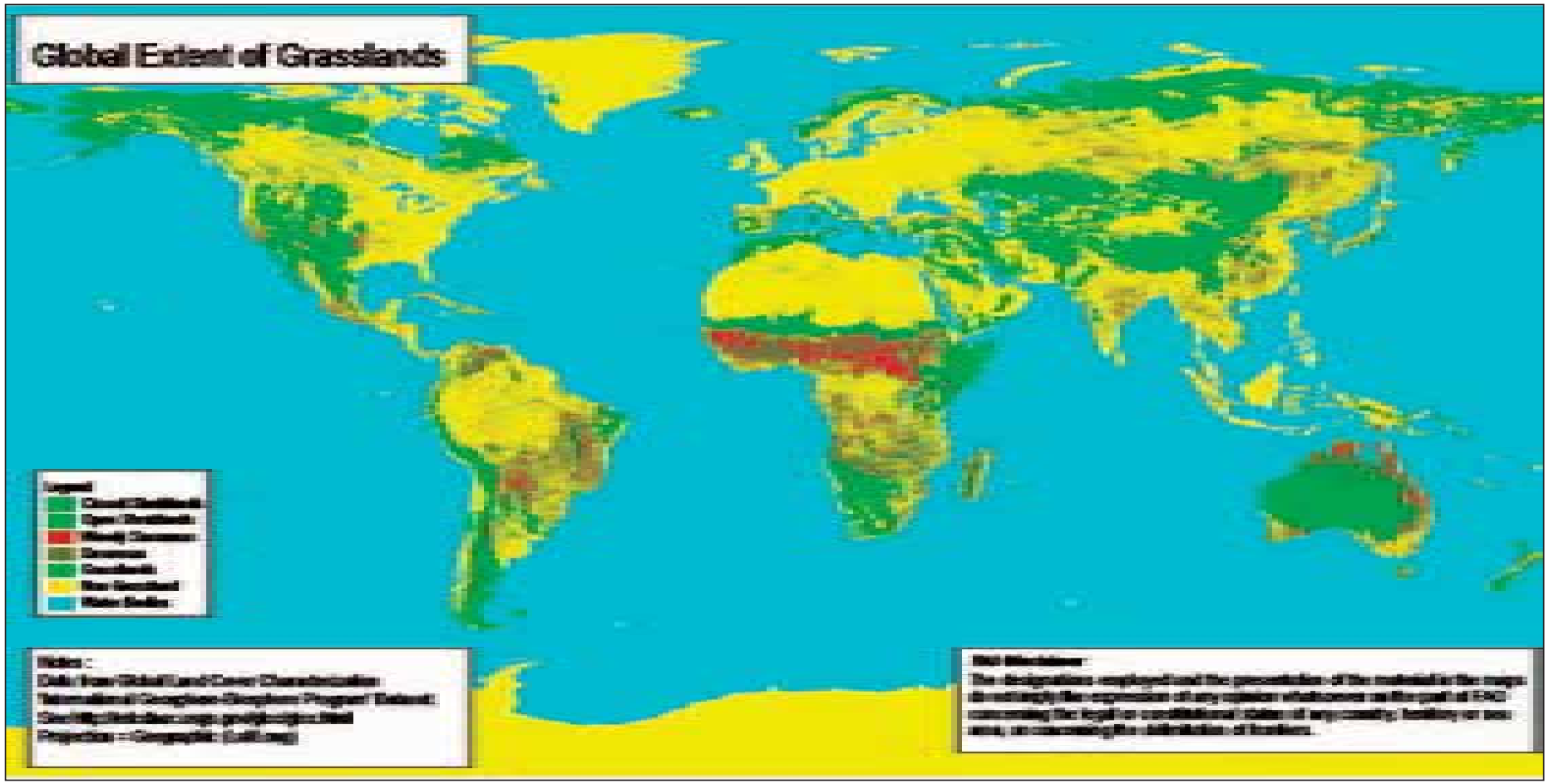

Figure 1.1
Extent of the world's grasslands.

Chapter 1
Introduction

Grasslands in the wider sense are among the largest ecosystems in the world (Figure 1.1); their area is estimated at 52.5 million square kilometres, or 40.5 percent of the terrestrial area excluding Greenland and Antarctica (World Resources Institute, 2000, based on IGBP data). In contrast, 13.8 percent of the global land area (excluding Greenland and Antarctica) is woody savannah and savannah; 12.7 percent is open and closed shrub; 8.3 percent is non-woody grassland; and 5.7 percent is tundra.

