18. Case Study A: Northern Tablelands of New South Wales

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Learning objectives

On completion of this topic you should be able to:

- Describe in broad terms the biophysical environment of the Northern Tablelands and the structure of the main farming enterprises
- Understand the biophysical controls and the potential influence of management on pasture production
- Appreciate the diverse range of socio-economic and biophysical sustainability issues confronting New England graziers
- Discuss some of the opportunities and hazards that the future holds for the region's primary producers

Key terms and concepts

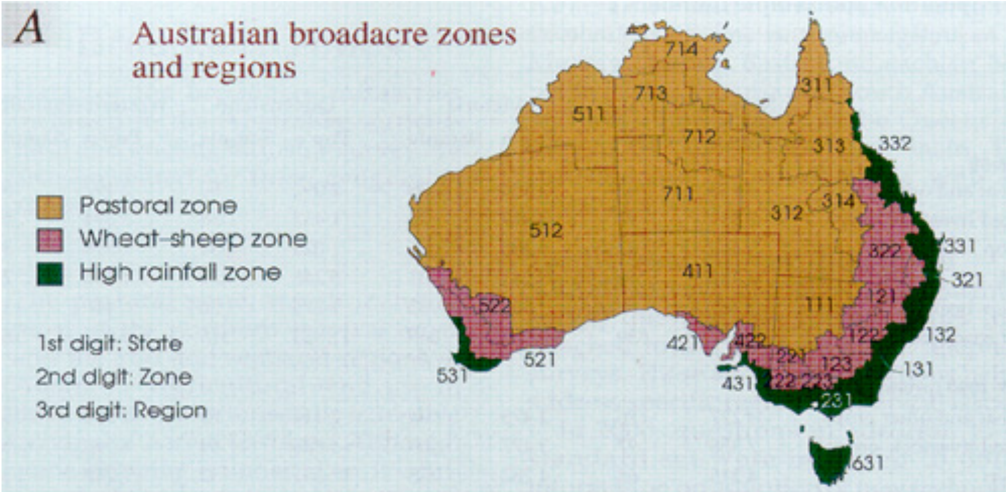
Carrying capacity, climate change, C3 and C4 plants, dieback, dryland alkalinity, environmentally and ethically responsible production, environmental stewardship, erosion, high rainfall zone, farming as a lifestyle, fertiliser, grazing management, kangaroos, land capability, lack of sown pasture persistence, loss of biodiversity, market opportunities, native pasture, parasites, rural adjustment, soil acidification, sown pasture, water resources, weeds, wild dogs, withdrawal of services, wool.

Introduction to the topic

The high rainfall zone (HRZ) in Australia, as defined by the Australian Bureau of Agricultural and Resource Economics (ABARE), forms the greater part of the coastal belt and adjacent tablelands of the three eastern mainland states, small areas in south-eastern South Australia and south-western Western Australia and the whole of Tasmania (Figure 18.1). Higher rainfall, steeper topography, more adequate surface water, greater humidity and infertile, erodible soils make the HRZ less suitable than the wheat-sheep zone for grains based cropping but more suitable for grazing and other crops (ABARE 2001). Typical broadacre agricultural industries in the HRZ are dairy, beef, sheep meat and wool.

The Northern Tablelands of NSW are part of the HRZ and cover about 3.3 million ha in seven local government areas (LGAs) (Table 18.1). After a long period of Aboriginal prehistory, the region was settled by squatters in the 1830s. For most of the period of European settlement, native pastures sustained livestock production. High wool prices in the 1950s prompted sown pasture development over 23% of the region by clearing, cultivating, fertilising and sowing to introduced grasses and clovers (Reid et al. 1997). By 1993, 'natural pastures' dominated by native species and naturalised introduced species comprised 51% of the region. Although 6% of natural pastures have been topdressed with superphosphate and clover seed, 3% of sown pastures have reverted to volunteer native grasses and naturalised species. In the most intensively developed Shire (Walcha), 48% of the pasture is sown or top-dressed.

Figure 18.1 Australian broadacre zones and regions. Source: ABARE (2001).



The principal land use is agriculture (69% of the region) and grazing properties supporting beef, fat lamb and wool enterprises predominate (Table 18.1). The population in 2001 was 62 700 (ABS 2003). Agriculture, Forestry and Fishing accounted for 18% of the 24 800-strong workforce, with only Services (21%) and Retail and Wholesale Trade (19%) employing larger numbers of people.

Table 18.1 The area of agricultural holdings and the number of agricultural establishments in Northern Tablelands Local Government Areas in 2001. Source: ABS (2003).

Local Government Area	Area	Agricultural Holdings		Number of Agricultural Establishments							
	(km²)	(km²)	(%)	Plant Nurseries	Fruit and Vegetables	Grains and Crops	Total Livestock	Sheep	Beef	Dairy	Horses, Pigs and Poultry
Armidale-Dumaresq	4234	2864	68	4	1	5	296	174	212	0	8
Guyra	4427	3342	75	0	14	0	357	282	244	0	0
Inverell, eastern portion	1714	1317	77	0	14	20	146	74	110	6	2
Glen Innes-Severn	5645	3716	66	0	5	20	440	262	331	1	9
Tenterfield	7184	4535	63	0	30	15	465	121	390	14	5
Uralla	3224	2889	90	2	11	2	258	204	159	1	4
Walcha	6230	3773	61	3	0	0	348	210	281	2	1
TOTAL	32 659	22 436	69	9	75	62	2310*	1327	1727	24	29

The grazing industries on the Northern Tablelands face a variety of social, economic and biophysical sustainability issues. They include:

- Animal production issues associated with vertebrate pests and parasites
- Market requirements and restrictions associated with product quality and pesticide residues
- The economic problems of balancing farm finances with declining terms of trade, commodity price fluctuations, and a variable climate
- The social issues of farm succession planning, an ageing dwindling farmer population, and the withdrawal of services from the bush
- Resource base issues such as soil acidification and riparian zone management
- New environmental regulations concerning native vegetation and endangered species.

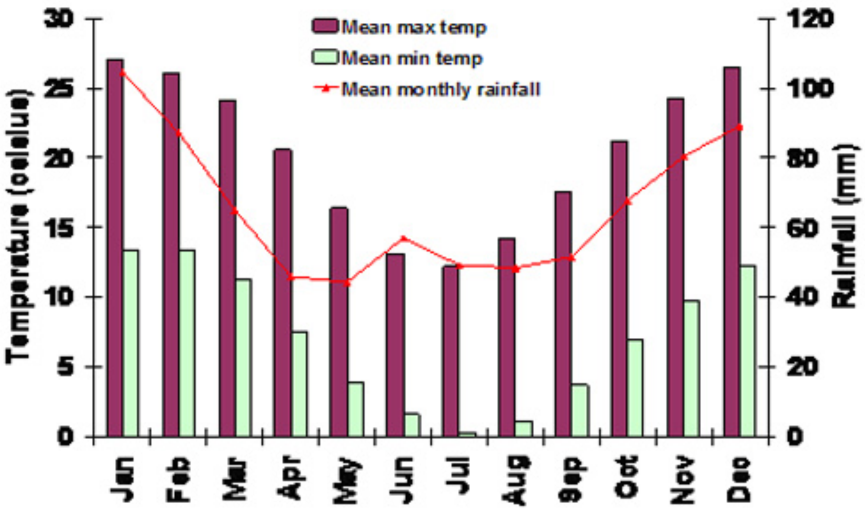
The objectives of this case study are to briefly review the Northern Tablelands environment and farm structures before analysing the key sustainability issues facing the region's graziers. The topic concludes by looking at what the future holds for Northern Tablelands graziers.

18.1 Climate, landform, soils and vegetation

Climate

The Northern Tablelands climate (Figure 18.2) is characterised by mild summers and cold winters. Rainfall increases towards the east and temperatures towards the west. In Armidale, the maximum temperature exceeds 30°C on an average of only five occasions per year. The mean annual frequency of frosts is 97 days, these usually occurring in winter, but light frosts may occur in most months. Mean annual rainfall is 790 mm and summer dominant. Mean annual evaporative losses are 1222 mm with peak losses of 5 mm/day in December-January and smallest losses of 1 mm/day in June-July. Mean monthly rainfall exceeds mean evaporation only in June and July (Reid and Kahn 2006).

