NSW GOVERNMENT
Department of Primary Industries

Ninth edition

PROGRAZE™

Profitable, sustainable grazing

mla
MEAT & LIVESTOCK AUSTRALIA

dpi.nsw.gov.au

ISBN print: 978-1-76058-004-9
web: 978-1-76058-005-6

First edition, April 1994

Second edition, March 1995

Third edition, April 1996

Fourth edition, June 1998

Fifth edition, April 2000

Sixth edition, February 2003

Seventh edition, March 2006

Eighth edition, June 2011

Ninth edition, March 2017

Department of Primary Industries

PROGRAZE™

profitable, sustainable grazing

Phillip Graham
Technical Specialist Livestock Management
Primary Industries
NSW Department of Primary industries

dpi.nsw.gov.au

FOREWORD

PROGRAZE was initiated by the former NSW Agriculture and was a collaborative project between NSW Agriculture and Meat and Livestock Australia Limited as part of the Sustainable Grazing Systems Key Program.

PROGRAZE is based on a model for working with producer groups developed by Bob Marchant and Michael Duncan, former departmental officers at Armidale, NSW.

PROGRAZE aims to develop beef cattle and sheep producers', and those who service these industries, skills in pasture and animal assessment and assist them identify ways to use these skills to improve their grazing management decisions.

PROGRAZE deals specifically with the interaction of pasture and livestock and the impact each can have on the other. It deals with the management issues associated with this interaction. Due to the importance of environmental sustainability PROGRAZE also emphasises the role pastures and pasture management have in addressing these problems.

PROGRAZE does not formally address issues such as pasture establishment, pasture nutrition, livestock genetics, marketing, or drought feeding. Although topics such as these are discussed through PROGRAZE, it is up to the group to raise issues relevant to them.

It is often asked why economics do not receive greater prominence in PROGRAZE. It is mainly because the course aims to increase participant's skills and knowledge of pasture and grazing management to place them in a position to make better decisions. That is not to say we do not believe an economic evaluation, particularly for the more important decisions, should not occur and maybe some training is required to undertake this process effectively.

Also, PROGRAZE does not recommend a recipe for grazing management; in fact it encourages participants to be flexible in their management based on prevailing circumstances. The course covers a broad range of skills and technology which individual participants will implement in widely varying ways depending on their priorities, farm and prevailing conditions.

In these circumstances, it is difficult to undertake economic assessments that are going to be meaningful for the group. However, those who have completed PROGRAZE do recognise its importance in a financial sense to their farms, with about 90% indicating the course had resulted in increased profits.

Alan Bell, former Technical Specialist (Grazing Systems) was responsible for compiling the first six editions of this manual, as well as managing the project across NSW from 1993 to 2005. His work is acknowledged by all staff.

Phil Graham, Technical Specialist (Grazing Systems), Yass compiled the 7, 8th and 9th editions with support from staff in NSW DPI, especially:

Suzanne Boschma, Research Scientist

Todd Andrews, Development Officer (Beef)

Neil Griffths, Technical Specialist (Pastures)

Stephen Love, Veterinarian/State Worm Control Co-ordinator

Technical assistance is acknowledged for this and previous editions from:

Cameron Allan, Meat & Livestock Australia

John Ayres, former Senior Research Scientist

David Buckley, former District Veterinary Officer

G Donald, CSIRO

Bill Fulkerson, former Principal Research Scientist

Bob Gaden, former Technical Specialist (Beef Cattle)

Mike Hill, CSIRO

Marcus Holdsworth, former Veterinary Officer

Warren McDonald, former Technical Specialist (Pastures)

David Jordan, Senior Research Scientist

Colin Langford, former District Livestock Officer

Harry Rose, former Technical Officer

Peter Simpson, former District Agronomist

Chris Shands, former District Livestock Officer

Doug Alcock, former District Livestock Officer

Bruce Clements, former District Agronomist

Arnold Turner, Technical Manager

Lester McCormick, former Technical Specialist (Pastures)

Greg Meaker, former District Livestock Officer (Beef)

Fiona Leech, former District Agronomist

CONTENTS

GLOSSARY

Botanical composition	Mixture of plant species in a pasture.
Carrying capacity	A measure of a paddock or farm's capacity to carry livestock. Usually measured in DSE's/hectare.
Deferred grazing	Delay grazing a paddock for a strategic purpose such as after germination.
Digestibility	A measure of the proportion of pasture or feed which, once consumed, can be utilised by the animal. Higher digestibility usually means higher livestock production.
Dry matter	Plant material without water (i.e. dried).
DSE	Dry sheep equivalents (see Segment 8).
Fat score	A measure of fat cover on livestock.
Herbage mass	Amount of pasture/fodder crop available to grazing livestock. Measured in kg DM/ha.
Intake	Amount of feed eaten by an animal, measured in kg DM/head/day.
kg DM/ha	Kilograms of dry matter per hectare (includes green and dead pasture or fodder crop).
kg green DM/ha	Kilograms of green dry matter per hectare (includes only the green component of pasture or fodder crop).
Livestock class	Animals of the same type e.g. aged, dry, pregnant, lactating.
Nutritive value	A measure of the nutrient status (energy, protein, minerals and vitamins) of a feed.
Over stocked	Indicates when the stocking rate exceeds carrying capacity.
Pasture density	The concentration of plants in a pasture, usually measured as plants per square metre.
Pasture utilisation	The amount of pasture consumed by livestock compared with that produced usually on a 12-month basis.
Rotational grazing	Stock are rotated across several paddocks with timeliness of moves based on a fixed time period or regrowth of the pasture.
Rotation length	Period since animals finished grazing a paddock before they re-enter that paddock.
Selective grazing	Preference of grazing stock for particular pasture species and parts of a plant in a pasture mix.
Set stocking	Fixed number of animals graze a paddock for an extended period.
Spray-grazing	Weed control using a low level of herbicide followed by grazing at a high paddock density to eat out the growing point.
Stage of pasture growth	An indication of pasture maturity, e.g. early vegetative, late vegetative, flowering, in head or setting seed.
Stocking density	Number of stock on a paddock or part paddock (strip grazing). Usually described as head/hectare.
Stocking rate	Number of stock on a paddock or farm. Usually described in DSE's/hectare; but also head/hectare particularly when describing stocking rate at the paddock level.
Strip grazing	When parts of paddocks are subdivided (usually with electric fencing) to increase stocking density for reasons which can relate to pasture and/or livestock management.
Time controlled grazing	A modified form of rotational grazing (also called cell grazing).
Under stocked	Indicates when stocking rate is below carrying capacity.

INTRODUCTION

All sectors of Australian agriculture are under increasing pressure to lift efficiency while at the same time maintain or, in many cases, improve the environment and resources employed for production.

The pressure to lift farm efficiency comes from what economists might term the cost/price squeeze or the decreasing terms of trade (a trend faced by primary producers for as long as most can remember). Those directly involved recognise the trend through their farming business not generating the financial returns it once did.

To offset this decline primary producers have improved production efficiency. Unfortunately, this has often been coupled with a rundown in farm resources such as soils, pastures, improvements to fencing, machinery and yards. As cost/price pressures are not going to disappear, there is a continuing need to improve production methods for increasingly competitive markets while maintaining or improving the resource base.

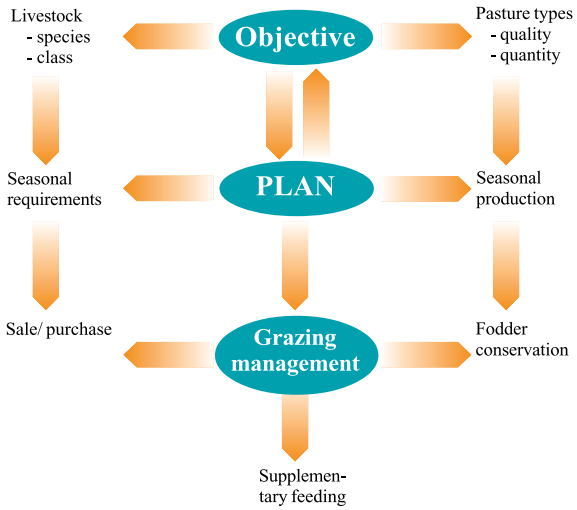
For the livestock producer, the key issues are the efficient conversion of pasture to animal products, which are capable of competing effectively on domestic and international markets. This conversion must originate in a production system capable of maintaining pasture stability and productivity.

To achieve this many variables must be considered in grazing management, with each pathway interlinked (see Figure 1).

The interaction that occurs when livestock graze pasture is complex. Technology exists to help managers more effectively achieve production objectives from livestock on pasture. This technology will allow livestock managers to better control production systems through more effective and sustainable use of pasture. In addition, production and marketing targets for livestock would be more consistently met.

The economic impact of improving grazing management decisions is difficult to assess because the nature of such decisions can vary greatly. From say, more effective decisions relating to paddock selection for sheep or cattle and timing their moves from paddocks to more effectively achieve production or market outcomes; to quite complex control grazing systems which take into account the grazing management requirements of both livestock and pasture, involving feed profiling and fodder budgeting and due to the complexity of the system will probably require a formal planning process. It is not difficult, even at what might be considered the lower levels of more effective decision making, to envisage such decisions will result in improved financial returns. This is particularly so when many of these decisions have no, or little, cost.

Figure 1. Pathways of grazing management decision making.



PROGRAZE participants were surveyed 10–12 months after completing the course. Eighty nine percent of those replying to the survey indicated their participation led to increased returns from their farms and 91% believed their participation had led or would lead to more stable pastures.

PROGRAZE addresses the issue of pasture and livestock interaction to provide a basis for more efficient and effective grazing systems. It will involve the development of skills namely in pasture assessment, livestock assessment and plant species recognition, and will explore how these skills can be used in daily decision making.

PROGRAZE™

Profitable, sustainable grazing

SEGMENT 1

PRODUCTION, PROFIT AND SUSTAINABILITY PASTURE ASSESSMENT

In this segment you will learn:

- How productive perennial base pastures address problems of land degradation.
- How to assess pasture quantity and quality.
- Of those pasture characteristics that impact on livestock production.

PRODUCTION, PROFIT AND SUSTAINABILITY

The efficiency with which the farm's rainfall is managed significantly influences its viability, both financially and environmentally.

This efficiency influences the level of pasture production and therefore potential stocking rate and so farm profitability. Inefficient use of rainfall contributes to sustainability or land management problems which impact on the individual grazing enterprise and its water catchment. Such problems include:

- Salinity
- Soil acidity
- Soil erosion
- Poor quality water entering dams, streams and rivers.

A strategy to achieve profitable grazing enterprises while, at the same time, addressing these sustainability issues, is to utilise as much of the rainfall as possible for pasture growth (maximising kilograms of pasture dry matter per millimetre of rainfall) and to minimise the loss of water from run-off and deep drainage. This can be achieved by growing and maintaining vigorous, well managed, productive pastures, particularly those dominated by adapted perennial species. These pastures use rainfall efficiently to generate feed for livestock while protecting the soil surface and minimising deep drainage below the plant roots which is the cause of much environmental decline – a potential win/win situation for land managers.

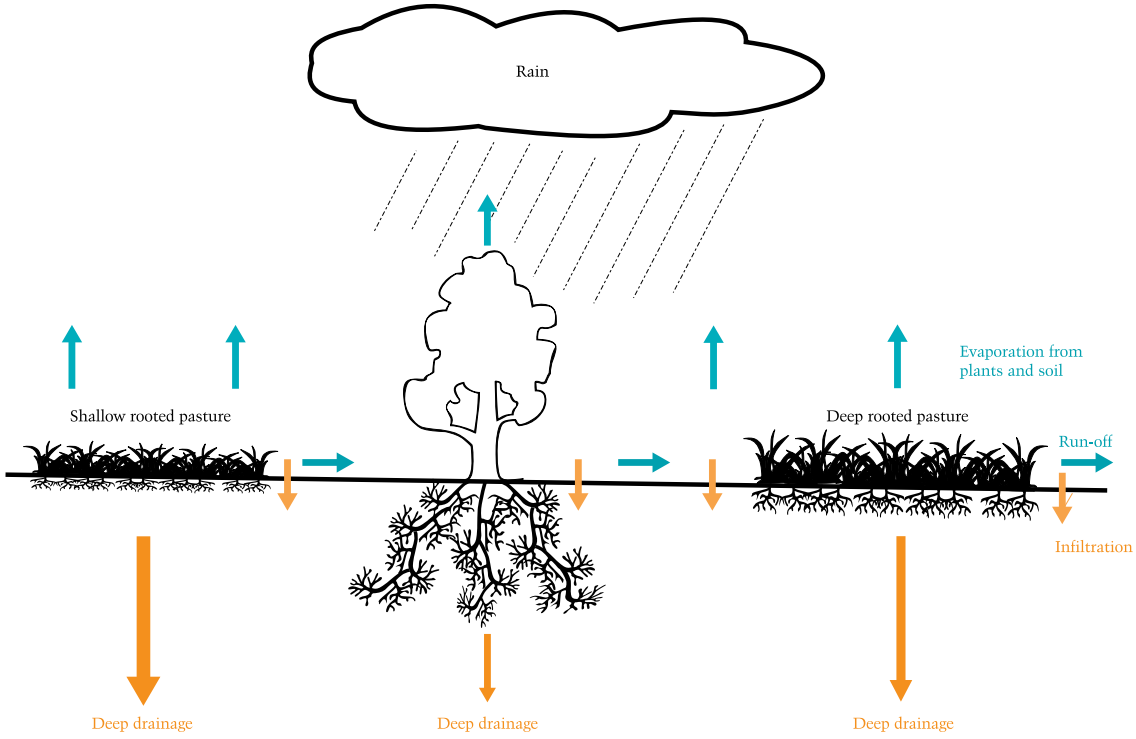
As we progress through PROGRAZE the link between productive pastures and sustainability issues will be expanded, as will your knowledge and skills to manage these pastures. However, as a basis for understanding how rainfall may eventually impact on both production and sustainability, some knowledge of the water cycle is required.

THE WATER CYCLE

When rain falls, besides evaporation from the soil surface, water moves via three pathways in a pasture based system (Figure 1.1):

- Across the soil surface (run-off).
- Infiltrates the soil and is used by plants (transpiration), the main reason soil dry out.
- Infiltrates the soil and drains past the root zone of plants to the water table (deep drainage).

Figure 1.1 The water cycle on a pasture system.



Run-off

Water moves across the soil surface when soils are saturated, during periods of high intensity rainfall or when the soil surface limits infiltration. Effective ground cover slows the rate of run-off, promoting infiltration.

Run-off is required to fill dams and maintain water flows in our streams and rivers however.

Run-off is a natural process if it is clean water leaving our farms. Ground cover is the key to limiting the movement of our soil.

Water used by plants

Water that infiltrates the soil surface and enters the root zone of plants has the potential to contribute to their growth. It is this water that underpins the potential productivity, and so profitability, of the grazing system. A grazing system can only survive in the long-term if managed to ensure the efficient use of rainfall by pasture plants.

Deep drainage

Deep drainage is water which drains past the root zone of plants and into the water table. This water is not only lost to pasture production, it is the major cause of salinity, contributes significantly to soil acidity and removes nutrients from the root zone of plants through leaching. Deep drainage will always occur in very wet periods and is needed to recharge the water table. Our aim is to restrict deep drainage to wet period only.

SUSTAINABILITY IMPACT OF POOR WATER USE

Soil erosion/nutrient loss

Run-off from unprotected soil carries soil and nutrients leading to erosion and a lowering of water quality entering dams, streams and rivers. The impact is well recognised and includes the silting of dams, the presence of algal blooms in dams and rivers and water being unfit for use by humans or livestock. In addition, there are costs associated with replacing lost nutrients and repairing areas impacted by erosion.

Soil Acidity

When water drains through the soil, it carries with it nitrate nitrogen, causing soil acidification (lower pH). Pastures dominated by nitrogen fixing legumes accentuate the problem. Soil acidity may restricts plant growth, resulting in a decline in pasture productivity. Optimising soil water usage, with productive deep rooted perennial pastures can reduce deep drainage, encourage the uptake of nitrogen and so reduce the likelihood of acidification. The use of lime, acid tolerant species and sound pasture management all play an important role in addressing acidification.

Salinity

Salinity results from the deep drainage of water through the soil profile and into the water table. This causes the water table to rise, bringing with it naturally occurring salt. As water tables rise, the result is saline soils and waterways – environments unsuitable for plants, livestock and people. The loss of these environments is a substantial cost to the community. Pasture species selection and their management can minimise deep drainage through increased water use. Dryland salinity is associated with the reduction of trees in our landscape and cycles across years lagged to extend wet periods. The big increase in salinity seen in the 80s was influenced by the wet 70s.

MANAGING FOR PRODUCTIVITY AND SUSTAINABILITY

Pasture and grazing management influences the way water moves across the soil surface and through its profile. Productive pastures, profitable grazing systems and improved sustainability are all about efficient water (rainfall) usage.

Efficient water use in the grazing situation requires decisions about:

- *Pasture species*: greater use of deep rooted perennial species that stay green longer – using more water and producing more feed over extended periods for livestock.
- *Pasture management*: optimising pasture growth, persistence,

- *Ground cover preservation*: encouraging rainfall to enter the soil for use by pasture, protecting the soil surface from run-off and ensuring the quality of run-off water.

In some landscapes productive pastures alone will not be sufficient to reduce deep drainage to sustainable levels. In rainfall areas of less than 600 mm, or 750 mm in the northern summer rainfall zone, good pasture and grazing management are likely to be sufficient.

However, in the southern winter rainfall zones receiving 600 mm/year or more, and summer rainfall zones receiving 750 mm or more, pastures alone are unlikely to be sufficient to reduce deep drainage to satisfactory levels in some parts of the landscape. In these areas, trees need to be integrated into the grazing system to prevent excessive amounts of deep drainage.

To indicate how effective trees are in reducing deep drainage, studies in a winter rainfall area showed annual crops and pasture allowed about 100 mm per year of deep drainage, perennial pastures about 50 mm and trees about 5 mm.

Apart from the nature of the vegetation and the amount and distribution of rainfall, soil type has a significant impact on the level of deep drainage.

OTHER SUSTAINABILITY ISSUES

While management of the water cycle is critical to achieving profitable and sustainable grazing systems, there are other issues we need to be aware of – some of these are mentioned below.

Weeds

Weed invasion indicates a grazing system out of balance and represents a significant cost to livestock production. Well managed productive pastures compete strongly with weeds and are a low cost way of controlling them. It is also the most efficient way to prevent weeds colonising in pastures. The loss of productive pasture to weed monocultures is becoming an increasing problem across the state.

Sodicity

Sodicity is a naturally occurring common problem with many soils and especially sub soils. An excessive quantity of exchangeable sodium in the soil causes clay dispersion, which in turn predisposes soils to sealing, erosion and water run-off. Pasture and livestock production can be adversely effected.

Good ground cover reduces run-off and the risk of erosion. A dense well managed pasture increases soil organic matter, which may reduce the adverse effects of sodicity.

Other Issues

There are other factors important to the sustainability of the grazing business which are not dealt with in PROGRAZE, these include:

- Soil structural decline
- Preservation of native flora and fauna (including biodiversity)
- Tree decline
- Feral animals
- Social and rural community issues
- Competition from other rural industries.

SUMMARY

The PROGRAZE approach to improving the link between profitability and sustainability:

- Understand the water cycle and how it drives both productivity and sustainability, and the way it should be managed to achieve both outcomes. Recognise the role of trees in controlling deep drainage.
- Use well adapted perennial pasture species that suit the environment and enterprise. Using effective management and robust production systems capable of using water efficiently will reduce the rate of acidification, potential salinity and weed invasions.
- Manage pasture species to enhance their persistence and stability to achieve more reliable ground cover, efficient rainfall use, reduced water and nutrient run-off, erosion, deep drainage and weeds.
- Use inputs such as herbicides and fertilisers strategically to achieve dense healthy productive pastures, the basis for a profitable and sustainable grazing system.
- Closely matching feed supply to livestock requirements results in the more efficient use of resources, leading to better use of water and generally higher production per mm of rainfall. Be prepared to de-stock pastures in drought to minimise the devastating effects on pastures.

Further reading and information

More specific information on the sustainability issues can be obtained from NSW Department of Primary Industries and your Local Land Services office.

Other sources of information include:

- CSIRO Land and Water, GPO Box 1666, Canberra, ACT 2601 (www.clw.csiro.au)
- Murray-Darling Basin Commission, GPO Box 409, Canberra, ACT 2601 (www.mdbc.gov.au)
- Land and Water Resources Research & Development Corporation, GPO Box 2182, Canberra, ACT 2601 (www.lwrrdc.gov.au)

PASTURE ASSESSMENT

During this course major emphasis will be placed on developing pasture assessment skills. Such skills provide the basis on which to build sound pasture and grazing management. Pasture assessment will be a component of each segment of PROGRAZE and Pasture Recording Sheets are included at the end of this segment which allows you to retain a record of each assessment undertaken during the course.

By the time most people complete the course they will, through 'eye balling' (visual assessment) a paddock, be accurate in estimating the amount of pasture present and its quality. However, after completing the course you should occasionally consider 'recalibrating' your eye by following one of the procedures described later in this segment.

WHY ASSESS PASTURE?

- To match animal requirements and pasture production.
- To achieve more precise supplementary feeding.
- To enable accurate feed planning.
- To more effectively manipulate pasture production and composition.
- To ensure ground cover is sufficient to protect soil from rain and run-off, and to encourage infiltration.

Visual assessment of pasture involves being able to:

- Estimate the quantity of pasture available. This is referred to as herbage mass and is measured in kilograms of dry matter per hectare (kg DM/ha). Herbage mass, as well as fodders in general, are usually described in terms of their dry matter. This is due to the considerable variation in water content of pastures and conserved fodders and that water has no nutritional value to livestock. So to be able to assess and make valid comparisions between feeds, in respect to their livestock production potential, it needs to occur on a dry matter basis.

  Primary factors in determining herbage mass is pasture height, its density and dry matter.

  Sometimes the term herbage mass is used to describe the total pasture available. Alternatively, it might be used to describe a component of the pasture, for example, the green portion only. With pasture assessment it is important to recognise the proportion of green and dead material in the pasture mix. Be sure you know which element is being discussed. The influence of herbage mass on animal production is dealt with in Segment 2.
- Predict the quality of pasture available. The most useful measure of pasture quality is digestibility. Digestibility is the proportion of pasture or feed which once consumed can be utilised by the animal. It is expressed as a percentage. Digestibility may refer to the total pasture but often a more useful measure is the digestibility of pasture components, for instance, the green or dead component. Another useful measure of pasture quality is its legume content.
- Estimate ground cover. Ground cover reduces or even eliminates the adverse impacts of rain and run-off, providing protection against soil erosion. Ground cover encourages the infiltration of water into soil for use by pastures.

  There will be an appropriate ground cover which should be a minimum target for your situation. This figure will vary with slope, soil type and the amount and intensity of rainfall. For example, from research undertaken on the North Western Slopes of NSW a 70% minimum has been established for many situations. The Department of Land and Water's SOILOSS program can be used to establish these minimum targets.

  Groundcover includes existing pasture, weeds and other herbage, as well as litter. To estimate ground cover simply stand in a representative part of the pasture with your feet half a metre apart. Visualise a square 0.5×0.5 m in front of your toes. Looking vertically into the pasture, estimate the percent area covered by plant material and litter. By doing this a number of times across the paddock and averaging the results this method should give a good indication of paddock groundcover.

The influence of digestibility and legume content of pasture on livestock production are also discussed in Segment 2.

During the course, emphasis will also be placed on developing skills in recognising pasture species that are of significance to pasture and animal production.

MEASURING HERBAGE MASS

The method we will use to measure herbage mass is what is known as the median quadrat technique. This technique will be demonstrated to you during the first segment of the course, but after that it is likely your course coordinator will have used the technique prior to your arrival to obtain pasture estimates on a number of plots. The technique is described in Appendix 1 of this manual.

As indicated earlier, following the course it is likely you will need to 'recalibrate your eye' two or three times a year. This can be done by following the median quadrat technique or by taking pasture cuts with a single quadrat. While the median quadrat technique is preferred, the single quadrat technique has the advantage of being a simple technique.

If the single quadrat method is used it involves firstly making a square quadrat with an internal measurement of 500 mm × 500 mm (0.25 sq m).

The technique then requires selection of a small relatively even area of pasture, say 2 m × 2 m, and peg the four corners. Then, within this area, select an area the size of the quadrat that is representative of the whole.

Place the quadrat over this area and cut the pasture to ground level. Dry this sample via methods described within the median quadrat technique (see Appendix 1) and weigh the dry sample to the nearest gram. Multiplying the weight in grams by 40 results in an estimate of kg DM/ha (a quadrat of the size described above is 1/40,000 of a hectare). It is then a matter of going back to the pegged area, relating the estimate to the pasture present and so 'recalibrating your eye'.

The emphasis during both the course and through the suggested post-course recalibration, is the development of participant's visual assessment skills by measuring relatively small pasture areas.

These skills are used to assess paddocks, the assessments of which form the basis of grazing management decisions.

As these skills are being developed, common circumstances where errors occur are:

- Where clover makes up a significant proportion of the pasture there is a tendency, as pasture height increases, to over estimate herbage mass. This is due to clover being very 'showy' and lacking density beneath the leaf canopy.
- Pasture density needs to receive the same emphasis as height when making assessments.
- There is also a tendency to over estimate herbage mass when pasture is in the early vegetative stage, leafy and actively growing. Remember, herbage mass is based on the amount of dry matter available and pastures in this condition can be in the range of 10–20% dry matter. That is, 80–90% water.
- Conversely, where a pasture contains mainly mature dead material there is a tendency to underestimate herbage mass. You might say: 'Well what the heck, this is poor quality pasture anyway'. Such pastures, when little or no green feed is available (often the case in the southern parts of New South Wales during summer), makes an important contribution to livestock production even if they require some supplementation. These pastures may be 80–90% dry matter.
- Plant species such as thistles or tussock etc, that you know will not be consumed by livestock during the period relevant to the assessment should be ignored when assessing The following is a guide you may find useful for visually predicting the approximate green herbage mass of a dense pasture. Firstly, estimate the height of the green component. Then calculate its herbage mass by allowing 1000 kg DM/ha for the first 3cm of height, plus 200 kg DM/ha for each additional centimetre. For less dense pastures, such as lucerne and fodder crops, it will be necessary to multiply this calculation by a figure that is less than 1. For example, for a good dense stand of lucerne this figure is likely to be about 0.4 while for a sparse native pasture with a lot of bare area or standing dead pasture the figure may be as low as 0.1. herbage mass.

The following is a guide you may find useful for visually predicting the approximate green herbage mass of a dense pasture. Firstly, estimate the height of the green component. Then calculate its herbage mass by allowing 1000 kg DM/ha for the first 3cm of height, plus 200 kg DM/ha for each additional centimetre. For less dense pastures, such as lucerne and fodder crops, it will be necessary to multiply this calculation by a figure that is less than 1. For example, for a good dense stand of lucerne this figure is likely to be about 0.4 while for a sparse native pasture with a lot of bare area or standing dead pasture the figure may be as low as 0.1.

MEASURING PLANT HEIGHT

The average plant height of a pasture, along with pasture density and dry matter, are the factors that determine herbage mass. You will learn in the next segment how herbage mass impacts on cattle and sheep production but you will also learn that plant height can independently impact on production as well.

Plant height becomes increasingly important as the indicator of livestock production as plant density of the pasture declines. Average plant height is obtained by simply measuring, at random, the height of individual plants and averaging these measurements.

MEASURING DIGESTIBILITY

Digestibility is mainly influenced by the pasture's stage of maturity. Information in Segment 2 of the manual will assist you in getting into the 'ball park' on digestibility. In addition, in some locations, previous pasture research and pasture monitoring projects are other sources of digestibility information.

During the course, pasture samples will be collected to obtain digestibility estimates via laboratory analysis. It may be that you would find it useful to have a digestibility profile on your pastures. The collection technique is important. Samples which arrive for testing in an unfit state will result in a meaningless analysis.

The collection technique is described in Appendix 2. Samples must be placed in an esky with ice immediately after collection, or oven dried.

Also nutritive value analysis, which includes a prediction of digestibility, energy and protein content, on fodders is useful for determining feeding levels when supplementing or drought feeding livestock. Appendix 5 provides average values for commonly used feeds. More information on feeds can be found on the NSW DPI'S web site www.dpi.nsw.gov.au.

MEASURING BOTANICAL COMPOSITION

The proportion of species in a pasture can give a quick estimate of pasture quality. As the proportion of less desirable species increases, so pasture quality declines. By monitoring you keep track of changes in composition and so corrective measures can be applied before the decline is too great, and costly resowing is required.

The simple 'pointed stick' technique is used to monitor the species present in a pasture. The stick is randomly thrown across the paddock and the plants that are nearest the ends of the stick are recorded. Assessing botanical composition is best done in southern NSW in early winter after the autumn break. Plants have then established full ground cover. In the north of the State this is likely to be early spring.

The technique is undertaken using a 1 cm thick dowel about 30 cm long with pointed ends – or a nail can be partially driven into each end of the stick.

The stick is thrown ahead, at random, while walking across the paddock. After throwing, identify the pasture component touched or directly below the end of each nail head. Record these on a sheet similar to Table 1.1. A blank copy of this form, which can be photocopied for on going use, is available at Appendix 6.

Repeat the process 50–100 times throughout the paddock. Fifty observations of a double ended stick will give you 100 observations (hits). The total hits for each pasture component divided by the total number of hits, indicates the percentage of each species in the pasture.

Table 1.1 Recording sheet to determine pasture composition. (Number of times each pasture was encountered. Each time a recording is made cross off a number).

Species																					**Total**
Improved grass,	~~1~~	~~2~~	~~3~~	~~4~~	~~5~~	~~6~~	~~7~~	~~8~~	~~9~~	~~10~~	~~11~~	~~12~~	~~13~~	~~14~~	~~15~~	~~16~~	~~17~~	~~18~~	~~19~~	~~20~~	22
(e.g. ryegrass,	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
phalaris etc.)	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	44%
Clover or	~~1~~	~~2~~	~~3~~	~~4~~	~~5~~	~~6~~	~~7~~	~~8~~	~~9~~	~~10~~	~~11~~	12	13	14	15	16	17	18	19	20	1
medic	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	22%
Weeds	~~1~~	~~2~~	~~3~~	~~4~~	~~5~~	~~6~~	~~7~~	8	9	10	11	12	13	14	15	16	17	18	19	20	7
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	14%
Annual grass	~~1~~	~~2~~	~~3~~	~~4~~	~~5~~	~~6~~	~~7~~	~~8~~	9	10	11	12	13	14	15	16	17	18	19	20	8
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	16%
Bare ground	~~1~~	~~2~~	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	2
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	4%
Dead pasture	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	

You may want to categorise species or look at them individually. For example, all undesirable species may be called ‘weeds’; all sown species grouped together; annual grasses together etc. A blank sheet in provided in Appendix 6.

PASTURE SPECIES IDENTIFICATION

Developing skills in the recognition of pasture species will also receive emphasis during the course. If a species cannot be identified by your coordinator or individuals within the group, the coordinator will take responsibility for having the species identified by the next meeting of the group.

When collecting specimens for identification remember, it may require a flower or seed head to be successfully identified.

For future reference, you might consider starting a collection while undertaking the course. Following identification, placing specimens between sheets of newspaper is a cheap and reliable method of storage.

For information on identifying your pasture plants see the list of books in further reading at the end of the segment.

HERBAGE MASS DIGESTIBILITY AND ANIMAL INTAKE

Herbage mass and digestibility interact to determine the amount of pasture consumed by livestock. Assuming the animals are healthy, the level of pasture intake will determine animal production. There are critical levels of digestibility as there are with herbage mass. One can offset the other when high levels of production are not required.

Through pasture assessment and understanding this interaction, we can better match animals and pasture. This interaction is explained in Segment 2.

A major aim of a grazing enterprise is meeting market specifications. Using skills developed in PROGRAZE, along with strategies such as production targeting (see Segment 3), you will be in a better position to determine if you are on track to get animals to a particular target.

Once a market is identified, livestock production requirements can be determined (e.g. 1.3 kg growth per day in steers, 200 grams/day growth between 5 and 8 months in lambs). Similarly, you can better allocate stock to paddocks to keep them on target, as PROGRAZE will outline what the characteristics are of a pasture that will produce 1.3 kg/day growth in steers.

Where pasture is limiting, supplements may fill the shortfall. The amount of supplement needed by animals, like pasture, depends on the quality of the supplement, which can be determined by 'feed tests'. A knowledge of pasture and supplement quality will allow you to more accurately satisfy animal feed requirements.

Over the following segments a computer program known as GrazFeed®, will be used to determine how available pasture meets animal requirements. From this, a decision can be made as to the need for supplementary feeding and the amounts of supplement needed.

SUMMARY

Pasture assessment is used to determine the capability of the pasture for animal production and as a basis for pasture management decisions.

- The objective is to develop skills in visually assessing pastures (eyeballing) but this is calibrated on cutting, weighing and drying of pasture.
- Pasture assessment involves recognising pasture quantity and quality.

Quantity

- Herbage mass, the amount of pasture available in kg DM/ha.
- The amount of green and dead material.
- Herbage mass = total green + dead material.
- Herbage mass is primarily a function of a pasture's height, density and dry matter.

Quality

- The digestibility of a pasture.
- The percent legume on a dry weight basis.
- The species composition in a pasture.

Further reading and information

- *Grasses of temperate Australia – a field guide*. CA Lamp, SJ Forbes & JW Cade. Bloomings Press.
- *Plants of Western NSW*. GM Cunningham, WE Mulham, PL Milthorpe & JH Leigh. Inkata Press.
- *Grasses of NSW slopes*, *Grasses of coastal NSW*, *Grasses of NSW tablelands*; phone 1800 025 520 to order from Tocal college.
- www.dpi.nsw.gov.au

PROGRAZE PASTURE ASSESSMENT RECORDING SHEET

PROGRAZE group		**Pasture quantity**								**Pasture quality**					
Property/Paddock	Pasture Species	Total Herbage Mass (kg DM/ha)		Green (%)		Dead (%)		Total Green (kg DM/ha)		Legume (%)		Digestibility Green (%)		Digestibility Dead (%)	
		Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual

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.

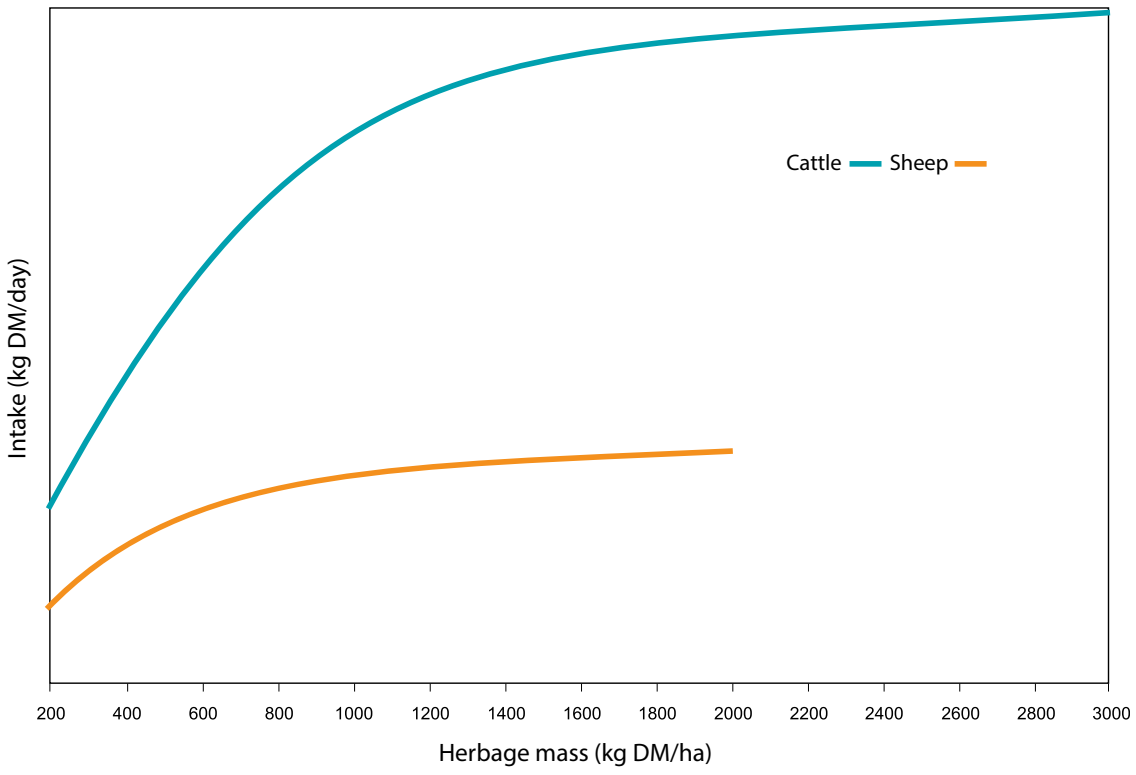
Intake is influenced primarily by the quantity of pasture available as well as its quality. Skills in estimating pasture quality and quantity provide the basis for improved grazing and pasture management decision making.

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.

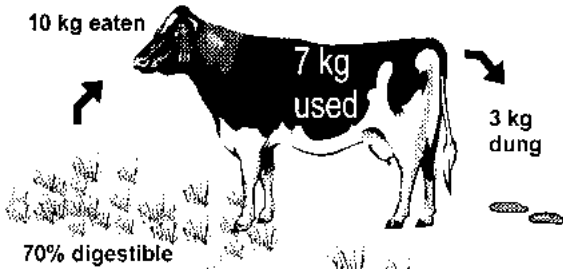
PASTURE QUALITY

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.

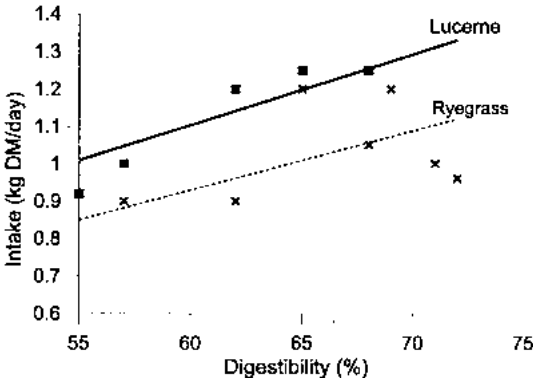
- Digestibility is positively related to protein content – when digestibility is high, protein content also will be high. However, there is variation between pasture species in protein content. For example, clovers are generally higher in protein than grasses.
- Digestibility directly relates to the 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.

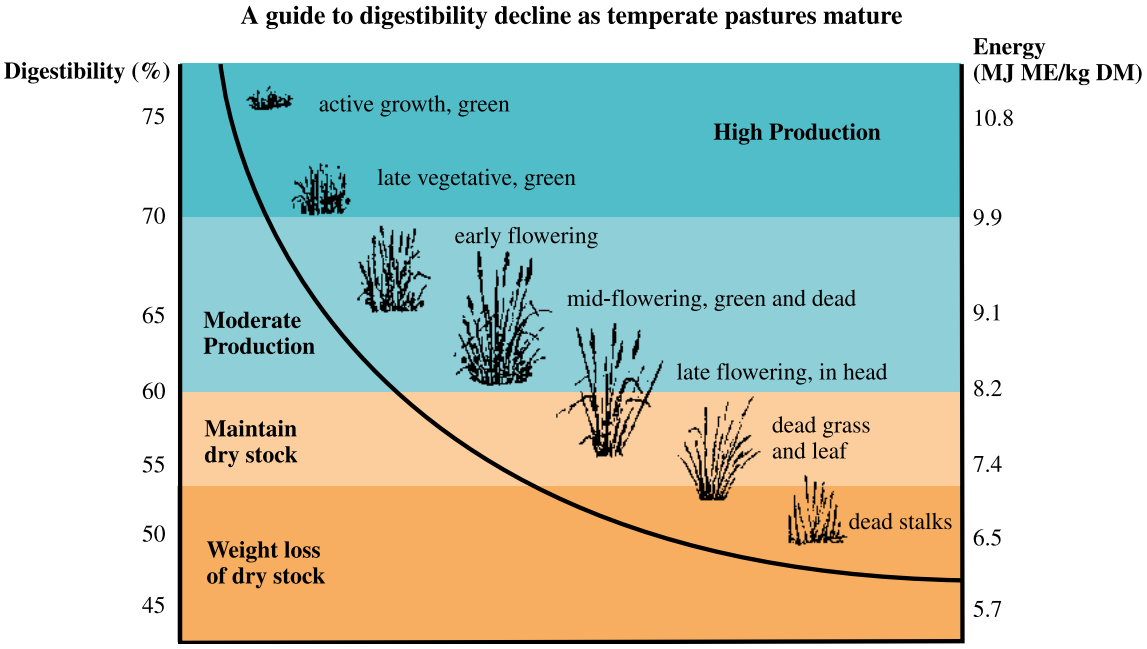


Figure 2.5. A guide to the relationship between digestibility and pasture maturity in tropical pasture.

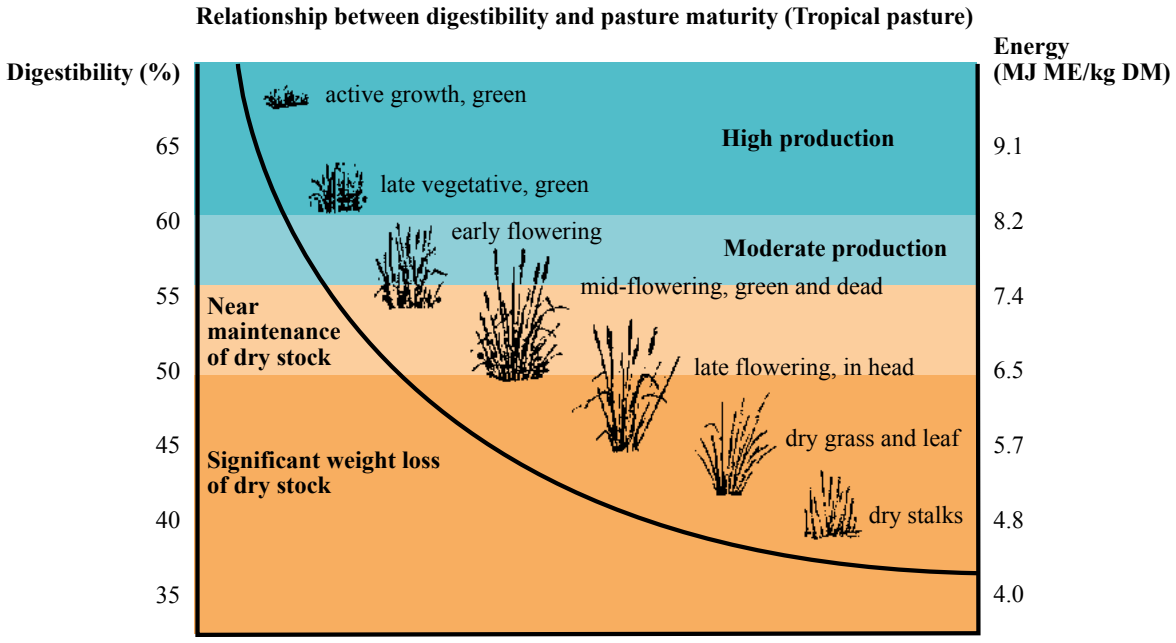
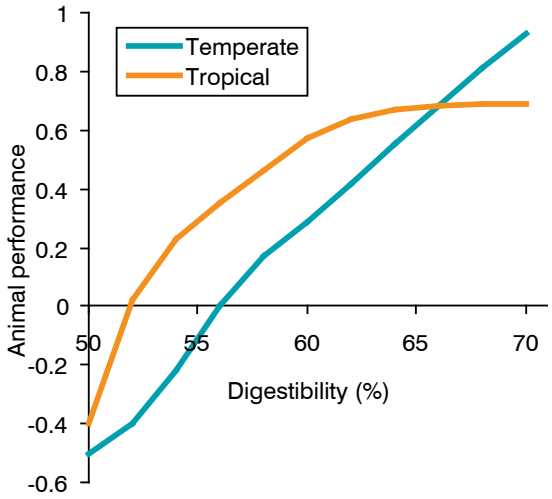


Figure 2.6. Relative cattle performance on tropical and temperatre pastures – Source GrazFeed®



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.

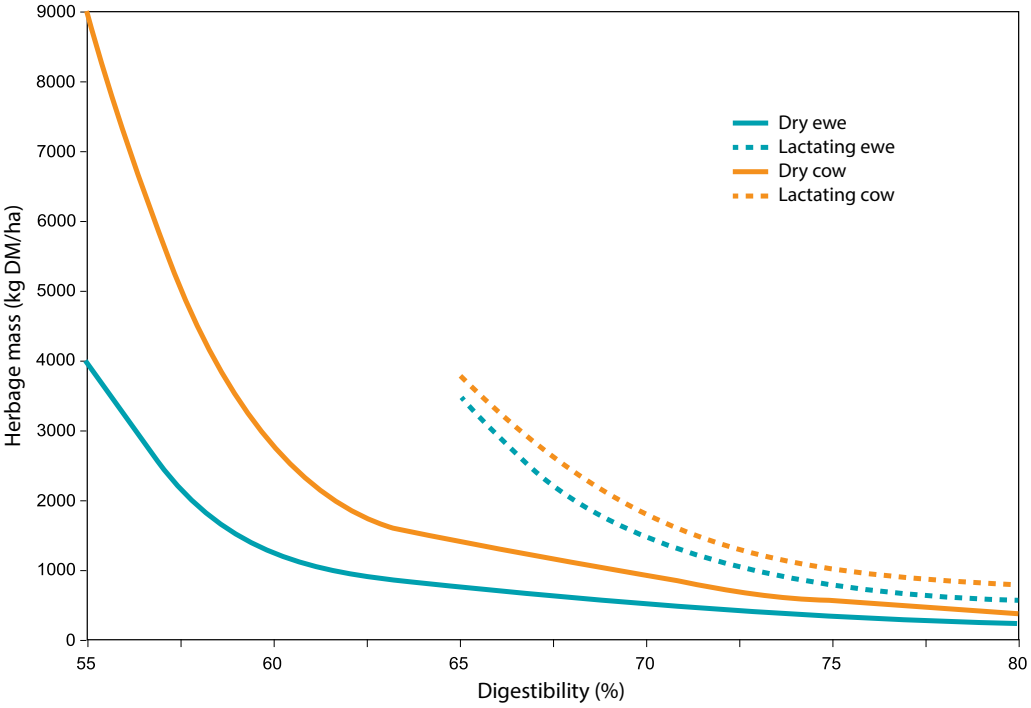
Livestock production, in the situation of low herbage mass and high digestibility is not necessarily improved by reducing the stock numbers in a paddock; that is, lowering stocking density, or providing a larger paddock with a similar quality and quantity of pasture.