In its narrow sense, "grassland" may be defined as ground covered by vegetation dominated by grasses, with little or no tree cover; UNESCO defines grassland as "land covered with herbaceous plants with less than 10 percent tree and shrub cover" and wooded grassland as 10–40 percent tree and shrub cover (White, 1983). In this study, grassland is used in its wider sense of "grazing land". Definitions of grassland and the associated term "range" are multitude, many with specific local legal connotations; the Second Expert Meeting on Harmonizing Forest-related Definitions for use by Various Stakeholders (FAO, 2000) gives eleven pages of them. The Oxford Dictionary of Plant Sciences (Allaby, 1998) gives a succinct definition:

> *"Grassland occurs where there is sufficient moisture for grass growth, but where environmental conditions, both climatic and anthropogenic, prevent tree growth. Its occurrence, therefore, correlates with a rainfall intensity between that of desert and forest and is extended by grazing and/or fire to form a plagioclimax in many areas that were previously forested."*

S.G. REYNOLDS

Plate 1.1
Grasslands – sheep on spring grazing.

S.G. REYNOLDS

Plate 1.2
Mosaic of cultivated cropland and grassland.

This study has been undertaken by the Grassland and Pasture Crops Group of FAO and grassland is taken to be grazing land. The emphasis is on extensive grazing lands (Plate 1.1) since these form large, identifiable units. Unsown grassland that occurs as a mosaic of uncultivated patches within farming land (Plate 1.2) is not dealt with here, but it is nevertheless important in smallholder systems as a source of livestock feed; in commercial systems it is more important as a wildlife habitat and a refuge for biodiversity.

No grassland is entirely natural, and there are many degrees of interference: fire, whether spontaneous or lit by man, has influenced, and continues to influence, large areas; and grazing by livestock and, in some continents, by large herds of wild herbivores. More invasive interventions have been clearing of woody vegetation either to give better grazing or originally for cropping; subdivision with or without fencing; provision of water points to extend the grazing area or season; and various "improvement" techniques such as oversowing with pasture grass and legume seeds – with or without surface scarification and fertilizer. In the early days of FAO, Semple (1956) summarized much of the available techniques and problems, and most are relevant today, although some technologies have progressed in detail. In general, grassland is said to be natural if it is not the result of full ploughing and sowing – the composition of much old sown pasture has, of course, little to do with the seed mixture used at its establishment.

The better-watered parts of many of the world's great grassland zones have been developed for arable farming, notably in the North American Prairie, the South American Pampas, and the East European Steppe, and grazing is now often relegated to the more marginal lands, unfit for cropping, where

J.M. SUTTIE

Plate 1.3
Milking at a transit camp on the way to summer pastures in Tarialan, Mongolia.

the population is often totally dependent on livestock for its livelihood. In Africa also there is little extensive grassland uncultivated in regions where the rainfall permits the production of even meagre subsistence crops. The effect of developing the best land for crops has several negative effects on the use of the remaining land for grazing, including obstructing traditional migration routes in zones of transhumance and denying access to water points.

The terms "nomadism" and "transhumance" are sometimes used indiscriminately when applied to mobile livestock production systems. Transhumance describes those pastoral systems where people with their animals moved between two distinct seasonal pasture areas, usually at considerable distance or altitude from each other (Plate 1.3). Nomadism is used for pastoral groups that have no fixed base, but follow erratic rain storms.

Great grazing lands still exist, however. Among the most important are the steppes that stretch from Mongolia (Plate 1.4) and northern China to Europe; the Tibet-Qinghai Plateau (Plates 1.5 and 1.6) and the adjacent mountain grazing of the Himalaya-Hindu Kush (Plate 1.7); the North American prairies; in South America – the Pampas, the Chaco, Campos (Plate 1.8), Llanos and Cerrados pastures, the cold lands of Patagonia (Plate 1.9) and the Altiplanos; the Australian grasslands; in the Mediterranean Region and western Asia there are large areas of semi-arid grazed land; south of the Sahara there are the vast Sahelian and Sudano-Sahelian zones, as well as most of the eastern part of Africa from the Horn to the Cape.

