care of by non-Lachungpas from other parts of Sikkim on a product-sharing basis, similar to the barter system. The owners supply the herders with rations and other necessary items, while the income from the milk and meat products and newborn calves is shared equally between the herders and owners.

Yak herding in West Sikkim

The livestock composition and population in West Sikkim adjoining the Khangchendzonga National Park (KNP) has been changing rapidly over the last six decades. The current livestock mix includes sheep, cows, yaks, yak-cow crossbreeds, and horses. Historical records (Hooker 1853, Risley 1894, Smith and Cave 1911) indicate that while sheep and trans-Himalayan yaks (Tibetan breed) were traditionally grazed in the alpine landscape of the KNP, cows, buffalo, Nepalese breed yaks, female yak-cow crossbreeds (urang or dzomo), and horses only arrived in the greater Himalayas during the last 60 years. The total livestock population in the KNP decreased significantly from 11,010 in 1950 to 3,710 in 2004, while the total livestock biomass increased from about 608,000 to 764,000 kg over the same period as a result of sheep being replaced by large-bodied livestock (Tambe and Rawat 2009).

Yaks are exotic to the moist alpine meadows of West Sikkim, and prior to 1975 there was only one herd belonging to the Sikkim royal family (Chogyal). It was only in the middle of the twentieth century that yaks were brought from eastern Nepal to the western part of Sikkim. For a few decades, the yak herders practised subsistence level pastoralism and also carried out crossborder trade with the remotest villages of Nepal, bartering rice, salt, and other rations for butter. The average villager sustained their livelihood through agriculture or pastoralism. The winter pastures of the yaks and yak crossbreeds are located largely outside the KNP in the temperate and subalpine forests of Yambong and Barsey sanctuary, which have less snowfall and are more accessible during winter.

Unlike the summer pastures, the winter pastures are used only by the yaks and their crossbreeds, since the sheep descend farther down to the farmers' fields in winter (Tambe and Rawat 2009). During 2000–2005, the Forest Department of the Government of Sikkim imposed a ban on grazing in the forest areas of Sikkim, resulting in grazing activities being phased out within protected areas and Reserve Forests and grazing animals being evacuated and then banned. Grazing in the high elevation parts of KNP and North Sikkim could not be

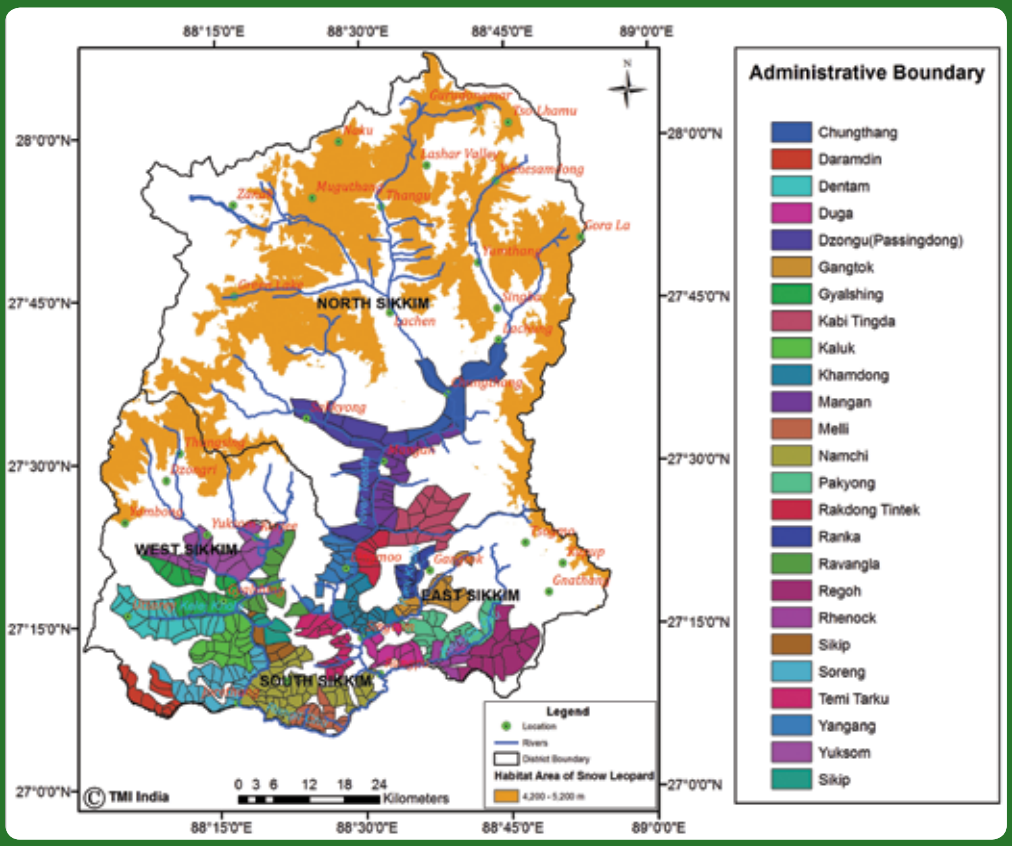
completely banned, however. During December 2013, the Himal Rakshaks recorded around 1,000 yaks and 500 sheep in Khangchendzonga Biosphere Reserve.

Stocking densities

It is estimated that a cumulative area of around 620 km^2 is used for yak grazing in East, North, and West Sikkim and 166 km^2 for sheep grazing in North and East Sikkim. This area overlaps with potential snow leopard habitat area (Figures 22 and 23).The cumulative area required for yak and sheep grazing and re-grazing in different months of a single year was calculated to be around 1,152 km^2 and 340 km^2, respectively, in 2008/09; the average yak density was 38.6 per square kilometres and the average sheep density 112 per square kilometres.

The stocking densities for yaks at 11 different locations ranged between 11,781 and 53,146 per square kilometres (annual animal days per square kilometres). There is a high grazing

Figure 22: **Potential habitat area of snow leopard, Himalayan tahr and blue sheep and the adjacent administrative blocks in Sikkim, India**



intensity in these areas which is attributed both to the high density of grazing animals per unit area and re-grazing during different months in a given calendar year. Dambochey had the highest density of yaks (480 per square kilometres) and thus the highest stocking density (26,387 per square kilometres). The density of yaks during grazing months ranged from 131 to 480 per square kilometres in these areas, which are also the habitat areas for blue sheep and Himalayan tahr, which compete for the same grazing pasture. The herders also recounted sighting more than 20 snow leopards in this area over the last ten years (Figure 23). In most of the grazing areas, the herders graze the animals twice a year, grazing during the movement of yaks to higher locations and then re-grazing when they move back to the same pastures. Several grazing areas in Gurudongmar and Tsho-lhamu plateau are exposed to grazing competition between domestic and wild herbivores.

Challenges for pastoralists in the Sikkim Himalaya

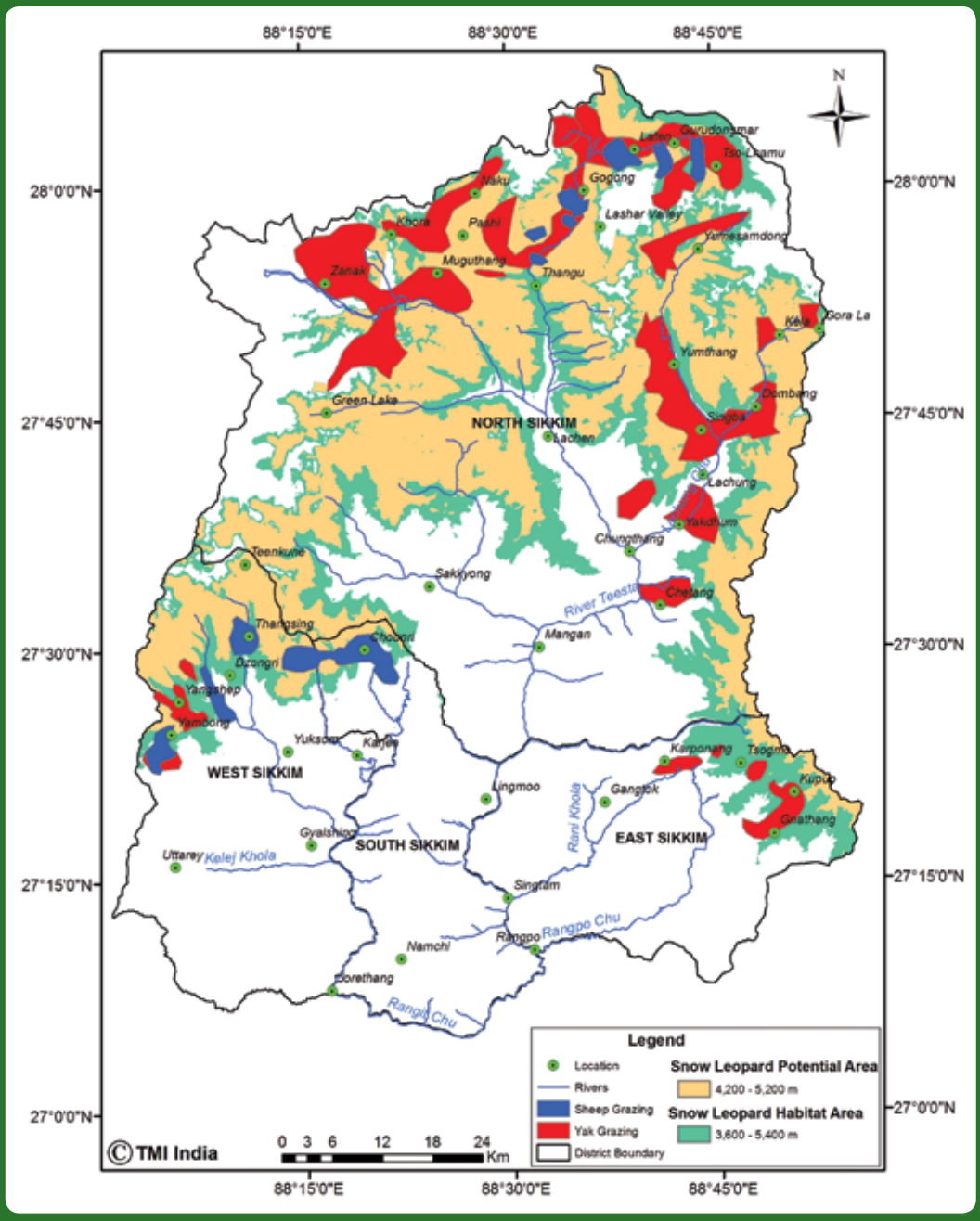
One of the greatest challenges in the trans-Himalayan and greater Himalayan zones is the changing climatic variation and increase in extreme events, which is leading to increased vulnerability. Over the past 15 years, the grazing area has been reduced by over 40%. The increasing climatic variation and grazing competition between the semi-domesticated and wild ungulates mean that wildlife species such as blue sheep and Himalayan tahr are migrating to lower elevations to find good pasture. Predator species such as snow leopard and Tibetan wolf are following the prey species and also migrating to lower elevations, and as a result, cases of livestock depredation and human-wildlife conflict have increased. The environmental changes are rapidly altering the foraging ecology of blue sheep, Himalayan tahr, and yaks and sheep. The emergence of new diseases such as respiratory diseases and foot and mouth disease has killed a large number of sheep, yaks, and wild ungulates. The seasonal shift of snowfall events and untimely snowfall, frequent avalanches, and disease have impacted greatly on the trans-Himalayan wildlife species and contributed to a 10–20% decline in the population of yaks, goats, and sheep over the past 15 years. The habitat range of snow leopard, blue sheep, and Himalayan tahr has expanded from 4,200–5,200 masl to 3,600–5,400 masl due to fragmentation of habitats, habitat requirements, and overlapping of grazing pastures. Land use change, soil degradation, resource degradation, overstocking in certain locations, flooding, and landslides have increased the vulnerability both of the ecology and of the indigenous Dokpa, Lachenpa, and Lachungpa communities.

Transboundary issues in the Sikkim Himalayan region

The trans-Himalayan region in the northern part of Sikkim

The trans-Himalayan ecoregion in Sikkim extends from 4,300 to 5,500 masl with a characteristic cold desert type of vegetation. It falls in the Reserve Forest category and has yet to be notified as a protected area, despite its unique features as a home to extremely vulnerable indigenous ethnic herders and location of critical habitats for endangered wildlife species of global significance. The region is home to some of the last surviving species of endangered wildlife like blue sheep (*Pseudois nayur*), Eurasian lynx (*Lynx lynx*), Himalayan

Figure 23: **Grazing locations of yak and sheep and critical habitat areas for the snow leopard in the greater and trans-Himalayan areas of Sikkim**



brown bear (*Ursus arctos*), red fox (*Vulpes montana*), snow leopard (*Uncia uncia*), Tibetan argali (*Ovis ammon*), Tibetan fox (*Vulpes ferrilatus*), Tibetan gazelle (*Procapra picticaudata*), Southern kiang (*Equus kiang*), Tibetan wolf (*Canis lupus*), black-necked crane (*Grus nigricollis*), lesser kestrel (*Falco naumanni*), snow partridge (*Lerwa lerwa*), and Tibetan snowcock (*Tetraogallus tibetanus*), which are also listed under Schedule I of the Indian Wildlife (Protection) Act, 1972. The region has a short four-month growing season during which grasses, sedges, and medicinal herbs grow abundantly, supporting a host of wild and domestic herbivores, including yaks, sheep, and pashmina type goats, insect fauna, and larks and finches. The human population consists of a small number of herders (Dokpas and Lachenpas) and a large number of defence personnel. Historically, Dokpas took their livestock in winter up to Khambazong in TAR, China, while their relatives in TAR brought their livestock down to Dongkung, Lungma, Khering, and Lhechen in Sikkim during the summer (Lachungpa 2011).

According to official records, there were around 30 households of Dokpas (130 persons) in the 1950s, but the population reduced by 43% during the 1990s and a further 20% during the 2000s (NBSAP 2002). This was due to the changing environment, the geopolitical situation, vulnerability to the agroecological conditions, and the substantial reduction in grazing pastures to 40% of the original area, a bare minimum, by 2010 (Sharma and Dhakal 2011). One of the reasons for their vulnerability was that they could no longer cross the border; the previous transborder migration had agroecological and social advantages for yak

breeding, including wide winter pasture areas, and maintaining relationships in the form of marriages and trade. There are now nine Dokpa households with 45 members in the Lhonak valley rearing 746 yaks. Over the past ten years, the Dokpas have realized the importance of formal education and have started sending their children to good schools in Gangtok, Kalimpong, Darjeeling, Bangalore, and Delhi.

Before the 1950s, the Lachenpas of Lachen valley (2,500–3,300 masl) went to Tibet (TAR) on yaks and horses to trade oil, food rations, sugar, fir planks, and cloth. They brought back wool (large bales which were taken directly to Kalimpong), tsampa (roasted barley flour), salt, carpets, blankets, cloth, mutton, and sheep fat. Similarly, the Lachungpas of Lachung valley (2,900–4,500 masl) went to Tibet (TAR) via Dongki La to Chho-Lhamo and up to Gyantse, Zigatse, and Tsekya for trade (NBSAP 2002). However, this established transboundary trade route stopped in 1959 when the Sino-Indian international border was closed (Subba 1989). The transborder migration used to ensure mixing of people through intermarriage, as well as crossbreeding of the domestic livestock of yak, sheep, and goats. It also ensured that herders on both sides of the border could utilize the large grazing area effectively. Closure of the border to semi-nomadic pastoralism over the last three decades has led to intensified grazing pressure by both the domestic and wild herbivores in the region (NBSAP 2002; Lachungpa 2011; SBAP 2012). The Sikkim Dokpas are now confined to a tiny patch of the vast Tibetan Plateau in the Tso-Lhamo region, Lhonak, and Lashar valleys. Throughout the year, they remain at the mercy of natural forces, and now supplement their rich tradition of semi-nomadic pastoralism with odd jobs from the Indian army and husbanding of some livestock belonging to the Lachenpas alongside their own herds.

Transboundary issues in the Singalila Range in the greater Himalaya

The Singalila range of mountains (26°46′57′′ to 27°52′5′ N and 88°11′43′ to 88°11′18′′ E) within the Sikkim and Darjeeling Himalayan region of India borders Nepal to the west and TAR, China to the north and provides a transboundary corridor along the India-Nepal border (ICIMOD 2007; TMI India 2010b; WWF India 2011a). On the Indian side, the area within the transboundary landscape forms one of the most important wildlife corridors in the Himalayas, while also demarcating the boundary between the Central and Eastern Himalayas.

The long stretch of the Singalila range separates the state of Sikkim from the Darjeeling Hills of West Bengal in India, and from Ilam, Panchthar, and Taplejung districts in Nepal. The border between India and Nepal along the Singalila range is open and porous. A number of trekking routes have been established along the international border – not for tourists but for the movement of local people to bring their livestock to graze and/or for trade, as they have done for the past several hundred years. There are also a number of temporary routes for trade via subalpine and temperate passes between the Ilam, Panchthar, and Taplejung districts of Nepal and the fringe villages of the Singalila National Park (SNP), Barsey Rhododendron Sanctuary (BRS), Khangchendzonga National Park (KNP), and Khangchendzonga Biosphere Reserve (KBR) in India.

Unlike the Nepali side, the Indian side of the Singalila range lies within the protected area network. The Singalila National Park, Sinchel Wildlife Sanctuary, Barsay Rhododendron Sanctuary, Khangchendzonga National Park, and Khangchendzonga Biosphere Reserve are all adjacent to the Indo-Nepal border. Supported by strong conservation policies, grazing in the protected areas has been banned, and thus abandoned since 2000 on the Indian side of the Singalila range (NBSAP 2002). On the Nepal side, free grazing continues all along the border areas. After grazing was banned in the Indian border area in 2000, the cattle from India were sold to the herders of Nepal and are now grazed in the transboundary region along the Singalila range (Table 22). The crossborder movement of traders continues from Nepal for the sale of dairy products (mostly butter and cheese).

Livelihoods from yak herding showed the highest inequity in benefit sharing, with high incomes concentrated amongst ten households, followed by livelihoods from herding crossbreeds of cow and yak (urang female, and dzo male). Benefit sharing of income from herding sheep and pack animals (dzos/urang) was found to be more equitable and provided benefits to a larger section of society. The lower environmental impact and greater equity in benefit sharing made sheep and pack animal herding relatively more sustainable in the western part of Sikkim.

Table 22: **Locations under different grazing practices in the India-Nepal transborder region of the Singalila range**

	Nature of grazing	Grazing locations	Approx. no. of cattle	Period
Grazing by goths[a] from Nepal in the western part of Sikkim and Darjeeling	Rotational grazing at high elevations during the rainy season	Tori-phuley, Gosha, Kalijhar, Chewa-bhanjyang, Sikkim-Mejor, Sikkim-dund, Sikkim-Meghu, Gora-khet, Lam-pokhari, Gomathang	300–450	June to October
Grazing by goths[a] from Sikkim	Seasonal movement of grazing animals to high elevations during the rainy season and low elevations during winter	Yak: Gomathang, Yangshep	Around 1,000 yaks	May to October
		Sheep: some areas of Barsey Rhododendron Sanctuary, Khanchendzonga National Park, Lakshmi-Pokhari, Jadari, Chauri-bhanjyang, Thangsing, Sikkim-dund, Gora-khet, Tal-dadeli, Sikkim-Mejor, Gosha, Toriphuley	300–400 sheep	June to September
Grazing by goths[a] from Nepal and Sikkim towards the Nepal side	Winter grazing of yaks and cows	Nepal Tori-phuley, Ektharey, Panibhitta, Pahadey-bhnjyang	Around 1,000 yaks and 300-350 cows[b]	November to May

Source: Interview with Himal Rakshaks in Sikkim, July 2014
[a] Nepali word meaning a herd of animals; [b] cows only from Nepal

Habitat fragmentation in the Singalila transborder area

Unregulated grazing along the transboundary areas together with a variety of anthropogenic pressures such as extraction of forest resources, tourism, illegal collection of wildlife and NTFPs, and road construction have resulted in the fragmentation of several forest habitat areas. The region is an important habit for red panda (*Ailurus fulgens*), Himalayan black bear (*Ursus tibetanus*), musk deer (Moschus spp.), barking deer (*Muntiacus muntjak*), goral (*Nemorhaedus goral*), Himalayan tahr (*Hemitragus jemlahicus*), and others. The protected areas and forest areas are scattered as conservation islands without the connectivity required for movement of species. There is a diversity of agroforestry systems such as large cardamom-based agroforestry, and farm-based agroforestry systems which function as corridors under the cultivated systems (FAR 2014).

Grazing induced illegal collection of wildlife parts and trade

The unregulated grazing across the Indo-Nepal border has unfortunately also facilitated the illegal poaching/hunting and collection of wildlife and NTFPs along the Singalila range. The forest areas have become highly degraded due to frequent forest fires and fuelwood, fodder, and NTFP collection on both sides of the border. The impact of crossborder livestock and human movement, illegal poaching and hunting, illegal grazing and forest fires, and increasing poverty within the fringe village communities in the Indo-Nepal transboundary region are rarely addressed by development agencies. Regional cooperation and enforcement between countries and agencies is considered the best and most effective way to work towards resolving these transboundary issues and ensuring effective biodiversity conservation in the region (Sharma et al. 2007; TMI India 2010a).

Transboundary cooperation initiatives

A number of transboundary conservation issues such as resource extraction (illegal collection of NTFPs, poaching, hunting, and others), land-use systems (grazing pressure), livelihood options (mainly crossborder grazing/tourism), and policies (governance issues) have been identified by institutions and organizations working in the region over the last few decades (TMI India 2010a, b; WWF India 2011a, b; Phuntsho et al. 2012). As many as three regional transboundary meetings have been organized between India and Nepal in recent years – one in Kathmandu, Nepal in 2010, and two in Sikkim, India (Gangtok) in 2011 and 2014 – to enhance cooperation and conservation in the region (WWF Nepal and WWF India 2013; Agreement 2014). Transborder joint monitoring is now regularly conducted at both the government (India and Nepal) and community levels (FEWMD and WWF India 2011; WWF 2011a, b, 2013).

Policy implications

The ban on grazing within the protected areas and reserve forests of Sikkim was implemented by the Forest Department, Government of Sikkim, from 2000 to 2005, with some herds in

Dzongri and the greater and trans-Himalayan areas in North Sikkim excluded. Grazing in all the protected areas was eventually stopped and the animals were either sold or distributed to farmers in other villages by the government. The policy was strictly enforced by evacuating several herds of livestock from forested areas in East, North, South, and West Sikkim. This sudden shift in livelihoods brought about a socioeconomic transformation for the families engaged in livestock herding, some of whom eventually opted to become porters and pack animal operators in tourist destinations such as Yuksam-Dzongri, the Singalila trekking corridor, and Yambong in West Sikkim.

