Australia's productive forests and its most visited national parks.

1a. Southern Humid Pasture Regions

These regions receive, on average, at least 400 mm of winter rain and 100 mm of summer rain. They consist of coastal plains, low hills, dissected uplands and some wetter areas of tableland.

All southern major urban areas lie within or near the borders of these regions and urban land occupies 3.8% of the regional area—a proportion equalled only by the Tropical Crop Regions. Forestry land (7.7% of the regional area) and conserved land (3.8%), which is also predominantly forested, tend to occupy the higher, more rugged and potentially least agriculturally productive areas. The forestry areas are similar to those of the adjacent, wetter, Southern Forestry Regions and are described below under 1d.

Half the agricultural land, which makes up 83% of the regional area, is under sown pasture (mainly rye grass and clover) and the average stocking rate is about one beef beast per hectare. Locally, as in west Gippsland (Vic.), this rises to about two dairy beasts per hectare, which is very high for Australia. First-class pasture land occupies half the agricultural area and second-class land makes up a further third. Cattle comprise about 70% of total livestock units as much of the regional land is too wet for successful sheep grazing, although important fat lamb areas occur on the drier inland margins in Victoria and New South Wales.

Figure 5. *Southern Humid Pasture Regions: dairying on lush sown pasture in southern Gippsland, Victoria.*

The large urban population creates a heavy local demand for dairy products and almost all southern non-irrigated dairying lies in these regions. Dairy cattle constitute 26% of the regional livestock units and occur almost exclusively in areas shown on the land use map as first-class grazing land with cattle predominant. Sown pasture makes up 95% of these dairying areas. Further away from the major cities beef cattle are more important, particularly on poorer pastures on higher ground.

Only 2.5% of the agricultural area is cropped, mostly intensive market gardening close to major cities and specialised fruit and vegetable growing where soils and local climate are particularly favourable. Much of Australia's temperate fruit (apples, cherries, plums and berry fruit) is grown in these regions.

Because of the high stocking rates, the strong emphasis on dairying, and the high value of most of the crops grown, these regions have a high value of production per hectare. Accordingly, farm sizes tend to be small by Australian standards, averaging about 270 ha. The mean size of dairy farms is about 140 ha. Fruit and vegetable farms are even smaller, averaging about 45 ha, although potato farms average about 100 ha. Beef and sheep farms are much larger, averaging about 500 ha.

1b. Northern Humid Pasture Regions

Climatically these regions are similar to their southern counterparts except that the rain falls mainly in summer and the winters are much warmer. They are also topographically similar except that those areas of coastal lowland that are sufficiently warm and wet in winter for the production of tropical crops have been put in a separate set of regions (see 1c below). Agricultural land covers 84% of the regional area. Forestry land (14%) is similar to that of the adjacent, wetter, Northern Forestry Regions, described below under 1e. Conserved land amounts to about 2%.

Like 1a, these regions are climatically well suited to livestock grazing. A much smaller proportion (about 15%) of the agricultural area is under sown pasture although much of the coastal pastures in northern New South Wales is dominated by introduced grasses, notably *Paspalum dilatatum*, which have spread naturally. Accordingly the mean stocking rate of one beef beast to about two hectares is only half that of 1a. First-class pasture areas occupy a quarter of the agricultural area and second-class areas make up a further third. These regions are too warm and humid in summer for successful sheep grazing.

Figure 6. *Northern Humid Pasture Regions: dairy and beef grazing land on the Atherton Tableland, northern Queensland.*

Dairy cattle constitute about 28% of the livestock units and, as in 1a, occupy the better grazing land. Sown pastures make up a much smaller proportion of the dairy grazing land compared with 1a, constituting 40% in New South Wales and only 20% in Queensland. The hotter summers and the drier winters of these regions make them less suitable for dairying than 1a and milk yield per cow in northern New South Wales and southern Queensland is only 60% of that in Victoria. Beef cattle grazing forms the major land use, occupying all of the poorer grazing land and an increasing proportion of the better land as dairying declines.

Cropping accounts for only about 2% of the agricultural area. As in 1a, these regions are too humid for successful wheat grain production so that cropping is restricted to small areas of winter cereals, grown mainly for fodder, in the south; summer-grown cereals (mainly sorghum and maize) in the north; market gardening close to Brisbane (notably in the Lockyer Valley); and small areas of fruit and vegetables where the local environment is particularly favourable.

The most northern of these regions, the Atherton Tableland inland from Cairns, grows maize and peanuts and has a locally important dairy industry. Irrigated tobacco growing has developed on its northern border around Mareeba.

Farms tend to be larger than in 1a, averaging about 350 ha, reflecting the lower stocking rates. Dairy farms average about 150 ha in New South Wales and 180 ha in Queensland while beef farms average about 1000 ha, twice that of 1a.

1c. Tropical Crop Regions

Climatically these regions are very similar to 1b except that the winters are wetter and hotter. They consist of coastal lowlands and the lower foothills of the coastal ranges. These regions are well suited for sugar cane, many tropical fruits and early vegetables. About 67% of the area is used agriculturally and about 17% is forestry land, which is mostly confined to land too steep for cultivation as well as the poorer, sandy 'wallum' country of the south Queensland coast and adjacent islands such as Fraser and Bribie islands. About 6% is conserved land, which is mainly forested and includes a number of Great Barrier Reef islands. Some of the latter are also tourist resorts.

Urban land accounts for about 4% of the regional area and is increasing. Brisbane and Gold Coast make up most of this but other coastal settlements in southern Queensland and northern New South Wales are growing rapidly due mainly to the attraction of the winter climate for retired people and holiday-makers.