Two fairly important types of grassland are not dealt with. Very large areas in the tropics are covered by *Imperata cylindrica,* often in nearly pure stand; this relatively unpalatable, strongly rhizomatous grass is hard to eradicate,

S.G. REYNOLDS

Plate 1.4
Horse herd on grasslands near Arkhangai, Mongolia.

PETER HARRIS

Plate 1.5
Grasslands on the Qinghai Plateau, China.

burns easily and thus makes the re-establishment of forest cover difficult. It usually establishes itself when forest has been cleared, often for crop production. It occurs throughout the tropics; the total area has not been established, but Garrity *et al.* (1997) estimate that the area of *Imperata* is 35 million hectares in Asia alone. There are also large areas of potential grazing in the herbage under tree crops (Plate 1.10), mainly in the tropics; some is used, but much is not yet exploited for livestock production; this is dealt with in detail in another FAO publication, *Pasture – cattle – coconut systems* (Reynolds, 1995).

Extensive grazing is usually the exploitation of managed natural ecosystems on which human activities may have had a considerable impact to facilitate or

S.G. REYNOLDS

Plate 1.6
The high plateau near Lake Namtso, Tibet Autonomous Region, China.

S.G. REYNOLDS

Plate 1.7
Subalpine pastures at Suri Paya, Kaghan Valley, Pakistan.

improve livestock production; it is a land use, not a specific crop, and must, for example, compete with crops, wildlife, forestry and recreation. The choice of use is not fixed and depends on economic factors as well as soil and climate. It is usually on land unsuitable for intensive cultivation because of topography, poor soil or a short growing season – the season may be limited by moisture availability or temperature. Exploitation by the grazing animal is, in many countries, the principal practical method of exploiting the natural vegetation of arid, stony, flooded, montane or remote areas. It follows, therefore, that all discussion of grassland must be in the context of animal production and of the human communities that gain their livelihood thereby (Riveros, 1993).

ELBIO BERRETTA

Plate 1.8
The Campos – winter scene on the Basaltic Campos in the north of Uruguay.

PABLO BORELLI

Plate 1.9
Patagonia – sheep being herded on the Magellan steppe, near the Coyle river.

Sown pasture (Plate 1.11) is important within commercial arable farming systems, and, since it competes with other crops for land and inputs, must be economically viable compared with other crops at the farm-system level. In well-watered areas it may replace natural grassland, often in association with crop production. Sown pastures are usually most productive in their early years and yields fall off thereafter; to remain productive they require careful management and inputs, with or without periodic resowing; they usually

S.G. REYNOLDS

Plate 1.10
Cattle grazing under coconuts.

S.G. REYNOLDS

Plate 1.11
Improved pastures – Brazil.

also need fencing and water reticulation. Since grazing requires fairly large, enclosed areas to be managed effectively, sown pasture is not really suited to smallholder farms.

Sown fodder, often irrigated in semi-arid areas, can provide conserved fodder for winter use, and examples are given in the chapters on North America, Patagonia, Russia and the Campos. Fodder growing is traditional in some smallholder areas, but, unlike sown pasture, fodder can be used on any size of farm, not only large ones, whether for use green or conserved; how it has

S.G. REYNOLDS

Plate 1.12
Inner Mongolia – meadow hay prepared by herders for winter feeding.

S.G. REYNOLDS

Plate 1.13
Straw stacked for use as winter feed – Muzaffarabad, Pakistan.

become very important economically in the Pakistan Punjab is described by Dost (2004). Hay from natural meadows has been used by herders (Plate 1.12) for a very long time, but traditional pastoralists do not usually sow fodder; Wang (2003) describes an interesting scheme in the Altai region of Xinjiang in China, wherein Kazakh herders produce alfalfa (*Medicago sativa*) hay for winter feed on irrigated lowlands while maintaining their spring to autumn transhumant migration.