Figure 18.2 Maximum and minimum monthly temperature and average monthly rainfall at Armidale, NSW. Source: L. Kahn (unpubl.).



Landform, soils and land capability

The Northern Tablelands lie between 800 and 1400 m above sea level. The highest points occur along the eastern rim, with most of the western boundary below 1000 m. The region is diverse geologically with three principal parent material types: (1) Palaeozoic granites and acid volcanics, (2) Palaeozoic metamorphosed sedimentary rocks (principally chert, greywacke and mudstone, commonly referred to as 'trap rock'), and (3) Tertiary basalts (Harrington 1977). Parent materials are important determinants of soil development by virtue of their mineralogy, chemical content and grain size. These parent materials weather to form distinct soil landscapes. Basalt weathers to fertile, clay-dominated soils with uniform to gradational profiles. The acid volcanics and metasediments form low to medium fertility duplex soils that are often poorly structured and susceptible to water erosion.

The soils derived from the different parent materials differ in physical and chemical characteristics. The primary chemical limitation of the soils derived from granite and metasediments is phosphate, while for basalt-derived soils it is often sulphur. These soil landscapes vary in extent, with granites and acid volcanics occupying 44% of the region, metasedimentary soils 34% and basalt landscapes 22% (Reid et al. 1997). Thus the most fertile basalt soils are of limited extent, while the low-fertility granite and acid volcanic soils are the most extensive. Tertiary and Quaternary fine-textured alluvial soils are found on valley floors and although of limited extent, are also fertile.

Soils and topography form the basis for land capability classifications which describe the biophysical potential of land to sustain particular uses. Despite relatively high rainfall, New England is dominated by grazing rather than cropping as a land use, because the soils and topography over most of the region are incapable of sustaining cultivation on a regular basis. Most of the soils are relatively infertile, of poor structure and erodible due to the duplex profiles, sodic subsoils in lower-lying parts of the landscape and the undulating topography.

Table 18.2 shows conceptually how soils and topography combine to form a mosaic of zones of varying potential for primary production across the New England landscape. All other things being equal, upper slope positions in a landscape have shallower soils and experience a more xeric micro-climate due to exposure and the continual movement of water and matter downslope under the influence of gravity. Lower slope positions and valley floors, on the other hand, receive water, soil and nutrients and thus have deeper, more fertile, finer textured soils with greater water holding capacity and productive potential than upslope. Floodplains also receive periodic accessions of silt, clay and organic matter in floods and may be underlain by shallow aquifers associated with surface water ways, within reach of tree roots.

When position in the landscape is coupled with the inherent differences in soil fertility associated with parent material, productive potential is seen to vary from low to high across the region. Areas of low productive potential such as most of the coarse granite and acid volcanic landscapes, are suited to agricultural enterprises that do not require high nutrient inputs and are profitable under low rates of primary productivity, such as fine wool production (from wethers) and timber from native forestry (e.g. stringybark *Eucalyptus* spp) and radiata pine (*Pinus radiata*) plantations. More agricultural options are available in zones of medium productivity, including cattle and sheep breeding, stone fruit and grape production, and occasional sown pasture establishment and renovation (using tined implements). In highly productive areas such as basalt landscapes and broad alluvial valley floors, meat production from beef and fat lambs, forage crops, hay and vegetable production become possible. Although grazing occurs across all soil types, apart from small areas of fodder cropping, the growing of crops (e.g. potatoes) and horticultural species is largely restricted to the more fertile basalt-derived soils and alluvial soils.

Enterprises suited to zones of low productive potential are also generally suited to zones of higher productivity although perhaps are not as profitable as more demanding land uses. The examples of land uses, mentioned above, are typical of central New England. Productive potential declines to the west and increases to the east with temperature and rainfall gradients, typical enterprises varying accordingly.

Table 18.2 Opportunities and constraints matrix showing the productive potential of the central New England environment as defined by parent material and position in the landscape. Source: Reid and Kahn (2006).

Soil Landscape	**Landscape Element**		
	Ridges, upper slopes, rocky skeletal soils	**Midslopes**	**Lower slopes and valley floors**
Coarse granites and acid volcanics	Low	Low	Medium
Metasedimentary	Low	Medium	Medium
Basalt	Medium	High	High

Native vegetation

Originally, the native vegetation was grassy woodland and open forest, with small areas of grassy plains, swamps in valley floors and denser forest on ridges and toward the eastern escarpment (Curtis 2001). The grass layer was dominated by kangaroo grass (*Themeda australis*), wild sorghum (*Sorghum leiocladum*), barbed wire grass (*Cymbopogon refractus*) and tussock poa (*Poa sieberiana*) (Norton 1971; Lodge and Whalley 1989). As the native grasses are predominantly warm season perennials, animal production was initially constrained by low primary production and poor nutrition in winter. The post war use of superphosphate and introduced cool season grasses and clovers led to a doubling and quadrupling of sheep and cattle numbers, respectively, between 1945 and 1975 (Johnson and Jarman 1976).

Pasture types

Sown pastures are generally sown to a 'New England cocktail' mix of:

- phalaris (*Phalaris aquatica*)
- perennial ryegrass (*Lolium perenne*)
- cocksfoot (*Dactylis glomerata*)
- fescue (*Festuca arundinacea*)
- clovers, principally white clover (*Trifolium repens*) and sub clover (*T. subterraneum*).

Native and volunteer naturalised pastures are dominated by native grasses, but livestock grazing pressure, fertiliser and cultivation have changed the species mix from the original pre-European warm season dominants. Four major types of native pasture now occur in grazing country (Lodge et al. 1984; Lodge and Whalley 1989):

1. Redgrass (*Bothriochloa macra*), Parramatta grass (*Sporobolus creber*) and paddock lovegrass (*Eragrostis leptostachya*) dominated pastures on former cultivated country and fertilised, grazed areas
2. Tussock poa dominated pastures in fertilised open country
3. Wiregrass (*Aristida ramosa*) dominated pastures on lightly stocked, low-fertility soils
4. Weeping rice grass (*Microlaena stipoides*) dominated pastures in grazed woodland beneath trees.

18.2 Farm characteristics, enterprises and pasture management

High rainfall zone farms differ substantially from farms in the wheat-sheep and pastoral zones (Table 18.3). On average, HRZ broadacre farms are smaller, carry less livestock, use less hired labour and generate lower profits than pastoral zone farms. These differences are due to the higher productivity per hectare of HRZ farms, the proximity of services, and the lower overheads and operating costs of HRZ producers compared to pastoralists and farmers in the wheat-sheep zone.

Table 18.3 Comparison of selected physical and financial estimates of broadacre farms in the high rainfall, wheat-sheep and pastoral zones of Australia (defined in Figure 18.1) in 2001-02 (preliminary estimates). Source: ABARE (2003).

	Pastoral Zone	Wheat-Sheep Zone	High Rainfall Zone
Number	3795	38 784	67 875
Total farm area (ha)	85 531	2149	1238
Sheep flock at 30 June	2896	1574	1410
Beef herd at 30 June	2116	188	295
Cropping area harvested (ha)	80	468	38
Labour used (weeks)	159	108	90
Total cash receipts ($)	552,450	377,410	181,930
Total cash costs ($)	376,390	253,970	127,080
Farm business profit ($)	112,510	56,490	11,140
Farm business equity ratio at 30 June (%)	87.8	87.4	91.6
Off-farm income ($)	23,640	26,330	23,940

Within the HRZ, there are 2300 grazing properties on the Northern Tablelands, with 75% running beef cattle and 57% sheep. By comparison, only 2% of grazing properties manage dairy, horses, pigs or poultry (Table 18.1). Specialist sheep producers average between 30% (Walcha) and 45% (Uralla) of total sheep enterprises per shire, while specialist beef-only enterprises account for between 30% (Uralla) and 82% (Tenterfield) of all beef operations (ABS 2003). Broadacre farms in the region derive about 80% of their cash receipts from livestock and wool sales (Sheales and Barrett 2001). For the average grazing property (Alford et al. 2003):

- Returns to equity are low
- Variable commodity markets result in varying levels of profitability
- Profits are sensitive to small changes in prices
- In practice, however, the enterprise mix doesn't change much in the short-term, with most farms maintaining a range of sheep and cattle enterprises; this is due to various biological lags, and infrastructure, financial and management constraints.