After the eviction of livestock from West and South Sikkim, most herders had no direct alternatives for generating livelihoods. Herding for these people had served as their only source of income and they had a rich knowledge base associated with the lifestyle that had been built up over generations. With the help of NGOs such as TMI India, the Khangchendzonga Conservation Committee (KCC), Sindrabong Khangchendzonga Ecotourism Society (SKES), and Travel Agents Association of Sikkim (TAAS), and in conjunction with the Government of Sikkim, the ex-herders were eventually trained and transformed into ecotourism service providers, while a few are volunteering as Himal Rakshaks (see Materials and Methods).

A number of governance issues such as differences in regulatory mechanisms; coordination and networking conflicts between line agencies, departments, states, and countries sharing common resources; and the role of a regional cooperation framework in reconciling the transboundary issues have yet to be formalized (TMI India 2010b). However, the trading of illegal wildlife products across the borders along the Singalila passes has now gained the attention of governments and the institutions working in the region. Trade here has been enhanced by technological interventions such as mobile phones that circumvent cross-cultural and crossborder limitations.

Conclusion

The Sikkim Himalaya is endowed with varied ecoclimatic conditions and a rich biodiversity, with a relatively small area of alpine rangeland. It is estimated that the state contains an area of only around 620 km^2 suitable for yak herding, grazed at present by about 4,500 head of yak. Approximately 66% of the yak population is in North Sikkim and 16% and 18% in the East and West, respectively, in transboundary areas adjacent to TAR China, Bhutan, and Nepal. The pastoral practices and yak herding in the state are at a crossroads and on the decline.

The semi-nomadic and agropastoral communities in the greater and trans-Himalayan areas of Sikkim have not received sufficient focus from the government, and the critical role they play in maintaining the delicate ecological balance at such high elevations has not been well recognized. Conversely, the issues, challenges, and opportunities that transhumant herding communities experience have yet to be scientifically assessed, analysed, and formally considered as a basis for developing landscape level conservation programmes and policies.

A number of governance issues such as differences in regulatory mechanisms, lack of coordination and networking between line agencies, departments, states, and countries sharing common resources, a weak regional cooperation framework for regulating trans-border grazing, and enforcement against illegal collection of wildlife and NTFPs, all play a role in the situation in the KL region.

In the northern part of Sikkim, the Dzumsa maintains the natural resources through rotational grazing using a locally adapted and innovative approach. The Dokpas of this region are socioeconomically marginalized, and have experienced a rapid reduction of their herd size, grazing pasture, and population. The long-term sustainability of trans-Himalayan rangeland management is in peril unless it can be addressed through effective conservation strategies involving the institutions and organizations in the region.

The Singalila range in the KL has a number of transboundary issues that can be resolved through sustainable transboundary cooperation and joint actions. An ecosystem conservation approach embracing the biological, socio-ecological, economic, and cultural elements in a conservation framework with a strong emphasis on community development, followed by regional cooperation, could bring about sustainable development in the KL region.

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2 Policy and Institutional Arrangements

Open the 'Closed Frontier': Managing animal disease and fodder shortage in the Afghan Pamir through crossborder collaboration

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The pastoral Kyrgyz communities in the Afghan Pamir are characterized by their geographical and social isolation and high exposure to geopolitical conflicts, which has aggravated many of the problems they share with pastoral communities across the world such as seasonal fodder shortages, lack of social services, and poor accessibility. In the past few years, the Aga Khan Foundation (Afghanistan) has successfully facilitated crossborder collaboration between Afghanistan and Tajikistan to help the Afghan Kyrgyz communities address some of these problems from the Tajik side. Such efforts have greatly helped the local communities in coping with the adversities and improved services for pastoral development. However, to be more sustainable and effective, these bilateral collaborations should be institutionalized to open the 'closed frontier' for direct people-to-people contact across the border.

Keywords: Afghan Pamir, crossborder collaboration, Kyrgyz, pastoralism, Wakhan

Introduction

The Afghan Pamir is located in the south of the Pamir Mountains and includes parts of the Little Pamir (Pamir-e-Khurd) and Big Pamir (Pamir-e-Buzorg). The overall terrain lies above 4,000 masl, with ridges and peaks rising between 6,500 and 7,000 masl. This area constitutes the extreme northeastern part of Afghanistan and is connected to the main body of Afghanistan by the Wakhan Corridor. The area borders Tajikistan to the north, China to the east, and Pakistan to the south.

There are no climate data available specifically for the Afghan Pamir since there are no weather stations dedicated primarily to this area. However, data from weather stations in the nearby Tajik Pamir as summarized by Vanselow (2011) suggests that annual rainfall in the eastern Pamir is generally below 100 mm, falling mostly in summer (May to August) as sleet or snow and rarely as rain. The annual mean temperature fluctuates between -3 and -1°C and the absolute minimum can be below -40°C. In July, the average temperature rises to between 8 and 12°C. Only 10 to 30 nights per year are frost-free. Potential evaporation is extremely high (estimated to be about 1,000 mm/yr); the relative humidity is 5–70% in winter and approximately 20% in summer.

The dominant land cover is rangeland, which according to the Wildlife Conservation Society (WCS) can be divided into six vegetative cover types: *Artemisia* Steppe, Low *Artemisia* Shrub, *Kraschenninnikovia* Shrub, Salt Grass, Sedge Wetlands Meadow, and Alpine Grassland (Bedunah 2008). Historically, these rangelands have been known for their good quality and abundance of wildlife and domestic animals. Marco Polo, while passing through the Big Pamir in 1273, wrote that "the pastures were so good that even the leanest animals can be fattened within ten days" (Komroff 1953). Today, these rangelands form the major pastures for the native Kyrgyz and Wakhi people for grazing yak and sheep. The Wakhi people have their settlements in the lowland area and some graze their animals (yak, sheep, and goats) on the Big Pamir, while the Kyrgyz people are pure pastoralists who live on the Big and Little Pamir all year round and depend exclusively on the extensive use of these rangeland resources for their survival. The Kyrgyz herders in the Afghan Pamir are close to China, Tajikistan, and Pakistan, but they are also highly marginalized and face unique problems because of the political borders and the remoteness of this area from the centre of Afghanistan.

This article describes how the Aga Khan Foundation (AKF, Afghanistan) facilitated crossborder collaboration to help Kyrgyz communities in the Afghan Pamir overcome the lack of veterinary services and seasonal fodder shortages and improve their livelihoods. It provides a good example for other regions facing similar difficulties.

Pastoralism in the Afghan Pamir

Due to the harsh conditions and geographical and social isolation, the Kyrgyz people in the Afghan Pamir depend solely on pastoralism of yaks, goats, and sheep for their survival. According to an AKF survey, there were 1,545 Kyrgyz people in 331 households living in the Afghan Pamir in 2012, with a total of 3,220 yaks and 10,607 sheep and goats. On average, each Kyrgyz household in the Big Pamir has 7.0 yaks and 20.3 goats, and each household in the Little Pamir has 12.5 yaks and 44.3 sheep and goats (AKF internal report). The Wakhi people send an additional 1,380 yaks and 10,100 sheep and goats to graze in the Big Pamir, and many fewer to the Little Pamir, each year (Mock et al. 2007).

The animals are kept on the winter and spring pastures from late October to early June, from where they are taken up to the summer pastures where they stay to the end of September. They then move to the autumn pastures for about one month until the end of October, after which they return to the winter and spring pastures.

The harsh climate prevents any agriculture. Outmigration for non-farm work is almost non-existent as it is too far for the communities to get to the job markets in places like Faizabad or Kabul (more than one week travel on foot to the next roadhead), and they are hindered by a lack of education and skills and by cultural barriers.

The nearest market on the Afghan side is a 6–8 day walk or horse-ride away, which makes trading of local products very difficult. Occasionally, traders from outside come to purchase

yaks and other animals, but the prices are in favour of the buyers. The lack of an alternative source of livelihood makes the Kyrgyz communities fully dependent on their livestock for milk, meat, fuel, transport, cash, and others. Shahrani (1979) described pastoralism in the Afghan Pamir as "closed frontier pastoralism" due to their enforced confinement in a small geographical area and lack of exchange with the outside

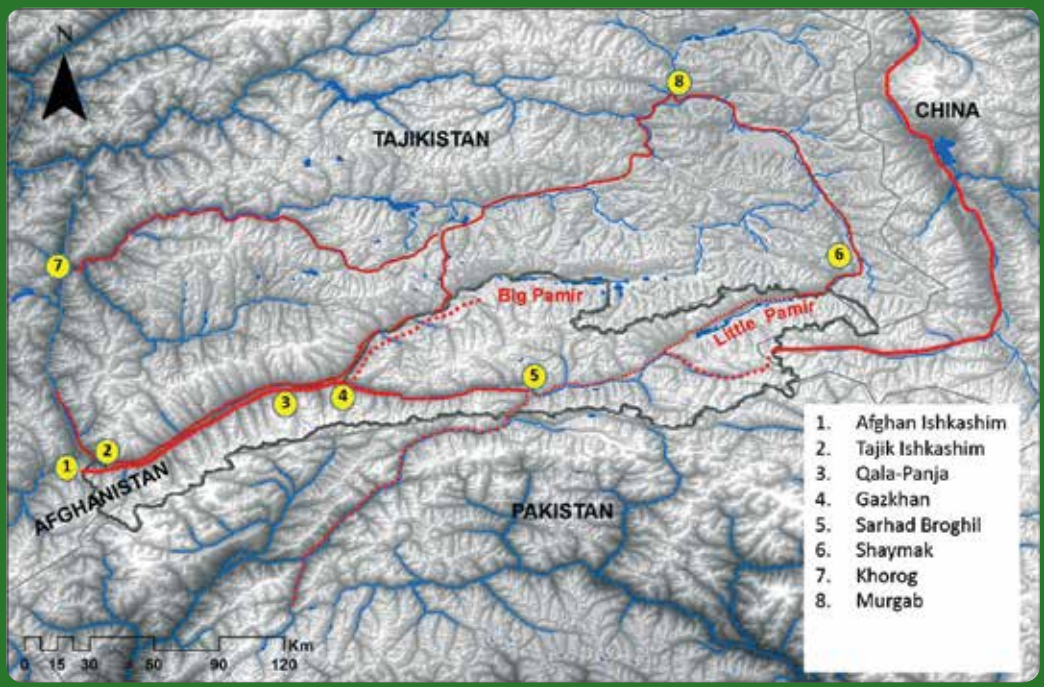
Key challenges faced by Kyrgyz herders

Like pastoralists around the world, the Kyrgyz communities in the Afghan Pamir have to cope with challenges like winter fodder shortages, rangeland degradation, and lack of access to social services and markets. However, these problems are more severe for geopolitical reasons.

Geographical and social isolation

Isolation is the main feature and root cause of the problems faced by the Kyrgyz communities in the Afghan Pamir, who are the victims of a geopolitical struggle. These communities are far from the social and political centres of Afghanistan and the area has no vehicle access from the Afghan side (Figure 24). The Little Pamir is 350 km from Qala-Panja and 430 km from Ishkashim in Afghanistan. The nearest vehicle road point to the Little Pamir from the Afghanistan side is Sarhad-e-Broghil in Wakhan District, but it takes 6–7 days travel on donkey or by foot. The nearest vehicle road point from the Afghanistan side to the Big Pamir is

Figure 24: **Access to the Afghan Pamir**



Gazkhan, also in Wakhan District, from where it takes 7–8 days by donkey, horse, or on foot. In contrast, on the Tajik side, people can easily travel from Khorog to Murgab and then to the Tajik-Afghan border along the Little Pamir by vehicle with good road conditions. They can also travel from Tajik Ishkashim to the Big Pamir by following the highway along the Panji River and the Pamir River. It is only 180 km from the Little Pamir to Murgab by road, and there are also several small towns in between, but the local Kyrgyz communities cannot benefit from this road access as the border is permanently closed.

The current geographical shape of the Wakhan Corridor extending to China was a result of geopolitical wrestling. In the late 1900s, fearful of direct confrontation, Czarist Russia and British India divided the then unified Badakshan into two to create a buffer zone (the Afghan part) between the Russian area and the British Empire in India. Later, in the early 1920s, when the current area of Tajikistan was formally integrated into the USSR, the border between Afghanistan and the USSR was sealed. In the 1950s, the border between China and Afghanistan was also closed. As a result, the Kyrgyz communities in the Afghan Pamir were cut off from their fellow Kyrgyz communities who live in the Tajikistan (USSR) Pamir and the Chinese Pamir. Up to the early 2000s, they could still travel to the Pakistan border, the nearest place they could reach for trade (even though it still took three days by horse). However, in the early 2000s, the border between Afghanistan and Pakistan was also closed as an anti-terrorism measure. Although there is a vehicular road from the fenced border between Tajikistan and Afghanistan that leads to Murgab and some small settlements, the border is closed all year round. This makes Ishkashim in Afghanistan the closest town that they can go to without major legal hassles. The Kyrgyz communities in Afghanistan Pamir are close to borders with China, Tajikistan, and Pakistan, but are still isolated from all of them. This geographical and social isolation created by geopolitics has led to a unique and major problem for the local people. The issue needs to be resolved through innovative thinking and transboundary dialogue between the four countries.

Lack of social services and external inputs

Due to the remoteness and poor accessibility of the area, there are limited external inputs into the local socioeconomic and ecological system in the form of health services, information, veterinary services, winter fodder supply, or modern livestock management technologies. According to our interview with the herders in Qara-Jilgha village in 2012, the nearest school on the Afghan side was three days away, thus almost all of the villagers were not-literate, and school-age children could not attend school.

Public health services are non-existent. During our visit in 2012, one key problem the villagers mentioned was the lack of doctors or medical services in the Little Pamir. As a result, both the maternal and infant death rates were very high, leading to very slow population growth rates and low population density. In 2002, the Ministry of Public Health of Afghanistan tried to establish a mobile clinic with an operating theatre in Qara-Jilgha using a brand-new spacious bus donated by the Government of Pakistan. However, due to the lack of local doctors to

maintain it and reluctance of doctors from outside to work there, the clinic has remained dysfunctional since shortly after its inauguration, and is now a pile of waste, leaving the villagers with nowhere to go for medical treatment even for the smallest ailment.

The lack of adequate veterinary services also causes a high mortality rate in the animals, low livestock productivity, and high loss to family property as a result of diseases such as foot and mouth (FMD), black leg, hypodermatosis, and pneumonia.

There is also no regular market service in Little Pamir. Animals or animal products are sold to seasonal traders coming from lowland areas on the Afghan side. These traders are in full control of the purchase price.

All these factors have severely affected the overall livelihoods and socioeconomic development of the pastoral communities.

Seasonal fodder shortage

Lack of winter fodder reserves greatly reduces the resilience of the Kyrgyz pastoral economy. The Pamir are characterized by extremely long winters and short summers. The fodder productivity (total standing crop) of the Pamir pastures ranges from 177 kg/ha for *Artemisia* Steppe (*Stipa* spp. community type) to 1,226 kg/ha for Sedge Wetlands Meadow (Bedunah 2008). Unlike herders on the Tajik side who can migrate between pastures at different elevations with different temperature and precipitation conditions, the Kyrgyz herders in the Afghan Pamir stay at almost the same elevation above 4,000 masl all year round because they have no lower places to go to. In Qara Jilgha (near the hot spring) of Little Pamir, the villagers graze their animals in summer on the right side of the Aksu River and in winter on the left side of the river. As a result, the quality of the winter and autumn pasture is extremely low by the time the animals return to these pastures. As the animals have to stay much longer on the pastures, the quantity of forage is insufficient. Cultivation of fodder plants is not possible or practised. Villagers harvest whatever they can to prepare for the winter months, usually making hay out of the sedge grass. But the quantity of hay is not enough even during years with normal temperatures, and the situation is worse in extremely cold years when all the animals need to be fed for a certain time to keep them alive. There is no place where the herders can purchase hay and feed for the winter months. As a result, the winter and early spring mortality rate of animals is extremely high, sometimes reaching 50% (Mock et al. 2007).

Aga Khan Foundation (Afghanistan) supporting local communities through crossborder cooperation

AKF (Afghanistan) started working in the Afghan Pamir in 2005 when the National Solidarity Programme (NSP) was initiated. Following completion of the NSP, AKF started implementation of new natural resources management activities in 2009.

The root cause of the problems of the Kyrgyz herder communities are geopolitical, thus political cooperation of the parties involved accompanied by technical solutions is key to solving the problem. With the facilitation of the Aga Khan Foundation, related government departments from Afghanistan and Tajikistan agreed to cooperate with each other to provide assistance/services to the Kyrgyz communities in the Afghan Pamir from the Tajik side. Such arrangements allow service providers from Afghanistan (such as AKF staff) to reach the Afghan Kyrgyz communities in the Little Pamir through Shaymak in Tajikstan using the Murgab-Shaymak vehicular road and the Big Pamir communities from Tajikistan Ishkashim via the Ishkashim-Alichure road. At the same time, AKF also hired a Tajik Kyrgyz veterinarian from Murgab in the Tajik Pamir to provide veterinary services to the pastoral communities in the Afghan Pamir. The arrangements also make it possible to link the Afghan Kyrgyz communities with the nearby Kyrgyz communities on the Tajik side to make sure they have some people to turn to during emergency periods such as heavy snow.

Through this crossborder mechanism, the AKF was able to conduct a series of activities to help enhance the resilience of the isolated Kyrgyz communities and link them with the outside world as described below.

Providing veterinary services through Tajikistan

With the financial and technical support of AKF, an agroveterinary service centre was established in Murgab, Tajikistan, in 2009 to provide veterinary services to the Afghan Little Pamir through Shaymak. Another centre was established in Ishkashim in Afghanistan to provide services to the pastoral communities in the Big Pamir through the Tajik-Afghan border. From 2009 to 2013, the Aga Khan Foundation provided 20,000 doses of ETV (enterotoxaemia vaccine) and 2,000 doses of FMD vaccines to the agroveterinary service centre. Tajik vets were hired by the centre to provide services to the Kyrgyz communities in the Little Pamir. The accumulated achievements of the four years from 2009 to 2013 include:

- 9,951 sheep and goats vaccinated in the Little Pamir
- 6,440 sheep and goats in the Big Pamir vaccinated against enterotoxaemia by the Wakhan seasonal mobile veterinary service team
- 1,880 livestock treated for infectious and non-infectious diseases
- 1,722 yaks vaccinated against FMD

Building the capacity of herders through the Tajik-Afghan border

Using the crossborder arrangements and engaging Tajik vets from the Murgab agroveterinary service centre, awareness building workshops and campaigns were conducted in eight shuras or community development committees in the Little Pamir to familiarize the Kyrgyz pastoral communities with the importance of animal vaccination, basic skills in treating animal diseases, and knowledge on animal health and nutrient requirements.

Setting up fodder banks in the Little Pamir with fodder from Tajikistan

The shortage of fodder in winter and early spring is another key factor that makes the pastoral communities in the Afghan Pamir especially vulnerable. AKF supported the local communities through a two-pronged approach: establishing fodder banks and linking the isolated Afghan Kyrgyz communities with the nearby communities on the Tajik side, both involving crossborder collaboration between the two countries.

A fodder bank is a community-managed system of fodder in a settlement or village. The idea behind the fodder bank was that households that run out of fodder in late winter and/or early spring can borrow fodder from the nearest fodder bank to meet their immediate fodder needs rather than buy it from other sources at a higher price. At the end of the harvesting or growing season, they return the fodder with an additional 15–20% (fixed and decided by each shura) in quantity of the borrowed fodder. In this way the bank accumulates additional fodder and increases its stock year by year. This is a mutual-help type insurance system for emergency fodder needs. Individual households can also deposit their surplus fodder into the so-called bank and are then entitled to withdraw it in times of need without paying (in kind) interest.

In the Little Pamir, two fodder storage houses ('banks') were set up with financial and technical support from AKF using construction materials purchased and transported from Tajikistan. Hay for the first deposit (10 tonnes) was purchased from the Tajik communities across the border. Basic training on bookkeeping and fodder bank management was also provided to the fodder bank management committee members to manage the bank in a proper manner on a sustainable basis. By the end of 2014, six fodder banks had been established in the Big and Little Pamir through crossborder cooperation. These fodder banks have considerably reduced the vulnerability of the communities to the extreme cold weather conditions during winter.

At the same time, regular linkages have been established between the pastoral communities in Afghan Little Pamir and the nearest communities on the Tajik side so that the Afghan Kyrgyz communities can get timely emergency assistance in terms of fodder shortage, animal disease outbreaks, or human diseases.

Challenges and recommendations

This crossborder collaboration has really brought new hopes for the confined Afghan communities in the Afghan Pamir. However, many challenges still exist.

First, the governmental procedures for this collaboration are still too complicated. Until now, the collaboration has been facilitated by AKF. AKF has to report to the governments of both sides on a case by case basis. This often takes a long time and is full of uncertainty. Direct people-to-people exchange has not been fully established.

Second, the local people have a distrust of both the Tajik vets and modern veterinary services. At the same time, there are no educated people in the local communities who can be trained as paravets.

Based on past experience, we recommend that

- regular official intergovernmental arrangements should be made to facilitate direct transboundary cooperation between the neighbouring communities;
- a crossborder market be established between Tajikistan (Murgab District) and Pamir for selling livestock and livestock products; and
- local Kyrgyz paravets be developed in the Pamir to ensure timely vaccination and proper treatment of animals against various diseases.

Conclusion

Crossborder collaboration has offered new hopes for the Kyrgyz communities in the Afghan Pamir who have been suffering from the consequences of geopolitical conflicts. To be more effective and sustainable, such collaboration needs to be institutionalized to facilitate direct people-to-people exchange and turn the 'closed frontiers' into open arenas for cooperation.

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Institutionalizing Transboundary Grassland Resource Management for Sustainable Yak Production in the Border Areas between China and Nepal

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The Hindu Kush Himalayan (HKH) region is a transboundary realm with rich natural resources of regional importance. Rangelands represent one of the most important natural resources in the borderlands of the Himalayan ranges between Nepal and China. For centuries, the local pastoralists practised traditional transhumance grazing to maintain the sustainability of the rangeland ecosystem and livestock (yak) production. However, poor cross-nation governance associated with inadequate institutional arrangements are challenging the sustainable utilization and effective conservation of the transboundary rangeland and the management of livestock (yak) production along the China-Nepal border. We present an empirical overview of transboundary cooperation in establishing institutions for rangeland resource management and livestock (yak) production compiled from a literature review, a case study, and a series of semi-structured, open-ended, and in-depth interviews. We suggest that the regional institutions, in close collaboration with the national and local governments of the two countries, need to develop a vision for an integrated approach to institutionalize transboundary rangeland resource management and livestock production based on the indigenous practices and local institutions.

