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Beef stocking rates and farm size - Hunter Region

NSW DEPARTMENT OF
PRIMARY INDUSTRIES

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Contents

Introduction

This publication seeks to help aspiring farmers in the Hunter Region to identify:

- The important features of grazing properties and more profitable cattle enterprises,
- Sustainable carrying capacities, and
- Realistic sized properties for efficient, sustainable beef cattle enterprises, based on the concept of a function cattle unit and capacity to cover operating costs.

It also provides a guide for retaining the capacity for efficient, sustainable cattle enterprises when considering the subdivision of rural grazing lands.

Although focused on the Hunter Valley and Gloucester areas, the methodology and background information would also apply to the wider Hunter Central Rivers CMA region and the Mid North Coast.

Definitions

In this publication, you will find the following terms used:

DSE	Dry sheep equivalent (DSE) is a measure used to compare the feed requirements of different animals. 1 DSE is the average amount of pasture feed consumed by a 50kg wether (an adult but non-lactating sheep) on a monthly basis. As cattle are much bigger than sheep and need more feed, they have a higher DSE rating. DSE also depends on lifecycle, pregnancy stage and growth rate. For more information, see Appendix 1 at the end of this publication.
DSE / ha	DSE per hectare expresses the average amount of feed available within a paddock (or property) and is useful when calculating suitable stocking rates.
Stocking rate or Carrying Capacity	The number of cattle carried in a paddock or on a property - usually expressed as the number of cattle or breeding units per hectare. A sustainable stocking rate is one which does not degrade the natural resources or permanently reduce pasture productivity as a result of overgrazing, species loss and weed growth.
Breeding Unit (Cow & followers)	A breeding unit is a cow and her offspring; that is dependant calves plus weaned cattle (followers) from the previous year, which are not yet ready for sale or use as breeders. The average (monthly) DSE requirement for a breeding unit varies for different beef enterprises in different regions because of the differing feed needs and periods over which calves are retained. Hence it is important to know the type of breeding enterprise (or DSE / breeding unit) when calculating carrying capacity, property size and future returns.
Functional Cattle Unit	A breeding herd of 40 cows was upheld in the Archibald vs. Scone Council Land & Environment Court [NSW LEC proceedings No. 10180, 1987] as a reasonable and typical unit for efficient, sustainable beef cattle enterprises.
Weaner, Vealer, Yearling, Bullock	Growth stages of calves. Weaners are recently weaned and typically 8 – 9 mths old. Vealers are heavier calves of around the same age. Yearlings refer to calves around 13 – 15 mths old. Bullocks are larger cattle over 2 years old.
Store Cattle	Cattle requiring further fattening (i.e. storing) before being suitable for slaughter
Hunter region	For the purpose of this guideline includes the local government areas of Upper Hunter, Muswellbrook, Singleton, Cessnock, Maitland, Lake Macquarie, Newcastle, Port Stephens, Dungog, Great Lakes and Gloucester.

Beef cattle outlook

Beef cattle are an established and dominant agricultural industry in the Hunter region (and Mid North Coast). The industry defines the rural character of the region, contributes significantly to the economy and facilitates the ongoing management of rural resource lands.

The Australian Bureau of Statistics 2001 survey identified that within the Hunter Central Rivers CMA region (central coast, Hunter region and Taree):

- Cleared pasture represents 64% of the available 1.7 million hectares of agricultural land.
- 2,800 rural holdings or 70% of all surveyed properties held beef cattle.
- the estimated value of beef cattle is 9% of the statewide value. The conservatively estimated value of cattle slaughtered in 2001 was $127 million.

Across much of the Hunter region the typically shallow soil depths, erodable sub soils, low soil phosphorous levels and naturally moderate to high acidity. Those soils are best suited for permanent pastures and hence grazing enterprises.

Factors in favour of cattle grazing and the region's beef industry (HEDC 2003) include the:

- Suitability of the climate, pasture types and landscape.
- Available service suppliers (eg, produce merchants, contractors).
- Proximity to infrastructure (abattoirs, saleyards, transport etc) and a range of markets.
- Potential for higher returns from group marketing activities.
- Increasing adoption of Industry standards, such as Meat Standards Australia (MSA) grading, which provide a tool for producers to identify and differentiate their products.
- Good international and domestic market prospects and the opportunity for professional beef producers to increase productivity and become more competitive.

Most beef cattle holdings in the Hunter (and mid north coast) region, however, tend to be of relatively modest size. Contributing factors are the extended period of rural subdivision, the high cost of land and the popularity of cattle for owners of small, rural lifestyle lots. Small-scale beef enterprises (with less than 40 head of cattle) are disadvantaged by:

- The higher unit cost of buying relatively small quantities of items such as fertiliser, drenches, farm equipment and yards.
- Increased costs per head for small scale pasture improvement, cattle management and mustering operations.
- Limited ability to negotiate prices, or to access profitable cattle markets.
- Reduced eligibility for taxation offsets and primary producer assistance.
- Limited capacity to adapt to changing market requirements, or climates, or to cover the cost of rising overheads.
- Higher levels of dependency on off-farm income and the associated lack of available time and focus on pastures and cattle enterprise.

Stark contrast exists in the sustainability of Australian cattle enterprises linked to enterprise scale and the level of management (ABARE 2002). Whereas the top 25% of cattle producers generated an average 7.5% return on investment (excluding capital appreciation), the lowest 25% had significantly smaller scale enterprises on average and generated an average loss of around $66,000/yr with a return of minus 7.5%. The bottom 25% of beef enterprises also had a cattle death rate twice that of the top grouping of producers, indicating poorer, less sustainable management practices.

Sustainable beef cattle

With an established industry and so much of the Hunter (and mid north coast) region better suited to grazing than other forms of agriculture, beef cattle will remain a dominant rural land use. The challenge is to retain or enhance the potential for reasonably efficient beef enterprises that are at least capable of covering direct operating costs and maintaining the resource base.

Options to improve the profitability and sustainability of cattle enterprises that are particularly relevant where land prices are high include:

- Increased productivity from better management of pastures and herds.
- Increased returns per head by producing cattle for higher value markets, or by direct sale to retailers.
- Increased operating efficiency and reduced unit costs through economies of scale (larger herds), smarter purchasing and professional management.
- Running the enterprise over more than one holding and using the complementary features of each property to reduce risks such as feed shortages and increase productivity.
- Leasing rather than buying farmland and equipment.
- Using increased land prices over time to realise returns on the capital invested in buying land, rather than unrealistically relying on cattle sales, or reducing future productive options through subdivision.
- Diversifying. Timber sales traditionally provided an important source of supplementary income for cattle properties in the Hunter region. Other options include managing other properties, contract farm work, eco tourism, value added farm enterprises and income from work not related to farming.

The majority of NSW farming families have more than one income source to cover living expenses and/or the cost of major property improvements. This is not regionally or industry specific. It also reflects an established pattern for most urban Australian families. Research into farm income sources additionally found that a high proportion of farmers selected for their innovative farm practices were members of farm households with multiple income streams (Gleeson, Turner, Douglas 2002).

Off-farm income is poorly correlated with the productivity of a holding or sustainable land use and is consequently an invalid rationale for subdivision. It is similarly inappropriate to decide future land-use options based on subjective consideration of the economic viability of an individual lot and its' capacity to cover highly variable living costs.

The most relevant base level indicator of whether the productive use of Hunter region grazing lands can be sustained is whether it can support a *functional cattle unit* i.e. a breeding herd of 40 cows. A functional cattle unit was upheld in the Archibald vs. Scone Council Land & Environment Court [NSW LEC proceedings No. 10180, 1987] as a reasonable and typical unit for efficient, sustainable beef cattle enterprises. Key concepts are the ability to maintain the natural resource base and at least cover direct operating costs of that enterprise.

The section Calculating carrying capacity and area sets out a six-step process for calculating the area reasonably required to sustain beef cattle grazing. This process can also indicate the sustainable carrying capacity of a particular lot or holding.