In 2001, farm size averaged 800-1100 ha (Table 18.1), with smaller farms in the shires with more fertile soils and cropping (Inverell east and Glen Innes) and larger farms where sheep enterprises are most common (Walcha). However, within any one sector, there is considerable diversity in farm structure and enterprise mix. In the case of southern New England wool growers (Walcha to Glen Innes), a 2003 survey of 356 producers revealed four main types (Table 18.4). 'High input wool producers', of which there were few (9% of the sample), and 'range managers' (49%) had large properties and large sheep flocks but differed markedly in the proportion of their properties under native vegetation (native pastures and bushland). 'Meat producers' (26%) had smaller sheep flocks and somewhat smaller properties with intermediate proportions of native vegetation and introduced pasture. About one in six wool growers (17%) were 'life stylers' with small properties, small flocks, a significant proportion of native vegetation and with mostly off-farm income.

Table 18.4 Characteristics of four groups of wool growers in southern New England (Walcha to Glen Innes), based on cluster analysis of sources of income and types of country; n = 347. Source: Reeve and Bock (2004).

Attribute	Wool Grower Group			
	Range Managers	Meat Producers	High-Input Wool Producers	Life Stylers
Sample size (%)	49	26	9	17
Wool income* (%)	68	30	70	19
Beef income* (%)	20	37	16	4
Off-farm income* (%)	3	12	5	70
Introduced pasture** (%)	23	64	83	19
Native pasture** (%)	59	31	9	53
Bushland** (%)	16	9	5	20
Ave. property size (ha)	1377	966	1236	522
No. of sheep shorn annually	4355	2806	7303	831

* Income expressed as an average percentage of total income.
** Area of type of country expressed as a percentage of total farm area.

Pasture production

Climate strongly regulates pasture production in New England and this is partially compensated by the presence of both cool season (C3 species) and warm season (C4) pasture species (Reid and Kahn 2006). Cool-season pasture species include:

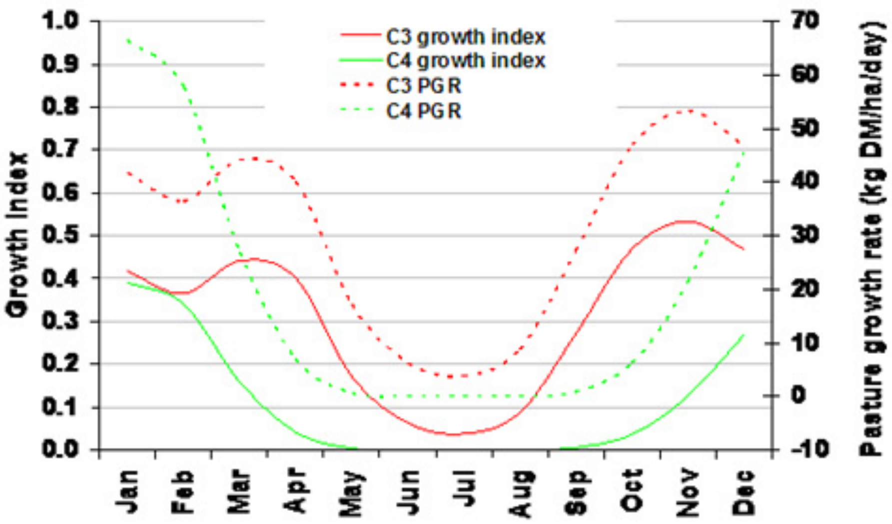
- All the legumes (*Trifolium* and *Medicago* spp)
- Introduced annual grasses such as oats (*Avena sativa*) and brome grasses (*Bromus* spp)
- Native annual grasses such as blown grass (*Lachnagrostis filiformis*)
- Introduced sown grasses such as perennial ryegrass, fescue and phalaris
- Native perennial grasses such as wallaby grass (*Austrodanthonia* spp), wheat grass (*Elymus scaber*) and weeping rice grass.

Warm-season pasture species include the native perennial grasses such as paddock lovegrass, Parramatta grass, redgrass and wild sorghum, and introduced perennial grasses such as paspalum (*Paspalum dilatatum*).

These pasture groups have distinct seasonal growth profiles with production of C3 and C4 species peaking during November and January, respectively. Growth indices, calculated from the GROWEST program (Hutchinson et al. 2002) for the major pasture groups for Armidale are presented in Figure 18.3 (Ranatunga et al. 2004). The growth indices are calculated from the product of light, temperature and moisture indices and reflect pasture production as a proportion of maximum production under a non-limiting environment. A maximum growth index of 0.53 (i.e. 53% of potential) is predicted for C3 species and 0.39 for C4 species, indicating that the New England climate imposes the greatest growth restriction on C4 grasses.

Pasture growth rate estimates for C3 and C4 pasture groups (Figure 18.3) indicate mean maximum daily growth rates of 53 and 67 kg dry matter (DM)/ha/day in November and January, respectively. Summing daily growth rate estimates over the year provides an indication of the potential annual pasture production from C3 and C4 species. It is estimated that the mean maximum annual pasture production for C3 species is 11 300 kg DM/ha and for C4 species 7100 kg DM/ha. With a mean annual rainfall of 790 mm, mean maximum annual water use efficiency of these pasture groups is 15.8 and 9.0 kg DM/ha/mm rainfall, respectively. With rates of pasture utilisation (i.e. the proportion of annual pasture production consumed by grazing animals) of 0.60, the mean maximum estimated stocking rate is 19 and 12 DSE/ha for C3 and C4 dominated pastures, respectively.

Figure 18.3 Growth indices and estimates of daily growth rate (PGR) for C3 and C4 pasture species. Growth indices calculated from GROWEST (with some local amendments) and growth rates derived from the product of growth indices and estimates of maximum rates of production. Source: Reid and Kahn (2006).



In fact most pasture swards are composed of a mixture of cool and warm season species. Assuming that C4 species comprise 60% of the pasture, estimated mean maximum annual pasture statistics are (i) 8800 kg DM/ha; (ii) 11.1 kg DM/ha/mm rainfall; and (iii) 15 DSE/ha. These estimates fit well with values measured on a range of New England pasture types (Earl and Kahn, unpubl.).

Pasture management

The perennial grass base of New England pastures distinguishes the region from the southern areas of Australia where native perennial grasses have largely been replaced by introduced annual grasses (Reid and Kahn 2006). The perennial grasses provide resilience to droughts, erosion, weeds and soil acidification. Historically, grazing and other practices have altered the composition of grasslands from the original dominance of tussock grasses such as kangaroo grass, barbed-wire grass and wild sorghum. While these species are still present in grazed paddocks, other more grazing-tolerant native perennial grass species have increased in importance. These species include paddock lovegrass, Parramatta grass, wallaby grass and redgrass.

The productivity of perennial grasses is responsive to management. The major management influences on pasture productivity include:

- paddock design (in terms of paddock area and geometry with respect to the landscape)
- grazing management
- fertiliser amendment.

Historically, the use of superphosphate fertiliser (containing phosphorus, sulphur and calcium) has caused the most dramatic changes in land-use practices in New England. From the 1930s but only becoming widespread in the 1950s, the use of superphosphate in conjunction with the spreading of various clover species, increased pasture productivity and nutritional quality to allow the reliable establishment of sheep and cattle breeding enterprises. In 1996, about 17% of the New England farm area was fertilised, on average, at a rate of about 0.1 t/ha of superphosphate (ABS 2003).
More recently, the benefits of rotating grazing animals among paddocks according to plans based on animal and plant requirements have been established. These management strategies are compatible and the benefits of these factors to pasture and animal production are detailed in Table 18.5.

