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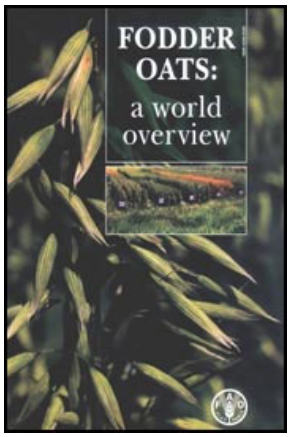
Note: over 8,000 reads and 100 citations. Members of our group played a major role in initiating and then later contributing as co-authors to a number of chapters.



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FODDER OATS: a world overview

Edited by
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Chapter I - BACKGROUND TO FODDER OATS WORLDWIDE

Introduction

Oats are a crop of Mediterranean origin; not as old as wheat and barley, but their domestication dates back to ancient times. They have many uses: a cereal, a feed grain, green or conserved fodder and, more recently, as a winter cover crop in no-till rotations. Recent changes in farming systems as well as the availability of new cultivars better suited to grazing and mowing have altered the distribution of oats as a fodder: their use may have lessened in some temperate areas, but has greatly increased in many subtropical zones, in both smallholder and mechanized farming systems where previously they were little used. Oats are finding new uses and farmers and researchers are finding ways of integrating them into their production systems wherever they are economically interesting. This book deals with the whole green oat crop used as fodder (whether fed fresh or conserved) and emphasizes their increasing use in smallholder production systems. Oats as a cereal is dealt with in great detail by Welch (1995).

This publication aims to bring together information on fodder oats from all regions of the world; its contributing authors are all regional experts in their field. Much of the Asian work consolidates FAO-supported work carried out in recent years in smallholder farming areas. One chapter is devoted to a worldwide overview of fodder oats; thereafter there are chapters by continent for North America, South America, Europe and Australasia, and country or regional studies from the Maghreb, the Himalaya, Pakistan, China and Japan. A chapter on diseases follows, and the final chapter discusses perspectives for fodder oats.

The genus *Avena* comprises about seventy species; a few are cultivated. *Avena sativa* L. (Figures 1.1a, b & c) and *Avena byzantina* K. Koch sometimes known as the white oat and red oat, respectively, are the main oats grown for fodder and grain. They are hexaploids and modern cultivars may contain genetic material from both species. *Avena strigosa*, the bristle-pointed oat or black oat, is a diploid. Until recently it was a minor crop of poor soils and harsh climates in parts of Eastern Europe, Wales and some Scottish islands. Recently, *A. strigosa* has become very important in subtropical and temperate

situations as a winter cover crop and forage, as described in Chapter IV. Oats are well suited for use as cover or break crops in winter rotations since they are not susceptible to the major root diseases of wheat and barley; they have a high reputation for weed control, partly due to their high biomass production, but this may be enhanced by allelopathy.

Naked types occur in several species: *Avena sativa* (6n=42) is the naked oats used in commerce, conspecific with the domestic covered oat. The diploid *A. strigosa* Schreb. (2n=14) is hulled, but also has a naked type. There is also a diploid naked oat, *A. nuda* L. (2n=14), but it is not commonly cultivated. Naked oats are a minor crop, notably grown at high altitudes in China. There has been increasing interest in the crop recently as the hull-free grain has a higher energy concentration than common oats. Free-threshing is not an important characteristic for green fodder production, and the naked quality is unimportant for this purpose. Information on areas sown is scarce, but Hu and Zhang (2003) give the area in China of naked oats in 1998 at 118 700 ha, compared with 155 700 ha for *A. sativa*.

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Figure 1.1a
Cultivated oats (Avena sativa L.) at different growth stages: (a) boot stage

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Figure 1.1b
Cultivated oats (Avena sativa L.) at different growth stages: (b) head emergence

