20. Case Study C: Northern Wheat/Sheep Belt

Martine Maron and Charlie Zammit

Learning objectives

On completion of this topic you should be able to:

- Identify the major climatic, soil and vegetation characteristics that distinguish the northern wheat/sheep belt from other agricultural zones
- Contrast the major agricultural activities in the northern wheat/sheep belt with those of other Australian agricultural regions
- Recognise the major land degradation issues faced by northern wheat/sheep belt farmers and discuss potential solutions
- Compare the agricultural practices and sustainability issues of two case study farms in the northern wheat/sheep belt

Key terms and concepts

Major agricultural activities in the northern wheat/sheep belt, common summer and winter crop types, management of biodiversity and ecosystem services, woody weed management and vegetation clearing, significance of water erosion and the role of summer rainfall, common practices for managing wind and water erosion, landowner duty of care.

Introduction to the topic

Australia's wheat/sheep belt encompasses the country's most productive agricultural land, with major agricultural practices ranging from grazing of sheep and cattle on native or improved pastures, to dryland and irrigated cropping. It stretches in a broad band from the south-east of South Australia, inland of the Great Divide to south-east Queensland. The wheat/sheep belt coincides largely with the eastern parts of the Murray-Darling Basin (Figure 20.1), which supports the relatively fertile soils of the region. Because of the large area covered by the wheat/sheep belt, the agricultural practices and major sustainability issues vary throughout the region, most notably from north to south. This case study will focus on the part of the wheat-sheep belt that lies to the north of Coonabarabran, New South Wales, and extends into south-east Queensland (Figure 20.1). This area is termed the northern wheat/sheep belt.

Figure 20.1 The location of the northern wheat/sheep belt (hatched area). White circles indicate wheat-growing areas. Source: MDBC (2005a).

20.1 Characteristics of the northern wheat/sheep belt

Soils

The major soil groups of the region include Vertosols, Kandosols and Sodosols. The most fertile soil types are Vertosols, which are mostly cropped. Vertosols include the cracking, self-mulching and non-self-mulching clays, and have a minimum surface soil clay content of 35%. The most common Vertosols are Grey and Brown Vertosols, which are associated with brigalow (*Acacia harpophylla*) and coolibah (*Eucalyptus coolabah*) vegetation communities. They are generally deep and moderately fertile, and in parts are characterised by gilgai puffs. These soils are particularly subject to structural decline and soil erosion when cropped or heavily grazed. The highly fertile Black Kandosols occur in only a small area, largely restricted to the Condamine floodplains, but are of great local importance. Most of this area is cropped and irrigation is common. These soils are also prone to soil erosion and declines in fertility and soil structure.

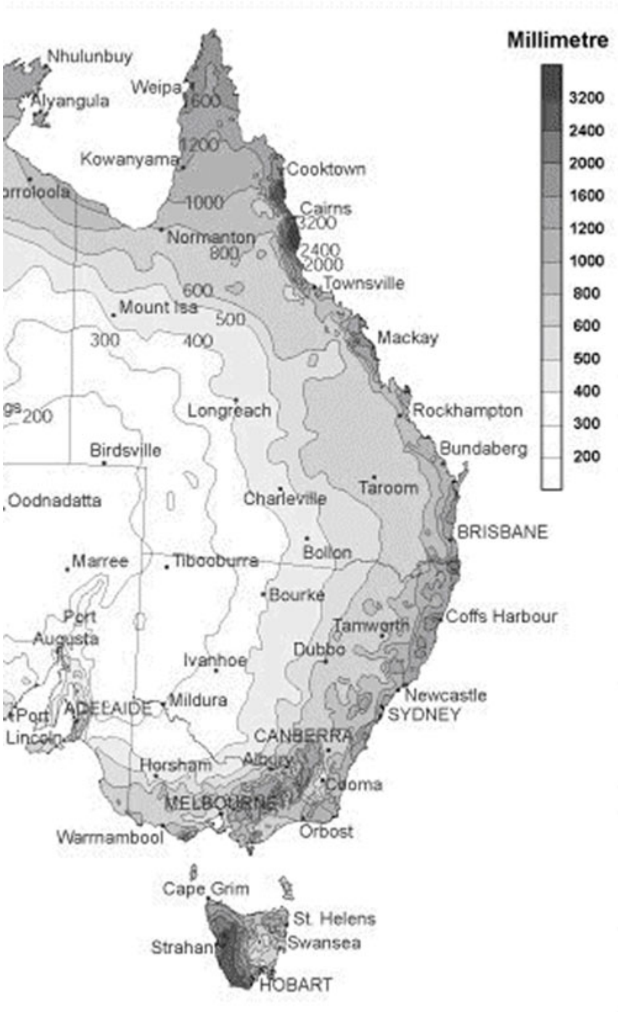
Red and Red-Brown Kandosols are either cropped or grazed. Red Kandosols are less fertile than Red-Brown Kandosols, and typically occur in the western parts of the region. Grazing of native pasture is most common. Red-Brown Kandosols are more fertile, and are associated with woodlands of poplar box (*Eucalyptus populneus*). They are duplex soils and are cropped in some higher rainfall areas. Potential management problems include wind and water erosion, soil structure decline, and acidification.

Sodosols are less important for agriculture and have generally low fertility. Grazing and forestry are the most common land uses on these soil types, which are associated with cypress pine (*Callitris* spp), buloke (*Allocasuarina leuhmannii*) and mixed eucalypt (*Eucalyptus* spp) forests.

Climate

A major characteristic that distinguishes the northern part of the wheat/sheep belt from the southern part is the region's climate. While the southern wheat/sheep belt has a temperate climate with predominantly winter rainfall, the part of the wheat/sheep belt that lies north of about Coonabarabran is sub-humid, with most rain falling in the summer months in Queensland, changing to variable winter/summer rainfall dominance around Moree and Narrabri. Annual rainfall totals vary from 676 mm at Dalby in the north-east to 749 mm at Coonabarabran and 579 mm at Moree (Figure 20.2). The annual rainfall totals tend to be more variable from year to year than those further south.

Figure 20.2 Mean annual rainfall for eastern Australia. Source: ABOM (2003).