Despite its climatic suitability for tropical crops, 75% of the agricultural land is used for livestock grazing. Areas of first-class grazing land, predominantly sown pasture, make up nearly 25% and second-class land a further 45% of the grazed area. The mean stocking rate is one beef beast to about 2 ha, the same as for the climatically similar 1b regions. These regions are exclusively grazed by cattle since they are generally too hot and humid for sheep. Dairy cattle make up 20% of the livestock units and are mainly concentrated on first-class grazing land to the south, where they provide fresh milk and dairy products for the nearby urban areas of Brisbane and Gold Coast.

Figure 7. *Tropical Crop Regions: sugar cane growing on the Barron River flats near Cairns, northern Queensland.*

Sugar cane accounts for almost all of the 25% of the agricultural area that is cropped. It is grown on the fertile alluvial flats and, in a few places, on the less steep lower hill slopes where the soil is exceptionally good. Its local importance decreases with the increasing length of time the crop takes to mature, from one year in the north to up to two years in the south.

In the northernmost region, centred on Cairns, cane is grown on almost all suitable land to the near exclusion of all other crops and livestock. In the central region, centred on Mackay, cane is still the most important crop but is mixed with livestock grazing. (The irrigated cane in the Burdekin delta falls in 2b because of lower rainfall.) These northern areas contain 80% of the sugar cane area. Further south, from Rockhampton to the Burnett delta, no cane is grown and, apart from some pineapple cultivation near Rockhampton, this is primarily a livestock area. The Burnett delta centred on Bundaberg and the Childers area to the south are the southernmost major cane areas. Here cane is the dominant crop but is mixed with cattle grazing and small areas of fruit and vegetables. South of Maryborough cane is growing in relatively small areas as far south as the Clarence River (N.S.W.) but fruit (notably pineapples and bananas), vegetables (for the Brisbane and Gold Coast markets and as early crops for southern markets) and dairying are of greater importance.

Farm sizes are similar to those of 1b. Sugar cane farms average about 100 ha.

1d. Southern Forestry Regions

These are the wettest and coolest regions in southern Australia and are generally confined to the higher uplands where rainfall is locally increased orographically. The natural vegetation is mostly medium to tall forest dominated by various eucalypt species. However, a few areas are naturally unforested. One such area is the very wet heath and sedgeland in south-west Tasmania, which, although at a lower altitude than most of the rest of these regions, is unused agriculturally and much is now conserved land. Other generally treeless areas are the alpine grasslands above about 1500 m on the ridge tops of the Snowy Mountains (N.S.W.) and the Bogong High Plains (Vic). Now mostly conserved land, they are snow covered in winter and all Australian ski-resorts are located close by. Parts of this alpine area in Victoria are still annually leased for grazing beef cattle in summer, the animals being herded down to lowland pastures as winter approaches, but this practice has declined as alpine conservation areas have been increased.

Much of the natural forest remains. It covers the 42% of the regional area which is managed forest, and most of the 13% which is conserved land and the 22% which is unused land. Notable timber species are the jarrah (*Eucalyptus marginata*) and karri (*E. diversicolor*) of Western Australia and messmate stringybark (*E. obliqua*) and mountain ash (*E. regnans*) in Victoria, Tasmania and New South Wales. Forests are not confined to these regions and extend into all adjacent regions (notably 1a), generally in areas of low agricultural potential.

While the eucalypt forests in these and adjoining regions provide a plentiful supply of hardwoods, Australia is deficient in native softwoods. Plantations of exotic softwoods, predominantly *Pinus radiata*, have been established on the lower and generally drier margins of these regions, and extend into adjacent areas.

Catchment protection is particularly important in these regions because they include the upper catchments of the major river systems of southern Australia and contain the Snowy Mountains Hydro-electric Scheme, the largest integrated water storage scheme in Australia, and much of the Tasmanian Hydro-Electric Commission's storage system.

Only 23% of the regional area is agricultural land, largely confined to valley floors and lower hill slopes and predominantly grazing land, 20% of which is sown pasture. Nearly 85% of the livestock units are beef or dairy cattle, since these regions are generally too wet and cold in winter for successful sheep rearing. Dairy cattle make up about 15% of the livestock units and are grazed on sown pasture on the narrow valley floors. Elsewhere, particularly at higher altitudes, beef cattle predominate. The mean stocking rate is one beef beast to about two hectares.

Crops occupy less than 1% of the agricultural land. They are restricted to small areas of winter cereals grown for fodder and temperate fruit (chiefly apples), which are mostly confined to valleys cutting through the forested uplands.

Farm sizes are much the same as in 1a, averaging about 500ha, except that beef properties in the higher country are somewhat larger.

1e. Northern Forestry Regions

These regions consist generally of the higher and wetter parts of the eastern seaboard hinterland north of the Hunter Valley (N.S.W.). They differ climatically from 1d in that summer rain is generally more abundant than winter rain—a trend that increases northward. Like 1d the natural vegetation is mainly eucalypt forest although smaller areas of (non-eucalypt) rain-forest still exist, particularly in the north. About 82% of the regional area remains as forest, 73% as managed forest and 9% as forested conserved land.

As in 1d, State forests producing hardwood occupy most of the area. Various stringybarks and ironbarks and the spotted gum (*E. maculata*) are the most important timber species of the eucalypt forests. The rain-forests are composed of a large number of non-eucalypt species, many of which produce excellent timber for furniture and veneers. The native softwoods of these regions, notably the hoop, bunya and kauri pines (*Araucaria* spp.), are a small and diminishing natural resource. Hoop pine is now grown in plantations supplemented by an even larger area of the exotic slash pine (*Pinus elliottii*) and, to a lesser extent, *P. radiata.* This development has been most extensive in the drier marginal areas in south-eastern Queensland and adjacent areas of 1b, mainly between Brisbane and Maryborough.