Keywords: grazing practices, institutions, livestock production, rangeland management

Introduction

The Hindu Kush Himalayan (HKH) region is one of the largest and most varied mountain regions in the world, extending 3,500 km across eight Asian countries from Afghanistan in the west to Myanmar in the east, and from the Tibetan Plateau in the north to the Ganges Basin in the south, across many great mountain ranges, including the Hindu Kush, the Karakoram, the Himalayas, and the Hengduan Mountains. The region covers 4.3 million square kilometres of varied landscapes with mountains, plateaus, river valleys, and adjoining foothills, and is inhabited by more than 210 million people representing diverse ethnic and sociocultural groups (Wu et al. 2013). The HKH region varies both in eco-climatic conditions, from tropical to high alpine and nival zones, and in vertical vegetation regimes, from tropical and subtropical rainforests, through temperate broadleaf, deciduous, and mixed forests, and temperate coniferous forests, to alpine moist and dry scrub, alpine meadows, and desert

steppe. A recent estimate of land cover shows the HKH region to have 54% rangeland, 14% forest, 26% agricultural land (including areas with a mixture of natural vegetation), 1% water bodies, and 5% permanent snow and glaciers (Wu et al. 2013). The dominant land cover of rangeland varies from the subtropical savannas of the Siwalik foothills to the high-elevation alpine meadows in the Himalayan mountains, extensive alpine steppes of the Tibetan Plateau, and the high-alpine cold, dry desert steppes of the Kunlun Mountains (Miller 1997). These rangelands are critically important in terms of the many important ecosystem services they provide for millions of people, including key habitats for many endangered wildlife species, critical sources of wood, medicinal plants, wild food, and fibre, and major sources of freshwater for the people living in the region and many more downstream. Most importantly, these rangelands have served as the grazing grounds for indigenous livestock such as yak, Tibetan sheep, and Himalayan goats and have maintained the subsistence economy for both local and migratory pastoral communities since ancient times.

In the past, local pastoral communities shared the rangelands in the transboundary areas of the HKH for herding livestock. There were many transboundary grazing pastures across the HKH countries that were traditionally used by pastoralists from more than one country, e.g., from China, Bhutan, India, and Nepal in the east, from China, India, and Nepal in the centre, and from Afghanistan, China, India, and Pakistan in the west. In recent decades, these

transboundary resource-sharing regimes have been affected by national border closures, regional terrorism, border conflicts, and geopolitical changes. As a result, sustainable use and development of the rangeland resources in the HKH region is confronted by a number of challenges such as declining wildlife populations caused by habitat loss and degradation, disappearance of original vegetation due to localized overgrazing by livestock, overexploitation of medicinal plants, especially in the high-altitude belts, rapid and unplanned growth of tourism leading to rangeland degradation, and insufficient participation of local herders in protected area planning which often ignores local traditions and customs (Dong et al. 2010). In addition, there is a severe lack of information sharing and cooperation among the countries on the ecological conditions and vegetation dynamics of these rangelands. There is an urgent need for better transboundary coordination and management of the rangeland resources in the HKH region.

China and Nepal share a long border of more than 1,400 km along the Himalayas, in an area where pastoralism has existed as an invaluable social, cultural, economic, and ecological asset for a very long time. In this study, the transboundary issues in the area between China and Nepal was taken as an example to elucidate the challenges and opportunities in transboundary rangeland management across the HKH region and highlight the importance of transboundary cooperation in establishing institutions for sustainable rangeland management and yak production.

Research area and methods

The case study was conducted in a 415 km long border area between northern Nepal and the southern part of Tibet Autonomous Region (TAR) in China. Rangeland is the dominant land cover type and livestock grazing the major land use.

On the Nepal side, this region is called the High Himalaya and accounts for about half the nation's rangeland resources (Table 23). Administratively, the area is divided into different districts whose peoples are often isolated from each other and who differ in some cases in ethnicity, culture, and language. Yak raising in Nepal is mostly confined to these northern districts where pure yak are grazed on alpine pastures. Many hybrids of yak and domestic cattle (chauri) are kept, sometimes alongside yak, but generally in neighbouring areas at somewhat lower elevations (Wiener et al. 2003). In 2001/02, Nepal had 95,447 yak and chauri, about 10% of all the large-body livestock population in northern Nepal (CBS 2004). The local people are heavily dependent on the income generated from yak germplasm resources; yak also have ecological and socio-cultural importance and play an important role in the ritual values of the local Nepalese (Joshi and Lensch 1996; Sherchand and Karki 1996). Although yak and chauri production is no longer as profitable for local people as it was in the past, there is no other system that is based upon and takes advantage of the experience, skill, and knowledge of the indigenous people in these remote and fragile rangeland areas (Sherchand and Karki 1996; Dong et al. 2009).

Table 23: **Distribution of rangeland in Nepal**

Physiographic region	Total land area		Rangeland		
	'000 ha	%	'000 ha	% of total land	% of total rangeland
Terai	2,100	14.4	49.7	0.3	2.9
Siwaliks	1,900	12.7	20.6	0.1	1.2
Middle mountains	4,400	29.5	292.8	2.0	17.2
High mountains	2,900	19.7	507.1	3.4	29.8
High Himalaya	3,500	23.7	831.5	5.6	48.9
Total	**14,800**	**100.0**	**1,701.7**	**11.4**	**100.0**

Source: Dong et al. (2007)

The case study was conducted in Rasuwa District in northern Nepal, which represents a typical transboundary pastoral area between Nepal and China in terms of geographic location, geopolitical setting, traditions of resource utilization, and present day conflicts on resource sharing. A desk study, literature review, and field survey were used to collect data and information. Relevant public reports, government documents, and personal communications from resource persons were collected to extract information about historical rangeland use patterns and formal and customary rangeland institutions in these border areas. Numerous publications and documents were collected from libraries, the internet, and other reference sources and analysed to gather information on the challenges and problems of transboundary rangeland management, limitations in enhancing rangeland institutions, and potential solutions for improving transboundary rangeland management. Key stakeholders were also surveyed to understand historical rangeland management strategies, indigenous rangeland management and yak production practices, and local adaptations to changes and dynamics in the transboundary rangeland area. The data and information were analysed using the systematic qualitative techniques recommended by Patton (1990) and Miles and Huberman (1994).

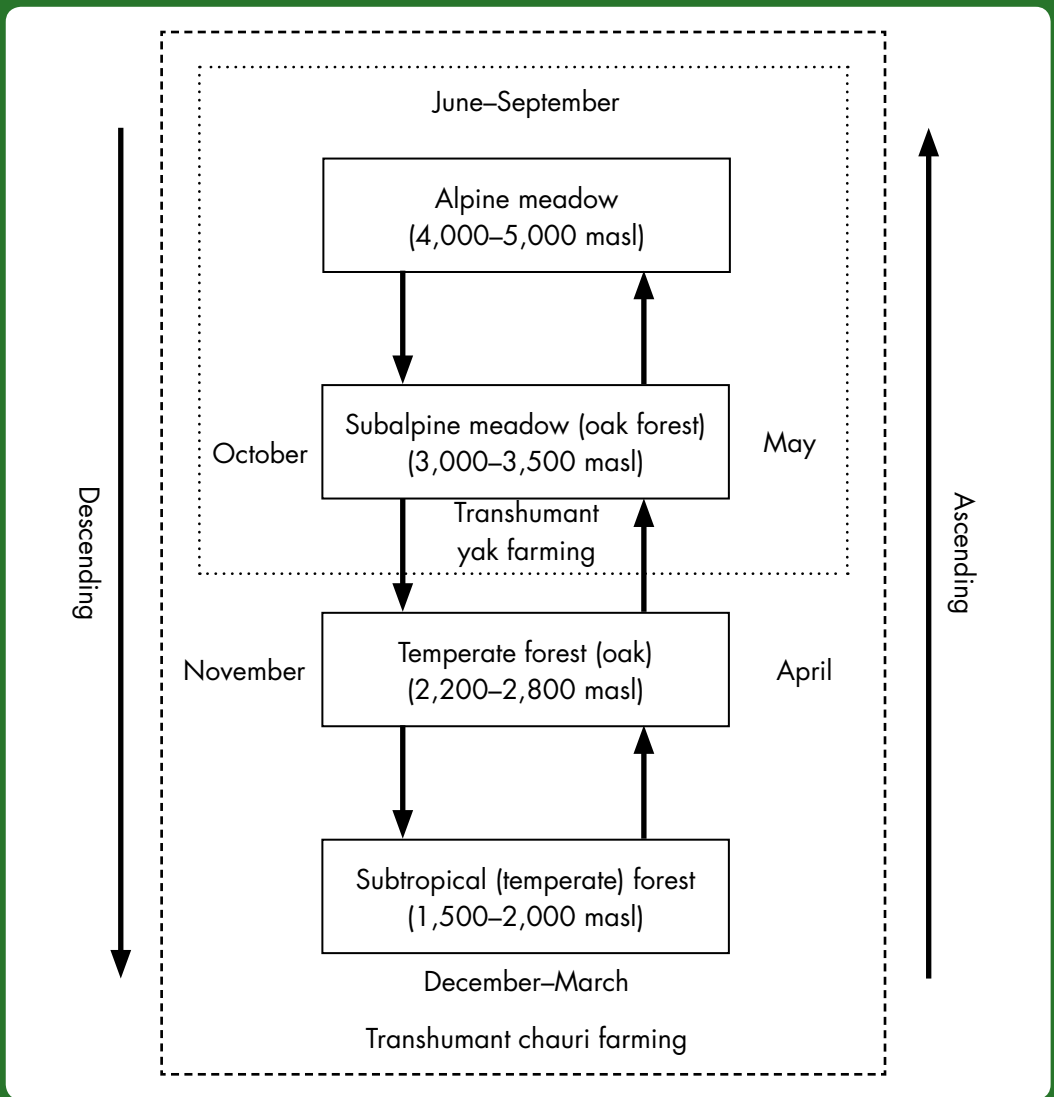
Results and discussion

Traditional yak grazing practices in the transboundary rangelands

The local pastoralists in Rasuwa District (mostly Tamang people), like many other pastoral groups in northern Nepal, mostly belong to ethnic groups that originated in Tibet, and which have maintained a close relationship with the Tibetans on the other side of the Himalayas since ancient times. Before the closure of the border between China and Nepal in the early 1960s (or effectively in the 1980s as some sources claim), there was no clear boundary between the pastures used by the herders in northern Nepal and those used by the herders in Tibet Autonomous Region (TAR) of China. Historically, the local pastoralists followed a transhumance grazing system, moving herds of different domestic animals such as yak and chauri along various migration routes and pastures according to the physical features of the

landscape, changing climatic conditions, demand for forage, and the availability of pasture. They normally herded their livestock on alpine pastures across the Nepal-China border in summer (monsoon season), and moved down to lower subalpine pastures or temperate forests in winter (dry season) with the yak remaining at a higher elevation than the chauri (Figure 25). Using this indigenous practice, the pastoralists could optimize rangeland management and yak production, capitalizing on the physical and climatic characteristics and plant communities of the Himalayan range and converting many constraints into opportunities. The forage demand of yak for maintenance, movement, growth, production,

Figure 25: **Indigenous transhumant yak (—) and chauri (–) farming system in Rasuwa District, northern Nepal (adapted from Dong et al. 2007)**

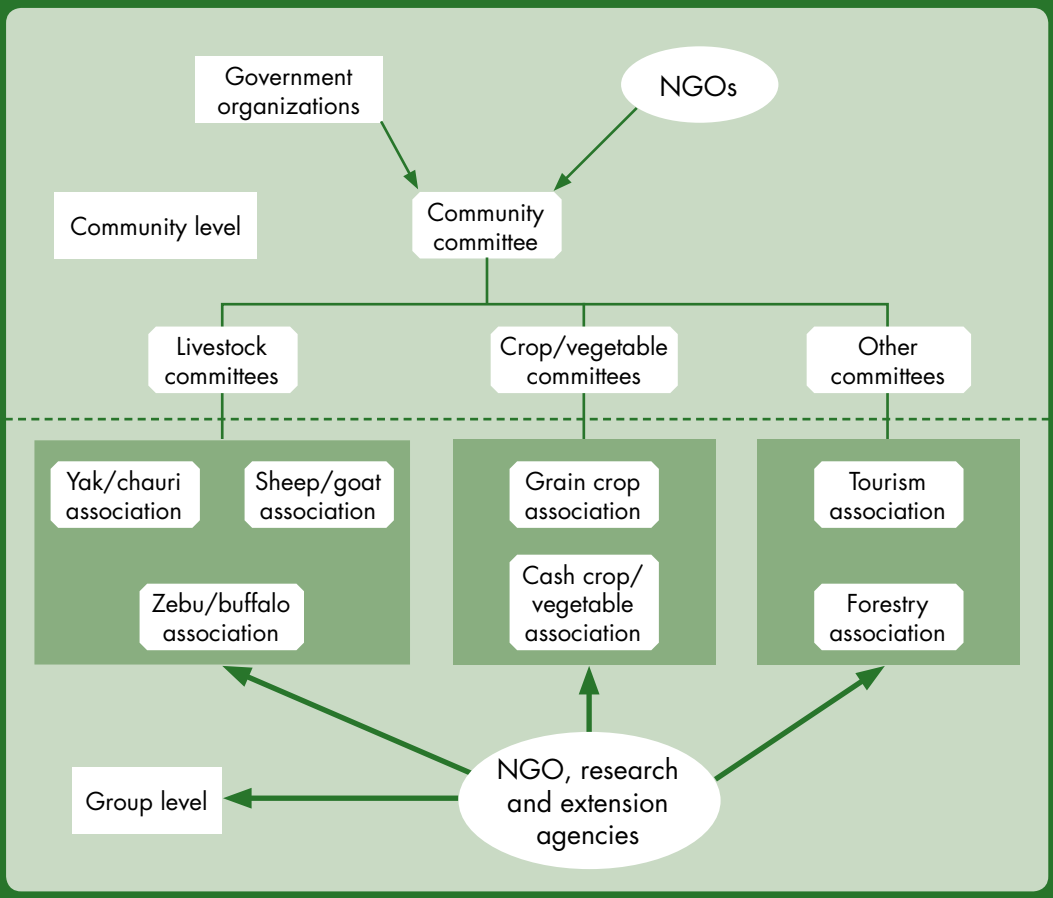


and reproduction drove the seasonal movements of both herders and livestock throughout the year. Local pastoralist groups estimated the carrying capacity of a pasture using a well-defined method derived from experience, and could assess roughly how many animals could utilize a pasture for how long. Based on the estimation of carrying capacity and the available winter food supply (forage and fodder), each pastoralist household was assigned and allowed to keep a certain size of herd. The local pastoralists grazed the pastures rotationally (summer, winter, transitional) moving every 10–15 days based on the grass cover and sward height. The same sites could not be grazed again in the same season until the cover and height of herbaceous vegetation had recovered to an acceptable level. To avoid soil erosion and land degradation, some pastoralists protected their campsites by covering the ground with stones or reseeding with native grasses when they moved to another campsite. Although these indigenous practices were not documented as scientific knowledge, they were in full accordance with the theories of rotational grazing and rangeland management advocated in modern textbooks of rangeland ecology.

Local institutions for sustainable yak production and rangeland management

Over the years, local pastoralist groups have evolved well-organized institutions and effective rules and regulations to govern rangeland management (including in transboundary rangelands) and livestock (including yak) production at the local level. Community groups and civil associations are the main local institutions and organizations involved in rangeland management and yak production (Figure 26). A community committee normally consists of 11 to 12 people elected by all community members, who are the leaders and key decision makers, as well as representatives, for the entire community. Civil associations are self-identified groups of individual households that have common interests or share the same resource pool (e.g., livestock, crops, or forests) and make decisions specific to their interests. The yak association is responsible for selecting the grazing sites and herd movement time during the migration cycle. These two sets of local organizations are more influential than governmental organizations and political institutions for pastoral communities in terms of rangeland management and livestock production. These local institutions are actively involved in guiding local people to access, understand, and apply the policies and techniques on rangeland management and livestock production designed by policy makers and professionals, although there is little institutional support for sustainable rangeland management and livestock production. In addition to providing good organizational structures, these local institutions are responsible for fostering well-designed civil regulations and rules based on those that have evolved through tradition and experience. Elaborate organizational measures and regulatory social control mechanisms have evolved to minimize risks and maximize the benefits of livestock production and rangeland resource use. These measures can promote relatively equitable access to the resources for all members of the community, including poorer and socio-politically weaker individuals. Such integrated approaches, built upon the best aspects of indigenous systems, can promote sustainable rangeland resource management and livestock production.

Figure 26: **Local rangeland management and livestock production institutional arrangements and their linkages with other organizations**



Source: Adapted from Dong et al. 2007

Problems and challenges in transboundary rangeland management and yak production

Over centuries, local pastoralists have developed transhumance grazing systems that utilize the transboundary rangelands to sustain subsistence livestock (mostly yak) production. The Nepali and Tibetan pastoralists had reciprocal arrangements between their local institutions. The indigenous practice of transhumance grazing and reciprocal arrangements between local institutions, enabled pastoralists on both sides of the border to overcome the problems of feedstuff deficiency and livestock inbreeding. Pastoralists spent a long period in summer in the productive high-altitude pastures and had yak bulls available for crossbreeding.

However, with the beginning of closure of the national border to livestock movement in the 1960s and final closure in the 1980s (some farmers claimed in the 1960s), many new problems arose in both rangeland management and yak production. Grazing pressure increased on the pastures in Nepal as a result of the reduced area of grazing land available especially in summer, leading to problems of rangeland degradation and feed deficiency. Local pastoralists have also had to focus on their own stock of male and female yak for breeding, which with the small herd sizes has led to problems of inbreeding and reduced genetic diversity. Local farmers complained that inbreeding has resulted in poorer quality stock, or as one interviewee put it: "We cannot get the very good yak bulls from the Tibetan side as in the past, and our yak are becoming smaller and smaller. Moreover, we cannot get enough grazing pastures for yak due to the closure of the Tibetan border. We have to overgraze our own (Nepali side) pastures to maintain our livelihoods." In addition to rangeland and livestock degradation, social conflict has also developed as a result of the problems with transboundary resource management. For example, the pastoralists from the Tamang villages of Gatlang and Chilime in Rasuwa District are fighting with each other about sharing a large grazing pasture, the Sanjen pastureland, which has historically been shared by the transhumant pastoralists from Gatlang, Chilime, and TAR. After the closure of the border, the two village development committees (VDCs) both claimed use rights for the pasture and have been unable to reach an agreement about sharing through negotiation. The interviewees from Gatlang village stated that the problem had negatively affected their pastoral production and livelihoods. Due to the shrinkage of rangeland resources and decline in livestock (yak) production, some pastoralists have shifted their livelihoods from livestock production to hotel management and other tourism-related types of business. This has also disrupted the traditional subsistence yak production system in the border areas between China and Nepal.

Management implications and recommended strategies

For centuries, the traditional rangeland management and livestock (yak) production systems adopted by indigenous pastoralists in the border areas between China and Nepal worked well in promoting environmental sustainability and maintaining livelihoods (Dong et al. 2007; Dong et al. 2009), as typified in our case study example, Rasuwa District. Indigenous systems are critically important in the marginal regions of the world as an adaptive strategy for surviving in harsh and uncertain environments. Extensive livestock grazing practices and well-organized institutions have been shown to help maintain rangeland health, especially if pastoralists can maintain a degree of mobility that fosters the optimal use of rangeland resources (Steinfeld et al. 1997; Naimer-Fuller and Turner 1999). However, such traditional practices are vulnerable to geopolitical changes across border areas. Political conflicts, social tensions, epidemic diseases, and others can easily lead to border closure and blockage of pastoral mobility. The closure of the Nepal-China border from the Chinese side has negatively impacted the local environment and pastoral livelihoods, especially in Nepal, and poses a challenge to sustainable rangeland management and livestock (yak) production in the transboundary zone. This understanding calls for the development of strengthened transboundary institutions for rangeland management and livestock (yak) production.

Although the local pastoralists in transboundary zones have highlighted the importance of reopening the borders, their voices can barely be heard by decision makers as they are often marginalized from society (Dong et al. 2007). Reviving the traditional grazing practices and reciprocal local institutional arrangements could be an ideal way to address the problems of rangeland and livestock degradation in border areas. There is an emerging trend in some parts of the Tibetan Plateau, such as Hongyuan in Sichuan Province, China, towards reviving the traditional institutional arrangements in pastoral production systems through comanagement or collective grazing (Ze et al. 2007). If this model can be successfully transferred with the support of Chinese government policies to the border areas between Nepal and China, the transboundary social and environmental problems in the pastoral sector might be substantially alleviated. Translation of this model needs to be facilitated by regional and international coordination and cooperation that reaches beyond China and Nepal, and to other Himalayan countries.

Although many voices have advocated better transboundary coordination and management of natural resources and environments in the HKH region, evidence indicates that regional institutions are still not sufficiently robust to address transboundary challenges effectively (Sherpa et al. 2003; Dong et al. 2010). Analysis of the HKH transboundary challenges in natural resource management and environmental protection (especially biodiversity protection) and the regional institutional response indicates a series of gaps. The first relates to the inadequacy of the institutional structural arrangements, e.g., a lack of channels for direct communication among the full range of stakeholders, local communities, local governments, and national governments (ICIMOD 2004; Sharma and Chettri 2005). The second highlights the opportunities for overcoming the shortcomings in governance practice, requiring shifts in the ways in which national governments and regional institutions interact with the general public (ICIMOD 2004). These two gaps are critical for the creation of an enhanced regime of regional institutions that meets the challenges in transboundary natural resource management, as such institutions can, in principle, overcome the obstacles that appear when there are the gaps between theory and reality in transboundary issues (van Schoik et al. 2004).

