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SHERPA LIVESTOCK MANAGEMENT IN SAGARMATHA (MOUNT EVEREST) NATIONAL PARK, NEPAL

TEXT AND PHOTOGRAPHS BY

BARBARA BROWER

OUTREACH PUBLICATION SERIES

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Eric Crystal
Outreach Series Editor
August, 1986

Introduction
Sherpa Cattlekeepers of Khumbu

Pemba Noru Sherpa is a cattleman on the roof of the world. He keeps his 39 yak, cows, and crossbred *dzum* and *zopkio* on the slopes and glacial valleys of Sagarmatha (Mt. Everest) National Park, where his people, the Sherpas of Nepal, have made their home for 20 generations.

Pemba moves his livestock up the valley of the Bhote Kosi when summer's monsoon rains turn the highest meadows green. He brings them down toward his village, Thangmiteng, when fall shortens the days, and sends them high again to winter under the care of his sister, who feeds hay to the cold-adapted yaks when snows are too deep for foraging on wild pasture.

He herds his animals up valley and down in the way he learned from his fathers, who were taught in turn by their fathers. He spins yak hair into the yarn his mother weaves into blankets, as her mother did, and her mother's mother. His sister heats the summer's milk over a fire of dried yak dung, and makes of it the butter and cheese that have been a part of the Sherpa way of life for years beyond counting.

Historians surmise that the first Sherpa came to the Khumbu (Sagarmatha National Park's name to its residents) 450 years ago, possibly crossing from Tibet over the pass--the Nangpa La--that heads the Bhote Kosi valley. They brought the language and traditions of their old home to the new. Yak-keeping was part of that transported tradition, and is probably the oldest Sherpa occupation. Along with agriculture and trade, animal husbandry enabled the Sherpa to live in a forbidding environment mostly of rock and ice.

In the 30 years since Pemba Noru was born, the relative isolation of Khumbu has given way with the opening of Nepal's long-locked borders. Today, the Sherpa of Khumbu have added these to their traditional occupations: expedition climber, hotel

keeper, tourist guide, government worker, politician. These new jobs reflect the major changes that have come to the area over the last few decades. Climbers and other tourists visit Sagarmatha National Park by the thousands, Sherpas leave Khumbu for jobs in Kathmandu or schooling in other countries, and the once-remote world of Khumbu becomes increasingly involved in the society, economics, and politics of the outside world.

Being part of the rest of the world and defined as a national park has had a major impact on the environment of Khumbu, and on the society and economy of the Sherpa. There are new pressures on people and land, new expectations about what Sagarmatha National Park ought to look like, whom it is for, how and by whom it should be managed. These pressures and expectations are having a profound effect on the animal husbandry practices of cattlekeepers like Pemba Noru. Western visitors come to see a national park like Yellowstone or Glacier and are shocked to discover instead a park with 3000 residents making full use of the place; they lobby for restrictions, especially on livestock grazing, to make Khumbu more like their imported vision of a *natural* park. Jobs in trekking or mountaineering draw young men and women away from the care of their family's herds. Not only Sherpas find such employment; expeditions and trekking groups hire Sherpa cattle, too, to transport their equipment, and thus intensify trampling and grazing impacts on tourist routes. The high returns on the labor of these beasts of burden encourages more Sherpas to invest in the most versatile *zopkio*, creating for others the incentive to breed these yak/cow crosses. The result of these and a host of other new developments is an alteration of a centuries-old system of animal management that affects both the traditional life of the Sherpa people and the fragile high mountain environment of Khumbu.

The Region

The Himalaya mark the collision of a wayward chunk of continent, later to be called India, with the unyielding mass of Eurasia. The process began 60 million years ago, and continues; the reverberations of the forced descent of the Indian plate under the master continent still shake the region. The landscape engineered by the unimaginable power of plate tectonics is distinctive: the earth's crust here is its thickest, and forms the vast, high Tibetan plateau; the most extensive array of high ranges is found here, and includes the Hindu Kush, Karakoram, and highest of all, the Himalaya. But there is more to this part of the world than big peaks. The lowlands of India, Pakistan, and Bangladesh abut the Himalaya to the south. Major and minor valleys parallel the east-west trending ranges. Some of the world's most powerful rivers cut across the mountains. It is a landscape of great diversity, encompassing highest frozen mountains and flat fertile plains, sacred rivers and secret valleys.

The variety of the physical landscape is echoed in the living environment. In Nepal alone there are more than 6500 species of seed plants and over 800 species of birds. The richness and diversity of plant and animal life is a response to the combination both of a constellation of different environments and of the intersection of several distinct biotic provinces brought into proximity by the Tertiary collision of the Indian subcontinent and the main mass of Asia.

The people at home in the Himalayan region are no less diverse than the land they live in. Six countries lie within the area (Nepal, India, Pakistan, Bangladesh, Bhutan, China's Tibetan Autonomous Region), but there is far more ethnic and cultural variety than national boundaries alone might suggest. Hindu, Buddhist, Moslem, and tribal groups speaking dozens of languages live here in cities, villages, farmsteads, and even as roving nomads.

Nepal

Nepal encompasses much of the variety found in the Himalayan region. A small country, roughly 150 kilometers by 700, (the size of Florida), it lies along the center of the Himalayan arc. Nepal's topography is typical of the larger region's.

Along the southern boundary is a narrow strip of the Ganges Plain, once densely forested and the home of tiger, elephant, one-horned rhinoceros, and the malaria-resistant Tharu people. Today the *Terai*, as this lowland area is called, is the fastest growing part of Nepal. In the lands here newly opened to settlement, tropical forest is rapidly being cleared to accommodate commercial enterprises and the thousands of immigrants fleeing stringent Indian taxation, escaping the crowding of the Nepalese hills, or simply looking for new opportunities.

Inward from the Terai are the remnants of mountains older than the Himalaya: the Churia Range, a relatively low (to 1500 meters) line of wooded, sparsely populated hills. These are backed to the north by a higher range, the Mahabharat Lekh, aligned east-west like the Churia Range, and separated from the lower front range by a discontinuous valley system known as the Inner Terai.

Behind the Mahabharat Range in central Nepal lie the large mid-montane areas, including the Kathmandu and Pokhara valleys, where the region's densest population, most intensive agricultural production, and political power have been concentrated.

The high Himalaya rise behind the mid-montane area to elevations approaching 9000 meters, and yield in their turn to the valleys of the inner Himalaya. These share Tibet's cold, arid, high altitude environment, and are occupied by people of the Tibetan cultural tradition.