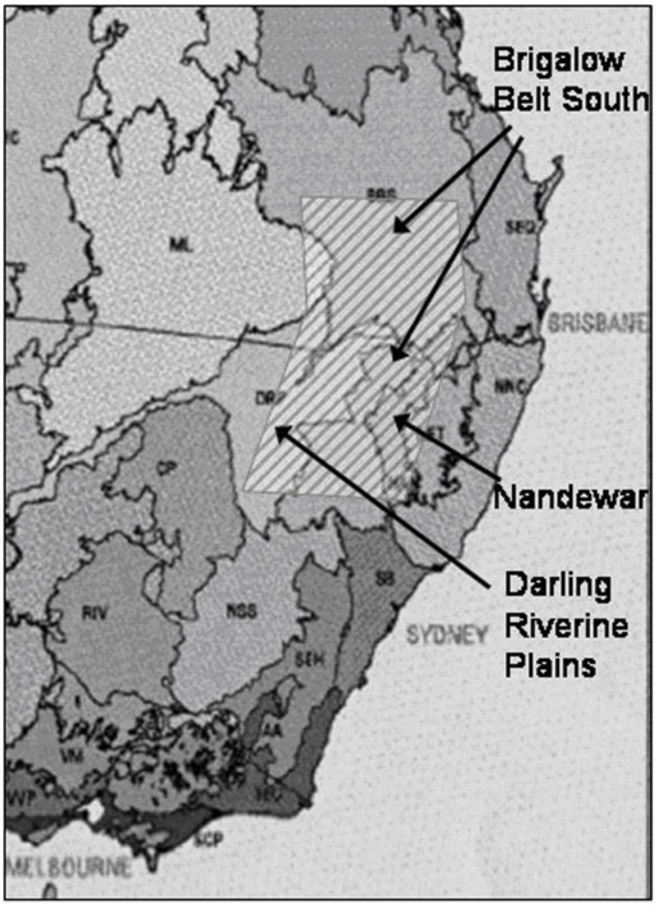


The region receives winter rainfall from low pressure systems moving eastwards across the continent, as does the southern wheat/sheep belt. This rainfall is generally gentle and widespread. Summer rainfall, however, is often associated with tropical monsoon weather systems to the north and rainfall at this time of year tends to be heavy and localised, and it is common for several inches to fall in a single thunderstorm. Precipitation that falls in this way can results in problems with sheet erosion in areas with sloping topography.

Native vegetation

The major bioregions that encompass the northern wheat/sheep belt include the Brigalow Belt South, the Darling Riverine Plains and the Nandewar Bioregions (Figure 20.3). The Brigalow Belt South covers the most area within the northern wheat/sheep belt, running from the north of the region to the south. Its native vegetation historically comprised woodlands, forests and grasslands growing on the bioregion's relatively fertile Vertosols. Alluvial or clay plains were historically dominated by grasslands dominated by bluegrasses (*Dichanthium* spp), as well as forests and woodlands of brigalow often in association with belah (*Casuarina cristata*) and poplar box. Various ironbark species (*Eucalyptus* spp), spotted gum (*Eucalyptus maculata*) and cypress pines occur on sandstone plateaux and slopes. River red gum (*E. camaldulensis*) is common along rivers and streams, and myall (*Acacia pendula*) occurs on the flats.

Figure 20.3 Major bioregions occurring in the northern wheat/sheep belt (hatched area) as identified under the Interim Biogeographic Regionalisation for Australia. Source: Modified from DEH (2005).



Historical land use changes

European settlement of the region began in the 1830s, with squatting licenses being issued. Sheep were the first livestock to be run, followed soon after by cattle which were at first grazed in the more remote parts of the region where water was scarce, as they could walk further to drink. Travelling stock routes were developed during the mid to late 1800s, particularly along major waterways. The development of railways in the latter half of the century improved the supply of goods to remote areas and facilitated further pastoral development. Wool prices increased in the 1880s, encouraging further expansion of the industry.

In the 1890s, wool and beef prices fell, and the lower prices, coupled with a severe drought in 1902 resulted in a great decline in stock numbers in the region. Pest species such as European rabbits (*Oryctolagus cuniculus*) and prickly pear (*Opuntia stricta*) began to cause substantial economic damage, with rabbits competing with stock for food and prickly pear growing in impenetrable thickets, covering 25 million ha. Kangaroo numbers had also increased as a result of increased pasture and watering points and were culled in great numbers to reduce competition with stock. The cactoblastis moth (*Cactoblastis cactorum*) was introduced to control prickly pear in 1926, and its success was phenomenal, reducing prickly pear populations to manageable levels within 6 years (Figure 20.4). The introduction of the myxoma virus in the 1950s to control rabbits was similarly successful, if only temporarily.

Figure 20.4 An example of Prickly Pear invasion in Queensland before the introduction of *Cactoblastis cactorum* on the left, and on the right, the same site three years following the moth's introduction. Source: Ricklefs (1990).

Figure 43-9 (a) A pasture in Queensland, Australia, is blanketed by the imported prickly pear cactus, whose spread was unchecked by predators. **(b)** The same site 3 years after the introduction of a predatory cactus moth appropriately named *Cactoblastis cactorum*. (Courtesy of the Department of Lands, Queensland, Australia.)

Cropping was slower to spread throughout the region than grazing, although wheat crops were being grown on the spectacularly fertile Darling Downs of south-east Queensland by the early 1860s. The development of machinery to work heavier clay soils in the mid 1900s as well as improved grain prices led to an increase in the area sown to wheat, and the area under irrigation also increased. In recent years there has been a trend away from grazing and towards cropping, as improvements in cropping machinery provide increased efficiency.

Clearing and thinning rates increased during the 1900s with the chaining of vegetation to clear large areas and poisoning (using Tordon) to kill large numbers of individual trees common practices. Clearing tended to favour more fertile lands suitable for cropping or improved pastures while thinning was practiced on less fertile country to open up the canopy for native grass growth to increase stocking density. The historical pattern of clearing resulted in significant regrowth from several native species (e.g. brigalow) which over time established large stands of thickened regrowth vegetation impenetrable to grazing animals. Farmers were forced into a cycle of reclearing or extensively thinning this regrowth (see section below on Grazing).

Although there was substantial early clearing of the northern wheat-sheep belt, patterns of extensive clearing, especially in the Queensland portion have continued, especially in the Brigalow Bioregion. During the late 1990s, the Queensland Government came under increasing pressure to better manage vegetation clearing on leasehold land. In 2004 the Queensland Government passed legislation that effectively stopped all clearing of native remnant vegetation. This legislation does not apply to previously cleared regrowth vegetation.

Current major land uses

Livestock grazing and cropping are the major land uses in the region today. Other land uses include forestry, horticulture and conservation. Irrigated cropping is common along the major creeks and rivers, and dryland cropping is widespread on flat, fertile soils.

