
Chapter 12

Impact of Changing Agropastoral Systems on Agrobiodiversity: A Case Study of the Qinghai-Tibetan Plateau

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Introduction

The Qinghai-Tibetan Plateau consists of the vast area extending from the Pamir range in the west to the Hengduan mountains in the east and bordered by the Kunlun and Qilian mountains to the north and the Himalayas to the south. Because of the high altitude and harsh environment of the plateau, cropping is not practicable in most areas and the only way that the land can be used is for it to be grazed by animals tolerant of the cold. Thus pastoralism represents the main economy of the Plateau. There are 167 million hectares of natural rangeland resources on the Qinghai-Tibetan Plateau, 42 per cent of the total area of grassland in China. In 1986 there were 17.2477 million head of large livestock (mainly yaks, horses, cattle, and cows), 14.5 per cent of the national stock, and 37.6981 million goats and sheep, 20.9 per cent of the national stock. Animal products from this region, such as wool, cashmere, hair, mutton and beef, account for 12.32-13.47 per cent of national production. As a result of the geographical pattern, the Qinghai-Tibetan rangelands have attracted pastoral societies for thousands of years. Even now, more than half of the regional population makes a living from the various livestock production systems.

The study described here was conducted in the east of the Qinghai-Tibetan Plateau in western Sichuan, at an elevation of between 3,000-3,500m. The region plays an important role as a link, both economic and ecological, between the plateau and the hinterland of China. At present this region is impoverished. It has a long history of pastoralism. Today, following the changes that have taken place in China in recent decades, it is at the transitional stage between a self-sufficient

subsistence economy and a market economy. This study describes the daily lifestyle of the pastoralists and discusses the economic progress and resultant pressure on the environment, particularly on the rangeland ecosystem and its biodiversity.

Livestock Farming Niches in Western Sichuan

Western Sichuan covers a vast area between the Longmen mountains and the Dadu and Jinsha rivers. It is located between 97°26' and 104°27' E, and 27°57' and 34°21' N. The total area of this region is about 236,000 sq.km., 41.6 per cent of the total area of the province. There are 13.9 million hectares of rangeland. Administratively, the region is divided into the Graze Tibetan Autonomous Prefecture and the Aba Tibetan and Qiang Autonomous Prefecture, which include 31 counties. The population in 1993 was 1.61 million, 1.46 per cent of the total in the province (SSB 1994).

According to the survey of rangeland resources in Sichuan Province (SAHB 1989), there are 22.5 million hectares of natural rangeland in Sichuan, about 40 per cent of the total land area. The 19.6 million hectares of available rangeland account for 35 per cent of the total land and are three times the present area of tillage land. These rangeland resources not only play an important role in the regional economic system and environment. They are also the basis of the livelihood of local communities (minority nationalities) and are home to a unique agrobiodiversity system, especially in terms of animals.

The traditional agropastoral system maintained a diversity of animal combinations so as to enable farmers to adapt to different agroclimatic conditions. Some of these animal combinations are as follow.

Pig-rearing in the Basin Area

As a result of the ideal climatic conditions and fertile soil in the valley basin, farming, and particularly pig-rearing, is well-developed. This system depends on the provision of fodder and grain and forms the pillar of animal husbandry in the basin. Pigs comprise up to 86.0 per cent of the total number of domesticated animals. There are also goats (5%) and cattle (2.3%). The basin is largely dominated by *Han* farmers who play a dominant role in rural societies. *Tujia* farmers are mainly scattered in the southeast of the region.

Cattle, Goats and Pigs on the Periphery of the Basin

Hills and low mountains surround the basin, agricultural land is marginal and fragile, and sloping pastures create the conditions for combining farming of domesticated cattle and goats with pigs. In this periphery area, cattle make up 33

and goats 17 per cent of the livestock. The number and proportion are more than in the basin and there is more potential for development. There are settlements of various ethnic groups scattered in the region, *Qiang* (*Kiang*) and *Han* along the northwest upper reaches of the Mimiang river in the Dahangshan and Xtaoliangshan mountains and in the north in the Daba mountains, and Tibetans on the western fringe.