Figure 8. *Northern Forestry Regions: eucalypt forest in the New England National Park, on the eastern escarpment of the New England Tableland, New South Wales.*

Only about 18% of the regional area is used agriculturally, predominantly beef cattle grazing. Sheep are almost completely absent except for a few on the drier inland margins of the southernmost areas. Dairy cattle make up about 15% of the livestock units and are restricted to sown pastures in valleys. Sown pasture occupies only about 6% of the grazing land and accordingly the mean regional stocking rate of one beef beast to about 3–4 ha is the lowest in the Humid Zone.

Cropping is negligible, amounting to about 0.5% of the agricultural area and mainly consisting of small areas of cereal fodder crops such as maize.

The mean farm size of about 500 ha is large for the Humid Zone and reflects the predominance of beef cattle grazing at relatively low stocking rates.

2. SUB-HUMID ZONE

Climatically this zone is transitional between the wetter coastal hinterlands and the semi-arid inland areas. The major part includes the drier inland slopes of the coastal ranges and tablelands and the wetter portions of the adjacent inland plains of eastern mainland Australia. Although it contains only 18% of Australia's agricultural land, this zone is the core area of agricultural production and the area where the major agricultural innovations of this century have had their greatest impact. It produces almost all the cereal grain, oilseeds and cotton and much of the irrigated fruit. It also provides grazing land for about 60% of the national sheep flock and about 40% of the national beef herd.

A very large proportion (89%) is agriculturally used. About 5% is managed forest while the remaining 6% is roughly equally divided between conserved and unused land. The latter mainly consists of uncleared mallee in poor sandy areas in Victoria and South Australia and sand plains on the drier margins of this zone in Western Australia.

Although the area of urban land is very small, this zone contains nearly half the urban centres with populations greater than 2500; most are small rural service centres.

2a. Southern Sub-humid Pasture Regions

These regions mainly occupy relatively narrow belts lying between the coastal humid zone and the drier cereal regions inland. They also include small coastal areas in Western Australia, South Australia and Victoria, while in Tasmania they include most of the central lowlands.

Although topographically diverse they mainly consist of tablelands and the adjacent inland-facing slopes. In the south and west most of the rain falls in winter. In the north in central and northern New South Wales, where the rain is more evenly distributed, it is the winter rainfall that is the more effective for plant growth.

The Monaro region south of Canberra is included here, even though much of it is as dry as parts of the cereal regions (due to the rain-shadow effect of the Snowy Mountains), because it is generally too cold in winter for economic wheat production.

Most (86%) of the land is used agriculturally. Forestry land (3%) and conserved land (6%) are largely confined to higher and more rugged areas. Unused land, which makes up 4% of the regional area, is largely confined to part of the infertile sandstone plateau north-west of Sydney, much of which was proclaimed as a national park at the end of 1979. Urban land, mainly Canberra and the drier western portion of Melbourne, makes up the remaining 1%.

Livestock grazing predominates, to a large extent on sown pastures (mainly *Phalaris* grass and subterranean clover), which occupy about 40% of the grazed area. Nearly 75% of the grazed land is composed of first-class or second-class pasture areas although most is in the second class (see photograph on page 15). The mean regional stocking rate is one beef beast to about two hectares or four sheep per hectare. These regions are too dry in summer for the year-round maintenance on dryland pasture of dairy cattle, which account for only about 4% of the total livestock units and are mostly confined to small areas of privately irrigated river-flats. Sheep and beef cattle each make up almost equal proportions of the remaining 96% of the livestock units. Sheep predominate in the drier parts of these regions in areas of better pasture while beef cattle predominate in the wetter areas and in areas of poorer pasture, particularly in the more heavily timbered hill areas. However, in recent years beef cattle have increased in sheep areas and now many sheep farms (particularly those producing fat lambs) also run small cattle herds.

About half the sheep properties run merinos primarily for wool production while the remainder run non-merino breeds for the dual production of wool and fat lambs. Properties specialising in fat lambs consist almost entirely of sown patures.

While cropping is much greater in total area than in the adjacent Humid Zone, it only amounts to about 4% of the regional area. Most of this is winter cereal cropping (mainly oats and barley for fodder) spilling across from the adjacent, drier, cereal regions. These sub-humid pasture regions are marginally too humid for successful wheat grain production, with rust a problem in wetter years.

Many of the vineyards producing high quality table wines are located within or very close to the borders of these regions. The largest concentrations are in the Barossa (S.A.) and Hunter (N.S.W.) valleys. Elsewhere there are vineyards at many scattered localities ranging from the Swan Valley north of Perth to near Mudgee in New South Wales. The vineyards take advantage of the climate, which is sufficiently wet to make irrigation mostly unnecessary, giving the grapes more flavour, while the summers are normally of sufficient heat and length for the production of grapes with optimal sugar content for quality wine-making.

The mean regional farm size is about 500 ha, similar to the least productive regions of the adjacent Humid Zone. Sheep properties average about 700 ha and beef properties, which are generally on poorer pasture, are about twice as large. Vineyards average about 25 ha.

2b. Northern Sub-humid Pasture Regions

The main region forms a narrow belt between the Humid Zone and the Northern Cereal Region in southern Queensland and extends north to include the drier coastal areas and inland to where the winter rainfall is, on average, just sufficient to keep pasture growing. The summers are much wetter than the winters—a characteristic that increases northward due to the strengthening monsoon influence.

Like their southern counterparts (2a), a large proportion (90%) of the regional area is agricultural land. About 7.5% is forestry land similar to that in 1e and about 2.5% is commercially unused reserved land.