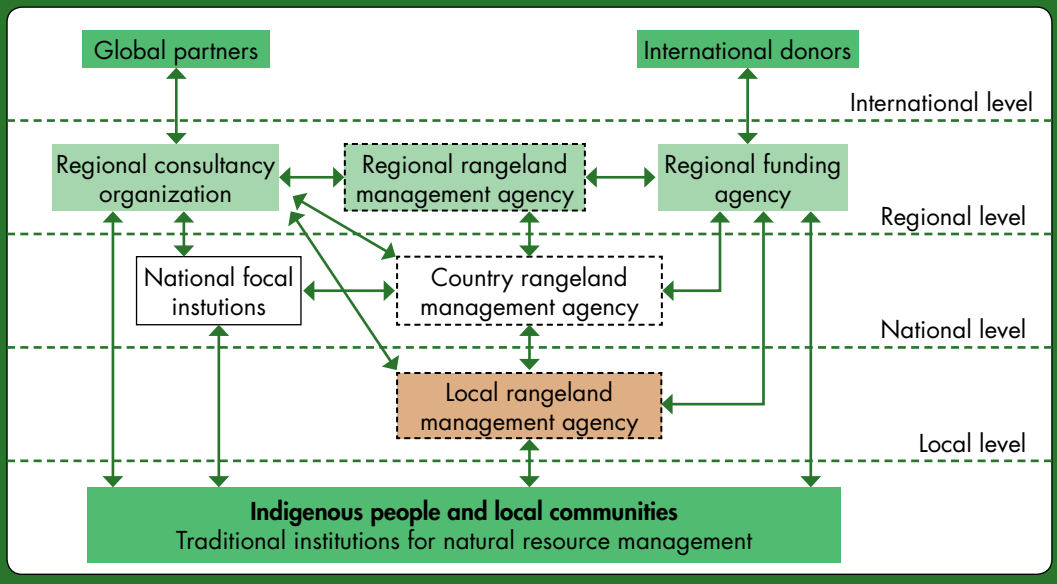
The challenges in transboundary rangeland management and livestock production in the HKH region highlight the need for decision-making processes that go beyond the borders of individual nation states. They illustrate the necessity of creating administrative structures for transboundary biodiversity conservation that are designed to nurture ecologically sustainable and socially acceptable development that functions on many levels. Institutional richness – a diverse range of institutions with overlapping and complementary mandates and with multiple channels of communication and accountability – will result in more effective governance of transboundary issues (Lipschutz 1997). At the regional level, the role of regional institutions is increasing as they begin to provide more effective channels for cooperation and collaboration among a number of stakeholders. At the national level, national governments occupy a central position within almost all decision-making processes in the HKH region and their

participation is needed for any viable long-term solution to the area's biodiversity conservation problems. At the local level, provincial, district, and village administration bodies are very important in decentralizing policies and decisions related to transboundary rangeland management and livestock (yak) production.

The authors propose that a regional administrative institution should be developed for natural resource management comprising a decision-making body, a technical support body, and a funding body, across different levels (Figure 27). The decision-making body, which could be a regional environmental protection agency possibly hosted by the South Asia Association for Regional Cooperation (SAARC), can be instrumental in facilitating the traditional transboundary movement of domestic animals. The technical support body could be a regional research and development organization like ICIMOD, which acts as a consultancy organization to provide the technical support for decision making. The funding agency could be a foundation or financial organization like the Asian Development Bank, which can provide the funding resources for implementing the transboundary cooperation framework. All these regional institutions would work closely with international institutions, national governments, research institutions, educational organizations, local government, and communities to form an institutional network for the implementation of a regional transboundary cooperation framework (Figure 27).

A number of strategies should be developed to institutionalize transboundary rangeland management and livestock production, as described in the following sections.

Figure 27: **Proposed structure for a regional administrative institution for transboundary rangeland and livestock management**



Locate decision making at the lowest appropriate level

Decision making on rangeland management and livestock production takes place at multiple levels, and the subsidiary principle calls for authority to be located at the lowest appropriate level for each decision. The need for interaction across the regional, national, and local levels on issues of transboundary rangeland management and livestock production is particularly acute. Governments in the region should continue to gradually increase the role of supra-national and sub-national actors in decision making as required by the many different scales of the challenges in rangeland management and livestock production. The potential role of subnational governments in preventing and managing conflict in transboundary situations such as border closure and illegal migration is of particular importance. Regional institutions, especially ICIMOD and SAARC, will need to play more flexible and reflective roles that are compatible with the demands for transboundary natural resource governance as it evolves over the short, medium, and long term.

Link rangeland governance to regionalization trends

It is likely that the benefits gained from cooperation and communication on transboundary resource management can be increased if the issues of sustainable rangeland management and livestock production are linked to a broader range of political and economic cooperation trends. Although institutions are not yet up to addressing the region's challenges at the level of natural resource management, increased political and economic cooperation has created a

number of opportunities for bridging gaps between the HKH countries on governing natural resources. ICIMOD has developed a regional cooperation rramework (RCF) to encourage transboundary landscape management across a number of selected transects in the HKH region. Such a framework can help the member countries in the region to discuss mutually beneficial approaches for improved transboundary biodiversity conservation. There are good examples for regional cooperation on transboundary rangeland management and livestock production. A sound RCF can actively promote broad-based dialogue that fosters political commitment for enhanced national and subnational rangeland governance practices. A broadly construed regional rangeland governance agenda will increase the likelihood that common areas of interest and cooperation among the national governments will emerge. For this, SAARC should use its dialogue with China to establish an agreed upon set of basic norms for cooperation that would provide a basis for dialogue and exchange among the member countries to gain a win-win situation between regional development and transboundary rangeland management and livestock production.

Integrate transboundary rangeland management concerns

Regional institutions, in close collaboration with national governments, should help to develop a vision and approach for institutionalizing transboundary issues of rangeland management and livestock production. Funding agencies such as the World Bank, Asian Development Bank, United Nations Environment Programme (UNEP), and other foundations could mobilize financial resources, and regional institutions such as ICIMOD and their partners can facilitate access to information related to transboundary rangeland management and livestock production. Regional intergovernmental organizations such as SAARC could lead efforts to increase political support from national governments for promoting sustainable rangeland management in transboundary zones. SAARC, ICIMOD, and other institutions should engage with the research community to devise methodologies and approaches to sustaining the utilization of transboundary rangeland resources and maintaining sustainable livestock production in crossborder zones. Local governments of member countries should be actively involved in transboundary rangeland management and livestock production interventions. Local communities and interest groups should be more thoroughly integrated in the decision making on transboundary rangeland management and livestock production. In addition, both national governments and regional institutions should expand their frameworks for assessing and monitoring transboundary rangeland management performance.

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Yak Husbandry and Rangeland Management in Nepal

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Livestock farming is an integral part of the agricultural system in rural Nepal, with 80% of households owning livestock. Extensive ruminant production prevails in the lower altitudes of the mid-hills, while transhumant ruminant production is practised in the high-altitude areas. Yak (Bos grunniens) is the only domestic large animal that survives and thrives well in the high Himalayan region. Yak are the prime source of milk, meat, and wool and are also used as pack animals for expeditions in the Himalayas. Yak are an important means of livelihood for the people living in the high mountain areas, who have followed yak and chauri (yak/cattle cross) farming practices for generations. It is estimated that there are about 69,000 yak and chauri in the 28 higher elevation districts of Nepal. Although yak and chauri farming is the main source of income and means of livelihood in the high Himalayan region, there is a growing reluctance amongst herdsmen to keep these animals. Inadequate availability of pasture, restrictions on grazing in transborder pastures, and low incentives are the main factors behind this decline. There has been a gradual change away from the traditional occupation as herdsmen towards tourism and working as porters. It is essential to focus on rangeland management by engaging the herdsmen to increase the quantity and quality of grass. To explore the root causes leading to the decline in yak herds, the Directorate of Livestock Production (DOLP) carried out stakeholders' interaction workshops in the four districts of Sindhupalchok, Rasuwa, Myagdi, and Jumla. This paper presents the findings from these workshops and their comparison with an intensive literature review. The study highlights the need for further work on research and management and presents recommendations for the improvement of yak husbandry and rangeland management in Nepal.

Keywords: climate change, livelihood, Nepal, rangeland, transboundary issues, yak

Introduction

Nepal is a mountainous and landlocked country situated between China and India with a total area of 147,480 km^2. Only about 17% of the land area is suitable for agriculture (AICC 2012), but agriculture forms the main occupation for about 66% of the population and provides 31% of the national gross domestic production (GDP). The share of the livestock sector in agricultural GDP is 12%, with dairy, meat, and eggs contributing 63%, 32%, and 5% of livestock GDP, respectively. Livestock farming is an integral part of the agricultural system, with 80% of rural households owning livestock. Extensive ruminant production prevails in the lower altitudes of the mid-hills, while transhumant ruminant production is practised in high-

altitude areas. The Agriculture Perspective Plan (APP) identified the livestock sector as an important sector with a potential for a 6.1% growth rate by the end of the plan period (2014/15) from a 2.1% growth rate in the base year (1995/96) (APP 1995). There are about 7.3 million cattle, 5.2 million buffalo, 0.8 million sheep, 9.8 million goats, 1.2 million pigs, 48 million chickens, 380,000 ducks, and 70,000 yaks and chauris (female yak/cattle cross) in Nepal (AICC 2012).

Rangelands, comprised of grassland, shrubland, and forest, occupy 22.6% of Nepal's land area (NASA 2004). About 70% of the rangeland lies in the Western and Mid-Western Development Regions, with the major part in the mountainous region (50.5%, 29.0%, 16.7%, 1.2%, and 2.8% in the high mountains, high hills, middle hills, Siwaliks, and Terai, respectively). Forest, agricultural land, grassland, shrubland, water, non-cultivated land, and others occupy 29.0%, 21.0%, 12.0%, 10.6%, 2.6%, 7.0%, and 17.8% of the rangeland area, respectively. The rangelands in Nepal have low productivity, and only 37% of the total production of rangeland forage is available for livestock (LMP 1993; Pariyar 1994). The Government of Nepal promulgated a national Rangeland Policy in 2011 to address rangeland issues. The policy highlights the importance of rangelands and the major issues. It also analyses the holistic management of rangelands from the viewpoint of different stakeholders, and identified that the rangelands face constant and serious challenges which require urgent attention. The Directorate of Livestock Production (DoLP) of the Department of Livestock Services (DLS), in collaboration with International Centre for Integrated Mountain Development (ICIMOD), prepared a draft rangeland policy implementation framework in 2014 (Parajuli et al. 2013).

The primary occupation of mountain communities is livestock farming. The main livestock species are local cattle, sheep, a mountain goat known as chyangra, and yak, and they are raised mainly for milk, meat, wool, and draught power. However, the increasing reluctance by herdsmen to keep these animals (Joshi 2000) is threatening the sustainability of livestock farming in these areas. This study is based on an extensive literature review and stakeholders' consultation workshop to find the current status of yak farming in relation to rangeland management in Nepal.

Study area and methodology

The information was collected from four districts: Rasuwa and Sindhupalchok in the Central Development Region, Myagdi in the Western Development Region, and Jumla in the Mid-Western Development Region. District level consultations and interaction workshops were conducted from December 2013 to April 2014 at the district headquarters with the active participation of line agencies including chiefs of the district livestock services offices, local development officers from district development committees, chiefs and/or representatives from district forest offices, district soil conservation offices, and district agriculture development offices, chairpersons and/or representatives from rangeland management committees, representatives from wildlife and protective areas, and others. Lead papers on yak farming

and rangeland management were presented from the director and senior officers of DOLP prior to in-depth discussion. Group formation, group discussions, and group presentations were carried out during the workshops. Meetings were also held and interviews conducted with key informants using semi-structured questionnaires. Suggestions, feedback, and recommendations were taken from the workshops and a central-level meeting of selected officers was held in DOLP. The outcomes of the workshop and meetings were compared with the findings of the extensive literature review to prepare the final report.

Results and discussion

Yaks in Nepal

Yak (*Bos grunniens*) is the only domestic animal which survives and thrives in the high Himalayan region of Nepal (Neopane et al. 1999). For generations, yak farming has not only been a tradition but also an important means of livelihood for the people living in these areas (Pande 2004; Paudel 2006). Yak skins are used for making bags, sacks, and other materials. Fibres are used for making ropes and blankets (radi). Yak steak (dried yak meat) is quite popular among tourists (Paudyal 1993; Sherchand and Karki 1996), and yak milk is used to produce various products like cheese, butter, and chhurpi, which are sold in both local and bigger markets like Pokhara and Kathmandu.

Yak are reared on grazing pastures and meadows at elevations of 3,000–5,000 masl in 28 northern mountain districts in Nepal. The male is called yak and the female nak. Yak and nak crossed with local cattle in the high hills produce hybrids called chauri (Shrestha et al. 1996). It is estimated that there are about 69,000 yaks, naks, and chauris in Nepal (AICC 2012). Although the number of herds is decreasing, herders have increased herd size in recent years to increase their income. The average herd size increased from seven animals in 1991/92 (Shrestha et al. 1996) to 20–30 animals in 2011/12 (Parajuli et al. 2013).

Chauris are more productive than yaks and naks (Paudyal 1993) and thrive better on poor quality roughage. Transhumant ruminant production is practised in both yak and chauri farming, with animals moved from one area to another for grazing (Pariyar 1998). During summer, they graze on alpine pastures at higher elevations, and at the onset of the winter season are gradually taken to lower altitudes to subalpine pastures for grazing (Miller 1987; Kharel 2000; Neopane et al. 2001). Nomadic sheds are built for herders and the yaks graze openly in the areas around them (Cai and Gerald 1996). The DOLP supports farmers through breed improvement, pasture management, and other supporting services like construction of track roads, drinking water supply, and training and animal health related activities through extension and training programmes. Although the government implements several measures supporting farmers, the farmers don't consider them to be sufficient. The High Mountain Agri-business and Livelihood Improvement (HIMALI) project under the Ministry of Agriculture Development also supports yak and chauri herders in the area in trade promotion using the value chain approach. This project is working in nine high hill and mountain districts in Nepal.

Due to the support and facilities provided to the herders by various government agencies, there has been a slight increase in the population of yaks and chauris.

Breeding system and productivity performance of yak in the study area

Small herd size and inbreeding problems have adversely affected yak farming in Nepal due to the lack of a systematic planned breeding programme to develop genetically improved breeds of yak (Sherchand and Karki 1996). Milk production from the female yak (nak) is generally low and herders prefer to keep crossbreeds, which have a higher milk productivity (Shrestha et al. 1996). Crossbred females, locally known as dimjo, are obtained from mating nak with high-mountain cattle (kirkho) bulls, whereas the crossbred female (urang) is obtained from mating yak bulls with the high-mountain female cattle. All crossbred female animals are referred to as chauris. The crossbred males, called zhopkyo, are sterile and are used as pack animals (Neopane et al. 2001).

Limited information is available on the performance of yak, nak, and chauris in Nepal, and efforts towards conservation and productivity enhancement of yak and chauris have also been limited (Sherchand and Karki 1996; Neopane et al. 1999). Table 24 shows some of the production related parameters available from the Yak Development Farm at Syangboche in Solukhumbu, and Table 25 shows the production parameters of chauri on different pastures in Jumla.

Table 24: **Production parameters of nak at the Yak Development Farm, Syangboche, Nepal**

Parameter	Value
Calving interval	13 months
Milk yield/day	650 ml
Lactation length	63 days
Milk production/animal/lactation	42 litres
Mortality	
a. calf	2%
b. heifer	1%
c. adult	1%
Age of first conception	36–38 months
Gestation period	9 months
Birth weight	
a. Male	12 kg
b. Female	11 kg

Source: Yak Development Farm (2013)

Yak and nak farming is still practised in a traditional manner in Nepal (Parajuli et al. 2013) with little or no attention being given to breed improvement, enhancement of productivity performance, or selection of breeds for breeding purposes. Production performance has gone down because of inbreeding among the animals (Sherchand 2001). In order to maintain the yak population and increase their productivity, high quality yak and nak (total 30) have recently been imported from Tibet Autonomous Region TAR of China by the HIMALI project and are being maintained at the Yak Development Farm in Syangboche. It is expected that this initiative will contribute towards breed improvement and better yak farming in Nepal.

Table 25: **Production parameters of chauris grazing on different kharka (pastures) in Jumla, Nepal**

Parameter	Kharka 1	Kharka 2	Kharka 3	Kharka 4	Kharka 5	Average
Age at first conception (months)	39	42	38	42	40	40.2
Lactation period (months)	5	6	6	6	5.6	5.7
Milk production /lactation (litres)	300	360	324	342	314	328
Weight of inner coat/cutting (kg)	0.3	0.4	0.4	0.4	0.5	0.4
Weight of outer coat/cutting (kg)	0.8	1.2	1.1	0.9	0.9	1.0
Birth weight of calves (kg)	18	21	19	23	20	20
Length of wool (cm (inches))	20 (8)	18 (7)	23 (9)	18 (7)	20 (8)	20 (8)
Month of conception	June to August					

Source: DLSO Jumla (2014)

Only a very limited amount of research has been carried out on yaks in Nepal (NASA 2004), and different studies have produced differing results. Joshi (1982) reported that the lactation length for nak was 40 days, while Kharel (2000) reported 167 to 180 days. At the Yak Development Farm it was 63 days (Table 24). Similarly, reports of the lactation length for chauri range from 96 days (Neopane et al. 2001), to 120–180 days (Sherchand and Karki 1996), and 150–180 days (DLSO Jumla 2013). The reported milk yields are also highly variable. The present study found a daily average milk yield of 0.65 litres per animal for nak, and 1.91 litres per animal for chauri averaged across all four sites. The maximum average daily milk yield reported for nak was 1.5 litres per animal in Myagdi District, where nak are fed with abundant natural forage and hay. The farmers from Rasuwa and Sindhupalchowk who participated in the workshops considered that the decline in milk production from naks and chauris was due to the lack of care given in the selection of bulls, and asked for provision of artificial insemination for nak and chauri.

Male yaks have been reported to have a working life of 10–12 years, while male crosses (zhopkyo) have a working life of 12–15 years (Shrestha et al. 1996). Both yak and zhopkyo can carry a 50–100 kg load depending on their body condition, which is strongly influenced by the kind of fodder they are given (Shrestha et al. 1996).

Problems of yak husbandry and rangeland management in Nepal

The majority of the stakeholders in the workshops suggested that the emergence of community forest management systems, and subsequent restriction of grazing and fodder collection, had forced farmers to choose alternative ways of gaining income and made them more reluctant to continue yak rearing. Stakeholders, especially the farmers in the workshops, also considered that the gradual declaration of new conservation areas by the government has restricted large areas for yak grazing, which has also created problems in yak farming.

Recent research shows increased health concerns in yaks. A study done by the Regional Veterinary Laboratory, Pokhara (RVL 2013) revealed more parasitic infestations in females than in males with a higher infestation rate at lower elevations and in weak and older animals. The findings suggest that routine drenching and vaccination programmes, good feeding, and effective herd management would help prevent such infestations. The workshop discussions conducted at the four sites and the collected data corroborate these findings. Some of the participants in the workshops, especially those from Rasuwa and Sindhupalchowk, commented that further important problems included very limited or no access to roads to reach new and virgin pastures, lack of drinking water in the rangelands, and invasion of unwanted and thorny weeds. The major outcomes of the workshops and meetings related to problems of yak husbandry are briefly summarized below.

Natural resources

The inadequacy of green pastures and hay during the winter months together with the closure to yak herders of alpine pastures in TAR has been a key constraint to efficient resource use and yak herding practices. Almost all the participants in the workshops at all four sites confirmed that issues of uncontrolled grazing due to overstocking, depletion of native vegetation and legumes, proliferation and invasion in the rangelands by thorny, bushy canopy and unpalatable species, unsustainable harvesting of range resources, and deforestation, soil erosion, and forest fire all need to be addressed immediately.

Research and technology

There are limited research interventions in yak husbandry with a lack of scientific and efficient yak breeding programmes to maintain genetic diversity for yak breeding farmers, and only very limited work on the interface between climate change and yak production. There is an absence of proper infrastructure such as roads and electricity for marketing high value yak cheese. Mobile cheese processing technologies available in other countries and very suitable for the transhumance system of yak husbandry are still not available in Nepal. The stakeholders at the workshops and meetings also raised the issues of artificial insemination for nak and chauri to enhance milk productivity. Simple technologies such as provision of solar lights, climate friendly shed management, and hay and silage making were demanded by farmers from Rasuwa and Myagdi districts.

Government programmes and schemes

Pastoral development is not a priority issue for the Government of Nepal, and this is reflected in the lack of programmes to attract farmers, especially youth. As a result, there has been a gradual change from yak farming to tourism, particularly among the youth. There is an absence of soft loan disbursement programmes to help farmers increase the herd size and achieve economic growth of scale and efficiency of the enterprise. Selection and procurement of appropriate forage pasture seed, provision of budget for construction of track roads to virgin pastures, and training in processing of high value products at every level of value chains

were suggested as programmes that need to be launched by the government immediately. Farmers from Jumla and Rasuwa also demanded the provision of soft loans from the government to support the development of yak, nak, and chauri farming enterprises.

Research and management priorities

Although there are ample possibilities for yak farming to flourish in Nepal, low priority has been given to scientific research and management, and very limited work has been done so far in these areas. Some of the main interventions on research and management priorities for the yak and rangeland development are summarized in the following.

Stakeholder involvement: Proper facilitation is needed for community-based rangeland management involving local authorities at all stages of production and supply chains. Development of hill station networks at accessible sites for development workers and mountain people would be very useful. Many of the farmers at the workshops also considered that provision of integrated service centres at the potential sites would serve to resolve many of the problems that they are currently facing.

Research: Scientific studies on production performance, breed selection, and breeding plans; studies on indigenous rangeland species, seed production technology and its promotion, dissemination, conservation, and utilization; and studies on carrying capacity, stocking density, and the potential of the rangeland for yak farming should be initiated (ETH 2009) to get recent data for the interpretation and validation of people's opinions on these issues. Temperate forage seed production, dissemination, and cultivation, as well as preservation methods, conservation, expansion, and utilization of animal and plant genetic resources in the high mountains and Himalayan regions are among the most important issues for research in this field.

Ownership and accessibility: A proper inventory and documentation should be made of the indigenous knowledge related to yak husbandry and rangeland management, and government regulations related to property rights and the community need to be understood. There is a need for action research on in situ rangeland management in accordance with community ownership.

Products: Research on proper product diversification in relation to the value chain at all stages in the production and supply chains of yak farming and rangeland management are an immediate need. A focus on high value commodities like yak cheese, organic milk, dry yak meat (sukuti), Nepali pashmina, herbs, and others would add value to the yak enterprise and provide youth with ample opportunities for employment.

Policies: The government needs to pay due attention to resource pooling and a one-door development mechanism to motivate pastoralists and herders to continue yak farming. Programmes for productivity enhancement and rangeland management, especially

implementation of the rangeland policy implementation framework and a value chain approach, would provide for the betterment of yak husbandry in Nepal.

Conclusion

Yak farming is not only a source of income generation but also a way of life for the high-mountain Himalayan people of Nepal, and has been since time immemorial. Although yak farming has been taken as the symbol of Himalayan agriculture in Nepal, it has suffered in many ways over the past few decades. Small herd size, lack of proper breeding plans, insufficient fodder availability, and limited programmes from the government have led people, especially youth, to change changing from yak farming to other disciplines, especially tourism or even migration to other countries in search of better opportunities. This scenario has not only directly affected the farming system but also the social harmony of the area.

The following recommendations are proposed for the betterment of yak farming and rangeland management in Nepal:

- Realizing the importance of yaks in Nepal, yak husbandry and rangeland management should be given a high priority by the government. Construction of walking trails, drinking water management, conservation and promotion of local forage species, recognition of traditional knowledge, the gender role in yak farming, and value addition to yak products are all extremely important.
- Effective crossborder cooperation (Nepal-India-China-Bhutan) in the areas of research and management needs to be facilitated in line with the global warming and climate change perspective.
- Incentive mechanisms, e.g., effective programmes for agri-ecotourism, product diversification and value addition, entrepreneur insurance, and others, need to be introduced, as mentioned in the Rangeland Policy for the promotion of yak husbandry in Nepal.
- Proper selection of breeding bulls for natural services and arrangement of artificial insemination for naks and chauris to reduce inbreeding and increase the production and productivity of yak, nak, and chauri should get the highest priority in government programmes.

