beef+lamb new zealand

PASTURE QUALITY

PRINCIPLES AND MANAGEMENT | THE Q-GRAZE MANUAL

Resource Book 14

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BY FARMERS. FOR FARMERS

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Further Reading

400g/day: A Guide to improved lamb growth. (Beef + Lamb New Zealand)
A guide to feed planning for sheep farmers (Beef + Lamb New Zealand)

Introduction

This is a reference document to accompany The Beef + Lamb New Zealand FeedSmart Workshops. The workshops have been designed by AgResearch and delivered by AgResearch and Beef + Lamb New Zealand.

The need to consider pasture quality as well as quantity in feeding pasture to livestock has increased in recent years. This is due to a move towards production to specification, particularly for carcass weight and timing of supply. As stocking rates have dropped and per animal performance targets have become more important, pasture quality has become a critical constraint to achieving potential growth rates.

Pasture quality and intake have a major effect on stock performance (Figure 1). Findings from New Zealand and international research have been refined into The Beef + Lamb New Zealand FeedSmart Workshop to provide a simple method of assessing pasture quality in the field for every day use on-farm. Visual assessments of dead matter, legume content, grass leaf and grass stem are turned into quantitative estimates of nutritive value by the computer package Q-Graze, which adds the effects of grazing to estimate the growth of young animals on that pasture.

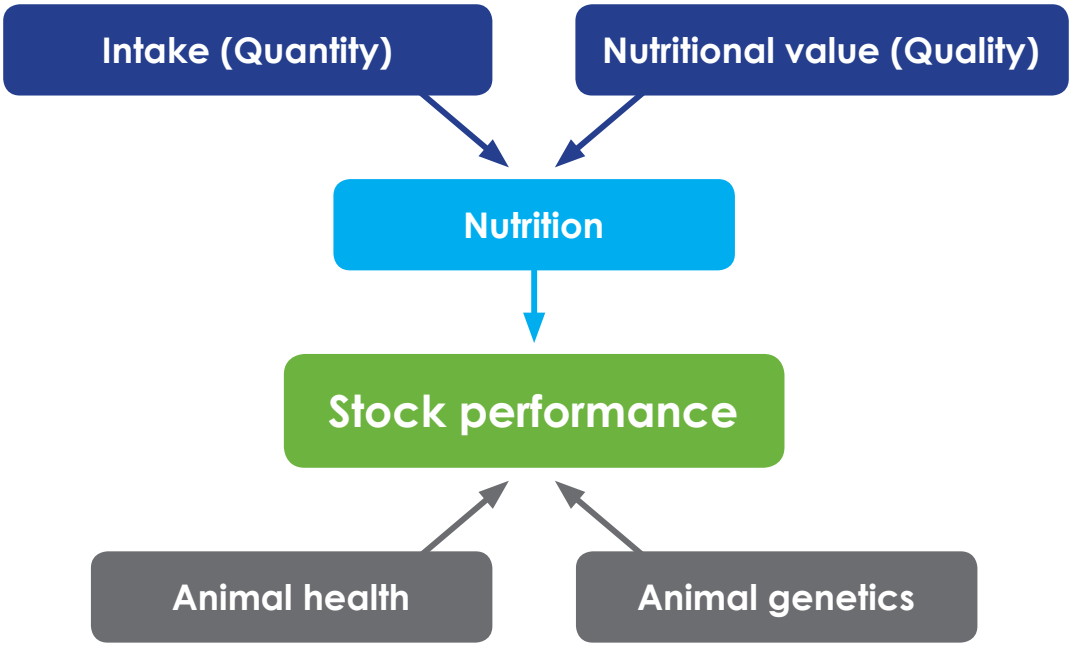

Figure 1: Factors affecting stock performance.

Principles of Pasture Quality

Pasture quality and measurement – an introduction

Intake and nutritive value have a major effect on liveweight gain, milk and fibre production, and livestock health and reproductive performance.

Measuring the nutritive value of a pasture can be done by direct laboratory assessment or by indirect visual assessment. Laboratory measurements include metabolisable energy (ME), digestibility, fibre and protein.

