



INTRODUCTION

Australian sheep and cattle are almost completely dependent upon pasture grazed in the paddocks. Most fodder grain is used as pig and poultry feed while hay and silage are used as dry-season supplementary feed or reserved for times of drought.

Australia's 500 million hectares of grazing land can be divided into two markedly different sets of regions. First, the humid and sub-humid regions of the south and east, which contain a quarter of the grazing land including almost all the improved pasture, provide grazing for three-quarters of the nation's sheep and cattle. Second, the arid and semi-arid regions together with the monsoonal north contain three-quarters of the grazing land, little of which is improved pasture, and support only a quarter of all livestock.

Before the widespread introduction of exotic pasture plants, which has largely occurred in the last thirty years, the pastoral industries had to rely on native pastures. These are generally poor in comparison with those in other parts of the world where European-style animal husbandry is practised. Most native Australian grasses grow in tussocks as opposed to the sward-forming grasses which make the most suitable grazing for domestic livestock.

Before European settlement, the greatest pressure on Australia's native pastures had been grazing by free-ranging marsupial herbivores able to respond rapidly to drought by cessation of breeding and by migration. Many pastures have been unable to withstand continuous heavy grazing by large flocks of sheep or herds of cattle confined in fenced paddocks and have, accordingly, deteriorated.

Another factor leading to deterioration was the all too successful introduction of rabbits in Victoria in 1859. Within 50 years they had spread through most of the southern half of the country, causing serious pasture damage over large areas. This occurred when graziers were still learning how to manage the land and overstocking was common, particularly in the semi-arid regions.

Rabbits and overstocking have diminished the more palatable plants, which have been replaced by less useful or even harmful ones. In more extreme cases perennials needed to maintain year-round grazing were eliminated or the pasture totally destroyed, creating bare 'scalds' which are very difficult to revegetate on some soils.

On the other hand the area of native pasture has been considerably increased by the clearance of trees and shrubs. In the past, especially in the drier areas, this was achieved by ring-barking trees, allowing native pasture to advance slowly into the clearings as the trees eventually died. More recently, mechanical clearance of trees and shrubs has made possible a more rapid increase in pasture area, although cleared areas are now commonly sown with crops or non-native pastures.

This large increase has certainly raised livestock carrying capacities but has created some new problems and exacerbated others. On some soils and on steeper slopes clearance of trees and shrubs has led to serious soil

erosion. The breeding and feeding habitats of native grassland fauna have expanded and some—notably kangaroos, locusts, grasshoppers and certain beetles whose larvae feed on the roots of grasses—now increase more frequently to pest levels.

The most dramatic improvement of Australian pastures has resulted from the introduction of high-yielding pasture plants from overseas. This began around the turn of the century but the largest gains in area have been achieved since the Second World War. This development has been largely confined to the more humid regions, particularly in the cereal-growing belts. An essential part of this development has been the extensive use of fertilisers (notably superphosphate), trace elements and nitrogen-fixing clovers, which have largely overcome the problems posed by Australia's inherently poor soils.

Where land has been converted to sown pasture, stocking rates have on average quadrupled and the large increase in sheep and cattle numbers since the turn of the century has been almost completely due to this conversion.

Today sown pastures cover nearly 30 million hectares, mostly concentrated in the humid and sub-humid regions of the south and east, where they cover about a quarter of the grazing land. However, nationally, they occupy only about 6% of the grazed land and accordingly the mean Australian stocking rate, equivalent to about one sheep to 1.25 ha or one beef beast to 10 ha of grazed land, is low by comparison with other major livestock producing countries. For example, the mean stocking rate of the U.S.A. is one beef beast to about 2 ha.

Table 1. Sown Pastures ('000 ha)

State	1950-51	1965-66	1975-76	1979-80
Queensland	716	1 593	3 582	3 170
New South Wales & A.C.T.	1 611	4 958	5 788	6 049
Victoria	2 910	6 108	6 234	5 671
Tasmania	285	683	935	895
South Australia	437	2 722	3 589	3 211
Western Australia	1 453	4 611	7 463	7 141
Northern Territory	n.a.	7	116	99
AUSTRALIA	7 410	20 682	27 707	26 236

Notes: Lucerne included in all years.