Yak and Sheep Farming on the Plateau

With its extensive rangelands, the northwestern plateau is the most important area for Sichuan in terms of developing herbivore husbandry. About 76 per cent of the total number of herbivores in the province are found here. Among these, sheep and goats dominate, followed by yak, *zu*¹ and cattle. Yak and *zu* constitute 80 per cent of the total number in the province and 20 per cent of the total number in China. Beef and mutton production in this area is 26 per cent of the total production in the province. Most inhabitants of the Plateau belong to the Tibetan ethnic group.

The Four Pastoral Systems

Table 12.1 summarises some key descriptors of present pastoral systems. Common to all systems is the use of communal land as pasture, they differ in the degree of mobility of herds and households. With increasing altitude, in particular the transfer to the plateau, mobility increases reaching its extreme in the migratory pastoralism that uses the most marginal areas in the region.

Very different management considerations and practices apply to the livestock production spectrum from nomadism through semi-nomadism to mixed agropastoralism. The available resources influence both the occurrence or choice of production system, and the manner in which the system is managed. This is especially true for the nomadic system (including nomadism and semi-nomadism), which is a response to the environment. The central concern of nomadism is to maintain animal numbers and animal products, such as milk and butter, by seeking good grazing areas and adequate water and avoiding predators and known foci of disease.

There is no single management system which applies to all livestock over the large area of their distribution on the Qinghai-Tibetan Plateau. Since yaks play a vital role in the pastoralism of western Sichuan, the management system here is

1 *Zu* also called *Zumo* is a crossbreed between yaks and cattle (*Bos taurus*), which may date back to 3,000 years ago when the *Qiang* nation adopted this technique of reproducing animals. The word comes from the *Qiang* language. The result of continuous crossbreeding of *Zu* with yaks for five generations is considered to be a yak.

Table 12.1: Descriptors of Pastoralism

Agro-pastoralism	Combination of crop production with grazing of livestock on both individually owned and communal land in the immediate vicinity of a permanent homestead
Sedentary pastoralism	Grazing livestock on communal land in the vicinity of permanent homesteads throughout the year
Semi-sedentary pastoralism (Semi-nomadism ^a)	Grazing livestock on communal land in the vicinity of a permanent homestead for part of the year, and long-distance movement of herds during the warm season
Migratory pastoralism (Nomadism ^b)	Grazing livestock on communal land and moving herds and homesteads as seasonal forage supply demands

a The term 'semi-nomadism' is used to describe those lifestyles and economic systems for which migration and livestock are still the most important economic factors, but in which extra-pastoral activities - in particular arable farming - are also of great significance. Further typical characteristics of semi-nomadism are shorter migration distances with greater frequency of husbandry small livestock, and the possession of permanently fixed huts/houses in long-term settlements around cultivated areas or other places of employment where at least some members of the group remain for a large part of the year, in addition to 'portable housing' (Scholz & Janzen 1982).

b The term 'nomadism' is taken to mean a lifestyle and economic system in which the groups concerned carry out episodic and/or periodic migration together with their main source of income, livestock, in order to ensure their livelihood, and on the basis of special physical-economic and/or sociopolitical conditions in specific areas. Nomads usually carry their housing accommodation with them on their travels, and may also carry out other extra-pastoral activities on a temporary basis (for example, arable farming trade, transport services, wood/herb collection, employment as agricultural labourers) (Scholz and Janzen 1982).

mostly based on yak breeding. Grazing methods differ according to the different regions, influenced by altitude, climate, and other natural conditions. In recent decades, proximity to centres of population or urban areas that provide a market for yak products has also affected the pattern of management. Proximity to markets determines whether certain products, such as milk, are used primarily by the families herding the yaks or whether they are supplied to the market.

Temporal Differentiation of Nomadic Systems

The temporal differentiation of nomadic systems means that grazing systems are arranged according to the seasons that delimit the grazing period and spatial migration. In the plateau area the natural rangelands are always divided into two parts, winter-spring pasture (cold season pasture) and summer-autumn pasture (warm season pasture), which are used in a rotational 'two season grazing system'. Such a division can also be found in areas where pasture land is too limited for livestock to migrate over a long range.

A 'three season grazing system' is sometimes found in mountainous areas,

characterised by winter pastures, spring-autumn pastures, and summer pastures. In this system the migration is from low altitude to high altitude, and the transitional belt between the winter pasture and the summer pasture supports the grazing activities in spring and autumn.