Knowing the relationships between a pasture and its nutritive value give an understanding of the importance of botanical (plant species) and structural (stem versus leaf, dead versus green) makeup, and how to use this information to assess the nutritive value of a pasture.

Nutritive value has a direct effect on feed intake, but other factors such as legume content, and the amount of stem and dead matter also affect intake because livestock will consume the more attractive parts of a pasture. Visual assessment of the pasture components is therefore used in the programme to predict both the nutritive value of a pasture and animal intake.

The main determinants of pasture quality that can be visually grass stem. These factors are further influenced by air temperature during growth and the length of the re-growth period.

Rules of thumb include:

- The quality of a pasture can be predicted from its botanical and structural components.
- Many grasses are of similar quality.
- Legumes are of higher quality than grass.
- Dead material is very low quality.
- Stem is of lower quality than leaf.
- An old leaf is of lower quality than a young leaf.
- Increases in temperature decrease pasture quality.
- Fertiliser may change pasture composition and its mineral content.
- Soil moisture has little direct effect on quality.
- Animal growth is also affected by trace elements, internal parasites, fungal toxins and other factors such as pasture toxicity.

How much do animals eat and why?

What drives potential intake?

The potential feed intake of animals is determined by physiological state (e.g. pregnancy, lactation, sex) and genetics. The animals' health and the feed offered determine whether the potential is reached.

Intake is influenced by the amount of pasture offered to the animal, commonly estimated as pasture cover, pre- and post-grazing dry matter yield or height (Figure 2).The more that is offered, the more that can potentially be eaten, up to a maximum where increased pasture dry matter yield has no more influence on intake and liveweight gain. This has to be balanced by the need to keep pasture quality high, ensure good regrowth and maintain economic stocking rates.

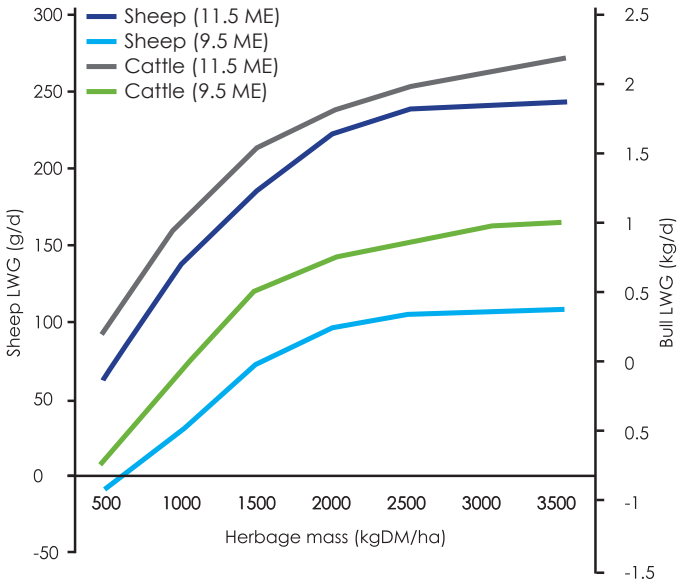

Figure 2: The generalised relationship between pasture dry matter yield and liveweight gain in animals

Intake is also influenced by pasture quality, because herbage of low nutritive value moves more slowly through the animal's digestive tract and this physically restricts intake.

Pastures that have a high nutritive value contain more useful energy per unit of dry matter (DM). An animal will also eat more when pasture quality is high. Animals therefore have a higher intake on high quality pasture, and the energy is used more efficiently, getting closer to the potential intake and performance.

Animal pasture preferences

Grazing animals generally select a diet of higher quality than the average of the pasture offered. The preference of animals for particular components, and their accessibility in the pasture, governs selection.

The palatability of a pasture can be described as the readiness with which animals consume it, so palatability is affected by both the pasture itself and by the preferences of the animals grazing it.

Grazing animals prefer not to eat dead material and, coincidentally this component is often inaccessible in the base of the pasture.