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Yak Herding in Bhutan: Policy and practice

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Yak herding in Bhutan forms an economic mainstay as well as providing a social and cultural foundation for highland communities. Yaks are reared under a transhumance system with migration between winter and summer pastures. The absence of a pro-pastoral policy, weakening of customary rangeland tenure, limiting of livestock numbers, outmigration, lack of labour for herding, and growth of alternative livelihood opportunities are leading to a decline in yak herding. This paper reviews the current status of yak herding, government policies, legislation, and development plans that have an implication for the sustainability of yak farming. The study concludes that fair and equitable allocation and efficient administration of rangeland use rights will be important for the sustainable management of rangeland resources. Harmonization between the different acts, and their timely enforcement, are crucial for resolving the conflict between yak herders and community forest users. A dedicated institution equipped with a multidisciplinary team should be established for highland research and development in Bhutan.

Keywords: yaks, rangelands, grazing, tenure, Bhutan, government policy

Introduction

For the highland communities of Bhutan, yak herding is not only an economic mainstay, it also provides a social and cultural foundation. Yak herding is practised in ten of the 20 districts in the country, and is confined to the subalpine and alpine regions, ranging from 3,300 to 5,100 masl (Derville 2010; Wangchuk 2011). The yak herding system is characterized by the migration of herds between winter pastures in the subalpine region and summer pastures in the alpine region (Chophyel 2009; Wangchuk 2011).

About 1.2% of the population of Bhutan, distributed over 34 subdistricts in ten districts, is involved in yak herding (Dorji 2013). The social groups that derive economic benefits from yak herding include the royal family, central monastic body (Zhung Dratshang), district monastic bodies (rabdeys), religious groups, private individuals, and rural communities. Many individual yak herders and community members depend solely on yak husbandry, while some with high-altitude farmlands combine it with agriculture.

The grazing resources in the different ecoregions that support yak production exclusively, including the rangelands of the subalpine and alpine regions, are called tsamdro in Bhutanese. Different social groups and individuals hold rangeland use rights. The total grazing land in the country registered under the use rights of different rights holders is

500,198 ha, about 13% of the total area. About 271,837 ha, 54% of the total grazing area, are rangelands in the alpine and subalpine regions (Dorji 2013).

With increasing modernization, yak herding in the Hindu Kush Himalayan (HKH) region is believed to be on the decline. The principal causes are the absence of a pro-pastoral policy, weakening of customary rangeland tenure, limiting of livestock numbers, outmigration, lack of labour for herding, and growth of alternative livelihood opportunities (Gyamtsho 2000; Banjade 2008; Tambe and Rawat 2009; Derville and Bonnemaire 2010; Bhasin 2011). Throughout the world, traditional pastoral practices are affected by the lack of policies to improve pastures or rangelands (Sandford 1983).

The yak production system in Bhutan is only supported by marginal material and knowledge inputs, which limits the opportunities for increasing production (Dorji et al. 2003). The main inputs supporting yak production are water, salt, pasture, supplementary fodder and feed in winter, and labour. Most feed comes from the rangelands where dry matter production is determined by the elevation, soil conditions, rainfall, and management (Dorji et al. 2003). The productivity of summer pasture and winter pasture in Bhutan's rangelands is estimated to be 0.4 t and 0.7 t of dry matter forage production per hectare, respectively (Roder et al. 2001), which means 3 ha of pasture are required per adult yak in summer and 2.4 hectares in winter.

As elsewhere, yak production in Bhutan depends on the rangeland resources, animal heath, quality of breed, research and technological support, and efficiency of production and marketing of yak products. Some authors have suggested that yak herding in Bhutan is moving towards extinction (Wangchuk 2011). However, the actual status of the system has not yet been assessed. This paper reviews government policies, legislation, and development plans, and their effects on the improvement of rangeland productivity, yak health and breed, and efficiency of production and marketing of dairy, meat, and wool products.

Materials and methods

A review of the literature was carried out covering policy documents, legislation, research papers, consultancy reports and theses, study reports, and government documents related to yak rearing and rangelands. Qualitative deductive analysis was employed to determine the intent of policies, legislation, and development plans, and to determine the status and effects of their implementation.

Results

Rangeland tenure policy evolution

Rangeland tenure has undergone a transformation from individual, group, and communal ownership in the past to the present state ownership. The transformation is in the process of obliterating traditional herding arrangements such as keme-shimey (no birth, no death); puyig (annual head counting); and a practice of determining access to rangelands through community consensus (throwing of dice system) (Gyamtsho 2000; Ura 1993, 2002).

Prior to the advent of the monarchy in 1907, ownership of rangelands was granted to individuals and social groups through a kashos (order) issued by the governors of different regions, which was recorded in the Thram Martham Chenmo (a legal document with red seal) after 1907 (Ura 2002). In 1953, the National Assembly enacted the Thrimzhung Chenmo, under which de jure ownership of rangelands was granted to individuals and social groups at par with agricultural land.

With the enactment of the Land Act 1979, the state annulled the de jure ownership of rangelands granted to individuals, communities, monk bodies, and religious bodies under the Thrimzhung Chenmo. It abrogated the system of collecting annual tax on rangelands and instead institutionalized a permit system which required rangeland owners to obtain written annual permits from designated state agencies by paying a grazing permit fee to graze their yaks on their own rangelands (Dorji 2013). The Act allowed yak herders to lease their rangelands to other yak herders who did not own or have enough rangelands, but prohibited selling and buying of rangelands. In effect, it turned rangelands into state property (Ura 2002) and granted use rights only to the original owners.

The enforcement of the Land Act 1979 resulted in the registration of rangeland use rights in the name of individual households, monk bodies, religious bodies, and local communities. The data on registered rangeland use rights in the subalpine and alpine regions show that 4.7% of the use rights are held by the royal family, 6.4% by monk bodies, 1.7% by religious bodies, 56.6% by individual households, 28.4% by local communities and 2.1% by the government (Dorji 2013).

In general, the rangelands used for summer, autumn, winter, and spring grazing are distinct. The rangelands used for summer grazing are usually located in the alpine belt situated at the top of the mountain ridges, while those used for winter grazing are situated on warmer south-facing slopes at lower elevations. The rangelands used for spring and autumn fall in between the pastures used for summer and winter. Rangeland use rights were allocated accordingly.

The Land Act 2007 amends the Land Act 1979; enforcement is due to begin by the end of 2016. The Act promulgates rationalization of rangeland uses. It empowers the state to appropriate the rangeland use rights by paying compensation to the rangeland use rights holders and then to lease the use rights only to those individuals, local communities, and religious groups who continue to do yak herding for their livelihoods. The Act allows traditional yak rearing households to retain their rangeland use rights under the lease, whether or not they own yaks and irrespective of their herd size. The Act requires the rangeland use rights lessees to develop and manage the rangelands leased to them according to a rangeland management plan. However, while the implementation of the Act is pending, the use rights administered as per the Land Act 1979 are falling apart, and the challenge in rangeland governance and management is mounting. A general tendency to graze on a first-come first-serve basis, paying less attention to protecting and conserving the grazing resources, has already set in.

The definition of forest in the Forest Act 1969, amended as the Forest and Nature Conservation Act 1995, includes rangelands over which individual herders, local communities, and other social groups hold use rights. Protected areas have been set up for environmental conservation under the Nature Forest and Nature Conservation Act 1995, including Strict Nature Reserves, National Parks, and Wildlife Sanctuaries, as well as conservation corridors. There are nine protected areas, of which six are spread over the entire subalpine and alpine regions, putting most rangelands under stricter conservation measures. Almost all the rangelands used by yak herders fall within the protected areas. The protected area management principle restricts yak herders' access to the rangeland resources, making it difficult to optimize the economic returns from yak herding.

Rangeland productivity improvement

Prior to the advent of the Forest Act 1969, yak herders practised periodic controlled burning of rangelands to promote the growth of palatable fodder species and suppress the

unpalatable ones. The Forest Act 1969 and the Land Act 1979 prohibited this practice, as a result of which unpalatable species of juniper, rhododendron, and berries have increased reducing the production of palatable grasses (Gyamtsho 2002). The Pasture Policy 1985 was proposed in order to revive the practice of burning. It stipulated buying of rangeland use rights by the state from use rights holders who were no longer dependent on yak herding for their livelihood, and prescribed leasing of rangeland use rights only to those who depended on yak herding for a living. It envisaged promotion of high-yielding nutritious fodder species and improvement of management of leased rangelands to enhance rangeland productivity. However, the National Assembly only approved experimental implementation of the Pasture Policy to generate lessons, not its full scale implementation.

Under the experimental implementation of the Pasture Policy 1985, the state bought rangeland use rights from the royal family in two yak herding districts, Wangdue and Bumthang, in mid-1987. The rangeland use rights were for 3,088 ha of rangeland in Sephu subdistrict in Wangdue, and about 59 ha in Ura, 211 ha in Tang, and 914 ha in Chhoekhor subdistricts in Bumthang (Dorji 2013).

From mid-1987 to mid-1992, the state implemented the Pasture Policy 1985 under two projects – the Highland Livestock Development Project (HLDP) and the High-altitude Area Development Project (HAADP). The HLDP focused on pasture and nutrition improvement, breed improvement, animal health, milk collection and processing, meat processing, cooperative formation, and marketing. The only yak rearing subdistricts supported by the HLPD in the project area were Merak and Sakteng in Trashigang. The project supported setting up of pasture trail plots in the alpine meadows covering about 100 ha of rangelands to demonstrate the improvement in rangelands productivity through the introduction of exotic grasses such as cocksfoot, Italian rye, and lotus (Chophyel 2009). The author confirmed that trials were abandoned after the project wound up and the results of the experiments were inconclusive.

The HAADP focussed on high-altitude areas, which are by default yak rearing areas, and covered all four subdistricts in Bumthang, two northern subdistricts in Trongsa, and four subdistricts in Wangdue. Like the HLDP, the project focused on pasture and nutrition improvement, breed improvement, animal health, milk collection and processing, meat processing, cooperative formation, and marketing.

An analysis of the past livestock development plans of the government bears out the impression that policy support to develop rangeland resources is weak. The Pasture Policy 1985 has yet to be adopted. The Forest Act 1969 and the Forest and Nature Conservation Act 1995 banned the tradition of improvement of productivity of rangelands through burning and deprived yak herders of the opportunity to apply technological innovations to improve rangeland productivity. As a result, the condition of the rangelands has deteriorated because of invasion by juniper and rhododendron shrubs, lack of soil nutrient replenishment, and

Table 26: **Budget allocated to yak and rangeland development in national plans**

Five Year Plan (FYP)	Period	Total budget (million Nu[a])	Budget for yak and rangelands (million Nu[a])
First	1961–1966	1.50	Not available (NA)
Second	1966–1971	5.80	NA
Third	1971–1976	24.20	NA
Fourth	1976–1981	61.50	NA
Fifth	1981–1986	688.30	26.10
Sixth	1986–1991	331.00	122.60
Seventh	1991–1996	327.89	NA
Eighth	1996–2001	NA	NA
Ninth	2001–2006	NA	NA
Tenth	2006–2011	792.63	1.25
Eleventh	2011–2016	NA	NA

Source: Five Year Plans of the Government of Bhutan
[a] USD 1 = Nu 60.00 in 2015 (Nu = ngultrum, the unit of Bhutanese currency)

removal of dung for manuring crops and for fuel (Gyamtsho 2002). Table 26, although incomplete, gives an indication of the importance given to yak and rangeland development within the overall livestock development programme of the government.

Yak population and breed management

After the start of planned development in 1961, the then Department of Animal Husbandry was responsible for pursuing yak development activities in the country. The initial focus was on the control of yak disease, particularly gid, a tapeworm that caused the death of yak calves in the 1950s and 1960s. Over the next few decades, yak development schemes included managing rangelands, improving yak breeds, and interventions on product diversification and market linkages.

Traditionally, herders reared mixed herds of yak, cattle, sheep, and horses. Keeping mixed herds of livestock provided multiple products (food, clothing, transport, energy, and others) that are essential for basic sustenance. With the expansion of the network of motorable roads, use of horses has declined and there has been a significant reduction in the horse population. Similarly, the availability of cheap fashionable clothes in the market has led to a drastic decline in sheep kept for wool.

The Livestock Census 2008 gives the yak population as 48,400, 59% in the western districts of Haa, Paro, Thimphu, and Gasa; 16% in the central districts of Wangdue, Bumthang, and Trongsa; and 25% in the eastern districts of Lhuentse, Trashiyangtshe, and Trashigang. The government distributed two female yaks free of cost to each household that did not own yaks

during the Fifth and Seventh Five Year Plans, totalling more than 100 yaks (Gyamtsho 2002). Table 27 shows the yak population recorded by the Livestock Census in 2008 and 2013; it shows a significant decline in the yak population over the five years. In contrast, the Livestock Census data from 1986 to 2008 show a countrywide growth in the yak population by 39%, with a growth of 32% in the central region, 35% in the western region, and 62% in the eastern region (Derville 2010). The differences are attributed to the lack of an actual census; the reported yak populations are based on the herders' or owners' declaration and may not be reliable. The Livestock Census in 2000 estimated that 131 households in Katsho and Bjee villages in Haa were involved in yak herding and 62 households in Sephu in Wangdue District. A farmers' group discussion held in Haa confirmed that the number of yak rearing households is on the decline (Derville and Tenzin 2007).

Table 27: **Yak population 2008–2013 in different districts**

District	Yak population	
	2008	2013
Bumthang	3,984	2,974
Gasa	9,511	5,787
Haa	3,583	5,857
Lhuentse	454	234
Samdrup Jongkhar	NA	28
Paro	4,314	2,632
Thimphu	11,073	10,984
Trashigang	11,093	7153
Trashiyangtse	622	541
Trongsa	979	80
Wangdue	2,787	3,273
Total	**48,400**	**39,543**

Source: DOL 2013

The yak breeding system consists of pure line breeding in the western region, and crossing with cattle in the central and eastern regions (Winter and Tshewang 1989). The F1 female crossbreeds (zom) produced relatively more milk, while F1 males (zo) have good draught power capacity. While zom are fertile, zo are sterile, which creates difficulties in formulating a stable breeding programme (Win 1992). Regaining male fertility requires repeated back crossing for generations.

Two genetically different types of yak are said to be found in Bhutan – Hapa and Merak-Sakteng – (Dorji 2000), but Gyamtsho (2000) claimed that no investigation has been done to confirm these genetic differences. The government has implemented yak breed and health improvement policies aimed at improving yak productivity. The breed improvement involved mating yak with cattle to produce hybrids to improve milk production, draught power, and adaptation to wider ecological conditions. The most common method involves mating of yak cows with bulls of small Tibetan ox (*Bos taurus*).

The government has purchased and distributed breeding bulls since the 1970s. The herders also maintain private breeding bulls. The breeding bulls are selected based on the body size, colour, horns, body conformation, and temperament (Gyamtsho 2000). The breeding bulls are fed with feed concentrates such as mustard oil and oil cake at the end of each mating

season. The herders retain only the F1 generation in their herds as the productivity and quality of subsequent backcrosses decline. The government also supports the yak herders with an interdistrict yak bull exchange programme in order to avoid inbreeding in yak, and the Department of Livestock promotes the exchange of breeding bulls from one region to another. In some areas, crossing of yak with Brown Swiss cattle was promoted. Although these interventions will have reduced inbreeding in the population, there has not been any visible impact on milk or meat productivity. There is also no information available on the number and distribution of breeding bulls.

Artificial insemination with imported yak semen from China also had limited success due to the poor accessibility of yak areas (Tshering et al. 2000). Table 28 summarizes the information from the pilot artificial insemination (AI) programme. The conception rate was recorded as 30%. However, steep terrain made transportation and refilling of liquid nitrogen (LN2) and maintenance of the yak semen bank difficult. Since yaks are scattered during the breeding season, collecting female yaks in heat at one place was also difficult. Difficulties were also faced in separating off breeding bulls during and after AI. The learning from the pilot concluded that AI is not practical. There is still no systematic yak breed improvement scheme in Bhutan.

Yak health programme

Gid (*Multiceps multiceps*) used to be the most prevalent disease in yak in Bhutan causing high mortality rates (Samdrup 1992). About 70% of gid cases were reported in young animals one to two years old (Tenzin 1979). A gid eradication programme consisting of deworming yak calves with albendazole and fenbendazole and dogs with niclosamide was introduced with some success (Wangdi 1996). However, gid continues to persist across the yak rearing regions (Wangchuk and Wangdi 2015). The veterinary health care services are not able to reach out to the remote areas, and promotion of community-based animal health care workers has received little attention.

Table 28: **Results of artificial insemination (AI) piloting**

Year	Place	AI (No.)	Progeny record		Total
			Male	Female	
1990	Dagala (Thimphu)	16	5	1	6
	Ura (Bumthang)	40			
	Merak and Sakteng (Trashigang)	5	0	1	1
1996	Lingshi (Thimphu)	3	2	1	3
	Naro (Thimphu)	4	2	2	4
	Soi (Thimphu)	14	9	1	10
1997	Naro (Thimphu)	7			
2001	Merak and Sakteng (Trashigang)	17	1	3	4
Total		**106**	**19**	**9**	**28**

Most yak health issues are also related to inadequate feed and nutrition during winter. Dahl (2000) reported poisoning by plants as a major cause of yak mortality. Such disease conditions occur at the end of winter and onset of spring when grazing resources are scare. During these food deficient periods, animals consume plants such as *Senecio* species which contain the toxic pyrrolizidine alkaloid (Winter et al. 1994). Promotion of fodder conservation and supplementary feeding with feed blocks would help address this issue, but so far little progress has been made.

Animal health services are focused on dairy cattle and poultry production with sedentary communities, as there is a huge emphasis on replacing imported milk and eggs. There is a lack of a clear strategy for prevention and control of yak disease.

Product processing and marketing

Traditionally, the most important yak products, i.e. yak butter and hard cheese, were bartered with the downstream communities for red rice, maize, other cereals, and dried vegetables. High-value medicinal herbs, and shrubs such as incense materials, are also used to generate income in the highlands. Herders usually had a host family in the downstream valleys, and these helped in marketing the products. The host family system provided a strong social bond between the highland herders and the residents in the lower valleys and a unique platform for exchange of knowledge and experience between the upstream and downstream settlers in the landscape.

In recent times, imported rice and other essential food items have become easily available in the market. This has reduced the dependency of herders on barter trade, and the cash economy has become the norm. At the same time, the government's accelerated dairy development programme in the lower valleys has made the valley people less dependent on yak dairy products and has resulted in market competition for yak butter and cheese products (MOAF/RGOB 2014). Along with this change, the age-old system of the host family relationship between herders and valley residents has almost disappeared. Alternative options to diversify yak milk products into soft and hard cheese and improve the hygiene, quality, and packaging for the high-end tourism market are significantly changing the traditional business mode of the herding communities.

Yak products are produced at the household level by yak herding families scattered across the rangelands in the yak herding districts. No specific policy has been adopted to improve the efficiency of production, packaging, value addition, and marketing of dairy and meat products, and the extension and technological support rendered by the government as part of a socioeconomic development programme to improve production, product processing, value addition, storage, and marketing is limited, as shown by a review of government support for improving the efficiency of product production from yak. Improved technology has been supplied for churning milk to produce butter efficiently, but there is no evidence of support to improve the efficiency of cheese and cheese product production, and the conventional

practice for producing cottage cheese continues. To increase the shelf life, the cottage cheese is wrapped in a piece of cloth and the whey drained by placing it between two stones. This product, locally called telep, is consumed by the herders, and also processed further by cutting into small pieces, threading onto rings (called shey), and drying to form a product called chugho.

Yak meat is sought as a delicacy and is expensive, but there is no policy to develop yak meat production, possibly because Buddhism discourages animal slaughtering in general. The yak meat industry, as is the case with the meat industry in general, is not organized. There is no evidence of government support for setting up modern facilities for processing, packaging, fermenting, and marketing of yak meat. As a result, the traditional practice of slaughtering, processing, and fermenting predominates. Yak herders continue to arrange for manual slaughtering and processing of yak in the open. For fermenting, a whole yak leg is wrapped in a clean piece of cloth and kept hanging in a cold room for six months; it is then served in slices.

The yak rearing areas in general, particularly the summer pastures, have yet to be linked to urban markets through surface transport. There is no conscious policy to connect yak rearing areas and improve the integration of yak products into the urban market. As a result, a large part of the fresh yak produce does not reach the market; only about 40% of the 120 tonnes of yak butter produced annually is sold (Derville and Tenzin 2007), with the bulk of the butter being used for home consumption.

Marketing of yak meat is also not systematic or organized. Yak herders either sell live yaks, or arrange to slaughter them individually and sell the meat, fresh, dry, or fermented, to rural or urban consumers and hotels, besides keeping for their own consumption. Urban area buyers usually buy in bulk, dry, and store.

The traditional barter trade is on the decline. The traditional bartering system supported by rural agricultural communities is undergoing a transformation as more rural areas gain connectivity to the urban market. More and more traditional consumers of yak products are switching to the alternative dairy products that are available in the urban markets. There is also a growing view that concern about lifestyle diseases associated with modernization have reduced demand in urban areas. The situation is compounded by religious beliefs.

Discussion

Rangeland tenure: A mix of rights and responsibilities

Tenure is legally defined as relationship of people, as individuals or groups, to a property, as well as the relationship among them while dealing with the property. Tenure manifests as 'a bundle of rights' and brings a set of responsibilities to bear upon rights holders. Generally, the rights include the rights to use; the rights to appropriate return from the object, including

income; the right to change the form, substance, and location of the object; and the alienating rights. Tenure is termed as complete title when all four rights are guaranteed to the rights holder.

Tenure constitutes the basis for the nature of actions the rights holders can or cannot dispense in relationship to the property, as well as between or among the rights holders. Ideally, tenure must enable the rights holders to take actions that do not undermine the value of the property, including the value of the property to the other rights holders. Normally, the rights holders would readily safeguard and exercise their rights, but are often likely to deliberately overlook the responsibilities of maintaining the property as well as upholding the rights of other rights holders. Therefore, a system to administer and uphold the rights and administer and enforce the responsibilities is critical for the tenure to function.

Rangeland tenure on productivity

In Bhutan most of the rangelands used by yak herders fall within protected areas – national parks, wildlife sanctuaries, and strict nature reserves. The Forest and Nature Conservation Act 1995, which governs the management of protected areas, accords more importance to nature conservation than to enhancement of forage production capacity of rangelands to improve the economic status of yak herders. In other words, this legislation gives more weight to conservation of ecosystems for the habitat values of the alpine, subalpine, and temperate flora and fauna, as well as for upholding their hydrological functions. The legislation does not allow the use rights holders to take any action to improve forage production. Thus, the rangeland use rights holders are not only relieved of the responsibilities required for better stewardship of the rangeland resources, they are also deprived of opportunities to invest and improve the rangeland productivity and their economic status.