The starting point is an understanding of the site's productive potential and the most suitable (or likely) cattle enterprise.

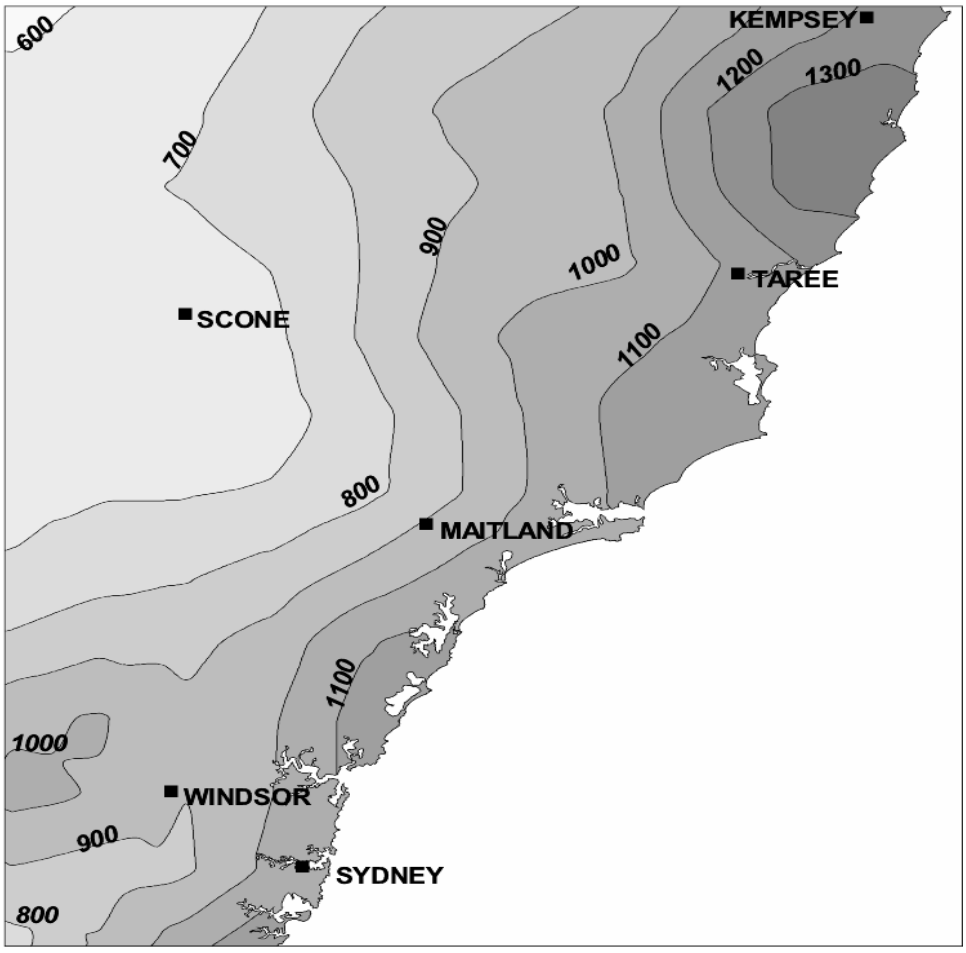
Climate

The Hunter (and Mid North Coast) is in the sub-tropical / temperate climatic zone and temperatures are generally mild. The region can also experience considerable variation including floods and droughts (NSW Agriculture 2002). Topography, elevation and proximity to the ocean create climatic variation and contribute to soil and production differences. Hence, an understanding of local climatic features is useful when assessing the potential of a property for sustainable cattle grazing enterprises.

Rainfall

The average annual rainfall for most of the Hunter and Mid North Coast is between 500mm to 1100mm, with a summer/autumn maximum, but there is considerable variation. The western extremities receive around 600mm, whilst the south and northeast regions with higher elevation or closer to the coast receive over 1,000mm on average (see Figure 1 below).

Figure 1 – Average Annual Rainfall patterns



Average annual rainfall figures can be deceptive - what actually falls varies considerably from year to year, and from month to month. This variability and unreliability can be just as important as the total average rainfall for defining agricultural potential and management needs. Inland, valley floor areas typically have higher climatic variability than coastal or mountainous areas.

The average number of rain days per year also decreases from east to west up the Hunter Valley, in a similar pattern to average rainfall. Coastal areas and the northern parts of the

region, however, are more likely to experience summer thunderstorms with high intensity rainfall. In such areas, lower stocking rates over summer can help retain effective groundcover and avoid erosion, especially on steeper sites and higher risk soils.

Temperatures

Summer maximum temperatures are warm to hot (average 30° C) throughout most of the Hunter region. Winter temperatures are cool to mild, with moderate frosting in some areas. In the Upper Hunter, lower temperatures over the winter months and more extreme summer temperatures can limit plant growth, resulting in lower average productivity than that for similar soils nearer the coast.

A frost-free period of seven months is usual for most of the Valley with the first frosts occurring in early May and continuing until late September. As height above sea-level increases, frosts become more numerous and severe and the frost-free period decreases with a resulting decrease in annual productivity.

The climate of the Lower Hunter generally supports higher volumes of pasture growth over a longer period, but the increased leaching of nutrients due to rainfall and the increased moisture content of the available feed can reduce the actual feed value of each kg of pasture, unless soil fertility levels are also high.

Rainfall also affects the leaching of free lime bases, so that soils in higher rainfall areas tend to be more acid. All coastal soils are naturally somewhat acid, but high levels of soil acidity can limit nutrient availability and increase the risk of aluminium toxicity, thus restricting plant growth rates (NSW Agriculture 1995).

Soils

The huge diversity in soil types and productivity across the Hunter region results in diverse productive capacity and stocking rates. Soils are also a key determinant of cattle enterprise options and the area required for a sustainable grazing enterprise.

The more favourable soils for grazing enterprises have a soil depth of at least 60cm, a balanced composition of clay, silt and sand, at least 2% organic matter, and a pH (CaCl2) of between 4.5 and 7.5. There should also be no significant deficiencies of phosphorus, sulfur, nitrogen, potassium, zinc or molybdenum.

Many soils in the Hunter region fall into this category, but many soils also have natural or induced deficiencies that require correction before pastures can support sustainable grazing enterprises.

The mineral composition of underlying parent rock types (as indicated in Table 1) and the influence of climatic conditions during soil formation over many millions of years largely determines local soil types.

Soils in the valley range from fertile alluvium and deep, fertile basaltic clay loams, through many intermediate soils, to shallow, light textured, stony and impoverished sandy granites. The transition from one soil type to another can also be gradual or very dramatic, sometimes within short distances.

Table 1. Characteristics of soils based on rock type

Rock Type	Characteristic
Basalt	High natural fertility and productive potential Can be rocky and not suited to cultivation Sulfur deficient
Granite	Low to moderate fertility and productive potential Erosion prone Low water holding capacity Responds well to fertilisers
Slate/Shale **(Trap soils)**	Low to moderate fertility and productive potential Hard setting surface Mostly acid and shallow
Sandstone	Low fertility, highly acidic Low water holding capacity Erosion prone Generally low to moderate productive potential
Alluvial	Good natural fertility and productive potential Usually good soil depth Often quite small areas Some flood / stream bank erosion risks

The following is a basic guide to the broad soil types encountered in the region. Additional information on soils and soil management is available from www.agric.nsw.gov.au/reader/soil-health-fertility and www.naturalresources.nsw.gov.au/care/soil/index.html.

Heavy textured (basalt) soils

Black earths, red/brown and other heavy-textured soils common around Merriwa, Cassilis and in elevated parts of the Upper Hunter developed from tertiary basalt and subsequent alluvium. These are usually highly fertile in their natural state, but often respond initially to sulfur. Including nitrogen-fixing legumes in the pasture mix can further increase productivity.