The Inner Himalaya, in common with other areas north of the Himalayan chain, is blocked by the mountains from the summer monsoon, which brings rain to the windward slopes. These rains arise from the Bay of Bengal and fall most heavily on

the south-facing slopes of the eastern part of the country. Western Nepal and the leeward slopes of each of the succeeding ranges are thus drier. The circulation pattern that brings summer rain from the warm waters of the Bay of Bengal reverses in winter, when cold, dry air pushes southward across the Himalaya from central Asia. Occasional frontal activity brings some winter rain and snow, and thunderstorms are common in late spring, but for the most part Nepal's precipitation is concentrated in the summer season.

As the weather patterns that shape the climate of Nepal come out of Chinese Tibet and up from India, so have the dominant social and political influences arisen in those countries. Peoples and cultures have made their way to Nepal from both north and south, and as we have seen, the country is a collection of ethnic elements from the Mongolian north and Indo-Aryan south. Nepal, a tiny monarchy squeezed between often hostile major powers, is sometimes in a difficult position as it struggles to maintain an independent political identity.

Nepal's strategic location helps to focus international attention on an otherwise small and out-of-the-way spot. The country is distinctive in other respects, too, of course: the world's highest mountains, spectacular scenery, people known for their friendliness and hospitality. Eyes turn to Nepal for other reasons as well. It is a relatively undeveloped, poor, crowded country of 16 million, where the environment puts severe constraints on the productivity of most of the land, and where steep slopes and intense seasonal rainfall create extreme vulnerability to such natural hazards as landslides and floods. There is widespread evidence of the ecological costs to be paid because of the pressures of expanding industrialization and growing population on an inherently unstable natural environment. People who know of Nepal may have heard about deforestation and overgrazing, and the catastrophic landslides and flooding that are linked in popular accounts with such processes.

As a consequence of these and other compelling factors, Nepal has attracted con-

siderable foreign assistance. Dozens of countries compete to provide financing and expertise for a wide array of development projects. Many of these are intended to mitigate environmental problems, both real and imagined. We will look especially at one such problem--overgrazing by livestock--and the ways in which foreign aid is involved both in exacerbating and in attempting to mitigate livestock impacts in the context of the following discussion of Sagarmatha National Park.

Khumbu Himal: Sherpa Homeland, International Park

Mt. Everest, the highest point of the earth's surface at 8848 meters (29,028 feet), rises from the border between Nepal and Tibet. "Everest" is for Sir George Everest, surveyor general of India from 1830, but the peak has other names. Chomolungma is what Sino-Tibetan language speakers call it; Sagarmatha is its Sanskrit name, and it is as Sagarmatha National Park that the peak and its Nepalese environs have been known since 1976, when the park was established. The park's boundaries correspond with the area called Khumbu; the terms will be used interchangeably in this account.

Physical Landscape: Terrain

Sagarmatha National Park is an area of approximately 1113 square kilometers (430 sq. mi.), a rugged landscape of interdigitating glaciers and ridges, glacial debris-burdened streams, hanging micro-valleys and constricted fluvial terraces. Within the park are found most of the upper catchments of three tributaries of the Sapt Kosi system: the Dudh Kosi and its feeder streams the Bhote Kosi and Imja Khola. These rivers begin as glaciers formed on the flanks of massive peaks including four of the world's seven highest: in addition to Sagarmatha, Lhotse (8501 m), Lhotse Shar (8383 m), and Cho Oyu (8189 m). They gather strength and flow southward, incising a path to the Ganges. Above about 4000 meters, the valleys have been scoured into the

broad U that is a glacier's track; lower, the rivers run in some of the deepest, most precipitous gorges found on the planet. At 2845 meters, the lowest elevation in Sagarmatha National Park, the river flows 4000 meters below the summit of the adjacent peak. Today, the big valley glaciers are dying, rotting away to milky meltwater under a burden of till. The smaller, higher, newer glaciers clustered around the mountain summits above about 5500 meters are still lively; twice in the last eight years, lakes associated with these young glaciers have ruptured and sent sudden, destructive floods which washed away bridges, houses, fields, a hydroelectric power development, livestock, and human lives.

Vegetation

Rock and ice dominate Khumbu's ultimate elevations, but at remarkably high altitudes vegetation begins to appear. Mosses, lichens, and cushion form plants (including *Arenaria bryophylla* and *Stellaria decumbans*) are found at 6000 meters (19,685 feet) and even higher.

Stabilized moraines, colluvial slopes, and other glacier--marginal surfaces support a surprisingly diverse alpine tundra-type flora above about 4000 meters. Grasses and sedges, more and more varieties of lichen, and a wealth of lovely, sturdy flowering plants including eidelweiss, potentillas, and many different poppies and heaths grow here during the rainy season.

Even at these high altitudes a pattern of site-related vegetation types becomes apparent. North and east facing slopes are characterized by a cover of low-growing, scrubby vegetation made up of several species of azalea (*Rhododendron anthopogon, R. nivale, R. setosum*), cassiope, and intermingled grassy plants. West and south facing slopes above approximately 4500 meters support grasses, sedges, and diverse herbaceous plants; only a scattering of the woody azaleas and other shrub species occur on such sites, which are preferred for stock grazing and show further composition

variations depending on degree and type of grazing use.

The different growing conditions associated with different aspects (moister, cooler north and east aspects; drier, hotter south and west slopes) affect the distribution of shrubs and grassy-herbaceous vegetation at lower elevations as well. Between about 4000 and 2800 meters, for instance, the dominant plant on drier sites is *Cotoneaster microphylla*, a stiff evergreen shrub that is deeply and securely rooted, tolerates browsing by livestock, and functions like Himalayan epoxy, holding the soil cover on steep slopes.

Tree growth in Khumbu is constrained both by altitude and by human use. Today, the highest trees are gnarled, stunted *Juniperus indica* found as isolated individuals up to almost 5000 meters. The extent of juniper forest at slightly lower elevations was formerly greater, but the demand for fuel wood by expeditions in particular has repressed tree line and thinned and transformed forest in many areas. This heavily exploited juniper forest, composed of an increasing proportion of the species *J. recurva* at lower elevations, grows on drier sites, especially on south-facing slopes, between 4000 and 4700 meters.

On cool, damp north slopes between 3600 and 4200 meters, birch and arboreal rhododendrons (*R. campylocarpum* and *R. campanulatum*) distinguish the forest type, which also contains a wide array of other trees (including *R. arboreum*--Nepal's national flower--maple, whitebeam, juniper, fir, and yew) as well as a varied shrub-forb-grass understory. The composition, diversity, and favorable growing conditions of such sites make the birch-rhododendron assemblage more resilient to the demands of local users; such forest is in relatively good condition today.

The fir (*Abies spectabilis*) that is a minor component of the birch-rhododendron type dominates some areas of Sagarmatha National Park forest between 3200 and 3900 meters, where it grows together with juniper and a few other understory shrubs on most aspects.