Grazing

Grazing is the most widespread land use in the region. Grazing is of native or improved pastures, and there is some grazing in State forests. Grazing tends to be more common on the poorer soils less suitable for cropping and in lower rainfall areas, and most paddocks used for dryland cropping are also occasionally sown to pasture and grazed. Most grazing is of beef cattle. In eastern and southern areas, most cattle are British breeds such as Hereford and Shorthorn, while in the north and east, *Bos indicus* breeds and their crosses, such as Brahman and Santa Gertrudis, become more common.

Sheep grazing is less common than cattle grazing in the northern wheat/sheep belt, as the humid climate is more suitable for cattle. Most sheep grazing is of Merinos for wool production (about 95% of sheep in the Queensland wheat/sheep belt are Merinos). About 5.3 million head of wool sheep are run in the Darling Downs. Wool produced in the Traprock area of south-east Queensland and the New England Tablelands, two areas marginal to the wheat-sheep belt, is the finest in the region, due to the poor nutritional value of the native pastures on infertile, rocky soils. A bale of 12.5 micron wool from the Traprock recently sold for about $700,000. Medium to strong wool (21-24 micron) is more common elsewhere in the northern wheat/sheep belt.

Grazing systems vary, with set-stocking being most common, but rotational grazing systems are gaining favour as a method of extracting maximum value from both native and improved pasture. Most pasture is dominated by native perennial grasses that grow in summer, such as Queensland bluegrass (*Dichanthium sericeum*). Bluegrass pasture can support approximately 1 DSE/ 0.8 ha. Native pasture in brigalow and belah dominated country is usually sparse and the timber is often cleared to facilitate sowing and growth of introduced pasture species such as buffel grass (*Cenchrus ciliaris*), panics (*Panicum* spp) and legumes such as medics (*Medicago* spp).

Pasture management in the northern wheat/sheep belt presents characteristic problems. Changes in traditional fire regimes and disturbance due to clearing and grazing have resulted in a thickening of the native woodland vegetation in much of the region. Many tree species, most notably brigalow, respond to bulldozing and blade-ploughing by vigorous suckering, creating dense thickets of regrowth that out-compete pasture and make mustering extremely problematic (Figure 20.6). Clearing of regrowth vegetation is therefore an ongoing practice on many grazing properties, with regrowth being treated as often as every 4-5 years, but only every 30-50 years on poorer soils. Regrowth is either bulldozed and stick-raked or blade-ploughed, or treated with aerially distributed herbicide.

Cropping

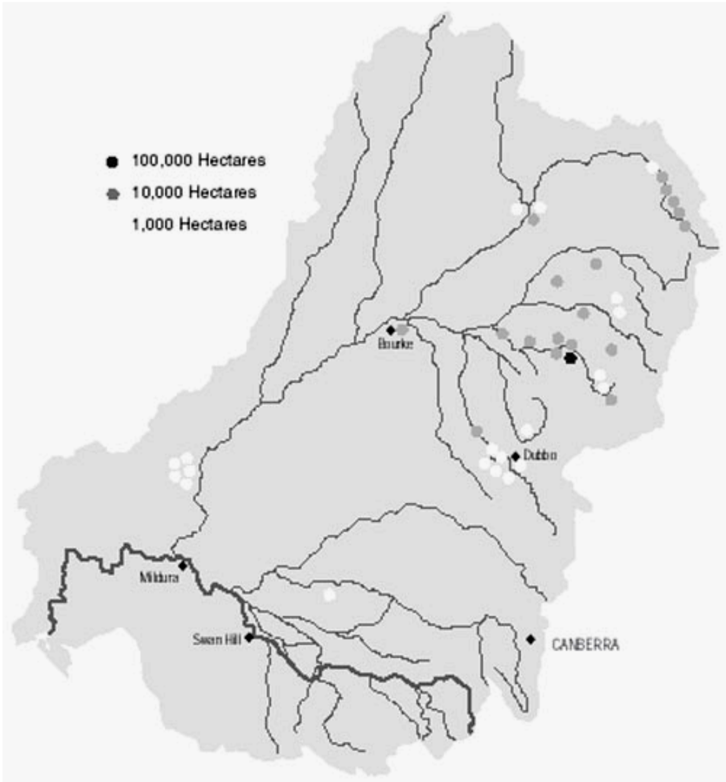
Cropping in the northern wheat/sheep belt tends to occur on the deep Vertosols on floodplains and near major waterways. Dryland summer cropping is common, and often occurs in rotation with winter cropping and fallow (Table 20.1). Irrigated cropping is a major contributor to gross agricultural production in the area, with cotton production in the Murray-Darling Basin (80% of which is irrigated) valued at approximately $1.25 billion in 1998/99. Furrow irrigation is the most common type of irrigation, and some smaller crops are grown under centre pivot or other sprinkler irrigation systems.

Table 20.1 Major summer and winter crops grown in the northern wheat/sheep belt. Source: Maron (2006).

Major Summer Crops	Major Winter Crops
Sorghum (grain and forage)	Wheat
Cotton	Barley
Maize	Canary
Pulses	Chickpeas
Millets/panicums	Canola
Sunflower	

Over 90% of Australia's cotton crop is grown in the Murray-Darling Basin. Australia is the fourth largest producer of cotton in the world. The northern wheat/sheep belt contains almost all of the wheatbelt's major cotton growing areas (Figure 20.5). Cotton is an irrigated summer crop, grown mainly along the tributaries of the Darling River. Water collected from channel systems from the rivers and streams is stored in large ring-tanks. Irrigation efficiency can be as low as 35%. Read Raine (2000) for more information on farm design for improved irrigation efficiency.

Figure 20.5 Locations of cotton crops in the Murray-Darling Basin. All major cotton growing locations are north of Dubbo. Source: MDBC (2005b).



Other summer crops include sorghum, which is mostly grown for grain but varieties are also grown for forage, which is often cut for silage. Sorghum is a dryland crop. The main summer oilseed crop is sunflower, which is grown mostly on the Darling Downs. Other grains, such as maize and millet, and irrigated pulses such as soy and navy beans are also grown.

Major winter crops in the northern wheat/sheep belt include, not surprisingly, wheat, with barley the second most important winter cereal crop. In 1995-96, 450 800 t of wheat were harvested from the Queensland part of the wheat/sheep belt alone. Although growers aim to produce Australian Prime Hard (APH) wheat, their ability to do so is reducing in the wheat/sheep belt due to long-term soil use and falling soil organic matter.