In the agriculturally used area livestock grazing predominates. In contrast with 2a only about 10% of the grazed area is under sown pasture. This is largely restricted to areas adjacent to the Northern Cereal Region and in some of the more humid brigalow country, where panic grass (*Panicum maximum*) and Rhodes grass (*Chloris gayana*) are important. Elsewhere livestock graze on native pastures now largely dominated by spear grass (*Heteropogon contortus*). Beef cattle predominate, making up over 90% of the total livestock units. Dairy cattle make up almost all the remainder and are largely confined to valleys from the Burnett River southward. These

Figure 9. *Northern Sub-humid Pasture Regions: beef cattle land, much of which is cleared brigalow country, near Biloela, central Queensland.*

regions are too humid in summer for sheep. The mean regional stocking rate is one beef beast to about four hectares, which is only half that of 2a, due largely to the much smaller proportion of sown pasture.

Cropping occupies only about 1% of the agriculturally used land. The largest concentration occurs in the Burdekin delta, where 35 000 ha of irrigated sugar cane and 2000 ha of rice are grown. Without irrigation this area would normally be too dry for sugar cane cropping, although suitable in other respects. This is the only major cane area which is wholly dependent on irrigation. Nearby at Bowen there is a small but important area growing about 2000 ha of irrigated vegetables for southern markets.

Further south, citrus fruit and vegetables are grown in the Burnett Valley centred on Mundubbera, and Australia's largest concentration of peanut cropping is centred on Kingaroy. In this southern area sorghum, oats and maize are also grown for animal fodder.

The mean regional farm size of about 1400 ha, almost three times that of its southern equivalent, reflects the much smaller proportion of sown pastures. Beef properties are generally larger than 2000 ha while specialist crop farms are similar in size to those in adjacent regions of the Humid Zone.

2c. Southern Cereal Regions

These regions extend inland to the drier limit, in average years, of winter-grown cereal grains (predominantly wheat). Flat or gently undulating plains predominate, broken in places by low hill ranges.

Agricultural use predominates, occupying 92% of the regional area. Unused land, mostly vacant Crown land, occupies about 5% and is mainly confined to the drier margin in Western Australia and areas of uncleared mallee and poor sandy country in north-western Victoria and parts of South Australia. About 2% is conserved land and a further 2% is forestry land. The latter is mostly confined to New South Wales and southern Queensland and consists of dry eucalypt woodland of much lower productivity than in the more humid regions and, more importantly, areas of native softwood (cypress pine) extending from central New South Wales into Queensland.

Despite the large cropped area of these regions (11 million ha or more than three-quarters of the national total), about 80% of the regional agricultural area is grazing land. About 30% of the grazing land is under sown pastures, mostly based on subterranean clover in the more humid portions, annual medics (small mediterranean legumes) on the drier margins, and lucerne or rye grass in irrigated areas.

Regionally, stocking rates average about 2.3 sheep per hectare or one beef beast to 3.5 ha. Areas of first-class grazing land are confined to irrigation areas and make up only about 5% of the grazed land. Second-class pastures make up about 40% and are largely composed of subterranean clover. Third-class grazing land, composed of a mixture of poorer subterranean clover, medic and native pastures, makes up a further 30% and occurs predominantly on the drier margins.

Sheep have historically been strongly predominant throughout these regions. Recently they have been partly displaced by beef cattle, particularly in northern New South Wales and Queensland, so that by 1975–76 they constituted only 60% of total regional livestock units. The sheep, predominantly merinos, are kept primarily for their wool although lambs for meat are produced on the better pastures on the wetter margins and particularly in the Murray and Murrumbidgee irrigation areas. Wool and wheat production are strongly integrated. Over most of the regional area both enterprises are undertaken on most farms and, on average, contribute about equally to farm income. The average wheat-sheep farm has about 25% of its area under winter cereal crops (most commonly wheat) and a further 25% under sown pasture, rotated in a ley farming system.

Figure 10. *Southern Cereal Regions: wheat stubble (yellowish) and improved pasture in central New South Wales. Railside wheat silos appear on the right.*

Beef cattle make up 35% of the regional livestock units and have increased throughout these regions in the last decade. Much of the increase has occurred on wheat-sheep farms as a subsidiary enterprise. This trend has been greatest in Queensland, New South Wales and Victoria. However, beef cattle are only predominant in the wetter areas in northern New South Wales and in small areas on the less productive fringes of mallee country in Victoria and South Australia.

Dairy cattle, which make up 5% of the regional livestock units, are largely concentrated in the irrigation areas of north-central Victoria. Here they form the largest inland concentration of dairying and are the predominant livestock type although sheep kept mainly for prime lamb production are also locally important. There are much smaller dairy concentrations in the Murray irrigation areas in New South Wales and on irrigated river flats near the Murray mouth in South Australia.

The 20% of agricultural land cropped is proportionally exceeded only by the much smaller Tropical Crop Regions. Although, in the early days of farming, there was considerable correspondence between crop distribution and areas of inherently better or more fertile soils, today there is little. This is due to a better understanding of soil management, including the widespread use of superphosphate fertiliser and the much increased practice of ley farming based on nitrogen-fixing exotic legume pastures. Gaps in the distribution of cereal crops are still apparent where gross soil defects occur, such as on the deep sands of relic sand-dune areas in the Victorian and South Australian mallee and on saline soils along ancient streamlines in Western Australia.

Two-thirds of the cropped area is under winter-grown wheat. Barley and oats make up the bulk of the remainder in Western Australia, Victoria and southern New South Wales. In South Australia barley makes up a large proportion of the non-wheat cropland, oats being relatively unimportant. This is the only State in which barley occupies nearly as much land as wheat, on Yorke Peninsula occupying about three times as much land. In northern New South Wales barley is less important and grain sorghum, grown during the wetter summers of this area, replaces oats as a grain crop secondary to wheat, although a considerable area of oats is grown for green fodder.