The Land Act 2007 has annulled the rangeland use rights arrangements legitimized by the Land Act 1979. In administering the rangeland tenure promulgated by the Land Act 2007, the state is required to buy the use rights from the rights holders – individuals, communities and institutions – and lease to those who depend on yak herding for their livelihoods. Unless the rangeland use rights granted under the Land Act 1979 are bought back and leased quickly and fairly to individuals, communities, and institutions, the use rights conflicts can escalate among the use rights holders and the open access to rangelands will intensify. As a result, in the short term, the rangeland ecosystems are bound to degrade, social harmony among the rights holders will be disrupted, the nature of local politics over rangeland resources will become divisive as conflicts among the use rights holders escalate, and quite likely the economy of yak herders will worsen.

As elsewhere, the rangelands in Bhutan are characterized by low productivity. The availability of fodder and water resources is determined by the climate, and utilization of the rangeland resources requires flexibility. Flexible utilization requires mobility of the yak herds, but rangeland use rights leased to individuals work against this. Although individual use rights are

desirable for better management of fodder resources, they make the utilization of rangeland resources less flexible, and enforcement entails high transaction costs associated with boundary delineation, registration, and administration (Banks 2003). Furthermore, the extent of rangeland is limited and leasing of individual use rights can pose a difficulty in equitable distribution of rights, while buying back and re-leasing rangeland use rights to the existing institutional use rights holders only leads to transactional costs and makes no economic sense. Most of the institutional rights holders no longer depend on yak herding for their income and supply of livestock products. Therefore, re-leasing the use rights to them will not lead to improved management of rangelands as intended by the Land Act, since these institutional rights holders will continue to engage individuals to carry out absentee herding of their yaks, as in the past. A further problem is that the rural communities holding the rangeland use rights under the land provision of the 2007 Act would not have the rights to mortgage the rangelands to borrow the financial capital required to improve productivity. Even if they could mortgage the rangelands over which they hold the use rights, and acquire the finance needed for improving productivity, the Forest and Nature Conservation Act 1995 will require amendment as in its present state it does not allow management of rangelands to improve forage production.

Rangeland use rights overlap and diverse interests

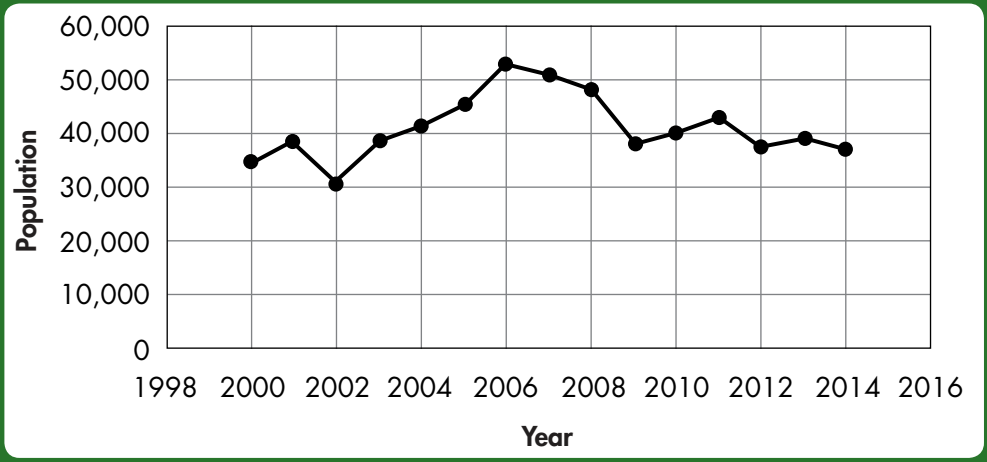
The rangelands used for winter grazing by yaks are also grazed by cattle in summer. A situation can arise where the use rights for the same rangeland is held by two different users – users owning cattle and users owning yaks. Resolving this issue will require careful political consideration so that the leasing of the use rights is based on the principle of equity and fairness. Furthermore, setting up a management system for the sustainable management of rangeland resources will demand innovative social and institutional mechanisms and capacity building both of the staff of government agencies and the use rights holders.

In addition, some of the rangelands, particularly in the winter grazing areas, are said to have been converted for community forestry and infrastructure building. The leasing of rangeland use rights will entail reconciling the interests of different interest groups.

Trends in yak population and yak herding

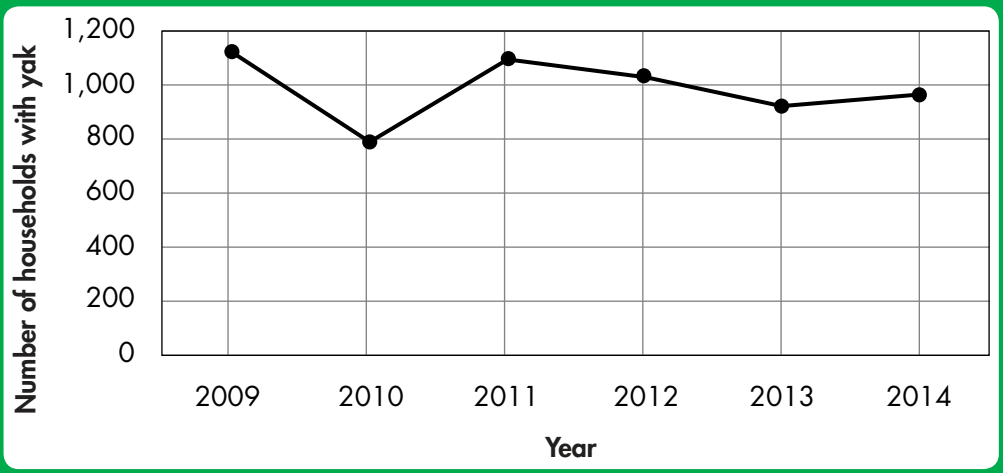
Poor accessibility and the existence of different herding arrangements makes it difficult to get an accurate yak census. Absentee yak owners such as monastic institutions engage herders as caretakers, and they would not usually reveal the exact population. Also, a livestock tax is levied based on population, and although low, this deters herders from giving true figures. Gyamtsho (2000) reported that the yak population may be underestimated by 25 to 30%. Analysis of the trends in the reported yak population over the last 14 years indicates a stable population of around 38,000 (Figure 28). Although there are reports of a decrease in the yak population due to the young generation of herders giving up yak herding and deriving more income from *cordyceps* collection, the current data do not support such statements. There

Figure 28: **Trends in the yak population**



Source: DOL 2013/14

Figure 29: **Trends in households rearing yaks**



Source: DoL 2013/14

appears to have been a reduction in the number of households rearing yaks, but this does not correspond to a decline in the yak population as the yaks are purchased and reared by neighbouring herders to maximize the economy of scale (Wangchuk and Wangdi 2015).

The Department of Livestock has attempted to monitor the number of households rearing yaks since 2009 (Figure 29). On average, 30 households per year over the past six years have ceased yak rearing. There may be inconsistencies in defining households that own yaks due to the existence of different ownership patterns, but the results provide a rough estimate and to

some extent validate general observations on the ground. Although there will be regional differences based on the dependence on yak, the number of yak herding families in Bhutan may reduce considerably over the coming decades if the trend continues.

Development support and yak production

In many yak herding settlements, motorable road networks have now shortened travel distances and enhanced the trade of yak and non-timber forest products. Changes have also been facilitated by the development of vital infrastructure including electricity, schools, and health and telecommunication facilities. In some areas, herders participate in community-based tourism.

The Department of Livestock has a dedicated programme for yak production in the 11th Five Year Plan, the Targeted Highland Development Programme. Its main indicator is to maintain a critical population of herders (1,039 families) and a yak population of around 40,100. The Department plans to institute a nodal agency to take responsibility for the highland programme, promote efficient management of rangelands and watersheds, and promote the use of alternative energy sources, ecotourism, and niche product development (MOAF/RGOB 2014).

Specifically, community mobilization of yak herders, capacity building initiatives, yak product value addition facilities, product processing and marketing support, establishing a nucleus yak breeding farm, and increasing yak health outposts are in the pipeline. Ongoing initiatives include development of improved pasture in winter grazing areas and scaling up of supplementary feed block initiatives (DOL 2013/14).

Conclusions and recommendations

Yak farming has to operate under harsh climatic conditions in remote mountain areas. Such farming is not an attractive option for the younger generation of herders, especially after they attain a certain level of education. As the younger generation of herders migrate to towns and cities in search of better opportunities, elderly people are increasingly being left in the landscape to tend to the yaks. As such, farm labour shortage is likely to become one of the biggest challenges in sustaining yak farming in the country. Appropriate policy measures and innovative strategies are required to address this issue.

Fair and equitable allocation of rangeland use rights and efficient administration of the use rights are of critical importance for the sustainable management of rangeland resources and institutionalization of a market-based yak production system. As such, there is an urgent need to resolve rangeland use rights and promote scientific management of rangeland resources to improve the economic efficiency of yak herders and sustainability of the rangeland ecosystems Unless the rangeland use rights are allocated adequately and fairly to yak herders, and they are empowered, capacitated, and given targeted support by the government to modernize

management of both the rangeland resources and yak product development and marketing, the number of households engaged in yak herding is likely to dwindle further which will accelerate the demise of yak herding.

The rangelands supporting the yak production system constitute an integral part of the national parks and protected areas network. Modernizing rangeland management as per the Land Act 2007 and development of market-oriented yak enterprise to optimize the economic returns from yak herding will require harmonization between the Forest and Nature Conservation Act 2005 and the Land Act 2007. Unless the Forest Act is revised, and the conservation and development interests in the protected areas balanced, scientific management of the rangelands and market-based development of the yak production system will be untenable. Promotion of a community-based yak-linked tourism value chain could offer a way forward as part of the effort to diversify the livelihoods of the yak herding communities and help the younger generation of herders meet their aspirations by modernizing their economic pursuits.

The annulment of the rangeland-related provision of the Land Act 1979 by the Land Act 2007 has led in practice to a disruption of the earlier rangeland tenure system and promoted open access to the rangeland resources. In some cases, conversion to community forests of forests used for grazing by the yak herders during winter, has led to conflicts between the yak herders and the owners of the community forests. Accelerated enforcement of the Land Act 2007 is necessary to arrest further degradation of the rangelands caused by the growing open access and to resolve the conflicts between yak herders and community forest users.

The Department of Livestock has been playing a lead role in implementing yak development activities. In recent times, the Department's main focus has shifted towards import substitution and it continues to invest its limited resources (both financial and human capital) in enhancing dairy, egg, and meat production with the sedentary communities around peri-urban and urban areas. Since yak farming has a geographical specificity in a difficult alpine landscape, it requires differentiated and focused development attention and approach. A dedicated institution or autonomous agency that is equipped with a multidisciplinary team (social scientist, ecologist, rangeland managers, and others) responsible for highland research and development will be crucial.

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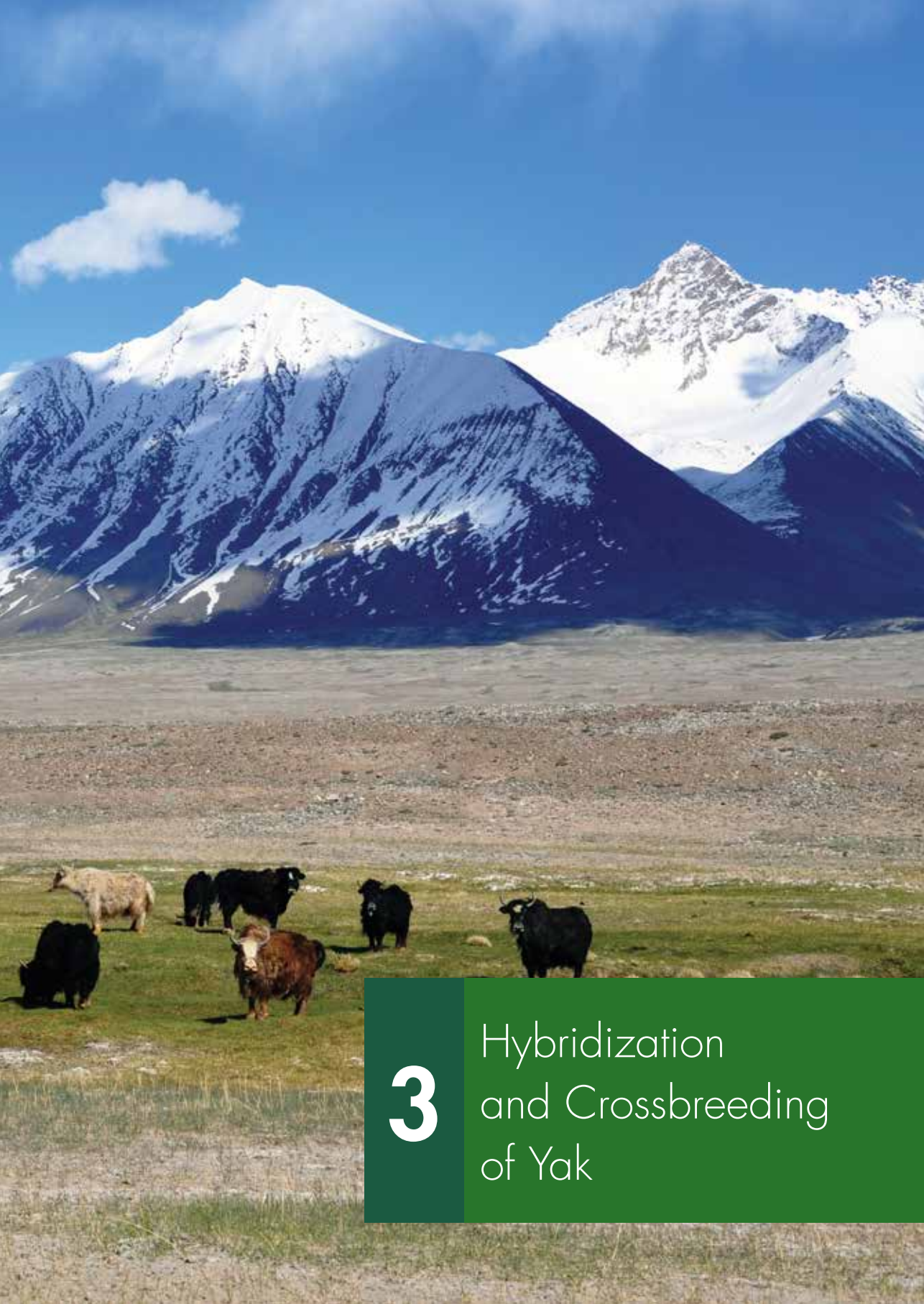

3 Hybridization and Crossbreeding of Yak

Indigenous Practices of Yak Breeding in Gilgit-Baltistan: Current status and future prospects for transboundary yak husbandry in the Karakoram-Pamir mountain area

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The Gilgit-Baltistan (GB) region of Pakistan, formerly known as the Northern Areas, has an estimated population of 25,000 yak and more than a 100,000 yak hybrids. Yak are kept in the highland pastures for their tractability, tolerance to the harsh climate, and high value products of meat, milk, butter, wool, hair, and hides. The Shigar, Shimshal, Chipurson, Misgar, Hisper, Hoper, Thalay, Phundar, Yasin, and Ishkoman valleys have significant numbers of yaks, while yak-cow hybrids dominate in the Baltistan area. There are seven main types of yak and local cow hybrids in Baltistan, which are more productive than pure yaks but still highly adapted to the harsh climate and thus the preferred livestock type. The communities living around the periphery of protected areas, i.e., Central Karakoram National Park (CKNP), Khunjerab National Park (KNP), Qurumber National Park (QNP), and Hundrap-Shandoor National Park (HSNP), largely depend on yak and their crossbreeds for their livelihoods and household income. Yak and yak-cow hybrids are used as draught animals for ploughing, threshing, and portering (transportation) in the agropastoral communities, whereas in the high-altitude cold deserts they are mainly valued for their animal products. Yak dung is the only available source of domestic energy and manure in the tree and fertilizer deficient highlands.

The population of yak and yak hybrids in GB has increased significantly over the past 15 years, but notwithstanding the good number and increasing demand for yak meat, milk, fleece, and hides in both China and Pakistan, yak husbandry has yet to become an economically viable activity. Yak husbandry can be transformed into a socially acceptable high-value, off-farm transborder agropastoral activity with ecological benefits by improving the productivity of yak and their crossbreeds, enhancing the forage productivity of pasture, and developing value chains for yak meat, wool, hair, and hides. Pakistan-China transborder cooperation for science, technology, and trade may offer a pathway for this. The upcoming Pak-China Economic Corridor Initiative could be a big stimulator for transboundary yak husbandry in the region.

Keywords: yak crossbreeds, economic corridor, Gilgit-Baltistan, Pakistan, yak husbandry, yak value chains

Introduction

Yak (*Bos grunniens*), a member of the Bovidae family, is a fascinating longhaired ox-like mammal, occurring mostly in the wild but also domesticated, originally by the ancient Qiang people in Tibet in the Eighth Century BC (Wiener et al. 2003). Wild yak inhabit alpine pastures at an elevation of 4,300–5,500 masl on the Tibetan Plateau in China. The yaks in the Karakoram-Hindu Kush Mountains of Pakistan are a domesticated breed and found at 2,000–5,000 masl in areas bordering China, India, and Afghanistan. The total world yak population is estimated to number around 14.2 million, with 13.3 million in China, about 0.6 million in Mongolia, and the remainder in other countries, mainly the Himalayan region and countries of the Commonwealth of Independent States, formerly the Soviet Union (Ceng and Chen 1980). In addition, hybridization of yak with cattle, most commonly with local cows, is widely practised in various parts of the world including China, India, Nepal, and Pakistan.

Yak is the largest and heaviest of all animals found in the Hindu Kush Himalayan (HKH) region and Pamir mountains. There are various local names for wild yak in the Gilgit-Baltistan (GB) region of Pakistan (formerly the Northern Areas): 'dong' in Baltistan, 'bapo' in the Gilgit and Astore areas, 'terminy' in Gojal, and 'bepai' by the Brusho people in Hunza-Nagar. None of the local dialects except Balti have specific words for yak-cow hybrids, even though yak herders in Baltistan have crossed their breeding male and female yak with domestic cows and ox since ancient times (Rasool et al. 2002).

Yak are seasonal breeders. The breeding season reaches its peak in July and August when temperatures are at their highest and grass growth is best. Yak oestrous decreases in frequency in November and then stops. Female calves born early in the year may show oestrous for the first time at 16–18 months; those born later do not show oestrous until they are more than two years old. The gestation period, around 258 days on average, is shorter than for *Bos taurus* cattle, particularly when a pure yak calf is carried. Female yak may live for more than 24 years in exceptional cases, but 15–16 years is the normal upper limit for reproduction. The peak reproductive ability generally lies between the five and nine years (Wiener et al. 2003).

The history of crossing yak with local cattle dates back 3,000 years (Jianlin et al. 2003). The genetic make-up of *B. grunniens* (60 chromosomes) is similar to that of *B. taurus* and *B. indicus* and their interbreeds. Yak-cattle hybridization produces fertile female and sterile male hybrids. Yak can also interbreed with bison (*Bison bison*) and wild ox, producing fertile female hybrids (Deakin et al. 1935) that are capable of producing further progeny and are often better in milk production than the pure yak.

In Pakistan, yak herding is confined to the alpine and subalpine areas of GB and Chitral. There are various estimates of the total number. Cai and Wiener (1995) estimated 25,000 pure yak and more than 100,000 yak-cow hybrids in GB and Chitral. Khan (1996) reported a total of 6,000 yak in 1996, mostly in the Khunjerab National Park (KNP) area along the Pakistan-China border in the country's extreme north; the Livestock Census counted 15,098 yak in GB in 1996 and 1998, with 9,311 females of which 7,015 were more than three years old (GoP, 1996, 1998). Skardu had the highest yak population (>7,045), followed by Ghanche (2,532), Ghizer (2,355), and Gilgit (1,982) (Hassan et al. 2007).

Yak rearing offers ample opportunity for socioeconomic development in various sectors of the economy ranging from food to tourism, and yak are highly valued among mountain people as a source of food, especially milk and milk products (Mody et al. 2015). However, yak have traditionally been kept in the high mountainous areas of Pakistan as strong, climate tolerant but low productive non-commercial animals. Despite the reasonably large number of yaks and yak-cow hybrids, and the increasing demand for their meat, wool, fleece, and hides, yak husbandry has never been an economically high return business in the area. This article attempts to unveil the hidden potential of yak husbandry in mountain areas, and the use of scientific management of yak populations and their grazing grounds to make it a socially acceptable, ecologically beneficial, and economically viable agro-pastoral enterprise for low-income mountain communities, both in Pakistan and in its neighbouring countries.

Materials and methods

Study area

Gilgit-Baltistan (GB) extends over 72,496 km^2 in the extreme north of Pakistan (77°41′20″ E and 35°27′24″ N to 72°30′26″E and 35°54′58″N) (Khan at el. 2004), with international

Figure 30: **Location of Gilgit-Baltistan and yak areas**

borders to the Xinjiang Uygur Autonomous Region of China, Wakhan Corridor of Afghanistan, and India (Figure 30). It contains an intricate system of great mountain ranges: the Himalayas, Hindu Kush, Karakoram, and Pamir meet at the Pamir Knot forming several valleys up and downstream on the Indus River (Baig 2001). The climate varies widely from monsoon-influenced moist temperate to arid and semi-arid cold desert. Below 3,000 masl, precipitation is less than 200 mm per annum. However, there is a sharp precipitation gradient with elevation, with annual snowfall of more than 2,000 mm water equivalent above 6,000 masl. Temperatures in the lower parts of the valleys vary from extreme hot (>40°C) in summer to below freezing (<-10°C) during winter. Only 2% of the total land is arable and <5% is under forest. Vegetation is classified into four distinctive zones: Mountain Sub-Tropical Scrub Forest, Mountain Dry Temperate Coniferous Forest, Mountain Dry Temperate Broadleaved Forest, and Northern Dry Scrub Forest, each with characteristic biota (Khan et al. 2014). The area is home to more than a million people belonging to five major and three minor ethnic groups, and dependent on subsistence mountain agriculture and livestock herding for their livelihoods. Transhumant yak herding is a major source of livelihoods at higher elevations (Khan et al. 2014).

Data collection and analysis

Basic data on livestock population, herd size, herd composition, and trends were acquired from the livestock census reports of the Government of Gilgit Baltistan (GOGB) and FAO (Khan 2013). Plant biomass estimates were taken from field studies (Bari 2001; WWF-Pakistan 2013). Key statistics on agriculture, rangelands, and pastures were estimated using an OBIA technique with ERDAS satellite images in ArcGIS 9.2 (Qamar et al. 2008; Barjracharya et al. 2009) and the results analysed using MS Excel 2007 (Stanford University 2002).