Figures in this and later tables may not add exactly to totals shown because of rounding.

Sources: Australian Bureau of Statistics—*Primary Industries: Part I—Rural Industries: 1950-51*, Bulletin No. 45; *Rural Industries 1965-66* No. 4; and *Agricultural Land Use, Improvements and Labour: Australia: 1978-79 and 1979-80* (N.T. revised).

NATIVE PASTURES

The map 'Native Pastures' shows the distribution of fourteen broad types and those areas where native pastures have been to a large extent replaced by introduced sown pastures and crops or greatly altered by self-sown naturalised species. Areas which still retain native vegetation that is largely unsuitable for grazing are also shown. Much of this is forest, shrub or heathland in which the ground cover is generally of low fodder value. Many such areas are reserved for forestry or nature conservation, from which grazing is generally excluded.

The pattern of native pasture types reflects, to a large extent, the combined influences of climate and soils. The climatic factors of greatest influence on pasture

composition and growth are the amount and seasonality of the rainfall. The wettest season is normally the summer (November-April) in the north and the winter in the south. Thus, except where there is an overlap in rainfall regimes as in central New South Wales, there is usually only one season of vigorous plant growth. However, even during the wet seasons other climatic factors adversely affect growth. In the north, summer rainfall coincides with maximum temperatures so that much moisture is lost by evaporation. In the south, considerable proportions of the higher rainfall areas are at sufficiently high altitudes for the low temperatures in the winter wet season to severely retard plant growth so that autumn and spring are the best growing periods.

Because vigorous growth is generally so restricted seasonally, the pastures need a high proportion of perennial species to maintain year-round grazing. Thus the relative values of Australian pastures for grazing livestock are determined to a large extent by their perennial components, even though these may be less palatable and nutritious than many of the annual plants that are briefly available during the limited wet season. Unfortunately, the heavy grazing pressures that these perennials have had to withstand during prolonged droughts—a recurrent feature of the Australian climate—has led to their decline over large areas and, in some places, to their complete elimination.

Much of Australia has poor soils supporting equally poor pastures. Sandy, saline, shallow or inherently infertile soils cover most of the interior and shallow soils occur over much of the more humid upland areas nearer the coasts, especially in the north. All these support pastures with very low stock carrying capacities. The best native pastures are those largely composed of perennial Mitchell grass, which cover extensive inland plains of deep, self-mulching, cracking clays.

Descriptions of the types of native pasture shown on the map are given in the Appendix at the end of this topic. These also include some brief comments on management problems and indications of the relative usefulness of each type.

Today, the large areas of grazed native pastures probably support less than a third of all livestock and this proportion is declining as the area of sown pastures increases.

SOWN PASTURES

The expansion of sown pastures of introduced species has been comparatively recent (see Figure 2). Although a few farmers were advocating their value at the turn of the century, significant increase did not begin until the 1920s, when State agricultural departments began to encourage their establishment and when the application of phosphatic fertilisers to pasture had been accepted as profitable. The really large expansion has occurred since the Second World War, quadrupling the area to reach a peak of 28.6 million hectares in 1975. Since then economic factors caused a slight decline to about 26 million hectares in 1980 (see Table 1).

Almost all this development has occurred in the humid and sub-humid regions of the south and east: there has been little in the semi-arid and monsoon regions and none in the arid interior, as the map 'Sown Pastures and Fodder Crops' shows. Sown pasture forms an integral component of the now widespread wheat-pasture rotation (ley farming) so that much of the increase has been linked directly to the large increase in the wheat crop since 1950.

In the regions in which sown pastures have become concentrated they, together with crops and volunteer exotic plants, have largely replaced native vegetation on most of the best land and have quadrupled the carrying capacity over large areas.