Few farms are completely dependent on cereals, the crops being rotated with sown or volunteer pasture as well as with each other. The sown pastures are grazed for three to four years then put under a crop for two to four years. This ley farming system has significantly decreased the proportion of fallow land and, therefore, the problem of soil erosion. Fallowing is still necessary where good perennial clover - based pastures cannot be maintained, as on the drier margins and on the plains of northern New South Wales and Queensland.

Although occupying a small proportion of the cropped area, irrigated crops are locally very important in New South Wales and Victoria. The large irrigation areas of north-central Victoria are mostly under pasture but contain areas of fruit, grapes and vegetables. The irrigation areas lower down the Murray between Robinvale (Vic.) and Cadell near Morgan (S.A.), which lie just inside the Semi-arid Zone, have a different land use system.

The irrigation areas in southern New South Wales using Murray water and centred on Deniliquin are, like their Victorian neighbours, mostly under pasture. Further north the Murrumbidgee Irrigation Areas (M.I.A.), centred on Griffith and Leeton, and the newer Coleambally Irrigation Area to the south use Murrumbidgee water and have much larger areas under crops than under pasture. Together they produce the bulk of Australia's rice crop. Rice (a summer crop) is grown in rotation with wheat and pasture and this rotation system makes up the largest proportion of the irrigated land in both areas. The M.I.A. also has considerable areas of orchard fruit and of grapes used mainly for the production of wine.

Further north in New South Wales and in southern Queensland, where the summer growing season is longer and hotter, cotton is the predominant crop on the smaller and newer irrigation areas on the Macquarie, Namoi and Balonne rivers. Much of the cotton is grown on a large scale by a few highly capitalised companies.

These regions, while unified by the near-ubiquity of the wheat-sheep farm, nevertheless encompass a variety of rural land use systems and so farm sizes vary accordingly. The mean regional farm size is about 750 ha and the average wheat-sheep farm is about 1000 ha, while those devoted exclusively to livestock average about 1200–1400 ha. Farms producing irrigated fruit and grapes average less than 50 ha while those specialising in rice are generally between 100 and 300 ha.

By Australian rural standards these regions have a dense transport network required to move the wheat harvest efficiently. The wheat is trucked to the nearest storage silo and then most of it is railed to the nearest wheat port, between 70% and 80% of the crop being exported. This transport network and the many small service towns form distinctive features of the regional landscape although occupying only a small proportion of the total area.

2d. Northern Cereal Region

This region is sufficiently wet in winter, with carryover of soil moisture from summer, for the growth of cereals such as wheat and, unlike most areas of the Southern Cereal Regions, is sufficiently wet in summer for the growth of sorghum.

It consists of a sequence of fairly broad valleys with relatively fertile soils separated by ridges and dissected plateaux with shallow and much less fertile soils. Much of this region was covered by brigalow forest, and clearance and intensified development are recent and continuing.

About 23% of the regional area is forestry land and about 2% is conserved land, confined almost entirely to the more rugged upland areas of plateaux and ridge tops. Much of the forestry land is low-grade eucalypt woodland which gives way in the south and south-west to cypress pine forest.

The remaining 75% is agricultural land, a much smaller proportion than that of the Southern Cereal Regions, and about 90% of this is grazed, predominantly by beef cattle. The mean regional stocking rate is one beef beast to about five hectares —considerably lower than that of the Southern Cereal Regions. This is due mainly to the lower (though rapidly increasing) proportion of sown pasture—only about 12% of the agriculturally used land in 1975–76, to which may be added a further 2% under annual forage crops. The latter are mainly confined to the fertile cropland areas of the Darling Downs in the south. The main sown pasture species are Rhodes, panic and buffel grasses and their area is increasing as more brigalow is cleared. The native pastures range from the better blue grass (*Dichanthium sericeum*) on the heavy self-mulching soils in the larger valleys, through spear grass (*Heteropogon contortus*) on intermediate country, to a mixture of poor pasture species in uncleared woodland in upland areas. About half the grazing land is second class and the bulk of the remainder is divided fairly equally between the third and fourth classes.

This region, with its hot and humid summers, is mostly unsuitable for sheep, which constitute only about 2% of the regional livestock units. They are confined to the drier south-western edge and small pockets associated with cropped land further north in the Central Highlands. Dairy cattle make up about 5% of the livestock units and are concentrated on the wetter eastern edge of the Darling Downs and along the Condamine River near Dalby.

Beef cattle make up 93% of the regional livestock units and are the sole enterprise of almost all farms outside the crop-growing areas. Within the densely cropped area of the Darling Downs many farms run small beef herds, grazing them on forage oats and sorghum supplemented by hay and silage.

This region has considerable areas of soils requiring little or no phosphatic fertiliser. However, a crop-pasture rotation involving a nitrogen-fixing perennial legume suitable throughout this region has not yet been developed (in contrast with the use of subterranean clover in the Southern Cereal Regions), so nitrogen deficiency persists. The major cropped area lies in the south in the more fertile portion of the Darling Downs centred on Dalby where, locally, more than 60% of the agricultural land is cropped. This is the largest single area in Australia where extensive cropping covers more than half of the agriculturally used land (see Figure 1).

Winter-grown wheat and summer-grown sorghum are the main crops. On the Darling Downs barley and forage oats each occupy, in winter, nearly as much land as wheat but they are unimportant in the northern parts of this region. Oilseeds are important summer-grown crops in the northern areas and to a smaller extent on the Darling Downs. Irrigated cotton is grown on the new Emerald irrigation area and to a much smaller extent at Cecil Plains on the Darling Downs.

The mean regional farm size is about 1700 ha. A wide variation exists between crop farms on the Darling Downs, which average about 250 ha, and the much larger beef properties elsewhere predominant, which average between 5000 and 6000 ha.

An important non-agricultural land use is open-cut coal mining. This has increased rapidly in recent years and is likely to expand further. Seams of black coal occur near the surface in many places in the north and the recent surge in their exploitation has created small but rapidly expanding towns at Moranbah, Dysart, Blackwater and Moura.