The diet selected often contains a high amount of clover. This is related to the positioning of clover leaves near the top of the pasture and may also be because the animals actively prefer clover.

Ruminants sometimes prefer not to eat pasture contaminated with fungal toxins, faeces or urine.

When animals graze a pasture faster than it is growing, the quality of their diet declines as higher quality components are removed and potential for selection reduces with time. This reduction in diet quality is coupled with lowered intake due to the lower diet digestibility and a decrease in bite size as the animal is forced to graze shorter pasture.

Feed energy

Just as pasture quantity has a marked effect on liveweight gain, so does pasture quality. The structure of plant tissues determines the chemical make-up and hence the quality of the plant. The animal turns the feed into energy by digesting these plant tissues.

Nutritive value is a combination of the digestibility of herbage eaten by the animal, and the efficiency with which the digestion end products are used. A percentage (55-85%) of the pasture eaten is digested, and this is known as its **digestibility**. The remainder is excreted as faeces.

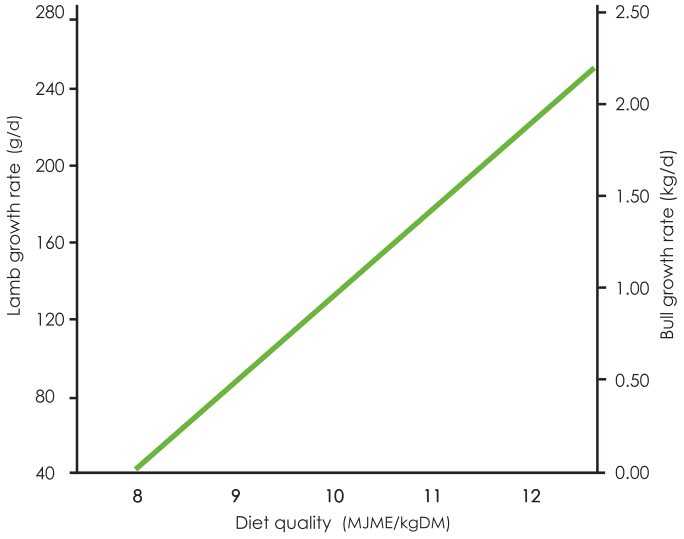

Figure 3: Approximate effect of diet quality on live weight gain of 300 kg Friesian bulls or 40 kg mixed sex Romney x Coopworth lambs grazing 3000 kgDM/ha pastures with 20% clover (information derived using Q-Graze).

Some of the energy in this digestible material is not available to the animal because of losses in urine and methane gas. The energy from the plant that can be used by the animal is termed metabolisable energy (ME).This is the energy present in the digestible portion of the plant, minus energy losses as gasses from the rumen and in urine.

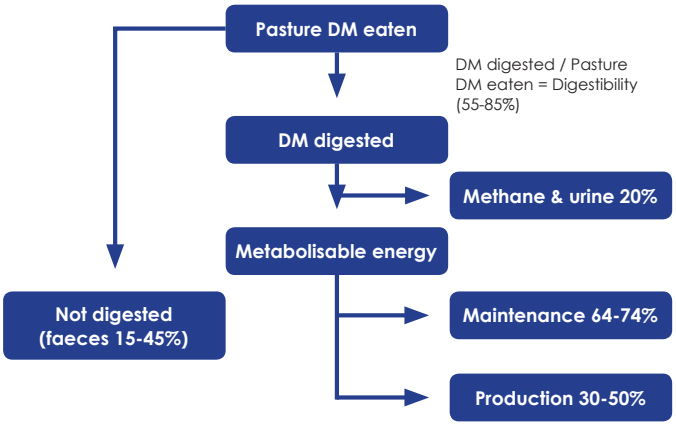

Figure 4: Diagrammatic representation of the conversion of pasture eaten into utilisable energy in the animal.

Typical ME values for pasture herbage are 8-12 MJME/kg DM (Figure 5).The ME is used with differing efficiencies depending on the characteristics of the digestion end products, and the purpose for which the energy is used, for example, for maintenance, growth, lactation and pregnancy.