Pine (*Pinus wallichiana*) is the dominant in the park's other principle forest type, found below 3300 meters. This type, occurring in the zone of permanent habitation, is considered to be a secondary successional form: more resistant to cutting, grazing impacts, and fire than the hardwoods that grew originally, it has replaced them.

In addition to these main forest types--juniper, birch-rhododendron, fir-juniper, and pine--there are other locally important tree assemblages shaped both by natural site characteristics and by exploitation history. While all types are put to use by the resident Sherpas, it is the forests in the vicinity of permanent villages, near herding and agricultural settlements, and within reach of expedition base camps that suffer most from human exploitation. These impacts range from subtle changes in forest composition in some birch-rhododendron forest to the wholesale elimination of trees that has happened to former juniper forest on the way to Everest Base Camp; and to the mixed forest that once occupied the slope above the village of Namche Bazar.

Cultural Landscape: Settlement

Almost all of Khumbu's 3000 residents maintain a principal home in one of the area's six main village communities: Namche Bazar, Fortse, Pangboche, Kunde, Khumjung, and Thamichok. Fortse is smallest, with about 55 houses; Khumjung's 125 houses make it largest (Thamichok, the name given a collection of fairly small, dispersed permanent settlements in the valley of the Bhote Kosi, actually encompasses the most permanent households). Typically, permanent villages occupy the few areas of reasonably level terrain found within ready reach of forest and grazing lands. Such areas include abandoned fluvial terraces (Pangboche, most of Thamichok, and Fortse), and structural depressions (Kunde and Khumjung). In most villages, houses are separated from one another by intervening fields. Namche Bazar is unusual in that it is sited in an amphitheater of uncertain origin with very little level land--houses are

built side by side on the slopes of the amphitheater, facing its center.

Houses, usually of two storeys, are built of unmortared stone and rough-dressed lumber, plastered with a mixture of mud and dung, and roofed with slates, shakes, bamboo matting, or more recently, corrugated metal. The upstairs is the family living space, usually a large room with open hearth for cooking, a bedstead in one corner, benches along one wall for seating and sleeping, and shelves along the facing wall where clothing, bedding, and equipment are stored, and the family's wealth of copper vessels and other precious items is displayed. There may be another upstairs room as well, usually outfitted as the family temple. The lower storey is often used as stable, toilet, and fodder store.

In addition to a permanent village home, most Khumbu Sherpas own other dwellings as well, scattered up and down the valleys in any of more than 50 subsidiary settlements. These are modest structures, often a single room with dirt or sod floor. These subsidiary dwellings were used traditionally by stockkeepers and farmers with fields and grazing lands distant from the home village; today they have other uses as well. People without such a dwelling may make use of tents, sometimes pitched above rock sidewalls, and cave shelters. Although there may be a mix of people from different home villages in the subsidiary settlements, there is a strong tendency for residents of a single village to own houses and fields in the same general area as their neighbors.

In a class by itself is Dingboche, a settlement at 4400 meters where individuals from all villages except Thamichok own or rent a house, fields, or both. It is the main residence for just two families. Dingboche is the only place in Khumbu where barley is grown under irrigation.

There are several important Buddhist temples, *gondas*, in Khumbu. In addition to a gonda in each village, there are monasteries of regional importance at Tengboche, Thami, Kerok, Devouche, Thamo, and Choplung, each with a resident population of

monks or nuns.

Land Use

Very little of Sagarmatha National Park is usable for Sherpa subsistence. More than 90% of the area is rock, glacier, or slopes too steep for use. Yet Khumbu has had Sherpa residents for 450 years, and was probably used by other ethnic groups for livestock grazing and perhaps even some settlement and agriculture before the Sherpas arrived. Although high altitude and the steep elevation gradient impose constraints on Sherpa use of the Khumbu environments, these same factors make for opportunities as well. A series of microenvironments is created by variations in altitude, aspect, and landscape history. Different locations undergo the sequence of seasonal changes at different times and at varying intensities: spring arrives first at lower elevations, and comes progressively later to higher places. By taking advantage of sequential changes Sherpas can schedule their planting, harvesting, and other subsistence activities through an extended seasonal period in a number of different locations, and thus both increase the productivity of a relatively small labor pool and reduce the risk of total crop failure or other environmental disaster.

It is advantageous for the people of Khumbu not to keep all their eggs in one basket, but it requires control of a number of widely dispersed tracts of land of different types. This accounts for the widespread ownership of houses in subsidiary settlements. It is also a reason behind the variety of Sherpa land tenure arrangements. In addition to private ownership of houses and walled fields, there are community controlled lands as well. These include the forest and grazing lands that lie outside the perimeter of the village proper but within village boundaries, as well as grazing and hay-gathering areas up the main valleys and beyond the highest temporary settlements.

Traditionally--and to a diminished extent still--exploitation of such lands for forest products and by livestock was subject to regulation by the community of users. In addition to the lands claimed by individuals and village communities, there have always been true common areas, open to use by all.

Sherpas have always relied on wild land resources as well as on cultivated fields and grazed pasture. Forests supply fir, pine, and juniper for house beams, floor boards, roof shakes, and framing lumber; birch makes tools and kitchen implements; suitably shaped rhododendron becomes pack saddles. Bamboo-like grass from lower elevation forests is gathered and bound in bunches to make brooms. Mushrooms, berries and other fruits, condiments, tea substitutes, medicines, aromatic leaves for incense, and a host of other wild products are collected for use. Stockkeepers without hay fields or the resources to buy fodder are heavily dependent on grass cut from village lands and commons. Everyone relies on forest-supplied fuel wood, which usually consists of small branches rather than chunks of whole trees. Another crucial forest resource is the leaf litter that is raked into mammoth carrying baskets for composting in latrines and lower-storey stables. Juniper branches are an essential element of many Sherpa rituals: they are burned at the start of most ceremonies to create a conspicuous, aromatic smoke plume intended to attract the benevolent attention of local gods. Juniper is also the preferred fuel for funeral pyres.

Society

Sagarmatha National Park Sherpa are a numerically small part of a larger population of about 20,000 dispersed along the south slope of the Himalaya from Sikkim to Helambu that calls itself Sherpa, speaks variations of one language, and has in common a set of shared culture traits. The Sherpas of Khumbu are Tibetan Buddhists living as nuclear to extended families in villages. It is a remarkably egalitarian society, where women and men are essentially coequal, and even young children have

standing. Both women and men are property owners; daughters inherit an equal share in their parents' estate. Children are given a great deal of responsibility at an early age, and are free to engage in their own business deals, play activities, and relations with others--including, for adolescents, sexual relations. Although most tasks may be allocated according to gender (women do most field work, men most construction, for instance) there are no tasks which are exclusively male or female. Men cook, clean, weed, and care for children (most often in the absence of women to do such jobs); women run businesses, trade in India and Tibet, tend livestock in remote areas, hold office in local government. In practical terms, however, there are considerable differences in the daily lives of men and women; roles are defined--if not circumscribed--by gender.