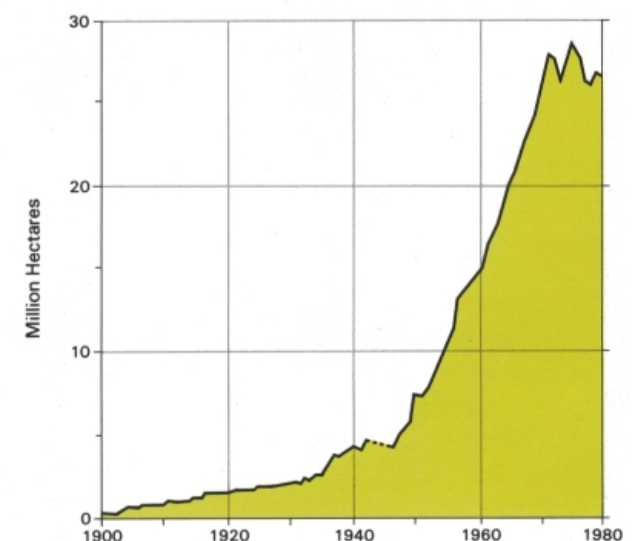


Figure 2. Area of Sown Pastures, Australia 1900-80

Based on statistics in various publications of the Australian Bureau of Statistics, with estimates for Queensland 1936-38 and 1939-42 and for New South Wales 1945-46. Statistics are not available for three or more States for 1942-45. Lucerne, classified by the Bureau as a crop before 1970-71, is included in all years.

PHOTOGRAPH ABOVE: Sown pastures of clover and grass support the wool and fat lamb industries of the Southern Tablelands of New South Wales.

This photograph and Figure 4 and 10 by Australian Information Service; Figures 3, 5-9 and 11 by F. T. Bullen.

Types of Sown Pasture

No one plant or combination of plants is suited to the entire range of climates and soils in which sown pastures have been established. Early introductions were largely temperate European plants which proved suitable mainly for the cooler and wetter climates of Tasmania and southern Victoria. Later, plants of Mediterranean, African and South American origin were introduced. These introductions were largely unsystematic but gradually plant breeders began developing varieties suited to local environments. It was not until the early 1950s that systematic efforts were made to collect species and varieties of potential value from climatically similar regions overseas.

No suitable source map or statistics are presently available from which a reasonably accurate map of major sown pasture types could be drawn. An indication is given by the generalised map of regional suitability included in the map-sheet 'Grasslands' (1970) of the Second Series of this Atlas.

Sown pasture development began in the cooler temperate south-east with the introduction of perennial European clovers, notably white clover (*Trifolium repens*) and perennial ryegrass (*Lolium perenne*), and advanced most rapidly in Tasmania and Victoria. Pastures of clover and ryegrass now cover much of the grazing land in Tasmania, the wetter plains and hill country of southern Victoria, the wetter eastern tablelands of New South Wales, and patches in the southern Queensland hill country as far north as the Burnett Valley. These pastures provide some of the best grazing land in Australia, such as the dairying country of Gippsland and the northern Tasmania coast, where grazing densities are commonly better than one dairy cow per hectare. Elsewhere beef cattle can be fattened for market in 18–24 months and, on slightly drier inland areas, sheep for fat lamb production can be stocked at about 8–12 per hectare.

In the drier coastal areas of Victoria and south-eastern Tasmania the self-regenerating annual subterranean clover (*Trifolium subterraneum*) takes the place of white clover in the perennial ryegrass pastures. On the western slopes of the New South Wales tablelands and extending through central Victoria, on the South Australian hill country and in the wetter south-west corner of Western Australia, pastures of perennial phalaris grass (*Phalaris aquatica*) and subterranean clover predominate. In wetter areas of the wheat belt in the south-eastern States and throughout the Western Australian wheat belt, sown pastures of subterranean clover together with annual (or Wimmera) ryegrass (*Lolium rigidum*) are widespread. In these areas, particularly in Western Australia, subterranean clover is also commonly sown into natural pastures mostly composed of volunteer grasses and forbs (other herbaceous plants) of Mediterranean and South African origin.

Subterranean clover (of Mediterranean origin) is the most important pasture plant grown in Australia. Accidentally introduced and unimportant in its place of origin, the value of subterranean clover under Australian conditions was first realised by a South Australian pastoralist in the 1890s but did not receive widespread recognition until the 1920s. Although an annual, it is a prolific seeder and regenerates easily. It grows well on poor acid soils and responds well to fertilisers, especially superphosphate. Like other legumes it fixes nitrogen in the soil, thus improving fertility, and is accordingly an ideal plant in a pasture-crop rotation. It requires a cold spell in winter for flower initiation and is therefore unsuitable for tropical areas. In all wheat-growing States except Queensland the large increase in sown pasture area since the Second World War (shown in Table 1 and Figure 2) was due to the widespread introduction of subterranean clover. Early maturing varieties suitable for the drier parts of the wheat belt have contributed much to the expansion and consolidation of wool-wheat farming in Western Australia in particular. Stocking rates in areas with much subterranean clover pasture range from about 1–2 sheep per hectare on the drier margins up to 8 sheep in wetter areas.

