PROGRAZE™

Profitable, sustainable grazing

SEGMENT 2

LIVESTOCK PRODUCTION FROM PASTURE

In this segment you will learn:

- About the significant pasture characteristics that impact on the production of cattle and sheep.
- The importance of pasture intake in determining cattle and sheep production.
- How pasture quantity and quality characteristics interact to determine pasture intake by cattle and sheep.
- How the PROGRAZE pasture benchmarks can be used to identify pasture that will result in specific levels of cattle and sheep production.

LIVESTOCK PRODUCTION FROM PASTURE

The quality and quantity of animal product derived from pasture fed livestock is directly related to the quality and quantity of the pastures they graze. The nutrient requirements of animals are most cost effectively met by grazing pasture.

> The critical factor determining the production level of livestock grazing pasture is the amount of pasture the animals are able to consume, otherwise known as intake.

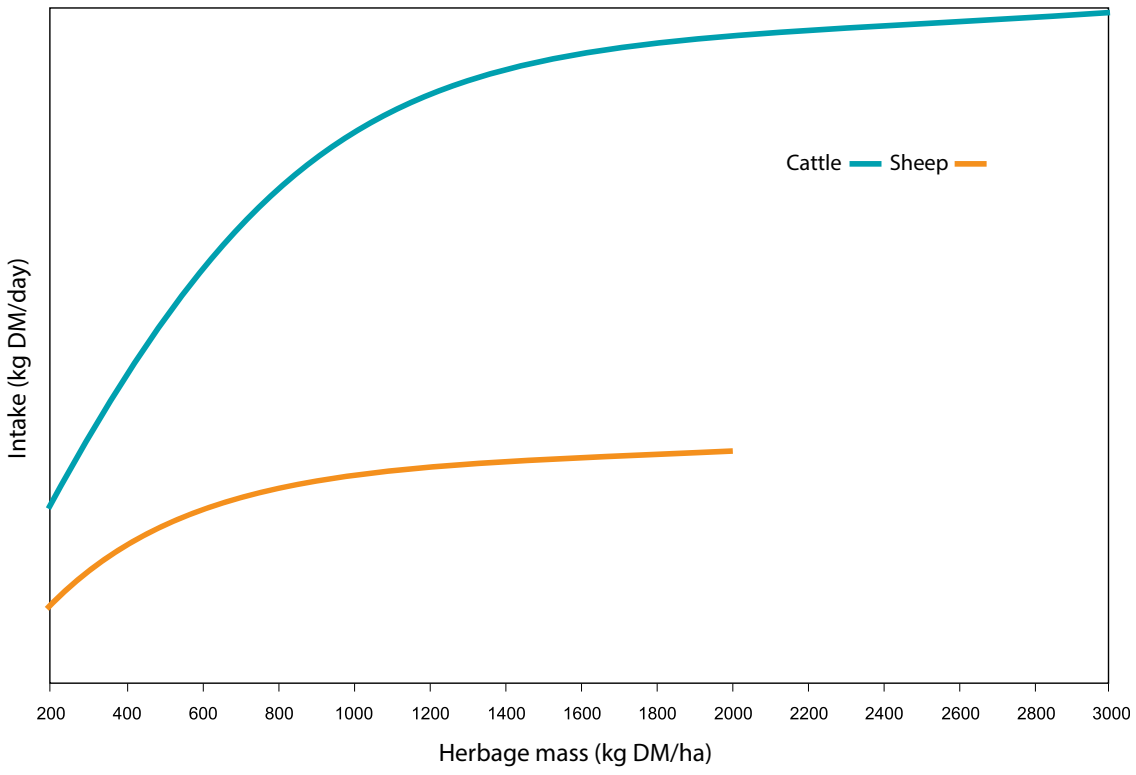
Intake is influenced primarily by the quantity of pasture available as well as its quality. Skills in estimating pasture quality and quantity provide the basis for improved grazing and pasture management decision making.

PASTURE QUANTITY

Pasture quantity, which is usually described as herbage mass, is expressed in kilograms of pasture dry matter per hectare (kg DM/ha). Herbage mass refers to the total amount of pasture present, assuming a cut was taken at ground level and includes both green and dead material. At times the term green herbage mass is used. This is a prediction of the green pasture present only, a critical factor where high levels of livestock production are required.