20.2 Catchment and farm scale sustainability issues and solutions

Most of the agricultural practices in Australia today are not sustainable, and many changes are being made to improve the sustainability of the industry (DEH 2001). There are numerous challenges facing farmers who are aiming to improve the sustainability of their production system (Table 20.2). Loss of biodiversity through habitat destruction and increasing chemical inputs are two major threats. Land degradation is a major economic and environmental problem in the northern wheat/sheep belt. A 2004 ABARE report (Nelson et al. 2004) found that an average of 52% of farmers reported signs of environmental degradation on their properties during 2001-02. The full report can be found at http://www.abare.gov.au/surveys/resourcemgmtsurvey.html.

Table 20.2 Catchment- and farm-scale sustainability issues. Catchment-scale issues are those which often cannot be dealt with at a local scale and can have an impact on farms that are remote from the ultimate cause or source. Source: Maron (2006).

Catchment-Scale Issues	Farm-Scale Issues*
Salinity	*** All catchment-scale issues affect individual farms**
Biodiversity and habitat loss	Soil fertility decline
Water quality and conservation	Woody weed encroachment
Herbicide/pesticide resistance	
Weeds	
Pests and diseases	

It is immediately evident from Table 20.2 that the vast majority of sustainability issues must be dealt with at least partially at a catchment scale.

Declining soil fertility

As mentioned earlier, one of the major issues facing farmers involved in broadacre cropping is a decline in soil fertility. Many areas have been cropped almost continuously since the 1950s, and this has led to a decline in soil nitrogen and organic carbon levels. Crop rotations including the growing of legumes, no-till farming and the application of nitrogenous fertilisers are the most successful methods for restoring and maintaining soil fertility.

Soil erosion

Soil erosion is perhaps the most significant threat to future farm productivity in many parts of the northern wheat/sheep belt. Soil erosion due to wind or water movement was reported to have occurred on their farms during 2001-02 by 21% of farmers involved in the cropping, sheep and beef industries.

Wind erosion is a problem when pastures are overgrazed and in traditional cultivation systems, where the topsoil is exposed to the wind, dries out and is blown away. Serious water erosion, in the form of hillslope erosion and gullying, becomes more prevalent as one moves north in the wheat/sheep belt. This is due to the fact that in summer rainfall areas, precipitation is not gentle but often falls heavily in localised storms.

Topsoil losses from cotton growing areas are estimated at 7.3 t/ha/year, and in cereal growing areas 2.6 t/ha/year. Native pasture grazing areas lose 9.0 t/ha/year (DEH 2001).

Any practice that reduces the amount of soil left bare assists in reducing soil erosion by both wind and water movement. The use of contour banks is a practice that often needs to be coordinated among properties, and is encouraged by regional natural resource management bodies. The adoption of cropping practices that retain crop stubbles helps to maintain soil structure and reduce water erosion. Minimum and no-till systems are increasingly common in the northern wheat/sheep belt, as farmers recognise the potential benefits not only of erosion control but soil water conservation. However, slightly less than 50% of cropping farmers Australia-wide have begun implementing minimum and no-till practices. Chemical costs are greatly increased in such systems due to the need to control weeds with herbicide, and concerns about diseases and pests also prevent farmers from taking up this practice. However, the production benefits of increased soil moisture retention and improved soil structure will usually outweigh the extra cost of herbicides, and crop rotations can address most of the potential problems with pests and diseases.

Grazing management is also important, particularly in reducing wind erosion. Rotational grazing systems are gaining popularity as a way of better controlling stock grazing behaviour, making it easier to avoid overgrazing and camping that damages pastures and leads to the denudation of soil, which can then potentially be lost due to wind. Membership of groups such as Resource Consulting Services, which promotes sustainable grazing practices, is particularly high in the northern wheat/sheep belt.

Weeds

Woody weed encroachment

In many parts of the northern wheat/sheep belt, the control of woody weeds is a major cost to farmers. When vegetation types such as brigalow are cleared, they vigorously regenerate, usually forming a thicket that prevents more light from reaching the ground than did the original stand (Figure 20.6). Pasture growth in brigalow regrowth tends to be scanty, and large areas of bare soil remain in amongst the thickets of vegetation. For this reason, graziers generally treat dense regrowth every 4-10 years, using either chemical or mechanical methods. The problem is not confined to Brigalow, and also occurs in *Eucalyptus*-dominated vegetation types.

Figure 20.6 Nine-year-old Brigalow regrowth on a cattle grazing property near Miles, Queensland. The area in the photograph has been cleared twice, once in the 1970s and once in 1995. Source: Photo taken by M. Maron (2005).

Other weeds

Other weeds commonly found in the area include burrs such as Bathurst burr (*Xanthium spinosum*), galvanized burr (*Sclerolaena birchii*), caltrop (*Tribulus terrestris*) and Noogoora burr (*Xanthium occidentale*). These burrs damage the feet of livestock and contaminate wool, resulting in a downgrading of fleece quality.

Other weeds outcompete pasture or are toxic to stock. Weeds such as harrisia cactus (*Eriocereus* spp) can quickly spread over large areas and reduce the amount of available feed for stock, while also making mustering difficult due to the sharp spines. Mother-of-millions (*Bryophyllum* spp) is a weed that spreads particularly along creeklines, and is highly toxic to stock, which are most likely to eat it if they are stressed or in unfamiliar surroundings.

Chemical resistance

Herbicide resistance is likely to be a significant future problem, particularly for the cropping industry. A recent study by the University of Queensland (TSWRU, 2001) found that populations of herbicide-resistant weeds were widespread throughout the northern wheat/sheep belt. Twenty-eight resistant populations of wild oat were identified, as well as several populations of resistant annual ryegrass and barnyard grass. Several instances of resistance in broadleaf weeds were also confirmed.

Pesticide resistance is a particular problem for growers of summer crops. The larvae of heliothis (*Helicoverpa armigera*) are resistant to several common pesticides (*H. punctigera* are still susceptible to most pesticides). The costs of crop damage by and treatment of heliothis in Australia are estimated at $225 million annually. Strategies to reduce the problem of resistance are similar for pesticides and herbicides – ensure a lethal dose is used and that the spray is effective; be sure of the identity of the organism present in the crop and that it is at the correct stage in its life cycle to be susceptible to the chemical; and do not spray unnecessarily. Transgenic varieties of cotton containing a gene from a bacterium (*Bacillus thuringiensis*) that produces a toxin that kills heliothis have been successful in reducing pesticide applications, but resistance to the *Bt* toxin is still possible. Other transgenic plant varieties with better resistance are being developed in Australia and overseas.