Economy

The traditional Sherpa economy was a three-way dependency on agriculture, animal husbandry, and trade. Today, the picture is somewhat more complicated. This is mostly a result of tourism, which affects almost every household in Khumbu either because of direct involvement in the business of tourists (as guides, porters, hotel- and shopkeepers, or owners of packstock) or indirectly as a result of the tourism-initiated restructuring of the economy. But in many respects the basic patterns are substantially unchanged.

What the earliest cultigens may have been is a matter for conjecture. Perhaps the Tibetan staple, barley, was grown more widely. Buckwheat was probably more important. The *Ariseama* that is presently encouraged as a weed in potato fields was likely cultivated for its edible tuber, which is now processed into a fat, gluey noodle and added to stews. Whatever the historical pattern, it was disrupted in the middle of the 19th century by the introduction of the potato which revolutionized Sherpa agriculture and society. Potatoes, domesticated in the Andes, are adapted to mountain

conditions. In the Himalayas they are out of reach of most of the pests and diseases that evolved with them, and are thus an especially reliable, productive crop. They are planted in the sandy walled fields of Khumbu in early spring, after the compost of forest litter and stable and toilet manure has been dug in. Following harvest four to six months later, the potatoes are sorted and stored in deep pits dug into the fields and insulated with dry plants and earth. Potatoes are prepared in bewildering variety and form the staple of Sherpa diet. They are fed to livestock. Sliced and dried, they are a valuable trade commodity, carried across the pass into Tibet where potatoes are much less easy to grow.

Buckwheat and barley are also grown in Sagarmatha National Park, along with hardy vegetables in the cabbage family: a white turnip, *loh*, that is interplanted with potatoes, and a leafy green that is planted after the potato harvest and cured for winter use. The brief growing season and relatively poor agricultural sites mean that agriculture alone would be insufficient to maintain the people of Khumbu. The location forces other economic activities on the Sherpa people, but it also provides a special benefit: the opportunity for trade.

Trade

Lying on the southern approach to one of a relative few Himalayan passes--the Nangpa La, 5716 meters--Khumbu is strategically placed for transHimalayan trade. Commodities from the lowlands, such as dyes, grains, metals, paper, and other manufactured items, are sought by people in the high, cold, dry lands north of the pass. Tibet in turn is the source for salt, wool, dried meat, and precious religious objects that are necessary to a good life in the lands south of the Himalayas. The Sherpas of Khumbu have traditionally dominated the trade across the mountains, both acting profitably as middlemen in the lowland-Tibet exchange, and also trading their own locally produced items such as dried potatoes taken to Tibet, or Sherpa-

made textiles which are traded south.

The scale of this trade varies, from the individual entrepreneur with a single load to a professional who is part of a far-flung trading network. A trader may be a Thame man who makes the trip over the pass once or twice a year when other work permits (in late fall or late spring), carrying on his own back a load of dry potatoes to trade for salt and barley at Dingri, the closest Tibet-side trade depot. Or the trader may be one of Namche Bazar's specialists, who exchanges high value items from Lhasa for goods from Calcutta, making stops in Kathmandu and Sikkim to buy and sell as part of a trading journey that takes a year or more.

Sherpa trade has changed character through its history as desired commodities change, as the permeability of political boundaries tightens and loosens, and as the options available to Sherpas vary accordingly. When Tibet came fully under China's control in 1959, traffic across the border was stifled at most crossing points. Trade over the Nangpa La diminished but did not cease, although the conditions of exchange became considerably less favorable from a Sherpa perspective, and traditional trading networks based on friendship and long-standing business relations were substantially replaced by strictly controlled government trade depots on the Chinese side. Perhaps the most significant change for Khumbu Sherpas was in the imposition of severe constraints on the export from Tibet of nak--female yak--for it upset what had been a mainstay of both the trading and cattle economy of Khumbu: the exchange of livestock.

Animal Husbandry

Livestock is central to the Sherpa way of life in Khumbu. Not all Sherpas own cattle, and only a few families are even dominantly dependent on livestock, yet agriculture, trade, and nearly every other facet of both the traditional and transitional Sherpa life are intimately tied up with cattle and cattle keeping.

Although several other kinds of livestock have been kept by Khumbu Sherpa--sheep, goats, horses--cattle[1] are by far the most important in terms of numbers, social and economic contribution, and environmental effects. Sherpa cattle include "hilly cattle," small, relatively rugged animals whose genes are most of *Bos taurus* type with varying admixture of *Bos indicus*, yak, and an assortment of yak-hilly cattle crosses.

The yak, a long-haired bovine native to the cold highlands of central Asia, is found in a relatively vast but lightly populated area from the Pamirs to the west, Lake Baikal to the north, east to the headwaters of the Yangtse and Houang Ho, and south to the southern slopes of the Himalayas. In the Sherpa's part of northeastern Nepal, yak are found from a minimum elevation of about 3000 meters to a maximum of more than 6000 meters. The lower limit for yak is determined by their physiology. Their heavy wool and other specialized thermoregulatory mechanisms keep them alive in the extreme conditions of high altitude, but are a liability in warm weather and heavy rain. A further low-elevation constraint on yak is their absence of immunity to lowland cattle diseases. Yak venturing below about 3000 meters run the risk of contracting a variety of water-borne afflictions as well as suffering from their unsuitedness to the warmer climate of lower elevations.

Regular cattle, in contrast, tolerate the temperatures and are somewhat protected from the diseases that plague yak at lower altitudes. Zebu cattle particularly are suited to the lowlands (The Himalayan *Bos Taurus* originates in more temperate landscapes and has some of the yak's sensitivity to tropical conditions). At lowest elevations, only cattle and a bovine of a different genus, the water buffalo (*Bubulus*) are found. But at intermediate elevations, from about 2500 meters to perhaps 3200, yak-cattle hybrids are dominant. These animals, called by Sherpas *zopkio* if male,

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[1] "Cattle" as a generic term in this article means any bovid from the genus *Bos*, which includes *B. indicus*, the hump-backed Zebu cattle of lowland India, *B. taurus*, the more familiar variety of the western range, and *B. grunniens* (formerly *Poephagus grunniens*) the domestic yak (female=*nak*), as well as a wide variety of hybrids. For lack of an alternative, "cattle" in a *nongeneric* sense here is used to mean bovines that are neither yak nor hybrid, i.e., either *B. taurus* or *B. indicus*.

dzum if female, combine many of the virtues of each parent while being free of some of the liabilities. The cow genes confer immunity to the diseases that pure yak can't tolerate, while the yak parent's longer hair and other high altitude adaptations are shared with the hybrid calf. The crossbreeds are classic examples of heterosis (hybrid vigor). They are bigger than either parent. Dzum give milk of greater richness than cow's milk, in far greater volume than nak; zopkios, sterile though not impotent, are more tractable than the males of either of the crossed species, are easier to train to pull a plough, and carry heavier loads than yak. According to Sherpas, the particular characteristics of a given crossbred animal depend on which parent was yak, which cow. When a yak sires a cow's calf, the cross, called *urang*, displays more of the mother's attributes: greater resistance to lowland disease, reduced tolerance to cold temperatures and high altitudes. A bull crossed with a nak produces *dimzo*, hybrids more like their mothers in their ability to cope with the high, cold end of the altitude gradient than with lower regions.