Herbage mass is expressed in terms of dry matter because water content of pasture can vary depending on the time of day and with different stages of growth. For example, a young leafy rapidly growing pasture may contain 85% water (or 15% dry matter) while flowering grasses may be 50% water and therefore 50% dry matter. Dead pasture on a hot summer day maybe over 90% dry matter. While being vital, water itself has no nutritional value. When relating herbage mass to what the animal can eat and utilise, the water component is ignored.

Figure 2.1. Influence of herbage mass on intake of sheep and cattle.



So why is herbage mass important to livestock production?

Probably a very obvious statement; if herbage mass drops below certain levels sheep and cattle are unable to consume sufficient pasture to maintain their weight. When herbage mass is low animals must spend more time grazing to meet their nutritional requirements since each bite of pasture harvests a smaller amount. Despite the extended grazing period they may be unable to consume sufficient quantity to satisfy their requirements.

Similarly there is a point at which intake will not increase even if more pasture is made available because animals physically can not consume more. They have reached their intake capacity for that quality of pasture.

The relationship between herbage mass and intake is described in Figure 2.1. You will see from the figure that with sheep, intake rises sharply as herbage mass increases to around 800 kg DM/ha and only small increases in consumption occur above 1600 kg DM/ha. With cattle these respective figures are 1200 and 2300 kg DM/ha.

Up to a herbage mass of 1600 kg DM/ha for sheep and 2300 kg DM/ha for cattle, livestock production may be manipulated to achieve a production target.

When a paddock contains a greater herbage mass than required for the particular livestock class grazing it, the opportunity occurs for manipulating the stocking density to improve the utilisation of pasture.

So far, herbage mass has been discussed in relation to livestock production but also, it influences pasture productivity, i.e. pasture growth rates and botanical composition. The influence of herbage mass on pasture production will be discussed in a later section of the manual.

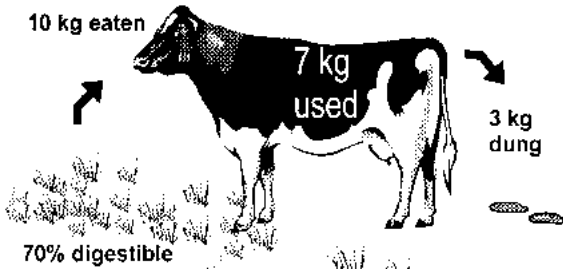
PASTURE QUALITY

Numerous quality characteristics of pasture can influence intake by livestock. From a practical point of view digestibility and the proportion of legume are probably the most useful measures even though they do not always fully explain the variation which can be observed in intake.

Digestibility

Digestibility, expressed as a percentage, provides a prediction of the proportion of the pasture consumed which is actually used by the animal. For example, if the digestibility of a pasture is said to be 70%, approximately 70% of that consumed on a dry matter basis will be used by the animal for its own nutritional requirements, while 30% will eventually pass as faeces (see Figure 2.2).

Figure 2.2. Digestibility, a measure of the amount of pasture used by the animal.



Digestibility influences the time feed spends in the animals stomach. A pasture high in digestibility will move quickly through the animal allowing it to consume more. More pasture consumed equates to higher production.

On a pasture of low digestibility, even though plenty may be available, stock cannot process enough feed, due to slow flow rate, to meet their nutritional requirements.

Digestibility is a useful measure of quality because:

- It is directly and positively related to the energy content of the pasture. Energy is needed by animals for body functions. Energy in feed is assessed as megajoules metabolisable energy per kg of dry matter. See Appendix 5 for energy contents of common feeds.

Digestibility %	Energy content (MJ ME/kg DM*)
40	4.8
50	6.5
60	8.2
70	9.9
80	11.6

*Megajoules of metabolisable energy per kg dry matter.