'Two season grazing systems' and 'three season grazing systems' are present all over the Plateau, with different ways of life and economic organization. The 'two season grazing system' is closer to the nomadic system and is found in northwest Zoige, Hongvuan, northern Zatang, and Sertar and Serqu counties. The 'three season grazing system' is a part of the semi-nomadic or mountain nomadic system² present in mountainous areas of NW Sichuan. As a result of the vast area and complicated natural conditions the duration of grazing time and composition of livestock are different in different areas.

Evolution of Adaptive Practices and Knowledge of Traditional Pastoralism

From the perspective of evolutionary ecology and cultural ecology, traditional pastoralism is an intrinsic feature of rangeland ecosystems in extremely harsh environments, and thus represents a form of human adaptation to a plateau environment. In order to survive, man has to struggle with nature and use natural resources to obtain energy, food, and shelter.

Although mainstream societies often have the impression that pastoralists are irrational in such matters as stocking rates and management of grazing, recent observations indicate that within their economic and natural environment they are as rational and productive as their counterparts elsewhere. Adaptive processes on rangelands brought on by pastoralism may have included elimination of favoured forage species and their replacement by species capable of preventing herbivores escaping, or adaptation of plant species already prevalent to withstand a different, heavier grazing pressure. Pastoralists keep evolving new herding and husbanding strategies in order to occupy different habitats without causing deterioration. They maintain the fitness of their herds through optimisation of herd size or stock composition by culling. The resource exploitation strategies involved in traditional pastoralism include herd management practices as well as biodiversity and pasture management approaches.

2 'Mountain nomadism' is a form of vertical nomadism. It is considered a type of semi-nomadism, adapted to orographic conditions, in which nomads migrate seasonally with their livestock along the mountainous relief upwards from their base rangelands, situated in the mountain valley or forelands, over intermediate pasture stages to the highest mountain pastures, and vice versa.

Transformation Processes of Pastoral Systems

The aim of pastoral systems is to use animals to harvest limited amounts of vegetation scattered over long distances that cannot easily be gathered by any other method. In energy terms it is very inefficient as only a very small proportion of incoming solar radiation is converted into usable material, yet without the method no benefit at all would accrue. The various nomadic groups follow a regular pattern of movement from one grazing ground to another at different times of the year so that they can always be where biological productivity is at its maximum. Of course, nomadic groups were never fully self-sufficient. They depend on the sedentary agricultural groups for cereals and fodder, and on trade to supplement their diets, thus maintaining strong linkages between production systems.

Transformation Processes in Pastoral Areas

Traditional pastoral production systems have remained stable for a long time. Today, however, numerous demographic and economic changes of a long-term nature have occurred which are triggering adaptive changes that are likely to transform the production systems. The most salient feature is the emerging precedence of market-oriented production over traditional subsistence production.

For some decades, highland development strategies in China were not related to the motives and aims of the pastoralists. Interventions focussed on modernising or fundamentally transforming the pastoral way of life. Individual pastoralists have sought to cope with pressures of intervention by such adaptive mechanisms as labour migration, increase in herd size, diversification of pastoral production, and the pursuit of education. Large sectors of, or even entire, pastoral societies have been involved in planned programmes and projects of development coordinated by the national government, with the aid of administrators, planners, technicians, and extension officers at provincial and country levels. The present crisis derives from unsustainable 'modernisation' such as the pressure to absorb pastoralists into the non-pastoral economy (settlement programmes, wage policies favouring migrant labour, forced commercialisation, a relative drop in the value of pastoral products) and measures that directly deprive pastoralists of their former share in economic and political life (the expansion of farming, restocking programmes, and the destruction of traditional systems of land tenure). The result of these powerful forces is that pastoralism is increasingly being relegated to people too old to change, lacking the skills needed to leave, or too far away from centres of power for anyone yet to care.

Since 1958 an attempt has been made to stabilise the nomads in western Sichuan through permanent settlement and communal rather than individual

ownership of livestock. After the 1970s, under the Gongse (people's commune) system, attempts were made to grow forage crops for winter fodder, veterinary facilities were made available, and winter livestock shelters were constructed. Livestock were also allowed to use state land as pasture, but seasonal movements to pastures were still made and allowed. In effect an attempt has been made to convert nomadism into a ranching system, the so-called 'modernisation' of animal husbandry, but the economy is still essentially nomadic.