Zinc deficiency is relatively common in crops grown in these soils, especially if alkaline. Molybdenum deficiency is also a possible problem. Red-brown earths around Scone and Murrurundi formed from sedimentary rock; however, pockets of basaltic and alluvial soils also occur. Similar red brown earths of basalt origin also occur in more elevated parts of the Lower Hunter for instance around Gloucester or Dungog.

Medium to light textured soils (granite or sedimentary rock origins)

These soils are developed from various shale, sandstone or granite parent rock types and are more widespread in the mid to Lower Hunter and Gloucester areas.

Soils derived from granite and sandstone are usually naturally low in fertility and require fertilising with phosphorus, sulfur, nitrogen, molybdenum and sometimes zinc and potassium to sustain productive pastures and hence reasonable stocking rates. They are also typically quite acidic, which can reduce pasture productivity unless carefully managed. In acid soils, the availability of nutrients may be lower and aluminium toxicity may occur. Liming may be justified in some situations. These soils often have shallow topsoils that expose pastures to moisture stress.

Soils derived from shales, slates (traps), and some sandstones, are usually low to moderate in fertility and require consistent fertilising to sustain productive pastures and support profitable grazing enterprises. Such soils can have reasonable clay content (which can help retain moisture), but are often very shallow, stony (or skeletal) and can be quite acidic.

Alluvial soils

Alluvial soils adjoining rivers and creeks are usually highly fertile in their natural state and ideal for both pastures and crops. They originate from various parent rock types further up the catchment (including basalt, granite and sedimentary), but usually have considerable organic material in their make-up and excellent depth of topsoil. Having alluvial soils within a grazing property is of particular value as the production of fodder crops and improved pastures can supplement the more seasonal / lower levels of pasture growth in the remainder of the property and increase overall carrying capacity. Retaining the connectivity between flood prone alluvial areas and adjoining flood free lands is also important.

Pastures

Native and naturalised pastures

Detailed descriptions of the region's grassland as they appeared to the first settlers do not exist, but tall summer growing perennial grasses probably dominated, similar to that found on the northern slopes and tablelands (Lodge & Whalley 1989). The dominant species was probably kangaroo grass (*Themeda australis*) with subsidiary grasses such as red grass (*Bothriochloa macra*), wiregrass (*Aristida ramosa*), bluegrass (*Dicanthium sericeum*), wallaby grass (*Danthonia spp*) and weeping grass (*Microleanna stipoides*).

Native and naturalised species still comprise about 70% of the grasslands in the Hunter region areas. They are consequently a major determinant of potential grazing options and capacity, particularly in steeper and less well developed areas.

Most native pastures are complex plant communities that contain a large number of species with varying drought tolerance, feed values and persistence when grazed. Up to 100 different plant species often occur in a single paddock. However, 5 to 20 common grasses usually dominate and determine the overall productive potential.

The dominant species within native pastures, however, can change from season to season and even from year to year depending on; rainfall, temperature, fertiliser application and grazing management. Native and naturalised grasses also vary widely in their forage value, acceptability to stock and ability to produce feed.

Native grasses with the highest grazing value are typically those that retain green leaf for most of the year such as Wallaby grass (*Danthonia spp*) (also known as white-top) or weeping grass (*Microleanna stipoides*). Other native grasses provide useful feed during their narrow growing season. Summer growing perennial grasses such as kangaroo grass (*Themeda australis*) produces reasonable spring and early summer feed...

Local native grasses of least grazing value include; wiregrass (*Aristida ramosa*), blady grass (*Imperata cylindrica*) and barbwire grass (*Cymbopogon refractus*). These species are composed mainly of coarse stems or leaves that are unpalatable and indigestible. Pastures considered as 'native' often also include introduced species that also have low palatability or feed value, such as carpet grass (*Axonopus affinis*), which is now widespread in the region.

Features of the main native and naturalised grasses are shown in Appendix 2. Table 3 shows estimated carrying capacities for both native and introduced pastures. For further information on Wallaby grass, also see www.agric.nsw.gov.au/reader/past-varieties/p2539.htm.

Most native pastures are drought resistant and do not require fertiliser to survive on poorer soils. Species diversity within native pastures can also provide adaptability to climatic

variability and grazing, hence they can be useful for erosion control and biodiversity. However, native pastures in the Hunter region usually support low stocking rates and will rarely fatten growing stock. The biggest limitation is their poor feed quality and lack of growth during the winter. When reliant on native pastures, cattle commonly stop growing or even lose weight during the cooler months.

Legumes, especially subterranean clover *(Trifolium subterranean) or white clover (Trifolium repens)* are often sown into native pastures to increase winter pasture growth. Applying a sulfur and phosphorus fertiliser (eg. single superphosphate) with the inoculated legume seed further increases pasture production and quality. This allows more consistent growth and improves cattle fertility and calving success. The diversity of native pastures can also be retained or increased with appropriate management.

Stocking rates need adjusting to use the additional productivity effectively. A more profitable type of beef enterprises may also become suitable. Further information on managing native pastures is available from DPI publications. See also www.agric.nsw.gov.au/reader/past-varieties/native-grasses.

Introduced pasture species

Introduced grasses in the Hunter region area include both cool season (temperate) and warm season (tropical) species. At the same stage of development, cool season grasses are generally more digestible (higher quality) than warm season grasses, produce higher animal growth rates and suit relatively intensive / specialist grazing enterprises. Cool season grasses prefer moderate temperatures and consistent soil moisture levels, and hence are only sustainable in more elevated areas of the region or irrigated paddocks.

Summer growing grasses are generally better suited to the Lower Hunter and have a significant role where cool season grasses cannot be grown reliably, or there is a need for warm season ground cover. Grazing management is important with warm season grasses to control rank growth, to maintain legume content and provide good livestock growth rates.

Pasture carrying capacity

Different grazing animals have different feed needs. Feed requirements also vary with different growth phases. Hence a standard basis of comparison is required; traditionally this is a dry sheep. A Dry Sheep Equivalent (DSE) is the amount of feed consumed in a month by a 50 kg mature sheep that is not lactating or breeding (commonly known as a whether). Common DSE ratings for different cattle growth phases are shown in Table 2 below. Appendix 1 contains a more comprehensive list of DSE ratings.

Table 2 Typical DSE equivalents

Cattle Enterprises	
3 to 6 month old calf, not yet weaned.	3.8 DSE
450 kg dry stock (non lactating, non pregnant cow)	6.0 DSE
Average for a 450 kg cow and weaner calf	13.5 DSE
350kg yearling maintaining weight	5.3 DSE
350 kg yearling gaining 1 kg/day	10.4 DSE
540 kg (EU) bullock gaining 1 kg/day	12.1 DSE

Because of the variable DSE ratings for different growth phases, annual production cycles need to be identified in order to calculate the average monthly DSE for different cattle enterprises.

Referring to pasture carrying capacities in terms of the equivalent number of dry sheep that can be sustained on a hectare of pasture (DSE per hectare) allows ready comparison of available feed for various enterprises. Typical carrying capacity for various pasture types across the Hunter region is shown in Table 3 below.

Appendix 2 and Appendix 3 provide further information on common pasture varieties and growth rates. Additional information on managing pastures for livestock production is available from the DPI website (www.agric.nsw.gov.au/reader/past-management). Several DPI publications are also relevant, in particular Agnote DPI 139 and DPI 500 'Matching pasture production to livestock enterprises'. Follow the links from www.agric.nsw.gov.au/reader/pub-series/pub-agnotes.htm and www.agric.nsw.gov.au/reader/pub-series/pub-agfacts.htm .