Table 18.5 Annual pasture production, water use efficiency and stocking rate differences between paddocks with low and desirable soil fertility and with grazing management either planned and rotational or unplanned and continuously grazed.
Source: Reid and Kahn (2006)

	Soil Fertility		**Grazing Management**	
	Low	**Desirable**	**Unplanned**	**Planned**
Annual pasture production (kg DM/ha/day)	14.0	19.0	15.0	21.0
Water use efficiency (kg DM/ha/mm)	6.9	9.1	6.7	9.7
Stocking rate (DSE/ha)	10.0	13.0	9.0	11.0

Note: These data are taken from 2004 results of Kahn and Earl (unpubl.).

Other benefits, such as to animal health, arise through the use of rotational grazing according to plant growth rate. For example, worm infections in Merino lambs at weaning are reduced from 7000 to 200 eggs per gram of faeces (Kahn 2004). This is a significant reduction in worm infection and likely to have important production consequences. The lower worm infection is also important in managing resistance of sheep worms to the chemicals used for control. Strategies that reduce reliance on chemical control form part of integrated parasite management approaches that seek to improve worm control and slow the development of resistance in sheep worms.

District stocking rates are lower than the values in Table 18.5 because much of the region is country of low carrying capacity and many Northern Tablelands graziers are risk averse, preferring to understock, thereby avoiding having to purchase feed at inflated prices or offload stock in dry spells and drought when prices are low. District stocking rates for different soils and pastures are shown in Table 18.6.

Table 18.6 Observed carrying capacities (DSE/ha) of different soils and pasture types on the Northern Tablelands. Source: Lowien et al. (1991).

Soil Type	**Unfertilised Pasture**	**Top-dressed Pasture (superphosphate and clover seed)**	**Sown Pasture (perennial grass and legume)**
Basalt	4.0-6.0	7.0-10.0	15.0-25.0
Fine Granite	1.5-2.5	5.0-6.0	7.5-10.0
Trap	1.5-2.0	4.5-5.5	7.0-8.0
Coarse Granite	1.0-1.5	2.5-3.5	3.7-5.0

Three successful, environmentally responsible but quite different approaches to property management on the Northern Tablelands (Taylor and Taylor 2004; Wright and Wright 2004; Dulhunty and Dulhunty 2004) are profiled in the *Land, Water and Wool* case studies on CD and on the web at:

http://www.landwaterwool.gov.au/downloads/pdfs/UNE43_CS_Taylor.pdf
http://www.landwaterwool.gov.au/downloads/pdfs/UNE43_CS_Wright.pdf
http://www.landwaterwool.gov.au/downloads/pdfs/UNE43_CS_Dulhunty.pdf

18.3 Socio-economic sustainability issues

Increase in farming as a lifestyle

In recent years, there has been a large upswing in farm sales in Australia (Martin et al. 2005). In 2001-04, average land values for broadacre farms increased by over 50% in real terms, driven by higher farm incomes, low interest rates, and increased demand from urban Australians seeking rural lifestyles and investment opportunities. While substantial farm amalgamation has been occurring (next section), there have also been many new entrants to farming in regions of higher amenity value. These new entrants have been buying small farms with low income potential.

Rural adjustment

In the broadacre farming sector in Australia, the proportion of farmers acquiring more land has been high since 1998 (Martin et al. 2005). The high level of land transactions over a prolonged period suggests a significant amount of structural adjustment in Australian agriculture. Farmers that have been acquiring additional land are, on average, younger and operate farms that generate better than average rates of return in the period prior to land acquisition. Farmers disposing of land are older and operate farms generating lower rates of return, but do not necessarily operate smaller farms.

Withdrawal of services

Since 1986, there has been a decline in the populations of more than half the small towns in rural Australia (Garnaut et al. 2001). In 2000, ABARE conducted a survey of farmer perceptions of service withdrawal in rural Australia (ABARE 2001). Some 1274 broadacre farmers responded to the survey. On average, farmers had lived on their current farm for 32 years and in the region for 40 years. Around 60% of farmers in the HRZ did not need to travel more than 30 mins to reach their nearest regional centre, with almost 50% reaching their nearest local town within 10 mins. Between 1990 and 2000, the proportion of Australian broadacre farmers using banking services in their local town declined from 36% to 27% while the percentage having to use their regional centre for banking increased from 53% to 60%. Of those with access to local banking services, 62% said that the quality of the services had declined. These figures are consistent with the closure of local branches of banks. Over the same period, about 15% of farmers felt that education services in their local town had declined. In relation to food services, however, a greater proportion of farmers thought that food services had improved locally and regionally than otherwise.

As rural populations have dwindled with farm build-up and the cutting back of on-farm employment, there have been insufficient people left to volunteer for the wide variety of community activities or participate in the social activities that once characterised rural communities across the Northern Tablelands (and elsewhere). In the agricultural sector, a grievous loss has been the reduction in public agricultural and resource management extension services by the State Government's primary production and natural resource agencies. To some extent, Landcare has filled part of the gap, but Landcare membership is voluntary and some 30% or so of primary producers in southern New England have not joined Landcare groups.

Low wool prices

The wool industry remains an important agricultural industry, contributing around 7% of the gross value of agricultural production and $3 billion in export income in 1999-2000 (Shaffron et al. 2001). However, the industry has experienced low wool prices relative to prices for other broadacre commodities over the past 15 years. Predictably, this has resulted in a shift in enterprise mix in HRZ farms, with lower sheep numbers, fewer wool producing farms and an overall decline in wool production from both specialist wool producing farms and mixed enterprise farms (Shaffron et al. 2001). While low prices persist, these trends can be expected to continue.

Markets requiring environmentally and ethically responsible production

Increasingly, agricultural commodities are part of a Demand Chain although farmers are probably used to thinking of their products as part of a Supply Chain (Christine Nunn, pers. comm.). Demand chains start in the shop, not in the paddock. This means that the needs and preferences of consumers are paramount in dictating what products to grow on-farm and to what standards. ‘Green’ products are now mainstream in Europe and European environmental legislation is increasingly comprehensive. European consumers are increasingly making environmentally responsible purchasing decisions provided that cost, fashion, functionality and quality are not compromised. They trust and rely on non-governmental organisations (NGOs) such as Greenpeace for environmental and health advice, and the NGOs are targeting European retailers. In turn, the retailers are pressuring the manufacturers and importers, who are targeting the brokers who are buying or marketing commodities from farmers in exporting countries.

The wool industry provides an example of the pressures on Northern Tablelands producers. About 30% of Australian wool is scoured in Europe. The European Union Parliament is enforcing the Integrated Pollution Prevention and Control (IPPC) directive in the textiles industry across the European Union, to be fully functional by 2007. To meet the strict European eco-label criteria, Australian ‘eco-wool’ will have to be certified low residue. The EU eco-label greasy wool criteria for the period 2002-2007 are shown in Table 18.7. About 45-50% of Australian wool complies but only a small fraction is currently certified ‘EU Eco-Label’, most notably some of the wool marketed by Roberts in Tasmania. By 2007, Australian growers will have to declare their wool low residue. The implications for on-farm insecticide use are shown in Table 18.8.

Table 18.7 EU eco-label greasy wool criteria for 2002-2007.
Source: I.M. Russell (pers. comm.).

Chemical Residue*	Greasy Wool Criteria (mg/kg)
Sum of organochlorins	0.5
Sum of synthetic pyrethroids	0.5
Sum of organophosphates	2.0
Sum of insect growth regulators (diflubenzuron, triflumuron)	2.0

* Note that cyromazine, dicyclanil and spinosad are exempt

Increasing market sophistication and demands can be expected from European and US consumers. The high profile protests of People for the Ethical Treatment of Animals (PETA) against the Australian sheep industry’s use of mulesing and live export trade will no doubt spawn new import requirements for Australian sheep products. There is less evidence that China will demand the same standards of environmentally and socially responsible production of Australian commodities as the west.