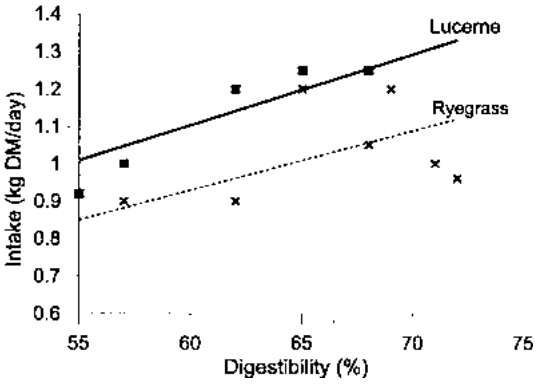
- Digestibility is positively related to protein content – when digestibility is high, protein content also will be high. However, there is variation between pasture species in protein content. For example, clovers are generally higher in protein than grasses.
- Digestibility directly relates to the speed of digestion and therefore the movement of feed through the animal. In general, pastures with higher levels of digestibility will be digested more rapidly allowing for greater intake and so greater animal production.

Digestibility differs between pasture species and varieties, parts of a plant and by the stage of growth of the plant. Let's now deal briefly with each of these aspects.

Species

Legumes usually have a higher digestibility than grasses. Maintaining legumes in the pasture mix will improve the overall quality and livestock production potential of the pasture. In addition, at the same digestibility the intake of legumes can be expected to be greater than the intake of grasses (see Figure 2.3). Perennial grasses may be more digestible for a longer period than annuals as annuals die off after seed production.

Figure 2.3. Intake of legumes may be higher than grasses at the same digestibility.



From Greenhalgh (1979), The management and diseases of sheep. Commonwealth Agricultural Bureau; pp. 201–12.

At the same stage of growth, the digestibility of tropical pastures is usually 10% below that of temperate pastures (see Figure 2.4)

Parts of the plant

Leaf material is of higher digestibility than stem. Pasture management that maintains pasture with a high proportion of leaf will provide a pasture of higher digestibility and so improved livestock performance. As well, by maintaining leaf area on a plant, its ability to recover following grazing is quicker.

The burr or pod (seed plus the fibrous casing) from clovers and medics have a reputation as a quality summer feed particularly in southern pasts of NSW. In one experiment when subterranean clover burr (46% digestible, 21% crude protein) was harvested and fed ad-lib. to sheep in pens, they lost weight at the rate of 33 grams per day. In another experiment the average digestibility of barrel medic burr was found to be 30%.

Stage of growth

The stage of growth of pasture plants has a major influence on digestibility. Figure 2.5 provides a guide to the decline in digestibility that occurs as temperate pastures mature. At the same stage of growth, the digestibility of tropical pastures is usually 10 % below that of temperate pastures. This is due to greater lignification of the plant leaves which is a mechanism they have developed to minimise water loss (transpiration) which increases their survival in hot summer conditions. It is important to remember two things, firstly, that temperate and tropical grasses grow at different times of the year and so in practice comparisons are of little relevance. Secondly, information suggests that the relative performance of animals grazing temperate and tropical perennial grasses is different (Figure 2.6). This difference is thought to be associated with the higher intake of green leaf material of tropical grasses, which is related both to their more upright structure and their indeterminate growth of green leaves during stem elongation and flowering. While animal performance will be higher for a temperate grass with digestibility greater than 66%, it may be greater for a tropical grass when digestibility is between 66% and 50%.

Figure 2.4. A guide to digestibility decline as temperate pastures mature.