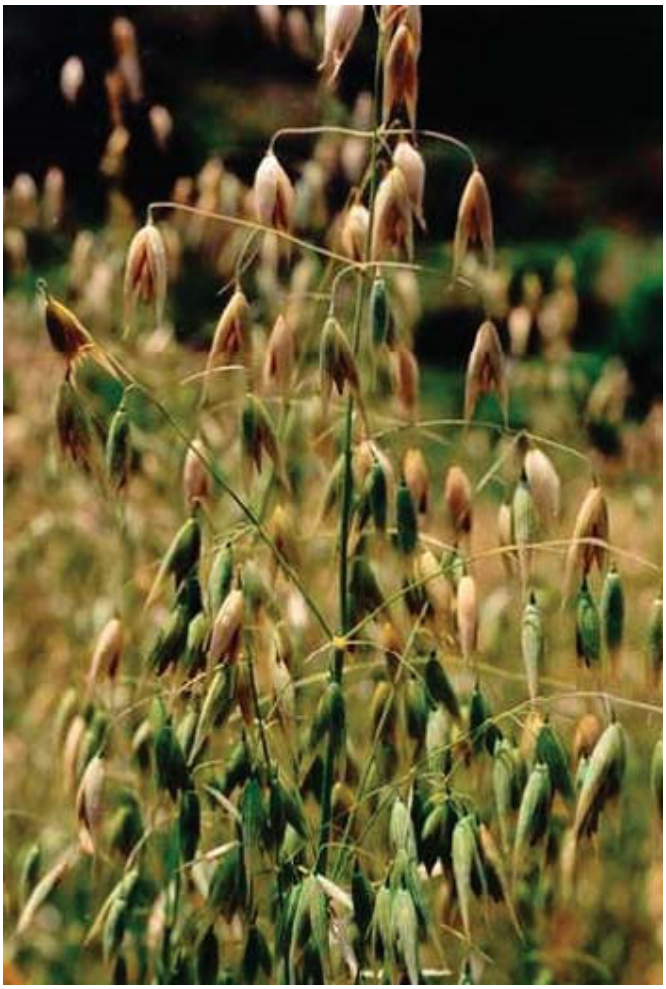

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Figure 1.1c
Cultivated oats (Avena sativa L.) at different growth stages: (c) grain filling stage

The oat crop

The area sown to oats has fallen sharply over the past century; part of this is due to the replacement of draught horses in the farming systems in the developed world and in haulage - oats were the basic feed of work horses in many places. While the area under white-straw crops worldwide differs little from that of forty years ago (Figure 1.2), the area under oats has fallen steadily and in 2000 was but a third of that of 1961; in contrast, barley is currently at its 1961 level, after a rise between 1970 and 1990.

The areas reported in the FAOSTAT database, however, do not always agree with those cited by some of the authors in this book nor with obvious increases in fodder oats in the field: they probably reflect the areas grown for grain. Where oats are grown to be harvested as whole green crop they may be ignored in statistics, or lumped with forages where such statistics are kept.

Great changes have taken place in the areas where fodder oats are important. Oats are now a very important winter fodder on small farms in Pakistan and northern India; some of this is described in Dost (2001, 2002, 2003). In the Himalayan zone - often in association with dairying - oats have changed from a minor fodder to a major crop in the past twenty years, mainly because of the availability of improved cultivars and their ability to produce green feed during the midwinter lean period. There has been a vast increase in the use of oats (mostly *A. strigosa*) as a winter cover crop-cumfodder in the southern cone of South America in recent years; this is described in detail in Chapter IV. The areas given in FAOSTAT

for the Southern Cone countries for 2003 are: Argentina, 300 665 ha; Brazil, 267 652 ha; Chile, 104 620 ha; and Uruguay, 50 000 ha. Federizzi and Mundstock, in Chapter IV of this book, indicate that over 2 million hectares of oats are currently grown in Argentina and Uruguay, and over 3 million hectares in Brazil. Oats have become an important fodder in Pakistan over the past twenty years; this is described in Chapter IV and is very obvious throughout Punjab in late winter through to spring, yet no oats are reported in FAOSTAT for that or any of the neighbouring countries.