3. SEMI-ARID ZONE

This zone epitomises the Australian 'outback'. It is normally just wet enough to produce plant growth sufficient for the maintenance of extensively grazed livestock but generally too dry for crops and sown pasture. Broad plains interspersed with low stony ridges predominate although in the Alice Springs, Pilbara and Kimberley areas the topography is more varied, with higher and more rugged dissected plateaux and hill and mountain ranges. Surface water is scarce and ephemeral so that settlement and land use are highly dependent on underground supplies. Fortunately the Great Artesian Basin underlies much of this zone in Queensland and northern New South Wales and a variety of other aquifers supply bore water elsewhere, though commonly limited in amount and only suitable for livestock.

The agricultural use of this zone is almost completely dependent on the natural vegetation, in contrast with the more humid zones described above. Mallee dominates in the extreme south, giving way northwards to low acacia (mulga) woodland interspersed with areas of saltbush. North again, in the summer rainfall areas, extensive, generally treeless, Mitchell grass plains extend in a broken arc from the Kimberley area to northern New South Wales. Northward from these grasslands low open eucalypt or melaleuca woodlands extend into the Monsoon Zone. Where the soil is shallow or deep and sandy in these northern areas, hummock grass (spinifex) is common.

Only about 12% of the Zone is unused. This is largely confined to areas with shallow or sandy soils in Western Australia, the Northern Territory and South Australia where seasonal drought is a virtual certainty. There is little unused land in the eastern section, where some rain may fall at any time of the year. Conserved land accounts for about 2% of the area and a few small areas of forestry land—mostly cypress pine—lie near the wetter, eastern border.

Extensive grazing (beef cattle in the north and sheep in the south) predominates throughout and crops are virtually absent except in a few irrigation areas along the Murray River on the south-eastern border. Most agricultural land is leased from the Crown and pastoral holdings are very large due to the low carrying capacity of the native pastures.

In the early days of settlement of this zone, in the 1880s and 1890s, overstocking was common, particularly on the arid margins, due to lack of experience in this climatically erratic semi-desert environment. The prolonged and severe droughts at the turn of the century brought disaster so that, for example, stocking rates in north-western New South Wales are now considerably lower than in the early 1890s. Even today, despite improved management, overgrazing during droughts is usually impossible to avoid. This history of spasmodic overgrazing has led to a general deterioration of the native pastures. Areas of bare ground ('scalds') have increased, leading to soil erosion, and valuable perennial species such as the saltbushes have diminished.

Although much research and extension work in recent years has led to limited improvements, pastoral productivity has, at best, remained stable and in many places has declined. This is in sharp contrast to the great improvements in productivity in the more humid zones.

The extensive nature of the land use system and the resultant highly dispersed pattern of settlement has created the need for a two-way radio school system ('School of the Air') and a 'flying doctor' medical network. Towns that are purely rural service centres are few and, outside the irrigation areas in the south-east, widely scattered. Most of the larger urban centres owe their existence to mining, both open-cut, as in the Pilbara, and underground, as at Mount Isa, Broken Hill and Kalgoorlie. Open-cut mining, notably iron ore in

the Pilbara and near Whyalla (S.A.), is an important land use although it occupies a minute proportion of the zonal area.

3a. Southern Semi-arid Pasture Regions

Over most of the regional area the rain falls mainly in winter except in the Pilbara, around Alice Springs and in Queensland. In these northern areas, however, the effectiveness of summer rain (which is normally less than 400 mm) for plant growth is considerably reduced by the very high summer temperatures, but winter rain is sufficient to separate these areas from the Arid Zone.

Plains and low stony ridges predominate but higher and more rugged hill ranges occur in the Pilbara and Alice Springs area and in the northern extension of the Flinders Ranges.

About 14% of the regional area is unused and about 1% is conserved land. Most land in these two categories occurs in the south and west, in areas of sandy mallee plains, waterless limestone plains, salt lakes and much of the higher and poorly vegetated country in the Pilbara. Forestry land is negligible, consisting of a few small areas of cypress pine near the eastern border in central New South Wales and river red gum along the Murray.

Agricultural land makes up about 85% of the regional area and is devoted almost exclusively to extensive livestock grazing on native pastures. Sown pastures cover less than 1% of the grazed area and are confined to the wetter edges. The largest concentration is centred on Blackall (Qld), where an increasing area of buffel grass is being sown on the southern fringes of the Mitchell grass plains.

The mean regional stocking rate is one sheep to about three hectares but a wide variation exists depending on the quality and quantity of the native pastures. The best are the large areas of Mitchell grass in central Queensland and northern New South Wales, and the saltbush country in the Riverina (N.S.W.). These are third-class grazing land, which makes up 15% of the grazed area, with a stocking rate of one sheep to slightly less than two hectares. They are associated with self-mulching cracking clays which retain moisture well. Fourth-class grazing land makes up about 45% of the grazed area and much of this is short grass - forb pasture, with sparse acacias above, extending over much of the regional area in New South Wales, Queensland and around Alice Springs (see Figure 2 on page 5 of the topic 'Soils'). The acacias (mostly mulga trees and shrubs) form useful browse during severe droughts: tree branches are lopped and larger shrubs are pushed over to make the foliage available to the livestock. Similar pasture covers much of the region in South Australia and Western Australia but, because it occurs on shallower soils and in areas where summers are normally very dry, its carrying capacity is much lower than in the east. Much of this is fifth-class grazing land, with stocking rates of one sheep to more than ten hectares. Here the ancient watercourses, despite their saline soils, provide better grazing (on perennial saltbushes and salt-tolerant ephemeral species) over a longer period than the sparse pastures of the mulga country on higher ground.