Managing genetically modified organisms (GMOs)

As noted above, modern agricultural biotechnologies are developing new transgenic crop varieties that are resistant to insect pests. While there is some evidence that transgenic crops require less pesticide application during the growing season, the use of genetically modified agricultural crops or grazing animals is not risk free. Over the past decade or so there has been growing concern about the environmental and health risks of transgenic crops and animals (see Independent Science Panel 2003 in the Readings Section). This debate is both scientific and political. The scientific debate focuses on the kinds of research evidence that investigate both benefits and risks of introducing transgenic species into the natural world (see, for example, Firbank 2003). The broader political debate, which is beyond the scope of this course, is concerned with the way in which a small number of multi-national agricultural and food corporations appear to be changing land use practices and associated cultural traditions, including in third world countries, through the introduction of new biotechnologies. There are many websites presenting these arguments (see for example http://www.saynotogmos.org/index.htm).

Salinity

Soil salinity can be caused either by rising saline water tables or by the application of water containing high levels of salts on clay soils where permeability is low. Water tables can rise due to the removal of deep-rooted perennial vegetation, thus increasing deep drainage from rainfall events, or with the addition of water by irrigation, causing excess water to percolate to the water table. Most saline sites in the Queensland part of the northern wheat/sheep belt occur in the Darling Downs, and salinity hazard areas are predicted to be widespread across the Queensland wheat/sheep belt by 2050 (MDBC 2002). The modification of irrigation practices to reduce water loss from under irrigated crops along with careful monitoring of water tables is essential to reduce the salinity hazard in irrigation areas, and the presence of deep-rooted perennial vegetation in recharge areas is required to reduce the dryland salinity risk.

Biodiversity and habitat loss

In the wheat/sheep belt and high rainfall agricultural zones, the removal of native vegetation in order to facilitate agricultural intensification and the presence of large areas completely bare of native vegetation is a striking aspect of the landscape. This loss of native vegetation, and the degradation of much of what remains, has directly reduced biodiversity, by removing many of the individual plants that comprise it. It also equates to a loss of habitat for animals that would once have been present. As a result, many species' populations are declining or becoming locally extinct in agricultural regions.

In addition to the impact of habitat loss on individual species populations, land clearing for agriculture also impacts on ecosystem structure and function by simplifying the overall structural complexity and functional capacity of ecosystems. One way of thinking about this impact is to view the landscape from the perspective of the **ecosystem services** it provides. These services include for example the capacity of ecological systems to:

- pollinate agricultural crops and natural vegetation
- disperse seeds
- generate and preserve soils and renew their fertility
- regulate populations and control agricultural pests
- contribute to climate stability and moderate weather impacts and extremes of drought and flood
- cycle and move nutrients and water
- protect stream and river channels and coastlines from erosion
- purify the air and water
- regulate disease carrying organisms.

A useful introduction to the concept of ecosystem services is provided by Daily (1997) in the Readings Section.

In Australia, CSIRO has conducted a large research project that aimed to quantify the kinds of ecosystem services found in different catchments, including the Gwydir Catchment which is partially within the northern wheat/sheep belt. See http://www.ecoman.une.edu.au/gesp/index.html for details.

Emerging solutions

Better use of science

The recent imperatives for public and private land managers to be more sustainable in their approaches has placed increased demands on science to provide analyses of the impacts of unsustainable land uses and agricultural practices and to develop new conceptual approaches and practical methods. Indeed, a casual examination of the ecological and agricultural scientific literature reveals the extent to which scientists are trying to address the major environment and natural resource use issues, including those associated with agricultural production.

Among the most important new concepts developed by scientists is the idea of '**adaptive management'**. This concept, originally developed by fisheries scientists in Canada, argues that all environment and resource management needs to be thought of as a scientific experiment in which properly designed field 'experiments' (the management plans and actions) are developed, appropriate monitoring and reporting undertaken and then the 'experiment' reviewed and modified if and when required (see Walters 1986 in the Readings Section). This simple insight, that management decisions need to be based on emerging information on the effectiveness and impacts of past practices, is at the heart of the adaptive management philosophy. Under this approach as environmental management programs are implemented, a rigorous monitoring program ensures that resource managers and policy analysts have access to how the program is succeeding, and if it is not, they have evidence on which to take remedial action. The philosophy assumes that managers and policy analysts have the organisational and program flexibility to respond quickly and appropriately if required. Although the concept of adaptive management is now widespread in the planning literature and in Government strategic plans, one of the major challenges is ensuring that Government bureaucracies are capable and prepared to be adaptive. Evidence suggests they are often not, preferring to remain within the rigid confines of existing policy directions or organisational approaches (see for example Ladson and Argent 2002 and Walters 1997 in the Readings Section).

Improved regional planning

The Australian Government has over the past decade or so initiated several large scale policy initiatives that aim to strengthen regional planning that delivers more sustainable outcomes for the environment and for local communities. The major initiatives include the Natural Heritage Trust (see http://www.nht.gov.au/index.html) and the National Action Plan for Salinity and Water Quality (see http://www.napswq.gov.au/index.html). These programs are integrated for the delivery of regional environment and natural resource outcomes (see http://www.nrm.gov.au/about-nrm.html) and their key features are:

- national coordination and delivery of integrated NRM
- State and Territory level coordination of the delivery of integrated NRM
- regional planning and accreditation process
- including biodiversity conservation in regional planning.

Community engagement and property planning

Over the past 15 years or so, local volunteer-based community groups have been established under National Landcare Programs to undertake specific on-ground works to address local environment and land use issues. These include tree planting programs, weed and feral animal control, endangered species protection, riparian zone management, improved water use and management and integrated property planning. A core component of the new regional planning programs outlined above is to build on and strengthen community capacity to undertake property and catchment planning and management.

20.3 Public vs private interest

Managing agricultural landscapes sustainably to meet a mix of environmental, social and economic goals requires that we recognise that these landscapes are made up of public lands, for example road reserves, forest production areas and national parks, alongside private property. Because most landscapes, including those that are primarily agricultural, are 'leaky' in the sense that what happens in one part can have impacts elsewhere (for example, nutrient runoff from croplands can pollute downstream rivers), it is important to recognise the mix of public and private interests that need to be taken into account when managing agricultural enterprises within a broader landscape context.