Results

Livestock husbandry as an important mountain livelihood strategy

Owing to the limited amount of cultivable land (<2%, 72,496 km^2), livestock herding is one of the most important sources of livelihoods for more than 90% of the population in rural areas of the region, providing 35–40% of household income and second only to low yield subsistence mountain farming. Currently, there are more than two million head of livestock in GB including both small and large ruminants (Table 29). Livestock are crucial for the local economy as well as the region's food security, with domestic animals kept for multiple purposes including milk, meat, manure, wool, hair, and hides, and as a movable capital asset for prestige and honour, as well as an insurance or endowment for use on occasions of celebration and sorrow.

Animal population and trends

The number of domestic livestock in Gilgit-Baltistan increased between 1996 and 2006 from a total of 1.5 to 1.9 million (Table 30). The number of yak and yak-cow hybrids increased only slowly during this period, from 15,000 to 16,000, but has significantly increased since then to an estimated 25,000 in 2013.

Table 29: **Estimated total animal population in Gilgit-Baltistan (2006)**

District	Cattle	Pure yak	Buffalo	Sheep	Goats	Camels	Horses	Mules	Asses	Total
Gilgit	123,457	1,982	304	168,024	311,657	89	107	24	7,642	613,286
Ghizer	59,609	2,455	95	47,145	76,827	33	516	38	3,487	190,205
Diamer	83,449	1,100	1,705	45,415	195,148	30	1,545	187	8,151	336,730
Skardu	121,257	7,045	145	168,433	244,268	20	695	228	869	542,960
Ghanche	47,079	3,732	14	75,138	92,921	14	2,234	537	989	222,658
Total	**434,851**	**16,314**	**2,263**	**504,155**	**920,821**	**186**	**5,097**	**1,014**	**21,138**	**1,905,839**

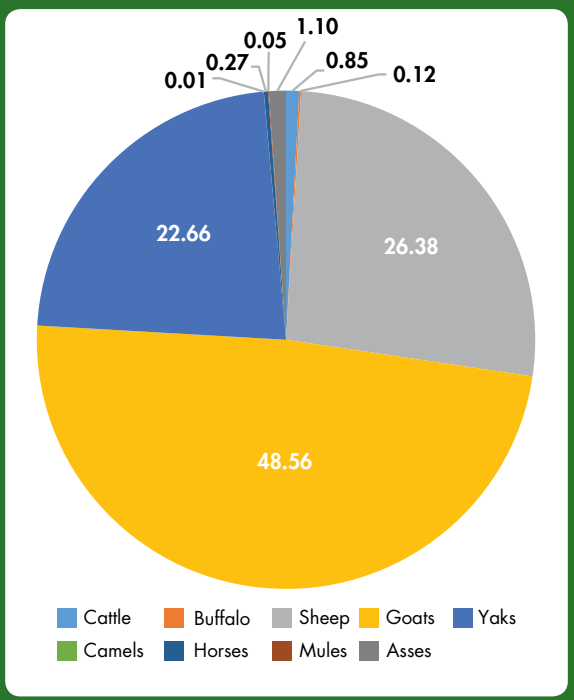
Source: GOGB cited in Khan 2013

Table 30: **Livestock numbers and trends in Gilgit-Baltistan (1996–2006)**

Species	Number of animals (millions)		
	1996	2006	± % (1996–2006)
Cattle	0.315	0.435	38
Buffalo	0.001	0.002	260
Sheep	0.458	0.506	10
Goat	0.698	0.932	34
Yak	0.015	0.016	9
Camel	0.000	0.000	32
Horses	0.004	0.005	19
Mules	0.001	0.001	56
Asses	0.015	0.021	39
Total	**1.507**	**1.919**	**27**

Source: GOP 1998; GOGB cited in Khan 2013

Figure 31: **Herd composition in Gilgit-Baltistan**



Source: GOGB cited in Khan 2013

Herd size and composition

Close to 90% of households in the rural areas of GB maintain a sizeable number of livestock (three to eight animals) in different combinations as part of their subsistence livelihood strategy. Cattle, goats, sheep, yaks, and draught animals generally establish the household economy and pasture grazing patterns. Figure 31 shows the average composition of livestock herds in GB, with goats the most popular animal (49%), followed by sheep (26%) and cattle (23%). The number of animals kept by a household is closely linked to the availability of land, water, and labour, and accessibility and productivity of grazing land (Khan 2013).

Plant biomass production for yak husbandry

More than 32% of the total area of GB is under pastures and rangelands; these are vast but with the exception of a few alpine pastures generally have low productivity (Table 31). Trials have demonstrated that most of the rangelands could produce significantly more biomass than at present (>1.5 t ha^{-1} from 0.2–0.5 t ha^{-1}). Although diminishing steadily, the snow-capped peaks and glaciers could also be tapped to irrigate barren land to produce food for humans and fodder for animals. Educated youth form more than 42% of the local population (AKRSP 2015) and could be instrumental in transforming traditional animal herding into a modern transborder high return yak farming industry.

Table 31: **Biomass production in HKH pastures and rangelands in GB**

Rangeland	Area (million ha)	Current production		Potential	
		DM	Total DM	DM	Total DM
		t ha^{-1}	t	t ha^{-1}	t
Alpine pastures	1.68	1.5	2.25	2.5	4.2
Trans-Himalayan grasslands	3.5	0.6	2.1	2	7
Himalayan forest grazing lands	0.67	0.6	0.4	3	2.01

DM = dry matter
Source: Khan 2013

Yak production characteristics

Yak milk has a high content of solids (18.5%) and fat (7%). The lactation period is generally five to seven months although calves may suckle milk for up to a year, but yaks are poor milking animals and the herders expect to get only 1–2 litres of milk daily (Muhammad 2003). Often, farmers only get milk from yakmo (female yak) for about 48 days when they are grazed in the winter grazing areas called rangas near to the village (Hassan et al. 2007) (Table 32).

Table 32: **Average productivity from yaks and yak hybrids in Gilgit-Baltistan**

Breed[a]	Milk (kg day^{-1})	Lactation (months)	Reproduction (young $year^{-1}$)	Hair (kg $animal^{-1}$)	Ghee (kg $animal^{-1}$)	Manure (kg $animal^{-1}$ $year^{-1}$)
Zomo	3.05	7.70	1.93	–	53.03	3.46
Yakmo	1.62	1.61	1.83	3.30	–	1.71
Zoo	–	–	–	–	–	3.21
Yak	–	–	–	1.70	–	1.31

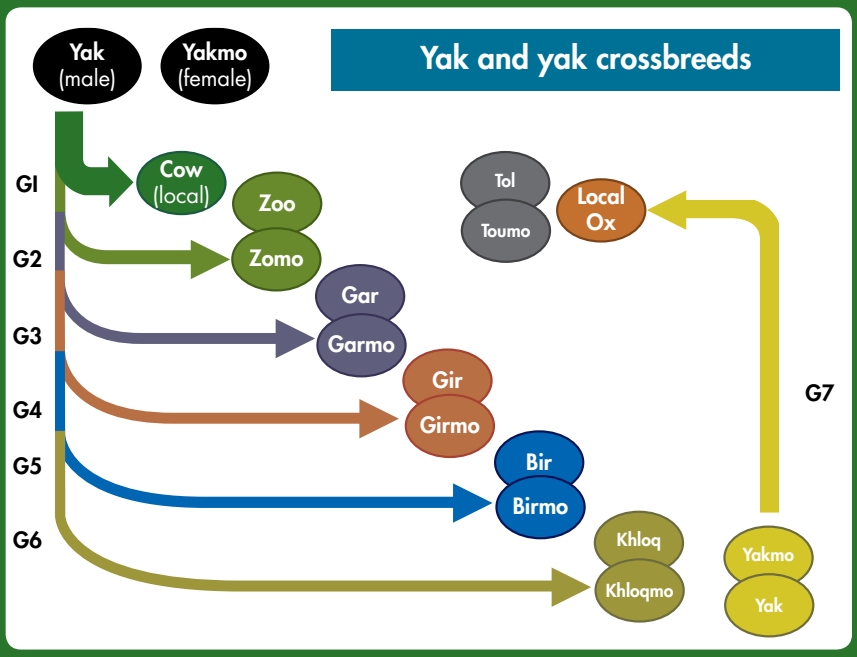
[a] zoo/zomo = male and female first generation offspring of yak-cow cross
Source: Hassan et al. 2007

Yak-cow hybridization

Traditionally, yak herders in Baltistan, have backcrossed their yak with local cows, especially in the high-altitude valleys where one or two male yaks were kept in the herd for this purpose. Systematic crossing and backcrossing of yak with local cows (spp. yet to be determined) was first introduced among highlanders of Baltistan by the Aga Khan Rural Support Programme (AKRSP) and Gilgit-Baltistan Livestock and Dairy Development Department (GBLDD) in the early 1990s to cater for the emerging demand for meat, milk, milk products, hair, wool, and hides in the local market.

So far, seven hybrid generations of sterile males and fertile females have been produced by backcrossing the fertile female offspring in each generation with male yak (Figure 32). They have good milk and meat productivity and are also much better adapted to the high elevation, harsh climatic conditions, and forage scarcity in the area than the local breeds of cattle and water buffalo brought in from down country (Kreutzman 2000a,b).

Figure 32: **Yak-cow crossbreeding programme in Gilgit-Baltistan**

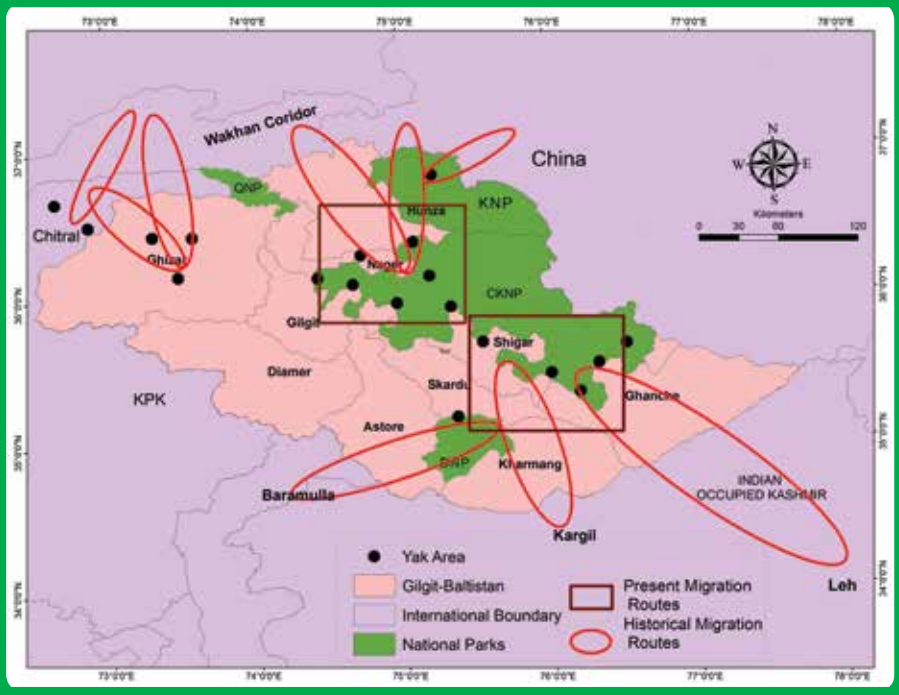


Transborder yak husbandry

Yak herding as an ancient and integral part of the agropastoral transhumance system is an important livelihood strategy and a prominent factor in the social systems of the HKH and Pamir highlanders in GB. Yak is the only (pseudo) domestic animal capable of surviving under the extreme climatic conditions in these mountains and has been used to cross the high-mountain passes for trade and economy for centuries. Although some of the ancient passes are no longer operational due to security and other reasons, yak are still used as key draught animals in barter trade, exchange, and trekking across the trans-Karakoram, Hindu Kush, Pamir, and Tian Shan mountain passes (Figure 33).

The Karakoram-Pamir mountain areas have a great expanse of pasture with a high potential for rearing a larger number of highly productive yaks and yak-hybrids to meet the increasing demand for yak meat, fleece, and hides in China, Pakistan, and neighbouring central Asian states. Yak husbandry in these areas can become a socially acceptable, ecologically feasible, and economically viable enterprise for local people through appropriate scientific management. The upcoming Pak-China Economic Corridor Initiative can be a big stimulator for the promotion of transborder yak husbandry as an option for economic development in the Karakoram-Pamir Mountain region (Figure 34).

Figure 33: **Historical migration routes in HKH mountain area, some still (partially) in use**



Courtesy: WWF-Pakistan 2015

Figure 34: **Proposed China-Pakistan Economic Corridor Initiative**

Discussion

The Karakoram-Pamir mountain area lies along the border between China and Pakistan. It has a unique agroecological and geostrategic position, and is historically well known for its vast meadows, trekking routes, and high passes which have been used by invaders, traders, and pastoralists. Domestic herds have been grazed across the high mountains of Asia, and yak have been a reliable source of travel and transportation. The central Asian high mountains, centred around the Qinghai Tibetan Plateau, still have the world's largest population of yaks (>14 million) which constitute an important animal genetic resource as well as providing an important livelihood strategy for pastoralists and agro-pastoralists in the region (Zhang 2000; Wiener et al. 2003).

Although there is no recorded evidence available confirming the existence of wild yaks in Pakistan, nevertheless, a herd of 50+ feral yak is known to have existed in Ghizer valley, west of Gilgit town (Rasool et al. 2002). There are also quite a few pure breeds of domesticated yak in Gojal valley in Hunza, and the Ishkoman, Nagar, Haramosh, Gupis, Phundar, and Yasin valleys, where crossbreeding of yak with local cow is not yet common (Khan 1996).

Yak hybridization is common in the high-altitude valleys in Skardu and Ghanche districts. Hybridization evolved here in response to the low productivity, high fodder consumption, and poor adaptability of local cattle breeds to higher elevations, which were not appropriate for the barren mountain landscapes and harsh climate. The yak-cow hybrids have a higher economic value and many different hybrid types have been produced (Farman and Tetlay 1991; Muhammad 2003). The quality of meat from locally raised yak-cow hybrids is far better than the poor quality meat from water buffalo transported from down-country Pakistan (Kreutzmann 2000b), and yak/yak hybrid numbers appear to be increasing in the region (Kreutzmann 2000a; Khan 2013).

During times of pressure, yak play an important role in the domestic and local economy, especially in the high mountain regions where livestock herders face many threats including drought, epidemic disease, and other climatic stresses. Yaks provide a certain safety factor as they are the best animals for utilizing the marginal pastures in remote mountain areas. There are further spin-off benefits in the form of different enterprises such as processing of yak milk and hair, and yak herding complements the combined approach to mountain agriculture as a part of a multi-faceted survival strategy in the stressful high-altitude environment.

Despite its tremendous potential, yak husbandry in the mountain areas of GB and the surrounding regions is constrained by depleting pastures, the declining interest of pastoralists, habitat fragmentation, forage scarcity, lack of market centres, increasing competition with wild herbivores for food, higher animal mortality, and increasing human-carnivore conflicts, particularly in protected areas and their surroundings, and above all there is a lack of appropriate value chains for the range of yak products. The newly proposed China-Pakistan Economic Corridor Initiative can help connect the fragmented habitats and divided

communities, possibly through a transboundary yak husbandry programme for sustainable development in the border area between China and Pakistan.

Conclusion

Traditional yak herding by highlanders has a great potential to be transformed into a socially acceptable, ecologically beneficial, and economically viable high-value off-farm transborder agropastoral activity for low income communities in the Karakoram-Pamir mountain areas. This potential can be achieved by improving the productivity of yaks and their cross-breeds, enhancing the forage productivity of pasture, and developing value chains for yak organic meat, yak pashmina, and yak wool/hair products. Pakistan-China transborder cooperation on science, technology, natural resource management, and trade in yak value chains and associated sub-value chains could contribute to this. The ICIMOD-led Karakoram-Pamir and Wakhan Corridor landscape initiatives may like to harness such emerging opportunities to benefit local and national economies, while increasing resilience through ecosystem management and livelihood improvement for local communities in the Karakoram-Pamir mountain area.

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Advances in Yak Molecular Biology Technologies

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Yaks are irreplaceable livestock in the alpine grassland ecosystem. With the rapid development of the life sciences, molecular biology technologies have been widely applied in yak breeding research. In this paper, we summarize the yak genomics, molecular genetic diversity, and candidate genes for economic traits identified in recent years, discuss the existing problems in current research related to yak molecular breeding, and propose future directions for scientific research.

Keyword: breeding, genetic diversity, molecular biology technologies, yak

Introduction

Yak (*Bos grunniens*) is mainly distributed in the Qinghai-Tibetan Plateau and adjacent areas at elevations above 2,000 masl. Yak are known as the 'universal animal' for their ability to provide milk, meat, wool, labour, fuel, and other products for the local herders (Wiener et al. 2003). There are around 14 million domestic yaks and 15 000 wild yaks in the world, of which China has the largest population and most diverse varieties (Wiener et al. 2003). With recent developments in molecular biology techniques, many innovative technologies have been used to study the molecular breeding of yak over recent years. In this article, we review the advances of genomics, taxonomy, and molecular marker-assisted selection in the field of molecular breeding of yaks. This can be helpful to provide an innovative approach for crossborder cooperation in yak breeding among yak-raising countries.

Yak genomics

With the deepening of the animal genome project, many domestic animal genome sequences such as cattle, pigs, chicken, and dogs have already been completed and published, whereas the genome project of yak started relatively late. Qiu et al. (2012) constructed a genome sequence map for yak and successfully predicted 22,282 protein-coding genes, detected 2.2 million single nucleotide polymorphisms (SNP) loci in the yak genome, and found 100 unique gene families for yak. Wang et al. (2014) re-sequenced the genome of three domestic and wild yaks and found 8.38 million SNPs (7.14 million novel), 383,241 insertion-deletion mutations, and 126,352 structural variations. The linkage disequilibrium analysis found that the linkage of disequilibrium degree of domestic yak was higher than for wild yak. A yak genome database offering information such as genomic data, and gene and protein functions

was constructed by Hu et al. (2012). Constant update of this yak genomic data will promote research of yak population genetics and molecular breeding.

Molecular genetic diversity of yak

Random amplified polymorphic DNA (RAPD), amplified fragment length polymorphism (AFLP), sequence-related amplified polymorphism (SRAP), and simple sequence repeat (SSR) technology have been used to assess the genetic diversity of yak. Wei et al. (1999) and Wang et al. (2002) studied some RAPD and AFLP markers in yaks. Zhong et al. (2006) used RAPD and AFLP markers to analyse the genetic diversities of different breeds of yak, including Jiulong, Maiwa, Datong, and Tianzhu White Yak. The genetic distance between the Datong and Tianzhu White Yak was the smallest, and that between the Jiulong and Maiwa breed was the largest. These four yak breeds were clustered into two groups with the Jiulong yak as one group, and the other three yak breeds in the other. Ramesha et al. (2011) used RAPD markers to analyse the genetic diversity of three Indian yak populations; the results showed no significant difference among the three types. Ritz et al. (2000) used 20 SSR markers to analyse the ethnic phylogenetic of 17 representative bovine groups; their results showed that cattle and zebu could be clustered into one group, followed by yak, gayal, bison, and buffalo together. Hu (2001) analysed nine SSR loci in Gannan, Datong, and Tianzhu White Yak and demonstrated that both the domestic and wild yaks have abundant genetic diversity. The Y chromosome of animals is the ideal marker to study paternal genetic diversity and paternal origin because of its complete haplotypes, low mutation rate, and insusceptibility to the effects of recombination and mutations (Yindee et al. 2010). Edwards et al. (2000) found mark INRA126 Y chromosome-specific SSR markers in yak. Han et al. (2000) detected three cattle Y chromosome-specific SSR markers (INRA12, BM861, and INRA189) in one Bhutanese yak group and four Chinese yak groups. Li et al. (2014) found six novel SNPs on Y chromosome that combined three kinds of haplotypes (YH1, YH2, and YH3), of which the YH1 haplotype was dominant in the yak population.

The mitochondrial genome of animals, with its high evolution rate, high polymorphism, and maternal inheritance, is considered to be an ideal molecular marker to study the origin and evolution of animals, classification, and population genetic diversity. Tu et al. (1998) found six restriction fragment length polymorphisms which combined five kinds of mitochondrial DNA (mtDNA) haplotypes in five Chinese yak populations. Li et al. (2008) studied the taxonomic status of yak based on the mtDNA D-loop region and concluded that domestic yak, wild yak, and bison could be clustered into one group with the closest relationship. Guo et al. (2006a, 2006b, 2008) analysed a partial sequence in the mtDNA D-loop region of ten Chinese domestic breeds and one wild yak population, and found that both domestic and wild yak had rich genetic diversity. There were two clusters which had significant genetic differentiation in Chinese domestic yak groups. The divergence between yak and bison may have occurred in Eurasia (Guo et al. 2006b). Wang et al. (2010) systematically analysed the D-loop region of domestic and wild yaks and found that the nucleotide diversity in wild yaks is higher than that of domestic ones. The divergences in the three lineages may have occurred around

420,000 and 580,000 years ago, consistent with the geological records of two large glaciation events experienced in the Qinghai-Tibet Plateau.

Studies on candidate genes for economic traits

Traits in coat colour

There are four main kinds of coat colour in yaks: black, brown, white, and white spotted. Several researchers have identified candidate genes affecting coat colour in animals such as the *Melanocortin 1 receptor (MC1R), premelanosome protein (PEML), v-kit Hardy-Zuckerman 4 feline sarcoma viral oncogene homolog (KIT)*, and others (Hoekstra et al. 2006; Durkin et al. 2012; Clark et al. 2006). Chen et al. (2009) cloned the *MC1R* gene containing an open reading frame of 954 nucleotides and found five SNPs in the coding region. Several studies identified 13 SNPs in the *MC1R* gene of eight domestic yak breeds (Tang et al. 2011; Gao et al. 2012; Chen et al. 2014). Zhang et al. (2014) found that the brown coat colour of yak was caused by mutations of *MC1R* and PMEL, the white and white spotted resulted from serial translocations of *KIT*. The white-faced coat colour is strongly associated with the *KIT* haplotype S^{wf}. The causal mutations found in *KIT* from domestic yaks are also reported in cattle, indicating the genetic origins of white spotting from cattle/yak crossbreeding.

Polled trait

Polled yaks are easy to manage and can help avoid economic losses due to accidental injuries. Therefore, raising polled yaks can further increase economic income on the basis of maintaining important production traits. In recent decades, several research groups have mapped the polled locus to the centromeric region of chromosome 1 (BTA1) in most European cattle breeds (Allais-Bonnet et al. 2013; Glatzer et al. 2013). Liu et al. (2014) mapped the Datong yak Polled locus to a 147-kb interval including three protein-coding genes *C1H21orf62, GC-rich sequence DNA-binding factor 1 (GCFC1) and synaptojanin 1 (SYNJ1)*. Wiedemar et al. (2014) reported that polled yak from Switzerland do not carry the polled variants which have been reported in cattle. This indicates the presence of an independent polled mutation in yak.