Sheep, almost exclusively merinos, make up slightly more than half the regional livestock units. They predominate over most of the southern and western areas but are mixed with beef cattle in central and southern Queensland and on the more humid margins in New South Wales, notably in the Riverina. Beef cattle predominate on the drier margins and in the outlying region around Alice Springs.

A specially constructed dog-proof fence protects the sheep areas of Queensland from dingoes (feral dogs probably introduced by the Aborigines), which are largely uncontrolled in the cattle areas. A similar fence runs along the New South Wales boundaries with Queensland and South Australia and, in the latter State, cuts across the Arid Zone to protect the sheep areas to the south. In Western Australia a dog-proof fence system protecting much of the northern sheep area is now largely abandoned and what remains largely protects the sheep in the Cereal Region.

Cropping is absent except for small areas of wheat extending from the adjacent cereal regions and the Murray irrigation areas between Robinvale (Vic.) and Cadell near Morgan (S.A.). The land use system of these differs from the Murray irrigation areas in the more humid Cereal Region in that irrigated pasture is almost absent and irrigated crops (mainly grapes, citrus fruit and peaches) predominate. These irrigation areas produce the bulk of Australia's dried fruit, chiefly dried grapes. The long hot dry summers give the fruit a high sugar content and provide ideal natural drying conditions.

Property sizes in these irrigation areas are small, averaging about 20 ha. Elsewhere the extensive grazing properties are large with a regional average of about 20 000 ha. Locally, mean sizes range from 5000–10 000 ha in the more humid areas in New South Wales, through 15 000–20 000 ha in the Mitchell grass plains of Queensland, to 30 000–50 000 ha on the drier margins in the east and even larger in South Australia and Western Australia.

3b. Northern Semi-arid Pasture Region

This region is the drier inland extension of the Monsoon Zone and rainfall is restricted almost exclusively to the summer, when high temperatures severely reduce its effectiveness for plant growth. The topography varies widely, ranging from the sharply dissected ridge and valley systems of the Kimberley area through the plains and low tablelands of the Northern Territory and north-western Queensland to the hill ranges and valleys in central Queensland.

Only about 5% is unused land and less than 1% is conserved land. The unused land consists mostly of marginal sandy desert country and some of the more inaccessible, sparsely vegetated uplands in the Kimberleys and Barkly Tableland. A group of large pastoral leases in the upper Ord River basin are presently unused to allow the regeneration of vegetation and hence prevent rapid siltation of Lake Argyle, recently created by the construction of the Ord Dam near Kununurra.

Figure 11. *Northern Semi-arid Pasture Region: a watering point, using bore water, on Brunette Downs, a 1.2 million hectare cattle station on the Barkly Tableland, Northern Territory.*

The 94% of the regional area used agriculturally is almost entirely devoted to extensive beef cattle grazing on native pastures. Sown pasture accounts for a minute proportion of the grazed land and consists of small areas of Townsville stylo near the wetter regional borders in the Kimberleys and the Queensland Gulf Country and some larger areas of buffel grass (*Cenchrus ciliaris*) in the extreme south of this region in central Queensland.

The mean regional stocking rate is one beef beast to about 25 to 30 ha. The best native pastures are those dominated by the perennial Mitchell (*Astrebla* spp.) and blue (*Dichanthium* spp.) grasses on self-mulching, cracking clay soils. These grasslands are mostly third-class grazing land, which makes up about 25% of the grazed area. The poorest pastures are the extensive areas of hummock grassland (spinifex) on the sandy desert margins and on the shallow soils of the stony ridges and tablelands. These are generally fifth-class grazing land and make up about 40% of the grazed area, with stocking rates of one beef beast to 70 ha or more. The remainder, predominantly fourth-class grazing land, are pastures associated with low open acacia (commonly mulga) woodland to the south of the Mitchell grass plains and open eucalypt woodland with spinifex to the north.

Sheep, only marginal in this region, are restricted to the northern extensions of the Mitchell grass plains in Queensland. Early attempts to run sheep in the Gulf Country of Queensland and in parts of the Northern Territory were unsuccessful and properties which ran sheep in the West Kimberleys until recently now concentrate entirely on cattle. Thus this region is now almost exclusively devoted to beef cattle, which are run on very large holdings leased from the Crown. The scale of operations is accordingly large and generally beyond the financial and labour resources of the typical Australian 'family farm' enterprise so that most leases are operated by large pastoral companies.

The large size of holdings and dispersed distribution of livestock create a number of problems. Livestock pests and diseases are prevalent and difficult to control. Mustering cattle on these large holdings is a lengthy operation involving many stockmen on horseback. The recent use of helicopters in this work has made considerable savings in time and in the number of stockmen needed, particularly for mustering in rugged, wooded country. The annual turn-off for slaughter is generally less than 10% except in the better areas, and transport of these cattle to sale-yards and abattoirs has always been a major expense, up to 30% of the total cost of production in the more remote areas. A federally funded scheme for improving the transport network by the construction of all-weather 'beef roads' was begun in 1961 and has resulted in the upgrading of most of the major roads. Movement of cattle by trucks and road-trains is now much easier, particularly in the wet season, when road transport used to be very difficult and often impossible.

Cropping is almost non-existent. Following the local demise of cotton growing in 1974–75 the Ord irrigation area, centred on Kununurra, produced less than 2000 ha of crops in 1975–76, mostly grain sorghum, rice and peanuts.

The mean size of rural holdings is about 125 000 ha and a number in the Northern Territory and Western Australia are over a million hectares, reflecting the low carrying capacities of much of this region.

4. MONSOON ZONE

This zone has a typical monsoon rainfall regime with a very wet period confined to the summer and almost rainless winters. Both seasonal excesses lead to land use problems. Dissected plateaux and hill ranges predominate in the west, generally with shallow soils except in the valley floors, while on Cape York Peninsula gently sloping plains form a large proportion of the area.