Another important arbiter of Australian farm production standards is Australian society. Public opinion on environmental issues has been firmly entrenched in the Australian political landscape since Bob Hawke’s federal election win on the ‘no dams’ platform in 1983. Increasingly, farmers will have to justify their ‘right to farm’ by complying with domestic, environmental and ethical standards and expectations. Native vegetation regulations are a case in point.

Table 18.8 Acceptable and unacceptable on-farm insect pest treatments to meet EU eco-label greasy wool criteria for chemical residues. Source: I.M. Russell (pers. comm.).

Insect Pest	Acceptable and Unacceptable Treatments
Lice	✓ Organophosphates in early season
	✓ Spinosad in late season
	Do not use:
	× organophosphates or synthetic pyrethroids in late season
	× persistent chemicals (as ‘pour ons’ or dips) in early season
Flies	✓ Cyromazine, dicyclanil, spinosad
	✓ Organophosphates for wound management
	Do not use:
	× organophosphates for dipping or jetting of whole flocks in long wool

× These treatments can be legally used up to the withholding periods specified on the label. However, residues exceeding EU eco-label requirements are likely. If you use these treatments, do not make a declaration that wool meets EU requirements.

18.4 Biophysical sustainability issues

In the New England region, the key environmental externalities and sustainability issues for woolgrowers are well documented, and consist of dryland salinity and alkalinity, soil acidification, soil erosion, livestock access to water ways and wetlands, downstream impacts on water quality in terms of sediment, nutrient and salt loads and bacterial contamination of water resources, capture of excessive overland flow and retention in on-farm storages, greenhouse gas profile, biodiversity loss due to clearing, overgrazing and pasture improvement, the poor condition of remnant vegetation and native trees (i.e. dieback), the spread of pasture and environmental weeds, vertebrate pests, the occurrence of endangered species and communities, and the paucity of the tablelands environment managed for conservation (EPA 1997; Kreeb et al. 1995; Lodge et al. 1984; Nadolny 1998; NPWS 2003; Reid et al. 1997; Reid and Kahn 2006; Upjohn et al. 2005).

Water resources

Assessment of agricultural impacts on water resources in the New England is speculative because of the absence of historical records on the extent and distribution of wetlands and data on in-stream water quality and aquatic biota (potential bio-indicators) (Reid et al. 1997; Reid and Kahn 2006). The initial impacts of European settlement were evidently severe, since much of the sedimentation in New England wetlands can be traced back to this period, when large flocks of sheep were penned in small areas close to permanent water. Over 1 m of sediment was deposited in Little Llangothlin Lagoon within 10 years of settlement (Haworth 1994; Gale et al. 1995). The other major impact was the draining of the majority of the small swamps on valley floors across the region to improve pasture production and reduce sheep parasite loads (Brock et al. 1999).

Most New England streams are in fair to poor condition (Reid et al. 1997). The low relief and substantial weathering of the New England tablelands environment promote meandering streams which are prone to sedimentation. This coupled with near-universal practice of watering sheep and cattle from streams has led to uncontrolled grazing of riparian zones on most properties. Riparian and fringing vegetation has most likely declined due to clearing, dieback and overgrazing, and nutrient and sediment accessions to streams have most likely increased (from increased erosion, animal excreta and fertiliser drift). In turn, shading from fringing vegetation and leaf and woody organic matter inputs is likely to have declined, and the temperature of the water column increased, shifting the trophic base of tableland streams away from shaded heterotrophic systems dominated by invertebrate decomposers to sunlit autotrophic systems dominated by algae and herbivores (A. Boulton, pers. comm.). The problems with blue-green algae in farm dams and provincial reservoirs (Anon. 2003) are testimony to the substantial leakage of nutrients from grazing properties in the surrounding catchments.

Changes in grazier attitudes and management may see an improvement in wetland and stream health. Local graziers know that clean drinking water is important for livestock performance (Taylor and Taylor 2004; Wright and Wright 2004; Dulhunty and Dulhunty 2004), and there is supporting scientific evidence (Lardner et al. 2005). With the control of livestock access to streams and farm dams afforded by rotational grazing management, more graziers may manage streams and dams for improved water quality in future.

Yiasoumi et al. (2005) provide a comprehensive account of farm water quality and treatment in the readings on the CD-ROM.

Weeds

As in any grazing system, long-term production from Northern Tablelands pastures is dependent on maintaining weeds at low levels relative to desirable grasses, forbs and legumes. Rather than weeds being the cause of pasture decline, it is increasingly recognised that weeds are the result of management-induced pasture decline (Mason et al. 2003). Weeds have one or more of the following characteristics:

- poisonous to livestock
- produce plant parts that affect animal health, prevent grazing or reduce the value of animal products (e.g. vegetable fault in wool or damage to the skin or meat)
- lower digestibility for livestock
- occupy space or resources that could otherwise be used to grow more desirable species
- rapidly spread to neighbouring areas
- costly to control.

Northern Tablelands weeds include annual grasses (e.g. silver grass *Vulpia* spp), broadleaf weeds (e.g. St John's wort *Hypericum perforatum*, spear thistle *Cirsium vulgare*), perennial grass weeds (e.g. African lovegrass *Eragrostis curvula*, Coolatai grass *Hyparrhenia hirta*, whiskey grass *Andropogon virginicus*), and woody weeds (including declared noxious species such as blackberry *Rubus fruticosus* species-aggregate and sweet briar *Rosa rubiginosa*).

Weed control in pastures relies on managing the species complex to achieve the desired composition (Mason et al. 2003), by:

1. reducing weed seed set
2. reducing weed germination
3. encouraging strong competition from desirable species.

Pasture re-establishment is one option, but often too expensive ($250/ha) or impractical on low capability land (Mason et al. 2003). Taking action early is critical so that a weed infestation does not get out of hand. Integration of various weed management tactics, including grazing management to benefit desirable species and disadvantage weeds, herbicides, mechanical control and fertiliser and seed to encourage desirable species, is the key.

Lack of sown pasture persistence and drought

Well fertilised sown pastures with a legume and perennial grass component sustain the highest livestock stocking rates (Tables 18.5 and 18.6). However, the sown species and production advantage are often short-lived. Long-term stocking rate experiments demonstrate that high stocking rates (20-30 DSE/ha) and periodic droughts drive set-stocked sown pastures towards systems dominated by annual and short-lived grasses (*Bromus*, *Vulpia*, *Hordeum*, *Eleusine* and *Poa annua*) and annual clovers that produce less metabolisable energy and animal products (Hutchinson et al. 1998; Hutchinson and King 1999) and are more 'leaky' of nutrients and water (Chen et al. 1999). Given the cost of sown pasture establishment ($250/ha) and the risk of failure, sown pasture renovation can be uneconomic or impractical at times of low commodity prices, in drought or on lower capability land (Pitt 1995; Jones 1995; Nadolny 1998). After the climatically favourable decades in the 1950s, 60s and 70s, many graziers reported less production from sown pastures and regular topdressing with superphosphate in the drier seasons of the past 25 years. Consequently, there has been more interest in the role of native pastures and in grazing management alternatives to set stocking in an effort to reduce costs, sustain sown and productive native pastures, and boost profits (Jones 1995; Nadolny 1998; Mason et al. 2003).

Soil acidification

Most Northern Tableland soils are naturally 'slightly acidic' (Upjohn et al. 2005). However, New England does not suffer the same degree of induced soil acidification experienced in southern Australia, due to the perennial pasture base and mix of actively growing species throughout the year, preventing the leaching of excessive nitrate below the pasture root zone (Chen et al. 1999). Topsoil pH in a heavily grazed, heavily fertilised phalaris pasture at Chiswick was invariant over a 50 year period (K. Hutchinson, pers. comm.).