Table 3 - Estimated carrying capacities for pasture types in the Hunter region

Pasture Types	Range (DSE/ha)	Average DSE/ha
Coastal Areas & Lower Hunter		
Unimproved pasture, carpet grass, blady grass	2 - 4	3
Top dressed pasture with some clover	7 – 10	8
Improved pasture; paspalum, kikuyu & clover on good fertility soils + regular fertiliser	14 – 24	15
Upper Hunter / Gloucester		
Native unimproved – low fertility (eg. dominated by Parramatta grass, barbwire grass, wiregrass, red grass)	1.0 – 2.5	1.8
Native unimproved – moderate fertility (no seed or fertiliser added)	1.5 – 4.0	2.8
Native semi-improved - high fertility (clover + fertiliser added)	3.5 – 8.0	5.8
Improved pasture – moderate fertility (perennial temperate grasses, clover + fertiliser)	5.0 – 12.0	8.5
Improved pasture – moderate fertility (tropical grasses, clover + fertiliser)	7.0 – 10.0	8.5
Improved pasture – high fertility (perennial grasses, clover + regular fertiliser)	10.0 – 20.0	15
Lucerne – moderate to high fertility (extensively grazed)	7.0 – 12.0	9.5
Lucerne – moderate to high fertility (rotationally grazed)	10.0 – 15.0	12.5

Soil P is the key

Whilst the dominant pasture types can indicate the typical productive potential of a site, the level of phosphate (P) in the soil is the key determinant of pasture productivity across most of the Hunter region. It also provides insight on the potential to increase productivity.

Identifying the soil phosphate (P) level is consequently a useful measure for identifying cattle carrying capacity. Checking sulfur levels at the same time can help identify whether a sulfur fortified fertiliser or single superphosphate fertiliser would be the most appropriate.

Soil phosphate originates from the parent rocks and is depleted or leached over time. Hence, most soils within the Hunter region are typically phosphate deficient. However, basalt derived soils in the Upper Hunter may be constrained by sulfur rather than phosphate.

The traditional and most efficient way to increase the productivity of grazing lands (and hence carrying capacity, production options and returns) is by adding superphosphate to increase soil phosphate levels. In the Hunter region, constraints posed by other major nutrients such as nitrogen can be reduced by including nitrogen-fixing legumes in the pasture mix, or by selecting the type of fertiliser.

Since 1990 most of the region has only been fertilised spasmodically, partly due to drought (1990-1991, 1994 and 2001-05) and low cattle prices. Short-term cash flows and taxation provisions, rather than a planned approach to maintaining productivity and economic returns also influenced phosphate applications for many landholders. Irregular phosphate applications result in sub-optimal productivity and poor overall returns on investment. The absence of effective pasture and grazing management, has also contributed to a progressive decline of pastures across much of the region.

With good pasture, grazing and livestock management the sustainable carrying capacity of beef properties in the Hunter region can usually be lifted above historically reported rates (eg from 3 or 4 DSE/ha to 8 DSE/ha). Denser pasture cover can also provide environmental benefits via reduced run off and erosion. Ensuring positive economic returns from pasture improvement, however, requires additional livestock management and marketing. The cost per hectare is also highly dependant on the scale of works undertaken. Significant pasture improvement is unlikely to be economically justified for many smaller holdings (<60ha).

The first step for identifying carrying capacity and estimating the area required for a sustainable cattle operation is to identify the relative level of soil phosphorus using soil test results and Table 4. In the absence of soil tests, classify phosphorus levels for light to medium textured soils as low.

Alternative indicators of pasture productivity are the pasture type, or dominant agricultural suitability class of the property, though neither are as accurate. Agricultural Suitability Assessment is most relevant when assessing the potential of a locality or region. Appendix 4: Land Classification provides further information on Agricultural Suitability Classes.

Table 4 Interpreting soil fertility tests

Phosphorus				**Sulfur**	
Phosphorus Level	Bray Test (ppm)	Colwell Test (Light-Medium Soils) (ppm)	Colwell Test (Heavy Soils) (ppm)	Sulfur level	KCL ^{40} test (ppm)
Low	less than 10	less than 20	less than 30	Low	less than 5
Medium	10-20	20-35	30 -60	Medium	5 -10
High	greater than 20	greater than 35	60 -120	High	greater than 10

General notes

- ppm is equivalent to mg/kg
- Low = very responsive to subsequent fertiliser application.
- Medium = moderately responsive to subsequent fertiliser application.
- High = marginally responsive to subsequent fertiliser application.

- Knowledge of soil texture improves the interpretation of Colwell test response for P

Notes on using test results to determine fertiliser requirements

- Soil testing laboratories can use different methods to analyse nutrient concentration (eg the Bray or Colwell test for Phosphorous). These methods can give slightly different results so it is important to identify the method used and to compare like with like.
- In NSW the standard test for soil Sulphur levels is the KCl^{40} test.
- Review soil test results in conjunction with animal enterprise intensity, the responsiveness of dominant pasture species and history of fertiliser applications when deciding fertiliser needs.
- Higher sulfur values are required for optimum production on light textured soils with low organic matter content, particularly where leaching below the plant root zone is likely.
- Lower sulfur values are required for optimum production where deep-rooted perennials are growing and sulfur reserves exist below sampling depth.
- Irrigation water may increase sulfur levels, depending on the source.
- Because the KCl^{40} test does not determine elemental sulfur, it may over-predict the pasture response to sulfur if a high analysis product containing elemental sulfur has been used in the previous few years.
- The KCl^{40} test may also over predict a response to sulfur where pastures do not have an adequate legume component, are in drought or hampered by other nutrient deficiencies.
- Areas close to the coast or with nearby gypsum deposits may not respond as well to sulphur applications as the KCl^{40} test suggests.

The DPI booklet 'Fertiliser for Pastures' provides recommendations on fertiliser use in the higher rainfall areas of eastern NSW, outlines environmental impacts and helps readers to interpret soil test results (see Fertilisers for pastures). Further information on soil phosphate and fertilisers is also available from http://www.agric.nsw.gov.au/reader/soil-fertilisers.

Common beef cattle enterprises

The diverse climate, property sizes and market options in the Hunter region suits a range of possible beef cattle operations (production systems) with varying feed requirements and profit potential. Differing property sizes (and pasture types) may be required to sustain a *functional cattle unit* due to the varying annual feed requirements of each production option. Different beef enterprises also require differing levels of management; personal factors (such as interest in more intensive management of pastures or herds) also need to be considered.

The follow sections briefly describe the key features distinguishing the five most widely adopted beef cattle enterprises in the Hunter region.

Weaner production system

Producing weaner cattle is a common, basic beef enterprise in the region. Cows are joined annually (usually between October – January) with calves born in the following spring. This means that the peak feed demand of 18 DSE per breeding unit (cow and calf) coincides with maximum production from native pastures in the Hunter region during early summer. The calves are sold just after weaning at the start of winter when feed supplies become limited. Feed requirements over winter typically average only 8.8 DSE per breeding unit (breeding cow and replacement heifers). About 20% of the calves are typically retained on farm to provide future replacement breeders.

Calving success and growth rates are limited by the available feed quality and herd management. Calves of around 8 – 9 months of age typically average only 160 – 200 kg and are suitable for sale for further fattening on other more productive properties. They are

eventually sold for slaughter at around 15 – 18mths of age when they reach a finished live weight of around 300 – 400 kg.

In the Hunter region the average monthly feed requirements of such an enterprise is approximately 14.5 DSE per breeding unit and the most relevant DPI gross margin budget is North Coast Weaners – improved land (see www.agric.nsw.gov.au/reader/beefbud).

Vealer production system

This follows a similar production cycle as for weaners, with cows joined annually in early summer and calves born the following spring. However, sites that are slightly more productive are required to allow calves to fatten better post weaning. Better performing calves with a live weight of 260kg -360kg at around 8 - 10 months can be sold for slaughter as “vealers”. Lighter calves in the mix are sold as store cattle, usually to inland areas for rapid finishing with supplementary feed, or are grown out for subsequently sale as yearlings (see below).