Lucerne (*Medicago sativa*), a legume of Middle Eastern origin, is locally important in areas of good soils. The largest concentration of lucerne growing is in south-eastern South Australia and it is also important on river flats in central and northern New South Wales, south-eastern Queensland and in parts of the Murray irrigated lands. In contrast with subterranean clover, lucerne was already recognised as an excellent fodder plant long before its introduction in Australia. It is highly productive and a long-lived perennial provided it is not grazed continuously. About a million hectares were grown in pure stands in 1976 declining to less than half a million in 1979, due to damage by an aphid species that has recently appeared in Australia. Mixed lucerne and grass pastures cover a larger area, probably about two million hectares.

In the driest marginal areas of the wheat belts, annual

medics of Mediterranean origin, notably barrel medic (*Medicago truncatula*), are used instead of subterranean clover. Stocking rates are lower than for subterranean clover pastures but are generally better than one sheep to two hectares.

The sown pasture species in the northern tropical and sub-tropical areas are quite different from those of the more temperate south, with little overlap except in north-eastern New South Wales and south-eastern Queensland.

Pastures in the wetter areas along the coastal fringe of Queensland and northern New South Wales commonly include perennial grasses of South American or African origin, notably paspalum (*Paspalum dilatatum*), kikuyu (*Pennisetum clandestinum*) and Guinea grass (*Panicum maximum*). A number of tropical legumes are grown with these grasses, notably siratro (*Macroptilium atropurpureum*) and desmodium (*Desmodium* spp.), but none has gained the pre-eminent position that white clover has in pastures of the equivalent southern higher rainfall areas. Protein deficiency in the dry winters, common to all tropical pastures, is a constant problem and the carrying capacity of these pastures is generally inferior to that of their southern equivalents. However, they are much superior to the tropical tall grass native pastures they have replaced and allow marketing of beef cattle 2–3½ years old.

In drier areas further inland, in central Queensland, sown pastures consist of xerophytic perennial grasses mainly of African origin such as Rhodes grass (*Chloris gayana*), green panic (*Panicum maximum* var. *trichoglume*) and buffel grass (*Cenchrus ciliaris*). These are the species commonly sown on cleared brigalow land; sowing has increased considerably in the last twenty years as land development has progressed. They have contributed most to Queensland's late upswing in sown pasture area in the 1960s (Table 1). Although a number of temperate legumes (in south-central Queensland) and tropical legumes are grown or are being tried, it is generally too hot and humid in summer for the former and too cold in winter for the latter. Accordingly none has found the general acceptance that subterranean clover has in equivalent southern areas. Stocking rates can be as high as one cattle beast per hectare but are generally much lower.

Buffel grass is also the most commonly sown species in cleared areas of acacia woodland (mainly gidgee, *Acacia cambagei*) in the Blackall area of semi-arid central Queensland. This is the only semi-arid area where sown pastures are grown on a large scale.

In the northern monsoon region sown pasture development began in the mid-1960s, mainly with sowings of Townsville stylo (*Stylosanthes humilis*), a legume of South American origin. However, an outbreak of anthracnose disease and lower beef prices in the early 1970s reduced sowings (exemplified by data for the Northern Territory in Table 1). Caribbean stylo (*S. hamata*), less prone to disease and commercially released in the mid-1970s, is now more frequently sown. In Queensland *Brachiaria*, *Panicum* and *Setaria* grasses and *Neonotonia* and *Desmodium* legumes are also sown.

Irrigation of Pastures

Nearly one million hectares of mainly sown pastures were irrigated in 1975–76, as shown on the accompanying map. This was a slight decrease from a peak of just over one million hectares in 1972–73. Complete data have not been collected since 1976. Irrigated pastures are heavily concentrated in the south-east, about two-thirds being in the Riverina of New South Wales and adjacent areas of northern Victoria (see enlargement on map overleaf). Here irrigated pastures fall into two types, annual and perennial. Annual ryegrass and subterranean clover pastures require much less water than the more productive perennial ryegrass and white clover pastures, which are common only where irrigation water is plentiful and cheap.