Governments have the general responsibility for managing all public lands and they do this in a variety of ways that include developing policies for particular issues (for example managing salinity), through legislation (for example, the *Queensland Water Act*) and through education, training and information sharing programs (for example, providing landowners with information and training for weed management). Taxpayer funds are used to support the management of public lands.

However, as we have noted already, public and private lands are not independent so some responsibilities for land management fall on private citizens including farmers and graziers. These responsibilities are in two parts: first to manage their private lands in such a way as to produce an economic return for themselves with minimal damage to the environment and secondly to manage their lands so as not to compromise the integrity of adjoining lands be they public or private. This responsibility of citizens, including landowners, is described as their **duty of care**. The idea of duty of care is a common law concept based around managing individual (or corporate) negligence. It is defined as (NSW Irrigators Council 2003):

'*The action of a person results in harm to either another person or the property of another person. A duty of care is a legal obligation to avoid causing such harm.'*

Today most Governments have environment and land management legislation that incorporates a statutory concept of duty of care, for example the Queensland *Environmental Protection Act 1994* (see NSW Irrigators Council 2003 for further examples).

When it comes to managing private property for the mix of public and private interests there is inevitably a conflict because individual landowners get no direct or immediate benefits from management options that protect off-farm environments. Indeed they might often see this requirement as a Government impost on them to take on responsibilities that are more appropriately Government's to implement. As a consequence, the issue of how to fairly apportion public and private interests in environmental management remains a topic of much debate, with one of the key issues being the definition, or indeed redefinition, of property rights and responsibilities (see Hogan 2003 in the Readings Section for a useful background).

20.4 Case study farms

'Manus', Goondiwindi

'Manus', 35 km north-east of Goondiwindi on the NSW-Queensland border, is owned by the McMicking family. It is a predominantly dryland cropping property with some cattle grazing, and Hugh McMicking is an example of the 40% of Australian crop farmers who have begun using no-till practices.

Property size:	2525 ha
Approx. annual rainfall:	600 mm, two-thirds of which falls between November and April
Main production types:	cereal and legume cropping; beef production
Soil types:	red soils, some sodic; deep black vertosols; grey cracking clays
Native vegetation:	originally brigalow/belah, some wilga and ti-tree; 10% of property is remnant vegetation

History

Wool sheep were common in the district until the late 1960s. A few sheep remained on 'Manus' until the late 1990s, but now only cattle are grazed. The major change in the district over the past 30-40 years has been a general move toward cropping, which was precipitated in part by the need to deal with dense woody regrowth following clearing. Prolonged cultivation has been reasonably successful in preventing regrowth.

Current management practices

Approximately 1550 ha of 'Manus' is regularly cropped. The region's climate permits **both summer and winter cropping**. Major summer crops include cotton (dryland), grain sorghum and millet. Winter crops are wheat and barley. Some forage crops are also grown, oats in the winter and forage sorghum in the summer. The current farming cycle results in the production of three crops every 4 years, with 1 year of fallow.

No-till farming is practised on 'Manus'. The main driver for this change in cropping practices has been the need to retain soil moisture. The only departures from no-till farming occur in years when weed growth is excessive and the chemical cost to treat would be particularly high. Therefore, paddocks are cultivated on average once every 2-3 years. Mr McMicking reports excellent productivity improvements and a decrease in year-to-year uncertainty resulting from the move to no-till. To keep the cost of herbicide down, weeds are managed largely through very dense crop plantings.

Much of the **remnant native vegetation** on the property occurs as linear windbreaks along the margins of paddocks and along watercourses. Only 200 head of cattle are run and no particular pasture management plan is followed due to the small herd. The pasture along creeklines is grazed for 3 months in every 12. Cattle breeds include Shorthorn and Hereford crosses. Most pasture is native and the main species is Queensland blue grass, with medics in the winter.

Sustainability issues

Disease can present a major threat in no-till systems so **crop rotations** are important. Crop rotation is the main method of disease control on 'Manus'. Typically winter cereal is grown for 2 years, followed by 1 year of fallow and then one summer crop. **Herbicide resistance** is also a potential serious problem with repeated applications of mainly glyphosate herbicide. Reduced risk of herbicide resistance is achieved by ensuring that doses of herbicide are large enough to kill all treated plants.

Soil fertility was declining on the farm before the introduction of a system of fertiliser application. Soil from each paddock is tested annually, and monoammonium phosphate and urea are applied as required.

Some **water erosion** occurs on the property as parts of it are gently sloping. Contour banks are not used as Mr McMicking feels that the water erosion is minimal. Although the primary motivation for a no-till system is soil water conservation, the retention of crop stubbles also plays an important role in minimising water erosion.

Mr McMicking considers **weed invasion** to be one of the greatest threats to sustainable agricultural production on his property and in the region. The most important weeds on his property include harrisia cactus (*Eriocereus martini* and *E. tortuosus*) and mother of millions (*Bryophyllum* spp). Harrisia cactus, a native of South America, is highly invasive and outcompetes pasture as well as making it difficult for stock to access pasture due to the spines. The underground tubers make control difficult. A biological control - a mealy bug - was recently introduced, but this is only active in the warmer months. Spraying with herbicide is therefore also necessary to control this pest.

Mother of millions is an invasive, herbaceous, drought-tolerant plant in the Crassulaceae family. It is highly toxic to stock, causing death within a day in many cases. Herbicide application is the main treatment. On 'Manus', mother of millions is treated by the removal of understorey vegetation, resulting in greater grass growth which Mr McMicking suggests outcompetes the weed.

The future

Mr McMicking intends to scale back grain-growing and increase the cattle herd on 'Manus' to about 1200 head. He will continue with the existing cropping practices which have been highly successful. As the domestic animal feed market expands, Mr McMicking will focus more on growing feed quality grain.

'Mulgowan', Stanthorpe

'Mulgowan', 30km north-west of Stanthorpe in south-east Queensland, is owned and run by Clive Smith. The property is located in the Traprock wool-growing district, where poor soils and native pastures are used to produce superfine Merino wool. All sheep are coated year-round to preserve wool quality. The finest wool produced on 'Mulgowan' in 2004 was 15.2 micron.

Property size:	2225 ha
Approx. annual rainfall:	750 mm, two-thirds of which falls between November and April
Main production types:	superfine wool
Soil types:	granite and traprock
Native vegetation:	Originally eucalypt woodland, primarily mulga ironbark and yellow box. Remnant vegetation makes up 10% of the property.