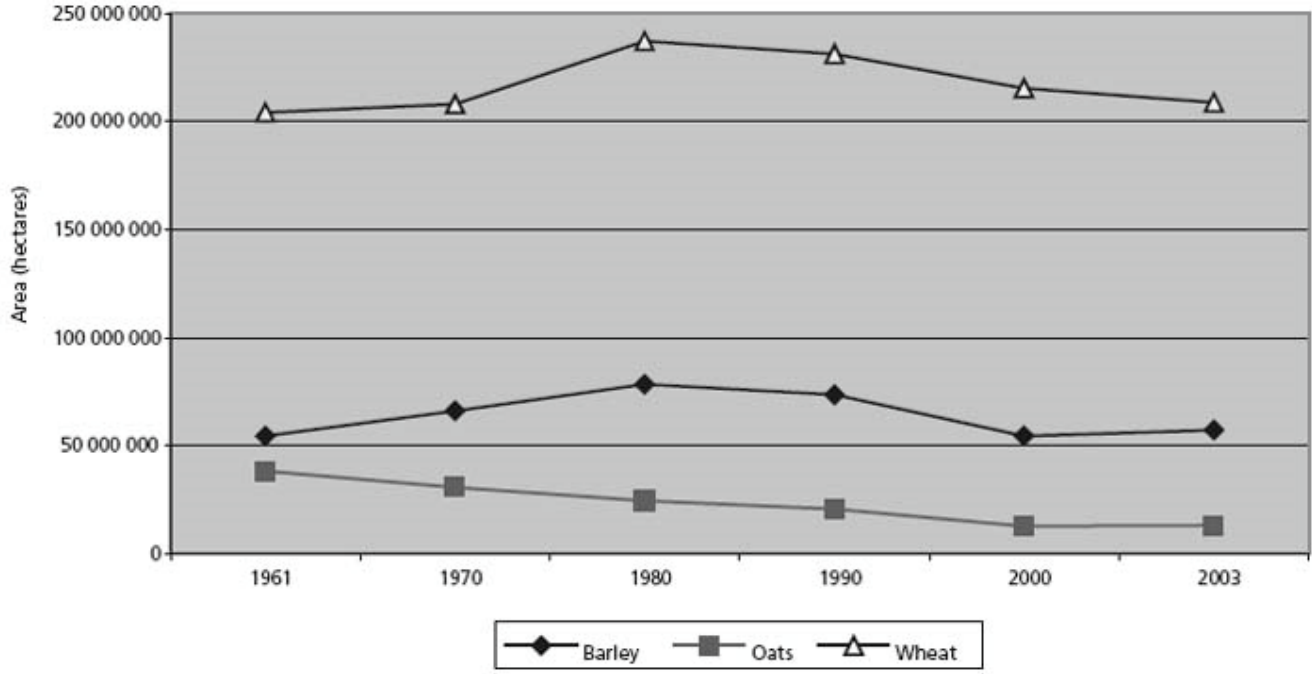

Figure 1.2
World areas of white straw crops
Source: FAOSTAT database

The cultivation of oats follows the general methods for wheat and barley, and similar equipment can be used. There are, however, many ways of growing these crops and some are described in the following chapters. A great range of methods are described, from simple manual techniques to highly mechanized systems. Basic techniques, such as seedbed preparation and seed rates, vary widely. No attempt is made to synthesize these methods: each region and system has to develop its own systems. However, the use of adapted cultivars, resistant to the main diseases and suitable for forage use, is common to all oat growing.

Oats as fodder

Whole-crop green oats may be grazed, cut-and-carried, ensiled or made into hay. In some situations, especially with multicut varieties, the crop may be lightly grazed before stem elongation (*déprimage* in French; there seems to be no English equivalent), allowing the crop to recover and produce a further forage crop, or grain for harvest. The suitability of grazing as a method of exploitation depends on the weather and soil conditions; oats do not recover well from heavy grazing and, where a second cut is desired, grazing must be careful or light. Multiple cutting is highly productive, especially manually - as in smallholder systems - and recently developed cultivars are better suited to such management.

Much of the breeding emphasis is on increased grain production, and disease issues. Crown rust and stem rust are important problems requiring attention, and especially for forage purposes. Oats for forage accentuate the problems of rust because oat crops for grain have very clearly defined seasons, limiting the spread of rust, but oats for forage can be grown outside normal or traditional seasonal timeframes, creating what some call the "green bridge" - continuous green forage crops on which the rust inoculum

can survive year round. There is great variation in green forage production yields between cultivars, and this can be easily measured. The various traits of thin leaves or wide leaves are not that significant insofar as yield goes, but may used by companies as marketing themes to highlight differences between competing cultivars. It is better to focus scarce breeding resources on disease screening, which is what most breeders do. Rust is the biggest single factor affecting yield and quality in areas where forage breeding is current: South America, Australasia and North America.