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

PROGRAZE™

Profitable, sustainable grazing

SEGMENT 3

INTRODUCTION TO GRAZFEED®/PRODUCTION TARGETING

In this segment you will learn:

- The role of GrazFeed® in predicting cattle and sheep performance on pasture and the type of pasture required to achieve specific livestock production targets.
- How GrazFeed® is used to predict supplementary feeding requirements of livestock.
- How to use production targeting as a means of achieving pasture and livestock objectives.

INTRODUCTION TO GRAZFEED®/ PRODUCTION TARGETING

Many factors influence the performance of livestock on pasture (see Figure 3.1). These divide broadly into those which relate to the:

- pasture
- livestock
- climate
- supplement
- health status

GRAZFEED®

The prediction of livestock production from pasture has, until recently, lacked precision unless one was prepared to undertake a complex time consuming set of calculations. The development by CSIRO of a computer program, GrazFeed®, enables these calculations to be undertaken rapidly. Being able to assess pasture in terms of quantity and quality is critical to making management decisions using GrazFeed®.

When making predictions GrazFeed® takes into account:

- The quantity, quality and height of pasture being grazed by the livestock (Segment 2).
- The topography of the paddock being grazed.
- Climatic conditions.
- Genetic capacity of livestock to grow and produce meat, wool or milk.
- Sex, age, weight, dry/pregnancy/lactation status of the animals (see Segments 4 and 5).
- The predictions from GrazFeed® assume animals are healthy.

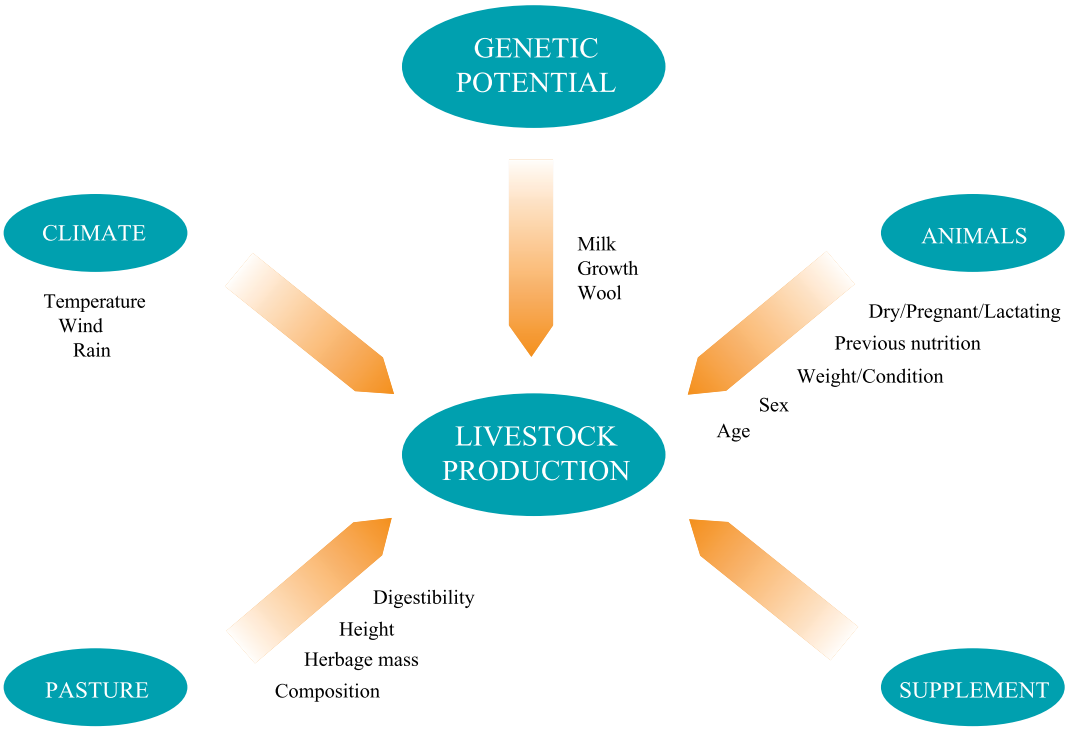
GrazFeed® also predicts the impact of feeding a supplement to stock. Remember, these predictions are only as good as the quality of the information provided to the program. As you work with the program you will see how sensitive GrazFeed® is to many inputs.

GrazFeed® takes into consideration the many factors associated with livestock grazing pasture in predicting animal production.

GrazFeed® allows greater precision in making decisions about:

- The quantity and quality of pasture that needs to be provided to stock for them to meet production or market targets.

Figure 3.1. GrazFeed® considers many variables in the determination of livestock production.



- Supplementary feeding – supplements are often significant cost items and their efficient use can significantly affect the bottom line of grazing enterprises.
- Predicting intake of livestock for use in fodder budgeting.
- The effects of cold stress on livestock production.
- Drought and lot feeding.

Applications of GrazFeed®

GrazFeed® may be applied to many different situations – not just for livestock before entering a critical feed period, but in all cases where animals graze pastures.

The following are examples where GrazFeed® has been used in practical applications:

- To determine the type of pasture necessary to achieve a growth rate in livestock that would achieve weight by a given age and then to stock that paddock to achieve optimum utilisation of the pasture.
- Decisions about the supplementation of weaners on dry summer feed.
- Supplementing pregnant stock on short, green winter feed.
- To investigate costs for each fodder type (matching kilograms needed with price per kilogram) to achieve the target result in animal production.
- To determine whether there would be a production response from bypass protein.
- Levels of supplementation in 'drought time'.
- As an educational tool. For example, to show the effects of winter shearing on intake, the effect of grazing particular paddocks and not others, in terms of animal growth.

PASTURE AND LIVESTOCK TARGETS

The process of targeting in grazing management is not just aimed at defining markets, although that is one component. Targeting is about setting short term goals or targets which may be pasture or animal based. For example, 'I am aiming to have my sheep in fat score 3 at lambing with the lambing paddocks having 1200 kg green DM/ha' or; 'I need my steers to grow at 1.3 kg/day to have them sold by October'. The pasture and animal assessment skills developed in PROGRAZE are the tools we use to assist in achieving our targets.

Tools we use to monitor the performance of our farm production are:

- Liveweight and/or fat score for meat marketing or reproductive targets.
- Species composition or herbage mass for pasture targets.
- Herbage mass and pasture quality to check that we are achieving the desired liveweight gains we need.

If this monitoring shows we are not going to achieve our target, it allows us to rethink and change our program. Do we supplement, how much and what is the cost? Do we sell early? Do we change paddock or stocking rate? Do we spell the paddock?

Our monitoring also allows us to react early to unplanned changes. Rather than waiting until the end to see if we made it, we have more control over ensuring we do make it.

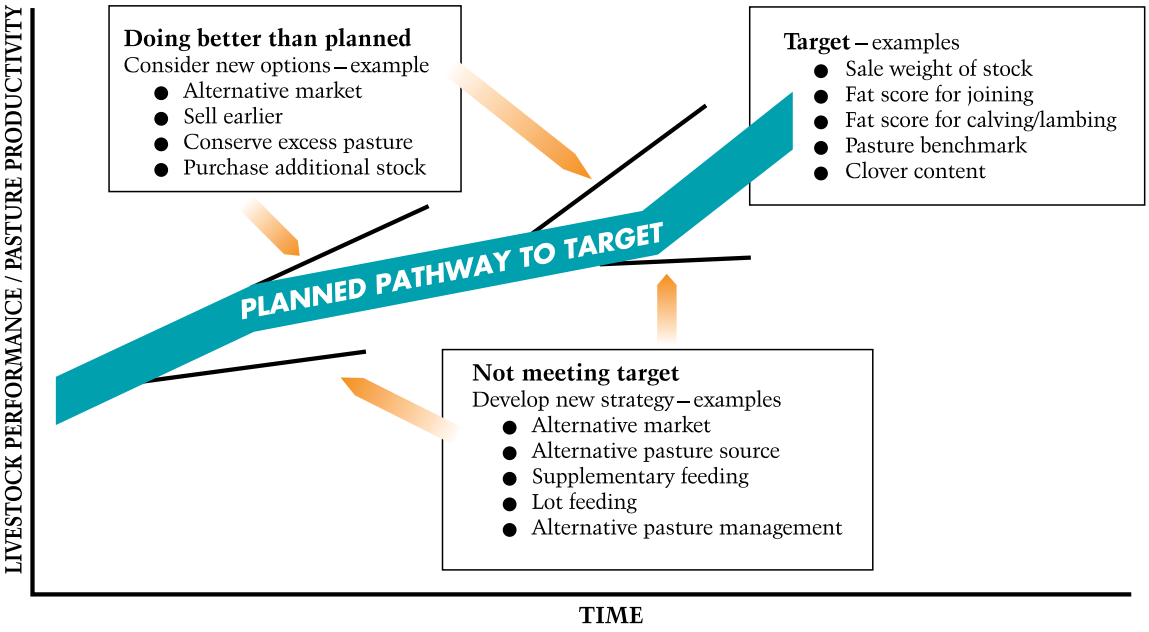
Setting targets

Targets can relate to any activity you undertake; markets, reproductive rates, pasture composition, growth in weaners etc. The key to setting targets is based around three factors:

- **Specification** – what you want to achieve.
- **Budget** – to achieve the target. Limit input cost e.g. supplements, herbicide etc.
- **Time frame** – over what period do you want to achieve the target.

All future decisions will be based on these three factors.

Figure 3.2. TARGETING – managing pastures and livestock to meet your goals.



Following is a general outline of the thought processes involved in targeting.

- **Step 1. Primary target**. Define and write down the target. What you want to achieve, how much financial input you will allow, and when do you want to achieve the target by.
- **Step 2. Sub-targets and strategies**. Establish sub-targets in terms of livestock and pasture needs required to reach the next sub-target.
- **Step 3. Review**. Reassess the original target using feedback information for future planning. Write down what was done right and wrong. If the target was not achieved, why?, what was it due to? – genetics, paddock feed, supplements used, cost of supplements, joining time, season, market issues, animal health or poor assessment of pasture. Write down changes to implement next year.

The following examples are for meat production:

Sheep

Step 1. Primary target – for male drop, 46 kg lambs at 8 months of age. That is, they must average 110 grams/day growth between weaning and 8 months. Pasture has been assessed and paddocks identified which have the feed available.

Step 2. Sub-targets and strategies – Establish sub-targets, key times, target weights and acceptable range and the pasture needed to get the liveweight at the next sub-target.

At 3 months, weigh. If the average is between 28 and 32 kg you are on target. If the average is below 28 kg, ask: 'Do I supplement?, do I move to better pastures?, maybe I look for another target?, do I sell early as trade lambs?, is the market suitable for these lambs?'.

Repeat the cycle at the next key time. Continue using pasture assessment and fat scoring to monitor growth rates.

As you approach the final key point consider market issues such as selling options, breaking even price, transport, using market intelligence and feedback.

Step 3. Review. – Assess strategies as you go along to assist you in an overall decision. After going through a cycle, identify limiting areas. This may be the period between 5 and 8 months for spring lambs. Growth was low, supplements costly. Should you consider putting in more lucerne? Use the process to identify problems in the cycle and then look at your options for the future.

Sub-target stage	Av. target weight (kg)	Acceptable range (kg)	Growth required (g/day)*	Example pasture to achieve the next sub-target
Birth	4		290	1400 kg green DM/ha; 73% digestibility
3 months	30	28–32	110	1300 kg green DM/ha; 65% digestibility
6 months	40	38–42	100	750 kg green DM/ha; 65% digestibility
8 months	46	44–48		

*Liveweight gain (g/head/day) required to meet the next target.

Beef

Step 1. Primary target – The primary target is feeder steers, with a liveweight of 450–500 kg, and fat score 2 in February/March.

Step 2–3. Sub-targets/strategies and review – Use the same steps as in the sheep example above. Establish sub-targets, key times to reach those sub targets, an acceptable range around the targets, and the options if you are above or below the sub target.

Sub-target stage	Av. target weight (kg)	Acceptable range (kg)	Growth required (g/day)*	Example pasture to achieve the next sub-target
May/June	250	230–270	0.3	700 kg green DM/ha; 73% digestibility
September	280	260–300	1.2	2500 kg green DM/ha; 70% digestibility
December	380	360–400	0.8	3000 kg green DM/ha; 65% digestibility
March	450	435–465		

* Liveweight gain (kg/head/day) required to meet the next sub-target stage.

Note: For steers that do not meet the target range, other markets or growing out (plus supplement) options must be considered. Feedlotters demand a tight line, as after 150 days feeding a 40 kg range at the start may blow out to 120 kg.

SUMMARY

- GrazFeed® is a computerised nutrition package that predicts the production of grazing cattle and sheep. In doing this GrazFeed® takes into account pasture and climatic conditions, the genetic potential of the animals and their age, sex, weight and physiological state (dry, pregnant or lactating).
- GrazFeed® also predicts the impact on production of feeding supplements to grazing livestock and when drought feeding.
- Production targeting is about setting livestock and pasture targets aimed at specific outcomes. The steps include:
  - » setting the primary target,
  - » developing a planned pathway towards achieving the primary target which may include a series of sub-targets,
  - » determine the critical inputs required to achieve the target and sub-targets,
  - » monitor progress through weighing or fat scoring livestock and by pasture assessment and
  - » continually reassess whether the target and sub-targets remain appropriate.

Further reading and information

- Primefacts – www.dpi.nsw.gov.au/primefacts

NOTES

PROGRAZE™

Profitable, sustainable grazing

SEGMENT 4

SHEEP BREEDING PACKAGE

In this segment you will learn:

- How to fat score sheep.
- How fat scoring is used, in conjunction with pasture benchmarks, to manage the nutritional requirements of the ewe flock through the annual breeding cycle.
- The appropriate management of ewes, rams and weaners through the breeding cycle.
- How the level of pasture intake by sheep influences wool growth and quality.

SHEEP BREEDING PACKAGE

Improving the productivity and viability of sheep breeding enterprises relies on a good understanding of feed requirements over the year. These requirements must be matched to available pasture, pasture improvement and, at times, the judicious use of supplements.

WHAT ARE THE TARGETS?

The aims of a sheep breeding program can be summarised as:

- Optimising per hectare production of wool and lambs.
- Meeting market specifications for the products (wool, meat, surplus sheep).
- Being cost efficient.

The keys to achieving these aims are:

- Skills in pasture assessment.
- An understanding of nutritional requirements of livestock.
- Use of pasture assessment to identify paddocks which will most effectively achieve flock fat score or liveweight targets.
- Skills to monitor fat scores.
- Use of fat scores to assist in setting nutritional requirements for the breeding flock.
- Skills to 'wet and dry' ewe's udders at marking.

In a breeding program particular emphasis is placed on:

- Preparation of the rams.
- Fat score of ewes at weaning.
- Fat score pre lambing.
- Nutrition during lactation.
- Weaner growth.

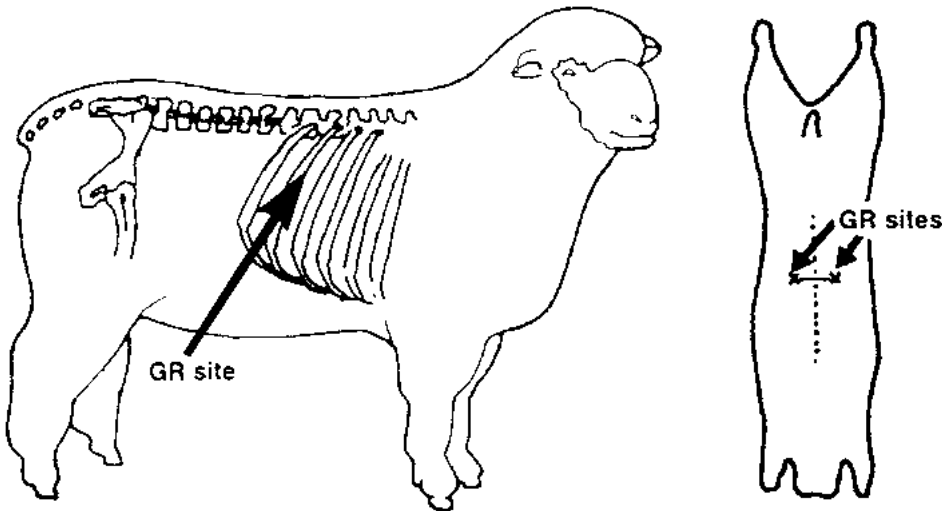
FAT SCORING SHEEP

Fat scoring is carried out on standing, relaxed animals and involves feeling the amount of fat over the long ribs. The specific location is about 10–11cm from the midline on the second last long rib (just before the short rib or loin area). In this location, fat is the main tissue and is a good indicator of general fatness.

Unlike cattle, visual assessment of sheep can be quite misleading and so for accuracy, requires careful palpation of the ribs. Make your main fat score assessment based on the long ribs.

Fat scoring firstly involves identifying the area on the sheep to place your hand (see Figure 4.1). Get your fingers through the wool onto skin level. Apply some downward pressure and move your fingers over the ribs. The amount of 'boniness' will determine the score. Scores and a description of each score are listed overleaf.

Figure 4.1. Use the long rib site for fat scoring sheep.



Description	Score
Individual ribs are easily felt and no tissue can be felt (sliding) over the ribs. Depressions are quite obvious between ribs.	1
Individual ribs are felt with some tissue able to be felt over the ribs. Depressions between ribs are obvious.	2
Individual ribs can still be felt but they are more rounded, with tissue movement being felt over the ribs.The depression between ribs is less obvious.	3
The ribs can just be felt, with no depression between the ribs. Tissue movement over the ribs is apparent.	4
Ribs cannot be felt.	5

MANAGING THE BREEDING PROGRAM

A positive relationship exists between liveweight and the fat content of sheep. Within a flock or between flocks of a similar frame size heavier ewes mean fatter ewes. Fat levels can be assessed by fat scoring and liveweight by weighing.

Fatter ewes at joining mean more lambs born. Table 4.1 demonstrates the association between fat score at joining and the number of scanned lambs per 100 ewes. Note that it is an average 13 foetus for each change in fat score for merinos (the figure would be higher for meat ewes). This average came from the three NSW sites in the Life Time Wool project over 2004 and 2005 joinings. The range in NSW was 6 to 20 foetuses per fat score. It is important that the responsiveness of your flock is known. This determines the pay back in extra lambs from your management and feeding input. Read Primefact 309.

Table 4.1. Effect of increasing fat score at joining on percentage of scanned lambs per 100 ewes.

Fat score	Lambs scanned per 100 ewe Merino
2	108
3	121
4	135
5	148

For the period from weaning to joining, emphasis should be directed towards getting ewes in the right fat score for joining. The target is a fat score 3 for merino and 3.5 for meat ewes in average years. In tough seasons the target will be lower but not below 2.5 merino and 3 for xbred.

A number of factors influence the condition of ewes at joining. They include:

- Ewe condition at the previous weaning.
- Length of time between the previous weaning to the next joining.
- Pasture quantity and quality.

The most critical factor for conception rates in mature ewes is the fat score at joining rather than the ewe's weight gain or loss prior to joining.

Ewe condition at weaning

Lactation represents the most nutritionally demanding period for ewes. For example, a lactating ewe can require up to three times the energy necessary to maintain her when she is dry. To satisfy this demand it is common for ewes to lose weight and decrease fat score.

A weight loss of 5 kg (6.5 kg is approximately 1 fat score) is not unusual and up to a 10 kg loss has been recorded in crossbred ewes experiencing poor pasture conditions during lactation.

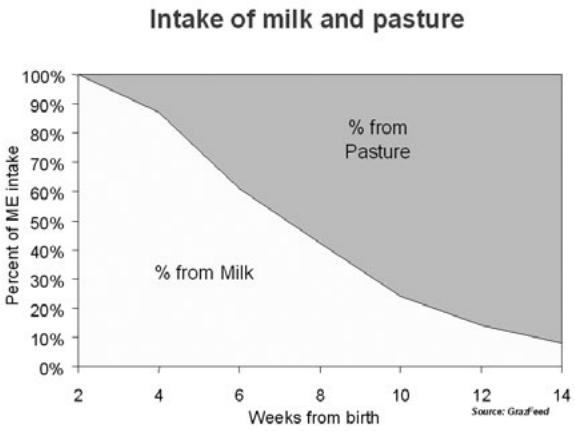
The extent of the loss of condition is controlled by the quantity and quality of pasture or supplement consumed during lactation. If your pastures for lactation are below the benchmarks in Segment 2, substantial weight loss can occur. If the Segment 2 pasture benchmarks are achieved, ewe's fat score at weaning can be the same as at lambing.

Weaning to joining

The longer ewes have between weaning and joining, the greater the opportunity to improve fat score. The period between lambing and weaning can often be increased by restricting the joining period to 6 weeks and weaning lambs when the oldest is 14 weeks.

By 7 weeks of age lambs obtain more of their energy requirements from pasture than they do from milk (see Figure 4.2). By 12 weeks the contribution from milk is relatively small, meaning lambs can be weaned and still maintain their level of production provided the weaning paddock has adequate digestibility.

Figure 4.2. The relative change in intake between milk and pasture with increasing lamb age.



The type of pasture provided to ewes between weaning and joining will obviously influence their condition at joining time.

Where seasonal conditions result in restricted pasture, consideration can be given to drafting off the lower fat score ewes at weaning i.e. below 2.5 fat score, for preferential treatment.

The cost effectiveness of supplementary feeding to achieve a fat score increase depends on the responsiveness of the flock and the price of the feed/grain. Even in low responsive flocks, supplementing to prevent weight loss, below fat score 2, is profitable. As ewes decline below fat score 2 they approach the point of being a dry ewe, resulting in a marked reduction in the number of lambs born. It rarely pays to supplement ewes if they are in the target fat score range for joining.

Ram management

To ensure a successful joining there are a number of factors that need to be considered:

- Rams should be in 3.5 (max) fat score at joining time, because they often lose considerable liveweight and fat score during joining. As the mature weight of rams increases more stress is applied to the back legs at joining hence ensuring ram are not too fat is more important. The rate at which rams are breaking down is increasing. Check rams at least 3 months prior to joining to allow for corrective action.
- Ideally, rams will be joined with 3–4 months wool growth as this helps moderate body temperature changes.
- Rams need to be in good health prior to joining. Careful planning is required to avoid flystrike or post shearing infections which can cause infertility. As well, the rams drenching program should be completed prior to mating. Freedom from Brucellosis needs to be ensured, test if a risk of infection exists.
- To ensure adequate sperm production, rams should have a scrotal circumference of at least 28 cm at the time of joining. The sperm development cycle is app 42 days, so the 2 months prior to joining is critical for ram health.

Joining

Ewe flocks which have reached target fat scores by joining need not be with the rams any longer than 6 weeks in the autumn breeding season and 8 weeks outside the season. 5 weeks is increasingly being used for autumn joining with little impact on marking percentages.

More than 70% of ewes joined in the breeding season (autumn), which have reached the fat score target range, can be expected to conceive within the first cycle (17 days) of joining. The remainder will be served in the second cycle with very few left to conceive during the last week of a 6 week joining.

Outside the breeding season ewes will come on heat less regularly. When they do, it will be for a shorter time. An additional 2 weeks (8 weeks joining) may be considered. Ram harnesses are valuable for monitoring joining progress and are strongly recommended when joining out of season. The 'ram effect' can be used to concentratelambing, this is especially useful in spring joinings.

By using these strategies ewes have about 4 months to achieve their target fat score for joining. Given reasonable seasons these targets should be achieved without having to place ewes on the best pasture, these being reserved for high demand livestock such as weaners or finishing stock.

Joining to lambing

In making decisions about management during pregnancy a producer will be faced with differing strategies depending on the fat score of the flock at joining: Add 0.5 score to the numbers below for meat ewes.

- Flocks at fat score 5 must lose weight during pregnancy.
- Flocks at fat score 4 will not be disadvantaged from managed weight loss.
- Flocks at fat score 3 should maintain weight
- Flocks below fat score 3 should increase in weight or at least not lose any more.

Where weight loss is to occur, the strategy should be implemented slowly in the first two months following the end of joining and certainly completed before the month preceding lambing (see Figure 4.3). Rapid nutritional changes may adversely affect both pregnancy and wool quality.

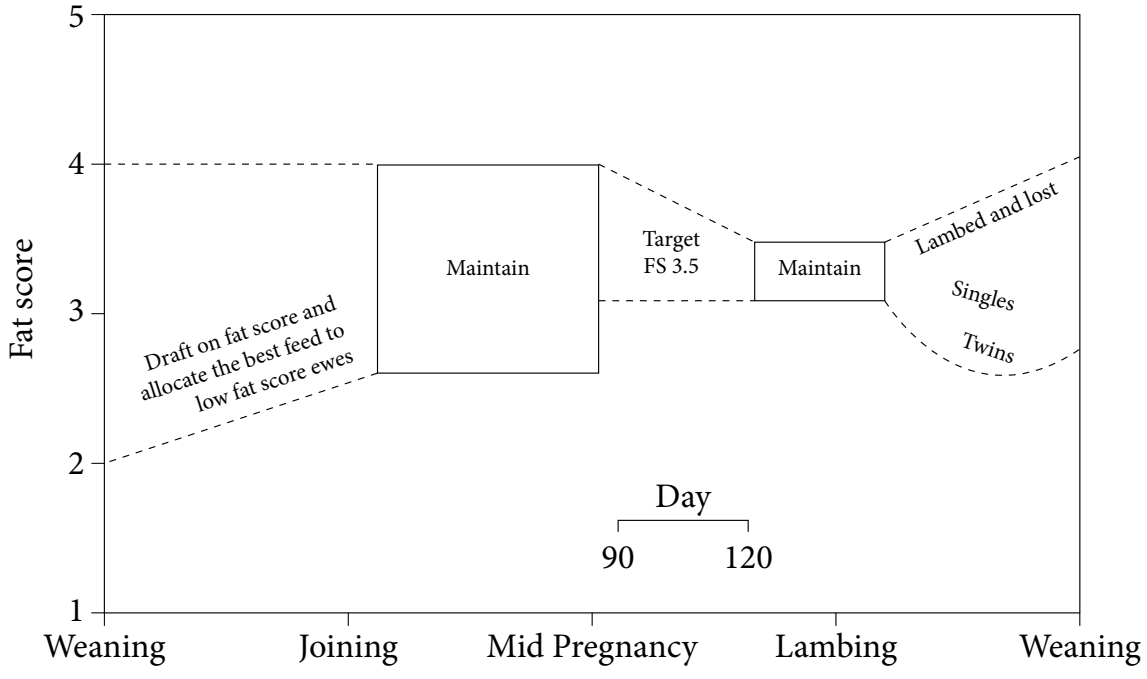
A fat score target, in the range of 3–3.5 (merino), should be the objective for ewes on the point of lambing. Where foot abscess is likely to occur it is better to target 3 as the lower weight decreases the risk of abscess developing. Managing the foot abscess is critical as it predisposes ewes to pregnancy toxaemia and loss of the ewes and her lamb/s. The foot abscess risk is greater in twins than singles.

Aim for 3 FS for merino ewe carrying singles joined to terminal sires. Meat ewes in FS 4.5 or better when run on grazing crops prior to lambing are increasingly having pregnancy toxaemia problems due to being too fat.

If at the conclusion of joining, substantial variation exists in fat scores, drafting on fat score allows management to better cater for the specific needs of ewes and to make more efficient use of pasture. Managing ewes based on singles or twins is better than on fat score.

During the last month of pregnancy ewes should gain at least 4 to 6 kg in liveweight to compensate for foetal development. This should ensure maintenance of fat score over this time.

Figure 4.3. Fat score targets for ewes.



Pregnancy is commonly associated with periods of low pasture growth. Nutritional requirements of the pregnant ewe need to be satisfied, while at the same time ensuring adequate pasture (both quality and quantity) is available for lambing.

Grazing management can be used to regulate pasture intake and ration pasture to ewes to help offset the period of low pasture growth. This will be discussed later in this manual.

Supplementary feeding is used through pregnancy to supplement periods of low pasture production. The critical period is the last 3 weeks of pregnancy and mainly for twins. Seasonal conditions will control the quantity that needs to be fed. Pregnancy scanning allows pasture and supplementary feeding to be targeted to the right ewes. Scanning for wet and dry only, does not allow the different pregnancy needs of singles and twins to be targeted decreasing the pay back from the scanning.

Lambing to weaning

Lactation is nutritionally the most demanding period for the breeding flock. It is desirable that lactation coincides with a peak in pasture production.

It is important that the best use is made of peaks in pasture production to achieve maximum ewe and lamb production. If high levels of livestock productivity are not achieved during these periods it is going to be difficult to reach fat score and liveweight targets in the future without using high cost supplements.

The pasture target for lambing paddocks should be a minimum of 900 kg green DM/ha. As the start of lambing is usually timed to coincide with the increase in seasonal pasture growth rates, the aim should be to build herbage mass levels to 1500–1600 kg green DM/ha by 4 weeks into lactation. If lambing is not in the growing season then supplements in the first 4 weeks of lactation are critical to achieve reasonable lamb weights.

Ewes are best set stocked for lambing. Following lambing, high lamb growth rates are achieved via set stocking or a slow rotation. Under any grazing system it is important to aim for the herbage mass to be maintained around the 1500 kg green DM/ha benchmark if lambs are to exhibit near to maximum growth rates. The legume content should be above 15% on a dry matter basis.

As stated earlier, lambing often coincides with a peak in pasture growth. If ewe and lamb production targets are to be achieved, pastures should remain in a vegetative (green leaf) state as long as possible. If pastures become tall and rank, digestibility will decline and so will livestock performance, especially the lambs.

To maintain control of pastures during periods of rapid growth it will be necessary to increase the stocking density on some paddocks to ensure they remain in the vegetative state. Combine mobs of ewes at marking time. This results in your stocking density better matching pasture growth rate. Initially lambing paddocks are usually stocked based on low winter pasture growth rates; this leads to a big imbalance by mid lactation, hence the need to change stock density during lactation. Low pasture digestibility in late lactation has a negative impact on lambs because by that stage the majority of their requirements are being met by pasture. Improved weaning weights can be achieved solely from a management decision with no added expenses.

WEANER GROWTH

The survival and growth of weaned lambs, is an important issue influencing the viability of breeding enterprises.

While it is important in the post weaning period for ewes to regain liveweight lost during lactation, weaners still have priority over ewes for the most productive pastures.

Managing pastures to maximise the duration of the vegetative stage, and so pasture digestibility will benefit weaner growth and production. The first 4 weeks post weaning are critical. Often weaners lose weight in this period increasing the risk of worm problems. Training lambs to eat supplements while still on the ewes is recommended, 6 feeds in the last 2 weeks of lactation is a minimum.

Worms often reduce weaner performance. Apart from following a strategic drenching program, decisions relating to grazing management will also determine the effect worms have on weaner production. Worm testing will lead to more effective drenching (see Segment 7).

Weaning at 14 weeks removes lambs off pasture which is likely to be highly contaminated by worm larvae. Lambs should be weaned onto 'safer' paddocks, those previously grazed by cattle or adult dry sheep (see Segment 7, Grazing for worm control). The build-up of a weaner's resistance to worms is achieved by ensuring they continue to grow. Aim to get the weaners to an average of 25 kg as soon as possible after weaning. Weight gain from weaning for 1 month will decrease weaner mortality. This will often require a protein supplement. Water quality is critical for weaners, poor water quality will lead to reduced feed intake and this starts a downwards spiral usually resulting in death due to worms.

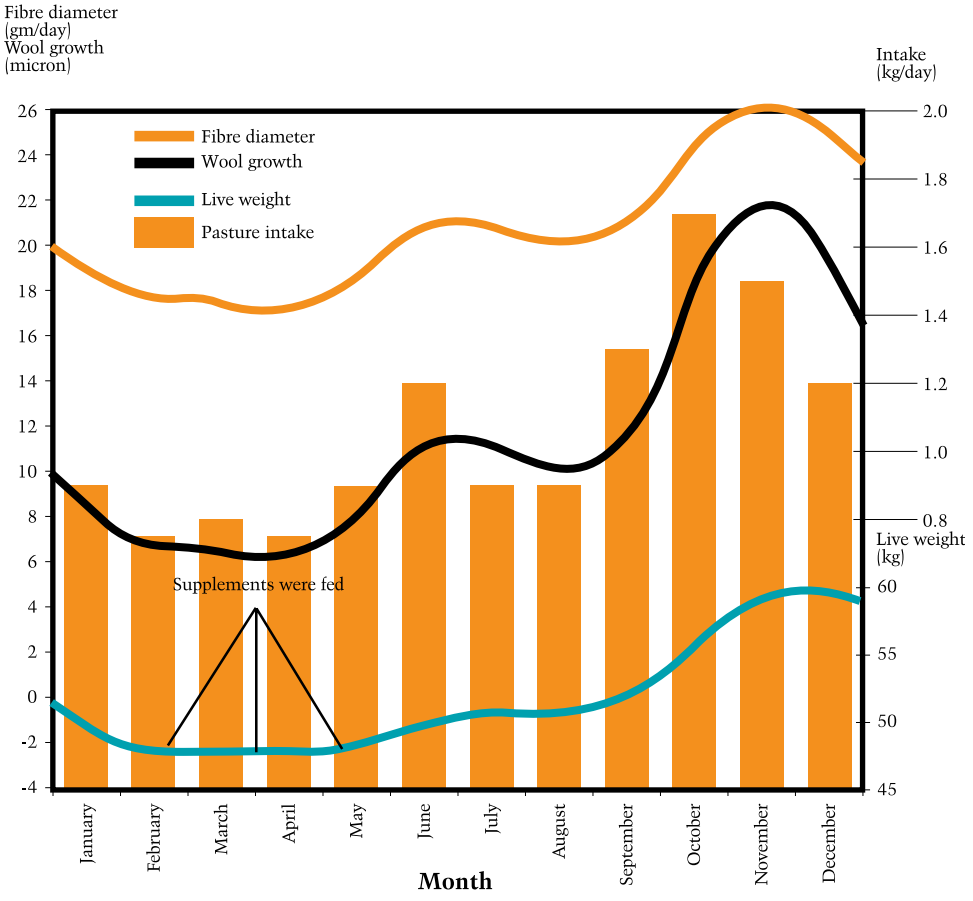
WOOL GROWTH

While this segment's major focus has been on management influencing the flock's reproductive performance, the effect of grazing management decisions on wool production and quality must not be ignored. There is a direct relationship between pasture intake and wool growth. Pasture characteristics influencing intake were discussed in Segment 2.

Figure 4.4 shows the results of a simulation using CSIRO's GrassGro. The simulation is based on a wether flock stocked at 10 wethers per hectare grazing a perennial/annual grass/subclover pasture at Yass on the Southern Tablelands of NSW.

The figure shows the relationship between pasture intake and changes to body weight, wool growth per day and the average fibre diameter for each month's wool growth. Note that as the pasture intake declines the

Figure 4.4. Relationship between pasture intake and production characters in wethers.



production characters, moving together, also decline; animals lose weight, wool growth per day slows and the fibre becomes finer, conversely as pasture intake improves due to increases in herbage mass and/or digestibility, the wool characters increase.

With regard to tensile strength, fibres break at their finest point. In addition, the larger the range in monthly fibre diameters the lower will be staple strength. With regard to the staple strength test (N/Ktex), the finest point of the fibre influences the Newton reading and the rest of the fibre influences the KTex reading. An understanding of how the staple strength test works helps in managing for improved tensile strength ie do I manage the finest point or the broadest point? Sudden changes in fibre diameter will cause a lower staple strength than a gradual decline.

Ewes lambing on an herbage mass below the benchmarks may rear a lamb but the penalty, apart from the likelihood of considerable weight loss in the ewe and lowered lamb growth, could be tender wool.

SUMMARY

Weaning to joining

Livestock targets

- Ewes – merino ewe 2.5 to 3 FS, meat ewes 3 to 3.5 FS by joining.
  Draft off ewes below FS 2.5 and supplementary feed in tough years to lower the dry ewe percentage
- Weaners – the first month post weaning is critical. Aim for a minimum weight gain of 0.5 kg/week until the weaner has reached 25 kg (merinos). Growth rates in xbred lambs will be driven by your marketing plan.
- Maiden Ewes – achieve liveweight targets by their first joining, minimum of 42 kg medium frame Merinos, and 47 kg for large frame Merinos and 50 kg crossbred ewes. These target weights also apply when joining ewe lambs.

Grazing management

- Wean lambs onto 'safer' worm pastures – ideally, pasture previously grazed by cattle or dry adult sheep.
- Weaners receive preference for pasture with potential for high livestock production.
- Hogget ewes generally receive second preference to weaners for quality pasture, followed by the mature ewes.
- Following weaning, consider drafting ewes on fat score.
- Supplements should be used to prevent mature ewes declining below fat score 2 for joining, and to ensure weaner and hogget ewes meet fat score/liveweight targets. Consider 'flushing' ewes prior to joining with short term supplement of lupins or green pasture/ lucerne to increase ovulation rate and the number of ewes cycling (if below 2 score).

Joining to lambing

Livestock targets

- The targets are 2.5 to 3 FS for merinos and 3 to 3.5 FS for meat sheep. Use pastures to achieve the top end of the FS range in as many seasons as possible. In tough years accept the ewes will be in the lower end of the range.
- In foot abscess areas aim to have ewes no more than FS 3 (M) FS 3.5 (MS) at lambing to help manage the problem. This could involve losing weight immediately after joining.

Grazing management

- Identify lambing paddocks early and plan to achieve a minimum of 900 kg green DM/ha accumulated in them by lambing, varies for twins and singles.
- Fodder budgeting provides the information to ration limited pasture supplies specifically to meet the needs of lambing ewes.
- While this period often coincides with a low seasonal pasture growth, target at least some growth in last year's weaners, 1.5 kg/month. Even low weaner growth rates should ensure the development of significant levels of worm resistance.

Lambing to weaning

Livestock targets

- Optimise lamb growth rates especially post marking.
- Optimise hogget growth rates to ensure target liveweights are met for joining.

Grazing management

- A minimum pasture benchmark of 1500–1600 kg green DM/ha 1 month after lambing for both ewes and lambs.
- Identify weaning paddocks early. Plan to achieve an herbage mass in the range of 1500–1800 kg green DM/ha and low worm status for weaners.

Where necessary, lift stocking density at lamb marking to ensure paddocks do not become rank and lose quality. If possible, maintain herbage mass below 1800 kg DM/ha. This could involve 3 lambing mobs combined into 1.

Further reading and information

- *The sheep business: prime lamb production and marketing guide for NSW*. NSW Agriculture (Booklet).
- *Livestock feeding on pasture*. New Zealand Society of Animal Production. Occasional Publication No. 10. Hamilton, New Zealand.
- www.dpi.nsw.gov.au
  Primefact 151 – *Fat score at joining: the benefits of optimal nutrition*.
  Primefact 309 – *How responsive is the conception rate of your merino ewes?*
  Primefact 308 – *Maiden merino ewe conception rates.*
  Primefact 807 – *Why fat score breeding ewes.*

PROGRAZE™

Profitable, sustainable grazing

SEGMENT 5

CATTLE BREEDING PACKAGE

In this segment you will learn:

- How to fat score cattle.
- How fat scoring is used, in conjunction with pasture benchmarks, to manage the nutritional requirements of the cow herd through the annual breeding cycle.
- Of the management of cows, bulls and weaners through the breeding cycle.

CATTLE BREEDING PACKAGE

Key factors in the cow breeding package are:

- Skills in pasture and livestock assessment.
- Establishing pasture and livestock targets.
- Developing sound cow/heifer management practices.

FACTORS TO BE CONSIDERED

Managing the breeding herd involves decisions on several key factors in determining the best annual breeding calender:

- Calving/weaning rate targets.
- Bull management.
- Joining time and length.
- Age to join heifers and heifer management.
- Weaning age.

Availability and reliability of pasture will influence some of these decisions.

WHAT ARE THE TARGETS?

The aim of a beef enterprise must be to get each cow to produce one calf per year at the optimum or most desired time (not one calf every 15 to 18 months). Given a gestation period of 280 days and a return to first oestrus (on heat) of 55 days, this leaves a period of 30 days for the cow to rejoin and so produce the required one calf each year.

280 days	55 days	30 days
Pregnancy	Normal time to start cycling	Two heat chances

Other targets are:

- A condensed calving over 6–12 weeks.
- Weaning rate of 85% or better (to cows joined)
- Joining heifers at minimum liveweights:
  - » 280 to 320 kg British breeds and crosses depending on mature cow size
  - » 300 to 340 kg European and Bos Indicus breeds and crosses
- Joining heifers to calve at 24, 30 or 36 months of age, depending on expected growth rates.

FAT SCORING CATTLE

Fat scoring cattle ideally uses both visual and manual assessments.

Visual assessment

Visual assessment is less accurate but can give a useful indication of overall fatness. A number of sites can be referred to when visually assessing fatness (Figure 5.1).

What to look for as cattle get fatter:

- Ribs become less visible.
- Fat deposits are visible beside the tailhead.
- Muscle seams of hindquarters become less evident.
- Brisket, flank, cod and twist all fill out giving less sharp – more rounded and then a squared appearance.

From the rear the top line gets rounder as fatness increases As cattle get fatter, knobs appear on both sides of the tail head and both the cod and twist fill with fat. Leaner animals have a more prominent tail head, the twist is more angular and more wrinkled and the cod is less noticeable with little fill. Like the twist area, the flank also appears much sharper in lean cattle but appears more rounded and 'let down' as fat is deposited there.

Individual muscle groups can be more readily seen in lean animals. In particular, muscle seams can be seen in the hind quarter from the side and rear when animals are in fat score 1 and 2.

From the front and side views, the brisket becomes fuller and more rounded as fat is laid down there. A deep, full briskets indicates excess fat.

Manual assessment

Manually assessing fatness often allows for a more accurate assessment of overall fatness. Sites are assessed where fat can be readily differentiated from muscle (see Figure 5.2).

These areas include the ends of the short loin ribs (A), or over the long ribs (B and D) and around the tail head (C). Some older animals may be very fat and ribs will not be able to be felt. If, by placing a hand flat on the hide, you cannot feel the ribs, this indicates that fat is likely to exceed 30 mm. In these cases assessments are best done on sites A, B, and C. Generally make assessments around the tail head area and cross check on the ribs.

Figure 5.1. Reference points for visual assessment.

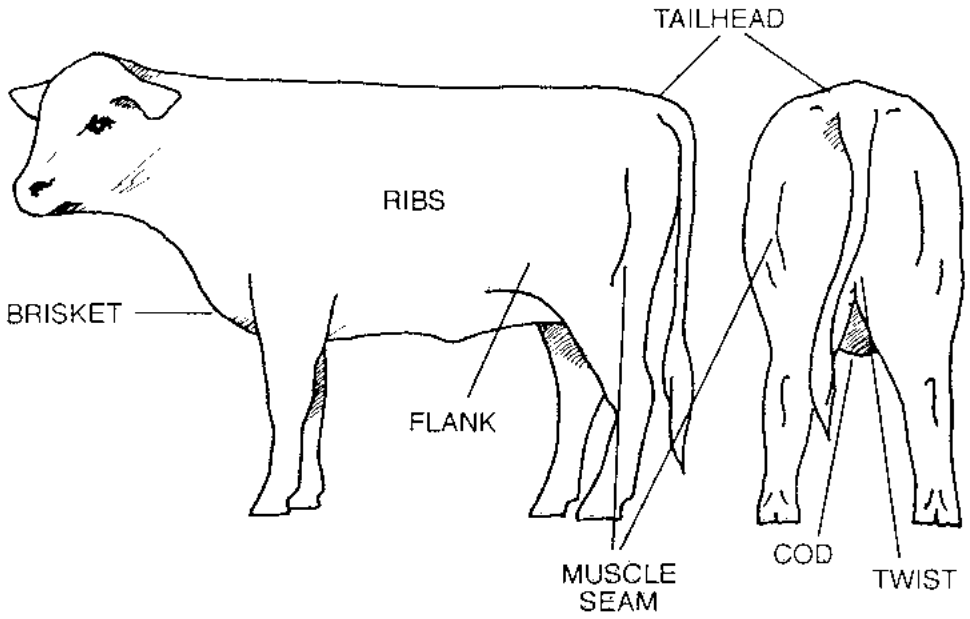
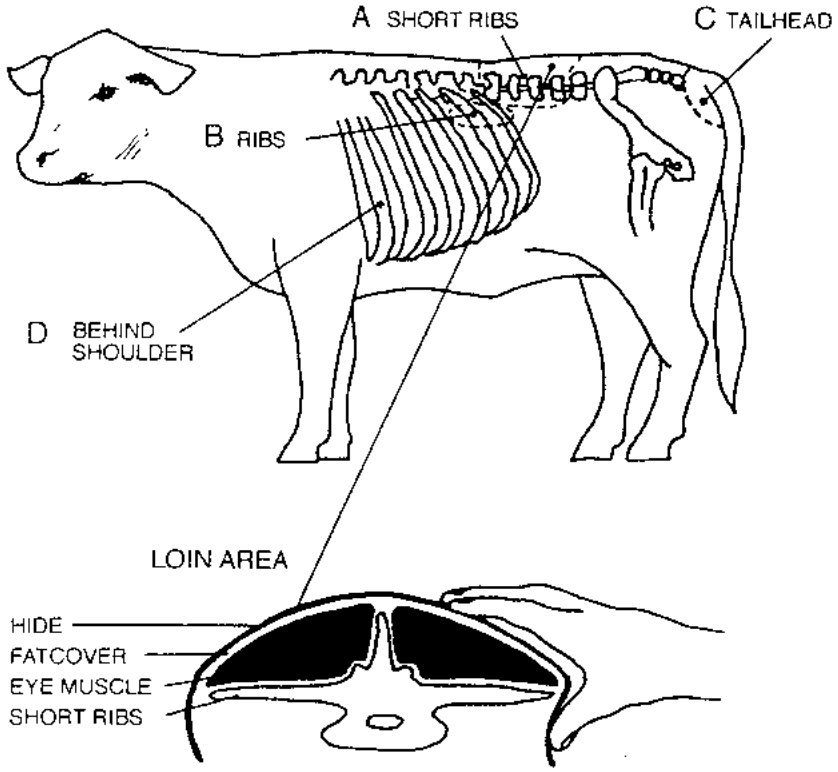


Figure 5.2. Location and position for fat scoring cattle.



Understanding Fat Scores

Fat scoring is used to assess fat thickness.

A description of fat scores is given below. (see Figure 5.2).