The breeding and sale of these hybrids is the most lucrative part of the Khumbu cattle business. The typical breeder maintains a number of nak, a few yak, and one bull, usually of the dwarf Tibetan type (*Bos taurus*). The resulting dimzo are sold or traded either personally by the breeder, or through an intermediary contractor who buys up the year's crop of calves to sell either in Tibet or at lower elevations in the Nepal hills. Dzum are sought by the cattle-keeping Sherpas of Solu, where lower elevations mean warmer temperatures, more rain, and better conditions for grass which in turn creates better dairying country than Khumbu and a demand for dzum greater than locally produced urang dzum can supply. Tibetans have traditionally been unwilling to breed their own crosses, but value them highly; there is a good market for zopkio across the pass to the north. In recent years, another demand for zopkio has come from within Khumbu, as more and more Sherpas both discover the money-making potential of zopkio as packstock on the trekking route to various tour-

ist destinations within Khumbu, and acquire the surplus capital that permits them to pay the fast-inflating prices of crossbreeds.

The importance of zopkio as pack animals is a new development in the cattle economy of Khumbu, a response to new opportunities in the tourist business. Other uses for livestock remain essentially unchanged.

Milk is not an abundant product of Khumbu nak, dzum, and cows, but what is produced is very important. Although very little fluid milk is consumed except what is added to the morning's sweet tea, a variety of important milk products is produced. Butter is essential to Tibetan ritual: it fuels votive lamps, is the base for sacred sculptures, and is offered to religious personages and dieties. It is also a staple of Sherpa diet, served with potatoes, added to vegetable stews in the absence of meat or animal fat, and the *sine qua non* of butter tea (a robust concoction of vigorously boiled green tea, Tibetan salt, and butter mixed together in a special tea churn and served with, between, before, and in lieu of meals, an inevitable element of all social gatherings). Although a few Khumbu households may occasionally have a sufficient surplus of butter or other milk product which can be used as payment for hired help, there is almost never enough to sell outright; virtually every Sagarmatha National Park household must buy its butter at least occasionally from the vendors who come from Solu, where conditions are more favorable for dairying, to the Saturday market at Namche Bazar.

The wooly hair that protects yak from Himalayan winters is a dividend to Sherpa stockkeepers. The soft inner coat that the animals shed in spring, *phu*, is plucked and saved for spinning. The long guard hairs on the legs, flanks, and tails of both male and female animals, *tshirpa*, is sheared and also spun. The two types of wool are sufficiently different that they are usually spun by different techniques and used for different purposes: men spin tshirpa with a hand-carried drop spindle into a coarse twine that is twisted into ropes or woven into the handsome, durable *charra*,

tarpaulins that are spread with drying grain or pitched as tents; women hand-spin the phu into fine yarn that is then woven into fabric for clothing. Charras are in demand as presents for newly-weds, and command high prices. Old ones, frayed by the generation of use that is the expected lifespan, are patched and made into *puhzie*, sturdy bags in which trade commodities are stuffed for the trip across the Nangpa La.

There are some households in Khumbu whose sole objective in animal husbandry is manure production. Probably for many--if not most--households, the most valuable cattle commodity is dung. Anyone with a potato, buckwheat, barley, or hay field needs it for fertilizer. Most households burn dried dung at least occasionally; for some it is the dominant fuel. Manure mixed with mud is the plaster for houses inside and out, and applied over a framework of rocks makes the kitchen stove as well. Sometimes the animals themselves deliver manure to its desired resting place, as when stock grazes on the post-harvest field stubble, or is confined on winter nights to fenced hay fields, or is stabled on a thick accumulation of leaves in the lower storey of houses. At other times it must be collected, and in the dry seasons gangs of school children go dung-hunting over the slopes where cattle have been grazing.

Calves, labor, milk products, wool, and dung are the primary returns to the Khumbu stockkeeper, but there are others as well.

Sherpas, Tibetan Buddhists whose religion deplores killing, will seldom slaughter their own livestock. They are happy to eat meat, however, and will hire butchers to kill low value or surplus animals, hurry to their inevitable end the second and third generation hybrid calves Sherpas consider worthless, and eat animals killed in accidents or by predators.

Yak tails are a highly valued component of Hindu ritual, an item of interest to tourists, as well as a useful housekeeping tool for Sherpas themselves (they make excellent dusters). For many years Tibet's dominant export to the West was yak tails--used for Santa Claus beards!

When animals are bled, which is done for an assortment of veterinary and religious purposes as well as a means of taming nak, the blood is collected, cooked, and considered a delicacy.

In addition to these and other miscellaneous uses for cattle products, Sherpas value their livestock for yet another purposes: as ritual objects. Stockkeepers have the option of dedicating one or another of their animals to a god. These *tshetar* are fed and cared for as before, but they are never killed, seldom used to carry loads, and otherwise considered to be somewhat sacred.

Management

Given the diversity in livestock ownership and use, the different environments of each village, and the accelerating rate of change in animal husbandry practices, it is difficult to generalize about Sherpa animal management. What follows are very generalized accounts of traditional management practices.

The animal husbandry year begins in early summer--Dawa Shiwa (Fourth Month) of the Sherpa's lunar calendar, late May to early June according to ours--just as the rains are about to begin. A few calves have already been born, and the rest will drop in the next few weeks. All livestock, whether sheep, goats, yak, cows, or hybrids, are banished from each village following a ceremony that begins a season of protection, called *Dee*, for village crops.

All cattle spend the summer months on high pastures, feeding on the grasses and forbs that monsoon rains pull from the slopes and meadows. Summer is grazing time for animals, hay-making time for man. Hay that grows during summer in the manure-enriched walled plots of the subsidiary settlements, called *yersa* ("summer place") is dried and stored in the little stone houses adjacent to many fields. Any Sherpa with a substantial number of animals must have property near these summer

grazing areas, which are also the wintering grounds for yak and nak (for Sherpas, herds of twelve to fifteen animals would be considered substantial). Ideally, the stockkeeper will have a succession of walled hay and potato fields, often with associated small houses, which are an essential concomitant of large scale animal husbandry. He will move his animals from one place to the next, staying no more than a couple of weeks at most of his yersa, moving on when the forage begins to show wear. It is not simply the linear altitudinal migration practiced by transhumanant stockkeepers in other mountain and desert environments. Sherpa cattle may travel up valley, down, and up again during the course of the summer, each owner moving according to his own schedule (with a certain degree of coordination among residents of the same yersa), leap-frogging his neighbor's herds, making several visits to a favored spot.