After 1978, and mainly from the early 1980s, the government of China recognised a general need for corrective measures. There was a major shift in policy with a slow movement away from state control and ownership (planned economy) towards a more market-oriented economy with policies to encourage private sector initiatives and investment. Communal livestock were again divided between families, but the tenure of pastures still belonged to the state. This left the shadow of an ecological crisis looming large in the high-frigid meadows because of overstocking and overgrazing.

From the mid-1980s, various major economic policy changes were introduced. These included the disbandment of the livestock marketing organization, a considerable reduction in marketing organizations for animal products, and the release of control over prices. Since the late 1980s there has been a move towards conservation policies and attempts to adjust stock numbers to the carrying capacity of the land.

Modern management techniques were introduced to improve the productivity of pastoral systems. While this can be accomplished fairly easily under private ranch conditions, it is much more difficult when the areas to be managed are vast, the range resources are publicly owned, and the animals are owned by individuals. Most new project strategies in the pastoral zone consider reintroduction of the old system of community control over the range resources to be a precondition for improvement.

The trend towards a mixed, more private economy, combined with liberalisation of the marketing of locally-produced animal products and a reduced role for public sector institutions, has proved successful. Thus, the very fact that the change in state-stipulated basic conditions led to the production increases mentioned, proves again that it was not — as is a common complaint — for exchanging a lack of mechanisation or pastoral inputs which are responsible for the poor yields.

Market-oriented Production

The nomads' strategy aims to secure rapid harvesting of the growing vegetation through their animals. But isolation, remoteness, and a primitive marketing system

are handicaps to commercial exploitation of animal products. Inefficient marketing discourages expanded commercial off-take but governments pay less attention to such factors

Schemes of pastoral development are often assessed by herd off-take and numbers of marketed animals. Yet, these rates are not simply a product of the various innovations of ownership such as credit, or fattening, they are fundamentally influenced by marketing opportunities, the requirements of the herd and its reproduction, and pricing structures. As long as prices are kept artificially low for the benefit of urban inhabitants, stockholders cannot be faulted for retaining stock. However, many people accuse pastoralists of not using the official markets and are indignant that they use unofficial marketing channels.

In western Sichuan, ineffective marketing outlets have led to an increase in the number of animals carried on the rangelands and a further decrease in prices. Although the private channels are never blocked, their capacity is still limited.

The traditional strategies modifying herd structure include trade, capital accumulation, and production of secondary animal products such as wool and skins. Herd owners try to track and exploit major regional, seasonal and year-to-year fluctuations in resources in order to optimise herd productivity through strategies of maximising potential reproduction and optimising potential mobility. Traditionally, the trade in products from live animals has always been the business of private entrepreneurs. Although prohibited in the 1960s and 1970s, when it was replaced by communal trade, private trade continued to function through a 'black' market. From the 1980s onwards, private business has been restored and become a second main trading channel, alongside communal trade.

At present trade is driven by market forces and not dictated by the government, although the state has stepped up its purchase of animal products and supplies of grain to pastoral areas. The market-pricing process has made people more aware of the new prospects.

In addition to the constraints of the socioeconomic system, limiting factors are also found in the ecological environment of livestock breeding and sustainable marketing. The milk trade in *Hongyuan* is a good example, here livestock rearing for marketing is generally characterised by short-term, profit-seeking production strategies which tend to promote inappropriate land-use practices. The process of settling nomads is encouraged because the market-oriented livestock breeder tends to settle near roads, settlements, and watering places where milk can easily be sold to traders. Another result is that pastoral migration distances are reduced, resulting in higher stocking rates and often longer periods of grazing in the vicinity of settlements. This concentration of man and animals in these fragile environments

leads to degradation of land resources and unsustainability of the production system.