About 34% of the Zone is unused and a further 5% is conserved land. About three-quarters of the unused land lies in Aboriginal reserves and some of this is used occasionally for traditional hunting and gathering. However, the Aborigines run beef cattle on many of their reserves; these areas are accordingly shown as grazing land. Although much of the wetter northern coastal areas are under eucalypt woodland, there is little forestry land.

The remaining 61% of the area is agriculturally used, nearly all of it for extensive beef cattle grazing almost exclusively on native pastures. Only a very small proportion (0.3%) of the grazed land is under sown pastures—the tropical legume Townsville stylo—most of which is in the Northern Territory. However, the area has declined in recent years, for example in the Northern Territory from 146 000 ha in 1972–73 to 112 000 ha in 1977–78. The predominant native pastures are tall or mid grasses under low open eucalypt or melaleuca woodland. These grasses grow vigorously in the wet season but dry out rapidly during the dry season with a sharp decline in nutrients causing a considerable loss in the weight of cattle. Pasture burning is a common management practice in the dry season to stimulate a small amount of more nutritious regrowth.

Figure 12. *Monsoon Zone: tropical tall grass drying off during the winter dry season in Arnhem Land, Northern Territory.*

The mean zonal stocking rate is one beef beast to about 50 ha, which is inferior to that of the adjacent semi-arid region. This is due to the particular pasture problems of this zone and the lower proportion of pasture equivalent in quality to the Mitchell grasslands. All the problems of that region apply to this zone as well. In particular transport on and off cattle stations is very difficult during the wet season. However, the 'beef road' construction program has brought about some improvements.

Cropping is virtually non-existent and is declining, for example the cropped area of the Northern Territory, which is largely confined to this zone, declined from 12 000 ha in 1972–73 to 1000 ha in 1977–78. Commercial attempts to produce peanuts on the Daly River and rice near Darwin have all ended in failure and the large-scale production of grain sorghum on the drier edge of this zone in the Northern Territory effectively ended in 1975–76.

The mean size of pastoral leases is about 100 000 ha, slightly smaller than that of the Northern Semi-arid Region because there are fewer extra-large leases of over a million hectares.

5. ARID ZONE

This is the driest zone, with a very low and erratic rainfall. Winter rain is slightly more likely and reliable in the southern portion while the central and northern portions generally receive more summer rain, which is

much reduced in effectiveness by the very high summer temperatures.

The widespread areas of sand dunes, which are mostly formed into long parallel ridges, cover 35% of the Zone. The remainder has a varied landscape of generally low relief consisting of sand plains, salt lakes, low rocky hills and gently undulating stony 'downs'. In the east the flood plains of the Channel Country of Queensland are of particular land use significance.

Surface water is scarce and ephemeral. Although parts of watercourses fill during local heavy rains, running streams seldom form. A major exception occurs in the Channel Country, where in most years floods flow down the Georgina, Diamantina and Cooper towards Lake Eyre in late summer as a result of monsoonal rains on their upper catchments in the adjacent Semi-arid Zone. The extent of the flood flow into the Arid Zone varies greatly from year to year and very rarely reaches Lake Eyre although this did occur in 1974. However, throughout this zone, human settlement and livestock are heavily dependent on groundwater.

Due to the hostile environment about 53% of the total area is unused land and a further 6% is conserved land. Aboriginal reserves make up a quarter of the unused land, occupying large desert tracts in Western Australia, the Northern Territory and South Australia. Large areas of conserved land in the deserts of Western Australia have only recently been converted from vacant Crown land. The remaining 41% of the Zone is used as grazing land. Only a small proportion of the sand dune area is used, mainly those parts on the fringes of large pastoral leases and only in years of good rainfall.

Figure 13. *Arid Zone: Innamincka, a large cattle station on Cooper Creek in the Channel Country of South Australia near the Queensland border. The homestead buildings are on the left, just above the timbered and better pastured flood-plain, which is bordered here by stony downs (fifth-class grazing land).*

Extensive livestock grazing on large pastoral leases is the exclusive agricultural land use of this zone. Beef cattle predominate almost everywhere but sheep, which make up 15% of the livestock units, are run on the wetter fringes, notably in the south. The livestock are completely dependent on the sparse native vegetation so the mean zonal stocking rate is accordingly low: one beef beast to about 64 ha. Fifth-class grazing land makes up 75% of the grazed area and much of this is dominated by spinifex (hummock grass), the characteristic ground cover of this zone. Spinifex grasses (*Triodia* and *Plectrachne* species), which are evergreen perennials with hard leaves rolled into spines, usually grow in circular hummocks throughout the sand dune country and on the shallow soils of rocky hillsides but are only eaten by cattle when more palatable annual species are not available. Higher stocking rates occur along watercourses where rainfall accumulates to give more pasture than on the surrounding higher ground. The best pasturage in this zone occurs after floods have receded in the Channel Country, although once this vegetation (mostly a variety of annual grasses, Mitchell grass and saltbushes) has dried off it is hardly better than surrounding areas.

The very low stocking rates inevitably mean that pastoral leases are very large, averaging about 200 000 ha. Apart from the widely scattered rural population, settlement is restricted to a few small mining towns such as Leigh Creek (S.A.) and Tennant Creek (N.T.), a number of small Aboriginal settlements, and the small town of Woomera serving the nearby rocket range.

FURTHER READING

Atlas of Australian Resources: Maps with accompanying booklet commentaries 'Dominant Land Use' (1957, scale 1:6 000 000) of the 1st Series and 'Land Use' (1973, scale 1:6 000 000) of the 2nd Series of the *Atlas*, together with other map-sheets on agriculture and forestry.

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