Yield is what the farmers require, although the cultivars being released have attracted interest not only for their higher yield but also for their wide leaves, later maturity and compact head type. Farmers often associate these traits with increased yield, but there are no direct linkages. Maturity can be important, particularly at lower latitudes where day length influences on growth rates in winter are minimal. However, if used for seed production at these lower latitudes, grain production may not be possible because of this late plant maturity characteristic.

Early biomass production is important. Uusually, the sooner the farmer can graze the crops, the better. Vegetative recovery in grazing systems is not oats' strong point in the colder environments, but improves according to winter temperatures. For example, more grazings are possible in Queensland than in Southern Australia, or in North Island, New Zealand, than in South Island. However, under cut-and-carry systems, where oat forage is cut to a controlled depth, vegetative recovery improves dramatically. Vegetative recovery from grazing in cooler winter environments requires additional breeding attention, which is ongoing in New Zealand, using different germplasm. This characteristic receives little attention from plant breeders, but it should be remembered that few plant breeders work on fodder oats.

There has been greatly increased interest in fodder oats in several subtropical situations where previously the crop was unimportant. In smallholder systems, especially where systems involve periurban dairying, this is most evident in the northern parts of southeast Asia. Oats are well suited to cultivation by smallholders as oats can be grown and harvested with the same simple equipment that is used for rice and wheat, the two main staples in most systems where oats have become popular; seedbed preparation and sowing are uncomplicated. Seed is easily produced, so farmers do not have to buy often, and farmer-to-farmer sales have greatly accelerated the spread of improved cultivars. Oats are largely self-pollinated so farmers can save their own seed for several crops, provided that rogueing is carried out and the usual precautions are taken against mechanical contamination. Green feed can be cut as required, using a sickle, the tool used for wheat and rice harvest. There is also a great increase in oat cultivation in mainly large-scale mechanized systems in South America, both for fodder and as a winter cover.

In some areas where they have been a traditional fodder, green oats have decreased sharply in importance. These include two major situations: in areas of mechanized farming and intensive stockraising with hot summers maize, is a much easier crop to conserve (as silage) and generally provides a feed of higher energy content; in moist, cooler temperate climates, short rotation pastures based on ryegrasses are now preferred for ensiling.

Oats can be made into good hay in areas with dry, warm conditions at harvest time but, because of their coarser stems, they are less easy to cure than pasture grasses and less suitable for hay in cooler climates. Oat hay is traded, sometimes internationally. Chapter X indicates that specialist cultivars for hay production are being developed to meet export quality specifications for Australia's growing oaten hay export trade to southeast Asia. Oats are easy to ensile, although their hollow stems require short chopping and good compaction. Oat straw is a good, palatable roughage and is also excellent bedding. Haymaking and the conservation of straw are dealt with in detail in another recent FAO publication (Suttie, 2000a).

Some "wild" species of Avena have excellent fodder characteristics and figure largely in the composition of the fallow *bour* phase of traditional cereal-fallow rotations in the rainfed cropping areas of North Africa and western Asia. *A. fatua* and *A. ludoviciana* (syn. *A. sterilis*), the "winter wild oat", are excellent natural grazing; unfortunately they are very serious weeds of wheat and barley. Wild oats are notorious throughout wheat and barley growing areas - they are known and detested in areas where cultivated oats are unknown; this can cause resistance to the introduction of fodder oats in traditional wheat growing areas. Oats have been spectacularly successful in Pakistan, and there are many agro-

ecological zones in neighbouring Afghanistan where they suit the needs of dairy farmers. The first attempts to introduce fodder oats to lowland Afghanistan by the FAO agricultural rehabilitation programme brought strong objections from the rural population. There is, however, a lot of contact between farmers in these neighbouring countries and now oats are being grown in suitable "dairy pockets" in Afghanistan.