Modernisation of Pastoralism: Approaches and Implications

Enclosure of Rangelands

In western Sichuan, as well as in the rest of the Qinghai-Tibetan Plateau, enclosure was introduced as a management technique at the end of the 1960s. At that time it was only used for cutting pastures in order to supply winter foodstuff to domesticated animals. In the last two decades, it has been used to delimit pasture boundaries, to enclose degraded pastures or abandoned fields for forage cultivation, to divide pastures for rotational grazing, and to provide better defence against the invasion of wild, predatory animals.

From one point of view, the construction of fences around pasture land is undoubtedly beneficial to the growth of grasses. After the regeneration of grass, the fenced pastures have improved soil, a better quality of grass, and a better vegetation structure. However, enclosed range areas are not immune to the problems of degradation of range condition. One problem is overstocking beyond the carrying capacity, which is common because of the needs and demands of the stock owners. Further, erratic precipitation and snowstorms can reduce forage growth in enclosed areas leading to temporary, functional overstocking and degradation. Enclosure leads to the breakdown of traditional resource-sharing attitudes in the pastoral system since it prevents emigration of herds from fenced lands.

Under natural conditions, herbivores act as predators on the rangeland vegetation, and grazing must be considered as a part of the energy flow of the rangeland ecosystems. Moderate grazing maintains the balance between plant species on the rangelands and stimulates productivity of above-ground biomass to twice that in ungrazed areas (Holzner *et al.* 1983). Total protection, on the other hand, leads to stagnation in vegetation growth and more or less complete dominance of a few species. Thus, no grazing has a detrimental effect on plant communities with a long history of grazing. So-called 'sustainable development in pastoral society' means rational use of rangeland rather than absolute protection.

Settlement of Nomads

Settlement indicates a changing process from a more nomadic to a less nomadic and sedentary way of life. This process is occurring with varying frequency in virtually all contemporary nomadic groups. The indications suggest that settlement

of nomads, singly or in groups, has resulted largely in their participation in non-pastoral activities.

Today, settlement has been forced on nomads by the market orientation of government policies. In western Sichuan the settlement of nomads started at the end of the 1950s and was mainly popularised in the 1970s. The process can be further divided into: 1) settlement, in which former nomads are settled in permanent settlements in order to build up a ranching system as in Hongyuan; and 2) semi-settlement, in which nomads (excluding semi-nomads) live in fixed winter houses during the cold season (winter and spring) with their grazing animals close by, but migrate to pastures far from the winter settlements in the warm season (summer and autumn).

Semi-settlement helps livestock survival during the cold season and helps establish the infrastructure for raising the living standards of nomads. But the change from a highly mobile herding system to a semi-sedentary way of life can also have negative effects. The most obvious negative effects are outlined in the following sections.

Increasing Risk of Environmental Degradation

Settlement is always accompanied by the enclosure of pastures. The emerging trend toward short-range herding systems has a bad effect on range vegetation and soil. The most severe impacts are found around permanent water sources and in the immediate vicinity of permanent settlements, although at the beginning they were limited to a small section of the total range. Grazing pressure on the residual open range is overtaxing the capacity, and migrations have to be rerouted. When areas with a higher potential are enclosed first, the residual open range areas, possessing lower support capacities, are prone to faster degradation.

Reduction in the Diversity of Production Systems as a Result of the Disappearance of Traditional Adaptive Management Strategies

One of the main purposes of settling nomads is to maintain adequate stocking rates and practice some form of grazing rotation. If pastoral areas are sparsely populated and include access to reliable, cold-season pastures, this presents no problem. Neither of these two conditions is met at present. Under the centrally controlled economy, long-term protection of larger range areas is impossible to achieve without a large police force. However, compulsory restocking, which has been suggested frequently in the past, would further reduce the already narrow base for subsistence of the pastoral population and damage the enthusiasm of nomads, as it may threaten their survival and traditional social structure.

Nearly all pastoralists are engaged in multi-resource economies and pastoralists' economic strategies are geared not just for current production but

for the long-term security of that production even through quite severe environmental fluctuations. Nomads will not easily abandon the lessons they have learned through bitter experience in hard lands. As a result, since pastoralists have their own systems of health control, breeding, insurance coverage, range and water conservation, and the like, there can be little doubt that improved methods will find acceptance among them as long as they are compatible with ongoing schedules and routines. In fact, simplification of local production systems to just western style ranching increases the risk of local people losing the basis of their subsistence.