Higher levels of soil phosphorus and better pastures also support higher pregnancy and survival rates. Peak feed requirements are higher than for weaners, but calves are again sold prior to winter when feed reserves on unimproved or partly improved properties are limited. About 20% of the calves are typically retained on farm to provide future replacement breeders.

In the Hunter region the average feed requirements of such an enterprise is 15.3 DSE per breeding unit. The relevant published DPI gross margin budget is Local Trade / Feeders (see www.agric.nsw.gov.au/reader/beefbud).

Yearling production system

Yearly production systems raise calves (usually steers) until 13 – 15 months of age. ‘Yearling’ cattle reaching a live weight of 360 - 460kg are sold for slaughter into the domestic market. Alternatively, in poor seasons the yearling cattle can be sold at 340-380kg liveweight to domestic feedlots as store steers for a further 60-100 days feeding.

Weaned calves may be bought-in as store cattle during autumn / winter. When bred on site a peak feed demand of over 20 DSE per breeding unit occurs in spring when the yearlings are being finished and a cow, the current calf and last years follower all need to be fed. Improved pastures, winter forage crops or supplementary grain feeding are needed to provide high quality feed over an extended growth period. Hence, this system requires additional pasture and herd management and suits properties that are more productive.

In Hunter region the average feed requirements of such an enterprise is 18.6 DSE per breeding unit. The relevant published DPI gross margin budget is Yearling Production (Central NSW) (see www.agric.nsw.gov.au/reader/beefbud)

European Union production system

Growing cattle for European Union (EU) markets is a specialised beef production enterprise, requiring a focused and professional approach to both herd and pasture management. It also provides the highest returns.

Cattle need to meet strict export standards and attain live weights of 550kg to 580kg within approximately 2½ years of age (no more than 4 permanent teeth). Achieving the required meat quality and weight gain requires consistent, professional management and moderate to highly productive pastures, or grain supplements. The peak feed demand occurs from spring to summer, but the need for around 23 DSE per breeding unit during winter is also very high compared to other production systems.

Suitable pastures contain clover and average more than 8 DSE/ha. Light-medium textured soils require regular top-dressing with single superphosphate to maintain soil phosphate levels of at least 35ppm (as measured by Colwell P tests) or 15ppm (as measured by Bray P tests).

The production system must be traceable and audited to meet market certification requirements. To justify the longer transport distances to slaughter for this specialist product and the higher management levels, a herd size of over 80 breeders is recommended. Hence, even on highly productive country, a relatively large holding is required to sustainable operate this higher value enterprise.

In the Hunter region the average feed requirements of such an enterprise is 29.5 DSE per breeding unit. The relevant published DPI gross margin budget is European Union (see www.agric.nsw.gov.au/reader/beefbud)

Feeder steer production system

This is a specialised higher value enterprise, which raises weaned cattle for sale to feedlots or bullock growers. Calves may be raised on the property or brought in as weaners and subsequently fattened to around 400 kg at around 18 mths of age. In the feedlot, they fatten for a further 150 days or more for the Japanese market.

Cattle need to have a consistent liveweight and moderate post weaning growth rates (0.7kg/day) are required to achieve the target live weights. Hence, this enterprise suits properties with semi-improved pasture, or with areas of highly improved pasture. To realise optimum prices consistent batches of cattle need to be produced in the required numbers, hence relatively large herds and properties are required.

In the Hunter region the average feed requirements of such an enterprise is 21.3 DSE per breeding unit. The relevant published DPI gross margin budget is Heavy Feeder Steers (see www.agric.nsw.gov.au/reader/beefbud)

Two other options for the Hunter region are; Japanese Ox production systems (export market) and organic beef production systems (briefly outlined below). The publication The Beef Business - Breeding and Marketing for Success provides additional information on selecting a beef cattle enterprise.

Japanese Ox production systems (export markets)

Grass-fed Japanese export markets require steers to reach a required target dressed weight of 300 – 400kg (approx 530 - 700kg live weight) at around 2 years of age. This was a common enterprise in the region and provides good returns from poorer quality lands, but requires a higher level of management and larger landholdings than basic weaner operations. A suitable balance of native and improved pasture is also required to sustain the breeding herd and two lots of progeny.

Organic beef production systems

Organic beef production is gaining interest and may provide alternative marketing options. However, its suitability is limited by; the high risk of clostridial diseases and internal parasites in high rainfall areas, and the relatively low growth rates of native pastures and low phosphate soils. The additional effort required to control weeds and maintain feed quality may also be unsuitable for smaller scale properties where the owners spend considerable time off-farm.

Marginal Weaner and Vealer breeding enterprises have been largely unprofitable over the last decade due to a steady decline in real returns. On smallholdings, buying store cattle to fatten and re-sell may be more profitable. Stocking rates can also be more readily adjusted to use (or preserve) the available pastures.

Breeding enterprises, however, remain popular on modest to smallholdings across the Hunter region. Possible factors include the suitability of Weaner and Vealer production for holdings dominated by unimproved pastures, and for managers with less capacity for more intense management of pastures and livestock, or marketing. The annual breeding cycle may also contribute to the continued popularity of Weaner and Vealer enterprises. Buy, fatten and sell operations may also be more risky due to their dependence on the relative prices of cattle.

Additional information on cattle management skills practices and options are also available via DPI training courses and publications such as NSW Agriculture (2005).

Gross margin budgets

The gross margin for an enterprise is the difference between the gross income derived and the variable costs directly attributable to an enterprise. Such costs vary in proportion to the size of an enterprise. For example, if the number of breeding cows is doubled, then the variable costs associated with carrying the additional stock, such as drench and vaccination costs, will also roughly double.

Calculating gross margins allows the economic returns and sustainability of different production systems to be compared. It also helps identify the funds potentially available to cover fixed or overhead costs which have to be met regardless of enterprise size (such as depreciation, interest payments, rates and permanent labour). For more information, follow the link to Gross margin information on DPI's web site.

DPI also publishes a series of regularly updated Gross Margin Budgets for a range of typical beef enterprises, which set out gross margin returns for a range of enterprises on:

- A per head basis, which indicates the potential return per head of livestock and can be readily adjusted to reflect differing average weight at time of sale. It also allows adjustment for lower or higher prices per head.
- A per DSE basis, which allows comparison based on productive capacity.
- A per hectare basis, which allows comparison based on property size. These assume 4 DSE per hectare for largely unimproved pastures and 8 DSE per hectare for improved country

The aim of these budgets is to provide producers with an additional planning tool to help evaluate enterprise options. They can be used to compare the relative returns of various systems or as a template for calculating property specific gross margins. The notes attached to the published gross margin budgets (see Livestock gross margins) also provide useful descriptions of the selected cattle grazing system and herd management assumptions including the average feed requirements (DSE/ha).

The DSE ratings for equivalent enterprises in the Hunter region vary slightly from the standard published budgets because of local production differences. For instance, the more uniform rainfall pattern in the region can extend the productivity of unimproved pastures. Hence the DSE requirements of a basic Weaner production on unimproved pastures in the Hunter region

is closer to that published for North Coast Weaners – Improved, than to North Coast Weaners - Unimproved.

Table 5 below shows the relevant Gross Margin Budget for the five typical beef enterprises in the Hunter region. To find the relevant published budgets and additional explanatory notes go to www.agric.nsw.gov.au/reader/beefbud and following the relevant links.

Table 5 Relevant Gross Margin Budgets for the Hunter region

Production System	Relevant Gross Margin Budget published by DPI
Weaner Production:	North Coast Weaners - Improved
Vealer Production :	Local trade / feeders
Yearling Production:	Yearling
24-30 month E.U. Production :	E.U. Cattle (0-4th tooth)
Feeder Steer Production :	Heavy Feeder Steers

Calculating carrying capacity and area

Deciding how much land is required to provide for sustainable grazing enterprises depends on productive potential or carrying capacity. Land values may not accurately reflect productivity (especially in areas such as the Hunter). Productivity also varies considerably across a property, so an understanding of the key environmental and resource features of a locality (or specific site) is essential. Soil phosphate levels are the primary indicator of productivity. More generic and less accurate alternatives are Agricultural Suitability Classification and pasture types.