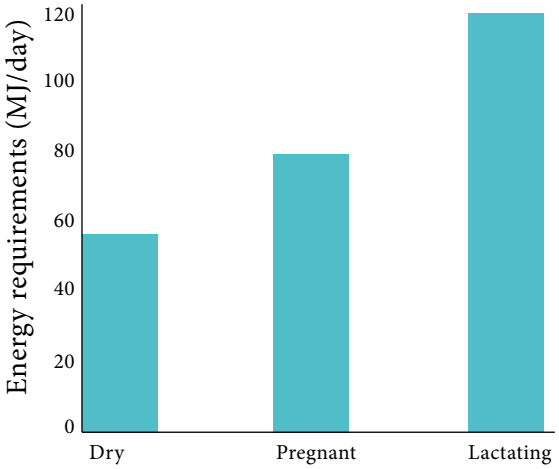
Description	Score
Animals maybe emaciated. Short ribs feel 'sharp'. There is no fat around the tail (C). Hip bones, tailhead and ribs are prominent.	1 (0–2 mm* P8; 0–1 mm 12th rib)
No fat beside tail head (C). Short (A) and long ribs (B) are easily identified. Short ribs feel rounded rather than sharp. Hip bone and ribs (B) still feel hard. Ribs are no longer visually obvious.	2 (3–6 mm P8; 2–3 mm 12th rib)
Short ribs are more rounded but still easily felt. The ribs (B) are easily felt with firm pressure. Muscle seems fill, appear smooth. Easily felt fat cover either side of the tail head (C).	3 (7–12 mm P8; 4–7 mm 12th rib)
Short ribs cannot be felt. Some fat cover over the hip and back bones. Small mounds of fat that are soft to touch are around tail head. Ribs are difficult to distinguish.	4 (13–22 mm P8; 8–12 mm 12th rib)
Short ribs cannot be felt. Tail head and hip bones are almost buried in fat. Ribs (B) are 'wavy' from fat folds. Brisket and cod appear full. Squaring off in the flank area.	5 (23–32 mm P8; 13–18 mm 12th rib)
Short ribs cannot be seen. Tail head and hips are completely buried by large 'rounds' of fat. Ribs 'waved' from fat folds. Heavy brisket and cod/udder. Squared off flank and blocky appearance. Mobility reduced to a walk.	6 (32+ mm P8; 18+ mm 12th rib)

*Millimeters of fat

NUTRITION

Feed requirements of a breeding cow are highest immediately after calving through to joining. Figure 5.3 indicates the relative change in energy requirements of a dry to lactating cow. These energy requirements must be obtained from pasture and/or supplements or through the use of the cow's fat resources.

Figure 5.3. Energy requirements of a breeding cow.



Research has shown that fat score at calving, cow age (with both first calvers and older cows susceptible to lower fertility) and nutrition during early lactation affect fertility at joining. The higher the fat score at calving the greater chance the cow will be in oestrus 60 days from calving (Table 5.1).

Table 5.1. Fat score of cows at calving and percentage of cows returning to oestrus (on heat) after 50, 70 or 90 days.

Fat score at calving	Days after calving % on heat		
	50 day	70 days	90 days
1–2	34	55	66
3–4	45	79	91
4–5	42	96	100

One third of cows in fat score 1–2 have not cycled by 90 days after calving. They will not calve again within the target 12 months. They will calve later and later each year until they fail to get pregnant at all. This effect is even greater with young females.

Following calving, cows should be on high quality pasture. This ensures early rejoining. When feed supplies are limited, supplementary feeding may be required to stop reproductive rates falling.

Bull management

To achieve a high reproduction rate, bulls must have a good libido, be able to serve cows and produce quality semen. Various injuries, fevers and high temperatures may influence libido and the bulls ability to serve.

Aim for fat score 3 of the bulls at joining. Fat bulls may become lazy and susceptible to high temperatures,

reducing their work rate. The rate of bull breakdown is related to excess fatness, restrict pasture to fat animals well before joining. Conversely, consider supplementary feeding bulls, commencing 3 months prior to joining, if bulls are in poor condition.

To avoid disease transfer, and fighting injuries, join young bulls to heifers and older bulls to cows. Check these three areas to improve bull joining performance:

- General health and condition; includes sound feet and legs, abnormal teeth formation (which will influence feeding).
- Sheath free of infections/irritations; testes firm and free from any lumps.
- A scrotal circumference of at least 35 cm and 31 cm for mature and young bulls respectively. Sperm production (and fertility of daughters) is directly related to teste size.

The joining period

Ideally, joining should coincide with the seasonal feed flush to maximize conception rates, although market targets can influence this aim. Joining prior to the feed flush can lead to increased costs associated with:

- Supplementary feeding.
- Lower stocking/fertility rates.

The joining period determines the length of calving. If calving is drawn out, cows may calve each year but not once every 12 months. This reduces herd productivity.

A longer calving period:

- Increases the chance of feed shortages
- Increases the range of weaning weights and likely selling costs.
- Reduces the time for heifers to reach joining weight. A tighter calving may give more calves access to the best feed from weaning, meaning more weight at 15–18 months.

Weaner and heifer management

Weaners require special attention to ensure they are well grown prior to joining but also avoiding obesity in heifers as it can reduce lifetime fertility and milk production.

Heifers must be grown out to meet minimum joining weights. These weights are set to ensure that 85% of heifers are cycling. The actual weights will vary depending on the mature weight of the cow herd and also the expected weight gain between joining and calving but guidelines are 280 to 320 kg for British breeds, and 300 to 340 kg for Euro/Bos Indicus heifers).

First calvers are the hardest group to get back in calf and need careful management. Heifers may be advantaged by joining 3 weeks before the main herd as it makes supervision easier gives them longer to recover for joining. Join heifers to sound young bulls for 6–9 weeks.

Calving heifers at 2 years of age has economic benefits but should be considered only when they:

- Reach minimum joining weights at 12–14 months of age.
- Can reach fat score 3 and weigh over 450 kg prior to calving.
- Can be supervised at calving.
- Can be given high quality feed after calving to make sure they rejoin.

Heifers calving at 30 months is an alternative to 2 year old calving. This practice allows heifers to calve down out of season, i.e. autumn for a spring calving herd, and vice versa. Heifers are then rejoined to calve early in the cow calving group.

Calving at 3 years (usually 3–6 weeks before the cow herd) is still common in areas with lower pasture quality. As heifers have an extra year to grow and mature, they are better prepared for returning to oestrus after their first calf, and in subsequent years.

Heifer nutrition

After joining the next target is minimum precalving liveweight which should be 450–500 kg for heifers calving at 30 months.

Over-feeding of heifers in late pregnancy can create calving difficulties. Nutrition must allow steady growth but not letting them become obese. Aim for fat score 3.

Avoid feed flushes for heifers if dystocia can be a problem. Where the clover content of pastures is high and is the dominant feed pre-calving, consider moving the heifers to a pasture less likely to improve fat score. Increasing stocking rate to reduce pasture availability and subsequent animal intake is the other alternative.

Feeding may be restricted over the last 6 weeks of pregnancy to maintain fat score.

Weaning age

Weaning age for calves depends on several factors:

- Feed availability and cow fat score. Cows can lactate for longer without losing weight in good years but may require early weaning in drier years.
- Type of cows. After 6 or 7 months, milk production in British breeds (more so than in cows with B. Indicus or European content) declines, with little gain for calves from leaving them on cows after this time.
- Type of production. Calves sold straight off cows (such as vealers and store weaners) may be left up to 10 months depending on whether feed is available and cows are not losing weight.
- Weight and age of cows. Cow fat score is the key factor to joining success. Ask: 'Can cows recover to the required weight by joining?'

Older, poorer cows will have greater difficulty in returning to oestrus than those in good condition.

Steers destined for the 2 to 4 tooth markets can be weaned, when feed is available, at 5–6 months. Once cows are back in calf, feed priority should be given to weaners.

Early weaning of late calving cows allows time for recovery and an earlier return to oestrus the following season. As well, first calvers falling to fat score 1 or 2 should have their calves weaned regardless of calf age.

Fat score and the weight gain associated with improving fat score are the major factors in improving conception rates.

FAT SCORE TARGETS

The use of fat scoring, in conjunction with the pasture benchmarks in Segment 2, enables realistic targets to be set and achieved as part of breeding herd management.

During the year pasture quality (digestibility) and quantity (kg DM/ha) will vary greatly between seasons. Cow fat score also varies as a result of both this and the lactation stage. Changes in cow fat score are normal and allow cattle to be managed through seasonal feed troughs, dry spells and droughts.

Cow fat score targets

Fat score targets for breeding cows can be set for weaning, calving and joining. These fat scores are the same for spring or autumn calving cows.

Feed supply will dictate how much the cow 'lives off her back'.

The relationship between cow fat score at weaning and cow fat score at the next joining is usually within half a fat score. This is why early weaning, based on cow fat score, ensure better fertility next joining (Figure 5.4).

As an example, a spring calving herd in northern New South Wales has a feed supply curve that reflects the summer dominant rainfall pattern. The cows lose weight after calving but then recover as pasture growth quality respond to spring/summer rainfall. After calving the cow will 'milk-off-her-back' if feed quantity is limiting. In a dry spring/summer, supplementary feeding or early weaning is necessary as cow fat score approaches 2.

Between joining and weaning, cows should put on weight. Early weaning can improve cow fat score dramatically when the autumn pasture is limiting and cows are losing weight. This practice particularly applies to fat score 1 and 2 cows.

Target fat scores and related management

Calving

- Cow fat score target range: 2.5–3.5
- First calvers require priority management.

Joining

- Cow fat score target range: 2.0–3.0
- Join heifers for 6 to 9 weeks
- Join cows for 6 to 12 weeks
- Supplementary feed if pasture quantity is inadequate, i.e. 'green drought', with hay or silage.

Prior to weaning

- Cow fat score target range: 2.5–3.5
- Wean early if cows fall below fat score 2
- Weaner education, health and nutrition are required to achieve weight targets, especially for early weaned calves.

Post weaning

- Cow fat score target range: 2.5–3.5
- In 'tight' seasons draft cows and heifers to above/below fat score 2.5 to allocate specific pasture and/or supplements.

When managing the breeding herd to fat score targets it is important this is done in conjunction with the pasture benchmarks contained in Segment 2 of this manual. The pasture benchmarks provide guidance to the type of pasture required to maintain or change cow fat scores.

Figure 5.4 shows cow fat score targets and the variation that may occur over the year. Breeding cows need to maintain fat score 2 or more in order to optimize production. A 1 unit increase in fat score can be achieved in 40–80 days on good quality pasture, except during peak lactation.

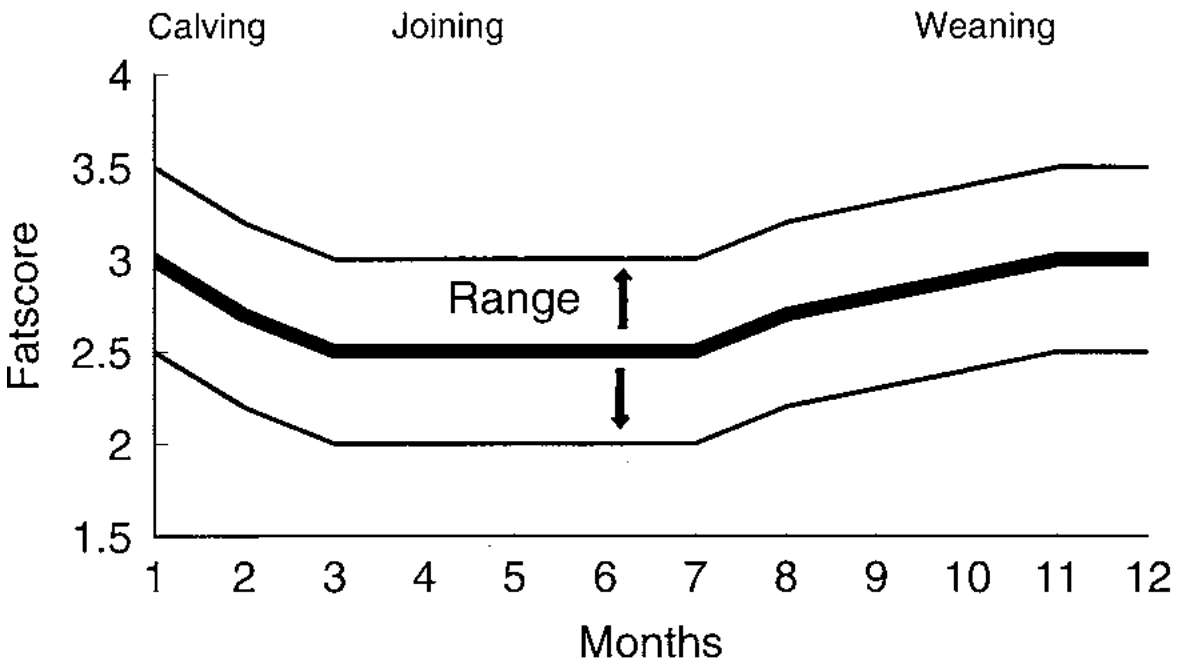
During the year (and across years) the fat score of individual cows in the herd will vary enormously. This range is normal and reflects the wide range of fat score that cows can tolerate. However, at either end of the fat score range production losses occur from poor reproductive rates and low calf weaning weights.

To break a cycle of low fat scores, and subsequent low fertility, in the breeding herd, wean calves early and cow fat scores will improve.

For best results the herd should be managed so that breeding cows remain within the range of targets shown in Figure 5.4. Calving time will vary between summer and winter rainfall areas.

Note that due to lower pasture availability over winter, autumn calvers need to be to the higher end of the fat score range compared to spring calvers. This often means weaning earlier to allow cows to build fat reserves over summer.

Figure 5.4. Cattle fat score targets.



Conclusion

The most critical period for a breeding cow (and for dollar return) is from calving to the end of joining. Cows must have sufficient herbage mass or fat score (or both) to be able to rejoin successfully.

Pasture benchmarks for herbage mass show when strategic feeding is required to ensure target condition scores are achieved. Drafting cows on fat score at weaning allows low fat score cows to have 'best' feed to improve fat score pre-calving.

Supplementary feeding to maintain the herd calving pattern should be considered in poor seasons.

SUMMARY

- Cattle fatness can be estimated using a combination of:
  - » visual assessment to determine the general levels of fatness
  - » manual palpation to fine tune the visual assessment.
- Breeding cows have their highest feed requirements (quantity and quality) after calving to joining.
- Fat score at calving, age of cow and nutrition in early lactation affect fertility.
- Aim for bulls to be in fat score 3 at joining, no more.
- A joining period of no more than 4 cycles is recommended.
- Early weaning, 4-7 months of age, is a practical way to manipulate the fat score of cows.
- Heifers to be joined as yearlings (12 to 15 months) need to reach critical mating weights (British breeds and their crosses – 280 to 320kg/European and Bos Indicus breeds and their crosses – 300 -340 kg).
- Joined heifers must not get to fat score 4 or more (over fat and lazy at calving).
- Weaning age/time depends on feed quantity/quality, fat score and age of cows.
- After weaning cows must be managed to increase their liveweight before calving. The benefits are:
  - » improved fertility at their next joining, and
  - » higher milk production, resulting in better calf growth, in early lactation.
- Fat Score Targets allows fertility and calf growth rate to be managed.

Further reading and information

- www.dpi.nsw.gov.au

NOTES

PROGRAZE™

Profitable, sustainable grazing

SEGMENT 6
INCLUDING APPENDICES 3 & 4

PASTURES AND GRAZING

In this segment you will learn:

- Some of the basic principles of pasture growth.
- How grazing management can impact on pasture production.
- How grazing management, and other complementary management tools, can be used to manipulate the species composition of pastures.
- The grazing management requirements of specific pasture species.
- The relative productivity of the major pasture types for your region.

PASTURES AND GRAZING

FACTORS CONTROLLING PLANT GROWTH

The 3 essential factors for plant growth namely photosynthesis are:

- Sunlight
- Soil water
- Carbon dioxide

If any of these factors are missing, growth cannot occur.

The rate of plant growth is influenced by:

- Leaf area – how much green leaf there is to capture the sunlight.
- Fertility – nutrient deficiency or toxicity slows plant growth.
- Available soil water – the harder the plant has to work to extract moisture from the soil the slower the growth. Water logging also slows growth but by different methods.
- Temperature – all species have a range of temperatures in which they will grow e.g. for winter growing legume and grass species the minimum temperatures for growth are 5 and 8 degrees respectively with a maximum of 27 to 30 degrees. Summer growing species have higher minimum and maximums for growth. Growth will be slower when the temperatures are near either end of the range. This applies within a day and across the year. These ranges will vary slightly between species within the same group.

We have some control over the speed of plant growth. The leaf area during the year at a paddock level is controlled by our grazing and paddock resting decisions. Soil fertility is controlled by our decisions on nutrient input. Growing pastures and selling livestock products removes nutrient from the soil. If the nutrients removed are not replaced then soil fertility will drop.

We have no control over soil water and temperature but we can modify their impacts by species selection and where in the landscape we plant species. Too often pastures fail because the wrong species are sown in the wrong paddock. It is essential to only plant species that are adapted to the soil type, aspect and climate.

PLANT GROUPINGS

The major pasture plants (native and introduced) can be grouped into grasses or legumes, then into perennial or annual. Perennial species regrow each year from root reserves while annuals grow from a seed each year.

Another grouping is temperate or tropical. Temperate species tend to be winter/spring growing, so are able to grow at lower temperatures. Tropical species are late spring/summer growing, can tolerate higher temperature and are more water use efficient. These differences are due to a different internal make up. Temperate species and tropical legumes are classified as C3 and tropical grasses as C4 species, with the C relating to the biochemistry of the plants photosynthesis.

Section 2 talked about the differences in digestibility and animal performance from the C3 and C4 species.

C3 and C4 species can both play an important role on any property. The proportion of each will depend on your location within NSW. There is a mixture of C3 and C4 species in all areas of NSW, C4 are more common in the north and towards the coast and C3 are more common in the south. The important issue is to match the different strengths of C3 and C4 species to the properties objectives.

Knowing what species, including weeds, you have is important for seasonal decision making. Record your species under the following headings:

- is it perennial or annual,
- is it winter or summer growing.

Where these species occur on the farm is also important as it determines where you should be grazing, with what stock and when.

Why include weeds? Most pastures contain some weeds or less desirable species. It is important to note that some weeds impact more seriously on a pasture, e.g. serrated tussock and need to be controlled. Other species, e.g. barley grass is positive for winter growth but negative to stock when seeding. It

is the negative aspects, i.e. seed set, that need to be managed or avoided, not necessarily the control of the species. The density of the weeds determines what control measures need to be used.

Weeds are most successfully controlled using competition. Knowing what pasture species and weeds you have and when they grow allow you to plan grazing or other control methods to place competition pressure on the weed.

The majority of pastures are made up of many species so competition is occurring every day between species for light, water and nutrients. This competition is influenced by the growth habit of the different species i.e. short or tall growing. Longer rest periods favour the taller growing plants by shading the shorter ones. This is positive if the shorter species are weeds but negative if the shorter species are desirable and the shading causes their loss. Legumes provide the nitrogen for the grasses, need sunlight for seed set and are often short growing hence sensitive to shading by grasses.

Plants and production

The key to obtaining high animal production from pastures is by maintenance of productive pasture species. Production is determined by:

- The number of plants.
- How quickly they grow.

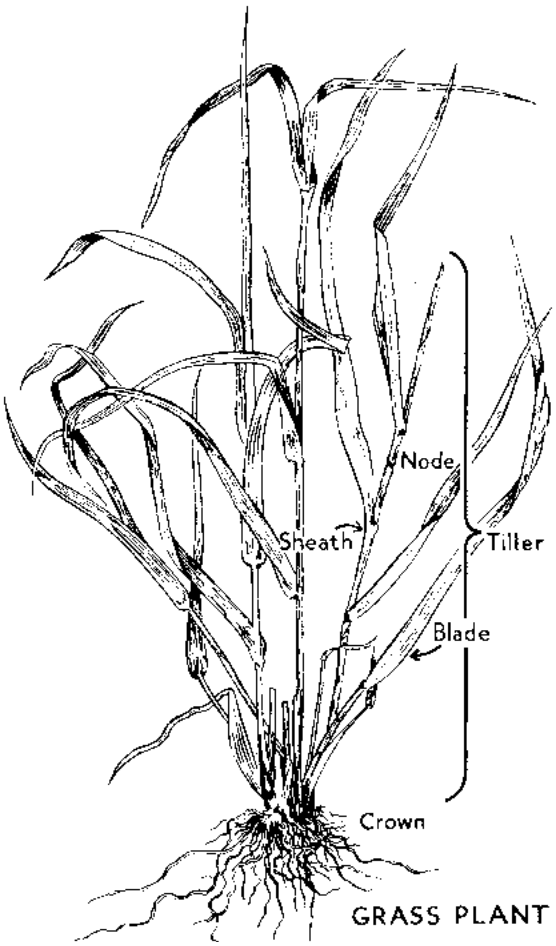
Growth of pasture occurs through an increase in the weight, and the number and size of leaves and stems. The rate of change of leaf and stem size and weight of an individual plant will be influenced by the competitive advantage of that plant.

In every pasture there is continual competition between plants (of the same species and of different species) for nutrients, moisture and sunlight. When one species is disadvantaged (for example, by selective grazing) another species may be advantaged. Similarly, as soils become acid, some species will tolerate and survive while the growth of others is reduced.

Grass growth

Grasses reproduce and become larger by production of tillers from the base of the plant causing the 'clumpy' appearance of most grasses (see Figure 6.1). Sunlight to the base of the plant is the stimulus for tiller production.

Figure 6.1. Key growth features of a grass plant.



Reprinted from *Pasture Legumes and Grasses* with permission from Westpac Banking Corporation.

Tillers are produced over growth periods but die when moisture becomes limiting or are shaded from sunlight by excess growth of older ungrazed tillers or competing species. Most species have a limit of 3 to 5 leaves per tiller. Once this maximum is achieved a leaf will die as a new ones grows

We can use the grazing action of animals to increase tillering and help thicken pastures. By keeping pastures in the range 3–15 cm sunlight reaches most of the plant material and allows maximum production of new tillers or competing species.

For reproduction, some grasses propagate vegetatively (e.g. kikuyu, rhodes grass) but most regenerate from seed. Opportunities have to occur for seeding and for regeneration of seedlings. This is essential for annuals, less so the perennials.

Perennial grass based pastures, well managed, use soil water to depth and help to reduce deep drainage. The deepest roots on perennial are survival roots. Their purpose is to access water in dry times or during dormancy to keep the plant alive. The roots that drive growth are in the top 40 cm.

Legume growth

The amount of legume (or clover) in a pasture is important because it increases the quality of the pasture mix. In the vegetative stage, legumes are highly digestible, and capable of supporting high levels of livestock production.

Where the digestibility of the grass and legume component is the same, the intake of the legume is likely to be higher than the grass, resulting in increased liveweight gain.

Legumes also benefit grass as they add nitrogen to the soil.

Too much clover in the diet of cattle can cause bloat. On the other hand, sheep grow well on high clover diets. As a recommendation, a balanced sheep/beef pasture will contain 15 to 30% of clover on a dry weight basis in spring.

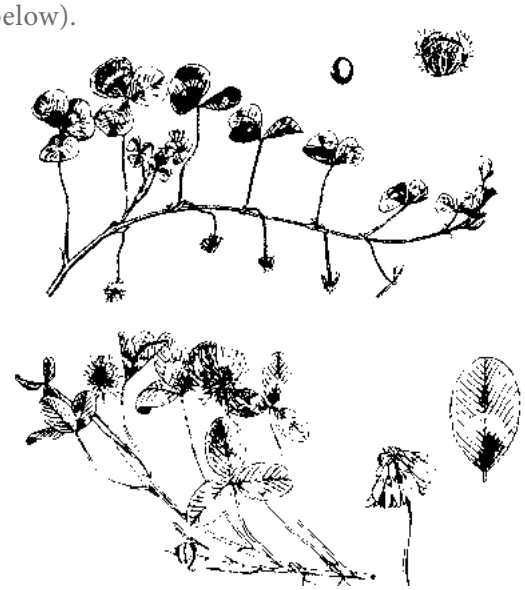
An efficient fertiliser management program will be important to achieving this outcome.

It is imperative then that management decisions take into account the legume component as it is a key factor driving the pasture/livestock system.

Legumes grow differently depending upon whether they are annual or perennial. For annuals such as subterranean clover, growth is from seed with numerous stems developing from the crown above a taproot. After rapid early growth in autumn, development slows over winter with seed production following flowering in spring. Grazing of taller grasses to open up the pasture over winter and spring allows sunlight to the clover leaves and encourages seed production.

A perennial clover such as white clover, consists of several shoots or stolons (see Figure 6.2). Stolons may have root systems and produce other leaves and runners (new stolons). Other legumes may form crowns and have a single tap root, producing a more clustered appearance rather than branching.

Figure 6.2. Subterranean (top) and white clover (below).



Reprinted from *Pasture Legumes and Grasses* with permission from Westpac Banking Corporation.

An example is lucerne, which when well managed, is efficient in reducing deep drainage of soil water.

Reproduction in legumes is by varied means. Some are dependent on high soil seed reserves, such as subterranean clover and medics, others can reproduce by vegetative means (stolons) such as white clover. As with grasses, opportunities have to be provided for regeneration if persistence is important. This will vary for the species, and even varieties within species (e.g. Haifa white clover is more dependent on seed set for persistence whereas small leafed types are less so). Strategic spelling and grazing can have a dramatic effect on seed set of annuals (e.g. subterranean clover).

Growth curve of plant production

The different growth habits, tall or short, of species varies the way you assess how they will perform in the growth phases. Figure 6.3 shows simplified and representative growth curve of pastures typically tall grasses, consisting of three phases: Short growing species can persist in phase 1 without the listed negative factors.

Phase I. Pasture growth is slow because of low leaf area. Prolonged grazing in Phase I during the dry season can kills plants, can create bare areas and leads to runoff of water, erosion and weeds.

Phase II. Most rapid pasture growth occurs here. More sunlight is caught by the increased leaf area and converted to pasture growth. Pastures maintained in this condition are highly efficient users of soil water.

It is in this phase where pasture growth rates will be greatest, where livestock productivity is highest and where pastures can make their most positive impact on sustainability. Management should aim to maintain paddocks in this phase for as long as possible, it can only be done on a selection of paddocks resulting in other paddock being allowed move into phase 3.There will be times when management requires that pastures be in Phase 1 or 3.

Phase III. Plants are mature, of lower quality and may, through competition and shading, reduce establishment of new plants or limit seed set on shorter species. Pasture growth is therefore slowing and death of plant material is greater than the re-growth.

The height to which pastures should be grazed varies with pasture species, climate and soil factors. For example, a phalaris/sub clover pasture in good tableland conditions responds to maintaining pasture between 5 to 15 cm whereas a microleana/sub clover pasture is best kept in the 4 to 8 cm range. (See Appendix 3 for more details)

There will be occasions when grazing in Phase II is not desirable and grazing in Phases I and III are beneficial – for removing dead material or competing species (Phase I) and for regeneration of the species (Phase III).

On the tablelands and slopes the critical times to be concerned with the phases of pasture are:

- At the end of winter before spring growth.
- Between summer and autumn for annual pastures.

Usually, pastures are in Phase I at the end of winter with minimal leaf area. Re-growth will depend on leaf area, soil moisture and temperature. To make the best use of increasing temperatures in the spring, plan to have some pastures with a greater leaf area to maximise growth. Paddocks below 800 kg/ha at the start of spring will grow slower and longer into spring. This helps with management of spring when control of the pasture quantity is required to maintain pasture quality. Over winter the aim should be to manage pasture so that at the end of winter, they are around the Phase I/Phase II boundary.

The same principle applies to annual temperate pastures following the autumn break. A spelling period to allow pastures to accumulate leaf area and achieve 500–800 kg green DM/ha before grazing, gives greater growth over early winter and improved spring production.

SOIL FERTILITY

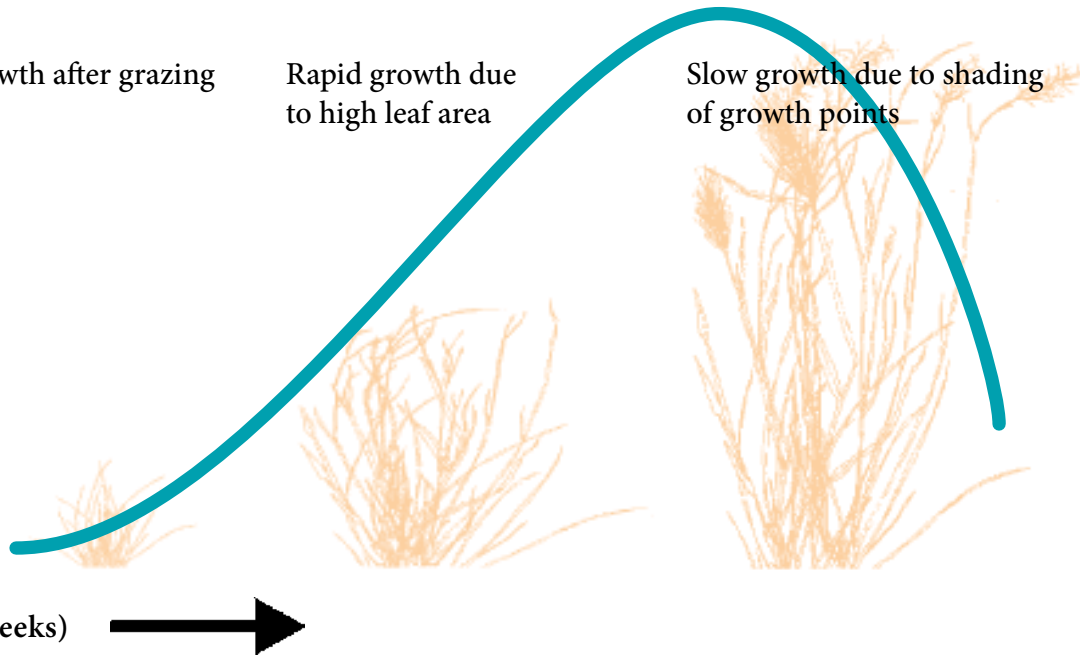
Of all the factors that producers have control over soil fertility is the one that has the greatest influence on pasture production and if this is combined with a stocking rate that make good utilisation of the pasture grown then farm profits/ha will increase. Benchmarking results for the last 30 years has shown the importance of stocking rate as a profit driver but stocking rate follows the improvement in pasture production. The positive impact of soil fertility works across introduced and native species and a variety of soil types.

Download the 5 easy step booklet from the MLA web site for more details on;

- Working out your critical fertility values, going above these values is a waste of money.
- How to taking a meaningful soil tests?
- How to calculate maintenance rates of fertiliser?
- Match your stocking rate to your soil fertility levels to drive profitability.

Figure 6.3. Simplified growth curve of pastures.

PHASE I	PHASE II	PHASE III
Characteristics		
Below about 800 kg green DM/ha of a moderately dense pasture	Between about 800–3000 kg green DM/ha of a moderately dense pasture	Above about 3000 kg green DM/ha of a moderately dense pasture
Positive aspects		
• Grazing enables control of unwanted species • Grazing enables reduction of litter prior to germination of desirable species • High digestibility	• High yield of high quality pasture • Grazing pressure will delay onset of flowering • Rapid pasture growth • Good livestock weight gain • High yields of feed • Good use of soil water • Good protection from run-off	• Replenishes energy reserves of perennial species • Allows seed set and replenishment of seed reserves in the soil for tall growing species • Low risk of run-off and erosion
Negative aspects		
• Slow pasture growth rate • Long term grazing threatens plant survival, tall species • Increased run-off and soil erosion risk • Low livestock weight gains	• May not allow desirable pasture species to seed down	• Low pasture quality Slow pasture growth rate • Suppression of companion species in pasture • Normally livestock lose weight • May inhibit germination of annuals the following season • Poorer use of soil water
Yield: Low Quality: High	Yield: Good to High Quality: Good to High	Yield: High Quality: Low
Slow growth after grazing	Rapid growth due to high leaf area	Slow growth due to shading of growth points



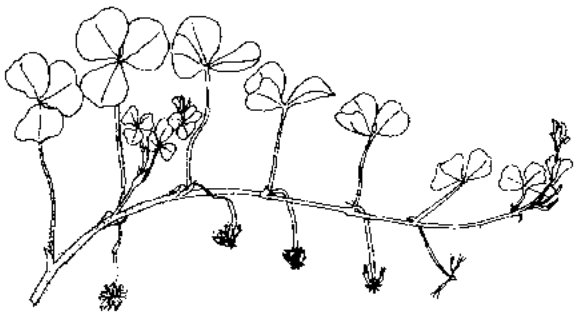
THE INTERACTION OF PASTURES AND LIVESTOCK

Pasture/livestock systems are very complex. Consequently, a large number of factors and interactions need to be considered to achieve the desired outcomes. For this reason, simple recipes for grazing management are not appropriate for optimal long-term pasture and livestock production. Knowledge of the principles and their application will enable greater progress.

Pasture plants of different species and varieties vary greatly in their response to grazing. Knowledge of how individual pasture plants respond to grazing is essential for top performance and pasture persistence. For example, lucerne has been extensively studied and a rotation with a 1 month rest is best for persistence and production. (See Appendix 3 including the north coast supplement for detail on individual species).

There are a number of features needed for successful pasture production. They are:

- Adequate ground cover of persistent adapted pasture species must be maintained. Besides being critical for farm carrying capacity, this reduces surface run off, erosion, improves soil health and the quality of run-off, and improves water infiltration reducing the potential for nutrients entering waterways and for weed control. Replacing washed off nutrient is very expensive.
- Good management at critical times (e.g. spring and autumn for many species) can favourably affect composition and persistence.
- Sown pastures need a well-adapted and persistent legume component. Without it, persistence and production of desirable grasses is likely to decline unless fertiliser nitrogen is added.



Pasture production and therefore carrying capacity, is mainly affected by species present, fertiliser, soil type, moisture, temperature, adequate leaf area and the grazing history. Producers can influence species choice, fertiliser inputs and the way stock graze pastures.

As perennial plants do not live forever, they need to be managed to keep them productive for as long as possible and provide opportunities for new plants to establish. To do this:

- Use the best adapted species and varieties for the climate, soil fertility and paddock.
- Have a range of pasture types on properties so that all pastures do not have to be managed in the same way at the same time. This provides practical flexibility.
- Ensure that soil nutrients are adequate; especially phosphorus, sulphur and molybdenum. The quickest way to improve pasture production is by getting the soil fertility to the right level to match the stocking pressure.
- During the establishment year, grazing management should aim to ensure that perennials establish good root systems and that annual legumes flower for seed production. Provided they cannot be pulled out and there is good soil moisture, new pastures can be grazed for short periods when greater than 15 cm tall. Do not leave stock in for extended periods allowing them to overgraze new plants. Grazing stimulates tillering and root development when growing conditions are good.
- Where perennial grasses are sown under less favourable conditions e.g. surface sowing, sowing late in the season, low fertility, dry conditions during establishment, and the root system is not developed; they will benefit more by not grazing in the first year.
- Desirable annuals should be encouraged to set as much seed as possible.
- In both annual and perennial pastures the proportion of clover in the pasture mix can be manipulated by pasture management strategies.

WHY USE GRAZING AS A MANAGEMENT STRATEGY?

Grazing management can have a significant role in achieving the following:

- Optimising pasture growth rate by keeping pastures in a growing state, which positively influences carrying capacity.
- Using feed efficiently and profitably to meet livestock production and market targets.
- Ensuring feed quality is satisfactory for stock.
- Enhancing persistence of desirable plant species.
- Maintaining adequate ground cover to reduce run off, prevent erosion, improve the quality of water entering waterways and resist weed invasion.
- In some instances, control insect infestations e.g. blue green aphid on lucerne.
- Strategic intervention by grazing management is often necessary because our pasture species are not ideally matched to:
- Climatic variability, soil type, weed competition, grazing habits of livestock, grazing pressure and soil fertility

Grazing management should be considered as routinely as any other management tool, such as fertiliser or herbicide and indeed grazing management is best used effectively in conjunction with one or more of these tools.

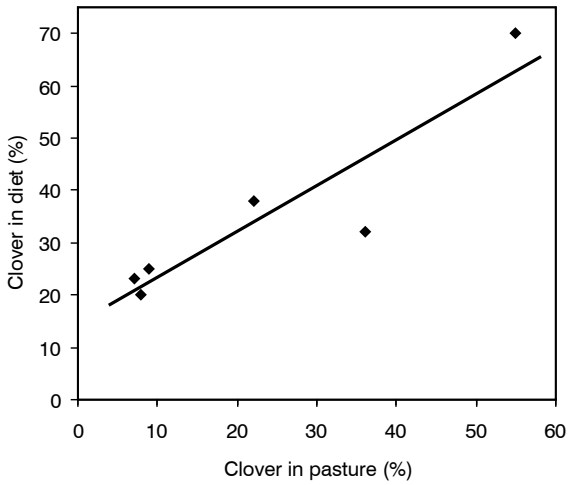
Impact of different livestock on pastures

Sheep and cattle have different feed preferences and different grazing behaviour. But both select leaf in preference to stem, and stem in preference to dead material.

When herbage mass is high, sheep will:

- Select green material.
- Tend to graze closer to the ground than cattle.
- Select leaf material and clover (see Figure 6.4).
- Have a greater impact on the botanical composition of the pasture than cattle.

Figure 6.4. Sheep preferentially selecting clover. Their diet may contain proportionally more clover than what is available.



From Milne et al, 1982 *Grass and Forage Science*, **37**: 209–18.

Cattle on the other hand:

- Also select green material but are less selective and are able to quickly reduce the mass of herbage, without particular selection of an individual plant.
- Can be used to clean up rank pastures because they are less selective than sheep and they will remove more dry feed, even though it is of lower quality.
- Grazing of sheep and cattle together on a pasture will often improve animal production and pasture stability.
- Selective grazing will occur according to variation in attractiveness of a plant to the animal.

Dry seasons – perennial grasses

Native grasses and the main introduced perennial grasses are relatively well adapted to our variable climate, some more than others (e.g. phalaris is better adapted than perennial ryegrass).

Recent research has indicated that survival in drought can be assisted by leaving a reasonable amount of pasture. This is also desirable as it reduces erosion risk and encourages water infiltration. Ideally leave a cover of 1000 kg DM/ha in prolonged dry conditions. To achieve this, concentrating stock into a few paddocks needs to be implemented in order to save the better paddocks for rapid recovery following the break of the drought. Native pastures will often recover better from intensive grazing during drought.

In the case of all perennial grasses, the effect of a moderate drought on their survival may be more severe than that of a major drought. Perennial species are at greatest risk if they grow in seasons when soil moisture is low and variable. Species that have good persistence (phalaris) tend to be dormant during this period and are protected. Species that continue to grow (summer active cocksfoot) during these periods are less likely to persist because they are providing all the quality feed for stock and so taking all the grazing pressure. To maintain these species leave 1000 kg/ha residue after each grazing.

The Stockplan program helps producers work through what drought strategies suit them best. There is no ideal drought plan. They range from feeding all to getting all stock off your place by sale or agistment and points in between. They have different strengths and weakness which need to be considered by each producer.

MANIPULATING SPECIES COMPOSITION

The botanical composition of a pasture affects the amount and quality of herbage on offer. This in turn affects animal production. Botanical composition can be modified in pasture using fertiliser, herbicides and strategic grazing and is more effective if used together in a planned improvement strategy. Note, when attempting to change the botanical composition of pastures containing native pasture species, The *Native Vegetation Act* (2003) may impact on some practices. Inquire through your local LLS office for further details.

By grazing management

Modification of botanical composition of a pasture by grazing can be achieved through:

- Heavy or light stocking densities.
- Continual grazing by either sheep or cattle.
- Changing the length and frequency of rests (for desirable species).
- Strategic grazing based on the stage of growth of the plant.
- Hard grazing over the flowering period to reduce seed production of undesirable species.
- Tactical cutting (fodder conservation or slashing).
- By allowing pastures to seed and regenerate.

In the establishment year of a pasture it is desirable that plants be allowed to set seed. However, with well established pastures, allowing perennial plants to seed annually is not critical.

The decision to allow established pastures to seed will be influenced by:

- Whether annual or perennial based (more critical with annuals than perennials).
- Density of pasture (low density pastures may benefit).
- Threat of weed competition.
- Current seasonal conditions and the increased stocking density required to manage other paddocks
- Previous and current stress on the pasture, e.g. disease, grazing pressure, nutrient deficiencies (more stress, the greater the need to rest).

Occasional spelling at the reproductive stage is important for the preservation of species. However, the spelling strategy can be used in conjunction with grazing to change botanical composition. The best example is the control of wiregrass by strategic grazing and its replacement by wallaby grass by spelling at critical periods such as seedling establishment, flowering and seed set of wallaby grass.

Spelling to allow regeneration of some pasture species from seed is desirable but not understood for many of our pasture species. Requirements for some species are known (e.g. autumn for annual legumes and Haifa white clover; spring and autumn for wallaby grass etc.).

By grazing management plus fertiliser and/or pesticides

- Legumes tend to be more responsive than grasses to phosphorus and sulphur, and so fertiliser can be used successfully to manipulate the legume content in conjunction with appropriate grazing management to encourage legume growth and discourage competition from companion species. By increasing rates of

phosphorus and sulphur on deficient soils in particular, the content of legumes can be increased relative to grasses. Conversely, on soils where soil nutrient levels are close to critical levels and where high legume content is present, a reduction in application rates can reduce clover content.

- A fertiliser program that reduces or eliminates soil nutrient deficiencies increases pasture production and so farm carrying capacity. This in turn results in more efficient water usage (kilograms of pasture dry matter per hectare per 100 mm of rainfall), especially if deep rooted perennials are a component of pastures. Fertiliser programs should not apply nutrient above the critical level for pasture production. Read '5 easy steps' see further reading.
- The addition of nitrogen can be used to stimulate growth and improve feed quality of responsive grass species where soil nitrogen levels are low. The use of fertiliser to manipulate composition assumes that soil moisture is adequate for good plant growth.
- Spray topping, in conjunction with subsequent grazing for annual grass control.
- Spray grazing using a combination of sub-lethal rates of phenoxy herbicides combined with increased stocking pressure to remove broadleaf weeds. The grazing pressure required must be above 30 DSE/ha and often can be 50 DSE/ha. In large paddocks this pressure is often not possible so the method should not be used.

By using pesticides alone

- Selective use of broadleaf herbicides to reduce content of broadleaf weeds e.g. using selective hormone herbicides.
- Selective use of grass-based herbicides.
- Tactical use of insecticides for control of red legged earth mite in spring, to reduce problems the following autumn (note: This tactic may not be suitable for blue oat mite – seek latest information).

By stock type

- Cattle vs Sheep. Different grazing habits and dietary preferences can affect pasture composition. No firm recommendations are available on desirable ratios of sheep to cattle, for various pasture situations.
- Goats. Grazing by goats can cause a change in botanical composition. Clover content can be increased by winter grazing with goats. As well, many weed species can be controlled by grazing with goats. Recommendations are available on the desirable mix of goats with other stock types.

LIVESTOCK HEALTH AND PASTURES

(See also Segment 7 for worm issues and Segment 8 for grazing management).

With increasing stocking rates and higher quality pastures, the incidence of animal health problems may increase.

Losses from animal health problems are usually small compared to increased production from pasture improvement. Bloat in cattle is one of the more important problems, in economic terms. Losses can be minimised by appropriate management.

Producers should be aware of the symptoms and preventative measures for the main conditions:

- Bloat with legumes – especially lucerne, white and sub clover.
- Nitrite/nitrate poisoning. Many grasses, broadleaf weeds and oats may be involved.
- Redgut when grazing lucerne, white clover.
- Internal parasites.(see Segment 7).
- Grass tetany.
- Phalaris poisoning.
- Ryegrass staggers.
- Clostridal diseases, including pulpy kidney.
- Photosensitisation – especially from the panic species, and fodder brassicas.
- Oxalate poisoning – especially pigeon grass, buffel grasses, kikuyu and setaria.
- Cyanide (prussic acid) – sorghum species.

Primefacts from NSW DPI are available on animal health issues, as well as the management of specific pasture species which include considerations for animal health. Consult your veterinarian when planning pasture improvement or if animal health problems should occur.

SUMMARY

The 3 essential factors for plant growth are sunlight, carbon dioxide and water.

The factors that control the rate of plant growth are temperature, soil fertility, leaf area and the available soil water.

Know your major plant species and where they are growing. This enables better grazing decision to be made within a year.

Legumes assist pasture quality and add nitrogen to the soil thus assisting grass growth. A balance between desirable species is needed to reach enterprise targets and management can assist in maintaining a suitable mix.

Pasture species differ in their grazing requirement for production and persistence. As a general rule, pastures maintained in Phase II – between 800 and 3000 kg green DM/ha provide the optimum combination of high quality and quantity of pasture as well as being beneficial for pasture sustainability. Growth in Phase I is slow. Pastures in phase III tend to be too low in quality to meet good livestock growth rates. Avoid prolonged under or over grazing of pasture, but there are occasions when pastures will benefit from being in Phase I or III.

Botanical composition can be modified by:

- Timing of grazing (especially on a seasonal basis).
- Grazing intensity and frequency.
- Grazing plus fertility and herbicide.
- Selective herbicides or insecticides.
- By using livestock behavioural differences.
- By allowing desirable pasture species to seed and regenerate.

When grazing pastures, especially intensively, knowledge of livestock health issues associated with the species is desirable.

Further reading and information

- *Prime Pastures Program*. NSW DPI (Booklet).
- *Managing high rainfall native pastures on a whole farm basi*s. NSW DPI, Goulburn, NSW. (Booklet).
- *Native grasses – an identification handbook for temperature Australia* (Book).
- *Regional pasture publications*, NSW DPI (Booklets).
- *Tip and Tools*. MLA, Sydney.
- *Weed control in lucerne and pastures*. NSW DPI (Booklet).
- *Five Easy Steps – to ensure you are making money from superphosphate*, MLA web site.
- www.dpi.nsw.gov.au

PROGRAZE™

Profitable, sustainable grazing

SEGMENT 7

FODDER BUDGETING AND GRAZING FOR WORM CONTROL

In this segment you will learn:

- How to prepare a fodder budget.
- How to use a fodder budget to assist with stocking rate and grazing management decisions.
- How grazing management is used to reduce the incidence of internal parasites.

FODDER BUDGETING AND GRAZING FOR WORM CONTROL

Pasture assessment and animal assessment skills form the basis of monitoring the targets that you will set for beef or sheep enterprises. Grazing management options allow you to modify the animal impact on pasture to achieve a certain animal or pasture target, while the need for an overall plan is paramount to ensure you and your enterprises are on track.