The summer day begins before dawn for livestock and their tenders. Adult cattle have been kept overnight within the walls of their owner's field. (In some areas adult yak and zopkio not needed for transport may be sent far up into the upper reaches of the glacial valleys that are Khumbu's rangeland, where they will be left to themselves for most of the summer except for an occasional taming visit by someone bringing them salt.) They are released in early morning and shooed to a grazing area within a half hour's walk, where they will feed for a few hours before the females are regathered and returned to the phu for milking. Dzum and nak often hurry back of their own accord, eager to find their calves, which have been confined since the previous night inside their owner's small house. Calves are allowed to nurse for a few moments to begin the flow of milk. Then they are pulled aside and tethered within sight of their mothers while the milking continues--into the Sherpa's wooden milk pail instead of the baby's gullet. Very young and high value hybrid calves are sometimes permitted to nurse for a longer period, but the progeny of dzum, second-generation crosses of low value to Sherpas, are sometimes prevented entirely from feeding. (A common technique for eliminating such worthless calves calls for starving the young

animals for a few days, then permitting them to nurse or freely feeding them the residual whey from butter-making, either of which causes the calf to bloat and die--suicide rather than murder to the Buddhist Sherpas.) Most of the morning milk is immediately scalded, sometimes strained, then cooled slightly and poured into a container reserved for yogurt making. It is then left for the day, wrapped cozily in the synthetic pile jackets and down sleeping bags that are the booty from family involvement in trekking and expeditions. Later the resulting cultured yogurt will be churned into butter and packed away. The buttermilk is heated again until it sets as soft curd that is dried or smoked into *churpi*, a jaw-breaking product that is snacked on by travelling Sherpas, added to stews, and mixed with barley tsampa, rice beer, and the dried root of a Tibetan *Potentilla*, called *jtoma*, to make a festive breakfast concoction. Some milk is used immediately for the milk-and-sugar tea that has displaced salt tea in the past decade as most Khumbu Sherpa's first morning beverage. A little milk may be set aside for the making of a soft cheese, *somar*, which is accumulated in a special crock (sometimes a skin container) where it rots away quietly until it reaches the relished degree of ripeness.

Once milking is finished, the animals are once again escorted away from the yersa to graze. In some localities someone stays with the cattle to watch for predators and other hazards. In other areas, the animals are left unsupervised; not surprisingly, losses to predators are higher in such areas.

Like stockowners everywhere, Sherpas are plagued with predators. The greatest threat, according to Sherpas, comes from three in particular which are not merely animals, but agents of angry gods: wolf, snow leopard, and yeti--the abominable snowman, legendary in the remote Himalayas. The evidence for yeti predation still eludes dispassionate science (although it can be fairly compelling to Sherpas and others), but both snow leopard and wolves have undoubtedly accounted for losses. Today, snow leopards may be missing entirely from Sagarmatha National Park; there

has been no sign for several years. Forest leopards, which used to come up as far as Kunde and Khumjung, and picked off dogs wandering Namche's streets at night, are also much more scarce (alas--as anyone who has tried to sleep through the dog-yappy night in Namche Bazar can attest). But canid predators are relatively common. Jackels, feral dogs, and wild dogs of possibly two types are potential predators of young stock. The most conspicuous predator, thought to be responsible for numerous attacks on animals as big as full grown nak and hilly-cattle bulls, is the wolf. For about five years, until the winter of 1984 when he was joined by several emigrants from Tibet, a single widower wolf was supposed to be responsible for a trail of stock losses and maimings that included every corner of Khumbu. His trademark, evidence of a failed attempt, is found on an amazing number of yak, nak, zopkio, dzum, cows, and bulls: a missing tail (the wolf attack comes from behind, making the streaming tail of a fleeing nak the first available piece to grab; the wild dogs, by contrast, hunt in packs, and encircle and disembowel their standing victims). There is a tendency for livestock owners everywhere to exaggerate their casualties to predation, and it seems certain that if the Khumbu wolf has really been responsible for all the damage credited to him, he must indeed be god-propelled. But it is also certain that wolf predation is a serious concern of Sherpas, and a real threat to their livestock. Before the national park's establishment made it illegal, and in spite of their religion's proscriptions against killing, the successful hunter of a wolf or snow leopard was rewarded by his grateful neighbors. Still scattered around the high grazing areas are wolf traps: a heavy rock is balanced on a slender prop, bait is placed beneath, and a knife-edged stone is set so that if a wolf takes the bait and unbalances the prop--and waits long enough--the stone will drop on his head and push his neck into the sharp edge beneath. (No one has ever known it to work, but making traps is entertainment for herders without a lot of other projects, rather like the inverted cairns and aspen-bark grafitti of sheepherders in the American West.) Wolf-scares resembling cornfield scare-

crows are posted around yersa, and other wolf repellents are also sometimes tried. One technique requires that a rope or string be strung around the place where stock is bedded. In addition to vigilance, folk remedies, traps, and bounty hunting, Sherpas call on other help in coping with predators. There is reportedly a daily ceremony performed in Tengboche gonda designed to placate gods who might otherwise send a vengeful agent.

During summertime at the yersa, there are other tasks than milk making and predator surveillance. Dry manure must be pulverized and spread over the hay fields. Potatoes must be planted and weeded at those yersa where residents grow them for winter feeding of animals and herders. The long hairs from the flanks of yak and nak must be sheared; during summer, no man is without a wad of tshirpa wrapped around his wrist, which he spins as he walks, talks, sits watching over his animals. During sunny parts of the day (relatively infrequent in this monsoon climate) a woman may set up her backstrap loom in the field next to her house and weave the coarse yak hair into charras. Then there are all the things to do to maintain the people staying at the yersa. There is water to carry, fuel to collect, tea to make, potatoes to boil, ceremonies to prepare, shopping to do--every few weeks someone must take a pack animal or two and go to the weekly market at Namche for supplies. Some tasks are shared among the temporary residents of a particular subsidiary settlement. Although they may come from different home villages, yersa residents are likely to have spent many summers in each other's company, sharing work and ritual, and bound by strong ties of friendship--or by more formal ties, since it is during summer that young men and women are most together, forming romantic attachments that often lead to marriage. Cooperation is required for some jobs, such as animal breeding and hay harvest.