Tree clearing and pasture fertilisation has resulted in some topsoil acidification in the region. At 'Newholme' near Armidale, the topsoil pH of native pastures on granite soils is consistently 0.5 of a pH_{Ca} unit lower in open areas compared to wooded pasture (unpubl. data). In separate work, Graham et al. (2004) showed the ameliorative effect of the canopies of certain eucalypt species (*E. viminalis*, *E. melliodora*) on topsoil pH in grazed pastures. They also showed that fertilised, commercially grazed pastures were associated with increased topsoil acidity compared to adjacent traveling stock routes (lightly grazed woodland). Light tree cover may therefore assist in maintaining productive pasture soils.

Upjohn et al. (2005) provide a comprehensive account of soil acidification and management responses in the readings on the CD-ROM.

Alkali scalds (dryland 'salinity')

Small areas of alkali scald occur commonly in valley floors and on lower to mid slope positions in grazing lands overlying marine metamorphosed sediments across the Northern Tablelands. These areas are where shallow local aquifers form surface seepages rich in carbonates and bicarbonates of the alkali cations, notably sodium (Kreeb et al. 1995). Drainage of the original perched swamps, tree clearing and grazing of domestic livestock have exacerbated the occurrence of bare areas of soil (scalds) and changes in pasture composition in the zones surrounding these alkali scalds. Characteristic species surrounding scalds are couch (*Cynodon dactylon*) and sea barley grass (*Hordeum marinum*). The bare soils are characterised by high alkalinity (pH_{H2O} > 10) and sodicity down the profile, but are only marginally saline at the surface. The scalds are formed by alternating wet and dry periods, which induce salt accumulation at the surface of the seepage through evaporation. These bare areas are usually fenced as the first step in reclamation. This protects the fragile bare areas from livestock trampling and licking of the salt encrusted surface, and encourages grass regeneration. The latter is important for increasing evapotranspiration and reducing the upward capillary movement of salts.

Soil erosion

Gully and streambank erosion are widespread across New England (Reid and Kahn 2006). In the Gwydir catchment portion of the Northern Tablelands alone, there are 180 km of moderate to severe streambank erosion, while in the Uralla area there are 76 km of gully erosion (Donaldson 1996). Extensive streambank and gully erosion in the Uralla and Tingha areas are a function of the destructive mining techniques used in the 19th and early part of the 20th centuries in these areas (Donaldson 1996). Uncontrolled livestock grazing and the denudation of vegetation along streambanks contribute to these forms of erosion across the region (Peasley 1995). The duplex and gradational soils over most of the region and the sodic subsoils in lower parts of the landscape are highly susceptible to gully and streambank erosion.

Parasites

Aside from land capability, pasture type and management, there are two natural constraints to livestock production in New England that affect the distribution of sheep and cattle (Reid and Kahn 2006). These are wetlands and swamps, and wild dogs. Wetlands reduce the available grazing area for sheep because of their reluctance to graze in sodden areas but also because these areas harbour parasitic liver fluke (*Fasciola hepatica*). Liver fluke infections reduce production in grazing animals and in severe cases may result in death due to blood loss. In the liver fluke life cycle, adult fluke live in the bile ducts of sheep and cattle and their eggs are passed in faeces. Under wet and warm conditions, the eggs hatch to release the first larvae which invade lymnaeid snails (both native and introduced *Lymnaea* spp), re-emerging as tadpole-like cercariae which encyst on vegetation and can infect grazing animals (Boray 1999). While sheep usually avoid these areas and liver fluke, they graze damp areas in dry weather and drought as they often contain the only areas of green forage. At these times, sheep are exposed to liver fluke infections.

Wild dogs

Dingoes (*Canis lupes dingo*), feral dogs (*Canis familiaris*) and their hybrids are a natural constraint to livestock production in New England (Reid and Kahn 2006). Dingoes have been exterminated from most of the region but, along with wild dogs, find refuge in the rugged wilderness areas and forests along the eastern escarpment. Stock losses due to attack of sheep by dingoes were common in the early phases of settlement until marsupial fences were constructed by landowners. These fences are typically 2m in height and constructed of a large-gauge netting to restrict entry of dingoes, kangaroos and other native animals. However, fences have not always been adequately maintained and as a result, losses of sheep to dogs continue. The response of many landowners in the east has been to graze cattle as they are less susceptible to predation. Where sheep are run along the eastern escarpment, baiting and trapping programs and dog-proof fencing are maintained by graziers, the NSW National Parks and Wildlife Service and the Rural Lands Protection Boards.

Kangaroos

On Northern Tablelands grazing properties, eastern grey kangaroos (*Macropus giganteus*) and wallaroos (*M. robustus*) breed up to densities where they compete with livestock for pasture as well as damage forage crops and fences. Accordingly, large kangaroos on commercial properties are generally only tolerated at densities which are deemed sub-economic. As kangaroos are protected fauna, the National Parks and Wildlife Service (NPWS) regulates the commercial harvest and non-commercial culling of large kangaroos in NSW. Under Section 121 of the *National Parks and Wildlife Act 1974*, property owners are required to apply for a licence to reduce kangaroo numbers. The NPWS assesses the application and may approve a commercial harvest or non-commercial cull. Under the NSW Kangaroo Management Plan, periodic censuses of the numbers of large kangaroos are undertaken throughout the commercial harvest zones of NSW, and quotas are set each year in consultation with the Commonwealth. The quota and take in Northern Tablelands management zones are shown in Table 18.9. Between 1% and 21% of the estimated population of each species has been harvested in recent years. Doubtless some unlicensed shooting goes on as well, but it is doubtful whether > 40% of the regional population of eastern grey kangaroos or wallaroos is culled each year.

The 2005 Kangaroo Quota submission by the NSW Department of Environment and Conservation (Payne and Irvin 2004) is provided in the readings on the CD-ROM.

Table 18.9 The commercial take of kangaroos and wallaroos in Armidale (Armidale-Walcha) and Glen Innes (Glen Innes-Tenterfield) Kangaroo Management Zones in 2001-05. Source: NPWS (2005).

	Eastern Grey Kangaroo		Wallaroo	
	Armidale	**Glen Innes**	**Armidale**	**Glen Innes**
2001				
Quota	35 100	35 122	6250	6250
Commercial take (%)	89%	52%	37%	23%
Take as proportion of population (%)	15%	9%	2%	1%
2002				
Quota	27 000	43 700	6250	6250
Commercial take (%)	100%	64%	29%	29%
Take as proportion of population (%)	15%	10%	1%	1%
2003				
Quota	32 263	34 487	6250	6250
Commercial take (%)	97%	98%	46%	55%
Take as proportion of population (%)	18%	12%	2%	3%
2004				
Quota	27 068	34 458	5212	19235
Commercial take (%)	100%	94%	86%	34%
Take as proportion of population (%)	15%	14%	13%	5%
2005*				
Quota	24260	22443	13468	8499
Commercial take (%)	99%	98%	54%	72%
Take as proportion of population (%)	13%	10%	21%	5%

* Current to approximately 1 October 2005

Overclearing, dieback and loss of shade and shelter

The woody vegetation of parts of the Northern Tablelands has changed more visibly than other landscape elements as a result of agricultural development. In the 19th and early 20th century, the main improvement of the productive capacity of grazing country was to clear the timber through ring-barking, with periodic removal of the young sucker regrowth or ringbarking of the sapling regrowth. J.F. Campbell, a surveyor in the region between 1888 and 1903, commented that most of the ' … pasture plants of the Tableland …required direct sunshine for the true development of their fattening properties, hence the indifferent average carrying capacity of four acres to the sheep [0.6 DSE/ha], as estimated by pastoralists prior to the destruction of the timber' (Gardiner 1998). Ring-barking became widespread in New England in the 1870s after the passage of the Robertson Land Acts, as free selectors and squatters began to improve their selections and conditional purchases of land. Jon Taylor (pers. comm.) estimates that his family were able to reduce tree cover on their 20 000 ha Terrible Vale run near Kentucky to about 25% of the original tree cover in the 120 years to the mid-1950s, largely through ring-barking and regrowth control.