Crop residues, especially straws and stovers (Plate 1.13), are very important as livestock feed in both commercial and traditional systems; in commercial farming they are usually part of the roughage ration and supplemented with

other fodders and concentrates; in traditional subsistence systems they may be the main feed when grazing is not available. In the irrigated lands of southern Asia, crop residues are often the main feed of large ruminants year-round. Residues are not discussed in detail in most of the studies, but their conservation and use is described in a recent FAO Grassland Group publication (Suttie, 2000). In some extensive grazing systems with adjacent cropping zones, crop residues may also figure as lean-season feed. Lean seasons vary: in some areas it is winter; in tropical areas it is the dry season; and in Mediterranean zones it is the hot, dry summer. It is, of course, much more important in agricultural and mixed farming areas. Crop residues and stubbles are important in West African transhumance systems and there is a complementarity between cropping and stock rearing communities: herders move north into the desert fringe during the rains (and the season when the crops are on the ground) and move back to the agricultural areas after harvest, in the dry season; traditionally the farmers did not keep livestock.

Some studies reported here, notably those on the Campos, North America and Australia, describe how exotic pasture plants have been introduced to grassland, often with fertilizer application and varying degrees of scarification of the surface and checks to the native vegetation, and have become naturalized. With an increasing interest in maintaining biodiversity and protecting native vegetation, attitudes to introduced "improving" plants may be changing. A primary quality of an improving plant is its ability to spread and colonize natural vegetation; now such qualities may cause a plant to be listed as an invasive alien.

Grazing systems can be roughly divided into two main types – commercial and traditional, with the traditional type often mainly aimed at subsistence.

Commercial grazing of natural pasture is very often large-scale and commonly involves a single species, usually beef cattle or sheep, which would mainly be for wool production. Some of the largest areas of extensive commercial grazing developed in the nineteenth century on land which had not previously been heavily grazed by ruminants; these grazing industries were mainly developed by immigrant communities in the Americas and Australasia, and to a much less degree in southern and eastern Africa.

Traditional livestock production systems are very varied according to climate and the overall farming systems of the area. They also use a wider range of livestock, since buffaloes, asses, goats, yak and camels are predominantly raised in the traditional sector. All species are discussed in the various chapters, but buffalo, of which there are 170 million worldwide (FAOSTAT, 2004), are little mentioned since most are kept in agricultural or agropastoral systems in tropical and sub-tropical Asia (only Egypt and Brazil have significant numbers elsewhere), and are fed largely on crop residues, not on grasslands. In traditional farming systems livestock are often mainly kept for subsistence and savings, and are frequently multi-purpose, providing

J.M. SUTTIE

Plate 1.14
Mongolia – the higher altitude summer pastures of Turgen are used to avoid the insects in the lower Uvs lake basin.

meat, milk, draught, fibres and frequently fuel in the form of dung-cakes. In many cultures the number of livestock is associated with social standing.

Many traditional systems are sedentary, and these are usually agropastoral, combining crop production with livestock that can utilize crop residues and by-products and make use of land unsuitable for crops. Extensive grasslands, however, are frequently exploited by mobile systems, transhumant or nomadic, where herds move between grazing areas according to season; some move according to temperature, others follow feed availability. Other factors may affect migratory movements: in the Great Lakes Basins region of Mongolia, herders have to leave the low grazing lands near Uvs lake and go to the mountains in June because of plagues of biting insects (Plate 1.14), returning to the lakeside in autumn, but having to move to the mountains in winter to avoid the very low temperatures of the basin (Erdenebaatar, 2003). Two areas of mobile herding are described in the chapters on Mongolia and the Tibet Plateau. Mobile herders often keep mixed flocks, as this helps reduce herding risk as well as making a fuller use of the vegetation on offer – the various species may be herded separately.

Political and economic changes over the past 150 years have had a marked effect on the distribution, condition and use of grasslands and these are described in most of the chapters. Settlement, ranching and the inroads of cropping into former grassland have been mentioned above. Former colonies have gained their independence and states that had been under absolute rulers have become democracies; this has often led to the breakdown of traditional authorities and grazing rights, raising the problems of privately owned live-

stock on public land. The great grazing lands of Central Asia, China and the Russian Federation have gone from feudal systems to collective management and then, in the past twenty years, to decollectivization and privately owned stock – approaches to management and grazing rights have varied from country to country and some are described in the chapters on the Russian Federation, Mongolia and Tibet Autonomous Region, China.