Another tool to keep the plan on track is fodder budgeting.

FODDER BUDGETING

Fodder budgets, which usually integrate production targets via the pasture benchmarks in section 2, provide a basis for planning over 2 to 5 months during the pasture growing season. Fodder budgeting involves assessing current pasture mass (kg DM/ha), adding potential pasture growth (kg DM/ha/day) and subtracting livestock intake/ha (stocking rate* animal intake). A fodder budgeting process can be used to determine stocking rate, grazing days or to identify pasture surpluses or deficits. A template for these calculations is given in Appendix 7. Strategies can then be developed to handle unexpected situations before they occur, thus avoiding crisis management.

A fodder budget can be for a paddock or any area up to the whole farm.

The budget period is normally set by the requirements of your stock, e.g. from mid-pregnancy until birth, or ensuring adequate growth of replacement females during winter. A quick budget can be done by comparing the pasture growth rates (kg DM/ha/day) with animal intake/ha/day (stocking rate/ha* animal intake). The units are the same kg DM/ha/day so you are not dealing with big numbers. This will tell you what direction and how quickly the paddock is changing.

A fodder budget by itself does nothing to improve management. It is the action resulting from the budget that is critical. If you do a budget at the same time each year and it is always in deficit, your overall management calendar needs re-thinking.

Budgeting over the dry period needs to include pasture decay rates which are hard to obtain. Advice is need if you intend to budget during the dry period of the year. Approximately half of the dry matter at the end of spring will decay by the following autumn even in an unstocked paddock.

Bill's fodder budget	
Pasture available	
Present pasture mass	1700 kg green DM/ha
Less Bill's required minimum pasture mass	1200 kg green DM/ha
Available pasture from the existing supply	500 kg green DM/ha
Plus pasture growth – 42 days lambing × 20 kg DM/ha/day	840 kg green DM/ha
Total available pasture	1340 kg green DM/ha
Livestock requirements	
Ewes intake 2.7 kg green DM/head/day × 42 days (Intake estimate includes an additional 15% for spoilage due to grazing)	113 kg green DM/head
No. of ewes per hectare = total available pasture ÷ livestock requirements = 1340 ÷ 113 = **11.8**	
Bill's stocking rate: **11.8 ewes/ha times 40 ha equals approximately 470 ewes for the paddock.**	

An example might be that Bill wants to know how many lambing ewes he can put on a 40 ha paddock. At present the paddock contains 1700 kg green DM/ha.

Bill wants the paddock to last the 42 days of lambing and to maintain at least 1200 kg green DM/ha in the lambing paddock (pasture benchmark for lactating ewes). Average pasture growth rate is estimated to be 20 kg DM/ha/day and ewe intake of pasture is 2.3 kg green DM/head/day.

Alternatively, the question may be how long a paddock is likely to last a mob; in these circumstances the calculations are just rearranged. For example, Bill has another mob of 200 ewes in late pregnancy grazing a 14 ha paddock. Will the paddock last the 42 days of lambing?

The intended stocking rate is 200÷14 = 14.3 ewes/ha, which have an intake of 2.7 kg dm/hd/day giving an intake/ha of 39 kg dm/ha/day. Expected pasture growth for the period was 20 kg dm/ha/day. So the animal intake is twice the pasture growth and the 500 kg dm/ha of pasture surplus will be quickly consumed, 500÷19 = 26 days so the paddock will not last the lambing period.

As there is a shortfall Bill is presented with four possible options: he can either reduce stock numbers in the paddock, find an alternative paddock for the mob, supplementary feed the mob in the existing paddock or accept a lower level of production from the ewes.

Another example might be that Bill wants to know how long a 12 ha paddock of oats is going to last his 55 steers.

Bill has assessed the crop and predicts the herbage mass to be 1900 kg green DM/ha and he will remove the steers once the herbage mass reaches 1500 kg green DM/ha. The growth rate of the oats is predicted over the next 2 months to be 27 kg DM/day.

Bill's other fodder budget	
Pasture available	
Present herbage mass	1900 kg green DM/ha
Less Bill's required minimum herbage mass	1500 kg green DM/ha
Available herbage from the existing supply	400 kg green DM/ha
Daily growth rate of the oats	27 kg DM/ha/day
Livestock requirements	
Stocking density (55 steers ÷ 12 hectares)	4.6 steers/ha
Livestock intake (9.1 kg DM/head/day × 4.6 steers/ha) (The requirement of 9.1 kg DM/hd/d is derived from an intake of 7 kg DM/d plus another 30% of this figure to allow for spoilage)	42 kg DM/ha/day
Results	
These calculations indicate a net herbage loss of 15 kg DM/ha/day (The livestock requirements of 42 kg DM/ha/day minus the growth rate of 27 kg DM/ha/day) Therefore, available herbage from the existing supply (400 kg DM/ha) is declining at the rate of 15 kg DM/ha/day.	
To Bill's question, how long will the paddock last? (400 kg DM/ha ÷ 15 kg DM/ha/day)	**About 27 days**

Intake by the steers is predicted to be 7 kg DM/day. Due to the relatively wet soil conditions usually experienced during these winter months, spoilage of the crop caused by grazing is expected to add 30% to the intake prediction. Adjust the spoilage figure to reflect the conditions.

Over the whole farm if there is a feed:

- **Surplus**. Options may be to make silage or hay, buy trading stock, take on agistment, increase target marketing weights of existing stock, or leave in the paddock for future use when feed is short.
- **Deficit**. Options may be to feed supplements, ration feed via high density rotation, seek agistment, sell stock, or accept lower levels of production.

Pasture growth

Pasture growth estimates are required for fodder budgeting. General examples for NSW can be found in Appendix 4. Remember these are generalised estimates and may require adjustment due to location, soils, fertility and/or season. Take account of existing soil moisture and paddock aspect when selecting growth rates in late spring.

Estimates of pasture growth rate, in conjunction with pasture assessment and individual animal requirements (see Individual animal allowances below), will allow fodder budgets to be calculated. If you are able to obtain relevant pasture growth figures from any source for your local area, the precision of the fodder budget will be increased.

Livestock intakes

As part of feed budgeting, a prediction of pasture intake by livestock is required. GrazFeed® was used to produce Tables 7.1 to 7.4 providing intakes over a range of herbage masses and digestibilities based on **temperature pastures**. The numbers are rounded to one decimal place which explains why the same numbers appear in different herbage masses.

These tables are a guide to the daily pasture intake of sheep and cattle. The tables are **NOT meant to indicate livestock requirements** but rather how much stock are likely to consume each day from the pastures described. In fact, at the lower herbage masses and/or digestibilities stock will have significant weight loss. In the sheep table the intakes figures in **bold** indicate that the ewes are gaining weight. These tables were developed using predictions from GrazFeed®. On most properties you will only be using one of the weight ranges for your sheep or cattle so most of the table does not apply to you. The weights are the mature weight of females at fat score 3, for sheep the 40 kg are traditional super fine ewes, the 50 kg and 60 kg cover the merinos and the 70 kg represents the xbred ewe. The same logical applies to the cattle weights.

These tables should be used in conjunction with the pasture benchmarks (see Segment 2). Remember, avoid grazing below the benchmark otherwise pasture intake would be insufficient for desired production levels.

Pasture spoilage

In addition to the pasture or fodder crop consumed by grazing livestock, there is an added loss of plant material which should be included in the fodder budget. This loss or spoilage is caused by stock treading on plants or as a result of their excretions.

Due to the interaction of a number of factors, it is difficult to be precise as to the extent of the spoilage. These factors include herbage mass, stocking rate, whether they be sheep or cattle, pasture and soil type and in particular, the moisture content of the surface soil. Below 1000 kg DM/ha spoilage is very low and can be ignored. By adding the spoilage to the animal intake figure (often rounding intake up to a whole number) variation in stocking rates are accounted for.

An appropriate percentage increase in per head intake is probably in the range of 5 to 30%, being at the upper end when soils are wet and herbage mass is greater than 2000 kg DM/ha.However, it is important to recognise spoilage can be considerably higher than indicated by this range. For example, total yield losses in the order of 50% have been estimated for cattle on grazing cereal crops under very wet conditions.

While spoilage results in potential loss of feed for livestock, it is not wasted to the system. This material is likely to become part of the litter layer, protecting the soil surface from rain and surface run-off and eventually incorporated as organic matter within the soil.

Table 7.1. Predicted daily intake of pasture by ewes.

Livestock Category	Herbage Mass (kg DM/ha)														
	500					1000					1500				
	Pasture Digestibility (%)					Pasture Digestibility (%)					Pasture Digestibility (%)				
	40	50	60	70	80	40	50	60	70	80	40	50	60	70	80
	kg/h/d					kg/h/d					kg/h/d				
40 kg Ewe when FS 3															
Dry or pregnant	0.2	0.4	0.6	**0.7**	**0.9**	0.3	0.5	0.8	**1.0**	**1.1**	0.4	0.5	**0.8**	**1.1**	**1.2**
Lactating – singles*	0.4	0.7	0.9	1.2	**1.4**	0.6	0.8	1.3	**1.6**	**1.8**	0.7	0.9	1.4	**1.7**	**1.9**
Lactating – twins*	0.5	0.8	1.0	1.3	1.5	0.7	0.9	1.5	1.8	**1.9**	0.8	1.0	1.7	**2.0**	**2.1**
50 kg Ewe when FS 3															
Dry or pregnant	0.3	0.5	0.7	**0.9**	**1.2**	0.4	0.6	1.0	**1.2**	**1.3**	0.6	0.7	**1.1**	**1.3**	**1.4**
Lactating – singles*	0.5	0.9	1.1	1.4	**1.9**	0.8	1.0	1.6	**1.9**	**2.1**	0.9	1.0	1.7	**2.0**	**2.2**
Lactating – twins*	0.6	1.0	1.3	1.6	2.0	0.9	1.1	1.9	2.2	**2.3**	1.0	1.1	2.1	**2.4**	**2.5**
60 kg Ewe when FS 3															
Dry or pregnant	0.4	0.7	0.8	**1.0**	**1.5**	0.5	0.7	1.2	**1.4**	**1.6**	0.7	0.8	**1.3**	**1.6**	**1.7**
Lactating – singles*	0.6	1.1	1.4	1.7	**2.2**	0.9	1.2	1.9	**2.2**	**2.5**	1.2	1.4	2.1	**2.4**	**2.6**
Lactating – twins*	0.7	1.2	1.6	1.9	2.4	1.0	1.3	2.2	2.7	**2.9**	1.3	1.5	2.5	**2.9**	**3.1**
70 kg Ewe when FS 3															
Dry or pregnant	0.4	0.8	1.0	**1.2**	**1.7**	0.6	0.8	1.4	**1.7**	**1.9**	0.8	0.9	**1.5**	**1.8**	**1.9**
Lactating – singles*	0.7	1.3	1.6	1.9	**2.6**	1.0	1.3	2.2	**2.6**	**2.9**	1.3	1.4	2.4	**2.8**	**2.9**
Lactating – twins*	0.8	1.4	1.8	2.1	2.8	1.1	1.4	2.6	3.1	**3.4**	1.4	1.5	2.9	**3.4**	**3.6**

* For lactating ewes, an allowance has been made for the pasture intake of their lambs.

Table 7.2. Predicted daily intake of pasture by cows.

	Herbage Mass (kg DM/ha)																			
	500					1000					1800					2600				
	Pasture Digestibility (%)					Pasture Digestibility (%)					Pasture Digestibility (%)					Pasture Digestibility (%)				
	40	50	60	70	80	40	50	60	70	80	40	50	60	70	80	40	50	60	70	80
Livestock Category	kg/h/d					kg/h/d					kg/h/d					kg/h/d				
400 kg Cow when FS 3																				
Dry/late pregnancy (8 mths)	1.1	2.3	2.7	3.4	4.2	1.9	3.0	4.1	5.2	6.3	2.5	3.7	5.2	6.3	6.8	3.2	4.9	6.6	6.8	7.0
Early lactating (2 mths)*	1.8	4.0	4.7	5.5	6.4	3.1	4.8	6.6	8.0	9.3	4.4	5.2	7.1	9.5	10.1	5.2	6.9	8.6	10.0	10.4
Late lactation (5 mths)*	2.5	4.9	6.2	7.4	8.5	4.7	6.8	8.9	10.6	12.2	6.3	8.8	10.7	12.7	13.5	6.8	9.3	11.3	13.4	13.9
500 kg Cow when FS 3																				
Dry/late pregnancy (8 mths)	1.4	3.1	3.5	4.2	5.0	2.3	3.8	5.2	6.5	7.8	3.4	4.9	6.5	7.9	8.5	4.0	5.4	6.9	8.4	8.8
Early lactating (2 mths)*	2.2	4.8	5.5	6.8	8.2	3.8	6.0	8.2	9.9	11.6	5.5	7.7	10.0	11.8	12.5	6.4	8.6	10.7	12.4	12.9
Late lactation (5 mths)*	2.9	5.7	7.1	8.9	10.7	5.1	7.8	10.8	12.8	14.0	7.0	10.0	13.0	15.4	16.4	8.3	11.0	13.7	16.3	17.0
600 kg Cow when FS 3																				
Dry/late pregnancy (8 mths)	1.6	3.2	4.1	5.1	6.2	2.8	4.8	6.2	7.8	9.4	4.1	6.5	7.8	9.5	10.2	4.9	7.3	8.4	10.1	10.6
Early lactating (2 mths)*	2.7	5.2	6.6	8.1	9.7	4.5	7.7	9.9	11.8	13.5	6.6	10.2	12.0	14.2	15.0	7.7	11.4	12.8	14.9	15.5
Late lactation (5 mths)*	3.4	6.3	8.6	10.7	12.9	5.8	10.1	12.9	15.3	17.5	8.5	13.4	15.7	18.6	19.7	9.9	14.9	16.4	19.5	20.3
700 kg Cow when FS 3																				
Dry/late pregnancy (8 mths)	1.9	3.6	4.7	6.0	7.4	3.3	5.6	7.1	9.1	10.7	4.8	7.5	9.1	11.1	11.9	5.7	8.6	9.8	11.8	12.4
Early lactating (2 mths)*	3.1	5.9	7.7	9.4	11.1	5.3	9.0	11.5	13.7	15.9	7.7	11.9	14.0	16.5	17.5	9.0	13.3	14.9	17.4	18.0
Late lactation (5 mths)*	4.0	7.2	9.9	12.3	14.7	6.7	11.6	14.9	16.6	18.3	9.7	15.4	17.9	21.1	22.6	11.4	17.2	18.9	22.4	23.4

* For lactating cows, an allowance has been made for the pasture intake of their calves.

Table 7.3. Predicted daily intake of pasture by weaner sheep.

	Herbage Mass (kg DM/ha)														
	500					1000					1500				
	Pasture Digestibility (%)					Pasture Digestibility (%)					Pasture Digestibility (%)				
	40	50	60	70	80	40	50	60	70	80	40	50	60	70	80
Lamb weight (kg)	kg/h/d					kg/h/d					kg/h/d				
15	0.2	0.3	0.4	0.5	0.6	0.3	0.5	0.6	0.7	0.8	0.4	0.6	0.7	0.8	0.9
25	0.3	0.5	0.6	0.8	1.0	0.4	0.7	0.9	1.1	1.2	0.5	0.8	1.0	1.2	1.3
35	0.3	0.6	0.8	1.0	1.2	0.5	0.9	1.1	1.3	1.5	0.6	0.9	1.2	1.4	1.5
45	0.3	0.7	0.9	1.1	1.3	0.6	1.0	1.2	1.5	1.6	0.7	1.1	1.3	1.6	1.7

1. The weaners described in this table are assumed to be the progeny from ewes with a standard reference weight of 50 kg.
2. The table is based on wethers. Intakes of ewe weaners would be approximately 10% below those indicated.

Table 7.4. Predicted daily intake of pasture by weaner/younger cattle.

	Herbage Mass (kg DM/ha)																			
	500					1000					1800					2600				
	Pasture Digestibility (%)					Pasture Digestibility (%)					Pasture Digestibility (%)					Pasture Digestibility (%)				
	40	50	60	70	80	40	50	60	70	80	40	50	60	70	80	40	50	60	70	80
Cattle weight (kg)	kg/h/d					kg/h/d					kg/h/d					kg/h/d				
150	1.0	1.8	2.4	3.1	3.8	1.6	2.8	3.5	4.4	5.2	2.3	3.6	4.2	5.1	5.4	2.7	4.0	4.5	5.3	5.5
200	1.3	2.3	3.1	3.9	4.7	2.1	3.6	4.6	5.7	6.8	3.0	4.6	5.5	6.6	7.0	3.4	5.1	5.8	6.9	7.2
250	1.4	2.4	3.3	4.1	4.9	2.2	3.8	4.9	6.1	7.4	3.2	5.1	6.0	7.4	7.8	3.7	5.7	6.5	7.8	8.1
300	1.4	2.5	3.5	4.3	5.1	2.4	4.1	5.3	6.6	8.0	3.4	5.5	6.6	8.1	8.6	4.0	6.2	7.2	8.6	9.0
350	1.5	2.7	3.8	4.7	5.6	2.6	4.4	5.8	7.2	8.6	3.7	6.0	7.2	8.8	9.5	4.4	6.8	7.8	9.4	9.8
400	1.6	2.9	4.0	5.0	6.1	2.7	4.7	6.1	7.6	9.0	4.0	6.3	7.6	9.3	10.0	4.7	7.2	8.2	9.9	10.3
450	1.7	3.0	4.1	5.2	6.3	2.9	4.9	6.2	7.8	9.4	4.1	6.5	7.9	9.6	10.3	4.9	7.4	8.5	10.2	10.7

1. The cattle described in this table are assumed to be the progeny from cows with a standard reference weight of 500 kg.
2. The table is based on steers. Intakes of females would be approximately 10% below those indicated.
3. For live weights greater than 450 kg, use pasture intake predictions indicated for 450 kg.

GRAZING MANAGEMENT FOR CONTROLLING WORMS IN SHEEP AND CATTLE

Increased animal production can be achieved by a well-defined strategy, matching livestock requirements with pasture production, Good parasite control is critical to such an outcome. This section outlines how grazing practices can optimise productivity and worm control.

Survival of worms on pasture

Parasite burdens occur in animals because they graze pasture containing infective worm larvae. The worm larvae migrate onto the herbage after hatching from eggs passed in animal dung.

Worm larvae can last for long periods on pasture provided the weather is not too hot or too dry. Paddocks grazed by livestock are rarely 'worm free' but graziers can create 'safer' pastures with low worm numbers by:

Resting paddocks or controlling contamination so that high levels of worm larvae are avoided.

Resting paddocks in summer is effective for worm control when it is hot for at least 6–8 weeks. Unless it is very hot, rapid rotation of stock around paddocks does not control worm problems because the resting phase is usually too short to be effective. However, adequate resting may be impractical on properties with limited feed. The lower the herbage mass the quicker that hot weather will kill the larvae as they are exposed.

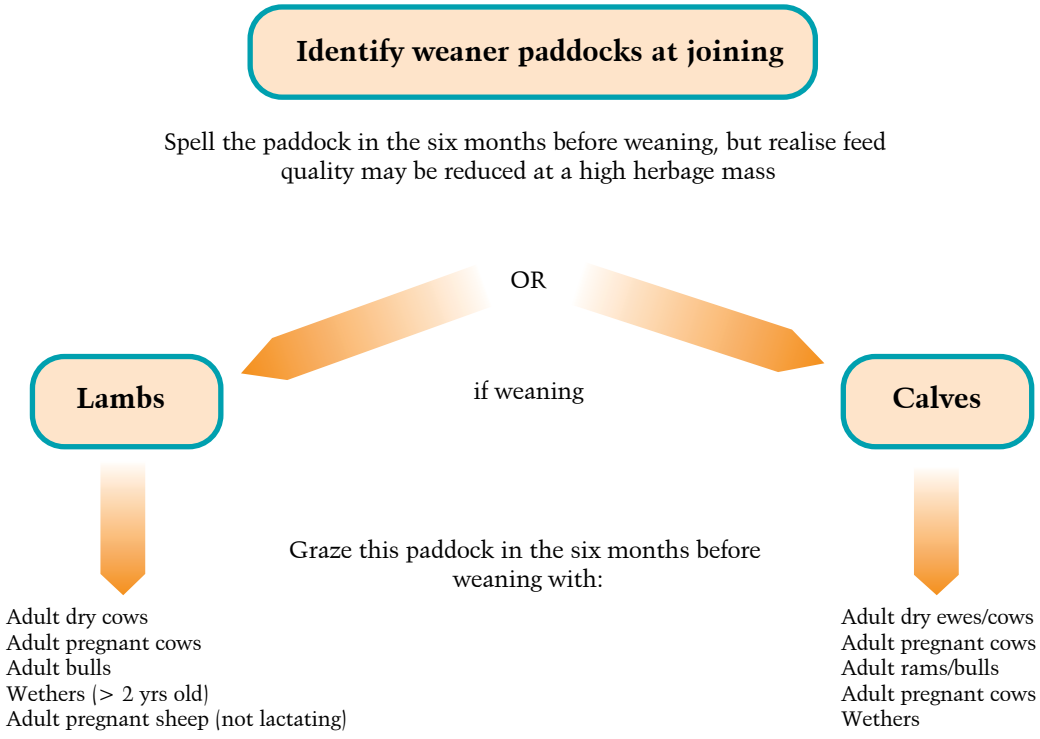
Alternate grazing of sheep and cattle

Alternate cattle/sheep grazing exploits the fact that major cattle worms do not affect sheep and vice versa (one exception is liver fluke). For example, in periods of peak pasture production cattle can usually be grazed on sheep paddocks; weaner cattle are drenched onto sheep-grazed pastures and young sheep drenched onto cattle-grazed pastures. (WormTest first to see if drenching is required.)

Avoid contaminating pastures where susceptible stock will graze.

Certain classes of livestock are easily infected by worms because they have not developed resistance or immunity (young animals) or have temporarily lost their resistance (lactating ewes). Similarly, well-nourished adult dry animals develop resistance to worms.

Figure 7.1. Specific stock classes to graze calf or lamb weaning paddocks.



Resistant stock can graze pastures that will be used later by susceptible stock. Also, resistant animals can safely graze paddocks that have been grazed previously by susceptible stock although, occasionally, barber's pole can infect resistant stock.

Livestock can be ranked for priority treatment of access to clean paddocks and to identify which class has the capacity to prepare clean paddocks:

Highest priority for clean pastures

Least resistant:

- Weaned lambs (less than 1 year old).
- Late pregnant and lactating ewes.
- Weaned calves (less than 18 months old).
- Hogget sheep.
- Cow with calf (combined with nutritional stress).

Most resistant:

- Dry (adult) ewes (more than 2 years old).
- Adult wethers (more than 2 years old).
- All adult dry cattle (more than 2 years old)

Strategies for worm control

Paddocks being made 'low worm' should only be grazed by the alternate species; or secondly, by resistant stock of the same species. Pregnant cattle can prepare pasture for both sheep and cattle weaners but heavily pregnant sheep (more than 4 months) should not be used to prepare paddocks for weaner sheep.

The maximum benefit from grazing management comes when it is used in conjunction with a strategic worm control program:

- DrenchPlan for sheep in southern New South Wales (winter rainfall).
- WormKill for sheep in northern New South Wales (summer rainfall).
- WestWorm and Far-West Worm for sheep in western New South Wales.
- Cattle strategic drenching programs recommended by your adviser.

Supplementary feeding and drenching are available to increase the flexibility of grazing options for worm control but they can be costly and not always necessary.

As part of the grazing plan which was discussed earlier, include strategies for 'low worm' paddocks for susceptible stock. Susceptible stock usually have high nutritional needs, so plan to create low worm, high nutrition paddocks.

Graze weaning paddocks with stock that will assist in making it worm-free (see Figure 7.1). For 'clean' weaning paddocks, avoid grazing with susceptible stock in the previous 6 months. Sometimes 2–3 year old wethers have considerably higher worm counts than mature wethers. Should it be the intention to use such wethers to prepare paddocks for weaners, especially if the intention is to graze the paddock at a reasonably high stocking density, it is advisable to conduct a Wormtest to determine the wether's worm status prior to grazing.

In northern New South Wales good control of barber's pole in sheep can be achieved by grazing cattle from October into summer. When barber's pole burdens increase in young sheep towards late summer they can be drenched (WormTest first) onto the paddocks previously grazed by cattle.

Good lambing paddock preparation improves productivity and worm control in ewes, lambs and weaners. The aim is for ewes to lamb on paddocks with 900 to 1500 kg DM/ha and few worms. To achieve the aim any grazing within 6 month of lambing must be done with sheep either WormTest and low or drenched with any effective product within the last 3 weeks. Lambing paddocks can also be grazed by sheep in the June to August period in the colder parts of the Northern Tablelands.

Poor nutrition combined with parasitism can have serious consequences. An early warning system is therefore required.

Monitoring progress

Monitoring parasite burdens is done by counting parasite eggs in dung (faecal worm egg counts) and is especially useful in young sheep.

Samples of faeces are collected from representative animals in mobs. These samples are then sent for analysis. Worm eggs are counted (and worm typed if required) and, in consultation with your veterinary adviser, a decision made about the need for drenching.

WormTest enables better use of drenches. Sheep that are not wormy are not drenched; sheep that are very wormy are drenched before deaths occur. On most occasions, ewes do not need a pre-lamb drench. Don't guess Wormtest.

The Wormboss web site provides detailed information on a regional basis for all aspects of worm control in sheep.

There is an increasing problem in cattle with drench resistance so more attention needs to be paid to the control programs. The cattle parasite atlas on the MLA web site is a good resource.

More than just drenching

Worm control involves more than just drenching. Grazing management is another tool that can be used to manage worms. As worm resistance increases the role of grazing management will become more important. An 'integrated' approach to worm control is advocated, employing several interwoven methods to achieve sustainable worm control. Following is an outline of integrated worm control:

- The right drench at the right time
- Grazing management
- Flock management, including 'early weaning'
- Breeding sheep more resistant to worms
- Nutrition, and
- 'Fine-tuning' based on regular worm egg count monitoring (Wormtest) and drench efficiency testing (Drench Test – worm egg count reduction test).

SUMMARY

Fodder budgets are used:

- to assist with more pro-active decisions in respect to grazing management.
- to assist in achieving pasture and animal targets.
- to predict surpluses and deficits in pasture supply. Early recognition of a deficit allows you to access fodder at potentially lower prices because you are in the market before the majority of producers. The same logic applies to buy trading stock in a surplus situation, early entry to the market can have price advantages.

Tactical grazing of pasture with sheep and cattle can be used to provide cleaner paddocks with a low worm burden.

Further reading and information

- *A guide to feed planning for sheep farmers*. New Zealand Sheep Council.
- *DrenchPlan*. Primefact 14. www.dpi.nsw.gov.au
- *WormKill*. Primefact 1079. www.dpi.nsw.gov.au
- *West Worm and Far West Worm*. Primefact 736. www.dpi.nsw.gov.au
- Other Primefact on worm control. www.dpi.nsw.gov.au
- *Cattle worm control – the basics*. Prime fact 419. www.dpi.nsw.gov.au
- WORMBOSS. www.wormboss.com.au

NOTES

PROGRAZE™

Profitable, sustainable grazing

SEGMENT 8

PUTTING IT TOGETHER

In this segment you will learn:

- Of the need for planning in managing grazing systems.
- The difference between carrying capacity, stocking rate and stocking density.
- The difference between various grazing management systems.
- How Tactical Grazing can be used as the framework for your grazing system.

PUTTING IT TOGETHER

Preceding segments of PROGRAZE dealt with both theoretical and practical aspects of livestock production from pasture. In addition we examined aspects influencing pasture production, in particular the effect of grazing.

In this segment we concentrate more on bringing together the management issues of livestock and pasture with the focus more on the farm as a whole. In doing so it is important to recognise that there will be times when the needs of pastures and those of livestock will be in conflict. Hopefully these can be minimised to achieve the best long-term results. Also, we need to recognise when compromises have been made we need to put strategies in place, probably at a later time, to counter any adverse effects. An example may be a pasture that was grazed for longer, consuming regrowth and diminishing root reserves, than management would normally desire. It would be important this pasture be given, as soon as possible, the opportunity to replenish reserves which probably means allowing it to mature and flower.

The grazing system is complex. It involves the interaction of social, environmental, financial, marketing, pasture and livestock management issues. PROGRAZE has concentrated on a component of the system, that is, grazing management and the interaction between pastures and livestock. It is important the broader issues are not ignored.

While recognising the total grazing system is complex, that component which is grazing management, as Figure 8.1 indicates, has its own degree of complexity. It is difficult to imagine how this complexity can be addressed adequately unless there is a planned approach to grazing management.

PLANNING

Through PROGRAZE, it is likely you have been challenged to incorporate technology which presently is not part of what might be described as your normal management. These may be targeting 900 kg green DM/ha for the start of lambing or 1500 kg for cows at calving, spelling pastures at certain times of the year to ensure their long-term

Figure 8.1. A view of the grazing management complex.

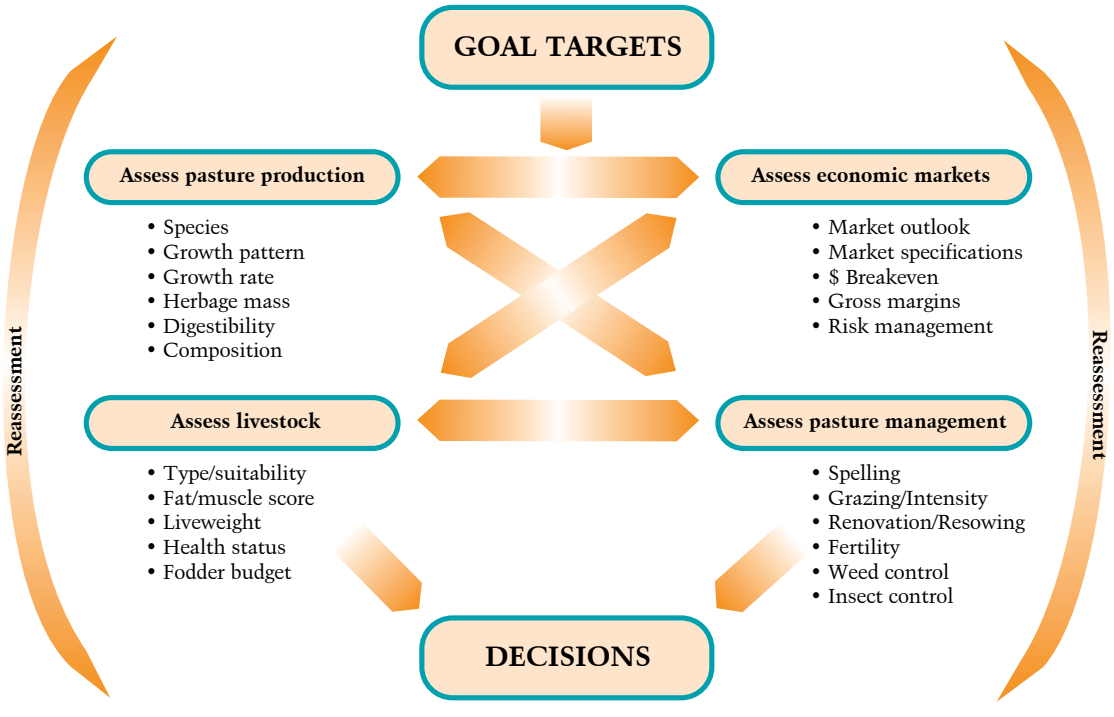


Table 8.1. An annual grazing plan of stock movements.

PADDOCK

MONTH	1	2	3	4	5	6	7	8
JAN	Ewes	Cows + Calves	Ewes	Ewes	Ewes	?	Heifers	Spray Topped pasture
FEB								Ewes
MAR					Rest	Heifers	Rest	Paddock sown to pasture
APR								
MAY	Rest	Cows	Rest		Weaner Calves			
JUN		Rest	Cows	Rest		Rest	Ewes - high density rotation	
JUL	Cows v Calves		Ewes high density					
AUG		Ewes v Lambs	?	Ewes v Lambs		Ewes v Lambs 'till marking	?	
SEP							Rest	Grazing
OCT	Rest		Cows v Calves			Closed for Hay	Probably Hay	Rest - check establish-ment
NOV	Weaned Lambs	Ewes		Allow to seed	Heifers	?	?	
DEC						?	?	

productivity, grazing with cattle to set up 'safer' pastures for weaner sheep or setting up paddocks to achieve targeted weight gains in steers or lambs to meet specific markets. To effectively incorporate such technology into management, while limiting adverse effects, some planning is required. It will probably mean a formal planning process is required rather than trusting it totally to a mental approach.

The key to efficient grazing management is effective planning. Planning is likely to exist at a number of levels. There is what could be called a *strategic plan* which, taking into account the overall farm and enterprise objectives provides a framework for the year's operation (see Table 8.1). In your plan set specific targets for paddocks or periods, e.g. 900 kg green for singles and 1300 kg green for twins at the start of lambing. Use colours to indicate paddocks where water supply is a problem in summer or the part of your farm where ground cover is most critical. For market targets record the weight and fat you are aiming for. Being specific in your targets helps when you have to make decisions, as the seasonal conditions unfold.

Then there is what might be called the *medium term plan* which is linked to the strategic plan but about developing the specific strategies needed to achieve the farm and enterprise objectives. The medium term planning process could have a time frame of 3 to 4 months. This is where fodder budgets are a useful tool.

Finally, there are the day-to-day decisions required to implement the strategies. Some modification of the strategy may be required at this point due to circumstances that exist at the time. Base your decisions on the pasture benchmarks, Segment 2 tables 2.1, 2.2 or 2.3 plus pasture and animal assessments.

In developing grazing plans knowledge of the requirements of your pastures and livestock are critical. Grazing plans need to be flexible to allow for the inevitable variations of weather, stock prices, worms etc. Implementation of grazing plans relies on sound pasture and livestock assessment skills.

PROGRAZE PLUS

If you are interested in adopting a whole farm planning process PROGRAZE Plus is likely to suit your requirements. PROGRAZE Plus is directed towards the development of individual whole farm grazing plans. While whole farm, the basic units dealt with are the paddocks and mobs of stock on your farm.

The development of whole farm grazing plans may be considered as a strategic planning process. But if you decide to undertake the course, and as you become increasingly familiar with the process, you will recognise PROGRAZE Plus also has the potential of providing valuable support for short term or tactical decision making.

Grazing plans developed within PROGRAZE Plus use fodder budgets as a means of assessing the plan's likely success. PROPlus is the computer program developed for this purpose. PROPlus is provided to all participants.

The benefits of PROGRAZE Plus are that it provides a process or frame work which allows individual graziers to develop and assess whole farm grazing plans.

PROGRAZE Plus, encourages users to implement pasture and grazing management technology appropriate to their farm – technology which may have been part of PROGRAZE but not exclusively so. It will allow participants to explore the implications of pasture/livestock grazing management decisions, on available pasture in each paddock and on the farm as a whole.

By way of example, it allows an examination of the effect on pasture availability across paddocks and farm of you implementing a policy of say; resting certain paddocks for pasture management reasons, for worm control or for building feed supplies for lambing or calving. It helps to identify whether the predicted available pasture in individual paddocks is likely to meet production or market targets for livestock grazing those paddocks. It allows one to assess the effect of introducing an alternate feed source e.g. a paddock of grazing oats or improved pasture, or a change to livestock management, e.g. changing the time of calving or lambing.

The purpose of the PROGRAZE Plus course is to have individual participants develop their own grazing plan, but more importantly, to become sufficiently familiar with the process, and at least some of its benefits, that will ensure it is constantly used in the future to develop planned pasture and grazing management decisions. Once familiar with PROGRAZE Plus, you will find it to be extremely flexible and can fit effectively to your management approach.

PROGRAZE Plus is available from Tocal college as an on line course which you complete at your own pace. Contact the college for details.

GRAZING MANAGEMENT

Issues surrounding carrying capacity, stocking rate and stocking density are critical factors influencing the short and long-term success of grazing enterprises.

Carrying capacity

Carrying capacity is a measure of a farm's capacity to carry livestock. It is usually measured in DSE's/hectare. Carrying capacity is largely influenced by the productivity of the farm's pastures. Pasture production will be influenced by the soils (depth, fertility, structure, water holding capacity) in which they grow, by their botanical composition, the presence or absence of insects or disease, by climatic conditions and to some extent, grazing management.

Management can significantly influence carrying capacity through pasture species selection, strategic fertiliser use, weed control and grazing management. Strategies that increase farm carrying capacity are linked closely to those which increase pasture production and these are likely to lead to more environmentally friendly systems.

Pastures of these systems are likely to be denser providing better ground cover and so the benefits of soil protection, reduced run-off and cleaner run-off water. They use more soil water, particularly if deep rooted perennials are a component of pastures, reducing deep drainage and so the risk of acidity and salinity.

Particularly as a result of climate, the farm's carrying capacity is not a constant. Grazing management should reflect the variation in carrying capacity.

Carrying capacity varies by season and within season. Seasonal variation is strongly influenced by temperature and the pattern of rainfall. For example, winter temperatures limit pasture production in much of the temperate areas of the State. Summer temperatures have a similar effect, but the summer rainfall experienced in the northern areas generally results in higher pasture production than that which occurs in the south of the State. The timing of lambing and calving or the sales of surplus stock are ways that managers address the seasonal variation in carrying capacity.

While pasture growth curves show a strong seasonal trend (see Appendix 4), there is still wide variation to those trends within seasons, which is mainly due to rainfall variation. Variation in pasture growth again leads to variation in carrying capacity. Drought is an extreme adverse effect of the variation. Managers react to the within-season variation by implementing strategies such as supplementary feeding, lot feeding, selling stock, buying stock or conserving surplus feed, time of lambing or calving.

Over stocking can be defined as where stocking rate is constantly exceeding carrying capacity or supplementary feeding is needed each year. While under stocked farms may be defined as those where stocking rate rarely exceeds carrying capacity or supplementary feeding is never needed.

Stocking rate

Stocking rate is a term used to describe the number of stock on a paddock or farm. It is usually assessed in terms of DSE's/hectare but also, head/hectare particularly when describing stocking rate at the paddock level.

One common goal of grazing systems, and probably the most important for producers, is to optimise profits from the grazing enterprise. Numerous bench marking studies have shown that the farm's stocking rate is a critically important parameter in achieving this outcome.

Figure 8.2 describes the general relationship between stocking rate and per head production, per hectare production and gross margin ($) returns. As stocking rate increases per head production, after holding steady for a time, can be expected to decline. However, per hectare production continues to increase

well past this point but eventually will plateau and then decline. Enterprise profit is likely to follow a similar line to that of per hectare production except it will plateau earlier and decline earlier. This is often associated with the increased costs of supplementary feeding. At low production per hectare the profit is down due to the overhead costs being spread over a small amount of production.

The stocking rate at which the profit is nearing its peak is probably the target at which most producers will aim, particularly when risk management issues are considered.

Livestock fat scores and the extent of supplementary feeding can be a useful guide to how close stocking rates are to carrying capacity. For example, if fat score targets in the livestock segments of the manual are rarely met or if it requires excessive amounts of supplementary feeding to achieve these targets, stocking rates probably exceed carrying capacity too frequently and profits suffer.

Conversely, if livestock are constantly in excess of fat score targets or rarely require supplementary feeding then it may be possible stocking rates are well below carrying capacity and potential returns have been foregone.

Stocking density

Stocking density is a term not dissimilar to stocking rate when stocking rate is referring to a paddock. Although, it might be that stock are being restricted to part of a paddock through the use of a temporary electric fence i.e. strip grazing. Stocking density is usually described as head/hectare.

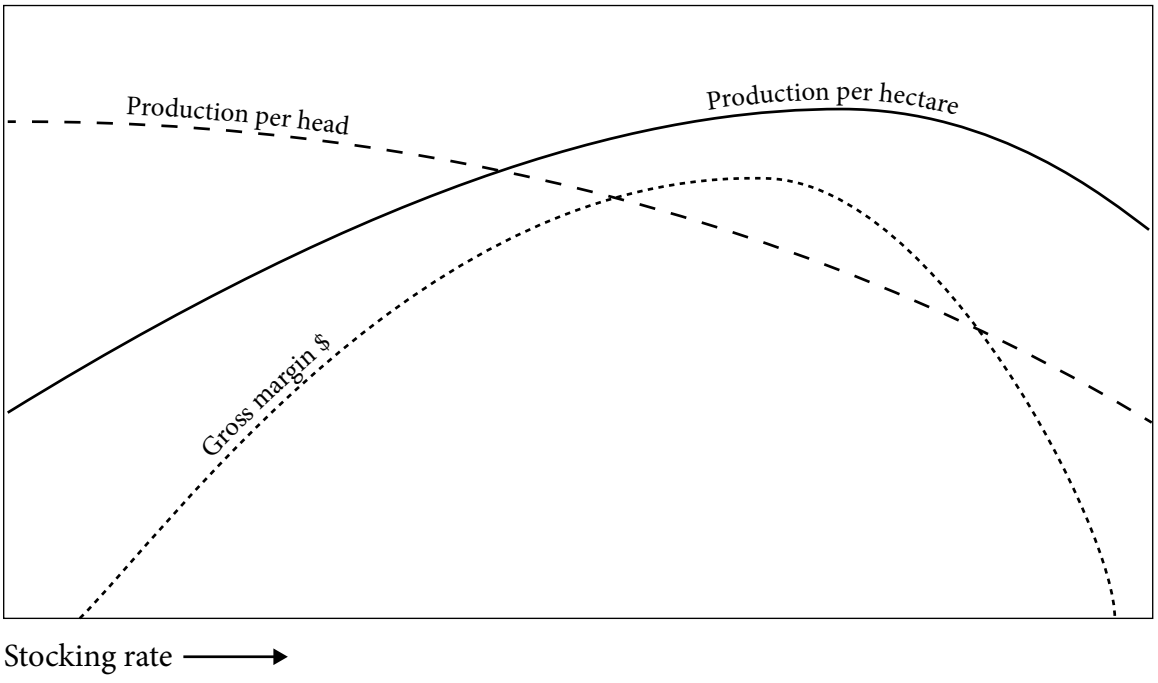
Stocking density is a very powerful pasture management tool. Densities to achieve a specific target may range from a relatively low level of up to 5 times the average stocking rate, to a high which may be 25 times.

The extent to which higher stocking densities can be achieved is determined by mob or herd size and the degree of subdivision of paddocks. When high stocking densities are required temporary electric fencing is commonly used.

Grazing systems

The following are some commonly used terms to describe grazing systems: The most critical factor for all systems is the stocking rate compared to the pasture's capacity of the paddock or farm. All systems will fail if the stocking rate exceeds the pasture's capacity. It is not the number/ha that is important but the relationship between pasture production and animal consumption. A stocking rate of

Figure 8.2. The fundamental relationship between stocking rate, livestock production and gross margin.



15 DSE/ha might be putting less pressure on the pasture and soil than 6 DSE/ha because it is growing 10,000 kg DM/ha rather than 3000 kg DM/ha.

Continuous stocking

As the name suggests, pastures are continuously stocked, rarely receiving a spell from grazing.

- The system allows animals to graze with a high degree of selectivity, so reducing their preferred species from the pasture. This allows the less preferred species to dominate. The likelihood of this eventuating depends on such factors as stocking rate; suitability of the pasture species to the location, paddock topography. Parts of the paddock might never be grazed and can result in increased biodiversity.
- Selection of preferred pasture species may lead to patch grazing and uneven growth.
- Management inputs are minimised.
- Because stock have a high degree of selectivity animal production/head can be very good.

Because the control in continuous grazing rest with the stock undesirable outcomes can occur. These include:

  - » the potential loss or decline of desirable pasture species;
  - » the lack of management control over pasture quality and quantity. This is important for both pasture productivity and managing the nutritional requirements of the stock. This is greatest if the paddock is under grazed.
  - » poor ground cover that results if the stocking rate exceeds the pasture's capacity.

There are examples of long term continuous grazed sites that have achieved the desired environmental outcomes and been profitable. **This system is the most sensitive to having the correct stocking rate**.

Set stocking

- Often used to describe continuous stocking but more appropriately it is a term used to refer to a specific grazing period when stock are not moved. For example, for lambing, calving or finishing stock.
- Following the period of set stocking, pastures may be spelled or stocked with a different stocking density. This is not a continuous stocking system. The major difference is that the stocking density during the year reflects the pasture capacity for growth.
- The stocking of pastures for extended periods of time, for example 3 months or even longer will not necessarily be detrimental to the pasture. However, this is going to depend on pasture type e.g. extended periods of grazing for lucerne are not recommended, seasonal conditions, soil fertility, the growth phase of the desired species within the pasture and the pasture's management prior to and after grazing.
- At times, set stocking may be the most appropriate pasture management strategy. An example may be when substantial grazing pressure is required over the growth phase of an undesirable plant species for its control or eradication.
- At times, set stocking may be the most appropriate strategy for livestock. It is a useful strategy where management does not wish to disturb stock say through lambing or calving and is the most appropriate for stock where high growth rates are required.
- Systems that involve moderate periods of set stocking, as compared to the more intensive rotational grazing systems, usually require lower input costs for fencing and watering.

Rotational grazing

- Period of grazing followed by a period of rest. The rest period or rotation length is generally influenced by pasture growth rate. The aim is for the pasture to have re-grown to a given stage of growth before the next grazing. The spell period length has a big impact on how these system works. A 30 consistent day rotation produces a completely different system to a consistent spell of 200 days. The longer spell length will result in a system with large amounts of low quality feed and therefore lower stock production.
- Controlled rotational grazing, block, crash, mob stocking and strip grazing, as well as cell or time controlled grazing, are varying forms of rotational grazing.

- The majority of pastures comprise a variety of species which have different growth times and habit i.e. tall or short. During any rest period some species might benefit and others suffer. Shorter growing species will be shaded by taller growing species, so not all species will benefit during rest periods, the longer the rest period the greater the potential impact.
- There are often well defined rules which determine the grazing and spell periods. These rules are usually based on time, which might be a one week graze followed by a six week spell, or one of grazing to a specific residual green herbage mass, say 1000 or 1500 kg DM/ha and then spelling until the pasture reaches 2500 or 3000 kg DM/ha.
- Recent research recommends using a green herbage allowance in kg DM/hd/day to set the rotation length. In spring the green allowance should be 0.8 to 1.2 kg DM/hd/day (use the higher figure for breeding animals) and as digestibility decreases it should be increased to 2 to 3 kg DM/hd/day to allow selective grazing to enhance diet quality. If the paddock has green that is of very low quality (e.g. dried off or frosted) then the allowance increases to 3 to 5 kg DM/hd/day. For example we have 1000 kg DM/ha of green and 1000 kg DM/ha of dead in the paddock. The dead is telling us digestibility is dropping so we will use the 4 kg DM/hd allowance. The stocking density will be 40 hd/ha. 1000 kg DM/ha divided by 4 kg DM/hd/day give us 250 grazing days divided by 40 hd/ha tells us we can graze the paddock for 6 days and achieve satisfactory animal performance. This allowance method only applies when there is green in the pasture.
- Rotational grazing may be implemented for part of the year or, in the case of time control grazing, conducted over the whole year.
- There is wide variation in the number of paddocks in rotational grazing systems. The minimum is usually about four while the maximum may reach 60, in some intensive systems. Recent research has shown there is little advantage in having more than a 15 paddocks rotation. It also showed improved dollar returns when moving from a continuously grazed 1 paddock system to a 20 paddock rotation system if the infrastructure is in place. There was no difference or lower returns between the systems depending on the infrastructure that had to be built.