Oat grain

The main use of oat grain is as animal feed, alone or in mixture; much is used on-farm. The traditional preparation of oats for human consumption is more laborious than that of wheat since the grain has to be milled to remove the glumes, often after kiln-drying; then winnowed to obtain the "groats", which are the edible huskless grain, before any further milling or preparation. Oatmeal and oat-flour are not suitable for bread making but are consumed traditionally as porridge or hard, flat cakes, or added to other dishes as a thickening. Nowadays, the main use of oats as human food is in breakfast cereals. Oatmeal, once the main staple in Scotland, came in for very strong competition from imported wheat from the mid-nineteenth century: Smout (1988) reports "Between 1857 and 1903 the price of a sack of 280 lb of oatmeal fell only slightly, from 37 shillings to 31 shillings; while the price of the same quantity of wheat dropped from 46 shillings to 22 shillings ... The consequence was that many poor families shifted from porridge to white bread and tea." Those interested in traditional oatmeal dishes should read MacNeill (1929) and Lockhart (1997).

The book

This book aims to bring together information on the state of fodder oats worldwide and is aimed mainly at agronomists and extension workers. Since oats are an excellent fodder on small farms in suitable climates, particular attention has been given to countries where fodder oats are, or are becoming, important in the smallholder sector.

Chapter II, which was originally the theme paper for the Fifth Meeting of the Temperate Asia Pasture Working Group, held at Wangdue, Bhutan, in 2002, provides an overview of fodder oats in a general context, as well as a specific focus on the Himalaya-Hindu Kush region and the proposal for a Fodder Oat Network. Chapter III gives an overview of fodder oats in North America, where oats are still very important, although their range has been reduced by other fodders and they are now mainly a summer crop on the Northern Great Plains and a winter crop in milder climates.

Chapter IV covers South America, where the use of oats as a fodder and winter cover crop has increased very greatly in recent years. Oats are grown in five major environments: the temperate area of Argentina and Uruguay; the temperate area of Chile; the subtropical area of Brazil (south of 24°S); the tropical area of Brazil (north of 24°S); and the tropical high altitude area (parts of the highlands of Bolivia, Ecuador and Peru). The largest area under oats is in temperate and subtropical regions, but oats as a grain crop are increasing in area and importance in all environments of South America. The cropped area is increasing every year because it is a major component in the rotation system used by farmers when they adopt the no-till system. In some parts of the region, oat-growing areas are not always currently animal production zones, and there may be great potential for more integration of the two enterprises.

In Africa, the main area of production - almost entirely for hay and grazing - is in the Mediterranean climate of Northwest Africa - the Maghreb - and Chapter V describes the present situation in Algeria, the Libyan Arab Jamahiriya, Morocco and Tunisia. Outside the Mediterranean basin, oats, in Africa, are a traditional crop only in Ethiopia, where the area has grown from 10 000 ha in 1961 to 42 000 ha in 2003 (FAOSTAT data). They can be grown at higher altitudes in the tropical and equatorial zones, and were an important fodder in the higher areas of Kenya, but the area sown dropped very sharply between 1960 and 1970, from 11 331 ha to 5 000 ha, partly because of changes in farming systems and holding size. According to Boonman (1993), discussing Kenya: "Oats owe their reputation to their versatility as they grow well from 1 750 - 3 000 m for grain, hay and grazing. At lower altitudes oats are less suitable as tillering is limited and no dense canopy is formed. Farmers are better off with grass sorghum as fodder-, break- or catch-crops." The main varieties in use in Kenya were Suregrain, Lampton and Grey

Algerian, the last-named being a popular porridge oat. South Africa still has an appreciable area, 25 000 ha, down from 80 000 ha in 1970 (FAOSTAT data).

Chapters VI and VII present case studies from Pakistan, India, Bhutan and Nepal, mostly provided through the FAO-assisted Temperate Asia Pasture Working Group. Fodder is grown on a large scale throughout the subregion, by both stock owners and specialist fodder producers, mainly for dairying; the main fodder, *Trifolium alexandrinum*, hardly grows from mid-December until early February - a period when oats remain productive. The multicut qualities of new cultivars can have their full expression under the prevailing system of hand-cutting and carrying the crop to the stock; grazing can cause heavy damage to oats, even when carefully done, especially on wet or light soils. Since the introduction of multicut fodder cultivars in the 1980s, the area under oats has increased rapidly on the northern plains of India and Pakistan, as well as in the Himalaya-Hindu Kush region. This has been encouraged by the increased profitability of peri-urban dairying and the fact that oats provide fodder at a season when most others crops are dormant. Oats have also increased as they are eminently suitable for haymaking under the hot, dry conditions prevailing at harvest time. The increase in fodder marketing to peri-urban dairies is described in detail by Dost (2003) and in Suttie (2000b). Case Studies are presented from Bhutan, China, India, Nepal and Pakistan. The major producer of oats in southeast Asia is, of course, China; the only other southeast Asian country featuring in FAOSTAT for oats is the Democratic People's Republic of Korea, with 7 000 ha, down from 56 000 ha in 1970. Mongolia grew a considerable area of fodder oats during the collective period, with about 50 000 ha in the 1970s and 1980s, falling to 30 000 ha in 1990 at decollectivization, and now, with the collapse of the arable sector, the crop has disappeared.