The major impact on tree cover in New England, however, commenced in the 1950s with pasture improvement, involving the sowing of introduced legumes and grasses in conjunction with superphosphate application. By the 1960s, aerial spreading of fertiliser and seed and sown pasture establishment was widespread. Coupled with tree clearing to permit sown pasture development and increased stocking rates, tree populations fell out of balance with the prevailing land use regime. In high rainfall years (particularly the 1950s and 1970s), defoliating insect numbers built up on remaining eucalypts, particularly the pasture scarab beetles that have a soil larval phase (Gregg 1997; Goodyer and Nicholas 2005). Pasture improvement encouraged high scarab numbers due to the increased nutrition available for the larvae in fertilised pasture soils. The high stocking rates and continuing clearing also eliminated the nectariferous forbs and shrubs that provided habitat and food for the parasitic wasps (scoliids, tiphiids), parasitic flies (Campbell and Brown 1995) and smaller insectivorous birds (Ford and Bell 1982) that control insect pests under natural conditions. The result was 'dieback', the decline and death of millions of eucalypts in the more intensely developed pasture lands in the lower parts of the landscape across the Northern Tablelands from the 1950s. Dieback continues today, both in the trees that remain in pasture developed landscapes, but also in less developed parts of New England as graziers continue to develop country and increase soil fertility.

The widespread death of eucalypts was reported in New England early in the 1850s (Norton 1886), so outbreaks of defoliating insects and widespread tree death is probably a natural phenomenon. However, under natural conditions, the eucalypt seedlings normally present in healthy eucalypt woodland and open forest grow up to replace dead canopy trees. The higher stocking rates associated with pasture improvement meant that seedlings and sucker regrowth were killed by browsing sheep (cattle are less damaging to eucalypt regrowth). Thus tree populations were prevented from naturally regenerating in fertilised and sown pastures, producing the stark, dieback-afflicted landscapes in intensively developed areas.

Although dieback can increase short-term livestock productivity through increased pasture production (Sinden and Jones 1985), tree clearing and dieback on the Northern Tablelands can proceed too far in terms of appropriate levels of shade and shelter for livestock. Cold weather can cause losses of lambs and sheep off shears, and reduced animal production in the absence of shelter due to the diversion of energy from growth to maintenance and thermoregulation. Near Walcha, lambing paddocks with sheltered campsites marked 92% lambs compared to 79% in open paddocks (B. Marchant, pers. comm.). In 2003, 34% of southern New England wool growers thought the amount of tree cover on their property was 'too little' (Reeve and Bock 2004). This group was planting on average 1200 trees per annum on their properties to reverse earlier tree clearing, thinning and dieback.

Recent farm planning guidelines have suggested an optimal level of tree cover on grazing properties in eastern Australia of 30% woodland in minimum sized clumps of 5-10 ha (McIntyre et al. 2002) to maintain healthy tree cover, sustain shade, shelter and other ecosystem services, prevent land degradation such as dryland salinity, and for wildlife habitat.

Loss of biodiversity

Agricultural development has had a significant impact on ground-storey vegetation over much of the New England, through clearing for sown pasture development and cultivation, fertiliser inputs and selective grazing by livestock. Lodge and Whalley (1989) described the shifts in composition of the dominant native pasture species over the past 170 years. The overall number of species declines under grazing, as well. Herbaceous native plant species richness is higher in nature reserves and other ungrazed or lightly grazed areas (e.g. roadsides, travelling stock reserves, cemeteries, private reserves) than in commercially grazed native pastures (McIntyre and Lavorel 1994; Reseigh et al. 2003). Several regional studies (Waters 2001; Reseigh 2004; N. Reid unpubl.) have found that native plant species richness is a positive function of tree cover and a negative function of fertiliser application, frequency and recency of cultivation, and grazing intensity. Typically, the herbaceous species disadvantaged by livestock grazing and associated management in south-eastern Australia include orchids, lilies and rare daisies (Mason et al. 2003).

Changes are also occurring in the shrub and small tree layer in New England open-forests and woodlands over time. A wide variety of understorey shrubs and small trees are common. Van Roessel (1995) surveyed the whole of the well-wooded, 2000 ha grazing property, 'Newholme' (including the ungrazed Mt Duval Nature Reserve), documenting the abundance and age structure of shrubs and small trees. The populations of five widespread species (*Acacia neriifolia*, *Allocasuarina littoralis*, *Banksia integrifolia*, *Dodonaea viscosa* and *Hakea eriantha*) were very small and threatened with local extinction. A combination of lack of fire and regeneration opportunities, competition with the dense grass layer, and sheep and rabbit grazing, is seemingly responsible for the decline of these species. If similar processes are replicated across New England, then even low levels of rabbit and sheep grazing and lack of fire for many decades may see the loss of once widespread shrubs and small trees.

A range of species and plant communities are now threatened with extinction across the Northern Tablelands, either directly or indirectly due to agriculture. You should visit the NPWS website for more details:

http://www.nationalparks.nsw.gov.au/npws.nsf/Content/Final+determinations

18.5 The future

Climate change

The likelihood of global warming has a number of implications for agriculture in the New England (Reid and Kahn 2006). Temperature is predicted to increase with more variable rainfall patterns. Increased temperature will favour C4 pasture species at the expense of C3 species. Figure 18.3 indicates that under the climate experienced for the last 100 years, the annual productive potential of C4 species is only 63% of that of C3 species. Climatic warming will increase the growth of C4 species but if C4 species also increase in dominance, then overall pasture production may decline. This trend would be reinforced by more variable rainfall patterns.

Changes in pasture production will necessitate a change in management to avoid reduced stocking rates and may encourage graziers to adopt best-management practices (Reid and Kahn 2006). These practices will include grazing management systems that provide periods of rest from grazing which reduce selective grazing and loss of palatable species, promote greater pasture growth and reduce worm infections. It is likely that fertiliser use and legume species will also change in response to climate. Currently, the timing of fertiliser application is typically in the autumn and winter to favour the more productive C3 species at a time of year when heavy rainfall events are less common.

Practices directly favouring C3 species will be more likely if C4 species increase in dominance.

Changes in international demand

In 1997, per capita consumption of livestock products in industrialised countries averaged 300 kg/year (Reid and Kahn 2006). In developing countries, consumption was 70 kg/year. However, diets in developing countries are changing as the income level of people rises. The contribution of cereals and roots is declining while that of meat and dairy products is increasing (WHO 2002). Between 1965 and 1998, meat consumption in developing countries increased by 150% and that of milk and dairy products by 60%. It is anticipated that consumption of livestock products could increase by a further 44% by 2030. Nevertheless, per capita consumption of livestock products in developing countries still has a large gap to close to approximate that of the industrialised world. In developing countries, demand for livestock products will grow more rapidly than production, generating a trade deficit of 5.9 million t of meat products by 2030 (WHO 2002).

The predicted trade deficit provides an export opportunity for countries like Australia (Reid and Kahn 2006). Unlike the ‘green revolution’ which was supply-driven, the increase in livestock consumption in developing countries is demand-driven. Livestock production in the New England may be influenced by increased global consumption through increases in the price for sheep and beef meat. If the price of wool fails to rise to the same extent, more graziers are likely to increase the representation of meat enterprises. However, meat (or dual-purpose) sheep require better nutrition to support greater rates of reproduction and growth, requiring changes in farm management to increase pasture production and pasture quality.

Ecosystem services and stewardship incentives

One of the most interesting developments in natural resource management in recent years is the concept of ecosystem services and the resulting focus on who pays for private versus public environmental goods and services (Reid and Kahn 2006). Ecosystem services are simply the benefits derived by individuals and society from the environment. Many goods (e.g. agricultural commodities) have well-defined markets. However, many other ecosystem services (e.g. attractive biodiverse landscapes, the generation of clean water from farming catchments, carbon sinks stabilising the global climate, etc.) do not. Market failure has resulted in the undervaluation and consequent diminution of these benefits. Some of the most vexed natural resource management issues in Australia arise from the quandary of how society can encourage farmers to continue to provide ecosystem goods and services for the rest of us when there is no means to reward farmers for their stewardship and when alternative forms of production would be in farmers’ best interests but with a loss of ecosystem services to the rest of society.