  Basing fencing decision to control under-utilized parts of paddock provides a return on the investment. It targets the costs to the area which will give the biggest returns.

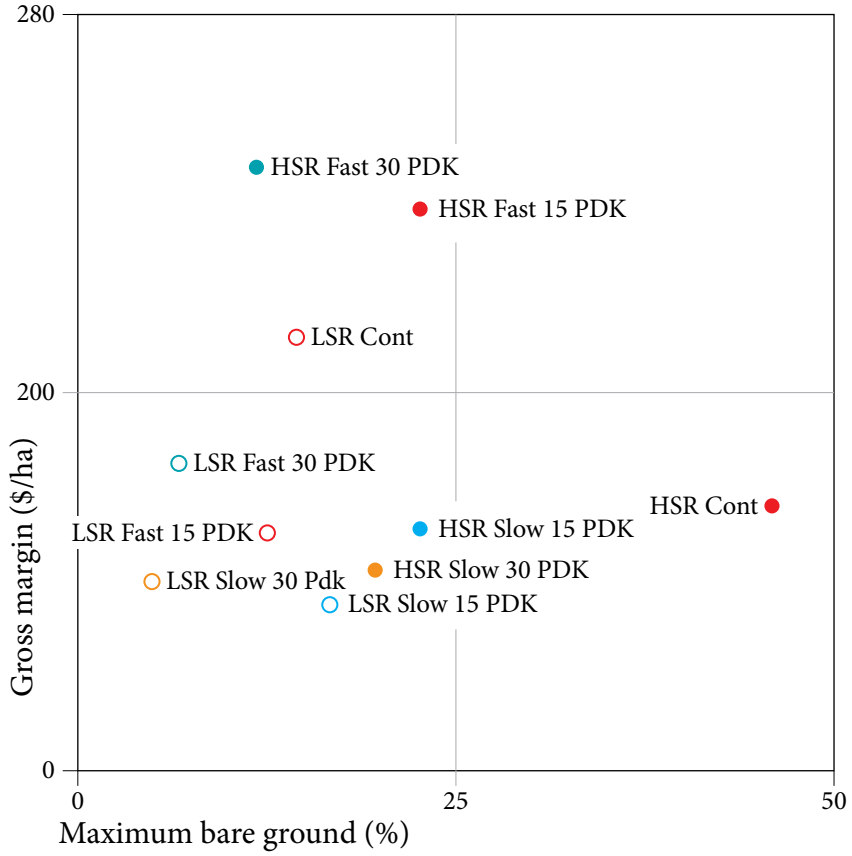
  As the grazing system increases stocking density the manager has increased control of pasture eaten and how it will recover. At low stocking densities the control moves to the stock. The 3 systems continuous, set stock and rotation all have strong and weak points. The critical issue is that you use the appropriate system for what you are trying to achieve.

  Evidence from around the world indicates that provided pasture are not seriously under or over grazed then the differences in pasture growth will be small. This is because pasture can change their growth habit under different systems i.e. smaller leaves but more tillers under set stocking or larger leaves on fewer tillers under rotational grazing. The benefits of moving to a rotational system are greatest at high stocking rates because you have better control of the feed and therefore animal nutrition.

Recent work compared continuous grazing against rotational systems with varying stocking rates, rotation speeds and paddock numbers. The results are shown in Figure 8.3 and the key points are;

- High stocking rate (HSR) and fast rotation (60 days) regardless of the number of paddock used in the rotation gave the best combined results while low stocking rate (LSR) continuous grazing (Cont) was not far behind.
- The slow rotation (120 days) regardless of paddock number or stocking rate had low gross margins and similar ground cover to the higher performing systems.
- The high stocking rate continuous system suffered reduced gross margins due to the extra feed required and had problems with amount of bare ground. These issues reduced in later years of the trial so the dot move towards the LSR Cont dot.

Figure 8.3 Comparing gross margin and maximum bare ground of grazing management options for a merino cross terminal sire system on cocksfoot pastures at Orange. Source W. Badgery.



SUMMARY

A successful grazing system can;

- manage seasonal variation mostly by the structure of the livestock enterprise
- improve livestock performance per head but it requires careful management and is difficult.
- improve pasture growth and composition by targeting the life cycle of the critical species. This is limited to certain parts of the year.
- there is currently no evidence that soil fertility and soil carbon are enhanced with intensive rotational grazing. Enhancing root production mainly by improving fertility will increase soil carbon.
- improve the bottom line provided the spending on infrastructure is targeted to areas of greatest return and the stocking rate results in utilisation rates of 40 to 50% for breeding operations. Trading operations have higher levels of utilisation due to the ability to vary stocking rate in line with pasture supply.

Tactical Grazing

Tactical Grazing is the approach promoted by PROGRAZE for the implementation of best practice in grazing management. It contains four components *setting objectives, determining strategies, implementing tactics and monitoring results*.

- *Setting objectives* is about setting outcomes for the farm. These are best set at three levels; the farm, paddock and enterprise.

  The objectives at the farm level could include issues involving the landscape, environment including biodiversity, effective use of on-farm rainfall, managing climate variability, farm carrying capacity and business profitability. At the paddock level, issues may include pasture productivity, pasture composition, efficient pasture utilisation, stocking rates and pasture management needed to meet livestock productivity targets, riparian protection, salinity control, ground cover levels. At the enterprise level production targets including calving/lambing percentages, wool production, meeting market specifications for livestock products and production costs are all issues for consideration.

- *Determining strategies* to achieve the set objectives is the next step. No formula exists for determining the strategy to achieve a particular objective. Strategies to achieve similar outcomes will vary from environment to environment and circumstance to circumstance.

  Strategies are the broad principles that need to be applied to achieve the objective but recognising there may be a need to vary tactics during the implementation phase due to any number of factors. The grazing plan in table 8.1 is an example.

  Wherever possible strategies should be measurable with targets in kgdm/ha, kg liveweight at an age or fat scores.

- *Implementing tactics* is about the day-to-day, week-by-week, management decisions required to achieve the desired outcome. Management needs to respond tactically to changing conditions in order to achieve that outcome. There are ranges of grazing management tools that may be part of a strategy. These include (but are not confined to):

  » timing, duration and intensity of grazing, for livestock performance,

  » species or class of livestock used for grazing,

  » timing and duration of pasture spelling, for pasture productivity/persistence,

  » grazing/spelling to pasture benchmarks as a basis for achieving production targets (e.g. growth in livestock), pasture objectives (e.g. botanical composition) and environmental outcomes (e.g. height of water table), and

  » grazing/spelling for the control of internal parasites in livestock.

  In addition, there are other tactics available to managers. While some are not specifically grazing management techniques, they may include components of grazing management in their execution, and may be important components of a strategy. These could include the:

  » sowing of new pastures or new species into existing pastures,

  » correction of soil nutrient deficiencies,

  » use of chemicals to control pasture pests,

  » use of fodder conservation as a pasture management tool as well as providing a future source of feed for livestock,

  » use of pasture renovation including mulching,

  » use of controlled burning,

  » strategically establishing trees and shrubs to assist water table management,

  » use of supplementary feeding to achieve livestock objectives when pasture lacks quantity and/or quality, and

  » use of sub divisional fencing to facilitate the implementation of grazing management strategies and the management of areas identified for conservation and biodiversity value including riparian zones.

- *Monitoring results* is the final component to tactical grazing. Tactical Grazing is targeted at achieving the stated objectives. Monitoring provides an assessment of progress and helps ensure objectives are achieved. As a result of monitoring, objectives may be changed or their priority altered. The effectiveness of tactics is assessed and adjusted where necessary. Monitoring indicators may include:
  - » stocking rate,
  - » pasture composition,
  - » ground cover,
  - » soil nutrients,
  - » herbage mass levels at critical times of the year,
  - » fat score of livestock at critical times of the year,
  - » physical and financial production ratios such as calving/lambing percentages, turn-off or cut per head and per hectare and income and costs per head and per hectare,
  - » supplementary feeding,
  - » water quality in dams and water ways,
  - » worm egg counts,
  - » the proportion of livestock products meeting market specifications, and
  - » farm business returns.

The essential element of Tactical Grazing is that grazing management needs to be flexible. It recognises grazing management cannot be based on simple recipes or driven by a set of rules that might claim to suit all pastures types, pasture conditions and enterprise types.

Tactical Grazing recognises that grazing management decisions need to be made within a framework which has considered farm and enterprise objectives. Decisions should be based on pasture type, the recent history and present condition of each pasture paddock, short and long-term pasture productivity and finally the specific requirements of livestock that graze within the system.

Tactics

The following are a few examples of different grazing tactics which could be implemented to achieve specific targets for pasture and livestock. Tactics that are appropriate in one year are not necessarily appropriate the next.

DROUGHT

PROGRAZE does not specifically address drought. However, it does address supplementary feeding and the effect of prolonged adverse conditions on pastures, two important components of drought.

Supplementary feeding is addressed through pasture assessment which is critical to sound supplementary feeding decisions and the use of GrazFeed. The early stage of drought and in many instances well into drought, the situation is still one of supplementary feeding i.e. pastures are still contributing to the farm's livestock production.

Specific issues relating to drought feeding and management are addressed in a number of NSW DPI publications. See the further reading and information list below and the Department's drought web site at www.dpi.nsw.gov.au. In addition, the Department's StockPlan program assists users develop drought strategies. These include strategies to be implemented pre-drought as well as those relevant to circumstances as drought develops and action needed post drought. Drought plans are similar to grazing plans in that there is no one plan that all producers should implement. Any drought plan should be judged on the business's health 2 years after the drought not during the drought. Different strategies have different times of impact on the business hence the need to assess over a longer time period. StockPlan covers all these issues.

The early part of this Segment addressed planning. It is essential both from a grazing management perspective, as well as from a broader whole farm perspective, that droughts are factored into planning. Historically, drought is a common occurrence within Australian agriculture and this should be reflected in planning. StockPlan can be accessed via the Tocal College web site.

PADDOCK RECORDING

Over time, monitoring the grazing use of a paddock enables comparisons between paddocks to be made and provides a better indication of the capabilities of paddocks for animal production. This enables pasture inputs to be directed where it will be most effective.

An example of a recording sheet is shown on the following page. Comparisons of stock carrying capacity are in dry sheep equivalent (DSE)/ha. Each paddock on your property will have a recording page. Care needs to be taken with paddock records i.e. paddocks used for finishing or reproduction will have a lower DSE/ha because higher animal performance needs increased herbage mass so a lower stocking rate, don't just look at the DSE/ha in making input decisions.

The DSE is a value based on the energy requirements of a 2 year old, 50 kg Merino wether. Table 8.2 shows the relative values for sheep and cattle of different classes and liveweights. Some DSE tables still use the standard as a 45 kg wether which creates confusion within industry.

Strategy	Tactics
• Remove bulky dead pasture residue to eliminate shading on new pasture growth. • Rationing pasture over winter. • Regeneration of annual based pastures in autumn. • Suppress annual grasses and encourage legume production. • Controlling rapid spring pasture growth, so keeping it vegetative to maximise stock growth rates. • Increase fat score of stock. • Feeding over lactation to maximise intake. • Feeding growing stock to maximise intake. • Preparation of a low worm, weaner sheep paddock. • Preparation of lambing/calving paddock.	• Moderate to high density grazing with dry stock. Supplements may be needed. • High density rotations. Short graze periods. • Defer grazing after the autumn break until pasture mass is around 500–800 kg green DM/ha. • High density set stocking winter/early spring grazing. • Aggregate stock; moderate density needs to start in late winter. Make hay or silage. • Set stocking has shown to have advantages over rotational grazing however, the decisive issue is that pasture is not grazed below critical benchmarks – manage pastures to optimise digestibility i.e. Phase II. • Paddock kept in a green, leafy phase and graze with cattle or dry adult sheep when necessary. • Remove any significant build-up of dry feed early. Sheep: plan for a minimum of 900 kg green DM/ha at the start of lambing. Cattle: plan for 1500 kg green DM/ha at the start of calving.

Table 8.2. DSE ratings for various classes of livestock.

Mature ewes					
Liveweight	Pregnant			Lactating	
kg	Dry	Single	Twin	Single	Twin
40	0.9	1.1	1.3	2.1	2.9
50	1.0	1.3	1.5	2.5	3.4
60	1.2	1.4	1.6	2.9	4.1

Growing lambs			
Liveweight	Growth (g/day)		
kg	50	100	150
20	0.6	0.8	1.0
30	0.9	1.1	1.3
40	1.0	1.3	1.5

Breeding cattle			
Liveweight	Dry	Pregnant	Lactating
kg			
350	6.0	7.0	12.3
400	6.5	7.7	13.7
450	6.9	8.2	14.8
500	7.1	8.4	15.2
550	7.7	9.0	16.5
600	8.4	9.7	17.3

Growing cattle			
Liveweight	Growth (kg/day)		
kg	0.5	1.0	1.5
200	5.3	6.8	8.3
250	6.4	8.1	9.7
300	7.3	9.2	11.1
350	8.4	10.6	12.9
400	9.1	11.4	13.7

Paddock area			**(ha)(a)**								
(b)	(c)						(d)	(e)		(f)	
Date in	Date out	kg/DM/ha Green in	kg DM/ha Total in	kg/DM/ha Green out	kg DM/ha Total out	Fatscore Out	No. of days in (c−d)	No. of stock	Class of stock	DSE	TOTAL (d × e × f)
						Year total					(g)
						Annual DSE rating (g÷a÷365)					DSE/ha

SUMMARY

- Planning is the key to efficient grazing management. Elements of planning include:
  - » Strategic planning.
  - » Medium term planning.
  - » Tactical day to day decisions.
  - » Drought preparedness needs to be an element of strategic plans.
- The balance between carrying capacity and stocking rate is critical to grazing management success.
- Stocking density is a powerful pasture management tool.
- Tactical Grazing provides the basis for effective grazing management.
- Paddock recording provides an opportunity to objectively measure their performance thereby providing a basis for more effective management.

Further reading and information

- StockPlan course and software – contact Tocal college.
- PROGRAZE Plus course – contact Tocal college.
- *Livestock feeding on pasture*. New Zealand Society of Animal Production. Occasional Publication No. 10. Hamilton, New Zealand.
- *Pasture management technology for the 21st century*. Kemp, D.R. & Michalk, D.L., (Eds), 1993, CSIRO Information Services
- *Managing Drought* – 6th edition NSW DPI
- Grazing Management system explained – Evergraze exchange – www.evergraze.com.au
- www.dpi.nsw.gov.au

NOTES

PROGRAZE™

Profitable, sustainable grazing

APPENDICES

1. Measuring herbage mass – median quadrat technique
2. Collecting your samples
3. Grazing management requirements of pasture species Subtropical North Coast Supplement
4. Estimates of pasture growth and feed year plans
5. Nutritive values of common feeds
6. Pasture composition recording sheet
7. Fodder budgeting calculation sheet

APPENDIX 1

MEASURING HERBAGE MASS – THE MEDIAN QUADRAT TECHNIQUE

The following is a step-by-step description of the median quadrat technique.

Equipment required

- 1.5 m × 0.5 m median quadrat. It is important that the dimensions are followed accurately (see Figure A1).
- Battery or hand operated shears.
- Plastic bags.
- Four marker pegs.
- Force draft or microwave oven.
- Scales capable of weighing to a gram.
- Forceps or tweezers.
- Pen and paper.

Method

Step 1. Choose the area of pasture to be assessed. This can be about 30 m × 30 m and its boundary identified with pegs, one in each corner. If this technique is used to predict the herbage mass of paddocks, selection of an area that adequately represents the paddock will be critical for an accurate assessment. Before selecting the representative area it is essential to evaluate all parts of the paddock to obtain an appreciation of the extent of the paddocks variation. The area selected should represent average yield (herbage mass) and composition (green, dead, legume and weed) of the whole paddock.

Step 2. Following selection, walk a set number of paces (5–10) from the edge of the area and place the quadrat at your toe. Herbage which has been bent over by the quadrat should be straightened.

Step 3. Eliminate the two highest and two lowest yielding subquadrats by eye. Cut all herbage within the remaining subquadrat to ground level and store in a plastic bag. Remove stones, dirt and faeces from the sample.

Step 4. Starting from the cut area, change direction and repeat Steps 2 and 3 at least 4–9 times. As the variation in the assessment area increases, increase the number of cuts (up to 10). Upon reaching the boundary of the selected area, turn 90°, turning back into the area, and continue pacing.

Step 5. Record the weight of herbage in each bag to the nearest gram. The attached sheet can be used to record weights, then calculate the average weight of the cut quadrats. Ensure the bag weight is not included.

Step 6. Bulk the herbage from all bags.

Step 7. Thoroughly mix the herbage so it appears uniform throughout. Split the herbage into four equal amounts. Discard two diagonally opposite portions. Recombine the remaining two portions.

Step 8. Repeat Step 7 until a sample equal to that which could be heaped onto a large dinner plate (approximately 150 grams) remains.

Step 9. To calculate the pasture dry matter percentage, record the weight of the sample. Place the sample in a force draft oven for at least 24 hours below 70°C; that is, until the weight of the sample is constant. Alternatively, use a microwave oven. If a microwave oven is used:

a. Place the sample on a microwave dish in the oven, along with a cup of water. Refill the cup if the water level gets too low.

b. Set the microwave to maximum power and dry for 5 minutes.

c. Weigh the sample, turn it over and loosen it (the sample tends to compact while drying).

d. Repeat steps (b) and (c) until the weight remains constant between successive weighings.

Then, to calculate the dry matter percentage (DM%), use the following formula:

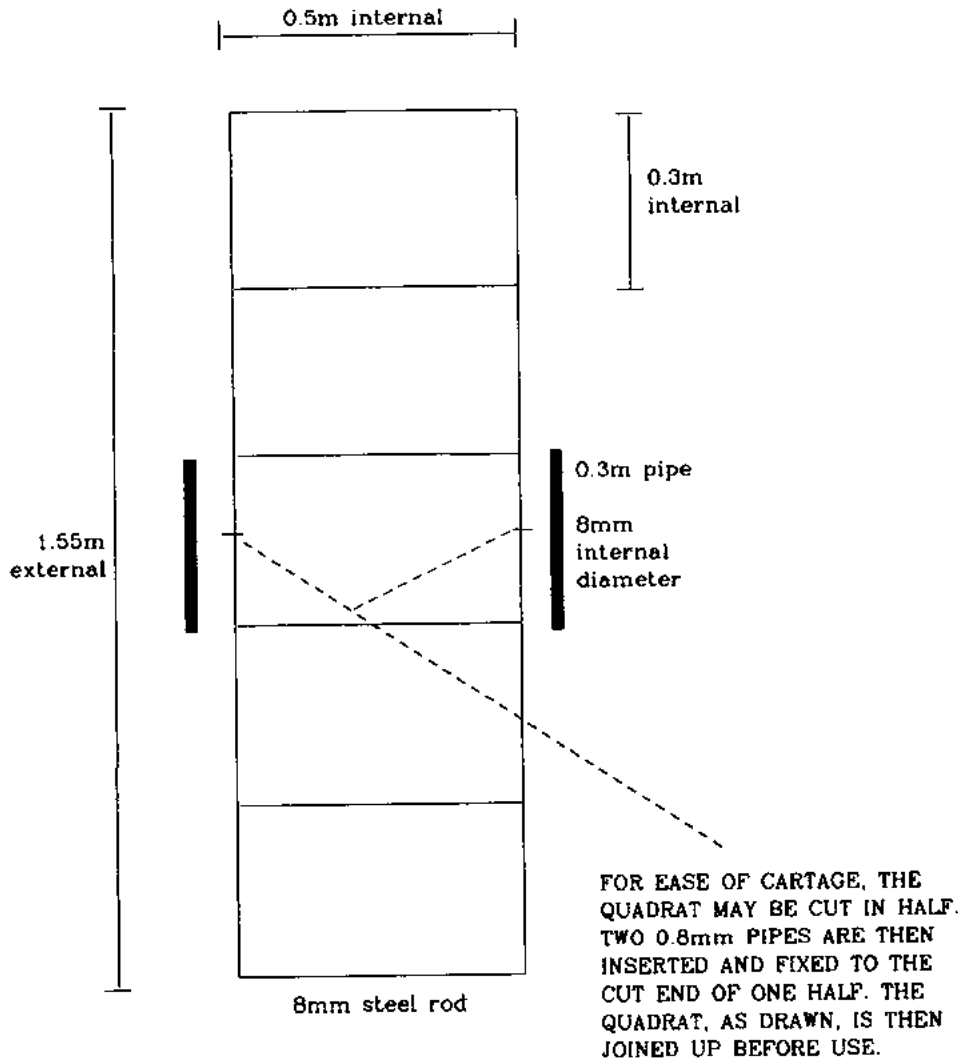
$$\text{DM\%} = \frac{\text{weight of sample dry (g)} \times 100}{\text{weight of sample wet (g)}}$$

Step 10. Multiply the average weight of herbage calculated in Step 5 by the DM percentage. Multiply this figure (in grams) by 67. To ensure this figure remains appropriate, dimensions for the median quadrat must be followed accurately. This will give kilograms of dry matter per hectare (kg DM/ha). This is your estimate of the herbage mass for the area being assessed.

Step 11. To obtain an estimate of pasture composition (percentage legume, percentage green and percentage dead) use the oven-dried sample. If the sample is significantly larger than an open handful it can be reduced using the technique described in Step 7. Sort the sample into fractions of interest, usually, green legume, dead legume, other dead and other green. Tweezers or forceps are useful for the sorting process.

Step 12. By weighing each fraction the percentage and yield (kg DM/ha) of each component is calculated. The attached data sheet should be useful for recording the weight and proportion of each component. Pasture samples dried in an oven can be forwarded for laboratory analysis to obtain predictions of pasture quality, e.g. digestibility, energy and protein levels. Samples dried by microwave are unsuitable for laboratory analysis.

Figure A1. Median quadrat.



Herbage mass calculation sheet

A. (Steps 1 to 5)		
Paddock name:	Quadrat number	Wet weight (g)
Date:	1	
Observer:	2	
Notes:	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	
	Total	
	Average wet weight	g

B. (Steps 6 to 9)									
Weight of container									
Weight of wet sample									
Total									

	Container	
	Dry weight	

Dry matter % = $\frac{\text{Weight of dry sample (g)} \times 100}{\text{Weight of wet sample (g)}}$ = %

C. (Step 10)
Herbage mass = Average wet weight (g) × $\frac{\text{dry matter \%} \times 67}{100}$ = kg DM/ha

D. (Steps 11 & 12)			
Component	Dry weight (g)	Percentage of total %	Herbage mass (kg DM/ha)
Green – legume			
Green – grass			
Green – other			
Dead – legume			
Dead – other			
Total			
Total legume			
Total green			
Total dead			

NOTES

APPENDIX 2

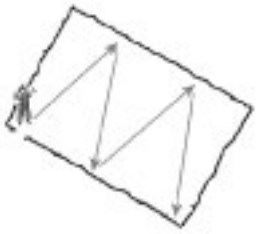
COLLECTING YOUR SAMPLES

The laboratory can only determine the quality of the sample as it is received. It is therefore very important how you collect, sub-sample and dispatch your sample to the laboratory.

- **Collect your bulk samples**. Collect your bulk sample early in the week so that it can be received and processed by the laboratory before the weekend. Ensure that the bulk sample represents the feed you are testing, (see below) and free from contamination from soil and leaves etc. For baled hay and silage it is recommended that a sample corer be used to collect your sample. If a corer is not available a 'grab' from deep within the bale or pit is recommended.
- **Thoroughly mix the bulk sample and sub-sample**. Use the mixing, coning and dividing technique shown below to obtain the quantity of sample indicated on the provided sampling bag.
- **Complete the sample submission form enclosed**. This information tells the laboratory who owns the sample and what tests are required.
- **Package and dispatch**. Package the sample and submission form into the prepaid envelop provided and send to laboratory.
  - » Samples with high moisture content (fresh pasture, fresh mown pasture and silage) must be frozen before sending to the laboratory. Once frozen, the sample will remain stable during delivery. The sample should be well wrapped in wet newspaper to minimise defrosting. Sample should be sent to the laboratory by overnight courier.
  - » Samples must not be allowed to heat during storage and transport prior to testing, as they will deteriorate. Never leave samples in vehicles, particularly on a hot day.

HOW TO COLLECT YOUR SAMPLE

Pasture – fresh and fresh mown



Sampling at random by taking between 15–20 'grab' samples across a paddock.

Grab to grazing height or the full depth of the swath or windrow.

Combine all 'grabs' in a bucket and mix well.

Baled hay

Small square bales: 10–20 bales selected at random. One core from each bale, through the 'butt' and at right angles to the surface.

Combine cores in a bucket and mix well.

Large round or square bales: 5–10 bales selected at random. One core from each side of the bale probing at right angles to the surface and at different heights.

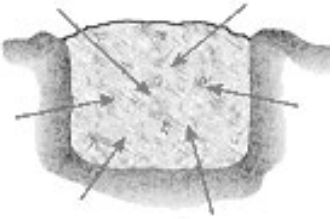
Combine cores in a bucket and mix well.

Cubes, pellets, meals and grain

10–15 'grab' samples from the bulk supply or individual bags.

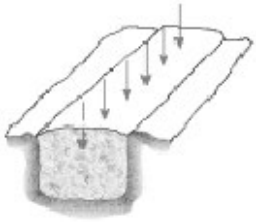
Combine all 'grabs' in a bucket and mix well.

Silage



Bunker or pit silage: 0–15 sites across a freshly cut silage face **or** 7–10 random sites along the length of the pit. Avoid sampling from only the top 50 cm of the pit.

Combine cores in a bucket and mix well

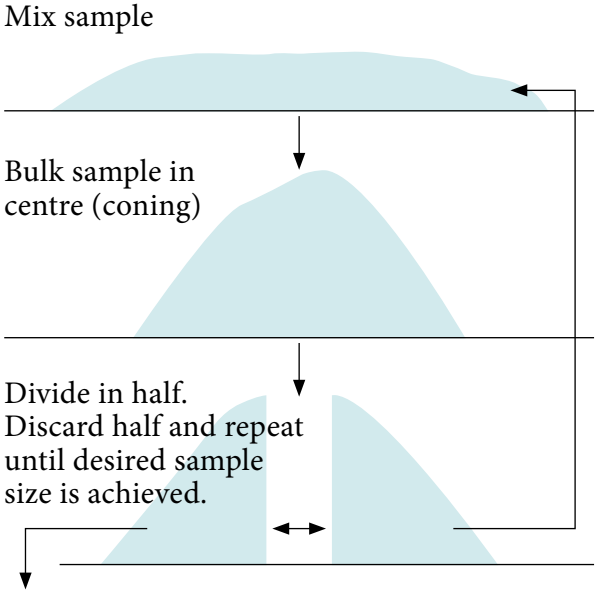


Baled silage: 10–15 bales selected at random. Two cores from the middle of the curved or one core from each side of a bale probing at right angles to the surface and at different heights.

Combine cores in a bucket and mix well.

Sub-sampling

Coning and dividing



Cubes, pellets, meals and grain

Sample corers

Core sampling devices are commercially available or can be made on-farm. A common construction material is stainless steel dairy airline. More sophisticated corers have a removable cutting head, but home-made corers simply rely on scalloping one end of the tube and sharpening with an angle grinder. It is important to keep the cutting surfaces sharp for efficient sampling.

Corers can be manually operated or fitted with an attachment to allow operation with a power drill. In the former case a hole is drilled through one end of the pipe so that a lever/handle can be inserted. **When operating a corer either by hand or by a drill, ensure the corer does not get hot by rotating the corer slowly**. The core can be pushed out of the corer using a length of wooden dowel.

For more information on sample collection, please contact our laboratory on (6938 1999)

References

1. *Fodder Analyst's Laboratory Manual*. Australian Fodder Industry Association.

2. *Successful Silage*. **Top Fodder**. Chapter 12. Authors: Alan Kaiser and John Piltz.

APPENDIX 3

GRAZING MANAGEMENT REQUIREMENTS OF PASTURE SPECIES

The following strategies have been successfully used for particular pasture species. In mixtures, optimal management must take into account other species and interactions between them.

INTRODUCED TEMPERATE SPECIES

Annual legumes

For species such as subterranean clover, medics, serradella, Persian clover, balansa clover and arrowleaf clover the following guidelines are provided.

Aim for 30–40% legume content (on a dry weight basis) in introduced mixed perennial grass/annual legume pastures and more than 50% in annual pastures in cropping rotations. If the percentage falls below 15%, in permanent pastures consider ways of increasing legume growth and controlling grass dominance (e.g. fertiliser use, grazing management, herbicides).

Most annual legumes (especially sub. clover) are well adapted to heavy grazing in winter. For the initial establishment year or where persistence is a problem in established annual legume based pastures, the following strategies can assist to build a larger seed bank:

- Graze in late summer/early autumn to ensure summer feed is kept reasonably short and excess litter removed. This enables better germination of annual legumes after the autumn break. Avoid grazing so short (exposing large areas of bare ground) that:
  - » erosion risk is increased;
  - » seed pods are grazed in significant quantities (e.g. large snail medic pods);
  - » weeds can invade.
- Reduce stock pressure following germination. When plants are well anchored pressure can then be increased to moderate levels.
- From flowering to seed set, stock pressure should be high enough to reduce shading by companion species (especially grasses) and seed set of undesirable weeds.
- Avoid heavy grazing of flowers and pods of species such as medics, serradella, rose clover etc. In well established balansa clover, grazing through flowering does not appear to reduce persistence. However, in the establishment year, removing stock at the commencement of flowering may maximise seed set.

Lucerne (*Medicago sativa*)

Year 1

During the establishment year it is best to allow lucerne to reach full flower, then to graze for a maximum of 2–3 weeks to a height of 7–10 cm.

Established pastures

Set stocking at moderate to high density can kill established lucerne quickly. High carrying capacity and good persistence are possible if you graze paddocks for 2–3 weeks, then rest until early flowering (usually about 5 weeks). The recovery period is more critical than the grazing time as it allows the plant sufficient time to replenish root reserves.

Sustainable grazing systems range from two paddocks on the Tablelands, to four to six paddocks on the Slopes. Strip grazing is used under irrigated intensive systems and is usually associated with the dairy industry.

Rotations must be flexible to allow for stock condition and climatic constraints. If dry conditions prevail it is preferable to graze lucerne rather than allow leaf fall to occur and waste valuable feed.

Higher quality feed can be obtained by reducing the rest period, so that grazing is carried out at the bud or pre bud stage, however this may reduce persistence of lucerne if done routinely.

If subdivision is inadequate for rotational grazing, accept that potential carrying capacities will be lower and stand persistence reduced. For best results under these conditions:

- Sow well adapted semi-dormant varieties, avoid highly winter active varieties.
- Use furrow sow establishment techniques where possible.
- Sow companion species with lucerne (e.g. sub. clover, white clover). These will replace lucerne plants as they die as well as improve the quality and continuity of feed supply.
- Avoid set stocking for long periods (greater than 5 weeks).
- Use conservative stocking rates.
- To replenish root reserves, allow lucerne to flower whenever possible, especially before and after stress periods (e.g. summer).
- Monitor insect pests and control them if they threaten survival of the stand.

White clover (*Trifolium repens*)

Year 1

Where grass competition is a problem in the spring following an autumn sowing, frequent light grazing during this period will improve survival.

Established pastures

When actively growing and under good soil moisture, white clover can tolerate heavy continuous grazing pressure without serious damage.

Close grazing, to 1500 kg DM/ha of total pasture or 750 kg green DM/ha, in autumn, winter and spring will increase clover presence.

Note: Haifa white clover does not root well at nodes and is easily over-grazed by sheep compared to other cultivars that are more stoloniferous .

Avoid grazing less than 2000 kg DM/ha of total pasture if moisture is limiting, especially in summer. Maintain leaf area at this time and avoid grazing to bare stolons, especially in areas with drier summers where white clover acts more as an annual.

Clover density and vigour can be greatly influenced by the density and growth of companion grasses. Strong summer growing grasses, such as kikuyu, can suppress clover.

Strong growing temperate grasses, such as phalaris, can also suppress white clover if spelled in the spring months.

Native grasses generally are less competitive although some, such as microlaena, can be very competitive.

Vigorous clover growth can lead to clover dominance in native grass/clover pastures. Such pastures may become unstable, susceptible to erosion and weed invasion, and cause bloat. To prevent this, increase grazing pressure to remove excessive clover growth and, in future years, reduce fertiliser applications.

Careful manipulation of stocking pressure and soil fertility is the key to maintaining pasture stability. Under intensive irrigated production, grazing can commence when lower leaves start to yellow. Graze to 5–6 cm.

Lotus

***Lotus pedunculatus* (e.g. Maku)**

Year 1

If grazing is necessary to control grass in spring, graze to 5–7 cm high.

Established pastures

Maku lotus is remarkably robust and withstands either close grazing or rank presence of companion grasses. However, maintaining herbage mass between 2000 and 3500 kg DM/ha (no less than about 1500 kg green DM/ha) is desirable for recovery and regrowth following grazing. Reducing grazing pressure in autumn may assist rhizome density and contribute to a better spread.

Lotus corniculatus (e.g. Goldie)

Year 1

Seedlings are especially vulnerable to competition so follow-up grazing to control grass competition is essential for good establishment. Light frequent grazing through the following spring/summer should be maintained because germination events continue to occur for at least 12 months following sowing.

Established pasture

Plants generally are relatively short-lived (2–4 years), so intensive flowering for natural re-seeding is essential for long-term persistence.

Like lucerne, it requires strategic grazing for persistence. Graze when tillers are fully developed (about 15–20 cm high). Cease grazing when plant height is reduced to 3–5 cm. Spell for 6–8 weeks in summer from first flowering to pod shatter to promote the development of the soil seed-bank and to promote subsequent seedling recruitment.

TEMPERATE GRASSES

Year 1

When establishing phalaris, cocksfoot, fescue or perennial ryegrass, appropriate grazing management strategies vary with sowing method, sowing time, soil fertility and anticipated soil moisture through the growing season.

Where grass is sown early into fertile soils and good soil moisture is likely through spring and summer (e.g. under irrigation and high rainfall tableland conditions), quick grazing, once plants are well anchored, to 800 kg green DM/ha (about 7 cm high in new pasture which is not very dense), will enhance tillering and plant development.

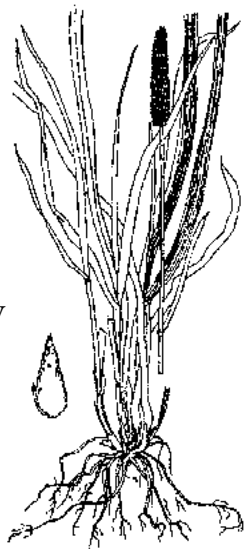
If late spring and summer soil moisture is unreliable, grazing should be limited to allow sufficient time for plants to flower in spring and summer.

Where possible, keep sheep off newly sown pastures for the first 12–18 months. Cattle are preferred for early grazing of well anchored plants.

Under less favourable conditions, perennial grasses should not be grazed until flowering has occurred and the root system well anchored. Even then, permit only a light quick grazing preferably with cattle. Such situations would be,

- surface sowing;
- late sowing (e.g. winter);
- low fertility;
- quick drying soils;
- areas with unreliable spring/summer soil moisture; and
- situations where plant development may be delayed.

Phalaris (*Phalaris aquatica*)



Established pasture

Once established, Australian phalaris is less sensitive to changes in grazing management than winter active types such as Sirosa. Grazing management can however be used to manipulate phalaris-based pastures in many situations:

Young pasture – say less than two years old

In autumn and winter, graze leniently to limit weed growth while encouraging sub. clover and phalaris tillering. Do not cut young pastures for hay. Leniently graze through summer months.

Degraded pasture

Firstly, ensure nutrient deficiencies, especially phosphorus, sulphur and molybdenum, are corrected.

Encourage pastures to recover and increase phalaris density. Defer grazing until after the autumn break for about six weeks. This allows around 1500 kg/ha of green dry matter to accumulate. Development may be enhanced by spelling for 8 weeks after a 1–2 week graze.

If annual grasses are a major problem, use high stocking rates in rotation. Consider herbicides to reduce dominance of both annual grass and broad leafed weeds. Reduce stocking pressure in spring to allow seed set of both phalaris and subterranean clover.

During summer degraded phalaris pastures should not be heavily grazed.

Mature pasture

Following the autumn break, avoid heavy grazing for about six weeks, aiming at an availability of 1500 kg/ha green dry matter in late Autumn.This allows phalaris tillers to develop and clovers to establish following the autumn break. Then rotationally graze – within dry matter limits of 1000–1500 kg green DM/ha – through autumn and winter using rest periods of around 6 weeks. Where paddocks are set stocked through winter, maintain green dry matter levels above 1000–1200 kg DM/ha.

In spring graze to keep pasture at less than 3000 kg/ha dry matter. This will encourage white clover in high rainfall areas and sub clover to set seed. Where annual grasses are a problem, use short periods of grazing to keep feed between 1500–3000 kg/ha of green dry matter.

Delay any hay cutting until after stem elongation and heading of phalaris. Earlier cutting can be successful if the growing conditions following cutting are adequate for the grass to send up seed heads. In late summer to early autumn use moderate grazing pressure to minimise residues to about 1000–1500 kg.

In 'summer dry' environments, some carry-over stubble is considered useful. In elevated areas (tablelands) that receive reasonable summer rain, keep pastures short and leafy through summer.

However, in hotter areas with more erratic summer rainfall (e.g. Northern Slopes), more carry over feed with flowering stems has been associated with preventing regeneration buds from shooting. Lack of follow-up rain and hot weather can deplete root energy reserves where new growth occurs. This bulk then needs reducing at the end of summer.

Rotational grazing practices may increase the incidence of the 'sudden death' form of phalaris poisoning in stock.

Perennial ryegrass (*Lolium perenne*)

Established pastures

Coastal

Graze when three new leaves have expanded on each ryegrass tiller. On the North Coast this is equivalent to a grazing interval of 30–45 days in winter and 15–20 days in spring.

Graze to a height of 5–6 cm of stubble. Do not allow cows to graze after 48 hours when intensively rotating livestock on pasture.

In summer, maintain ground cover to reduce invasion by summer grasses. In summer, graze infrequently (e.g. monthly) as required, but follow-up with a slashing if weeds are present, otherwise they may smother the ryegrass. Maintain soil moisture by irrigating every 4–5 days in summer if necessary, depending on soil type, depth, evaporation etc.

Grazing periods should be timed as far as practical to avoid soil pugging in wet conditions.

Inland

Strategies to maintain or upgrade the content of perennial ryegrass and sub. clover in a pasture include the following methods:

Late summer/autumn – reduce stubble before the autumn break to about 1000 kg DM/ha. If grazing with sheep-only, defer grazing until 1200 kg/ha green dry matter is present.

Winter – graze to maintain the green dry matter level between 1200–2000 kg DM/ha and increase pressure if weeds are shading the ryegrass and sub. clover.

Spring – graze to maintain green dry matter between 1000–2500 kg DM/ha. Control excessive spring growth to encourage sub. clover, reduce weeds and increase incidence of late tillers, providing more feed into summer.

When cutting for hay in spring, cut before tillers containing potential seed heads appear. This strategy will allow fresh regrowth to continue into the early summer period when moisture and temperatures are favourable. Grazing before leaf decay occurs encourages survival of spring tillers over summer.

Hotter areas – refrain from grazing paddocks during summer and early autumn where mean maximum temperatures exceed 30°C. The overall aim is to maximise tiller production following the autumn break. Graze before leaf decay occurs.

Allowing pastures to seed can increase plant numbers. Reduce stubble following seeding.

Endophytes

The endophyte fungus, which may be present in perennial ryegrass (and tall fescue) pastures, is responsible for a number of livestock health disorders, including ryegrass stagger. If present it is found in the leaf sheaths at the base of the plant and in seed heads. Where endophyte are known to exist and associated health disorders are of concern, grazing strategies need to avoid high intake of these plant parts, especially in summer and autumn when concentrations of toxin tends to be greater.

Annual ryegrasses such as Tetila (*Lolium multiflorum*)

If growing under high fertility conditions and good soil moisture, grazing when plants are well anchored (approximately 6 or 7 weeks) will assist tillering and allow light penetration.

Then graze when three fully expanded leaves appear on each ryegrass tiller.

Graze to a height of 5–6 cm. More frequent grazing may be necessary in spring if rust is a problem or if you wish to delay stem development.

Prairie grass (*Bromus wildenowii*)

From sowing, graze when plants reach 3–4 new leaves/tiller, which will be 30–35 days in mid-winter to 20–22 days in spring. However, this may be compromised by soil moisture as it seems critical not to graze prairie grass when the soil is waterlogged.

The intervals between grazing in spring, as indicated above, are essential for sward survival. They allow increased growth and senescence of the lower leaves of the canopy to form a mat. The mat is believed to have at least two important functions:

- Reducing soil surface temperature in summer
- Preventing weeds (summer grass) establishing.

This mat breaks down towards the end of summer and allows new prairie grass seedlings to germinate and establish.

There appears to be no advantage in deferring grazing in early autumn to allow the new prairie grass seedlings to establish. In fact, if there are weeds present, the effect of deferment from grazing is negative on prairie grass production.

If invasion by summer grasses becomes significant, spray out the pasture with herbicide (rate and herbicide type depends on weeds present) any time after mid-February and at the time the prairie grass seed begins to germinate. This practice may need to be repeated every two years but this depends on the weed seed bank. Such a practice has the potential to lead to a permanent grass pasture.

Cocksfoot (*Dactylis glomerata*)

Some varieties are more tolerant to grazing than others with low crowned varieties tending to be more tolerant (especially with sheep).

Important aspects of cocksfoot management are; to maintain a balance of legume and grass, and to keep growth under control in summer and autumn to avoid loss of feed quality and shading of other species, particularly clovers.

When grazing young cocksfoot pastures aim to leave at least 1200 kg of green dry matter per hectare (about 4 cm in height in a thick pasture) after grazing.

Once established, graze to reduce excess growth through summer and before the autumn break (1000 to 1500 kg DM/ha). After the break, defer grazing as far as practical to allow clover to develop and allow herbage mass to reach around 1500 kg DM/ha. Then stock through winter grazing between 1200 to 1500 kg/ha of green dry matter (cocksfoot will tolerate set stocking) until subterranean clover has flowered. If

cocksfoot is too dominant in winter, increase the stocking rate to reduce dominance and to encourage the subterranean clover to flower and set seed. Grazing to less than 800–1000 kg DM/ha of green dry matter may jeopardise persistence. If seeding down of cocksfoot is required, reduce the stocking density once the clover has flowered.

Set stocking by sheep through summer may reduce the density of cocksfoot. Should new shoots be grazed following summer rainfall, plant energy reserves may be depleted and this can cause plant deaths especially if followed by hot dry conditions.

High crowned varieties, growing in summer rainfall districts tend to form large tussocks that lose digestibility, smother legumes and render a pasture relatively less productive. Aim to keep pastures grazed to less than 1800 kg DM/ha (about 7 cm high in a dense pasture) through summer to reduce this problem. This management will also reduce the risk of Oncopora (Corbie grub) damage, favour autumn clover establishment and minimise the incidence of leaf rust.

Tall fescue (*Festuca arundinacea*)

Once established, fescue is relatively tolerant of grazing. For established stands, the main concerns are to keep growth vegetative for as long as possible in spring, and to encourage the legume component of the pasture.

Following the autumn break, spell to allow leaf area to develop, then set stock or use a system of alternate resting and grazing through the remainder of autumn and winter. Avoid grazing to below 1000–1200 kg green DM/ha.

Under good growing conditions in the early to mid spring, use heavy grazing pressure as far as possible to keep growth in the vegetative phase, but graze no shorter than 1000–1200 kg green DM/ha. At this stage, limit rest periods, where practical, to no more than 10 days.

Later in the spring, the rest periods can be lengthened (15 days or greater) to allow for adequate recovery, especially if hot dry weather is expected, in which case rest periods may have to be increased, or grazing stopped altogether. If the summer remains moist, the spelling interval can be kept short.

Tall rank fescue growth will inhibit subterranean clover germination in late summer/autumn. If increasing the subterranean clover component of pasture is the objective, graze to remove excess fescue by late summer. Ensure the retention of adequate ground cover.

See under perennial ryegrass for comments on endophytes.

Annual grasses

Temperate grasses in this group include barley grass, brome, sterile brome, Wimmera ryegrass and vulpia. These grasses tend to be early maturing and hence are vegetative for a very short period.

They need to be utilised while they are vegetative (green). Once they mature, feed value and attractiveness to stock decline sharply (especially with vulpia). Ensure control (keep pastures to 10 cm) over spring, as a dense mat of these pastures will shade flowering legumes. Spray topping has a role in controlling barley grass, ryegrass and vulpia.

HERBS

Chicory (*Chicorium intybus*)

Year 1

Chicory is ready to graze when it reaches 15–20 cm and the taproot is well established. Grazing should be quick and light to avoid crown damage and encourage new shoots.

Established pastures

Management of chicory will depend on the primary objective of the feed source.

When chicory is sown as a high quality specialist forage for say finishing stock, rotational grazing based on a four-paddock system will probably be the most appropriate. Aim to maintain plant height between 5 cm and 40 cm with a high proportion of leaf. In summer, maintain grazing pressure so as to prevent stem elongation. This is likely to require an increase in stocking density when chicory growth rates are high. Applying post-grazing nitrogen in conjunction with rainfall or irrigation over the warmer months will ensure quick regrowth and maximise production.

When part of a conventional perennial pasture mix, it is important the pasture is managed for the benefit of the chicory component. If perennial grasses and clovers are part of the mix there is the temptation to set stock for long periods, particularly during winter. The likely outcome of this approach is a decline in the chicory component.