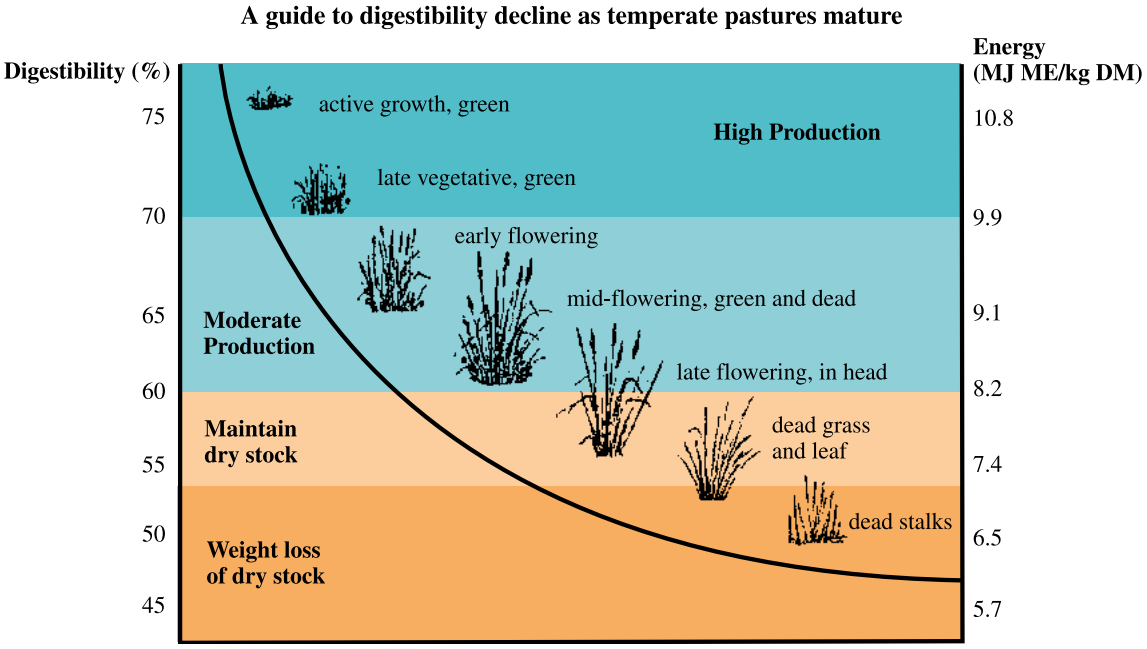


Figure 2.5. A guide to the relationship between digestibility and pasture maturity in tropical pasture.

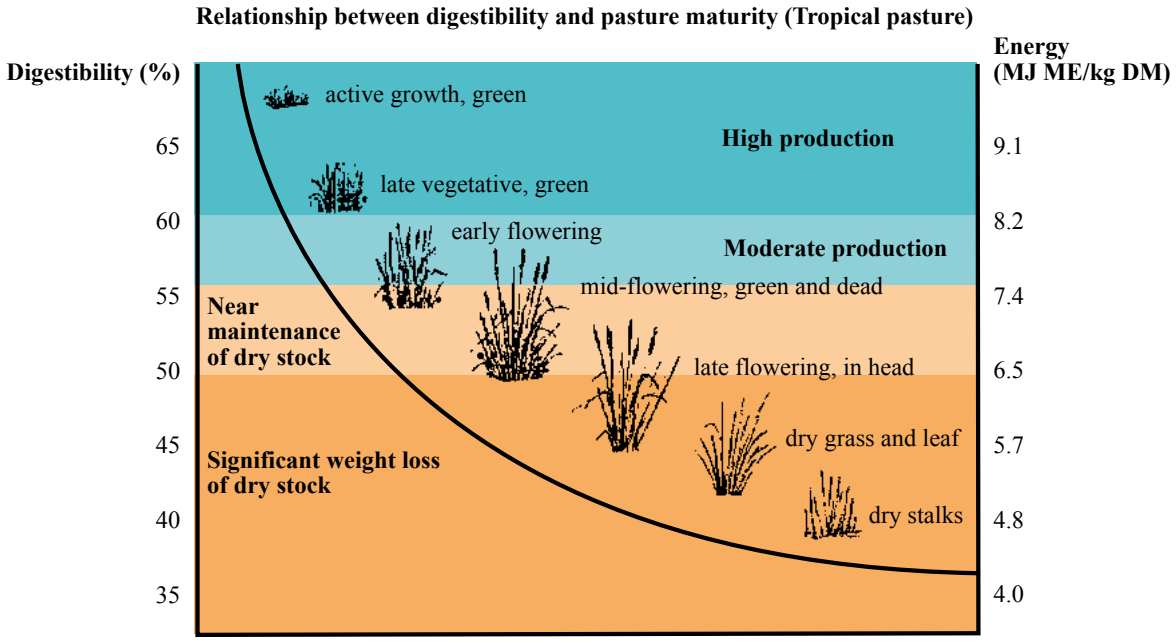
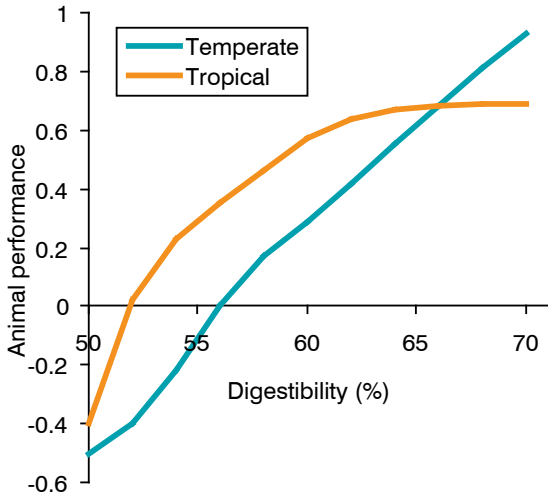