Accelerating the Breakdown of Social Structures which Previously Served As a Form of Social Security within Herding Communities

Settlement of pastoralists is a clear change in lifestyle, defined by its substance, and exemplifying the process of sociocultural change. Left to their own devices and the vagaries of their environment, societies change all the time, self-initiating even quite profound transformations. Traditional mobile livestock keeping is founded upon a traditional social system that secures the realisation of the multiple goals that pastoralists pursue rather than economic goals alone.

Government thinking is perhaps that it can help secure food and water supplies for pastoralists through settlement in order to improve the output of pastoral products. However, this oversimplifies the diversity of the real situation and undoubtedly neglects some of the diversity in pastoral societies. A nomadic economy requires different strategies for short-term productivity and longer-term insurance. Moreover, pastoralists also use their animals to acquire prestige and influence in their societies and for other purposes. All of these are not strictly justifiable on economic grounds alone. A nomadic society works as an entirety in response to changes in the environment and the availability of resources. Every attempt in which only part of a system is changed will lead to an imbalance in the whole system.

Introduction and Cultivation of Forage Grasses

Shortage of fodder for winter and spring grazing is one of the main constraints to increasing the production of livestock. The germplasm of grasses is considered to be a very important factor in animal production because appropriate grasses are needed to develop locations for animal husbandry and to construct the basis of production. In western Sichuan, research institutions are busy breeding forage species for high altitudes, focussing on both indigenous and exotic species. Since the 1960s, more than 200 varieties of forage plants, belonging to 16 families, 49 genera, and 98 species, have been collected or introduced and tested in the pastoral areas of Sichuan.

Various valuable grass species have been introduced in western Sichuan since the 1960s. Many grasses have been selected and identified as suitable for this area, including smooth brome (*Bromus inermis*), wild rye (*Elymus mutans*), Siberian wild rye (*Elymus sibiricus*), common oat (*Avena sativa*), *Trifolium pratense*, and alfalfa (*Medicago sativa*). Some indigenous grass species have also been improved, including *Elymus breviaristatus*, which is mainly suitable for artificial cutting pastures, and red fescue (*Festuca rubra*) and sheep fescue (*F. ovina*), which have been used for the rehabilitation of degraded pastures. Turnip (*Brassica rapa*) is one kind of indigenous and popular succulent forage in pastoral and agro-pastoral areas. It is always planted near the winter houses and used for winter fodder.

Common oat (*Avena sativa*), introduced in Zamtang in 1978, can give a fresh biomass production of 58 tons per hectare per year. Having been tested for a long time, it has now been planted widely in the county and is accepted by most herdsmen. In 1987 and 1988, 10 tons of common oat seeds were distributed free or bought by families. Through its cultivation around the winter houses and on winter pastures, the pastoralists were able to cope with the heavy snowstorms of the following years. After 1990 more and more pastoral families have been buying forage seeds from the government seed multiplication unit. People's participation has further improved the introduction and distribution of suitable forage plants.

There are some problems associated with the introduction of new grasses. In western Sichuan, trial pastures planted with improved seeds are always treated with an ammonia-based fertilizer. But the cost of fertilizer makes the benefit of its use on pasture debatable. Furthermore, in conditions of drought the present hybrids either die or revert to their original natural form; and they tend not to breed true above 4,000m, again degenerating to their natural form. A more serious problem is that the introduction of alien species is creating niches for pests and diseases of vegetation, animals and humans. Statistics show that there are about 600,000 hectares of rat-damaged rangelands, and 500,000 hectares of pest-damaged rangelands in western Sichuan. Locals attribute this disaster to the introduced species on these lands. Apart from these other factors such as environmental degradation of and diversity in the ecosystem can also be attributed to this disaster.

Maintenance of Agrobiodiversity

The following sections describe some of the prerequisites for the maintenance of agrobiodiversity in pastoral livestock. A successful pastoral system enables people and their animals to live in harmony. Development of the livestock sector can only be successful in the long term if development projects are economically, socially, politically, and ecologically sustainable.

The Need to Use Indigenous Knowledge

Over the past decades, environmental changes and economic development on the Qinghai-Tibetan Plateau have accelerated and are having a serious impact on biodiversity, traditional production systems, and landscapes. The biodiversity of this plateau's ecosystem is believed to be deteriorating more rapidly than that of many other global ecosystems.