Follow the steps set out below to calculate the average carrying capacity of a property (or locality) and identify how much area is reasonably and typically required for an efficient, sustainable beef cattle enterprise. In the Hunter region, 40 breeding cows is recommended as the minimum number of cattle needed to cover the direct costs and justify the effort of running a grazing operation. This is defined as a *functional cattle unit*.

Step 1.	*Use soil tests and table 4 to identify the average soil P range for the property in question. See 'Soil P is the key' for more details. Assume low soil P in the absence of soil tests or knowledge of fertiliser history.* Example: Soil tests identify less than 20ppm (colwell test) = low soil P
Alternately	*Check the **dominant** Agricultural Suitability Class for the area / property. This is particularly useful if you want to get an idea of how much area you might need for a particular enterprise and do not have a specific property in mind. See Appendix 2: Land classification for more information.* *Example: Class 3 Agricultural Suitability = Moderately productive grazing lands well suited for pasture improvement.*
Step 2.	*Use Table 6 to identify the relevant average DSE rating/ha for the property* Example 1: Soil P level is Low with moderately productive pastures but irregular super application = 4 DSE/ha. (Dominant Agricultural Suitability = Class 3)
Step 3.	*Select the relevant grazing enterprise (production system) for the property. The section on Common beef cattle enterprises provides an overview.*

	The default enterprise for smaller, less productive Hunter region holdings is to turn off cattle as 8 to 9 month old stores (Weaner Production).
Step 4.	*Identify the relevant feed requirements for that enterprise* Example 1: Weaner Production = 14.5 DSE/ breeding unit, ***or*** Example 2: Yearling Production =18.6 DSE / breeding unit.

Step 5.	*Identify the area (hectares) required for each breeding unit (cow and follower) by dividing the average DSE /breeding unit by the average DSE / ha for that property.* Example 1: Weaner stores on 4 DSE / ha pasture= 3.6 ha / breeding unit, Example 2: Yearling stores on 4 DSE /ha pasture = 4.6 ha / breeding unit.
Step 6.	*Divide the area of the property by the number of hectares required per cattle breeding unit to calculate sustainable carrying capacity.* Example 1: A typical 40 ha property with low soil P and unimproved pastures would be capable of sustaining 11 cows producing lightweight weaner (store) cattle (even fewer if pastures are less productive eg 2 DSE/ha). Example 2: The same property could alternatively carry only 9 cows producing 13 – 15 month old finished cattle.
Alternatively	*Identify the minimum area required to sustain a functional cattle unit by multiplying the required area per breeding unit by 40.* Example 1: Producing 8-9 month old stores = minimum of 144 ha. Example 2: 13 - 15 month old stores = minimum of 186 ha.

Native / naturalised pastures that have received limited recent fertiliser application and fall into the 3 - 6 DSE/ha range typically dominate grazing lands in the Hunter region. On such country, relatively large holdings are typically required for efficient, sustainable cattle grazing enterprises. Table 6 below shows that a property of at least 150ha (370 acres) is required to sustain a functional breeding unit on typical grazing lands in the Hunter region with a modest to low level of productivity and management.

A small holding of 40 hectares (100 acres) with an average productivity of 4 DSE/ ha (as used in the above example) could only sustain 11 breeding units and produce less than 9 weaner calves for sale each year. Such low levels of are highly unlikely to justify pasture improvement, or to cover basic operating costs.

Table 6. Estimated carrying capacity and area for grazing lands in the Hunter region

Soil P level	High	Medium	Med --Low	Low
Typical Fertiliser History	125 kg/ha Single Super every year + Mo Super every 4 years	125 kg/ha Single Super every 2nd year + Mo Super every 8 years	Irregular super application	Irregular or no super application & low quality pasture
Dominant Agricultural Suitability Class	2 & 3	3	3	4
Pasture Productivity	**10 DSE/ha**	**8 DSE/ha**	**4 DSE/ha**	**2 DSE/ha**
Hectares per Breeding Cow (and follower(s))				
8 – 9 months turn-off				
Store (Weaner)	1.4	1.8	3.6	7.3
Vealer	1.5	1.9	not applic	not applic
13 - 15 months turn-off				
Store	not applic	not applic	4.6	9.2
Finished Yearling	1.9	2.3	not applic	not applic
18 month old Feeder steers	2.1	2.7	5.9	not applic
24 – 30 months turn-off				
EU Market finished	2.9	3.6	not applic	not applic
Minimum area required for a functional cattle unit (40 cows plus followers)				
8 – 9 months turn-off				
Store	56 ha	72 ha	144 ha	292 ha
Vealer (finished)	60 ha	76 ha	not applic	not applic
13 - 14 months turn-off				
Store	not applic	not applic	184 ha	368 ha
Finished	80 ha	92 ha	not applic	not applic
18 month old Feeder steers	84 ha	108 ha	236 ha	not applic
24 - 30 months turn-off				
EU Market finished	116 ha	144 ha	not applic	not applic

Footnotes:

One hectare = 2.471 acres, One acre = 0.406 ha.

An average of 8 DSE/ha is typical of Hunter region beef cattle properties with a basic, but professional focus on pasture management. With increased fertiliser use, the growth of clovers and sub-clover is more vigorous. The resultant increased pasture quality and mass and the availability of higher quality feed over a longer period, allows better liveweight gain and increased stocking rates. Site features (eg soil type & depth, drainage and risk of environmental degradation), however, ultimately limit the scope for increased production, and the cost / benefit of the response gained.

Further subdivision of rural properties not capable of sustaining a functional breeding unit and the creation of additional dwelling entitlements is not justified based on current productivity levels alone. Strategic assessment of the key features and desired outcome for specific localities is required.

Land Use Planning Implications

Properties with high productive potential are of particular value for agricultural use, but low current productivity does not mean that further subdivision is necessarily appropriate.

On the contrary, larger holdings are required to allow the sustainable productive use of the typically moderate to low productivity grazing lands that dominant in the region. Optimal use of low productivity pastures is also more likely, where properties comprise an appropriate mix of low, moderate and highly productive grazing (or cropping) lands.

The total holding need not comprise a single parcel of land in the same locality or even region. Grazing properties also commonly include both leasehold and purchased land. The chance to combine sufficiently large areas of land and to retain an appropriate resource balance, however, decrease as lot sizes become smaller and the emphasis on residential use increases. Problems include; increased operating costs and increased difficulty in shifting stock from one property to another, increased property prices and rates, reduced interest in productive agricultural land use and increased risk of land use conflict.

Low current productivity may also be improved by appropriate soil and pasture management. When farmland prices are high, the most cost effective means to increase returns is to improve soil fertility. However, the capacity to sustainably improve pastures is ultimately limited by such factors as the risk of erosion or nutrient run off, the need to protect biodiversity and the relative difference between costs and benefits (see Fertilisers for coastal pastures for further advice).

With decreasing property size, the proportion of that farm not suitable for pasture improvement increases also tends to increase significantly along with the per head costs of pasture improvement and herd management. Making effectively use of the extra pasture volume and quality also requires additional herd management and marketing. Pasture improvement and maintaining increased productivity may consequently be inappropriate for smaller rural lifestyle properties, especially those with other production constraints (such as poor soils or limited growing seasons).

Subdivision and closer settlement can also result in landscape changes, loss of rural character, cumulative impacts on biodiversity and catchment values, the loss of farm forestry potential or the alienation of mining resources. Cumulative impacts and Ecologically Sustainable Development also need to be considered when deciding future land use options.

Retaining the capacity for sustainable primary production and creating further smallholdings and residential opportunities needs to be separately provided for within the context of local and regional planning policies and related conservation and development strategies. Key planning tools include the appropriate identification of zones and minimum lot sizes.