Some farmers are prepared to be land stewards and conserve natural resources and undertake works on ground for the public good at their own expense because they want to. However, the economic reality is that farmers will never be able to provide sufficient of the ecosystem services now required by society (e.g. on-farm nature conservation, riparian zone protection for healthy rivers, recharge zone protection etc.) without developing mechanisms to make it economically possible for producers to do so. The catchment management authorities being established across Australia will be at the forefront of developing equitable ways of balancing the public and private interest in ecosystem service provision. However, governments and bureaucracies have proved to be relatively poor at dealing with such complex intransigent issues to date. Success may ultimately depend on the way the agricultural industries, themselves, respond to the challenge.

Readings

The following readings are available on CD:

1. ABARE 2003, *Australian Farm Surveys Report 2003*, Canberra.
2. Alford, A., Griffith, G. and Davies, L. 2003, ‘Livestock farming systems in the Northern Tablelands of NSW: an economic analysis’, Economic Report No. 12, NSW Agriculture, Orange.
3. Goodyer, G.J. and Nicholas, A. 2005, *Scarab Grubs in Northern Tablelands Pastures*, Agfact P2.AE.1, revised ed., NSW Department of Primary Industries.
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5. Payne, N. and Irvin, M. 2004, *2005 kangaroo quota submission New South Wales*, Department of Environment and Conservation, Hurstville.

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7. Reseigh, J., Nadolny, C. and Reid, N. 2003, ‘Effects of recent changes in grazing and fertiliser management on species richness of native ground-layer vegetation, Northern Tablelands, New South Wales’, in *Land Use Change – YES! – But will Biodiversity be OK?* Proceedings of a conference at Attwood, Victoria, August 2002, pp. 1-9, Department of Sustainability and Environment, Melbourne.
8. Upjohn, B., Fenton, G. and Conyers, M. 2005, *Soils Acidity and Liming*, Agfact AC.19, 3rd ed., NSW Department of Primary Industries.
9. Yiasoumi, W., Evans, L. and Rogers, L. 2005, *Farm Water Quality and Treatment*, Agfact AC.2, 9th ed., NSW Department of Primary Industries.

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

The Northern Tablelands of NSW covers about 3.3 million ha of the high rainfall zone of Australia. Rainfall is summer-dominant and the soils and landform conspire to produce native vegetation dominated by grassy woodlands and open-forests, which were readily settled by squatters for pasturage in the 1830s. About 69% of the region is farmland, principally livestock grazing enterprises. The region’s 2300 farms average 800-1100 ha in size, 75% running beef cattle and 57% sheep. Returns to equity are low and farm profit is sensitive to small price fluctuations. One in six farms in the southern part of the region are smaller ‘lifestyle’ farms in which most income is generated off-farm. Since the 1950s, 23% of the region has been sown to introduced pastures, and a further 6% top-dressed with fertiliser and seed. Otherwise, native and natural pastures dominate the resource base, although these generally carry less livestock. Drier seasons since the 1980s and declining terms of trade have seen many producers look to lower-input native pastures and grazing management alternatives to the traditional reliance on continuously grazed sown pastures.

Socio-economic sustainability issues in the region are many and include low commodity prices and declining terms of trade, increasing demand for certified products to meet quality and environmentally and ethically responsible production standards, rural adjustment and farm aggregation by younger, more successful producers, dwindling rural populations and small communities in decline, the withdrawal of rural and regional services such as banking, schooling and extension services, and increasing interest in farming as a lifestyle for urban dwellers.

Biophysical sustainability issues include agricultural impacts on catchment water quality, weeds, lack of sown pasture persistence and drought, soil acidification, alkali scalds, soil erosion, livestock parasites, wild dogs, kangaroos, overclearing and dieback, and the loss of regional biodiversity.

The future presents opportunities as well as challenges for Northern Tablelands graziers, including climate change, expanding markets for meat and fashion products generated by a burgeoning middle class in India and China, and fundamental changes in the role of government and the agricultural industries in policy and management of natural resources and the environment.

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Glossary of terms

ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
Annual	A plant that only lives for 1 year or less
Biodiversity	The variety of life: the different plants, animals and micro-organisms, their genes and the ecosystems of which they are a part
Broadacre farm	An ABARE-defined term for farming (i.e. cropping, e.g. cereals, coarse grains, oilseeds or pulses) and grazing (e.g. sheep or beef) properties, or mixed farming and grazing properties
Carrying capacity	The upper limit to the number of livestock per unit area that land can sustain
C3 plant	Woody and herbaceous plants that fix solar energy through photosynthesis less efficiently than C4 grasses, tend to use water less efficiently and thrive in cooler, moister climates while C4 grasses prefer warmer climates
C4 grasses	Grasses which fix solar energy through photosynthesis more efficiently than C3 grasses, tend to use water more efficiently and thus thrive in warmer drier climates while C3 grasses prefer cooler climates
Cool-season species	Plant species with a thermal productivity optimum in winter-spring
Dieback	The widespread, premature death or decline of trees, characterised by progressive dying back from the tips
DM	Dry matter, usually referring to the dry weight of fodder in a paddock (in kg DM/ha or t DM/ha)
DSE	Dry sheep equivalent, or the daily amount of energy required by a 50 kg dry sheep to maintain itself in body condition score 3
Dryland alkalinity	The formation of alkaline surface seeps in agricultural landscapes as a result of vegetation clearance and swamp drainage
Ecosystem	An ecosystem consists of a dynamic set of living organisms (plants, animals and micro-organisms) all interacting among themselves and with the environment in which they live (soil, climate, water and light)
Environmental stewardship	A landholder's voluntary management of private land for public good outcomes, at some cost to themselves
Fixed	The process whereby a substance is removed from the gaseous or solution phase and localised, as in carbon dioxide fixation or nitrogen fixation
Herbage mass	Herbage mass is defined as the weight of pasture obtained off a hectare if it was cut right to ground level and completely dried to remove all moisture
High rainfall zone	An ABARE-defined geographical zone, comprising the greater part of the coastal belt and adjacent tablelands of the three eastern mainland states, small areas in south-eastern South Australia and south-western Western Australia, and the whole of Tasmania
Introduced species	Species that are not native to Australia
Land capability	The biophysical capacity of land to sustain particular uses without resource degradation
Mulesing	The procedure of cutting the wool-bearing skin from around the anus of lambs to prevent wool from growing back and becoming soiled with dung and urine, thereby lessening the likelihood of blow fly attack. The practice has been condemned by animal liberation groups such as People for the Ethical Treatment of Animals because it is undertaken in the field without anaesthetic

Native pasture	Herbaceous vegetation grazed by domestic livestock and dominated by species indigenous to Australia
Naturalised pasture	Herbaceous vegetation grazed by domestic livestock and dominated by a mixture of native species and introduced species that have invaded and established at the site without direct human assistance ('volunteered')
Pastoral zone	An ABARE-defined geographical zone encompassing most of the northern tropical areas and the arid and semi-arid regions of Australia. Agricultural land use is characterised by the extensive grazing of native pastures. Some cropping is undertaken but it is impractical on most farms because of inadequate rainfall
Perennial	A plant that lives for several years
Rural adjustment	Changes at farm, regional or national level in response to socio-economic pressures, such as land use intensification in response to declining terms of trade at farm scale, farm buildup at a regional scale and a declining rural population
Soil acidification	A reduction in soil pH over time
Sown pasture	Herbaceous vegetation established by planting seed in cultivated soil and subsequently grazed or harvested for livestock feed
Warm-season species	Plants with a thermal productivity optimum in mid-summer
Wheat-sheep zone	An ABARE-defined geographical zone which has a climate and topography that generally allows regular cropping of grains in addition to livestock grazing. Rainfall is generally adequate for variety of crops and pasture species, usually as part of a crop-grazing rotation
Wild dog	A generic term for feral domestic dogs (*Canis familiaris*), dingoes (*C. lupes* subsp. *dingo*) and their hybrids
Xeric	Dry; deficient of moisture