Figure 2.6. Relative cattle performance on tropical and temperatre pastures – Source GrazFeed®



Young, actively growing plants, said to be in the vegetative stage, will have the highest digestibility. Digestibility decreases as plants mature, particularly as they enter their reproductive phase and prepare to flower.

Following flowering the plant enters senescence and digestibility declines rapidly. This situation is characterised by declining green herbage and a rapid increase in the proportion of dead herbage. In this type of pasture, digestibility (55–60%) has reached a point where the pasture will barely maintain the weight of stock even if herbage mass is not limiting intake.

In dead pastures, and where significant amount of leaf remains, particularly clover leaf, digestibility should be in the range of 50–55%. In circumstances where the dead leaf has largely disappeared from the pasture, intake will be insufficient to maintain animals and an increased weight loss will occur (digestibility of 40–50%).

The digestibility of cereal straws is likely to be in the range of 35–40%. Dry crop finishes or frosting can result in stubbles of up to 50% digestibility. Rain on dead standing feed will cause a drop in digestibility, and consequently the feed value of the dead pasture.

To optimise livestock production, grazing management should aim to keep pastures in the growth phase for as long as possible, delaying the onset of flowering and an associated decrease in digestibility. This will be discussed further in a later section.

Proportion of legume

Proportion of legume in the pasture is the second quality issue mentioned earlier. Legumes are critical components of pastures, being the major source of nitrogen for pasture grasses. Legumes are also important to livestock production.

Legumes at the same stage of growth will often be of higher digestibility than grasses. So, on this count alone, intakes can be expected to be higher on pastures containing greater proportions of legume. In addition, research has demonstrated that, in general, intake of legume will be greater than grasses even when their digestibilities are the same.

Protein levels of legumes are usually superior to grasses especially as they approach maturity.

INTERACTION OF HERBAGE MASS AND DIGESTIBLITY

It is important at this stage to realise that herbage mass and digestibility are not stand-alone issues in grazing management. They in fact interact.

At a low herbage mass but where digestibility is high, intake is limited because of small bite size. While stock will extend grazing time in these situations, they are limited to about a total of 13 hours per day.