Property size, dwelling entitlement and the risk of land use conflict are key constraints for retaining or improving agricultural productivity. Retaining the capacity for sustainable cattle grazing can also help retain other productive land use options, and protect environmental and landscape values.

In coastal areas such as the Hunter region, the area typically needed to sustain a *functional cattle unit* provides a practical guide when considering buying or subdividing rural (resource) lands best suited for cattle grazing.

Appendix 1: Average feed requirements

Livestock Description	Energy Required (megajoules/day)	Ratio compared with 50kg wether (DSE rating)
Sheep - 50kg dry wether	9.0	1.0
Cattle - Dry stock 450 kg	54	6.0
450 kg cow last 3rd of pregnancy	66	7.3
450 kg cow early lactation	119	13.2
450 kg cow last 3rd mid lactation	112	12.4
450 kg cow last 3rd late lactation	102	11.3
Calf of above grazing pasture (3-6 mths)	34	3.8
Calf of above grazing pasture (6-9 mths)	56	6.2
380 kg heifer early lactation gaining 0.5 kg/day	150	16.7
350 kg yearling maintaining weight	48	5.3
350 kg yearling gaining 0.5 g/day	71	7.9
350 kg yearling gaining 1.0 kg/day	94	10.4
350 kg yearling gaining 1.5 kg/day	116	13.0
540 kg yearling gaining 0 kg/day	57	6.3
540 kg yearling gaining 0.5 kg/day	83	9.2
540 kg yearling gaining 1.0 kg/day	109	12.1
540 kg yearling gaining 1.5 kg/day	135	15.0
Bulls 800 kg	90	10.0

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Appendix 2: Common native and naturalised grasses - Hunter region

Species & Group	Common Name	Forage Value	Drought Resilience	Response to Grazing	Response to Fertility
Warm season perennials					
Andropogen virginicus *	whiskey grass	low	moderate	decrease	-
Aristida ramosa	wiregrass	low	high	decrease	decrease
*Axonopus affinis**	carpet grass	low	moderate	increase	increase
Bothriochloa macra	red grass	moderate	high	increase	increase
Chloris truncata	windmill grass	moderate	moderate	increase	increase
Cymbopogon refractus	barbed-wire grass	low	high	decrease	decrease
Cynodon dactylon *	couch grass	low / mod	high	increase	increase
Dichanthium sericeum	Qld blue grass	moderate	high	increase	increase
Eragrostis leptostachya	paddock lovegrass	moderate	moderate	increase	increase
Eragrostis curvula *	African lovegrass	low	high	increase	increase
Hyparrhaenia hirta *	Coolatai grass	low / mod	high	increase	increase
Panicum effusum	hairy panic	high	moderate	increase	increase
Paspalum dilatatum *	paspalum	high	moderate	increase	increase
Sporobolus creber	slender rat's tail	moderate	moderate	increase	increase
Themeda australis	kangaroo grass	low / mod	high	decrease	decrease
Cool season perennials					
Dichelachne micrantha	plume grass	moderate	moderate	increase	increase
Elymus scaber	wheat grass	high	moderate	increase	increase
Year long green perennial					
Austrostipa aristiglumis	plains grass	moderate	moderate	decrease	-
Austrodanthonia bipartita	wallaby grass	high	high	increase	increase
Austrostipa setacea	corkscrew grass	moderate	high	increase	-
Eriochloa pseudoacrotricha	early spring grass	high	mod	increase	increase
Microleanna stipoides	weeping grass	high	high	increase	increase
Nasella neesiana *	Chilean needle grass	low / mod	high	-	-
Poa sieberana	tussock grass	low	high	increase	-
Warm seasonal annuals					
Echinochloa crus-galli *	barnyard grass	mod / high	low	decrease	increase
Urochloa panicoides *	liver seed grass	mod / high	moderate	increase	-
Cool season annuals					
Avena fatua *	wild oats	mod / high	low	decrease	-
Bromus molliformis *	soft brome	high	low	increase	increase
Hordeum leporinum *	barley grass	high	low	increase	increase
Lolium rigidum *	Wimmera ryegrass	high	low	increase	increase
Phalaris paradoxa *	paradoxa grass	moderate	low	-	-
Vulpia myuros *	rat's tail fescue	low	moderate	increase	increase

Note; * = Introduced/naturalised - = Information not available

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(Adapted from Lodge et al. 1990).

Appendix 3: Common introduced perennial grasses - Hunter region

Introduced cool season perennial grasses

The four perennial cool season grasses most commonly sown in the Hunter region are phalaris, cocksfoot, perennial ryegrass and tall fescue. The preferred sowing time is autumn.

Phalaris (*Phalaris aquatica*)

Phalaris is a winter growing perennial, which performs best in areas with at least 500 mm annual rainfall. Phalaris requires medium to high soil fertility and whilst it is sensitive to highly acid, high exchangeable aluminium soils, it tolerates wet and/or moderately saline soils.

Its growth period is mainly from autumn to late spring with summer dormancy. Late spring grazing management is a critical factor for persistence of some of the more erect vigorous types. Allowing plants are occasionally “run to head” will enhance persistence. Phalaris shows good drought tolerance when established.

Phalaris litter contains toxins that can inhibit the establishment of sub clover. Excess litter build up (dry matter above 2000 kg/ha) should therefore be avoided as autumn approaches. All phalaris varieties contain alkaloids that can at times cause stock poisoning. Seek veterinary advice on stock and paddock management to overcome this occasional problem.

To ensure persistence phalaris is only recommended for sowing in favourable aspects (generally the Upper Hunter).

Cocksfoot (*Dactylis glomerata*)

Cocksfoot is a perennial suited to low and high fertility soils but on low fertility acid soils, has an advantage over other introduced grasses. It is well suited to areas of not less than 600 mm annual rainfall. In the Hunter it has better summer growth and is more drought tolerant than perennial ryegrass and fescue, but is not a good as phalaris.

Cocksfoot is relatively easy to establish and once established its main growth period is from autumn to late spring, with some varieties depending on climate responding to summer rain. Cocksfoot can have a lower nutritive value than phalaris, fescue and perennial ryegrass, but good nutrition and grazing management will allow it to perform as well as most other grasses. It is an important worthwhile grass for inclusion in mixes where soil variations occur. Selecting varieties with good summer dormancy may enhance persistence.

Tall Fescue (*Festuca arundinacea*)

Tall fescue is a long-lived perennial grass that requires good summer rainfall or irrigation for persistence (not less than 800 mm annual rainfall). Tall fescue is the best of the temperate grasses for supplying nutritious feed in late spring and early summer.

Tall fescue is adapted to a wide range of soil types (medium to heavy texture), soil fertility and pH, but like perennial ryegrass and white clover, it is most productive when soil fertility is high. It is quite tolerant of soils with high aluminium content and those, which are moderately saline. It is also the most tolerant perennial grass for flooded and severely waterlogged areas.

Tall fescue is slow to establish compared to perennial ryegrass and phalaris. Once established, grazing should be close but carefully monitored for the first two years to ensure persistence.

Perennial Ryegrass (*Lolium perenne*)

Perennial ryegrass is particularly suited to medium to heavy textured soils with good fertility and an annual rainfall of not less than 800 mm. Perennial ryegrass will also persist on lower fertility soils and is tolerant of acid soils (but less so than cocksfoot or tall fescue).

Perennial ryegrass is easy to establish, produces high quality forage during winter to late spring, and is quick to recover after grazing. In the Hunter, perennial ryegrass does not persist on sandier soils (due to its poor drought tolerance) or in coastal areas (due to high levels of competition from other grasses).

Take additional care when perennial ryegrass is included in pasture mixes. As the rate of perennial rye increases, so does the risk of competition to other sown species. High rates often result in failure of the slower establishing species.

Varieties that are early maturing have been the most persistent. Later maturing varieties can produce more feed if irrigation is available.