Hay is cut at the end of summer monsoon, when the weather is dry enough for the grass to cure. This is the year's most crowded season, for in addition to hay cut-

ting, it is harvest time first for barley, then potatoes and buckwheat; it is also the beginning of the expedition season, when animals and men are in demand for load carrying. Demand for labor exceeds the available bodies, wages are high, and stockowning households especially are pressed to finish the season's work. The harvest marks the end of the summer pattern of animal management. For the rest of the year, yak and nak will be handled differently from crossbreeds, and there is more variation in the practices of stockowners from different villages.

By October, most stockowners and their animals will be back in the neighborhood of their home villages. For some *nakpa*–cattlemen with herds of yak and nak–this period home may be very short, a matter of a few weeks. Then they will move off again, to begin the fall-winter-spring cycle of shifting grazing. The summer leapfrog movement pattern prevails in winter as well, but then it is hay stores and weather conditions rather than forage availability that determine herd movements. *Dzumpa*, as stockowners with herds of crossbreeds are called, are comparative stay-at-homes. Their animals are less sturdy than pure yak, and must remain at lower elevations. Their owners do not have so critical a need for hay fields and subsidiary houses, and hybrids spend a greater proportion of the year within a few hours' graze of their main village. The typical dzumpa household keeps livestock as a concomitant to other economic activities, particularly tourism; large nak herds, on the other hand, with more than perhaps fifteen animals, are often the primary source of subsistence for their owners who are likely to be less heavily involved in trekking and expeditions. Nakpa in consequence manage livestock in more traditional ways for more traditional uses. Crossbreed management is a less traditional, more variable matter, and it is in today's transitional patterns of crossbreed management that the greatest potential for environment disruption lies.

Animal Husbandry and Environmental Problems in Sagarmatha National Park

Animal husbandry practices, in common with other facets of Sherpa culture, have never been static, but have altered in response to changing factors of production in such a way as to maintain a dynamic balance between livestock-related resource exploitation and the limits of environment. The long history of Sherpa livestock use in Khumbu has not been without environmental effect. Most areas that have been grazed over the years show the effects of that use in grazing-modified floral composition, trails, trampled heavy use areas, and other ramifications of the long-term presence of livestock. But those changes came about at a rate that permitted a compensating adjustment in the natural landscape. Today the pace of change is accelerating. The traditional systems of resource management that regulated use and helped to prevent wholesale exploitation of the Khumbu environment have lost their effectiveness, and nothing has taken their place, despite efforts from concerned foreign philanthropists, agents of His Majesty's Government, and worried Sherpas. The accommodation of cattle business to environmental constraints is no longer being carefully made. New animal management patterns, such as those associated with growing numbers of crossbreed packstock, or with the scarcity of experienced labor, have considerable destructive potential. Unless something happens soon to reinforce and restore traditional protections against overuse of natural resources like grazing lands, serious environmental problems will be the inevitable result. Khumbu Sherpa and the landscape of Sagarmatha National Park will pay the price of a society out of balance with nature.

Sherpa Glossary*

charra sturdy woven blanket/tarpaulin made from tightly spun hair of yak and sometimes sheep

churpi cheese made from nak, dzum, or cow's milk that is dried rock hard

dee boundary line establishing seasons of protection for Sherpa agricultural and grazing lands

dimzo F1 hybrid of nak and bull, the most common crossbreed bred in Khumbu

dzum female yak/cattle cross

dzumpa people who keep dzum: cattlemen with crossbreed herds

jtoma dried root of a Tibetan *Potentilla* important in Sherpa ritual and cuisine

loh a white turnip intercropped with potatoes and eaten by both people and livestock

nak female of the bovine we know as "yak"--*Bos grunniens*

nakpa nakmen--cattlemen owning mostly yak and nak

phu subsidiary settlements owned and used by cattlemen, especially nakpa also, soft short body hair of yak

puhzie large sturdy bag made from worn charra used to transport and store such traditional trade goods as salt and barley

somar cultured milk product, *very* well ripened

tshetar any domestic animal dedicated by its Sherpa owner to the gods, and thereafter cared for but not much used

tshirpa long, coarse hair cut from the flanks of yak

urang F1 cross of yak and cow--the hybrid commonly produced by breeders at lower elevations than Khumbu

yak male of the bovine species *Bos grunniens*

* Spellings are in large part the author's inventions and do not represent scholarly transcriptions.

yersa summer settlement

zopkio male of the yak/cattle hybrid bred by Sherpas

MAN, YAK, AND MOUNTAIN:
Sherpa Pastoralism in Sagarmatha (Mt. Everest) National Park, Nepal

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KEY TO SLIDES

1. Title slide

2. Title slide

3. Title slide

4. Title slide

5. Location map: Nepal

6. Khumbu map

7. Landsat detail: Khumbu Himal (Sagarmatha--Mt. Everest--National Park)

8. Sagarmatha--Mt. Everest (8848 m -- 29,028 ft)

9. View rom Kala Patar: Khumbu Glacier; Kantega (6685 m) and Tamserku (6608 m) rising above the cloud-filled Imja Khola Valley

10. Kantega and Tamserku emerging from cloud: *Abies spectabilis* in foreground

11. Ama Dablam (6856 m) rises 5000 meters above the ridge on which Tengboche Monastery was built in the 1930s

12. Namche Bazar (3440 m), mercantile center of Khumbu; Tamserku is the background peak

13. Khumjung (3790 m) in summer. Villagers are constructing a new chorten in the foreground; fields behind are potatoes (dark green) and buckwheat (paler)

14. Upper Pangboche (3985 m): sacred juniper forest in foreground: red-painted *gonda* in center

15. Thame Og's houses and potato and hay fields (3800 m) are located on the flat created by deposition behind the terminal moraine of a former valley glacier.