The herbaceous layer of grazing lands is usually, but not always, grasses; several other plant types cover large grazed areas. Cyperaceae, especially *Kobresia* spp., dominate many of the better-watered, hard-grazed yak pastures, especially those of the alpine meadow type. Halophytes, notably Chenopodiaceae, both herbaceous and shrubby, are important on alkaline and saline soils in many arid and semi-arid grazing lands. In tundra, lichens, especially *Cladonia rangifer*, and mosses provide reindeer feed. Sub-shrubs are important: various species of *Artemisia* are important in steppic regions of the old world from North Africa to the northern limit of the steppe, and also occur in North America. Ericaceous sub-shrubs (species of *Calluna, Erica* and *Vaccinium*) are very important grazing for sheep and deer on UK moorland.

Browse is frequently mentioned as a significant feed source, often consumed in the lean season and in some cases fruits are also eaten. Tree fodder is especially important in tropical and sub-tropical situations with alternating wet and dry seasons and is discussed in the chapters on Africa and Australia (where it may be referred to as "top feed"). Various mixed shrub formations (garrigue, maquis) are grazed in the Mediterranean zone. Trees and shrubs, notably *Salix* spp., are also winter feed in some cold areas.

Extensive grasslands have multiple uses in addition to being a very important source of livestock feed and of livelihoods for stock raisers and herders. Most grasslands are important catchment areas and the management of their vegetation is of primordial importance for the water resources of downstream lands; mismanagement of the grazing not only damages the pasture, but, since it increases erosion and run-off, can cause serious damage to agricultural land and infrastructure lower in the catchment and cause siltation of irrigation systems and reservoirs. The main benefits of good catchment management mainly accrue to communities outside the grasslands, but the maintenance efforts have to be made by herders or ranchers. These grasslands are major reserves of biodiversity, providing important wildlife habitat and *in situ* conservation of genetic resources. In some regions, grasslands are important for tourism and leisure, and may have sites of religious significance (Plate 1.15); in other areas, wild foods, medicines and other useful products are collected (Plate 1.16).

Grasslands are a very large carbon sink at world level. Minahi *et al.* (1993) state that they are almost as important as forests in the recycling of greenhouse gasses and that soil organic matter under grassland is of the same magnitude as in tree biomass; the carbon storage capacity under grassland can be increased by avoiding tillage.

S.G. REYNOLDS

Plate 1.15
*Stupas (*Mane *in Nepali) at Sailung in Ramechap district, Nepal, at about 3 000 m altitude, used by Buddhists to offer prayers for peace.*

PETER HARRIS

Plate 1.16
Drying herbs at the summer camp, Qinghai.

PURPOSE OF THE BOOK

This book is primarily aimed at agricultural scientists, educationalists, extensionists and decision-makers with interests in the grassland and land-use fields. It brings together information on the characteristics, condition, present use and problems of the world's main natural grasslands. Since grassland is commercialized through grazing livestock, particular attention is paid to the livestock production systems associated with each main type. Grazing resources do not, of course, consist solely of the edible herbage – many other factors have to be taken into account, notably water in all areas and shelter in winter-cold climates. Seasonality of forage supply is a characteristic of almost all grazing lands so the strategies for dealing with lean seasons are described. The main problems of each type are described and possible strategies for their sustainable management discussed – taking into account their multiple functions beyond simply livestock production.

STRUCTURE OF THE BOOK

Nine area or country studies are presented as full chapters.

Chapter 2 covers eastern Africa in its wider sense from Eritrea and southern Sudan to Rwanda and Burundi. These comprise extensive semi-arid to arid grasslands, savannah, bushlands and woodlands, but also include the natural grazing areas of the extensive highland areas of the region, which are also pastoral rangelands. Stock rearing is traditional and has been a major land use for a very long time. The population is very varied; pastoral groups tend to be of different ethnicities from agricultural or agropastoral groups. Most pastoral systems are in the semi-arid areas, with small areas in hyper-arid and sub-humid zones. Access to resources are under national laws, but frequently traditional land use rights are granted by local communities. National land tenure systems, introduced after independence, are unrelated to traditional ones. Planted fodder is becoming important in farming systems as free grazing becomes scarce.

Chapter 3 covers South Africa, which has a range of climates from winter rainfall in the extreme south to summer rainfall in the lower latitudes. Much is semi-arid extensive grazing, especially towards the west. Grassland is mainly in the central, high regions. Sour-veldt occurs under high-rainfall on acid soils, and sweet-veldt on fertile soils in semi-arid zones. Savannah occurs in the north and east, and arid savannah extends to the Kalahari. Production systems in communal areas, based on pastoralism and agro-pastoralism, are subsistence-based and labour intensive; crop land is allocated to households, grazing areas are shared by a community. Commercial areas are fenced ranches. Much of the better-watered grassland has been converted to crops; in communal areas this gives a patchwork with thicket. Sown pasture is not of major importance, except on dairy farms.