Across both management situations, during periods of fast growth (Spring/Summer), chicory should be grazed for about a week and spelled for about three weeks. Through periods of slow growth (Autumn/Winter), grazing periods can extend to about two weeks with spell periods to about six weeks. This ideally suits a four-paddock system.

NATIVE AND NATURALISED GRASSES*

In general:

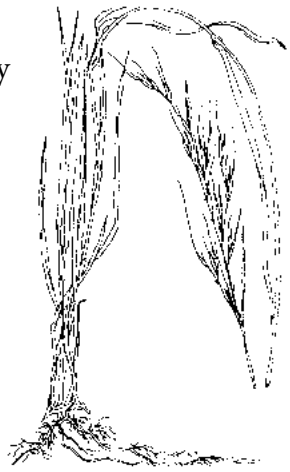
- Learn to recognise beneficial and undesirable plants. Note when they flower and when they establish.
- By resting paddocks periodically when flowering and seeding down, and during seedling establishment, the density and persistence of some desirable plants may be increased.
- Some undesirable plants that are less grazing tolerant can be discouraged by grazing hard at establishment and flowering. Where mixed pastures are involved, the effects of a grazing strategy on one species have to be balanced against any injurious effects on other species in the mixture.
- Avoid continued heavy stocking pressure, as far as practical, especially when pastures have been or are under stress, such as drought.

Wallaby grass (*Austrodanthonia*) and *Weeping grass* (*Microlaena*). Wallaby grass seeds down in autumn and spring, while Microlaena seeds from November to March. Both grasses respond to fertiliser and tolerate grazing. In spring, shading by strong sub clover growth can retard them.

To maintain a good presence of these grasses use moderate to heavy stocking rates to reduce residues in late summer and autumn to allow sub clover to establish. Avoid heavy grazing after the autumn break to allow grass seedlings to establish. If broad leaved weeds are a problem maintain ground cover in autumn to reduce establishment of these weeds.

Through winter, reduce grazing pressure to help establishing grasses. If annual grasses are a problem, defer grazing until late winter to spring when heavy stocking rates may be used to control them.

Grazing at low to moderate stocking rates until perennial grasses have set seed favours the grass component while controlling sub. clover growth. Shading of grasses by sub. clover and broad leaf weeds can be a problem in good seasons. Graze heavily in spring to reduce competition from sub. clover or broad leaf weeds. Favourable changes in species composition may occur faster under high fertility conditions.



With a low density of desirable species, use strategies that encourage seedling recruitment and seeding down, while discouraging undesirable competitive species. For example, see the section on wiregrass below.

Redgrass (*Bothriochloa*). Grows over summer and is frost susceptible. Grazing over summer increases redgrass density and oversowing with fertiliser and legumes increases winter feed availability.

Be careful of legume dominance in spring as it can reduce redgrass density over time. This can be manipulated by judicious use of fertiliser. High rates of phosphorus and sulphur can encourage clover dominance at the expense of redgrass. Sub optimal rates of phosphorus and sulphur may be preferable to losing the perennial grass component of the pasture.

* See note at the end of this section.

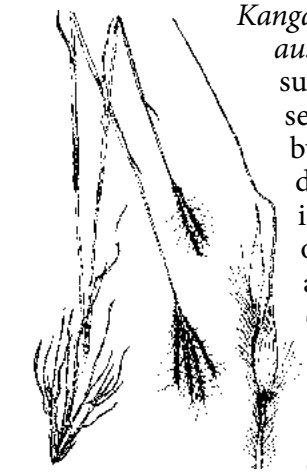


Diagram: N. Burbidge

Kangaroo grass (*Themeda australis*). Grows well with summer rain and is frost sensitive. It is threatened by grazing and clover dominance if pasture is improved with the oversowing of legume with appropriate fertiliser.

This grass is regarded as intolerant of heavy continuous grazing at heavy stocking rates but will survive at lower stocking rates. It appears to be encouraged by intermittent grazing.

Spelling in late summer to provide bulk going into autumn will reduce the presence of annual clover and strengthen the perennial grass.

Mitchell grass (*Astrebla* sp.) Stocking rates must be adjusted according to rainfall patterns.

In general, Mitchell grass pastures should not be grazed in the first summer, but left to set seed. However, if the pasture establishes well and has sufficient growth, a quick light grazing may encourage tillering and help control weeds.

The pasture is safe to graze from the following spring. If the stand is thick (a maximum spacing of one metre between plants, with medic or herbage in between) the best stocking rate is about one DSE per hectare.

Each winter, dry tussocks should be grazed down hard. Then remove the stock to allow spring growth and restock the area in summer.

Wiregrass dominant pastures. Research in northern NSW has shown that wiregrass dominant pastures can be manipulated with grazing management to promote more beneficial year-long green perennial native grasses.

Inspect pastures in spring for seed heads of winter green desirable native grasses – such as Wallaby grass (*Austrodanthonia*) or Weeping grass (*Microlaena*) and select a pasture to be grazed in the following year.

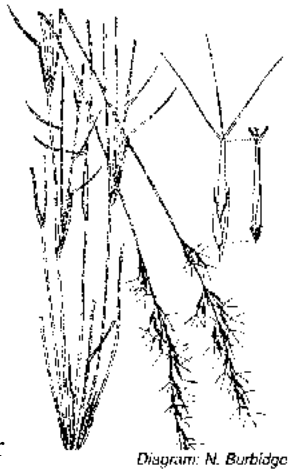


Diagram: N. Burbidge

In summer, select the best paddock for burning the following August. Ensure sufficient fuel builds up by not overgrazing in autumn. Aim to keep dry matter above 1000 kg/ha. Pasture can be grazed heavily in mid to late winter to reduce its green component. Keep green material below 200 kg/ha dry matter.

Burn the pasture in late winter to remove dead material or, graze heavily through to summer and supplement stock. Mob stock at 15 DSE/ha before wiregrass seed heads appear.

In summer, grazing needs to be heavy to keep grass under control while maintaining adequate ground cover during the most likely heavy rainfall intensity period. Then use 'put and take' stocking – 15 DSE/ha – to keep the pasture below 200 kg/ha of green dry matter, depending on rainfall and growth. This can be continued until the first frost.

Reduce the stocking rate in winter to allow the desirable native year-long perennials to grow.

In the next spring, the treated paddock should be rested to allow plants to regrow. In subsequent years, rest paddocks in favourable spring conditions to allow the desirable winter growing native grasses to flower.

This procedure can be repeated for a second year if needed to reduce wiregrass and encourage beneficial species. Production will be further enhanced by oversowing the modified pasture with sub clover and applying fertiliser.

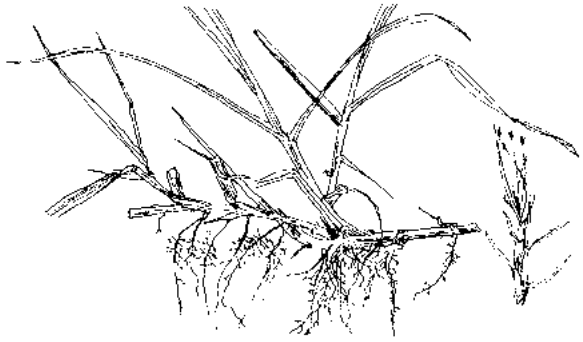
Note: In respect to issues raised relating to native pastures, before implementing a change to management check with the Department of Land and Water Conservation, that the proposed change does not contravene the *Native Vegetation Conservation Act* 1997.

INTRODUCED SUB TROPICAL SPECIES

Kikuyu (*Pennisetum clandestinum*)

Recent research has provided the following guidelines for high return, irrigated or high rainfall situations:

- If pasture height exceeds 15 cm, and if soil moisture is good, mulch (preferred) or slash to 5 cm to allow light into sward to initiate new growth.
- Apply adequate nitrogen fertiliser (under high utilisation/good moisture/high return systems – 46 kg N/ha) after every second grazing.
- Graze at adequate intervals (Phase II). Research at Wollongbar has found that optimal quality coincides with the four and a half leaf stage of regrowth. After this the proportion of stem increases rapidly as does the number of dead leaves.
- Provide a new 'strip' of feed after each grazing.



NOTES

SUBTROPICAL NORTH COAST SUPPLEMENT

This supplement should be used in conjunction with Segment 6, *Pastures and Grazing* and Appendix 3, *Grazing Management Requirements of Pasture Species* of this Manual.

The role and principles of grazing management for subtropical pastures are similar to temperate pastures. As with temperate pastures, grazing management of subtropical pastures can be a powerful, cost effective tool, but there are important differences between these pasture types in the temperate and subtropical environments of NSW.

CLIMATE

The north coast is a high rainfall environment ranging from 950 mm to over 2000 mm per annum in some locations. Rainfall is summer/autumn dominant with dry late winter and spring. Normally 30% or less of the annual rainfall falls in this period. Locations to the south of the region (lower Hunter/Manning) have a greater winter rainfall incidence than the far north coast.

Despite the high annual rainfall, the distribution is variable, with heavy rainfall events for short periods and often, long periods of low or no rainfall.

This variability in rainfall has a major influence on pasture growth and grazing management options.

LANDSCAPE, SOIL AND MICROCLIMATE DIVERSITY

As the north coast of NSW has a wide range of landscapes, has soils varying from fertile to infertile and has many microclimates, a range of pasture species is needed to meet these demands. Many of these species require specific grazing management practices for their persistence and productivity.

PASTURES

Perennial grasses

Most north coast pastures are dominated by perennial summer-growing and winter-dormant introduced naturalised grasses e.g. carpet grass, common paspalum and kikuyu. Although native grass pasture species are widespread, cattle production on the far north coast is mainly from grazing of the introduced naturalised perennial grasses.

Temperate perennial grasses such as perennial ryegrass and fescue do not persist well on the north coast. This is because the rainfall pattern (i.e. summer rainfall) does not coincide with the growing season of most temperate perennial grasses. High summer temperatures and humidity advantage the summer growing grasses resulting in strong competition to alternative species.

Selective grazing of temperate species, when mixed with summer growing grasses, also leads to poor persistence.

Annual temperate grasses, especially Italian ryegrass and oats, are often sown on the better land, e.g. alluvial soils, for high quality winter forage. Most reliable production from these grasses is with irrigation, but dryland sowings can also provide valuable specialised winter grazing.

Legumes

Maintaining a pasture legume is difficult in the subtropical environment. Temperate legumes such as white clover do not persist well, even with adequate soil fertility, because of strong grass competition in summer/autumn. Variable rainfall during dry hot springs, hot humid summers and disease and parasite problems such as root knot nematodes all impact on their persistence.

Also viny tropical legumes e.g. siratro, are not well adapted to growing with the mat forming grasses. Winters in much of the subtropical zone are too cold or rainfall is insufficient for survival of many of the tropical legumes.

As the environment is neither temperate nor tropical the legume species in particular tend to be a mixture from the two environments. However, because neither type of legume is well adapted over much of the north coast it is difficult to achieve the ideal pasture composition of 30% legume content on a dry matter basis. Most of the time the percentage of legume in the pasture is well below this figure. This is another major limitation to feed quality of subtropical pastures for the grazing animal.

Pasture quality

The summer growing subtropical and tropical pasture plants that dominate, are lower in digestibility and quality than temperate pasture plants at the same growth stage. This has major implications for animal production (see Segment 2, Pasture benchmarks) and for the management of the pasture to maintain the best quality of the subtropical pastures.

Ground cover

Maintaining total ground cover is essential for sustainable pasture production but this is usually not an issue on the north coast since most of the pasture species are perennial mat forming grasses. Even in the dry periods total ground cover is normally maintained.

The exception is when fire in spring (August/ September) is used to remove rank and dry pasture residue and to promote new green growth. Burning off pasture in these circumstances will reduce ground cover and expose soil to erosion and invasion of less desirable species. It is essential to maintain total ground cover on steep land due to high intensity rainfall. This is especially so with spring storms increasing erosion risk.

Animals

Cattle dominate animal production systems on the north coast. Few sheep, goats or deer are grazed. This dominance limits some of the pasture and grazing management options that have proven beneficial in mixed sheep/ cattle grazing enterprises.

GRASS PRODUCTION

Unlike the majority of temperate pasture grasses that become larger through the production of tillers, most of the well adapted summer growing perennial pasture grasses on the north coast are mat forming giving generally a more even ground cover. Setaria cultivars are exceptions since they enlarge by tiller initiation.

Most perennial summer growing pasture grasses in this environment reproduce and spread vegetatively by the production of stolons or above ground runners e.g. kikuyu (see kikuyu diagram in Appendix 3) or rhizomes or underground stems or runners e.g. some of the paspalum family. These grasses can also reproduce and spread by seed.

As a general rule the mat forming summer growing grasses are very tolerant of heavy grazing.

Grazing management using high-density stocking, followed by periods of rest, can be used to keep these pastures in a leafy, higher quality state. Lenient grazing leads to a high proportion of stem material, poor in quality and unable to support high levels of animal production.

LEGUME PRODUCTION

Although it is difficult to keep a high proportion of legume in north coast pastures, even a small legume content can have a large impact on the pastures quality and animal production.

It is therefore important to maintain as much legume in the pasture as possible through adequate fertiliser, especially those supplying phosphorus and to a lesser extent sulphur and molybdenum. Grazing management is the other important factor in maintaining legume content in pastures.

Temperate Legumes

Annual temperate legumes, such as subterranean clover, are not well adapted to, nor regenerate in the summer dominant rainfall environments of the north coast. However, some cultivars of subterranean clover (e.g. Clare) and other annual temperate clovers such as Persian and berseem clover can be useful winter legume forage, hay/silage or rotation crops.

White Clover

Of the temperate perennial legumes white clover is the most widely used and widely naturalised on the north coast. Naturalised strains and better-adapted cultivars such as Haifa have two survival mechanisms.

- Under adequate moisture and good grazing management to reduce heavy grass competition, it can survive as stolons i.e. living plants.
- Naturalised types are early flowering, heavy seeders and set a high proportion of hard seed ensuring a residual soil seed bank. A large soil seed bank is an important survival mechanism where conditions mitigate against survival as living plants.

Periods of heavy grazing are required to reduce strong grass competition to assist survival of stolons. Heavy grazing especially is necessary in late summer and autumn to reduce grass overburden to assist regeneration of white clover from the soil seed bank. Germination of white clover from seed banks is most common in May/June if late autumn early winter rainfall occurs.

Managing grazing by strategic spelling in spring, to promote seeding of cultivars such as Haifa, is especially important in newly sown white clover based pasture. Spring grazing those pastures containing a high proportion of mature white clover seed heads and then shifting cattle to pastures with little or no white clover is an important means of spreading seed.

Maku lotus

The other important temperate perennial legume on the north coast is Maku lotus. Maku is best adapted to seasonally wet or damp acidic soil situations or southerly-facing aspects in higher rainfall microclimates.

Maku lotus is a strong spring (if moisture adequate) summer and autumn grower, producing more dry matter than white clover under low fertility conditions. Its quality is not as good as white clover but it is palatable and of low bloat risk.

Frequent close grazing in autumn can retard rhizome development, which is the main mechanism of Maku lotus spread on the far north coast (Maku lotus sets more seed to the south). Therefore strategic spelling from grazing in autumn can assist the spread and regrowth of Maku lotus.

Tropical Legumes

Tropical legumes e.g. glycine, greenleaf desmodium, are generally only suited to the higher rainfall areas of the far north coast, north of the Richmond River or isolated frost free sites to the south.

The critical aspect in viny legume persistence is for strategic spelling from grazing. This is especially during their active growth period from mid summer to mid autumn. This is necessary for the plant to build up vine and leaf for rapid recovery from grazing.

Continuous stocking at any time at rates, which remove new growth, can quickly deplete the plant and result in their rapid decline in the pasture.

An exception to this general rule is Shaw creeping vigna that is a highly stoloniferous prostrate growing tropical legume. Once established Shaw will tolerate prolonged heavy set stocking, in fact, this grazing strategy is desirable as bulky, leniently grazed stands can develop severe leaf disease in autumn.

Other tropical legumes that will tolerate heavy grazing during their active growth stage are lotononis and Wynn round-leafed cassia.

Heavy grazing of pasture containing lotononis keeps down competing grasses and helps prevent a sudden collapse of a bulky stand due to disease when warm moist weather occurs. On the other hand, heavy continuous grazing of Wynn cassia may result in selective grazing of more palatable grasses and pasture plants. This can lead to a Wynn cassia dominant pasture, which can be unpalatable during good summer growth periods. Wynn cassia is best suited to hard short duration rotational grazing.

GROWTH CURVE OF PLANT PRODUCTION — SUBTROPICAL PASTURES

The following should be read in conjunction with Figure 6.3, Segment 6 of the PROGRAZE Manual.

Phase I. (Phase I is characterised as having below about 1000 kg of green DM per ha.).

Due to hot dry weather, most subtropical pastures can be in Phase I for extended periods from August to December (compared to winter/early spring for temperate species).

However, they often differ from temperate pastures in Phase I in that subtropical pastures can carry a large proportion of dead stem and leaf. The extent to which this occurs depends on season, grazing management and stocking rate.

So compared to a temperate pasture in Phase I, which may have little dead stem and leaf, subtropical pastures can be about 1000 kg or less/ha green DM leaf but up to 3000 kg/ha of dead material.

Because this is early in the growth phase of the pasture, this green leaf is of high quality. Where livestock can selectively graze the leaf and it is readily available, high levels of animal performance may be anticipated.

As this leaf is often combined with a high proportion of dead material in subtropical grass dominant pastures, overall pasture quality is often low, but yield is high. This is similar to Phase III in temperate pastures.

When, through grazing management, the dead material can be removed then the yield and quality characteristics are similar to Phase I temperate pastures. However, it should be keep in mind that subtropical pasture grasses are 10% to 15% lower in digestibility than temperate species at the same growth stage.

The grazing management of subtropical pastures should aim for high utilisation, of at least some of the farm's pastures, to reduce the carry over of dead material and maintain a leafy sward into Phase II.

Prolonged grazing in Phase I is unlikely to suppress mat forming grass dominant subtropical pastures, nor is it likely to reduce ground cover. Prolonged continuous grazing is not suited for some viny tropical legumes. (See earlier comments under *Tropical Legumes*).

Phase II. (Phase II is characterised as having between 1000–3000 kg of green DM per ha.).

The big challenge of grazing management of subtropical grass dominant pastures is to keep them in this phase for as long as possible. Depending on seasonal conditions subtropical pastures make their most active growth in late spring/early summer to early autumn. (See Appendix 4, North Coast pasture growth rates).

However, with the carrying capacity, often based on the late winter/spring carrying capacity, stocking rates are often too low in this active growth period to keep the pastures in Phase II over much of a property. Often it is observed that in a slightly drier summer season when there is a lower pasture growth rate (provided the growth rates are sufficient so as not to restrict intake), animal performance is better as the pastures can be maintained in Phase II for a longer period.

Grazing management is important when aiming to maintain a high proportion of a property's pasture in Phase II during this active growth period. It will involve more intensive grazing on sections of the property and allowing some other paddocks to grow through to Phase III. The most likely grazing management strategy would be to increase stocking intensity through using rotational and/or set stocking grazing management systems. Other management options include fodder conservation such as silage, pasture slashing or topping to maintain pastures in Phase II.

Whatever grazing system is used, the aim should be to match pasture growth rate with pasture removal by stock. The strategy reduces or delays the onset of stem growth and flowering, keeping the pasture with a high proportion of green leaf and so the highest possible quality for that pasture type.

Because subtropical pasture quality will rapidly decline as it moves into Phase III, to get better pasture utilisation, reduce selective and patch grazing and to improve animal performance, it is important to maintain as much of a property's pasture as possible in Phase II.

Phase III. (Phase III is characterised as having above 3000 kg of green DM per ha and mature).

With the poor rainfall distribution on the north coast and the need for a safety margin in stocking rates a high proportion of north coast pastures will move into Phase III in late summer and autumn. Also, high stocking intensity to keep some of a property's pasture as long as possible in Phase II will mean the remaining pasture will be in Phase III during late summer (see notes on Phase II above).

A high proportion of these pastures leaf and stem will die with the onset of winter resulting in large quantities of dry poor quality pasture.

Although this standing dry pasture will be of poor quality, it does offer an opportunity to be used for maintenance feeding certain classes of stock. For example, supplementary feeding breeding cows in winter and spring with suitable protein meals or access to a high quality temperate species fodder crop e.g. oats or ryegrass, can make good use of this dry pasture.

SEASONAL MANAGEMENT

The following seasonal recommendations and options are for the pasture and grazing management of grass dominant subtropical pastures.

Summer/early autumn

This is the wet and active pasture growth season on the north coast NSW. Keeping summer growing pastures at their highest quality during summer is a big challenge and on most properties matching stock requirements to pasture growth over all the property is most difficult (see earlier comments on Pasture Phases).

- As pasture growth accelerates increase stocking rates on those pastures that contain the largest amount of higher quality species e.g. kikuyu, setaria, paspalum. Rotational grazing or set stocking to keep pasture in the leaf stage (Phase II) for as long as possible is the aim. Grazing from about 15 cm high down to 5 cm is best for the mat forming pastures such as kikuyu. With tall tussocky grasses, such as setaria, graze to maintain pastures between 30 cm to 15 cm to ensure highest quality.
- Rotational graze for a short duration with high stocking intensity is best. This results in faster pasture recovery, lessening intervals between grazing and reducing patch or selective grazing. This also gives better feed utilisation. Strategic slashing or mulching to top seedheads in late summer/ early autumn may help retain pasture quality.
- Pastures which contain better quality species, and are surplus to summer requirements, can be conserved as silage and possibly hay. When conserving tropical grasses pasture management to ensure high quality conserved fodder is needed. This will include paddock preparation, adequate fertiliser and harvesting at the correct pasture growth stage (Phase II).
- Surplus pasture can also remain as low quality dry feed for late autumn winter or spring feed combined with protein supplementation.
- Grazing of newly sown subtropical pasture should be very limited in the first year to assist establishment and allow seeding. Grazing is most likely required in a favourable season as a means of controlling/ utilising vigorous growth from sown species, self-sown annual grasses or weeds. Control of unpalatable weeds such as fireweed, may be necessary.
- Strategic grazing/spelling of viny tropical legume pastures is required. Continuous heavy grazing will eliminate these legumes. These pastures are well suited to summer/ autumn saving for grazing in late autumn to spring.
- Heavy late summer early autumn grazing to keep pasture short and reduce grass overburden is necessary where white clover is an important component, where pastures are being prepared for surface sowing or direct drilling of annual winter species such as Italian ryegrass.

Late autumn/early winter

Late autumn can be a very wet period, but generally rainfall declines from March to May. However, with the onset of cooler temperatures the lower rainfall is generally quite effective at this time of the year.

- Continue high grazing intensity on pastures to be direct drilled or surface sown with annual winter pasture or forage crop species. Remove stock prior to preparations for sowing. Several preparation options or combinations are available including herbicide spray off, mulching and light cultivation to reduce competition and create a better environment for establishing the winter growing species.
- Rotationally graze winter pasture or fodder crop. Irrigation (if available), grazing management and the strategic use of nitrogen fertiliser are important tools for high winter pasture production.

  Details of the advantages and disadvantage of the different establishment techniques, grazing and management options for winter pastures and crops are available from your local District Agronomist or farm advisor.
- Depending on seasonal conditions, pasture growth, cattle classes and condition, protein supplementation either through access to high quality winter pasture, crop or protein meals can commence in early winter.

- Heavily graze late summer early autumn carry over feed of viny tropical legume based pastures prior to onset of frosts and cooler temperatures. This is to utilise green legume leaf prior to the quality decline that will occur in tropical viny legumes under the colder weather conditions.

Late winter/spring

This is the driest period of the year and with rising temperatures by late spring, subtropical pastures can be under severe moisture stress. Usually in late spring (late Sept./Oct.) early storm activity can result in some pasture growth but often these storms are patchy and unreliable.

- Subtropical pasture species are dormant or growing at low rates, but still have a high ground cover even when grazed continuously and at high grazing pressure.
- Strategic burning of dry pasture carryover may be acceptable in some situations such as timbered areas where there is a need to reduce 'fuel' thereby avoiding severe damage due to bushfires.

Burning reduces ground cover and litter exposing soil to erosion risk during high intensity spring storms. Other situations where one-off burning of dry carryover pasture is acceptable is in preparation for cropping or sowing improved pastures.

Annual burning of dry carryover material from subtropical pastures is not recommended because it favours fire tolerant species such as blady grass and weeds such as giant Parramatta grass. It is far better to use the carryover feed or slash or mulch it to increase soil organic matter and promote green leaf when the season breaks.

- Protein supplementation will improve digestion and intake of dry feed by cattle where dry feed is low in protein. In this way, pasture utilisation improves as does cattle production.
- When ever possible, allow white clover to seed especially in any new areas. Grazing white clover pastures, when seed heads are mature, in rotation with paddocks of lower white clover content, is a good way to spread white clover.

This option is usually only available in those years of 'good clover springs'. As the adapted strains of white clover set large quantities of seed, of which a high proportion is hard, one good seeding year can build a soil seed bank for many years. (See earlier comments under *Temperate Legumes*).

APPENDIX 4

ESTIMATES OF PASTURE GROWTH AND FEED YEAR PLANS

Following are estimates of pasture growth based on regional areas and are available for use when fodder budgeting. Extended fodder budgets – for greater than, say, three weeks – will be greatly improved by including pasture growth.

These estimates were derived from agronomists, livestock officers and scientists from NSW DPI and CSIRO. Pasture growth rate estimates and feed year plans have been broadly grouped into regions.

PASTURE GROWTH ESTIMATES

These estimates are for long term average conditions for the respective regions and are based on available research results and growth predictions from long-term observations by experienced agronomists and livestock officers. Growth predictions from the *Growest* and GrassGro® models were also used.

This approach has been adopted as it is inappropriate to base growth rates solely on research data. This is because of the climatic variability and the relatively short period over which research results are collected.

Growing conditions vary greatly between seasons, between regions, districts and even between parts of paddocks. The estimates presented are *therefore approximations only and intended only as a guide* to assist producers in budgeting feed supply to meet livestock requirements. It is expected that as further information comes to hand that these guidelines will be updated. Feedback is most welcome.

When using these estimates remember that large variability in feed supply can occur. Put together across the year, these monthly values do not reflect a 'typical' year. **Each month is an estimate in its own right, without any reference to what occurred the previous month.**

Consequently, the curves across a whole year may not reflect what is seen on your property. Nevertheless, for fodder budgeting these figures provide a good basis to assist in decision making about livestock moves over a 2–6 month period especially during the growing season.

Assumptions used

- Pastures are of satisfactory density for the area.
- Soil is of good moisture holding capacity (e.g. clay loam).
- Grazed at moderate stocking pressure and allowing for some pasture decay.
- Well managed and fertilised adequately (except where specified) to avoid nutrient deficiencies.
- Pastures are assumed to be maintained in the active phase of growth at all times.

Variability in feed production

The variability in pasture production in tableland and slopes districts can be very large. Therefore consider all important variables that may affect pasture production in a paddock. The more important factors to consider are:

- climate,
- soil type,
- grazing management,
- soil fertility/fertiliser use.

Climate. This is by far the largest variable. Note the comments below each growth rate table. These indicate the extent of the variation in pasture growth caused by climate. Growth rates are presented for regions. The growing conditions *within* these geographic areas can vary significantly. Generally growth conditions are more favourable in the east with drier and less reliable rainfall to the west. North to south differences can also be significant with summer dominance in rainfall increasing to the north. The major variable is the time of the season break.

Soil type. The daily growth rates assume a soil type with good moisture holding capacity, such as clay loam. It is also assumed to have good depth – not a shallow skeletal soil. On lighter textured soils, such as granites, the pasture production will be much

less. These soils dry out rapidly reducing potential pasture production. On the positive side, lighter soils tend to respond quicker following rain than do heavier soils.

Grazing management. Pasture production estimates assume that pastures are in the active stage of growth, stocked at a moderate grazing pressure and well managed. Overstocking and inappropriate grazing management may greatly affect the ability of the pasture to reach its full potential. Alternatively, correct management can greatly enhance the probability of the pasture reaching its full potential. Pastures that have been grazed hard may have inadequate leaf area to produce to its maximum potential. Similarly, previous lax grazing will result in a growth rate significantly lower than its potential.

Soil fertility/fertiliser use. Soil deficiencies – especially phosphorus, sulfur and molybdenum – can greatly affect potential pasture production. Similarly, low pH may have an adverse affect on growth rate, depending on the species in the mixture. Nutrient deficiencies can not only affect the overall production but also the reliability of production, seasonal production, botanical composition and feed quality.

Pasture quality. Along with pasture *quantity*, pasture *quality* is also very variable. In the growth rates presented, quality will not be uniform throughout the year from any one species. For example, in the spring of a winter-growing pasture, growth will tend to be lower quality than in the autumn. This is because of the greater proportion of stem-to-leaf produced. This factor is extremely important with summer growing species when they are in the reproductive phase. Summer growing grass can be especially low in quality during this phase.

Other factors. Other factors such as pasture species adaptability, weeds, pests, diseases, aspect, waterlogging, salinity and so on, can have a major impact on pasture growth. Consult your district agronomist if in doubt about the extent of the potential reduction in pasture production due to these factors.

FEED YEAR PLANS

For each of the following regional areas, tables are provided as a guide to planning the feed year. They identify those pastures and crops capable of giving high liveweight gain in cattle and sheep.

The estimates for the likely availability of feed of adequate quality are based on:

- Pastures are grown in suitable soils etc, and are well adapted to that environment.
- Pastures are well managed for both the good of the pasture and the livestock enterprise. This may involve spelling pastures for, say, up to two months to accumulate adequate quantity of feed to supply enterprise requirements. Pastures are also maintained in the active growth phase so that quality is at a high level. This is especially relevant with summer growing species such as forage sorghums.
- Quality feed, in these plans, means feed on offer having a digestibility of 70 per cent or better, and that a 'mixed' pasture has a good balance of legume present.
- Plans do not infer that this is only one paddock of a particular pasture type. That is, one may be grazed while others are rested to improve availability for livestock requirements.
- The estimates are intended as a guide only to help in selection of appropriate pasture types to suit the enterprise targets. Variability in production can be quite large.
- The quantity of feed available depends on the growth rate of the pasture, stocking rate, rate of wastage, and previous management of the pasture. These estimates only show that in any particular half-month period the pasture type is capable of having feed on offer, of adequate quantity and quality, to suit requirements in average seasonal conditions.

In addition, potential production may be greater than that indicated, given exceptional management and/or favourable aspects of pasture production. Similarly, production can be less than that indicated – especially if management is less than accepted 'best practice' or the season is unfavourable.

Northern Tablelands

Pasture types used in estimates:

Fescue/white and subterranean clover. High content of fescue, with at least 20 per cent legume – white clover significant during the warmer months. Minor amount of annual weeds only. Soils of at least moderate fertility with nutrient requirements maintained.

Phalaris/white and subterranean clover. High content of phalaris, with at least 20 per cent legume – with white clover significant during the warmer months. Minor amount of annual weeds only. Soils of moderate to high fertility with nutrient requirements maintained.

Red grass dominant pasture. Main perennial grass is red grass but other frost susceptible summer growing native grasses also present. There is little clover present with low to moderate annual weeds. Soils of moderate natural fertility. No fertiliser applied for many years, if at all.

Microlaena/white and subterranean clover. Microlaena (Weeping grass) is the dominant perennial grass with about 20 per cent legume present in the pasture. Soils of moderate to high fertility, with nutrient requirements maintained.

Oats. Sown early February on moderate to good fertility soil. Sown with adequate fertiliser applied at sowing.

Estimated pasture growth rate (mid month) of specific pasture types (kg DM/ha/day)

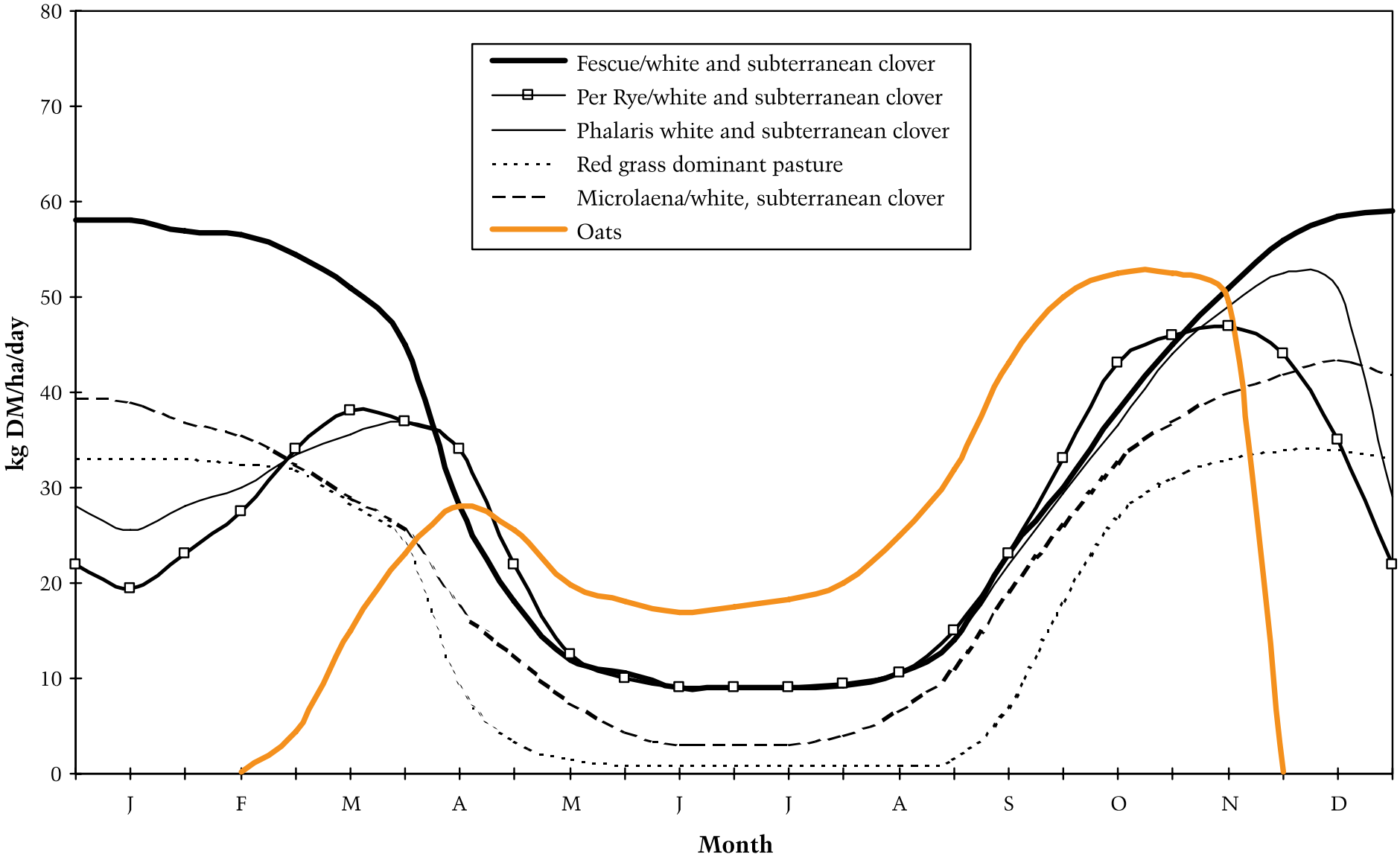
	J	F	M	A	M	J	J	A	S	O	N	D
Fescue/white and subterranean clover	58	57	51	28	12	9	9	11	23	38	51	59
Phalaris/white and subterranean clover	26	30	36	34	13	9	9	11	22	37	49	51
Red grass dominant	33	33	29	9	2	1	1	1	7	27	33	34
Microlaena/white and subterranean clover	39	36	29	18	8	3	3	7	19	33	40	44
Oats	0	3	19	27	19	18	19	29	47	53	25	0
Perennial rye/white and subterranean clover	20	28	38	34	13	9	9	11	23	43	47	35

Note: The wide variation in pasture growth which occurs between years needs to be remembered. For example the computer growth model, used to help generate these median values, predicts the growth rate could vary as follows:

	Good growing season	Poor growing season
Spring	30 per cent above	40 per cent below
Summer	30 per cent above	40 per cent below
Autumn	75+ per cent above	60+ per cent below
Winter	30 per cent above	40 per cent below

As red grass pastures have a low leaf:stem ratio and mature rapidly, pasture quality may not be adequate, or be maintained, to ensure livestock production targets are met.

Estimated growth rate of pastures - Northern Tablelands



A guide to pastures and forage crops capable of achieving at least 75% of maximum liveweight gain* given best practice management of pastures and livestock — Northern Tablelands

Pastures	JAN	JAN	FEB	FEB	MAR	MAR	APR	APR	MAY	MAY	JUN	JUN	JUL	JUL	AUG	AUG	SEP	SEP	OCT	OCT	NOV	NOV	DEC	DEC
Native summer grasses																								
Microlaena/white clover																								
Native/white clover																								
Cocks/fescue/white clover																								
Phalaris/white clover																								
Phalaris/sub clover																								
Lucerne																								
Chicory																								
Forage Crops																								
Japanese/shirhoe millet																								
Oats																								
Brassics (autumn sown)																								
Brassicas (spring sown)																								
S.T. ryegrass/red clover																								
Short term ryegrass																								

Key:

High quality sheep and cattle feed, capable of achieving at least 75% of potential liveweight gain

High quality sheep feed, capable of achieving at least 75% of potential liveweight gain

Feed inadequate in quality and or quantity to reliably provide for high growth rates in either sheep or cattle

Note: These estimates are provided by agronomists and livestock officers as an aid to pasture selection and represent the likely production from these feed sources in average years, given the feeds are grown in appropiate soils and are well managed. Adjustments will need to be made in most situations to cover the many variables involved in pasture production. Months are represented by two half months i.e. JAN JAN.

* See Segment 2 for benchmarks on feed availability requirements for various levels of liveweight gain.

North West Slopes and Upper Hunter

Pasture types used in estimates:

Phalaris/subterranean clover. Good balance of phalaris and subterranean clover with at least 20 per cent of the pasture being sub clover in the growing season. Low percentage of annual weeds present. Soils moderate to good fertility, with nutrients applied to maintenance level only.

Summer grass dominant. Red grass or frost sensitive summer growing grass dominant in pasture, with little or no clover. Small quantity of annual weeds present. No fertiliser applied for many years, if at all.

Austrodanthonia/subterranean clover. Main perennial grass is Austrodanthonia (wallaby grass) with at least 20 per cent subterranean clover present in the growing season. Small quantity of annual weeds are also present. Soils are of moderate fertility with fertiliser applied at maintenance levels.

Lucerne at 85 per cent content or more, with minor amounts of annual weeds. Soils are well drained, moderate to good fertility, with only maintenance applications of fertiliser.

Subterranean clover dominant. The pasture is 75 per cent subterranean clover, with lesser amounts of annual weeds. Soils moderate to good fertility with fertiliser applied to maintenance levels only.

Medic dominant. Pasture comprises 75 per cent barrel or naturalised burr medic with smaller amounts of annual weeds present. Soils moderate to good fertility. Fertiliser applied to maintenance levels.

Oats. Late February sown on good moisture with adequate fertiliser. Sown on moderate to good fertility soils.

Tropical grass pasture consists of a mix of bambatri panic and purple pigeon grass with less than 5% content of sub clover or medic. Moderate fertility with fertiliser at maintenance levels.

Estimated pasture growth rate (mid month) of specific pasture types (kg DM/ha/day)

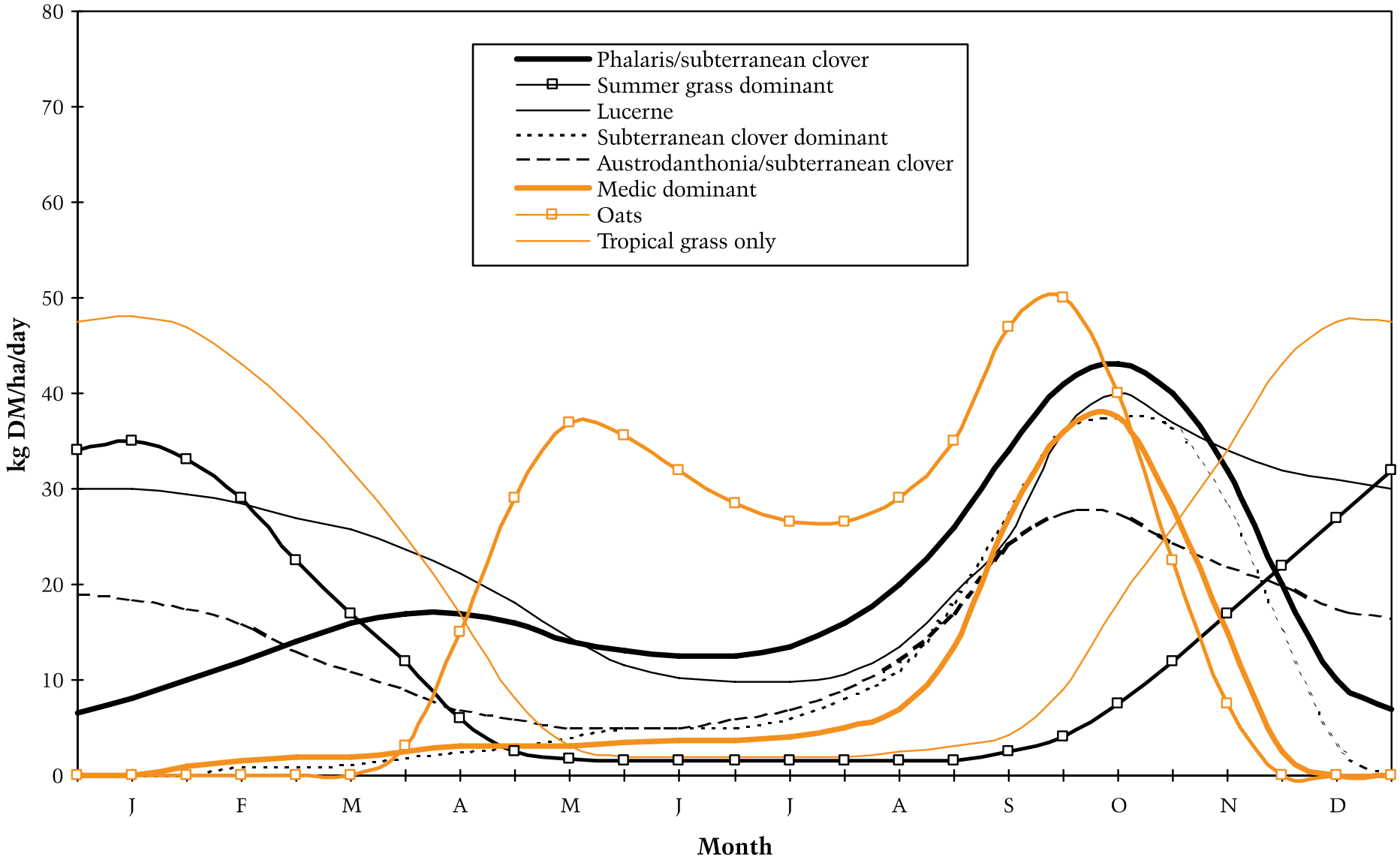
	J	F	M	A	M	J	J	A	S	O	N	D
Phalaris/sub. clover	8	12	16	17	14	13	14	20	34	43	32	10
Summer grass dominant	35	29	17	6	2	2	2	2	3	8	17	27
Austrodanthonia/ sub. clover	19	16	11	7	5	5	7	12	24	28	22	18
Lucerne	30	29	26	21	15	10	10	14	25	40	34	31
Sub. clover dominant	0	1	1	3	4	5	6	11	28	38	28	3
Medic dominant	0	2	2	3	5	4	4	7	27	38	15	0
Oats	0	0	0	15	37	32	27	29	47	40	8	0
Tropical grass only	48	43	32	17	3	2	2	3	4	18	34	48

Note: The wide variation in pasture growth which occurs between years needs to be remembered. For example, the computer growth model used to help generate these median values predicts the growth rate could vary as follows:

	Good growing conditions	Poor growing conditions
Spring	50 per cent above	50 per cent below
Summer	100 per cent above	50 per cent below
Autumn	100 per cent above	60 per cent below
Winter	30 per cent above	50 per cent below

As red grass pastures have a low leaf:stem ratio and mature rapidly, pasture quality may not be adequate, or be maintained, to ensure livestock production targets are met.

Estimated growth rate of pastures - North West Slopes and Upper Hunter



A guide to pastures and forage crops capable of achieving at least 75% of maximum liveweight gain* given best practice management of pastures and livestock — North West Slopes and Upper Hunter

Pastures	JAN	JAN	FEB	FEB	MAR	MAR	APR	APR	MAY	MAY	JUN	JUN	JUL	JUL	AUG	AUG	SEP	SEP	OCT	OCT	NOV	NOV	DEC	DEC
Native summer grasses																								
Native/sub. clover																								
Phalaris/sub clover																								
Lucerne																								
Chicory																								
Lucerne/sub clover																								
Annual ryegrass/sub clover																								
Danthonia/sub. clover																								
Trop. grass/minor luc./sub cl.																								
Lovegrass/serradella/sub cl.																								
Forage Crops																								
Hybrid pearl millet																								
Jap/shirhoe millet																								
Oats																								
Short term ryegrass																								
Forage sorghums																								
Lab lab																								
Cowpeas																								

Key:

High quality sheep and cattle feed, capable of achieving at least 75% of potential liveweight gain

High quality sheep feed, capable of achieving at least 75% of potential liveweight gain

Feed inadequate in quality and or quantity to reliably provide for high growth rates in either sheep or cattle

Note: These estimates are provided by agronomists and livestock officers as an aid to pasture selection and represent the likely production from these feed sources in average years, given the feeds are grown in appropiate soils and are well managed. Adjustments will need to be made in most situations to cover the many variables involved in pasture production. Months are represented by two half months i.e. JAN JAN.

* See Segment 2 for benchmarks on feed availability requirements for various levels of liveweight gain.

Central Tablelands

Pasture types used in estimates:

Oats. Sown early February into good moisture and moderate to good fertility soil with adequate fertiliser.

Temperate perennial grass/subterranean clover. Phalaris, cocksfoot, fescue or perennial ryegrass suited to the soil and area. Well balanced, with clover being at least 20 per cent in the growing season. Fertiliser applied to maintenance levels.

Microlaena/Austrodanthonia/subterranean clover. Year-long green perennial native grasses with a good balance of subterranean clover – greater than 20 per cent in the growing season. Moderate to good fertility soil. Fertiliser applied to maintenance levels.

Microlaena/Austrodanthonia grass. Pasture dominated by these species. Very little clover present, minor amounts of broadleaf weeds present. No fertiliser applied for many years.