Growth traits

Most of the candidate genes for growth traits are involved in the development of muscle and differentiation of muscle fibre. *Growth hormone (GH)* is the candidate gene for body weight in bovine, playing a crucial role in growth regulation. Zhang (2008) found SNPs of *GH* were associated with body weight and body length of yak. *Insulin-like growth factors (IGFs)* are growth factors involved in the growth and development of mammals. Yao (2008) and Wang et al. (2009) found that *IGF-I* and *IGF-II* had a significant effect on the growth traits of yak. *Myostatin (MSTN)* could prevent myoblast differentiation and the development of skeletal muscle, which was regulated by *myogenic differentiation (MyoD)*. Liang et al. (2011) found that SNP located in intron Ⅱ of *MSTN* significantly affects the body weight of yak. *Growth*

differentiation factor 10 (GDF-10) gene, related to bone morphogenetics, is a genetic marker for the growth traits of yak (Li et al. 2014).

Carcass and meat quality traits

The candidate genes for carcass and meat quality traits are mainly involved in the process of fatty acid metabolism and protein synthesis. Kuang et al. (2010) cloned the *fatty acid binding protein 4 (A-FABP)* of *Maiwa* yak, which encodes 132 amino acids. Meanwhile, *A-FABP* mRNA was detected in fat, skeletal muscle, heart, liver, kidney and spleen tissues, respectively. Cao (2012) found that *A-FABP* significantly affected the carcass weight and tenderness, while *fatty acid binding protein 3 (H-FABP)* was associated with cooked meat percentage and eye muscle area. Jiao (2012) found that the SNP in intron Ⅲ of the *protein kinase, AMP-activated, gamma 3 non-catalytic subunit (PRKAG3)* gene has a significant effect on drip loss and PH24. *Fatty acid synthase (FASN)* plays a role in the metabolism of lipids. It has been reported that *FASN* gene of yak was associated with intramuscular fat content, drip loss, and cooked meat percentage. Qin et al. (2014) found that *FASN* mRNA expressed higher in *longissimus* muscle of yak than those in cattle. *Calpain 1 (CAPN1)* and *calpastatin (CAST)* are considered as candidate genes for meat tenderness in farm animals. Yao et al. (2014) found that *CAPN1* expressed the highest level in the eye muscle. Wu (2010) found that *CAPN1* was significantly associated with shear force and drip loss of yak meat. Wang (2010) identified SNPs in the *CAST* gene which has a significant effect on shear force, drip loss, and water content.

Reproductive traits

Wang et al. (2012) identified polymorphism of the 5′ flank region and exon Ⅰ of the *follicle stimulating hormone receptor (FSHR)* gene in four yak breeds. There was no correlation between calving interval and the different genotypes. With the development of high throughput sequencing technology, RNA-Seq has been widely used in the identification of novel genes. Lan et al. (2014a, b) used RNA-Seq to analyse the transcriptome of yak ovary and MⅡ oocytes. The results will provide useful information to identify candidate genes for reproductive traits of yak.

Immune traits

A 23-bp deletion (D23) in the promoter and a 12-bp deletion (D12) in intron Ⅰ of the bovine *prion protein (PRNP)* were significantly associated with susceptibility to bovine spongiform encephalopathy. Zhao et al. (2009) found that haplotype frequency of D23–D12 was very low in the Chinese yak population. The *major histocompatibility complex (MHC)* is a cohort of closely clustered genes which play crucial roles in combating infectious diseases and determining antigen in vertebrates. Sun et al. (2014) found that *MHC-DRA* of yak and cattle-yak had high homology with that of buffalo. He et al. (2014) found that *MHC-DQB* of yak exhibited a high degree of nucleotide polymorphism and the exon Ⅱ suffered positive selection.

Altitude hypoxia adaptation mechanisms of yak

Owing to its adaptation to high-altitude environments and its high level of endurance for hard work, yak is a model animal for understanding the molecular basis of adaptation to high-altitude hypoxia. Studies in the singular adaptability of yaks are one of the present hot spots. The β chain of yak haemoglobin is different to that of most mammals, with alanine at position 135 (H13) replaced by valine. The changed structure can increase the oxygen affinity (Weber et al. 1988). Qiu et al. (2012) identified 85 positively selected genes involved in hypoxia response and energy metabolism in yaks. The hypoxia-inducible factor pathway plays an important role in response to hypoxia. Wang et al. (2006) found that hypoxia-inducible factor-*1a* (*HIF-1a*) mRNA expressed the highest level in the testis and HIF-1a protein expressed highly in the brain, spleen, and kidney of domestic yak. Wu (2012) found that expression of *endothelial PAS domain protein 1* (*EPAS1*) mRNA was higher in lung and liver of cattle living in highlands than in yaks. This shows that the physiological regulation of the hypoxic environment when cattle enter the plateau mainly occurs in the lung and liver. Mitochondria provide energy for various life activities and keep the body temperature constant. Wang et al. (2011) found that there is a remarkable increase in threonine (Thr) residue in the transmembrane regions of yak mitochondrial proteins. The increasing Thr may enhance the efficiency of oxygen utilization and oxidative phosphorylation.

Sterility of male hybrid between cattle and yak

Dzo (male) and dzomo (female), or pianniu in Chinese, is the first generation hybrid between cattle and yak. The hybrid has greater milk and meat production capabilities, but the F1 male hybrid (dzo) cannot produce sperm, which prevents the heterosis from being inherited. The inability of dzo to produce sperm has become a major problem in the crossbreeding of yak, but the molecular mechanism for male hybrid sterility is not clear. Many studies have focused on the genes involved in meiosis and sperm formation. *Sycp2*, *b-FKBP6*, *DMRT7*, and *Dmc1* are essential to the formation of the synaptonemal complex. Some studies found that the four genes expressed lower in testis of dzo than those in cattle and/or yak (Li et al. 2013; Luo et al. 2013; Li et al. 2010; Yan et al. 2014). Expression of *DAZL*, *PIWIL1*, *b-Boule*, and *bSYCP3* was different in testis of dzo cattle, and yak. There was a negative correlation between methylation levels and mRNA expression, indicating that the process of spermatogenesis might be regulated by DNA methylation (Wang et al. 2012; Gu et al. 2013; Liu et al. 2011; Li et al. 2011). Zeng et al. (2014) found that there were 17,784 and 18,529 genes expressed in the testis of dzo and yak, respectively. The genes involved in testosterone synthesis and apoptosis are up-regulated in the testis of dzo.

Conclusion

Rapidly developing molecular biotechnologies have been widely used in the research of yak genetics and breeding and have achieved great progress. The acquired molecular genetic characteristics and identification of genes related to economic traits have laid a solid

foundation for the genetic improvement of yak. However, there are still some challenges that require further studies. Firstly, the annotation information for genes and proteins is incomplete and more resequencing work is needed to further describe the yak genome structure. Meanwhile, it is essential to establish a map of gene-expression, miRNA, protein, and DNA methylation, which will provide a useful tool for yak functional genomics. Secondly, most of the studies on genetic diversity and functional genes have focused on a handful of yak breeds. It is necessary to construct a pan-genome in the future, which will be of high academic value for understanding the origin and evolution of yak, as well as for further protection and utilization of yak genetic resources. Integrating the genome information is an efficient way to identify the genes, regulating factors, and proteins related to economic traits which lay the foundation for the molecular design of yak breeding. Thirdly, some genes related to economic traits have been identified, however, their expression pattern, regulation mechanism, and function have not been experimentally validated. It is essential to establish cell lines of the various tissues and probe them in future studies to identify the gene expression pattern and function in cell lines and model organisMs These will provide the theoretical basis for unravelling the molecular mechanism of the economic traits of yak and achieving transgenic breeding. Furthermore, the traditional path followed for yak breeding in the yak raising countries in the Hindu Kush Himalayan region is to introduce yak bulls from the Qinghai-Tibetan Plateau. But this is not always feasible due to the physical inaccessibility and geopolitical restrictions. The molecular biology techniques undoubtedly open a new potential window for transboundary cooperation in yak breeding that will ultimately benefit the local communities in the high mountains.

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The Production and Utilization of Yak in China

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Yak (Bos grunniens) is one of the world's most remarkable domestic animals and is regarded worldwide as an iconic symbol of the Tibetan Plateau and neighbouring high-altitude areas. Yak provide meat, milk, and wool as a major subsistence livelihood and financial income for local herders. Moreover, yak husbandry is integrally bound to the culture, religion, and social life of the herders, their families, and their communities. Better opportunities for marketing yak and yak products and growing aspirations of herders encourage increased production and technological inputs to assist yak keeping. Moreover, the techniques of molecular genetics have been used widely to explore the potential of yak heredity and to improve yak productivity. A move from traditional to modern practices, however, can create tensions and problems if these modern practices are not sensitively integrated with the vast, accumulated knowledge and experience of the herders. This paper emphasizes a systematic yak breeding scheme involving pure-bred breeding, hybridization, and crossbreeding of wild yak with domestic yak in a process of breed development and production performance improvement. We also elaborate the current situation, future prospects, and major limiting factors in the comprehensive development and utilization of yak products in China.

Keywords: yak, production, products, pastoral development

Introduction

Yak (*Bos grunniens*) and cattle (*Bos taurus*) separated about 4.4 to 5.3 million years ago (Gu et al. 2007). While cattle have a worldwide distribution in most lowland areas, yak have dominated high-altitude lands, especially around the Hindu Kush Himalayan region, including the Qinghai-Tibetan Plateau (QTP), at elevations ranging from 3,000 to 5,500 masl. Yak are particularly common in the vast rangelands of the six provinces in western China: Tibet Autonomous Region (TAR), Qinghai Province, Sichuan Province, Gansu Province, Xinjiang Uygur Autonomous Region, and Yunnan Province. The yak evolved on the QTP, which extends over about 2.5 million km^2 and is often called the 'Roof of the World'. At present, the total yak population is estimated to be around 22 million (FAO 2013), of which 20 million, or 90% of the total, are distributed in China. So far, the Chinese Committee of Yak Experts has officially recognized 13 yak breeds on the basis of intensive surveys in the six major yak-raising provinces in China. A 'new' strain of yak has been developed by crossing wild yak bulls with the Huanhu breed of yak at the Datong Yak Farm in Qinghai Province using artificial insemination. Moreover, semen from wild yak and semi-wild yak bulls has been

extensively used to improve the productivity of domestic yak in Qinghai, TAR, Sichuan, Gansu, and Xinjiang.

Yak breeding technologies in China

The QTP is the highest and largest plateau in the world. It is characterized by a high-altitude continental climate with conditions of dry, cold, strong winds and high radiation. This unique harsh climate has a profound effect on animal survival. In the course of evolution, many indigenous animals have developed their own unique mechanisms to adapt to the high-altitude environment. They have acquired important characteristics to assist them to keep away from unfavourable environments and effectively acquire substance or energy to ensure normal growth and reproduction. The yak is a keystone species of ecosystems on the QTP and plays an important role in the preservation of indigenous biodiversity. However, it is still regarded as a low production breed and ways of improving yak productivity by selection might be of great importance to the people who depend on yak for their livelihood.

Pure-breeding

Pure-breeding is the traditional and predominant practice with yak, apart from a scheme involving selection in crossbreds of wild yak with domestic yak in a process of breed development (Wiener et al. 2003). Yak pure-breeding must have a clear breeding scheme to achieve the desired goals. However, in general, pastoralists don't have clearly defined breeding objectives or a well-established breed structure. From the late 1980s, Chinese scientists have attempted to develop breeding objectives for the principal yak breeds in China. The purpose was to provide technical assistance for a more systematic approach to yak breeding that would aim to promote earlier maturity, improve the animal's shape for meat production, and develop strains for either milk or meat or meat and hair production. The criteria used stressed body size, growth rate, dressing and meat percentages, milk yield and fat percentage, and yield of hair – both coarse and down, with an emphasis on down.

As the genotype has relatively stable hereditary traits, choosing pure-bred yak bulls and improving their rearing conditions, (i.e. meeting their nutritional needs) is the first choice. However, the major problem in using the pure-breeding approach to improve production performance lies in the low level of feeding conditions in livestock management. Thus survival of yak in a harsh and hostile environment is of paramount importance, perhaps of higher priority than any other single performance trait (although it is unlikely that this matter has been quantified).

The technical criteria proposed by scientists for yak breeding through pure breeds were approved in Sichuan and Qinghai for the Jiulong, Maiwa, Highland, and Huanhu breeds of yak, and a corresponding scheme was developed in Gansu for the Tianzhu White Breed in 1985.

The productive performance of some local yak breeds has been improved significantly through a considerable duration of pure-breeding. In the Qinghai Highland breed, the mean weight of 18 month pure-bred breeding yaks was 19 kg, greater than in individuals not produced through pure-bred breeding. After pure-breeding, the Jiulong Breed increased in size and had better meat productive performance. The numbers for white yak (Tianzhu breed) also increased by 2%. The body height, body length, body weight, cashmere yield, and meat yield increased by 2.06 cm, 2.28 cm, 9.49 kg, 0.2 kg, and 5.58 kg respectively. The parameters for the Maiwa breed were higher than for the other yak breeds. The survival rate of the nucleus herd was 54.8%. The milk yield of female yaks within 153 days was 252 kg. Pure-bred individuals of the Pali breed had significantly greater body weights at birth and six months after birth than individuals from non-pure-bred breeding.

As a traditional breeding method, pure-breeding has made some progress in yak breeding. However, as a result of the lack of research data on quantitative genetics and important genetic parameters, yak breeding activities are based on visual and phenotypic selection and performance, due to which yak selection has certain blind areas and lags behind selection in other livestock.

Factors to be considered in crossbreeding yaks with other cattle species

There is a long history of planned strategies of crossbreeding and improvement carried out to improve the productive performances of yak (Wiener et al. 2003). However, due to the poor productive performance of bulls, the improvement in meat and milk production was limited. In the 1950s, for example, crossing beef cattle with yaks was carried out in the Tibetan areas of Qinghai and Sichuan provinces. But because the bulls introduced from outside could not adapt to the local high-altitude conditions, most died of mountain sickness. In the 1970s, artificial insemination technology with frozen semen was implemented for yak hybridization in Qinghai and Sichuan. This technology solved the problems related to the introduction of bull yaks and accelerated the crossbreeding process. But the F1 males obtained from this technology were sterile, which limited the commercial application.

In the 1950s, yak was crossed with the Holstein or Simmental breed in places like the Datong Yak Breeding Farm in Qinghai province. The body weight of female F1 hybrids increased by 40 kg. The Datong yak breed were 86% taller than domestic yak of the same age and the carcass weight of improved bulls at six months was more than twice that of yak of the same age and sex.

Hybrids of yak with beef cattle have better productive performance, earlier sexual maturity, higher meat yield, and better adaptive ability. The body weight of hybrids at 6 and 18 months were 7.13 and 49.28 kg greater, respectively, than that of pure yaks of the same age. F1 hybrids of yak with beef cattle not only adapted to the high-altitude environment, but also lived well at low altitude where pure yaks could not survive well.

Practice and research in yak producing areas over a few decades showed that in binary crossing experiments in which the main purpose of breeding is for meat production, it's better to select beef type or dual-purpose cattle such as Angus, Simmental, and Hereford as the paternal line. If the breeding purpose is mainly for production of milk and butter, Jersey bulls and Holstein are better as the paternal line; the first generation cattle-yak then has a greater milk producing capacity. In three-way crossbreeding experiments, the second generation of terminal crossbreeds have the best productivity. So, planning yak crossbreeding and taking advantage of heterosis is an efficient way of increasing milk and meat production.

Crossbreeding of wild yak with domestic yak

Wild yak and domestic yak have been subjected to different selection pressures, and have large differences in genetic background. F1 hybrids have advantages in growth and development traits, stress tolerance, and others. Scientists at the Lanzhou Institute of Animal Husbandry and Veterinary Science used frozen wild yak semen to inseminate female domestic yak and cultivate the new Datong yak breed. The birth weight and meat productive performance of the new Datong breed were 86% higher than for domestic yak of the same age. The conception rate of yak heifers reached 70–80%, 15–20% higher than that of domestic yak of the same age. The sexual maturation time of the Datong breed was also earlier than that of domestic yak bulls.

The new Datong breed was mainly used to improve the body weight, meat and milk yield, reproductive performance, and tolerance of harsh environments. It was developed deliberately by crossing wild yak bulls with domestic yak females with the intention of creating a new breed of yak. It had excellent characteristics of high productivity and strong adversity resistance.

Yak products and their utilization

Almost everything from the yak is utilized by the pastoralists, either directly or through market exchange. The key issue in increasing the commodity rate and economic benefits of yak products is improving the yield and quality of existing products and promoting processing and comprehensive utilization of yak products.

Yak-based medicinal products

Due to their unique biological characteristics, yak were popular in the Middle Ages for their supposedly medicinal properties. For example, fat, bone, thymus, heart, brain, pituitary, lung, liver, kidney, gall bladder, spleen, blood, and other organs of the bull were used for medicinal purposes. Nowadays, modern biotechnology and bioengineering techniques are used in extraction, separation, and purification to obtain yak blood SOD, thymosin, pancreatic peptidase, amino acids, and other biological products that can be further developed into pharmaceuticals, cosmetics, food, and other raw products. With the advances in modern biotechnology, more and more valuable previously unknown yak resources are likely to be discovered that will serve human development.

Milk and milk products

Although the milk yield of individual yak females is low, the large population of yak on the plateau still provides a substantial quantity of milk to local communities. Yak milk includes a high content of solids (ca. 18%, including about 7% fat) and has a fragrant smell and naturally sweetish taste.

Butter is the principal product from yak milk and represents one of the staple foods of local people. It is also the principal milk product traded by herdsmen. The raw butter contains 12–15% water, 1% protein, and fat (old butter contains about 3% water). Butter production is regarded as the yardstick of the quality of yak milk, and herdsmen pay great attention to it. Butter is used for a number of foods, including zanba and pancakes. It is also added to milk tea and consumed salted or unsalted. When milk is not available, butter is used in tea in some areas. In pastoral areas like Northwest Sichuan and TAR, people prefer butter to milk in making tea.

Meat and meat products

Yaks have a very strong ability to adapt to the alpine environment. Yak meat is not only an important source of protein for the herdsmen and their families, but is also in great demand in the market. This cold-loving animal produces meat with low fat, high protein, favourable fat

composition, and high levels of minerals, especially iron. All these attributes of yak are demanded by today's consumers. The products include beef jerky, beef breast, beef loose, Tibetan sausage, dried meat, cut meat, vacuum-packed series (spiced beef, hoof, beef heart, chopsuey) and so on.

Hair and down fibre

Yak hair is of economic use and importance. Generally, in traditional uses of hair, the down and coarse fibres are mixed together. Uses of mixed fibres depend on the fibre length, the position on the body from which the hair is derived, and the down content.

Major factors limiting yak product development

Traditional beliefs

Due to traditional beliefs, many yak keepers like to keep their yak until they are very old. Even non-breeding yak are not slaughtered until long after they have reached mature adult weight. In some areas, an increasing number of yak are released into the wild, resulting in an increase in the number of unproductive yak, too high stocking rate, and lower overall efficiency of herd management. This has aggravated the situation in which the animals are strong in summer, fat in autumn, lean in winter, and have a high death rate in spring – a phenomenon common in traditional livestock management on the QTP. Yak often face nutritional deficiencies, reaching maturity late and having inadequate body weight and large generation gaps. As a result, beef production cannot meet the quality demand for yak meat in the market.

Slow adoption of new technologies in yak keeping

Pastoralists have long followed a traditional way of raising yak, depending heavily on livestock for their livelihoods. At the same time, excessive milking of cows for human use has led to insufficient and sub-quality milk for young cows, which further results in slow growth and development of calves. Poor fodder reserves make it difficult for herders to withstand natural disasters such as extremely cold weather and heavy snow days. As a result of these factors, it often takes more than eight years for a yak to reach the 250–300 kg slaughter weight. The longer the feeding time, the more harsh winters a yak has to pass through and the greater live weight loss it has to undergo. In many cases the decrease in yak production performance, so-called 'degradation', is the resulted of nutritional deficiency and is actually related to grassland degradation. Due to this nutritional deficiency, many yaks cannot realize their full genetic potential to meet satisfactory production performance.

Recommendations and the way forward

A move from traditional to modern practices can create tensions and problems if these modern practices are not sensitively integrated with the vast, accumulated knowledge and

experience of the herders. This should be taken into account as a background to the following suggestions and recommendations.

Strengthening breeding improvement

Improving yak productivity by selective breeding is of great importance to the people who depend on yaks for their livelihood. At present, there is a vital need to focus on building a number of yak improvement centres and improvement spots for thorough breeding matching. Optimizing the herd structure to increase the portion of breeding cows to at least 50–60%, and culling of old, low-yielding yaks, can significantly improve the quality and efficiency of yak production. At the same time, shortening the breeding period, accelerating herd turnover, and reducing stocking rates can improve breeding efficiency.

Strengthening research on nutritional intervention

Yak largely depend on natural pastures for their survival, and rarely receive regular and sufficient supplementation during the cold season. Given the high seasonal variation in both quality and quantity of forage biomass, yak tend to suffer from malnutrition for almost eight months of the year when kept in traditional farming systems On the Qinghai-Tibetan Plateau, growth dramatically decreases in the cold season when only dry native grass remains and legumes are largely absent, causing a decline in nutritional status. For example, the amount of weight lost by a yak from birth to four years of age during the four cold seasons is equivalent to the net meat weight of two adult yaks. For yak of four to five years, the traditional approach is to allow the animals to put on as much fat as possible during the warm season as an energy reserve to be used over the long cold season allowing survival beyond the early spring. Exploring mineral blocks and supplementary feed, and improving the production of forage on the natural grassland, could help to alleviate some of these probleMs

Improving traditional yak production practices

In recent years, there have been changes in the direction of yak production from meat to milk-based meat production. Full-nursing 5–7 month old yak calves weigh 96-127 kg and have an economic value equivalent to 75% of that of an adult. Slaughtering yak earlier can improve economic efficiency and promote herd turnover.

Exploring market-oriented mechanisms for yak production

Integrated yak husbandry and yak product marketing ultimately depend on the establishment of a sound market mechanism. The nutritive value of yak meat as a major food source has not yet been fully realized. It seems that the main cause of the low economic benefit in the yak meat industry is the low market price. Thus, the most important way to improve the benefit is to establish a good market mechanism for the yak industry and add value to yak products. Attention needs to be paid to the whole process of standardized production and marketing delivery. Timely development of new products in accordance with the changing market

demands, and wide distribution through newly emerging e-business should be strongly promoted in the future.

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