Chapter 4 covers Patagonia, which is treeless semi-arid grass and shrub steppes that have only been grazed by domestic livestock for a little over a

century. Temperatures decrease from north to south. Most vegetation has been seriously modified by sheep, particularly in the past 40–50 years, with palatable grasses being replaced by unpalatable woody plants. European settlement began at the end of the nineteenth century, with commercial sheep farming. Sheep farming is almost a monoculture in the steppes. Overstocking and poor grazing management have led to serious pastoral degradation, which, coupled with poor prices for livestock products, has caused serious economic problems for stock owners.

Chapter 5 deals with the Campos, grassland with few trees or shrubs, which includes parts of Brazil, Paraguay and Argentina, and all of Uruguay. Grassland-based livestock production is very important, exploiting the natural grassland that covers most of the area. Stock rearing is on large, delimited holdings and is commercial. Poor herbage quality is a major limiting factor to livestock production, as is usual in moist sub-tropical grasslands. Fattening off grass can take up to four years. Intensive fattening of younger stock uses some sown pasture. Exotic temperate legumes can be grown and may be over-sown into native swards after land preparation; once established, legumes encourage the development of winter grasses.

Chapter 6 deals with the grasslands of Central North America. At the time of settlement from Europe, there was extensive grassland from the prairies of Canada to the Gulf of Mexico, on mainly level topography. Great Plains grassland is in three bands running north-south: tall-grass; mixed grass; and short-grass with the tall-grass in the better watered west. About half of the beef cattle in the United States of America (USA) are in the great plains. Woody vegetation types are embedded, with the trees varying according to latitude. C_4 species comprise more than 80 percent from 30° to 42°N, while C_3 species increase dramatically north of 42°N. Cattle predominate, sheep are far fewer and declining. Most land is privately owned, much in small farms. In dry areas, there is extensive ranching. Grazing is seasonal, especially in the north, with supplemental feed in winter. Many small operations are no longer economically viable so are being abandoned.

Chapter 7 deals with Mongolia, where 80 percent of the country is extensive grazing and a further ten percent is forest or forest scrub, which is also grazed. Its climate is arid to semi-arid and the frost-free period of most of the steppe is one hundred days; transhumant herding on natural pasture is the only sustainable way of using such land. Cattle, with yak in the higher areas, horses, camels, sheep and goats are raised; local breeds are used. During the past century, management has changed from traditional transhumance, to collectives that retained herd mobility from the 1950s, to private herding from 1992. Mixed herds are kept, with herd composition varying according to region. Herding is based on using different pastures for the four seasons of the year. While livestock are now privately owned, grazing rights have not yet been allocated; this causes problems for maintenance of pastoral infrastructure and respect of good grazing practice.

Chapter 8 deals with the Tibetan Steppe, another cold, arid zone of mobile herding. Its high, cold grazing lands vary from cold deserts to semi-arid steppe and shrublands, to alpine steppe and moist alpine meadows. Much is above 4 000 m; some camps are as high as 5 100 m. It is traditionally an area of transhumant herding, which has undergone vast changes in the past half century – from feudalism, through a collective period, to privatized livestock and individual grazing rights, which are circumscribing the mobility necessary for herding risk avoidance in such a climate. The steppe contains the headwaters of many of the major rivers of Asia and has a very rich flora and fauna with many endemic species, so grazing management is not only important for herders' livelihoods but also for catchment maintenance and *in situ* preservation of genetic resources and biodiversity.

Chapter 9 deals with Australia's grasslands. Australia has a latitudinal range of 11°S to 44°S, which, coupled with annual precipitation from 100 mm to 4 000 mm, generates a wide range of grassland environments. Native herbage remains the base of a significant portion of the grazing industry. Most farms rely on animal products from grasslands, and most grasslands products are exported. Arid and semi-arid tropical areas are used for extensive cattle grazing; water from artesian wells and bores is necessary. Pasture growth is very seasonal and stock lose weight in the dry season. In the intermediate rainfall zones, crops are combined with sheep rearing; ley farming systems, where a legume-based pasture phase of two to five years is alternated with crops for one to three years, were widely adopted in southern areas. Sown pasture technology is well developed in the temperate zone, based on the use of selected, exotic species, with emphasis on legumes. Development of sown pastures was slower in the tropical areas and suffered a setback when disease affected *Stylosanthes* stands.