Traditional attitudes and behaviour in pastoral societies reveal a deep-rooted pastoral culture. Pastoralists perceive and manage both biodiversity and other environmental resources in their habitats for their needs. The biodiversity of the rangelands is the most important resource system and landmark of the Qinghai-Tibetan Plateau. High-frigid pastoralism, both nomadic and semi-nomadic, is directly supported by high-frigid range-lands.

In the traditional societies of this plateau, both the management of natural resources (including land-use protection, wandering, and grazing) and distribution practices are based on the perception of a man-environment relationship. Traditionally, rangelands and grazing systems are managed by pastoral societies as multiple-use systems to meet the needs of the people, namely, food, fodder, fuel, leather, wool, and medicinal products. The indigenous people of the plateau have a long tradition of practice in maintaining biodiversity as a sustainable resource.

In traditionally pastoral communities, one still finds a stronger sense of community and social responsibility than presently experienced in many developed societies where individual rights and freedom take priority. Villages and communities in western Sichuan have conserved biodiversity in the ecosystems surrounding their habitats over centuries with the help of their lifestyles, religion, and the interdependent relationship established with nature.

The current notion of pastoralism is that of a traditional, simplistic and somewhat static, low-input low-output system, which needs to be corrected to generate short-term successes. The opposite is true: if the terms 'traditional' and 'modern' are taken as a starting point and a temporary final point within the transformation process of a society, then there is no longer a 'traditional' sector in western Sichuan. All aspects of nomadic life are affected by 'modern' conditions and are thus modern. Pastoralists are today faced with a new set of problems resulting from these changes. During the previous 'Cultural Revolution Phase', enforced settlement of pastoralists was undertaken with the aim of transforming their production into that of a "modern sector based on scientific production and management". This policy, however, was not really supportive to pastoralism in the long term, for subsistence pastoralism is not only a particular mode of production, but also embodies the complex features of a total social system.

Traditional pastoral production systems have reached a very high degree of adaptation to the marginal environments they are using. The driving motive behind the high mobility that is a characteristic of these systems is risk aversion and sustainable use of biodiversity. These strategies have worked exceedingly well for many centuries, otherwise the system would have disappeared when confronted with recent changes. However, faced with rapidly changing conditions, such as increasing traditional social assurance systems, reduced mobility due to political and administrative restrictions, and widespread political strife, this adaptation is no longer sufficient to preserve the biodiversity. The danger of losing the traditional knowledge about diverse biospecies, mobility, and land-use practices is increasing.

Management systems for natural resources are localised systems that form a basis for decision-making for pastoral people. The majority of grazing systems on the Qinghai-Tibetan Plateau operate under indigenous knowledge systems, as do all productive land systems in developing areas. Thus these indigenous knowledge systems are not only of value for the culture from which they evolve, they are also useful for the scientists and planners striving to improve conditions in rural societies. They should be carefully studied, assessed, and incorporated into rural development strategies on a case by case basis, both for the improvement of livelihoods and for environmental conservation.

Those societies in western Sichuan that are associated with a nomadic way of life permit a degree of exploitation of ecosystems because their biodiversity cannot otherwise be used. Consequently, the management systems for conservation, production, purchase, and marketing need to be integrated, and this may provide a basic guarantee for protecting biodiversity.

The nomadic Tibetan, using different bio-types at different altitudes, can contribute considerably to the affluence of the state; the future depends on willing cooperation and the readiness to accommodate individual interest groups and institutions.

The most commonly-used indicators of progress in pastoral development projects are increased production and changes in income. While these economic measures are important, they are not adequate as indicators of sustainability or of biodiversity conservation. Economists must find a way to place an economic value on the resource base and assist with the contrasting choices between individual short-term gains and long-term benefits to society as a whole from conservation approaches.

The development of pastoral production systems is intertwined with biodiversity protection goals. However, the maintenance and sustainable use of pastoral ecosystem biodiversity cannot succeed without planning and cooperation between

the decision-makers on the one hand and livestock breeders on the other. Development approaches need to permit improvements in livelihood conditions and provide plans to cope with drought through effective food security programmes for herders, both mobile and permanent.