History

Wool growing has always been the main land use on 'Mulgowan' and in the Traprock district, although prior to the 1990s most wool produced was of medium grade. A major change was precipitated by the formation of the Traprock Wool Growers Association shortly after the removal of the Australian Wool Corporation's minimum reserve price scheme. The Association's aims were to develop a quality assurance system in order to produce and market superfine wool for the fine cloth market. This successful strategy has led to the Traprock producing some of the finest wool in the world, most of which is sold to the Italian clothing industry. In recent years, Traprock graziers have tended to diversify their businesses by including small orchards on their properties. Many graziers spend at least part of their time working in town.

Current management practices

The pastures on 'Mulgowan' are predominantly native, consisting of aristida (*Aristida* sp.), pitted blue grass (*Dichanthium* sp.) and Queensland blue grass, which is the most desirable species. Queensland blue grass is selectively grazed by stock and Mr Smith reports that local graziers have achieved success using **rotational grazing** to favour its growth. Although most of the Traprock is not suitable for oversowing of exotic pasture species, some trials of kikuyu and digitaria have been undertaken. Mr Smith believes that this is not usually successful and has not oversown on 'Mulgowan'. No fertiliser is applied to the native pastures, as the low protein content of the feed is part of the key to producing the superfine wool diameter.

Six thousand, five hundred merino wethers and dry ewes are currently **set-stocked** on 'Mulgowan', but the property is in the process of switching to a limited rotational grazing system. The main impetus for this change is the lack of available feed in the late winter in a set-stocking system and Mr Smith intends to leave some paddocks ungrazed for some months leading up to that time. A further benefit of the intended change is reduced time spent mustering.

Sheep are fed **bypass protein supplements** in the form of blocks and cottonseed meal and molasses-based liquid feeds to improve feed digestibility. Shearing takes place in spring to avoid a break in the wool, which can result in substantial discount on wool purchase price. No lambing takes place on 'Mulgowan', and Mr Smith annually purchases fine wool lambs, usually from the New England Tablelands.

Sustainability issues

Soil erosion has been a problem in the Traprock due to overstocking and Mr Smith hopes that the move to rotational grazing will result in less pasture damage and improved erosion control. **Hillside water erosion** is the major concern.

The control and eradication of **woody weeds** is also a concern and the main species are hop bush (*Dodonaea* spp), peach bush (*Ehretia membranifolia*) and the introduced tree pear (*Opuntia* spp). Mr Smith has observed that the regrowth tends to come back strongly following bulldozing, and treats regrowth on his property with herbicides.

Mr Smith and the Traprock Wool Growers Association, along with researchers from the University of Southern Queensland, have embarked on a project to quantify the **biodiversity** attributes of grazing properties in the district. The longer-term aim is to use this information to better manage properties so that both production and biodiversity values are maximised. The Association perceives that this will confer marketing benefits as well as improving the sustainability of farming in the district.

Drought is always a potential threat and 'Mulgowan' has a well-developed drought strategy. The sheep are graded on a scale from 1-4, and as a dry period increases in intensity the sheep are successively sold off, beginning with the older, coarser grade 4 sheep. Because the property can support approximately 3300 sheep throughout a drought if stock numbers are reduced in a timely fashion, the higher prices commanded for fine wool in such periods mean that profits suffer little.

The future

In the short term, Mr Smith plans to continue to improve the quality of the wool produced on 'Mulgowan', and aims to produce a 14 micron bale next year. The rotational grazing system is something that he aims to have running smoothly within about 5-10 years. Trickle irrigation will be introduced to a small area of lower-lying, relatively flat land and **forage plants** such as old man saltbush (*Atriplex nummularia*) established for drought protection and to provide feed for sheep off-shears in the spring. Further into the future, he believes that changes in the wool market will make it prudent to purchase more medium-wool sheep.

Readings

The following readings are available on CD:

Ecosystem services:

1. Daily, G.C. (Ed.), 1997, *Nature's Services: Societal Dependence on Natural Ecosystems*, Island Press, Washington, DC. **(Suggested reading but not provided on CD).**

Property rights:

2. Hogan, T. 2003, *There is nothing new under the sun: an essay on property rights from an historical and current perspective*. Queensland Department of Natural Resources and Mines. Retrieved May 1st, 2006 from : http://www.nrm.qld.gov.au/property/pdf/dg_speech.pdf.

GMOs:

3. Independent Science Panel, 2003, *The case for a GM-free sustainable world*, Institute of Science in Society, London and Third World Network, Penang. Available at www.indsp.org and Institute of Science in Society (partner to ISP) www.i-sis.org.uk for more information of GM.

Adaptive management:

4. Ladson, A.R. and Argent, R.M. 2002, 'Adaptive management of environmental flows: lessons for the Murray-Darling Basin from three large North American Rivers', *Australian Journal of Water Resources*, vol. 5, pp. 89-102.
5. Walters, C. 1986, *Adaptive Management of Renewable Resources.* Macmillan, New York. **(Suggested reading but not provided on CD).**
6. Walters, C. 1997, 'Challenges in adaptive management of riparian and coastal ecosystems', *Conservation Ecology,* vol. 1(2), pp.1. Retrieved May 1st, 2006 from http://www.consecol.org/vol1/iss2/art1. **(Suggested reading but not provided on CD).**

Irrigation efficiency:

7. Raine, S.R. 2000, 'Issues in farm design and water management for serious irrigators. Are you in the race?', in *Rural Property Conference 2000*, Australian Property Institute. 17-18th March, Toowoomba. Available at: http://www.usq.edu.au/users/raine/index_files/APIpaper_march2000b.pdf.

Activities	Available on WebCT
Multi-Choice Questions	Submit answers via WebCT
Useful Web Links	Available on WebCT
Assignment Questions	Choose ONE question from ONE of the topics as your assignment. Short answer questions appear on WebCT. Submit your answer via WebCT

Summary

Summary Slides are available on CD

The northern wheat/sheep belt comprises that part of the wheat/sheep belt that lies north of Coonabarabran, and stretches north to the Roma region. The major distinguishing factor is the dominance of summer rainfall associated with tropical monsoon activity, compared to the gentler winter rainfall of the southern wheat/sheep belt. The region's more fertile soils with a ready supply of water support irrigated crops, and dryland summer and winter cropping is widespread. Cotton, sorghum and maize are the most common summer crops, with most cotton being irrigated. Wheat and barley are the most commonly grown winter crops. The most extensive land use is grazing, predominantly of cattle on either native or improved pastures. Major sustainability issues in the region include declining soil fertility in continuously cropped areas, chemical resistant weeds and pests, dryland and irrigation salinity and biodiversity and habitat loss. Soil erosion by both wind and water is also a major problem and rotational grazing systems and no-till farming are increasingly used to conserve soil. No-till practices also result in improved soil water conservation. Dense regrowth of native vegetation following bulldozing or ploughing is an issue particularly in pastoral areas.