Chapter 10 deals with the Russian steppe, which is described with a view to its rehabilitation as a natural resource. The vast plains formerly provided a formidable grazing resource, due more to their extent than to their productivity. In the 1950s, the lion's share of the virgin steppe was ploughed not just for cereal but, ironically as it turned out, largely for fodder production. Large-scale stall-feeding operations based on maize silage and cereals were typical, but proved unsustainable, and livestock numbers have dwindled to less than half in the past decade. In the current transition to family-based livestock farming, however informal as yet, direct grazing has regained terrain. Fortunately, the succession from fallow land to "typical" steppe vegetation is quite rapid and passes through seral stages dominated by *Agropyron* spp., which provide a more powerful herbage resource than the climax *Stipa* spp. and *Festuca sulcata* steppe. Ecological monitoring of the steppe as a natural resource is paramount in order to assist in rehabilitating the fallow grasslands to the preferred botanical composition.

The above coverage leaves some obvious gaps, but it is not possible in a book of normal size to cover all grasslands in similar detail. Chapter 11 gives summarized information on many of the large grazing areas not covered in the nine studies, with sections on: (i) Africa – North Africa; West Africa; and Madagascar; (ii) Latin America – the Llanos; and the Gran Chaco; (iii) Western Asia – Turkey; Iran; the Syrian Arab Republic; and Jordan; (iii) Central Asia – Uzbekistan; and Kyrgyzstan; (iv) The Himalaya-Hindu Kush zone; and (v) China other than the Tibet-Qinghai Plateau. Much of the information for the minor studies comes from the FAO "Country Pasture Profiles", studies that provide information on the pasture and forage resources of countries, and usually drafted by national scientists. They are available on the FAO Web site, as described in Chapter 11. Much information for temperate Asia is available in the FAO Grassland Group publication *Transhumant Grazing Systems in Temperate Asia* (Suttie and Reynolds, 2003).

A final chapter discusses grassland perspectives.

COMPLEMENTARY INFORMATION RESOURCES

Four recent FAO Grassland Group publications deal with extensive grasslands: *Grassland Resource Assessment* (Harris, 2001); *Managing Mobility in African Rangelands* (in conjunction with IT Publications and Beijer Institute of Agricultural Economics) (Niamir-Fuller, 1999); *Grasslands: Developments Opportunities Perspectives* (Reynolds and Frame, 2005); and *Transhumant Grazing Systems in Temperate Asia* (Suttie and Reynolds, 2003). The FAO Grassland Web site contains a series of Country Pasture Profiles that give country-by-country descriptions of grassland-based production systems. To date, 80 countries have been described – see: http://www.fao.org/ag/AGP/AGPC/doc/pasture/forage.htm. These profiles provide the basis for Chapter 11 and are described therein. The interrelation of grassland, crops, livestock and other grassland resources is analysed in *The Future is an Ancient Lake. Traditional knowledge, biodiversity and genetic resources for food and agriculture in Lake Chad Basin ecosystems* (Batello, Marzot and Touré, 2004).

Sown pasture and fodder and their conservation are discussed in a number of FAO publications, including: *Hay and Straw Conservation* (Suttie, 2000), which also deals with fodder cultivation; *Silage making in the tropics with particular emphasis on smallholders* (t'Mannetje, 2000); *Wild and Sown Grasses* (Peeters, 2004); *Site-Specific Grasses and Herbs. Seed production and use for restoration of mountain environments* (Krautzer, Peratoner and Bozzo, 2004); *Forage Legumes for Temperate Grasslands* (Frame, 2005); *Fodder Oats: a World Overview* (Suttie and Reynolds, 2004). Tropical forages are dealt with in *Tropical Grasses* (Skerman and Riveros, 1989) and *Tropical Forage Legumes* (Skerman, Cameron and Riveros, 1988).

The FAO-AGP Grassland Index gives descriptions of and agronomic information on a wide range of forages – see <http://www.fao.org/ag/AGP/AGPC/doc/GBASE/Default.htm>.

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