16. Fortse's 55 houses (3840 m) occupy a hanging fluvial terrace

17. Summer view of Fortse (above) and Teshinga (3440 m), a subsidiary settlement at lower altitude where Kunde and Khumjung residents can be plant and harvest crops before higher fields are ready--land use that both increases the efficiency of labor and provides insurance against wholesale crop failure

18. Pheriche (4243 m) is a high altitude subsidiary settlement (constructed on the same sort of glacial moraine-dammed flat that Thame Og occupies) where potatoes and hay are harvested later than in main-village fields

19. High settlements Chhulung Marsal and Chhule (4470 m) at the far end of the Bhote Kosi Valley (the route to the Nangpa La) used by cattlekeepers from Thamichok

20. Gokyo (4750 m), squeezed between the Ngozumpa Glacier and Gokyo Tsho (lake)--in summer

21. Sherpa audience at Mani Rimdu

22. Man of Tangmiteng, with the silver prayer wheel he spins to gain merit according to the tenets of his religion, Tibetan Buddhism

23. Sherpa woman in traditional workday dress; her hired Kami helper stands behind

24. The staff of a commercial trek to Everest, including mostly Sherpas of Kunde and a few Namche Tibetans

25. Pemba Noru Sherpa, cattleman of Thangmiteng (wearing a synthetic pile jacket acquired during one of his trekking jobs)

26. Tengboche at the fall performance of Mani Rimdu (a Tibetan dance-drama), with Nuptse, Everest, and Lhotse visible above the roof of the *gonda*

27. House under construction in Kunde: rough-dressed stone is being covered with a mud-and-dung plaster

28. Potato harvest, Namche Bazar

29. Dingboche's checkerboard of irrigated barley and potato fields

30. Harvested potatoes of two varieties: *rigi seru* (yellow) and *rigi moru* (red)

31. The highest cultivated potatoes? At Chukhung, 4750 m

32. Potato harvest at Dingboche--everybody helps

33. Tibetan "black" barley

34. Readying harvested barley for threshing

35. Making the staple *tsampa*--parched barley milled to meal

36. Traders crossing the Nangpa La with loaded yaks--a painting by Khumjung's Kappa Passang

37. Two perfectly matched yak with ideal horns

38. Hardy yaks at snowy dawn in Arye (Bhote Kosi Valley)

39. An adult yak in the lean season

40. A zopkio--male hybrid of yak and cow--with a ring in his nose, typically required only for hard-to-manage animals

41. A *lang*, or bull, of the dwarf Tibetan cattle type

42. Weaving a *charra* (coarse, sturdy blanket/tarp) of yak *tshirpa*

43. Milking a dzum at Chukhung (the calf is staked nearby)

44. Dzum with newborn calf (the F2 hybrid of no value in Sherpa animal husbandry, and therefore expendable)

45. Zopkio drawing a plough across Pangboche buckwheat fields [Kern Hildebrand photo]

46. Loaded yaks on the trail. These animals carry potatoes from Tarnga (4050 m), subsidiary settlement where most of Khumbu's commercial potato production (these potatoes will supply tourist hotels in Namche Bazar)

47. Pack animals with trekking group loads bound for Mt. Everest

48. Yak, like these two with trekkers' baggage, are the best packstock for highest elevations

49. Zopkio, like this animal, can travel safely to lower elevations, and are increasingly used in the transport of expedition and trekking gear in Khumbu (Tengboch Monastery in the background)

50. Wolf trap: predators including wolf, snow leopard, and yeti plague Sherpa cattlekeepers yet are protected by the national park as valued members of the natural high mountain animal community

51. Sherpani (Pemba Noru's sister) with yaks and naks at Absona

52. The dark, vegetated slope in the center is Kala Patar, trekker destination and former summer livestock grazing area

53. At dawn, cattle of all types are released for free range grazing

54. These yak, grazing on grass barely higher than the pile of velvet, demonstrate the yak talent for "lapping up" short forage

55. Zopkio have more catholic forage tastes than pure yak; this animal is browsing on the shrub *Piptanthus*, which yak will not eat

56. High alpine flora (>5000 m): *Meconopsis horridula* (spiny poppy), *Waldheimia* spp., and *Leontopodium* (eidelweiss)

57. Juniper-Rhododendron scrubland; subalpine vegetation is dominated on many sites by colorful and diverse rhododendron of several species

58. Absona is a subsidiary settlement used intermittently throughout the year by three yak-keeping families from Thamichok.

59. Subsidiary settlement squeezed between the Ngozumpa Glacier's lateral moraine and the adjacent slope

60. Nuptse (7879 m) and Lhotse (8501 m) loom above several subsidiary settlements used by villagers from Pangboche and Khunde

61. A cattleman's neglected stone hut at Lhabarma (4400 m); *Primula sikkimensis* are the tall yellow flowers

62. Summer monsoon transforms high pastures like these above Gokyo; Cho Oyo (at 8153 m, one of the world's highest peaks) heads the valley

63. Yak at Chullung Marsal in late winter. For Khumbu cattlemen, winter is the crux season when unusually severe weather can prevent animals from grazing

64. When weather permits, yak and nak are sent out to graze following snowfall: strong animals force a path to slopes swept clear of snow by the wind

65. During the cold season, livestock are given some supplementary feeding; these yak at Arye are getting a small ration of hay

66. Hayfield at Pheriche: a high diversity of grasses (dominated here by *Elymus* and *Poa* spp) and forbs grow on well-manured ground waiting late summer harvest

67. Crop residues, such as these buckwheat stalks stored out of animal reach in Fortse, are also fed to livestock

68. Generations of grazing animals and pursuing children created this network of intersecting trails

69. Elsewhere in Nepal, such as here near Yarsa in the middle hills, human use through commercial lumbering, expanding agriculture, livestock feeding, and other practices creates moonscapes like this, but in Khumbu, environmental problems are much less pressing

70. RNAC's Twin Otter aircraft at Lukla with embarking trekkers who, along with mountaineering expeditions, government installations, immigrant Tibetans, and local people, help to contribute to the environmental problems that SNP does have

71. Tourists' use of scarce wood resources for fuel is one problem that is addressed by regulations of HMG staff of SNP: this wood pile will feed trekkers at Pheriche

72. The environmental effects of tourist demands for the services of pack animals, which are serious, have not yet been regulated: here, animals are packed at Namche Bazar with loads for Everest Base Camp

73. Negative impacts are likely to follow when packstock transport expedition loads to the highest and most fragile alpine areas, such as here at Lobuche

74. SNP headquarters on the rounded hill above Namche Bazar; army barracks, an elementary school, and a police post are also visible in this picture

75. National Park efforts to protect the environment have concentrated on forest protection and restoration: this walled plantation next to Kunde was planted with fir and pine in 1981, and replanted in 1985 when the first trees failed to thrive

76. Two national park plantations above Namche: the conspicuous rectangle on the right, established in 1983, and the irregular walled area to the left. The village-adjacent siting reflects the park's wish to use the plantations as demonstration projects to arouse local interest in reforestation, but also make the plantings vulnerable to livestock damage, for livestock use is concentrated increasingly around villages

77. One of the SNP nurseries, where several species of trees are grown for later planting in protected plantations

78. Fir, like these seedlings of *Abies spectabilis*, are part of the native flora, and likely to do well if they survive the chomping of cows and hybrids which in contrast to grass-eating yak and nak like to resinous new growth of these conifers

79. This Sherpani shepherdess is growing up during decades of change for Khumbu, when the traditional ways of her parents yield to the mix of old ways and new that her children will inherit. Careful livestock management can mean that Sherpas can continue to raise cattle without damage to the environment of SNP: an international park that is their ancestral homeland

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