Participatory Approaches

The natural resource scene of pastoralism on the Qinghai-Tibetan Plateau is composed of a harsh climate, high altitude, scarce water, and hardy livestock grazing the rangelands. The central figure in the management of these resources is the pastoralist who is the primary user. The pastoralist on the range should be the decision-maker in using and conserving the rangeland. The pastoralist's attachment to the land and pastoral customs should govern the herder's decisions with respect to maintaining the long-term utility of the grazing land. Technological developments should be used to supplement this conventional wisdom.

Biodiversity loss in the Qinghai-Tibetan Plateau of the Himalayan region is basically a product of human intervention for the use of various natural resources such as land, forests, pastures, water, and minerals. The scale and dimensions of disturbances are such that changes are often irreversible. The biodiversity of the Plateau is threatened by overgrazing — caused largely by mistaken policies.

The impact of biodiversity loss extends very deeply into the economy and environment and directly affects food, fuelwood, and fodder supplies. Further, livelihoods are affected by changes in production of land-based activities. It is **these** trends that need to be reversed so that the pastoral people can sustain their livelihood in full harmony with the environment. The conservation of biodiversity should only be one of the goals tied to the well-being of the people.

The conservation of biodiversity and the rehabilitation of degraded rangelands are now urgent concerns. In practice, the highest priority should be given to more rational harnessing of those pastures not yet degraded. This could be linked to a reduction in the density of herds to a level below the carrying capacity of the rangeland, and in some cases to partial protection to allow the regeneration of grasses and other species.

High-frigid pastures are and will remain a marginal resource. The only conservation technique applicable is the carefully considered use of such lands. This implies that the pastoral economy cannot sustain growing numbers of animals because the resource base is finite. Reducing pressures on this area means reducing the number of people dependent on livestock. Although there may be other chances, the overall need to find employment opportunities outside the pastoral sector should be a priority. At the strategic level, diversification of the pastoral

economy is seen as a viable solution for meeting the increased needs of pastoral societies, achieving economic growth, and alleviating poverty. Highlands in western Sichuan have rich biodiversity resources and varied ecological locations. These forest-pasture-based natural products could be further developed using an agribusiness approach.

Macro-policies for the use of sustainable resources in highland areas should be given priority. Many of the present policies on credit, prices, and access to resources have been designed and formulated with the needs of organized urban-industrial groups in mind. These policies have almost completely overlooked the needs of rural groups, including the need for protection and conservation. Very few policies, in fact, provide any benefit from or incentives for conservation. Therefore, policy reforms at all levels must take into account the basic needs of the local people and provide direct economic benefits to them. Incentives for rural development must be oriented to improving household livelihoods and to agro-biodiversity conservation.

Conclusion

The case history of a pastoral ecosystem discussed in this chapter shows that, despite the growing body of literature on monitoring the structure and function of biodiversity in range-land ecosystems and on species' inventories, a comprehensive framework for analysis is lacking at all levels. The complex nature of the interrelationship between biodiversity loss and sustainable development of pastoral areas has not yet been sufficiently clarified. However, pastoralists' control over their resources, decisions, and actions is a key factor in the success of strategies designed to include conservation of this unique agroecosystem.

In the decades ahead, the erosion of agrobiodiversity in pastoral areas may be attributed to many factors. Amongst others the modernised transformation of the pastoral ecosystem engineered by public intervention has contributed substantially to the high growth in the demands of human on natural resources and the decline of biodiversity. Meanwhile, limiting pastoral mobility, redefining rangeland tenure, overstocking of grazing animals, and rangeland degradation have played very decisive roles in the socioeconomic changes.

Undoubtedly the modernisation process has brought improved access and services to previously remote pastoral areas. But it does not recognise the efforts of pastoralists to use scarce land resources more efficiently for gainful employment and increased livestock. With the growing commercialisation of high-frigid pastoralism on the Qinghai-Tibetan Plateau, the loss of agrobiodiversity is unavoidable. It is imperative that we ensure the survival of traditional pastoralism for as long as we want agrobiodiversity to exist. The concern and emphasis here

are on the need for containing the backlash effects of the process of transformation of pastoralism on native agrobiodiversity.

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