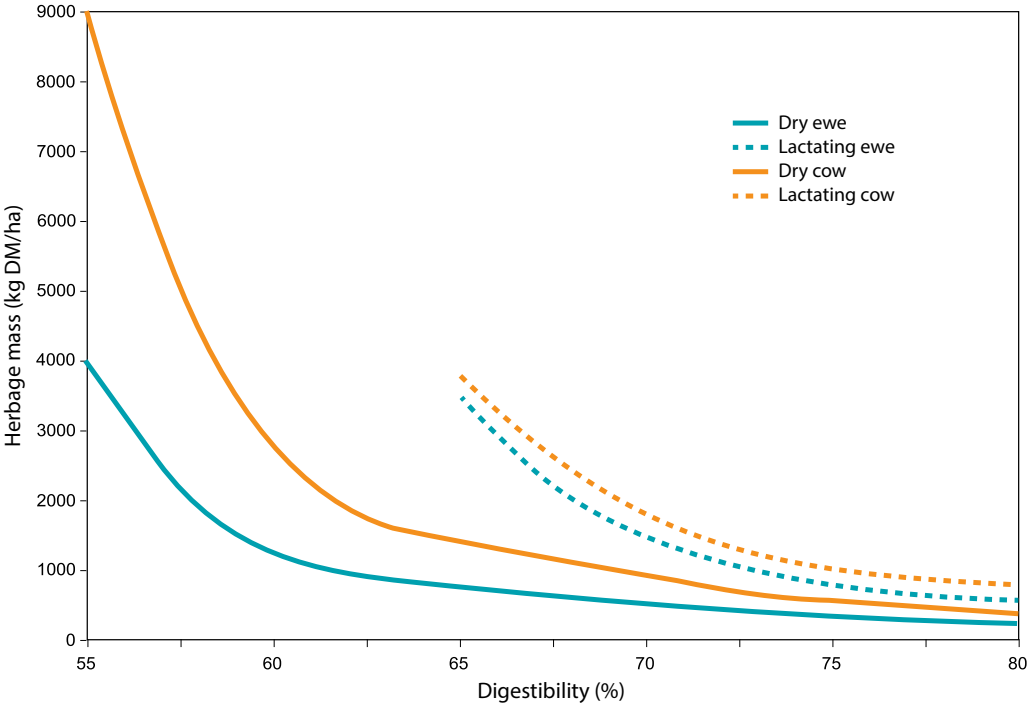
Livestock production, in the situation of low herbage mass and high digestibility is not necessarily improved by reducing the stock numbers in a paddock; that is, lowering stocking density, or providing a larger paddock with a similar quality and quantity of pasture.

The only way a reduction in stocking density may improve livestock production is that the availability of pasture, i.e. herbage mass, may increase but this is dependent on pasture growth rates being greater than intake of livestock.

At a high herbage mass but where digestibility is low, intake is limited by the slow movement of feed through the animal as described earlier in this section.

Due to the interaction between herbage mass and digestibility there can be trade-offs between the two to achieve the same production outcome in livestock.

Figure 2.7. The trade-off between digestibility and herbage mass.



Note. Once digestibility declines below 65% for lactating stock and 55% for dry stock, it does not matter how much pasture is available, these stock are likely to experience unsatisfactory performance levels i.e. increasing weight loss.

The potential for trade-offs is greatest in animals with low nutritional requirements, i.e. maintaining dry stock, but there are less opportunities in high demand animals as indicated in Figure 2.7.

The four classes of livestock shown in Figure 2.7, each achieve the same production level along their line; that is, the dry sheep requires a herbage mass of 2200 kg DM/ha at 57% digestibility to maintain weight. When at 70% digestibility, only 500 kg DM/ha is required.

Note that much below 55% digestibility it does not matter how much herbage mass is available – dry stock are likely to lose weight.

In the case of lactating cows, 3800 kg DM/ha at 65% digestibility achieves the same production level in those particular cows as what 1050 kg DM/ha does at 75% digestibility.

Where high production levels are required there is less opportunity for trade-offs between availability and digestibility. Digestibility of the green component needs to be above 70% and the amount of green for sheep around 1500 kg green DM/ha; for cattle around 2500 kg green DM/ha.

SELECTIVE GRAZING

Sheep, goats and cattle are described as selective grazers; that is, they show a preference for particular plant species within a pasture and for particular parts of the plant. This preference is reflected in what they consume. Sheep are more selective than cattle due to the size of the mouth.

Due to selectivity the digestibility of the intake will be greater than the average digestibility of the pasture.

Such grazing behavior can be used to manage pastures but, left unchecked under continuous grazing, can lead to a decline in particular pasture species especially where a pasture is under stress due to drought, or low fertility.

Selective grazing will also occur due to variation in the attractiveness or palatability of pasture to the animal. As the botanical composition changes and species, such as vulpia, barley grass or phalaris become more dominant at maturity, a greater grazing pressure will be placed on the remaining or more preferred species. The result is that the species such as vulpia, barley grass or phalaris will become more dominant and the over grazed (preferred) species will be removed.

As stated above, a changing composition can be a response to grazing management. Grazing management must be modified so that desirable species are not threatened.