Chapters VIII and IX deal with China and Japan. China has always been a large grower of oats and the naked form of *A. sativa* has been grown there for centuries. The area sown to oats has fallen sharply with the replacement of draught and army horses by machines, and a reduction in the use of naked oats as a subsistence food. Forage oats, however, are still very important, both in areas too cool for maize and other hot-season fodders, and as a winter fodder in mild areas. Imported, hulled cultivars have replaced naked oats as a fodder crop. Oat breeding is active. Oats are a recent (late nineteenth century) introduction to Japanese agriculture and their use as a cereal has dropped sharply, but they are still an important fodder.

Chapter X discusses Australasia. Oat fodder crop production occurs mainly in the southern agricultural regions of both New Zealand and Australia, but grazing areas are expanding in subtropical Queensland and the temperate North Island of New Zealand. In recent years, the New Zealand oat industry has moved away from the use of dual-purpose cultivars toward specialist oat cultivars bred for forage use. This move has been driven by an expanding dairy industry, intensification of livestock grazing lands and improved commodity prices for livestock products. Dual-purpose oat cultivars are widely used in Australia for livestock grazing. Forage is grazed before stem elongation, allowing the crop to recover and produce grain for harvest. Specialist cultivars for hay are being developed to meet export quality specifications for Australia's growing hay export trade to southeast Asia. Hay is the major oaten product in Australia, with Western Australia and South Australia being the major producers. Cereal hays are used on-farm as fodder reserves, and traded, both within the Australian animal feed industry and for export to Asian markets.

Chapter XI reviews the current and prospective importance of oats used as whole-crop forage in Europe. European livestock rearing is characterized by highly productive, high-yielding animals that need forage with high concentrations of energy and protein. New varieties of maize and barley have a higher nutritive value and can be grown in the areas occupied traditionally by oats. Ensiling, a mechanized, easy method of conservation, has replaced much of the hay in animal feeding. Maize became the most widespread silage crop due to its high yield, high energy concentration in dry matter, high content of water-soluble carbohydrates and ease of ensiling. The oat area decreased sharply while the area under silage maize increased considerably during the last thirty years and, together with pastures based on ryegrass, became the main forage and for ruminants in intensive stock raising in Europe.

The diseases of oats and their control, with an emphasis on fodder oats, is the subject of Chapter XII. A final chapter discusses and summarizes the perspectives for fodder oats by theme and region.

Other recent FAO Grassland Group publications include: *Hay and straw conservation* (Suttie, 2000a); *Grassland resource assessment* (Harris, 2001); *Silage in the tropics, with particular emphasis on smallholders* (t'Mannetje, 2000); *Managing mobility in African grasslands. The legitimization of transhumance* (in conjunction with Beijer Institute of Agricultural Economics) (Niamir-Fuller, 1999); *Transhumant grazing systems in temperate Asia* (Suttie and Reynolds, 2003); *Wild and sown grasses* (Peeters, 2004); *Site-specific grasses and herbs. Seed production and use for restoration of mountain environments* (Krautzer *et al.*, 2004); *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); *Forage legumes for temperate grasslands* (Frame, 2004); and *Grasslands: developments - opportunities - perspectives* (Reynolds and Frame, 2004).

The FAO-AGP Grassland Index gives descriptions of and agronomic information on a wide range of forages, including oats, and a series of Country Pasture Profiles gives country-by-country descriptions of grassland-based production systems - to date, 75 countries have been described (see: http://www.fao.org/ag/AGP/AGPC/doc/GBASE/Default.htm and http://www.fao.org/ag/AGP/AGPC/doc/pasture/forage.htm).