Summer grass plus subterranean clover. Main grasses are frost sensitive species such as Red grass. Subterranean clover at least 20 per cent of pasture in growing season and minor amounts of annual weeds present. Soils moderate to good fertility. Fertiliser applied to maintenance levels. Usually found at lower altitudes of the tablelands.

Summer grass. Dominated by frost sensitive grasses such as red grass. Very little clover or annual weeds. Soils have moderate to good fertility. Not fertilised for many years if at all – usually found at lower altitudes.

Annual grass/subterranean clover. Dominated by grasses such as vulpia, barley grass and ryegrass, with a good balance of at least 20 per cent clover. A moderate amount of broad leaf weeds. Soil fertility good.

Estimated pasture growth rate (mid month) of specific pasture types (kg DM/ha/day)

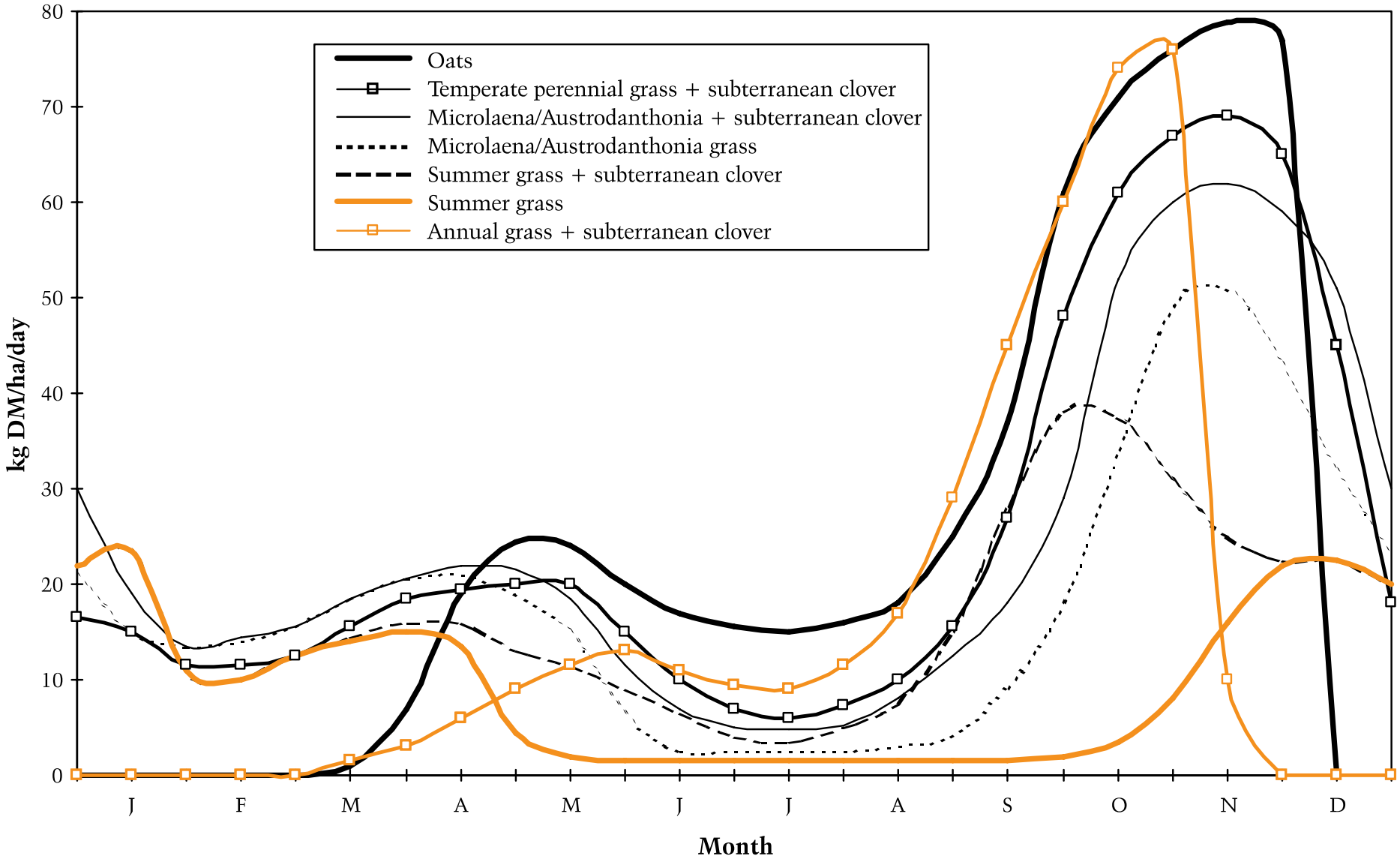
	J	F	M	A	M	J	J	A	S	O	N	D
Oats	0	0	1	19	24	17	15	18	37	71	79	0
Temperate perennial grass + subterranean clover	15	12	16	20	20	10	6	10	27	61	69	45
Microlaena/Austrodanthonia + subterranean clover	19	15	19	22	19	7	5	8	18	52	62	51
Microlaena/ Austrodanthonia grass	15	14	19	21	15	3	3	3	9	34	51	32
Summer grass/ subterranean clover	24	10	15	16	12	7	4	8	28	38	25	23
Summer grass	24	10	14	14	2	2	2	2	2	4	16	23
Annual grass/ subterranean clover	0	0	2	6	12	11	9	17	45	74	10	0

Note: The wide variation in pasture growth which occurs between years needs to be remembered. For example, the computer growth model used to help generate these median values predicts the growth rate could vary as follows:

	Good growing season	Poor growing season
Spring	50 per cent above	40 per cent below
Summer	100+ per cent above	70 per cent below
Autumn	65 per cent above	60+ per cent below
Winter	40 per cent above	60+ per cent below

As red grass pastures have a low leaf:stem ratio and mature rapidly, pasture quality may not be adequate, or be maintained, to ensure livestock production targets are met.

Estimated growth rate of pastures - Central Tablelands



A guide to pastures and forage crops capable of achieving at least 75% of maximum liveweight gain* given best practice management of pastures and livestock — Central Tablelands

Pastures	JAN	JAN	FEB	FEB	MAR	MAR	APR	APR	MAY	MAY	JUN	JUN	JUL	JUL	AUG	AUG	SEP	SEP	OCT	OCT	NOV	NOV	DEC	DEC
Native summer grasses																								
Microlaena/white clover																								
Summer grass/sub clover																								
Cocks/white/sub clover																								
Phalaris/sub clover																								
Phalaris/white clover																								
Lucerne																								
Chicory																								
Annual ryegrass/sub clover																								
Lucerne/sub clover																								
Per. Ryegrass/sub clover																								
Forage Crops																								
Jap./shirhoe millet																								
Oats																								
Brassicas, spring sown																								
Short term ryegrass																								
Hybrid sorghum/sudan																								

Key:

High quality sheep and cattle feed, capable of achieving at least 75% of potential liveweight gain

High quality sheep feed, capable of achieving at least 75% of potential liveweight gain

Feed inadequate in quality and or quantity to reliably provide for high growth rates in either sheep or cattle

Note: These estimates are provided by agronomists and livestock officers as an aid to pasture selection and represent the likely production from these feed sources in average years, given the feeds are grown in appropiate soils and are well managed. Adjustments will need to be made in most situations to cover the many variables involved in pasture production. Months are represented by two half months i.e. JAN JAN.

* See Segment 2 for benchmarks on feed availability requirements for various levels of liveweight gain.

Central West Slopes

Pasture types used in estimates:

Temperate perennial grass/subterranean clover. Phalaris, cocksfoot, ryegrass or fescue sown in soils and localities suited to appropriate species. Clover content good – more than 20 per cent in winter and spring. Fertiliser applied at maintenance levels.

Lucerne plus subterranean clover. Good density of lucerne at greater than 60 per cent. Subterranean clover content significant in winter/spring months – more than 15 per cent. Low content of annual grass or broadleaf weeds. Moderate to good fertility soils, with fertiliser applied at maintenance levels.

Lucerne. Good density of lucerne at greater than 75 per cent of pasture, with minor annual weeds present. Moderate to good fertility soils. Fertiliser applied at maintenance levels.

Annual grass/subterranean clover. Good density of annual grasses such as barley grass, vulpia, brome grass, with at least 20 per cent sub clover through winter/spring. Soils moderate to good fertility, fertiliser applied to maintenance levels only.

Tropical grass pasture consists of a mix of bambatsi panic and purple pigeon grass with less than 5% content of subterranean clover or medic. Moderate fertility with fertiliser at maintenance levels.

Subterranean clover. Predominantly sub clover – at least 60 per cent – with minor quantities of annual grasses and broadleaf weeds. Moderate to good fertility soils with fertiliser applied to maintenance levels.

Summer grass. Dominated by frost sensitive native grasses such as red grass. Very little clover, annual grasses, or broadleaf weeds present. Soils moderate fertility. Fertiliser not applied for many years, if at all.

Oats. Early March sown on good moisture. Soil fertility good and sown with adequate fertiliser.

Estimated pasture growth rate (mid month) of specific pasture types (kg DM/ha/day)

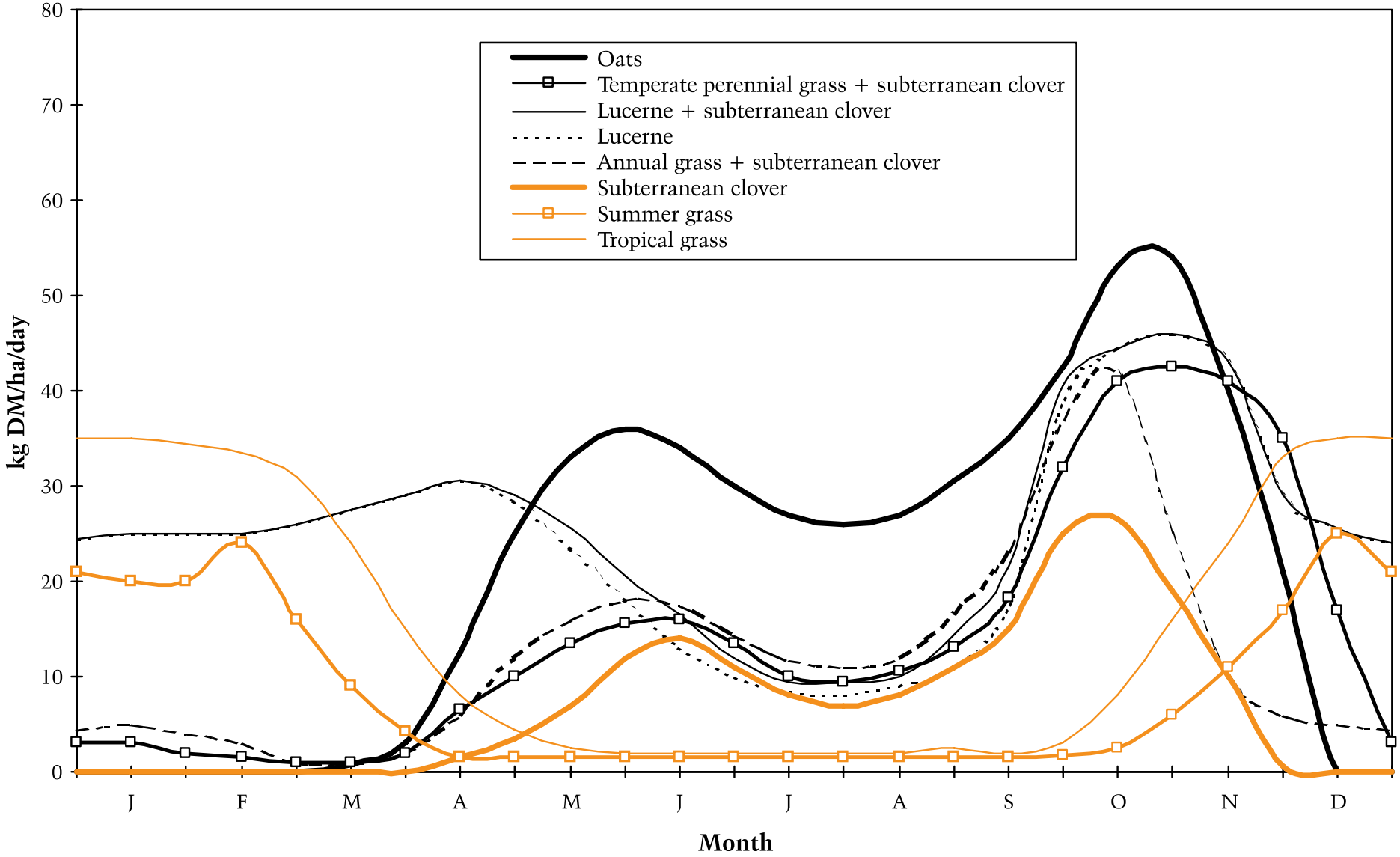
	J	F	M	A	M	J	J	A	S	O	N	D
Temperate perennial grass + subterranean clover	3	2	1	7	14	16	10	11	18	41	41	17
Subterranean clover	0	0	0	2	7	4	8	8	15	27	10	0
Summer grass	20	24	9	2	2	2	2	2	2	3	11	25
Lucerne/ subterranean clover	25	25	28	31	26	17	10	10	22	45	43	26
Lucerne	25	25	28	31	24	13	9	9	18	45	43	26
Annual grass/ subterranean clover	5	3	1	6	16	18	12	12	23	42	10	5
Oats	0	0	1	13	33	34	27	27	35	53	40	0
Tropical grass	35	34	24	8	3	2	2	2	2	8	24	35

Note: The wide variation in pasture growth that occurs between years needs to be remembered. For example, the computer growth model used to help generate these median values predicts the growth rate could vary as follows:

	Good growing conditions	Poor growing conditions
Spring	75 per cent above	80 per cent below
Summer	100+ per cent above	80 per cent below
Autumn	100+ per cent above	60+ per cent below
Winter	75 per cent above	60 per cent below

As red grass pastures have a low leaf:stem ratio and mature rapidly, pasture quality may not be adequate, or be maintained, to ensure livestock production targets are met.

Estimated growth rate of pastures - Central West Slopes



A guide to pastures and forage crops capable of achieving at least 75% of maximum liveweight gain* given best practice management of pastures and livestock — Central West Slopes

Pastures	JAN	JAN	FEB	FEB	MAR	MAR	APR	APR	MAY	MAY	JUN	JUN	JUL	JUL	AUG	AUG	SEP	SEP	OCT	OCT	NOV	NOV	DEC	DEC
Native summer grasses																								
Summer grass/sub clover																								
Phalaris/sub clover																								
Lucerne																								
Chicory																								
Annual rye/sub clover																								
Lucerne/sub clover																								
Perennial rye/sub clover																								
Cocksfoot/sub clover																								
Forage Crops																								
Japanese/shirhoe millet																								
Oats (grain recovery)																								
Oats (full grazing)																								
Brassicas, spring sown																								
Cowpeas																								
Hyb. for sorghum/sudan																								
Lab lab																								

Key:

High quality sheep and cattle feed, capable of achieving at least 75% of potential liveweight gain

High quality sheep feed, capable of achieving at least 75% of potential liveweight gain

Feed inadequate in quality and or quantity to reliably provide for high growth rates in either sheep or cattle

Note: These estimates are provided by agronomists and livestock officers as an aid to pasture selection and represent the likely production from these feed sources in average years, given the feeds are grown in appropiate soils and are well managed. Adjustments will need to be made in most situations to cover the many variables involved in pasture production. Months are represented by two half months i.e. JAN JAN.

* See Segment 2 for benchmarks on feed availability requirements for various levels of liveweight gain.

Central West Plains (wheat belt areas only)

Pasture types used in estimates:

Lucerne – winter active. A winter active variety (e.g. Aurora), sown under last wheat crop with additional fertiliser, and lasting about 4–5 years. Fertility moderate only with P/S levels just adequate. Grazing management is a flexible rotation, at a moderate stocking pressure. There is some invasion of annual weeds (20%) such as barley grass and ryegrass, with broadleaf weeds such as saffron thistle and Paterson's curse.

Native grass and legume. Low to medium density native perennial grasses (50%) consisting of species such as curly windmill grass, wallaby grass, windmill grass, spear grass, corkscrew grass, plains grass, neverfail grass, summer grass, with a large proportion of naturalised annual medic (when seasons permit), annual grasses and broadleaf weeds. P and S levels are low to moderate – never top-dressed. May have been cropped sometime in the past, and pasture volunteered since. Largely, moderate stocking, in a put and take system, with occasional rest periods.

Annual legume based pasture. Sown under last crop to species such as barrel medic. Producing from autumn through to spring. Annual weeds up to 25% of composition consisting of barley grass, saffron thistle, Paterson's curse in winter/spring. Additional fertiliser is added with the last crop. Fertility generally moderate only with nil or very little topdressing of P and S. Stocking pressure is moderate, and paddocks are stocked in a put and take system with occasional rest periods. Volunteer summer growing annuals present but not included in accompanying graphic as growth is sporadic and unreliable in this area especially in the south of the region.

Oats. Sown in early April at 40 kg/ha, on short fallow moisture with adequate P, S and N fertiliser. No further topdressing during growth. Grazed intensively from mid May to November or until late July if locked up for grain production.

Post-crop volunteer annuals. Volunteer annual grass dominate, with up to 10% perennial species. Cropped in the past. Barley grass, some ryegrass and up to 20% vulpia and 20% broadleaf weeds e.g. Paterson's curse and saffron thistle. Some summer growth but this is extremely variable. No fertiliser applied, since the cropping phase. Low to moderate fertility. Stocked at moderate pressure, on a 'put and take' approach, which can include long periods of grazing with occasional periods of rest.

Tropical grass. Consisting of a mix of Bambatsi panic, purple pigeon grass and Katambora rhodes grass with less than 5% legume present. Moderate fertility with little or no topdressing. Moderate stocking pressure with a 'put and take' approach, including long periods of grazing and occasional periods of rest. Applicable to northern half of region only.

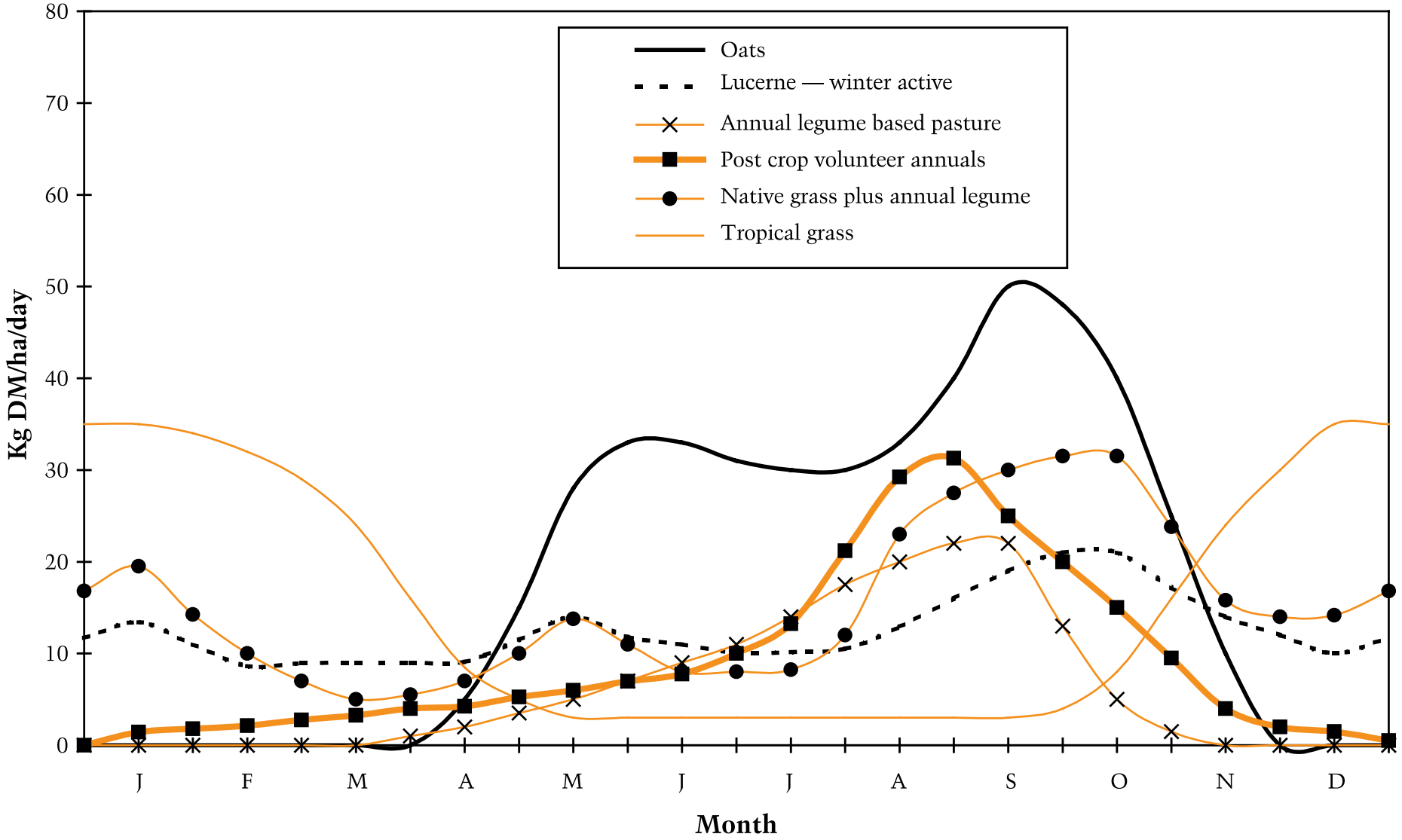
Estimated pasture growth rate (mid month) of specific pasture types (kg DM/ha/day)

	J	F	M	A	M	J	J	A	S	O	N	D
Lucerne – winter active	13	9	9	9	14	11	10	13	19	21	14	10
Native grass + legume	20	10	5	7	14	8	8	23	30	32	16	14
Annual legume based pasture	0	0	0	2	5	9	14	20	22	5	0	0
Oats	0	0	0	10	31	32	30	37	49	32	5	0
Post-crop vol. annuals	1	2	3	4	6	8	13	29	25	15	4	2
Tropical grass	35	32	24	9	3	3	3	3	3	8	24	35

Note. The wide variation in pasture growth that occurs between years needs to be remembered. For example, the computer growth model used to help generate these values predicts the growth could vary as follows:

	Good growing conditions	Poor growing conditions
Spring	105 per cent above	76 per cent below
Summer	130 per cent above	98 per cent below
Autumn	79 per cent above	89 per cent below
Winter	100 per cent above	91 per cent below

Estimated growth rate of pastures - wheat belt of the Central West Plains



A guide to pastures and forage crops capable of achieving at least 75% of maximum liveweight gain* given best practice management of pastures and livestock — Central West Plains wheat belt

Pastures	JAN	JAN	FEB	FEB	MAR	MAR	APR	APR	MAY	MAY	JUN	JUN	JUL	JUL	AUG	AUG	SEP	SEP	OCT	OCT	NOV	NOV	DEC	DEC
Tropical grass	■	■	■	■															▒	▒	▒	■	■	■
Native grass/annual legume											▒	▒	▒	▒	▒	■	■	■	■	▒	▒	▒	▒	▒
Lucerne (winter active)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Post crop vol. ann spec.									▒	▒	▒	▒	▒	▒	■	■	■	■	■	▒	▒	▒	▒	▒
Annual leg. based pastures					▒	■	■	■	▒	▒	▒	▒	▒	▒	▒	▒	▒	■	■	■	■	■	■	■
Cereal stubble/weeds											▒	▒	▒	▒	■	■	■							
Forage Crops																								
Jap/shirhoe millet	■																						■	■
Oats (full grazing) April sown										■	■	■	■	■	■	■	■	■						
Cowpeas		■	■	■	■	■	■	■																■
High density legumes		■	■	■	■	■	■	■						■	■	■	■	■	■	■				■
Hybrid for sorghum/sudan	■																							■
Lab lab	■	■	■	■	■	■	■	■																

Key:

High quality sheep and cattle feed, capable of achieving at least 75% of potential liveweight gain

High quality sheep feed, capable of achieving at least 75% of potential liveweight gain

Feed inadequate in quality and or quantity to reliably provide for high growth rates in either sheep or cattle

Note: These estimates are provided by agronomists and livestock officers as an aid to pasture selection and represent the likely production from these feed sources in average years, given the feeds are grown in appropiate soils and are well managed. Adjustments will need to be made in most situations to cover the many variables involved in pasture production. Months are represented by two half months i.e. JAN JAN.

* See Segment 2 for benchmarks on feed availability requirements for various levels of liveweight gain.

Southern Tablelands

Pasture types used in estimates:

Perennial and annual grass plus clover – fertilised 1 in 2–3 years. Older established perennial pasture of about 30 per cent introduced perennial grasses such as phalaris, 20 per cent native perennial grasses, 20 per cent annual clover, 20 per cent annual grasses, and 10 per cent weeds. Fertilised occasionally and around pH 4.5–5.0.

Microlaena, Austrodanthonia plus clover fertilised 1 in 2–3 years. Better native grasses – Microlaena and Austrodanthonia – making up 50–60 per cent of pasture. Also with 25–30 per cent clover and 10–20 per cent annual grass pastures. Fertilised occasionally, with a soil pH of 4.0–5.0.

Redgrass, Kangaroo grass – unfertilised. Frost sensitive native grasses like Stipa, poa, kangaroo and red grass with less than 5 per cent clover – pH usually 4.0–5.0 and not fertilised.

Introduced perennial grass and clover – annual fertiliser. Well-adapted perennial grasses for the area with a good balance of grass and clover. Fertiliser application and management optimum for good production.

Oats. Suitable variety sown early February with adequate fertility for good growth.

Estimated pasture growth rate (mid month) of specific pasture types (kg DM/ha/day)

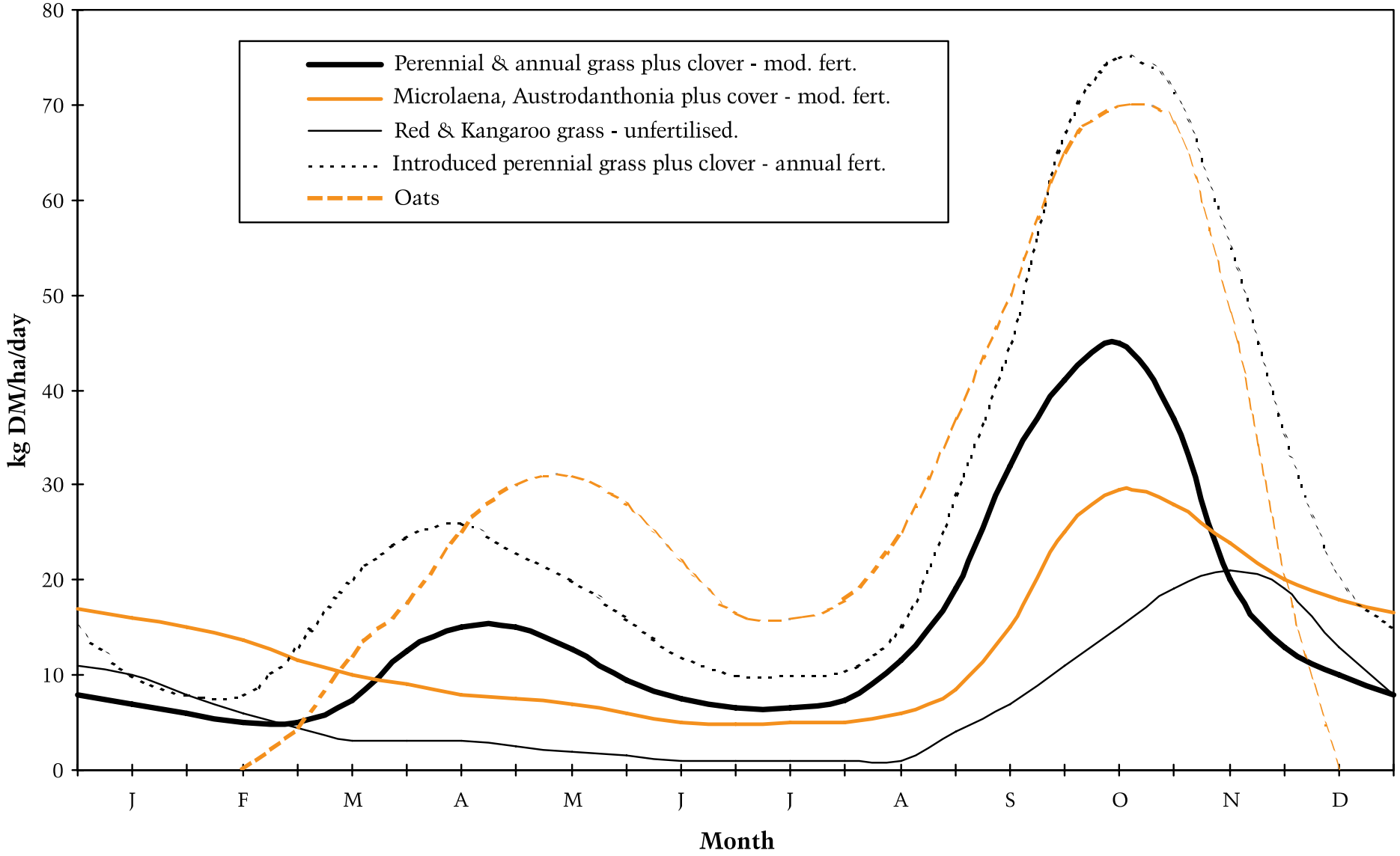
	J	F	M	A	M	J	J	A	S	O	N	D
Perennial and annual grass plus clover – fertiliser 1 in 2–3 years	7	5	7	15	13	8	7	12	32	60	20	10
Microlaena, Austrodanthonia plus clover – fertiliser 1 in 2–3 years	16	14	10	8	10	7	7	12	15	30	30	18
Red grass, Kangaroo grass – unfertilised	10	6	3	3	2	1	1	1	7	15	21	20
Introduced perennial grass and clover – annual fertiliser	10	10	15	26	20	12	10	15	45	75	55	20
Oats	0	0	12	25	31	22	16	25	50	70	48	0

Note: The wide variation in pasture growth that occurs between years needs to be remembered. For example, the computer growth model used to help generate these median values predicts the following variations from the Table's values:

	Good growing conditions	Poor growing conditions
Spring	80 per cent above	40 per cent below
Summer	100 per cent above	40 per cent below
Autumn	100 per cent above	30 per cent below
Winter	60 per cent above	60 per cent below

As red grass pastures have a low leaf:stem ratio and mature rapidly, pasture quality may not be adequate, or be maintained, to ensure livestock production targets are met.

Estimated growth rate of pastures - Southern Tablelands



A guide to pastures and forage crops capable of achieving at least 75% of maximum liveweight gain* given best practice management of pastures and livestock — Southern Tablelands

Pastures	JAN	JAN	FEB	FEB	MAR	MAR	APR	APR	MAY	MAY	JUN	JUN	JUL	JUL	AUG	AUG	SEP	SEP	OCT	OCT	NOV	NOV	DEC	DEC
Native summer grasses																								
Microlaena/danthonia/sub cl.																								
Summer grass/sub clover																								
Cocksfoot/sub clover																								
Phalaris/sub clover																								
Lucerne																								
Annual grass/sub clover																								
Lucerne/sub clover																								
Forage Crops																								
Japanese/shirhoe millet																								
Oats																								
Brassicas, mid Sept. sown																								
ST ryegrass (autumn sown)																								
ST ryegrass (spring sown)																								

Key:

High quality sheep and cattle feed, capable of achieving at least 75% of potential liveweight gain

High quality sheep feed, capable of achieving at least 75% of potential liveweight gain

Feed inadequate in quality and or quantity to reliably provide for high growth rates in either sheep or cattle

Note: These estimates are provided by agronomists and livestock officers as an aid to pasture selection and represent the likely production from these feed sources in average years, given the feeds are grown in appropiate soils and are well managed. Adjustments will need to be made in most situations to cover the many variables involved in pasture production. Months are represented by two half months i.e. JAN JAN.

* See Segment 2 for benchmarks on feed availability requirements for various levels of liveweight gain.

South West Slopes

Pasture types used in estimates:

Phalaris/subterranean clover. Good balance of phalaris and at least 20 per cent subterranean clover, with lesser quantities of annual grass/weeds. Soils are of moderate fertility and fertiliser is occasionally applied at maintenance levels only.

Cocksfoot/subterranean clover. Cocksfoot and at least 20 per cent clover in good balance, with some minor quantities of annual grass/weeds. Soils are of low-medium fertility and fertiliser is occasionally applied at maintenance levels.

Lucerne/subterranean clover. Dense pasture of lucerne at greater than 60 per cent and sub clover greater than 15 per cent. Very little annual grass or weeds present. Fertiliser is occasionally applied at maintenance levels.

Annual grass/subterranean clover. Mainly consisting of ryegrass, barley grass, vulpia, and subterranean clover at least 20 per cent. Moderate to good fertility soils with fertiliser applied occasionally.

Native grass – no fertiliser. Typical frost sensitive native perennial grass, such as red grass, with small amounts of clover. No fertiliser applied for many years – if at all.

Native grass/clover – maintenance fertiliser. Mainly native frost sensitive perennials with moderate amounts of sub. clover present – at least 20 per cent in the winter/spring period. Fertiliser applied occasionally at maintenance levels.

Oats. Early spring grazing/grain recovery variety, either for closing up for grain in late August or grazing through. Good fertility soil with adequate fertiliser applied.

Estimated pasture growth rate (mid month) of specific pasture types (kg DM/ha/day)

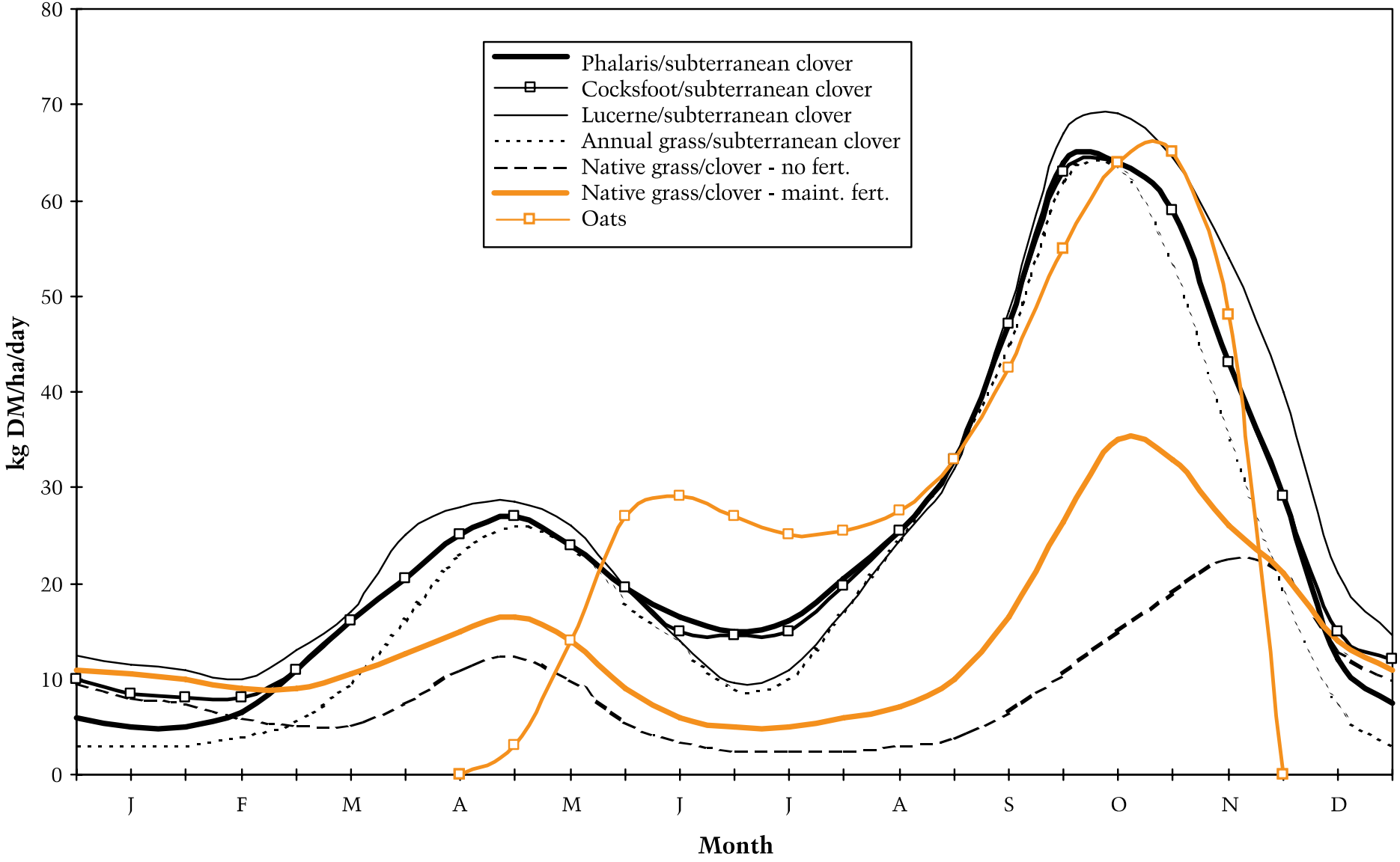
	J	F	M	A	M	J	J	A	S	O	N	D
Phalaris/ subterranean clover	5	7	16	25	24	14	16	26	47	64	43	12
Cocksfoot/ subterranean clover	9	8	16	25	24	14	16	26	47	64	43	15
Lucerne/ subterranean clover	12	10	17	28	26	14	11	25	49	69	54	21
Annual grass/ subterranean clover	3	4	10	23	24	14	10	25	45	64	35	7
Native grass – no fertiliser	8	6	5	11	10	4	3	3	7	15	23	13
Native grass/clover – maintenance fertiliser	11	9	11	15	14	6	5	7	17	35	26	14
Oats	0	0	0	0	14	29	25	28	43	64	48	0

Note: The wide variation in pasture growth that occurs between years needs to be remembered. For example, the computer growth model used to help generate these median values, predicts the growth rate could vary as follows:

	Good growing conditions	Poor growing conditions
Spring	75 per cent above	60 per cent below
Summer	100 per cent above	70 per cent below
Autumn	30 per cent above	60 per cent below
Winter	80 per cent above	20 per cent below

As red grass pastures have a low leaf:stem ratio and mature rapidly, pasture quality may not be adequate, or be maintained, to ensure livestock production targets are met.

Estimated growth rate of pastures - South West Slopes



A guide to pastures and forage crops capable of achieving at least 75% of maximum liveweight gain* given best practice management of pastures and livestock — South West Slopes

Pastures	JAN	JAN	FEB	FEB	MAR	MAR	APR	APR	MAY	MAY	JUN	JUN	JUL	JUL	AUG	AUG	SEP	SEP	OCT	OCT	NOV	NOV	DEC	DEC
Native summer grasses																								
Summer grass/sub clover																								
Cocksfoot/sub clover																								
Phalaris/sub clover																								
Annual grass/sub clover																								
Lucerne/sub clover																								
Forage Crops																								
Oats (grain recovery)																								
Oats (grazing only)																								

Key:

High quality sheep and cattle feed, capable of achieving at least 75% of potential liveweight gain

High quality sheep feed, capable of achieving at least 75% of potential liveweight gain

Feed inadequate in quality and or quantity to reliably provide for high growth rates in either sheep or cattle

Note: These estimates are provided by agronomists and livestock officers as an aid to pasture selection and represent the likely production from these feed sources in average years, given the feeds are grown in appropiate soils and are well managed. Adjustments will need to be made in most situations to cover the many variables involved in pasture production. Months are represented by two half months i.e. JAN JAN.

* See Segment 2 for benchmarks on feed availability requirements for various levels of liveweight gain.

North Coast

Pasture types used in estimates (dryland pastures only):

Naturalised pasture. Dominated by carpet grass on lower slopes with no introduced legumes present. The pasture has patches of blady grass, with occasional red grass, pitted blue grass, wire grass, traces of paspalum. On drier sites, Queensland blue couch, common couch, forbes and Parramatta grass are present depending on locality. Pastures are on low fertility soil with no fertiliser history. Generally continually stocked at low stocking rates. Occasionally burnt.

Naturalised pasture/clover. Pasture as above but a greater proportion of introduced clover (5–10%) and paspalum especially on lower slopes. Management consists of top dressing at 125 kg/ha of superphosphate or equivalent and white clover seed has been added. Management is usually by continuous stocking, but also used by alternated grazing and resting periods with growing stock.

Kikuyu. Grown on moderately fertile soils, kikuyu is dominant with minor proportions of clover and paspalum and carpet grass. Management consists of low fertiliser input, with intensive stocking at moderate stock pressure.

Kikuyu plus Nitrogen (N). As above but with routine N application. Kikuyu is dominant with most other species excluded. Management consists of intensive stocking at moderate rates. Pastures fertilised for P,S,K and N applied routinely (e.g. up to 300 kg N/ha) so that it is not limiting growth. These areas are often overseeded with annual ryegrass (not included in production curves). Response to N is often poor in spring because of low rainfall.

Ryegrass + N. Late March to early April sown Italian ryegrass (e.g. Tetila) on moderate fertility country, usually sown into renovated or suppressed summer pasture. Also surface sown into soybean cropped areas without fertiliser ('Beef 'n Beans' system). They are intensively managed with moderate to high stock pressure. P,S and K applied at sowing with 20–30 N/ha and 20–30 kg N/ha applied during season (only when not sown into soybeans).

Setaria/rhodes grass. Established on moderate fertility country. Setaria and rhodes grasses are fairly dominant with some carpet grass and introduced clover (10–15%) present. Fertilised at sowing and occasionally with P, S and K. They are managed semi intensively at moderate stocking pressure.

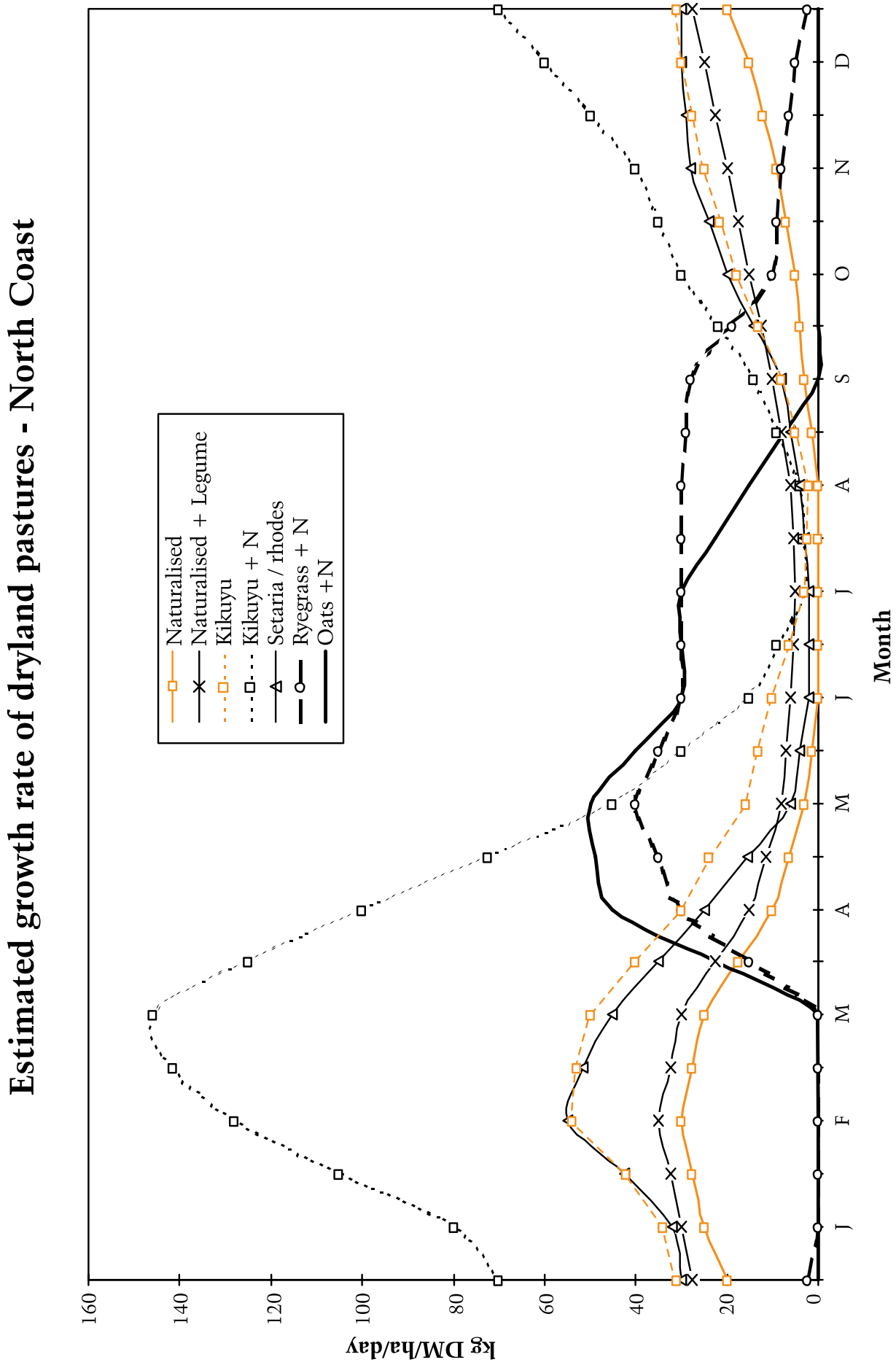
Oats + N. Late March to early April sown on moderate fertility country, usually into renovated or suppressed summer pasture. Also can be surface sown into soybean cropped areas without fertiliser ('Beef 'n Beans' system). Pastures are intensively managed with moderate to high stock pressure. Crops are grazed out in early spring. P, S and K is applied at sowing with 20–30 N/ha and 20–30 kg N/ha applied during season (only when not sown into soybeans).

Estimated pasture growth rate (mid month) of specific pasture types (kg DM/ha/day) – for areas similar to Grafton.