The influence of grazing on pasture production will be discussed in Segment 6 of the manual.

PASTURE BENCHMARKS

The pasture benchmarks in Table 2.1 and 2.2 for temperate pasture and Table 2.3 for tropical pastures indicate how much green herbage mass is required to satisfy the nutritional requirements of stock at various stages of their reproductive cycle, and for growth. Research has determined the association between pasture intake of sheep and cattle and pasture characteristics such as herbage mass, digestibility and legume content.

Benchmarks provide 'ball park' estimates for the minimum green herbage mass to which stock can graze and still maintain satisfactory levels of production. Primary factors determining herbage mass are pasture height, its density and dry matter. The 'sample pasture' on which the benchmarks are based is one which is green, reasonably dense; the first 3 cm of height is equivalent to about 1000 kg DM/ha, with each centimeter after that equivalent to about 200 kg DM/ha.

The pasture benchmarks are a guide. Apart from the descriptions within the tables, other features of the pastures on which the predictions have been made are that they contain 500 kg DM/ha of dead pasture which has a digestibility of 47% and there is a legume content of 15%.

Table 2.1 Minimum herbage mass (kg green DM/ha) to maintain satisfactory production levels in sheep.

	Pasture digestibility (green)		
Sheep Class	75%	68%	60%
Dry sheep	400	600	1200
Pregnant ewes			
mid	500	700	1700
last month	700	1200	ns
Lactating ewes			
single	1000	1700	ns
twins	1500	ns	ns
Growing stock, % of potential growth			
30 [116 g/d]*	400	700	1700
50 [194 g/d]	600	1000	ns
70 [270 g/d]	800	1700	ns
90 [348 g/d]	1600	ns	ns

*Predicted growth rates in brackets are based on a weaned 4-month old crossbred lamb of approximately 32 kg from a ewe with a standard reference weight of 80 kg.

Table 2.2. Minimum herbage mass (kg green DM/ha) to maintain satisfactory production levels in cattle.

	Pasture digestibility (green)		
Cattle Class	75%	68%	60%
Dry cow	700	1100	2600
Pregnant cow (7–8 months/ not lactating)	900	1700	ns
Lactating cow + 2 mth old calf	1100	2200	ns
Growing stock, % of potential growth			
30 [0.45 kg/d]*	600	1100	2900
50 [0.76 kg/d]	800	1600	ns
70 [1.07 kg/d]	1200	2600	ns
90 [1.37 kg/d]	2200	ns	ns

*Predicted growth rates in brackets are based on a weaned 13-month old steer of approximately 320 kg from a cow with a standard reference weight of 550 kg.

ns = not suitable, that is, at these digestibilities no matter how much pasture is available dry or pregnant stock are unlikely to maintain weight, lactating stock are likely to experience an unacceptable level of weight loss and growing stock will not achieve the targeted weight gain.

Note: The benchmarks relate specifically to the nutritional requirements of livestock. At lower herbage masses, particularly those indicated for sheep, there is a risk of excessive run-off and soil erosion through lack of ground cover.

Note: The predictions in Tables 2.1 and 2.2 are based on a pasture which also includes 500 kg DM/ha of dead pasture with a digestibility of 47% and a legume content of 15%.

Table 2.3. Minimum green herbage mass (kg DM/ha) to maintain satisfactory production levels in cattle and sheep on tropical grass pastures with digestibility of 65% (9.2 MJ ME/ kg DM), 60% (8.4 MJ ME/kg DM) and 55% (7.5 MJ ME/kg DM)). Note these predictions are based on a pasture which includes 400 kg DM/ha dead pasture with a digestibility of 45%. The value 'ns' indicates that the feed quality is not suitable for this livestock class.