Lucerne is a characteristic plant of irrigated river flats in central and northern New South Wales and the lower Murray in South Australia, as already mentioned. When grown as a pure stand almost all irrigated lucerne (nearly 100 000 ha in 1975–76) is cut for hay.



Figure 3. Irrigated lucerne on alluvial flats along the Macquarie River, central New South Wales.

Because of the heavy concentration of irrigated pasture on the well-levelled land of the Murray-Murrumbidgee irrigation areas, 80% is flood irrigated. Pasture on unlevelled land is spray irrigated.

Stocking rates on irrigated pastures are high, generally better than 8 sheep or one cattle beast per hectare. Dairying predominates in coastal areas and in north-central Victoria. Elsewhere irrigated pastures are used for fat lamb production or for finishing beef cattle for slaughter.

Fertiliser Use on Pastures

In general, Australian native pastures show a poor response to fertilisers so that most of the 9 million hectares of pastures fertilised in 1975–76 were sown pastures—see the map overleaf. (The statistics used for the map exclude the use of lime, gypsum and dolomite, which are soil conditioners rather than fertilisers.) This area was half that fertilised two years previously, due largely to low market returns on livestock products and the temporary removal of a government bounty on superphosphate, which makes up 90% of all fertilisers used on pastures (1.08 million out of 1.19 million tonnes in 1975–76). However, fertiliser use on pastures is again increasing and in 1979–80 2 million tonnes was spread on nearly 15 million hectares.



Figure 4. Aircraft top-dressing sown pasture with superphosphate in the Southern Tablelands of New South Wales. In 1979–80 aircraft spread 500 000 tonnes of superphosphate, top-dressing and seeding 4.4 million hectares.

The proportion of sown pastures fertilised also reflects the quality of the soils on which they are grown. This proportion ranges from more than half the sown pasture on the poor soils of Western Australia, through about a third to a quarter in South Australia, Victoria, Tasmania and southern New South Wales, to very low proportions in northern New South Wales and southern Queensland. In these northern areas relatively greater amounts of nitrogenous fertilisers are used to offset the lack of suitable nitrogen-fixing leguminous pasture plants. Fertilisers are rarely applied to sown pastures on the fertile brigalow soils of central Queensland.

FODDER CROPS

About one million hectares of fodder crops were grown in 1975–76 and this area has changed little in recent years. Of this, 750 000 ha were under winter cereals grown for green feed and silage. Oats make up about three-quarters of this area and are grown widely for this purpose throughout the wheat belts. The greatest concentration of winter-cereal grazing occurs in northern New South Wales and southern Queensland, where oats form an important source of winter feed, making up for the lack of suitable cool-season pasture plants.

Cereals cut for hay make up most of the remaining fodder crop area, producing 0.7 million tonnes from 230 000 hectares in 1975–76 to supplement the 3.7 million tonnes of hay made from almost a million hectares of pasture. Hay is mostly used as dry-season feed or drought reserve.

Other fodder crops of regional importance are forage sorghum, vegetables and lupins. Forage sorghums are grown in southern Queensland and northern New South Wales, where they provide summer fodder (85 000 ha in 1975–76) complementary to winter-grown oats.

About 20 000 ha of vegetables for stock feed are grown, mostly in Tasmania and southern Victoria. These are mainly turnips and chou moellier, a thick-stemmed variety of kale. Depending on the time of sowing they provide grazing in winter or late summer and autumn.

Lupins, a comparatively new leguminous fodder crop, covered a peak area of 139 000 ha in 1975–76, of which 120 000 ha were in Western Australia, in the northern and western margins of the wheat belt. Since then the total area has declined to 68 000 ha in 1978–79 even though lupin cultivation has increased markedly in the eastern States. The green plants have a toxically high alkaloid content but the dry foliage, pods and seeds form nutritious grazing for sheep in summer. Newer, low-alkaloid varieties are now available. Lupins have a number of other uses but, because the area statistics are not subdivided according to use, they were mapped here as a fodder crop and again in the 'Crops' topic as a cash crop.