	J	F	M	A	M	J	J	A	S	O	N	D
Naturalised	25	30	25	10	3	0	0	0	3	5	9	15
Naturalised + Legume	30	35	30	15	8	6	5	6	10	15	20	25
Kikuyu	34	54	50	30	16	10	3	2	8	18	25	30
Kikuyu + N	80	128	146	100	45	15	3	4	14	30	40	60
Setaria/rhodes grass	30	55	45	25	6	2	2	4	8	20	28	30
Ryegrass + N	0	0	0	30	40	30	30	30	28	10	8	5
Oats + N	0	0	0	45	50	30	30	15	0	0	0	0

Note: The wide variation in pasture growth that occurs between years needs to be remembered. For example, using the CSIRO model GrassGro®, to examine long term meteorological records for Grafton, the predictions for growth rate could vary as follows (using ryegrass and red grass as indicator pastures and 10/90 percentiles compared to the median):

	Good growing conditions	Poor growing conditions
Spring	70 per cent above	60 per cent below
Summer	60 per cent above	60 per cent below
Autumn	120 per cent above	90 per cent below
Winter	150 per cent above	70 per cent below


Estimated growth rate of dryland pastures - North Coast
kg DM/ha/day
160
140
120
100
80
60
40
20
0
J
F
M
A
M
J
J
A
S
O
N
D
Month
Naturalised
Naturalised + Legume
Kikuyu
Kikuyu + N
Setaria / rhodes
Ryegrass + N
Oats +N

A guide to the periods in which pastures and/or forage crops are capable of supporting a cow and calf (e.g. calf growing at 1 kg/day) given best practice management of pastures and livestock — North Coast

Pastures	JAN	JAN	FEB	FEB	MAR	MAR	APR	APR	MAY	MAY	JUN	JUN	JUL	JUL	AUG	AUG	SEP	SEP	OCT	OCT	NOV	NOV	DEC	DEC
Naturalised		■	■	■	■																			
Naturalised/legume	■	■	■	■	■	■	■	■												■	■	■	■	■
Setaria/rhodes grass	■	■	■	■	■	■	■														■	■	■	■
Kikuyu	■	■	■	■	■	■	■	■	■												■	■	■	■
Kikuyu + N	■	■	■	■	■	■	■	■	■												■	■	■	■
Forage Crops																								
Jap/shirhoe millet	■	■																			■	■	■	■
Oats										■	■	■	■	■	■	■	■							
Forage sorghums	■	■	■	■	■	■																	■	■
Lab lab				■	■	■	■	■	■	■	■												■	■
Soybeans			■	■	■																			
Cowpeas	■	■	■	■	■	■																		
Annual ryegrass + N											■	■	■	■	■	■	■	■	■					

Key:

■ Feed of adequate quality to support a cattle breeding enterprise.

Feed inadequate in quantity and or quality to reliably provide for high livestock growth rates.

Note: These estimates are provided by agronomists and livestock officers as an aid to pasture selection and represent the likely production from these feed sources in average years, given the feeds are grown in appropiate soils and are well managed. Adjustments will need to be made in most situations to cover the many variables involved in pasture production. Months are represented by two half months i.e. JAN JAN.

* See Segment 2 for benchmarks on feed availability requirements for various levels of liveweight gain.

**A guide to pastures and forage crops capable of achieving at least 75% of maximum liveweight gain on pastures*
(e.g. 13 month old steer growing at 0.9 kg/day) given best practice management of pastures and livestock — North Coast**

Pastures	JAN	JAN	FEB	FEB	MAR	MAR	APR	APR	MAY	MAY	JUN	JUN	JUL	JUL	AUG	AUG	SEP	SEP	OCT	OCT	NOV	NOV	DEC	DEC
Naturalised																								
Naturalised/legume																								
Setaria/rhodes grass																								
Kikuyu																								
Kikuyu + N																								
Forage Crops																								
Forage sorghum																								
Jap/shirhoe millet																								
Soybean																								
Oats + N																								
Lab lab																								
Cowpeas																								
Annual ryegrass + N																								

Key:

High quality cattle feed, capable of achieving at least 75% of potential liveweight gain on pasture

Feed inadequate in quality and or quantity to reliably provide for high growth rates in cattle

Note: These estimates are provided by agronomists and livestock officers as an aid to pasture selection and represent the likely production from these feed sources in average years, given the feeds are grown in appropiate soils and are well managed. Adjustments will need to be made in most situations to cover the many variables involved in pasture production. Months are represented by two half months i.e. JAN JAN.

* See Segment 2 for benchmarks on feed availability requirements for various levels of liveweight gain.

Mid North Coast/Lower Hunter

Pasture types used in estimates (dryland pastures only):

Naturalised pasture. Dominated by carpet grass on lower slopes with no introduced legumes present. The pasture has patches of blady grass, with minor areas of red grass, pitted blue grass, wire grass, traces of paspalum. On drier sites forbs and Parramatta grass present depending on locality. Pastures are on low fertility, low pH soil, with no recent fertiliser history. Occasionally burnt.

Naturalised pasture/legume. Pasture as above but a greater proportion of introduced legume (5–10%) and paspalum present especially on lower slopes.

Management consists of top dressing with superphosphate or equivalent. White clover seed has been added in the past. Maintenance fertiliser is below requirements with an average of the equivalent of 250 kg superphosphate spread over 5 years (adequate to maintain low levels of legume in pastures). Potential growth rates greater with fertiliser rates closer to optimum.

Kikuyu. On moderately fertile soils, kikuyu is dominant with minor proportions of clover and paspalum. Management consists of intensive stocking at moderate stock pressure. Fertiliser is applied occasionally (P & S), at levels adequate to maintain some legume in the pasture. Nitrogenous fertiliser is applied when oversowing with ryegrass. Pasture growth rate potential is greater with increased fertility and grazing pressure.

Paspalum. On moderate fertility country, dominated by paspalum, with some white clover content (commonly around 5% in autumn rising to 12–15% in spring). Pastures are managed at a moderate stocking pressure. They are occasionally topdressed with superphosphate or equivalent only. The potential growth rates are greater with increased fertiliser and management input.

Setaria. Established on low to moderate fertility country. Setaria is dominant with some carpet grass and introduced legume (up to 10% rising to 15% maximum in spring) present. They are fertilised at sowing and occasionally topdressed with P, S and K. Pastures are managed semi intensively at moderate stocking pressure. There is potential for higher growth rates with increasing fertility/fertiliser rates, and improved grazing management.

Ryegrass + N. This pasture consists of Italian ryegrass (e.g. Tetila) sown in late March to early April on moderate to high fertility country. They are usually sown into renovated or suppressed summer pasture.

Pastures are intensively managed with moderate to high stock pressure. Phosphorus (P), sulphur (S) are applied at sowing with 20–45 kg N/ha and 20–45 kg N/ha applied during the season. They are responsive to increasing rates of N. Potassium (K) is topdressed where deficient

Oats + N. This is sown as a crop in late March to early April, on moderate fertility country and usually sown into renovated or suppressed summer pasture.

It is intensively managed with moderate to high stock pressure. The crop is grazed out in early spring. P, S, K are applied at sowing with 20–45 kg N/ha and 20–45 kg N/ha applied during season.

Estimated pasture growth rate (mid month) of specific pasture types (kg DM/ha/day) – for areas similar to Taree/Paterson.

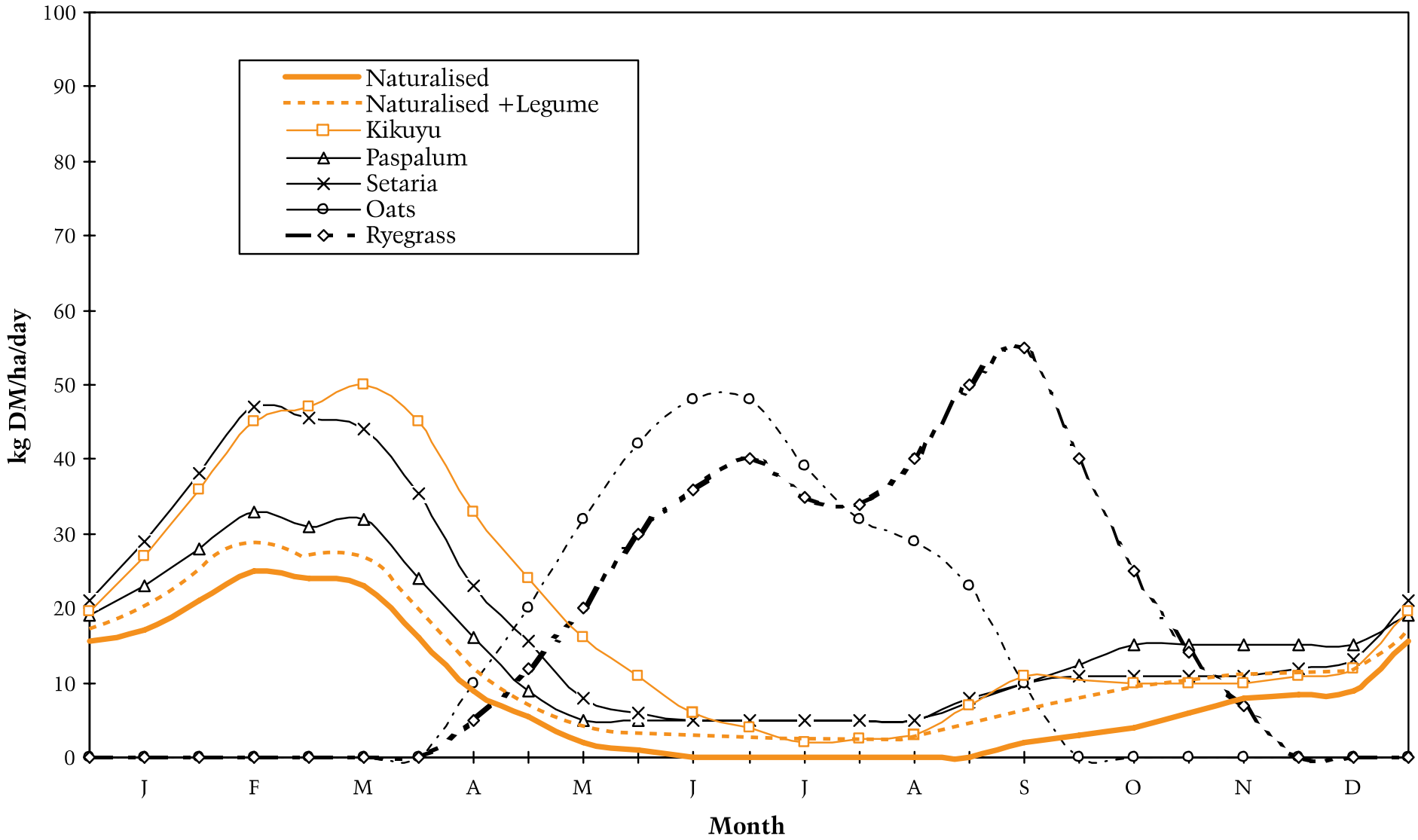
	J	F	M	A	M	J	J	A	S	O	N	D
Naturalised	17	25	23	9	2	0	0	0	2	4	8	9
Naturalised + Legume	20	29	27	12	4	2.5	2.5	2.5	6	9.5	12	12
Kikuyu	27	45	50	33	16	6	2	3	11	10	10	12
Paspalum	23	33	32	16	5	5	5	5	10	15	15	15
Setaria	29	38	44	23	8	5	5	5	10	11	11	13
Ryegrass + N	0	0	0	5	20	36	35	40	40	25	0	0
Oats + N	0	0	0	10	32	48	39	29	10	0	0	0

Note: The wide variation in pasture growth that occurs between years needs to be remembered. For example, using the CSIRO model GrassGro®, to examine long term meteorological records for Paterson, the predictions for seasonal growth rate could vary as follows (using ryegrass and red grass as indicator pastures for temperate and tropical plants respectively) and 10/90 percentiles compared to the median.

	Good growing conditions	Poor growing conditions
Spring	145 per cent above	73 per cent below
Summer	114 per cent above	46 per cent below
Autumn	70 per cent above	80 per cent below
Winter	89 per cent above	67 per cent below

This variability reflects the difference in plant types and seasons only. Other variables such as soil fertility, soil depth and type, grazing management etc. can increase or decrease this variability.

Estimated growth rate of dryland pastures - Mid North Coast and Lower Hunter



A guide to pastures and forage crops capable of achieving at least 75% of maximum liveweight gain on pastures* (e.g. 13 month old steer growing at 0.9 kg/day) given best practice management of pastures and livestock — Mid North Coast and Lower Hunter

Pastures	JAN	JAN	FEB	FEB	MAR	MAR	APR	APR	MAY	MAY	JUN	JUN	JUL	JUL	AUG	AUG	SEP	SEP	OCT	OCT	NOV	NOV	DEC	DEC
Naturalised																								
Naturalised + legume																								
Paspalum																								
Setaria grass																								
Lucerne																								
Kikuyu																								
Kikuyu + N																								
Forage Crops																								
Forage sorghum																								
Jap./shirhoe millet																								
Annual ryegrass + N																								
Oats + N																								
Lab lab																								
Cowpeas																								
Turnips																								
Annual Legume forage																								

Key:

High quality cattle feed, capable of achieving at least 75% of potential liveweight gain on pasture

Feed inadequate in quantity and or quality to reliably provide for high livestock growth rates in cattle

Note: These estimates are provided by agronomists and livestock officers as an aid to pasture selection and represent the likely production from these feed sources in average years, given the feeds are grown in appropiate soils and are well managed. Adjustments will need to be made in most situations to cover the many variables involved in pasture production. Months are represented by two half months i.e. JAN JAN.

* See Segment 2 for benchmarks on feed availability requirements for various levels of liveweight gain.

South Coast

Pasture types used in estimates:

Kikuyu. A kikuyu dominant pasture. Grazed rotationally at the 4½ leaf stage and top-dressed after each grazing over the growing period with 40 kg N/ha (90 kg urea or 120 kg ammonium nitrate/ha). Nutrition not limiting. Superphosphate applied at 20 kg P/ha/year, with any other nutrients applied as required. Paddocks are strategically mulched (approximately 3 times) over summer to reduce the build up of old runners (low digestibility). The legume content ranges from 5–10%. Management is intensive.

Forage sorghums. Sown when temperatures are sufficiently high usually in late October/early November. Sown with recommended rates of N, P and K. Top-dressed after each grazing with 50 kg N/ha. Grazing management is intensive with heavy stocking rates or harvested for fodder.

Oats. Sown in early February with recommended rates of N, P and K. Rotationally grazed every 4 to 5 weeks. Top-dressed with 40 kg N/ha after each grazing. Grazing is intensive.

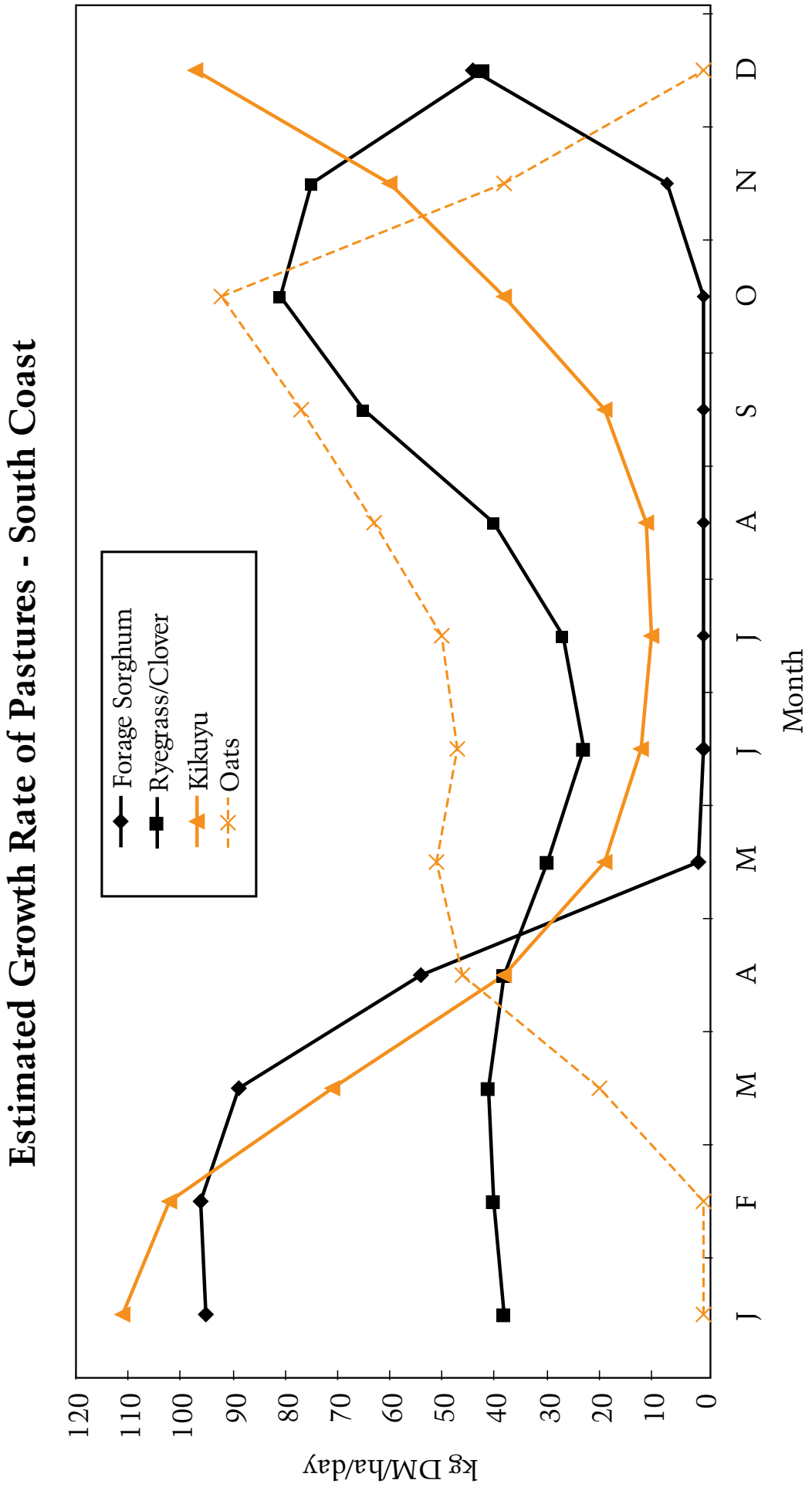
Perennial ryegrass/white clover. Perennial ryegrass with 10 to 30% white clover content. Rotationally grazed 2½ to 3 leaf stage (grazing interval of 18 to 20 days in the spring months, 35 to 40 days in the winter and at least 30 days in the summer). Top-dressed strategically during the autumn, late winter and spring with 40 kg N/ha (after each grazing). Paddocks are intensively grazed and fertilised with P, S, Mo and K as required.

Estimated pasture growth rate (mid month) of specific pasture types (kg DM/ha/day)

	J	F	M	A	M	J	J	A	S	O	N	D
Forage sorghum	95	96	89	54	1	–	–	–	–	–	7	44
Ryegrass/clover	38	40	41	38	30	23	27	40	65	81	75	42
Kikuyu	111	102	71	38	19	12	10	11	19	38	60	97
Oats	–	–	20	46	51	47	50	63	77	92	38	0

Note: The wide variation in pasture growth that occurs between years has to be considered. For example, the computer growth model (GrassGro) predicts growth rate could vary as follows (in relation to the median – using a native grass* and ryegrass# as representatives of warm season and cool season species):

	Good growing conditions	Poor growing conditions
Spring#	113 per cent above	92 per cent below
Summer*	77 per cent above	19 per cent below
Autumn*	32 per cent above	57 per cent below
Winter#	16 per cent above	74 per cent below


Estimated Growth Rate of Pastures - South Coast
Forage Sorghum
Ryegrass/Clover
Kikuyu
Oats
kg DM/ha/day
120
110
100
90
80
70
60
50
40
30
20
10
0
J
F
M
A
M
J
J
A
S
O
N
D
Month

Far South Coast

Pasture types used in estimates:

Kikuyu. A kikuyu dominant pasture. Grazed rotationally at the 4½ leaf stage and top-dressed after each grazing over the growing period with 40 kg N/ha (90 kg urea or 120 kg ammonium nitrate/ha). Nutrition is not limiting with 20 kg P/ha/year applied with other nutrients applied as required. Strategically mulched (approximately 3 times) over summer to reduce the build up of old runners (low digestibility). The legume content varies from 5–10%. Paddocks are intensively grazed.

Forage sorghums. Sown in late October/early November once temperatures are sufficiently high. Sown with recommended rates of N, P and K. Top-dressed after each grazing with 50 kg N/ha. Grazing management is intensive with heavy stocking rates or harvested for fodder.

Oats. Sown in early February with recommended rates of N, P and K. Rotationally grazed every 4–5 weeks. Top dressed with 40 kg N/ha after each grazing. Grazing is intensive.

Perennial ryegrass/white clover. Perennial ryegrass with 10 to 30% white clover content. Rotationally grazed 2½ to 3 leaf stage (grazing interval of 18 to 20 days in spring, 35 to 40 days in the winter and at least 30 days in the summer). Top-dressed strategically during the autumn, late winter and spring with 40 kg N/ha after each grazing, with fertiliser applied so that nutrition is not limiting.

Japanese millet. Sown at the end of September into early October with recommended rates of nutrients. They are intensively grazed at high stocking rates.

Native pasture. These pastures consist of weeping grass (*Microlaena stipoides*), love grass (*Eragrostis curvula*), with lesser amounts of annual grasses and broadleaved weeds. Legume content 5–10% consisting mainly of *Glycine* and *Desmodium* species. Nutrition is less than adequate with around 62.5 kg superphosphate/ha (or equivalent) at 1 to 2 year intervals. Fertiliser history is sporadic. Paddocks have low stocking rates relative to carrying capacity.

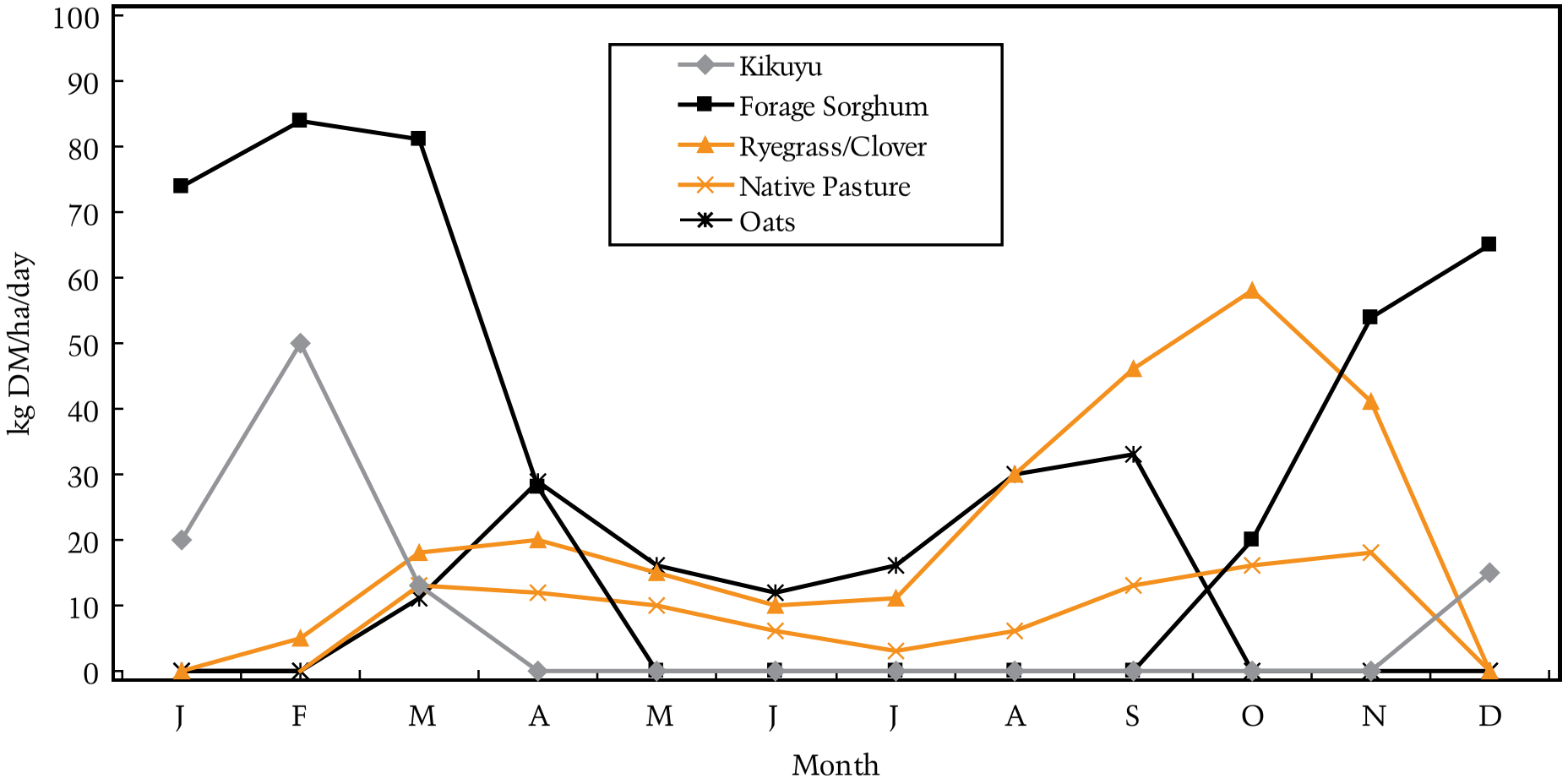
Estimated pasture growth rate (mid month) of specific pasture types (kg DM/ha/day)

	J	F	M	A	M	J	J	A	S	O	N	D
Kikuyu	20	50	13	0	0	0	0	0	0	0	0	15
Forage sorghum	74	84	81	28	0	0	0	0	0	20	54	65
Ryegrass/clover	0	5	18	20	15	10	11	30	46	58	41	0
Native pasture	0	0	13	12	10	6	3	6	13	16	18	0
Oats	0	0	11	29	16	12	16	30	33	0	0	0

Note: The wide variation in pasture growth that occurs between years needs to be remembered. For example, the computer growth model used to provide growth information rate information on pastures indicate the following variability in seasonal production based on using perennial ryegrass* as an indicator of a winter growing species and a native grass# as an indicator plant for summer growing species and using the average, 10, and 90 percentiles, to indicate the likely variability. Seasonal growth could vary as follows:

	Good growing conditions	Poor growing conditions
Spring*	108 per cent above	79 per cent below
Summer#	43 per cent above	65 per cent below
Autumn#	43 per cent above	26 per cent below
Winter*	71 per cent above	66 per cent below

Estimated Growth Rate of Pastures - Far South Coast



Riverine Plain (South West Plains)

Pasture types used in estimates:

Dryland

Annual pasture. Consisting of sub clover and invaded by significant annual ryegrass, barley grass, some vulpia and broadleaved weeds. The subterranean clover is the major species present during winter and spring, with moderate amounts of annual ryegrass and barley grass, with high amounts of broadleaf weeds. Grazing pressure is moderate with substantial periods of set stocking. P&S fertiliser is applied when the pasture is undersown and maintenance levels are below optimum for top production. Weed control using herbicides occasional to moderate use.

Lucerne – semi-dormant. The lucerne is sown under the last crop of the rotation at 1–3 kg/ha. P & S fertiliser is applied at the equivalent of 125 kg/ha of superphosphate every 2 years. Grazing pressure is moderate with stock being grazed on a flexible rotation system. (Winter active varieties are used by a moderate proportion of producers, but semi dormant varieties dominate).

Lucerne/subterranean clover. A similar pasture to the pasture above, except that it is sown with an additional 3.5 kg/ha of subterranean clover under a cover crop. Fertiliser is applied for maintenance as above. Grazing management less rigid than with the pure lucerne pasture, however paddocks are intermittently spelled to enhance lucerne persistence.

Oats. Oats are sown as a dual purpose crop in early April. It is sown into moderately fertile soil or better. A compound fertiliser is used at sowing, supplying adequate P, S and N for good crop growth. Nitrogenous fertiliser is applied to boost grazing yields in winter.

Irrigated

Annual ryegrass/subterranean clover. High producing pasture, sown with late maturing subterranean clover at 10 kg/ha. With 250kg/ha of superphosphate or equivalent and maintained with 125 kg/ha of single superphosphate or equivalent. Pasture is intensively utilised at 20–24 dry sheep equivalents once established. First irrigation taking place in early March with irrigation extending through until early October. At lower levels of input, production is significantly lower.

Lucerne. Sown in autumn with a winter active variety with good pest and disease resistance into moderately fertile alluvial soils. This pasture is well managed and grazed on good rotational grazing principles at high utilisation levels. Pests and weeds are controlled, and fertiliser is applied to address any deficiencies. Water scheduling management at moderate to high standard.

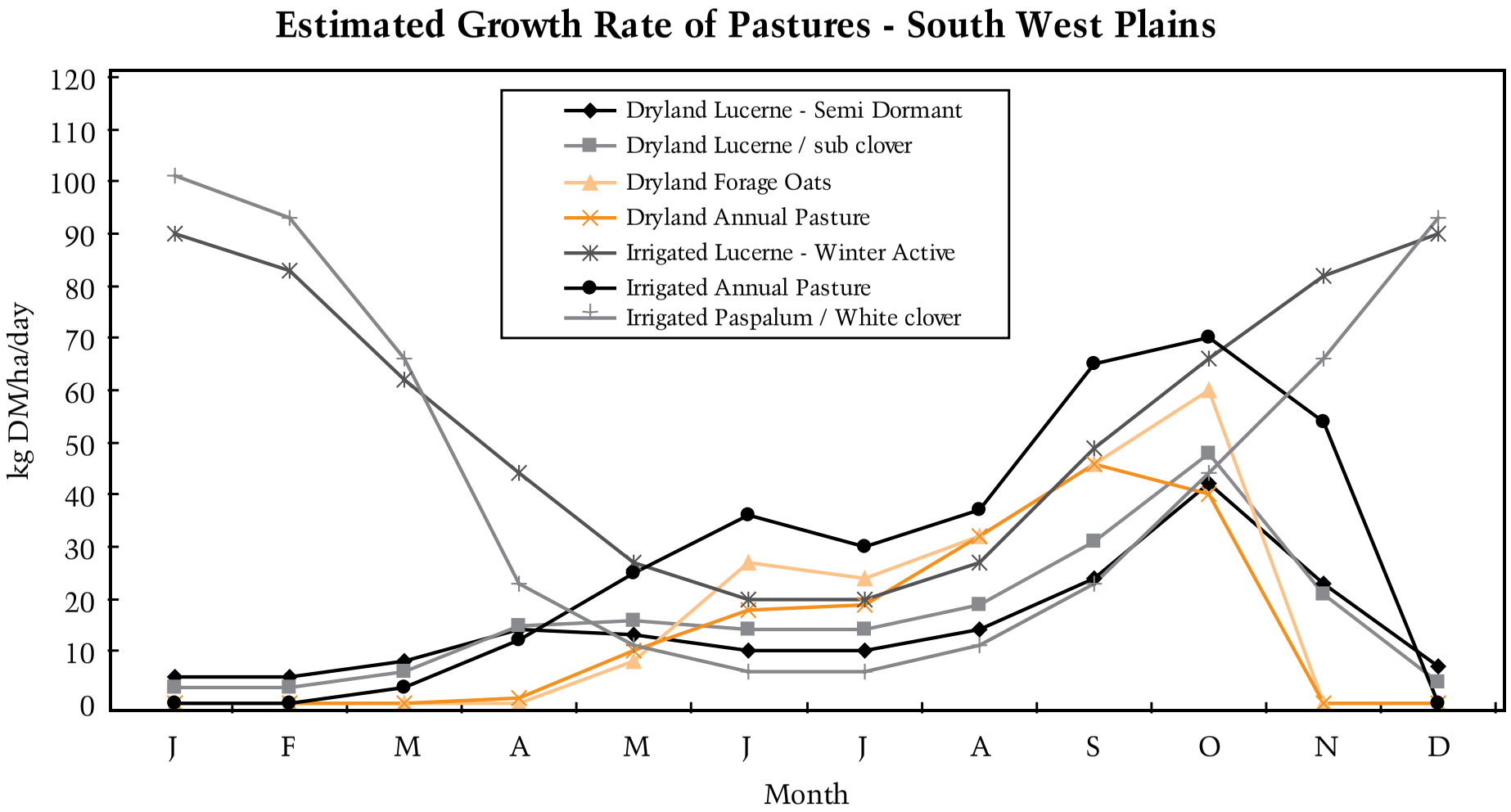
Paspalum/white clover. High producing well managed perennial pasture dominated by paspalum with up to 20 per cent white clover. Irrigation commences at the end of October, continuing through until late February to early March. Grazing management is intensive with feed maintained short and leafy. Fertiliser is applied at 250 kg/ha of superphosphate or equivalent.

Estimated pasture growth rate (mid month) of specific pasture types (kg DM/ha/day)

	J	F	M	A	M	J	J	A	S	O	N	D
Dryland												
Lucerne – semi dormant	5	5	8	14	13	10	10	14	24	42	23	7
Lucerne/sub clover	3	3	6	15	16	14	14	19	31	48	21	4
Forage oats	0	0	0	0	8	27	24	32	46	60	0	0
Annual pasture	0	0	0	1	10	18	19	32	46	40	0	0
Irrigated												
Lucerne – winter active	90	83	62	44	27	20	20	27	49	66	82	90
Annual pasture	0	0	3	12	25	36	30	37	65	70	54	0
Paspalum/white clover	101	93	66	23	11	6	6	11	23	44	66	93

Note: The wide variation in pasture growth which occurs between years needs to be remembered. For example, the computer growth model used to help generate these median values predicts the growth rate could vary as follows:

	Good growing season	Poor growing season
Spring	93 per cent above	93 per cent below
Summer	157 per cent above	92 per cent below
Autumn	175 per cent above	81 per cent below
Winter	61 per cent above	32 per cent below


Estimated Growth Rate of Pastures - South West Plains
Dryland Lucerne - Semi Dormant
Dryland Lucerne / sub clover
Dryland Forage Oats
Dryland Annual Pasture
Irrigated Lucerne - Winter Active
Irrigated Annual Pasture
Irrigated Paspalum / White clover
kg DM/ha/day
120
110
100
90
80
70
60
50
40
30
20
10
0
J
F
M
A
M
J
J
A
S
O
N
D
Month

North West Plains Cropping Belt

Estimates of daily growth of pastures as shown on the accompanying graphic are based on the following descriptions of typical pastures for the North West Plains cropping zone. They are based on clay soils at Narrabri, using long term average rainfall records. Models such as GrassGro and Growest have been used as well as research results of Mr T Launders to construct basic curves. Additionally the experience of agronomists and producers in the area have been used to modify curves to reflect likely responses of typical pasture mixes used in the area (see acknowledgements).

Pasture types used in estimates:

Native grass/annual legume. Dominated by summer active grasses such as Mitchell grass, Queensland bluegrass, native millet, significant quantities of burr medic, woolly burr medic and winter growing forbs (e.g. emufoot, bindweed, tar vine) and with a minor quantity of barley grass, button grass.

Moderate grazing pressure only. No fertiliser unless with previous cropping activity. Soil P and S levels moderate only.

Tropical grass/annual legume/lucerne. Mixture of bambatsi panic, purple pigeon grass, and Katambora rhodes grass at least 2 years old with a significant amount of burr medic depending on seasonal conditions and grazing management. Minor but useful lucerne content. Managed at low to moderate stocking rates. No fertiliser applied since sowing. Soil P&S levels moderate only.

Medic dominant. Main species present burr medic but also a range of winter growing grasses (eg barley grass) and forbs and occasionally other winter growing medics (woolly burr medic, cut-leaf medic, barrel medic). A low presence of perennial grasses, but a small presence of summer growing annual grasses. No fertiliser applied except in previous cropping program. Moderate stocking pressure. Soil P & S levels moderate only.

Winter active lucerne. At least 2 years old winter active aphid and root rot tolerant variety, sown under a crop of wheat at 2 kg/ha with fertiliser as for crop. Moderate stocking rate. A flexible grazing system (not a rigid rotation) with rest periods provided as far as practical. No fertiliser since sowing. Minor invasion of winter growing weeds such as barley grass, medic, and some summer growing annual grasses (button grass, lovegrass). Soil P&S levels moderate only.

Forage oats. Sown as a dual purpose crop in late March and grazed intensively from May to July. Grain harvested occasionally where potential exists, otherwise crops grazed. No additional fertiliser applied after sowing.

Forage sorghum. Hybrid forage sorghum sown in late October. Paddocks intensively grazed with moderate stocking rate. Feed kept in vegetative stage. Sown with a starter fertiliser with no follow up application

Estimated pasture growth rate (mid month) of specific pasture types (kg DM/ha/day)

	J	F	M	A	M	J	J	A	S	O	N	D
Lucerne – winter active	12	8	7	10	11	8	8	19	32	24	18	15
Medic based	1	2	2	5	10	17	25	37	31	14	2	1
Native grass/a legume	18	14	11	13	12	6	5	5	7	16	22	22
Forage oats	0	0	0	8	28	31	32	42	27	2	0	0
Forage sorghum	33	57	54	34	0	0	0	0	0	0	45	24
Tropical grass/annual legume/lucerne	30	22	17	17	15	6	6	6	12	24	35	35

Variation in feed supply

Note: The wide variation in pasture growth that occurs between years has to be considered. For example, the computer growth model (GrassGro) used to help generate these values predicts the growth could vary as follows (in relation to the median – using a native grass* and medic# as representatives of warm season and cool season species respectively):

	Good growing conditions	Poor growing conditions
Spring*	99 per cent above	86 per cent below
Summer*	158 per cent above	90 per cent below
Autumn*	215 per cent above	88 per cent below
Winter#	128 per cent above	97 per cent below

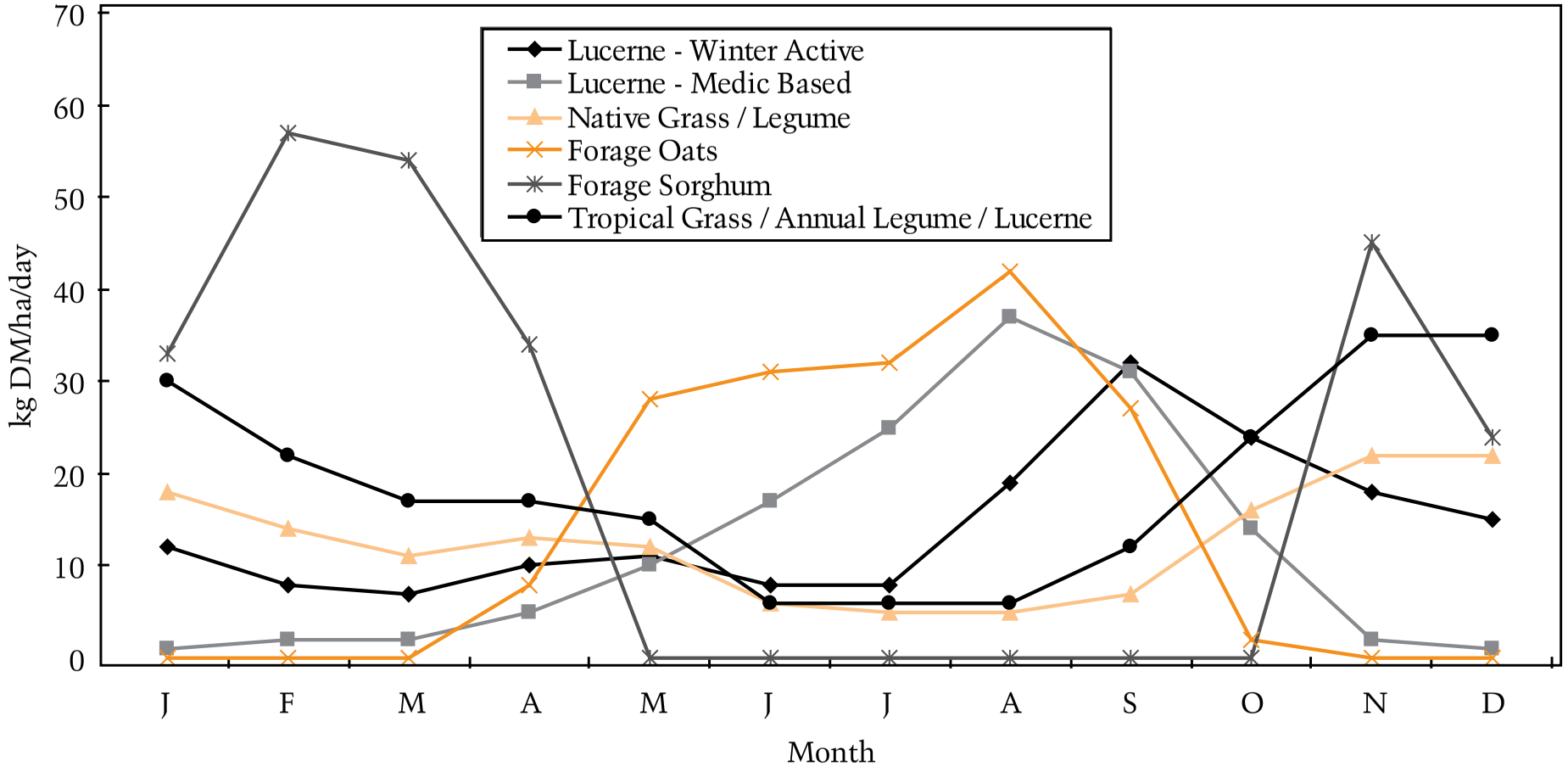
Note: Due to the variation described above, it is extremely important that these estimates be used only as a guide to pasture and fodder crop growth rates. On individual properties, modification must be made for differences in soils and rainfall to those used in these estimates as well as the differences in pasture composition, nutrition, grazing management and stocking rate.

Acknowledgements

This information has been compiled by W McDonald, Technical Specialist (Pastures), Tamworth. Thanks are expressed to the following people for information provided and for on-going feedback and assistance:

- T Launders Senior Research Agronomist, Taree (formerly Research Agronomist, Narrabri)
- D Alcock, Livestock Officer (Sheep and Wool), Cooma
- A Bell, Technical Specialist (Grazing Systems), Tamworth
- S Murray, Goddard Agricultural Services P/L, Narrabri
- R Anderson, Moree
- G Avendano, Narrabri
- G Esdaile, formerly Moree, and
- B Clarke, R Everly, C Burchell, L Serifin, C Cole and A Bowman – former agronomists working on the NW Plains.

Estimated Growth Rate of Pastures - NW Plains Cropping Belt



APPENDIX 5

NUTRITIVE VALUES OF COMMON FEEDS

Feed	Energy (MJ.ME/kg DM)	Crude protein (%)
Grains		
Lupins	13.0	31.2
Oats	12.0	10.6
Sorghum	12.4	13.1
Wheat	12.9	13.8
Pasture		
Short vegetative (80% digestible)	11.6	25.0
Flowering (60% digestible)	8.2	12.0
Dry stalks (50% digestible)	5.7	8.0
Hays		
Lucerne	9.1	16.3
Oaten	7.7	6.0
Pasture (mainly grass)	8.0	7.0
Pasture (mainly clover)	8.5	10.0
Silage		
	higher than the above hays	higher than the above hays
Protein meal		
Cottonseed meal	12.6	42.0

Note: The values provided in this table are average values for these feeds. Considerable variation usually exists in these values so laboratory testing of feeds is recommended when substantial feeding programs are planned.

APPENDIX 6

Recording sheet to determine pasture composition.
(How to use the sheet is described in Segment 1).

Species																					Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	

You may want to categorise species or look at them individually. For example, all undesirable species may be called ‘weeds’; all sown species grouped together; annual grasses together etc.

APPENDIX 7

FODDER BUDGETING CALCULATION SHEET

Q1. how many days will this paddock last a specific number of stock?

Step 1: Calculate available pasture

Present herbage mass		kg DM/ha	(A)
Residual herbage mass (that remaining after grazing)		kg DM/ha	(B)
Available Pasture (A–B)		kg DM/ha	(C)

Step 2: Calculate livestock requirements

Stocking density (head per ha) x intake per head per dayplus ADD spoilage i.e. 15%		kg DM/ha/day	(D)

Step 3: Estimate pasture growth

Growth rate		kg DM/ha/day	(E)

Step 4: Balance between growth and requirements (E–D)		kg DM/ha/day	(F)

- If (F) is positive, present herbage mass (A) accumulates by this amount each day.
- If (F) is negative, the number of days the paddock will last is calculated by dividing C by F.

Q2. how many stock would I need to put into a paddock to graze it to a specific residual herbage mass over a given number of days?

Step 1: Calculate available pasture

Available pasture (as per step 1 above Present – Residual)		kg DM/ha	(C)
Plus growth for the period:			
Growth per day × no. of days		kg DM/ha	(G)
Total pasture available for the period (C + G)		kg DM/ha	(H)

Step 2: Livestock requirements

Intake per day (Add spoilage i.e. 15%) × number of days		kg DM/hd	(I)
Stock density required to achieve the desired outcome (H/I)		hd/ha	(J)

Step 3: Number of stock in the paddock to achieve desired outcome

(J) × the area of the paddock in hectares		hd

FURTHER READING

Controlled Grazing Management for Sheep. Beattie, A. & Thompson, R., Department of Agriculture, Tasmania.

Grazing Management – Science into Practice. Hodgson, J. 1990, Longman Group, UK.

Grazing management of temperate pastures: literature reviews and grazing guidelines for major species. FitzGerald, R.D. and Lodge, G.D., Technical Bulletin 47, NSW Agriculture

Holistic Resource Management. Savory, A., 1988, Island Press.

Home Study Guides on Beef, Sheep and Pastures. NSW Agriculture, Tocal, NSW

Light Soils – Managing them better. NSW Agriculture, Orange, NSW.

Livestock Feeding on Pasture. Nicol, A.M. (ed), 1987, New Zealand Society of Animal Production, (Occasional Publication 10).

Managing High Rainfall Native Pastures on a Whole Farm Basis. NSW Agriculture, Goulburn, NSW.

Pasture management technology for the 21st century. Kemp, D.R. & Michalk, D.L, (eds), 1993, CSIRO Information Services.

Plants of Western NSW. Inkata Press.

Proceedings of the Annual Conferences of the Grassland Society of NSW.

In addition, NSW Department of Primary Industries offer a number of publications relating to PROGRAZE.

GRAZFEED* ORDER FORM

FOR PROGRAZE MEMBERS

Name	
Business name	
Address	
Phone	Fax
Email	

GRAZFEED*: Nutritional Management System for Grazing Animals

Please send		copy/copies of GrazFeed*

Optional credit card payment

Mastercard		Visacard	

Card owner's name	
Credit card number	Expiry date
Card owner's signature	
PROGRAZE deliverer	

After installation, when you first open GrazFeed a dialog box will appear with a 14 digit ID Code. Please contact Horizon with this code (email preferred) so we can generate a Key for your installation as well as supplying the Serial number for your Program.

Included with each CD is a demonstration program for sheep and cattle. [* Trademark]

Submit your order to:

Horizon Agriculture Pty Limited
PO Box 598 ROSEVILLE NSW 2069
Phone (02) 9440 8088
Email horizonag@hzn.com.au
www.hzn.com.au

PROGRAZE™

Profitable, sustainable grazing