References

Australian Bureau of Meteorology (ABOM) 2003, *Average annual rainfall*, Retrieved 1st May 2005 from http://www.bom.gov.au/cgi-bin/climate/cgi_bin_scripts/annual_rnfall.cgi.

Daily, G.C. (Ed.), 1997, *Nature's Services: Societal Dependence on Natural Ecosystems*, Island Press, Washington, DC.

Department of Environment and Heritage (DEH) 2001, *Australia: State of the Environment 2001*. CSIRO Publishing, Melbourne.

Department of Environment and Heritage (DEH) 2005, *Interim Biogeographic Regionalisation for Australia*. Retrieved 1st May 2005 from http://www.deh.gov.au/parks/nrs/ibra/version5-1/qld.html.

Firbank, L.G. 2003, ‘The farm scale evaluations of spring-sown genetically modified crops: Introduction’, *Philosophical Transactions of the Royal Society of London: Biological Sciences,* vol. 358, pp. 1777-1778.

Hogan, T. 2003, *There is nothing new under the sun: an essay on property rights from an historical and current perspective*. Queensland Department of Natural Resources and Mines. Available at: http://www.nrm.qld.gov.au/property/pdf/dg_speech.pdf.

Independent Science Panel 2003, *The case for a GM-free sustainable world*, Institute of Science in Society, London and Third World Network, Penang.

Ladson, A.R. and Argent, R.M. 2002, ‘Adaptive management of environmental flows: lessons for the Murray-Darling Basin from three large North American Rivers’, *Australian Journal of Water Resources*, vol. 5, pp. 89-102.

Murray-Darling Basin Commission (MDBC) 2002, *Basin Irrigation and Salinity Mapping Atlas of Australia*, Edition 2.1. Murray-Darling Basin Commission.

Murray-Darling Basin Commission (MDBC) 2005a, *Location of northern wheat/sheep belt*, Retrieved 1st May 2005 from http://www.mdbc.gov.au/education/encyclopedia/agriculture/ agriculture.htm.

Murray-Darling Basin Commission (MDBC) 2005b, *Location of cotton growing in the Murray-Darling Basin*, Retrieved 1st May 2005 from http://www.mdbc.gov.au.education/encyclopedia http://www.mdbc.gov.au/education/encyclopedia/agriculture/agriculture.htm.

Nelson, R., Alexander, F., Elliston, L. and Blias, A. 2004, *Natural resource management on Australian farms*, ABARE *e*Report 04.7, Prepared for the Australian Government Department of Agriculture, Fisheries and Forestry, Canberra.

NSW Irrigators Council 2003, *Responsibilities for Resource Rights*. New South Wales Irrigators Council, Sydney.

Raine, S.R. 2000, 'Issues in farm design and water management for serious irrigators. Are you in the race?', in *Rural Property Conference 2000*, Australian Property Institute. 17-18th March, Toowoomba. Available at: http://www.usq.edu.au/users/raine/index_files/APIpaper_march 2000b.pdf.

Ricklefs, R.E. 1990, *Ecology, 3rd Edition*. W.H. Freeman and Company.

Walters, C. 1986, *Adaptive Management of Renewable Resources.* Macmillan, New York.

Walters, C. 1997, 'Challenges in adaptive management of riparian and coastal ecosystems', *Conservation Ecology,* vol. 1(2), pp.1. Available at: http://www.consecol.org/vol1/iss2/art1.

TSWRU, 2001, *Herbicide Resistance Reporter,* Issue No. 9, Tropical and Subtropical Weeds Research Unit, University of Queensland. Available at: http://www.weeds.uq.edu.au/ newsletters.htm#hr%20 reporter.

Glossary of terms

Biodiversity	The variability among living organisms from all sources (including terrestrial, marine and other ecosystems and ecological complexes of which they are part); includes diversity within species and between species, and diversity of ecosystems
Bioregion	A territory defined by a combination of biological, social and geographical criteria rather than by geopolitical considerations; generally, a system of related, interconnected ecosystems
Broadacre farms	Commercial farms over a large area. Produce includes crops, wool, beef and sheep meat. Farming is usually under dryland conditions
Catchment	An area of land where run-off from rainfall goes into the one river system
Dryland salinity	Where water balance has been altered due to changing land use (e.g. clearing of native vegetation for broadacre farming or grazing), excess water entering the watertable mobilises salt which then rises to the land surface. Movement of water drives salinisation processes and may move the stored salt towards the soil surface or into surface water bodies
Ecosystem	A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit
Fallow	The practice of maintaining land free of plant growth. Land is left either in a cultivated or herbicide-treated state for a period before sowing a crop or between successive crops. It is mainly carried out to conserve soil water and mineralise soil organic nitrogen reserves. The period of fallow can vary from between 3 months (short fallow) and 14 months (long fallow)
Habitat	The biophysical medium or media occupied (continuously, periodically or occasionally) by an organism, or group of organisms, and into which organisms of that kind have the potential to be reintroduced
Irrigation salinity	A localised rise in the level of groundwater and the associated mobilisation of salt, caused by the application of large volumes of irrigation water, compounded by the replacement of native vegetation by plants with different use patterns
Leasehold	Land owned by governments on behalf of the people they represent but leased to specified people or organisations for a specific purpose; about 50% of Australia, mostly in the drier regions, comes under some form of leasehold; governments retain a variety of controls over how leasehold land is used

Monitoring	Routine counting, testing or measuring environmental factors to estimate their status or condition
Perennial	Plants that live for more than 1 year
Recharge	Rainfall that moves through the soil, beyond the roots of plants, to replenish the aquifer
Minimum tillage	Any procedure for preparing land for sowing, where herbicides partially replace cultivation. Also known as reduced tillage
Riparian zone	On the fringes and adjacent to water bodies
Salinity	The total amount of water-soluble salts present in a soil horizon
Sustainable	Referring to an activity that is able to be carried out without damaging the long-term health and integrity of natural and cultural environments
Watertable	A surface defined by the level to which water rises in an open well or piezometer
Weed	A plant species growing where it is not wanted by humans
Woodland	An area with scattered trees, where the portion of land surface covered by the crowns of trees is more than 30% (open woodland), but less than 60% (forest)