Introduced warm season perennial grasses

Paspalum (*Paspalum dilatatum*)

Paspalum is a spring/summer growing perennial, which if well managed also, provides grazing through into autumn. Paspalum has moderate frost tolerance, and is suited to a wide range of environments, including; salinity, water logging, acidity and variable soil fertility.

It is very tolerant to overgrazing. Paspalum often colonises valley floors providing valuable green feed over the summer period. During the summer, paspalum requires heavy grazing or slashing to prevent rank growth. Seed heads can be infected with ergot (a cause of a stock health disorder), which can poison livestock.

Kikuyu (*Pennisetum clandestinum*)

Kikuyu is a prostrate spring/summer/autumn growing perennial that requires high fertility and well-drained soils for optimum production. Under favourable conditions kikuyu runners spread rapidly, making it a very suitable species for erosion control and stabilising earthworks. Keeping Kikuyu short during summer helps to maintain feed quality and high feed volumes. In mixed pastures, close grazing is also necessary to avoid suppressing clovers. Nitrogenous fertiliser will increase production levels during the summer growing season. Annual ryegrass and oats are often drilled into kikuyu pastures to provide feed during colder times of the year.

Rhodes Grass (*Chloris gayana***)**

Rhodes grass is another spring/summer/autumn growing perennial. Rhodes grass is suited to a range of soils from light textured sandy loams to medium clay soils, has some degree of salt tolerance, and is moderately drought tolerant.

It is also relatively easy to establish and extremely useful for erosion control and stabilising earthworks. Hence, it is widely used in mine rehabilitation. Rhodes grass can also be used in pastures as an alternative to paspalum, subject to careful management. It must be kept short to maintain feed quality and palatability, but may not persist under heavy grassing. The variety Callide has higher feed value and is preferred for grazing.

Introduced legumes

Lucerne (*Medicago sativa*)

Lucerne is the most productive legume for arable, fertile areas of the Hunter Valley, especially in cropping rotations. Lucerne suits deep, fertile soils with a pH ($CaCl_2$) level of between 6 and

7.5. Lucerne is a true perennial, that is relatively easy to establish and will persist for several years, with careful grazing management and reasonable seasonal conditions.

Select varieties based on winter growth rating, insect and disease resistance characteristics. The most successful varieties are those with resistance to spotted alfalfa aphid and blue green aphid. Good resistance to *Phytophthora* root rot and at least moderate resistance to anthracnose are essential, particularly on poorly drained soils.

Winter dormant lucerne varieties have not performed well in grazing systems, in part because of inferior seedling vigour, but they have performed well for irrigated hay production. Semi-dormant and winter-active varieties are very adaptable as all purpose varieties. Highly winter active varieties are very useful for short-term pastures between cereal crops. However, under extensive grazing management and moderate to high stock pressure, winter active varieties are less persistent than semi-dormant varieties.

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Appendix 4: Land classification

Two classification systems are used in NSW to assess land for agricultural and other rural uses. As each system fulfils a distinct purpose, the resultant classifications and maps are not directly comparable.

The eight-class Rural Land Capability system defines land based on the capacity for a site to be used for agriculture, urban or other purposes without permanently damaging soil resources. Hence, it focuses on the physical (or biological) constraints imposed by geology, soils, slope, climate, drainage and groundcover. Land Capability is generally used in soil conservation and property plans to identify constraints to urban development or areas requiring different soil management practices.

The five-class Agricultural Suitability system was developed to support land use planning and focuses on the potential agricultural productivity of the site and its suitability for grazing or cultivation. Agricultural Suitability Class I land has few if any constraints, can sustain high levels of agricultural production and a wide range of crops. In the Hunter region, this typically corresponds with alluvial river flats used for vegetable, lucerne or turf growing. At the other end of the scale Class 5, land has severe production constraints (eg steep slopes, forest cover) and is generally unsuited to agriculture. Agricultural Suitability Classes associated with grazing enterprises are described further in Table 7.

Table 7. Agricultural land suitability classes for grazing enterprises

Class	Principal Features
2	Prime crop lands of superior quality and limited extent. They are suitable for regular, but not continuous cultivation such as intensive horticulture or crops. Constraints to sustained levels of agricultural production are minor to moderate. The economic loss from floods is low in the longer term. In the Hunter region, these are typically well-drained alluvial flats with moderate to deeper soils.
3	Prime grazing land well suited to pasture improvement, extensive horticulture (eg viticulture, orchards) or for periodic cultivation. Constraints to production are moderate and can be managed by conservation or drainage works such as a pasture phase, conservation tillage or fallow. The overall level of production is moderate. In the Hunter region these are typically undulating cleared pasture areas that have been pasture improved or used for occasional crops in the past.
4	Land suited for grazing, but not cultivation. Agriculture is based on native pastures or improved pastures established using minimum tillage techniques. Production may be high seasonally but the overall level of production is low because of a number of major constraints. In the Hunter region, these are typically areas with steeper slopes and / or shallower soils (10 – 40 cm) with native or naturalised, summer dominant pastures. Such lands can be prone to erosion if poorly managed.

Properties that comprise mostly Class 4 Agricultural Suitability have relatively low levels of pasture productivity and a larger area is required to sustain the year round feed requirements of each animal or breeding unit. Hence, smaller properties of less than 60 ha are only capable of supporting small numbers of cattle. Such properties, however, may require the same level of effort and costs as a larger property and are unlikely to ever be capable of covering the costs of running and selling the livestock.

Grazing properties that have a better balance of resources (eg a mix of Class 3 and 4 lands) are able to balance out available feed supplies over a longer period via improved pastures, lucerne hay or silage production, or to provide higher value feed at critical periods. Better returns are consequently obtainable because of higher calving rates, lower mortalities and better finished (i.e. fattened) stock. They also have the potential to sustain higher stocking rates (more head of

cattle per hectare on average). Landholders who consistently produce higher quality cattle in larger numbers typically secure higher prices per head by targeting premium markets.

Agricultural Suitability mapping for the Hunter and Mid Nth Coast regions was progressively undertaken between 1983 and 2002 to help land use planners identify the productive potential of a locality or shire. They are not suitable for identifying the agricultural suitability of individual properties as local variations, smaller than 40ha, are not mapped. Additional information on Agricultural Suitability Mapping and its limitations is provided in Agfact AC 25 (see www.agric.nsw.gov.au/reader/agfact-ac).

Procedures for mapping agricultural suitability are set out in The Rural Land Evaluation Manual (Dept of Planning 1988). Knowledge of current agricultural practices and enterprise options within a region as well as physical, social and economic constraints to agricultural production is required. Hence, agricultural suitability mapping is usually only considered when planning for regional land use options or major projects.

An assessment of productive carrying capacity (DSE rating) is the more usual basis for deciding land use options for a particular site or locality. This requires an understanding of the areas climate, soils, pastures, fertiliser history and environmental values (such as the protection of catchment values or remnant vegetation). A broad over view of these factors is provided in the main section of this document.

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www.dpi.nsw.gov.au – Web site for Department of Primary Industries.

www.agric.nsw.gov/au/reader/tocal-publications –Web site for Tocal publications

www.tocal.nsw.edu.au/reader/tocal-course - Web site for DPI external training courses at Tocal.

For additional information on grazing enterprises in the Hunter Region, you are also encouraged to contact Department of Primary Industries Offices at the following locations:

Tocal Agricultural Centre	Tocal Paterson NSW 2421	Tocal Paterson NSW 2421	Phone: 02 4939 8888 Fax: 02 4938 5549
Scone District Office	Cnr Susan & Guernsey Streets Scone NSW 2337	PO Box 168 Scone NSW 2337	Phone: 02 6545 1800 Fax: 02 6545 2639
Taree District Office	1 Macquarie Street Taree NSW 2430	PO Box 253 Taree NSW 2430	Phone: 02 6552 7299 Fax: 02 6551 2253