	Pasture digestibility		
Livestock class	65%	60%	55%
Dry cows	870	1250	2400
Pregnant cows (7–8 months)	1650	2700	7500
Lactating cows + 2 mth old calf	2500	4000	ns
Growing cattle, % of potential growth			
30	770	1150	2400
50	1050	1700	4500
70	1600	2700	ns
90	2200	ns	ns
Dry sheep	560	800	1300
Pregnant ewes (100 days)	800	1700	2300
Lactating ewes + single lamb	1200	ns	ns
Growing lambs, % of potential growth			
30	500	600	1100
50	600	750	1900
70	800	1250	ns
90	1300	ns	ns

Managing stock based on the benchmarks should ensure their nutritional requirements are being met. However, there will be occasions where this is not possible or even desirable. Under these circumstances supplementary feeding, selling, agisting or just finding a different paddock become options. Controlled weight loss can be a sound management option in some circumstances.

For example, when ewes are fat at the end of joining, it is desirable that they lose weight slowly during early pregnancy. A managed weight loss can be achieved by grazing pasture below the maintenance (dry sheep) benchmark, or by providing a higher herbage mass that has a lower digestibility. The same principle applies to over fat heifers in late pregnancy.

When pasture is limiting and benchmarks are not able to maintain production levels, supplementary feeding may be required. GrazFeed® (to be introduced and used during later segments of the course) becomes extremely useful in assisting decisions on the most appropriate supplement to feed and how much should be fed.

Plant height

Herbage mass **should not** be used alone as the only quantitative indicator of pasture intake by grazing livestock.

Due to variation in pasture density the average height of plants in different pastures can vary, in some cases substantially, even though their herbage mass measurements may be similar or even the same. Examples where such variation might occur is between a productive phalaris and clover pasture compared to many native pastures particularly on the Slopes, lucerne pastures or fodder crops.

Despite having the same herbage mass, a taller pasture is more 'available' to grazing livestock and this could mean they consume more from this pasture each day. If this happens it will lead to increases in production. This situation is described diagrammatically in Figure 2.8.

Figure 2.8. Relationship between pasture height, feeding behaviour and pasture intake.

Pastures each having 500 kg DM per hectare but of different height and densities	Hours grazing	Amount per bite	Pasture intake (kg/day)
	8		1.4
	9.5		1.1
	11		0.7

However, once the average height of plants in a pasture reach about 6 cm in the case of sheep and 14 cm for cattle any additional height is likely to have only minor impacts on their daily intake of pasture.

The Pasture Benchmarks are based on a specific pasture which was described earlier (see Note under Table 2.2). To make the Benchmarks relevant to a broader range of pasture types, consideration of the average plant height of pasture is required. To do this use Table 2.4

To use Table 2.4, predict the average height of green plants within the pasture. Apply this prediction to the table and select the relevant 'indicative' herbage mass from the table. This 'indicative' herbage mass figure is then used within the Pasture Benchmarks (Tables 2.1 and 2.2) for assessing the pasture's ability to support livestock production.

The 'indicative' herbage mass is always used in preference to the actual herbage mass although in many instances they will be the same or similar.

Table 2.4. Relationship between green pasture height and the 'indicative' herbage mass (temperate pastures).

Average plant height (cm)	'Indicative' herbage mass (kg green DM/ha)
2	700
4	1200
6	1600
8	2000
10	2400
12	2800
14	3200

SUMMARY

- Herbage mass = total of green and dead pasture.
- Herbage mass is primarily a function of a pasture's height, density and dry matter.
- Pasture quality is influenced by digestibility and the proportion of legume.
- Animal production will be determined by pasture intake.
- Intake is determined by the interaction between herbage mass (the amount of pasture) and the digestibility of the pasture (the amount of feed actually used by the animal).
- Digestibility decreases with plant maturity.
- Digestibility is positively related to the energy and protein content of pasture.
- Digestibility of a pasture will be influenced by pasture species, stage of growth and percent legume.
- Pasture benchmarks are a prediction of the minimum herbage mass of green pasture that a particular livestock class (dry, pregnant, lactating, growing) can graze to and still meet their production requirements.
- Average plant height of a pasture must be considered when using the benchmarks to predict a pasture's suitability to support a specific level of livestock production.

Further reading and information

- *Tropical Perennial Grasses for Northern Inland NSW.* NSW DPI
- *Livestock feeding on pasture*. New Zealand Society of Animal Production. Occasional Publication No. 10. Hamilton, New Zealand.
- www.dpi.nsw.gov.au