High quality	Spring pasture (short)	12.0 MJME/kg DM
	Barley grain	12.5 MJME
Medium quality	Pasture silage	9.0 MJME
	Maize silage	10.5 MJME
Low quality	Wheat straw	7.0 MJME
	Weathered meadow hay	7.0 MJME

Figure 5: Typical metabolisable energy values of feeds used in New Zealand.

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Metabolisable energy and digestibility are the two estimates of nutritive value most commonly used in New Zealand. Both are good estimates of pasture quality, but ME is more useful because it is expressed in quantitative units that can be used in allocating feed. Other parts in the pasture, including protein, minerals, and vitamins, are only of concern when they are either limiting or too high.

What is a plant made of?

Water and dry matter

Plant tissues contain a high proportion of water, with a dry matter content of 10-50%. Only the dry matter has a nutritive value. In general, high quality pastures have low dry matter concentrations. Pasture dry matter consists mainly of two parts – highly digestible cell contents and less digestible cell walls. The dry matter content of the cell is mainly proteins and carbohydrates. Pasture also contains 2-4% of dry matter as fat, and up to 12% of dry matter as minerals (ash).

What is inside the cell?

Protein and soluble carbohydrate are the major components within the cell and are usually rapidly digested. Protein makes up 7-30% of the dry matter, decreasing as the cell ages. Soluble carbohydrates (usually taken to include sugars and organic acids) comprise 5-25% of the dry matter. They are greatest in young leaves 3-4 weeks of age and decline with cell age. Soluble carbohydrate concentrations are influenced by sunlight, with the highest levels being measured in late afternoon. Overcast conditions will reduce potential soluble carbohydrate concentrations.

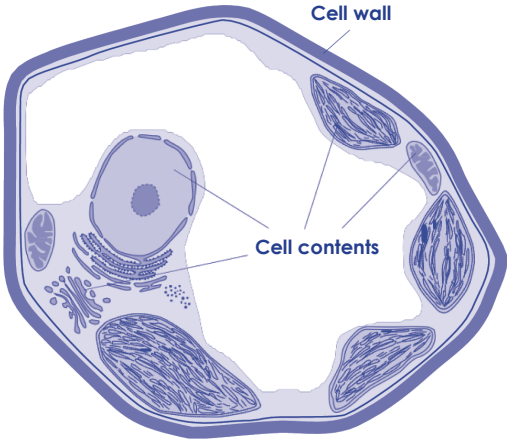


Figure 6: Sketch of a generalised plant cell

What are cell walls made of?

Cell walls are mainly fibre. This has three components that all increase as the cell ages. The main components are the slowly digested carbohydrates hemicellulose and cellulose, making up 35-70% of the dry matter. The third important component is lignin, which is indigestible and contributes 3-6% of the dry matter.

Lignin binds the cell wall carbohydrates together in a process called lignification and reduces the cell wall digestibility.

The total cell wall of herbage is measured as neutral detergent fibre (NDF) while the cellulose plus lignin is acid detergent fibre (ADF).The difference between the two (NDF – ADF) is the hemicellulose.

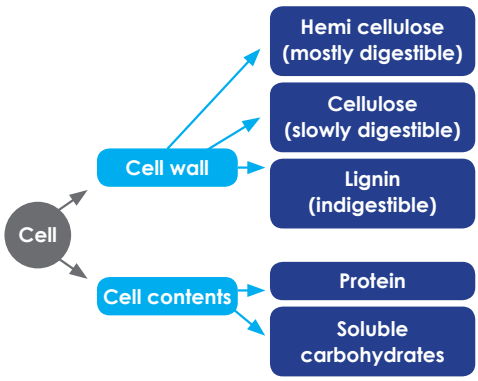


Figure 7: Cell components and their percentage of the total cell dry matter

Influence of plant structure on nutritive value

The structure of a plant is important in determining the amount of each of the cell components. Leaves, stem and dead matter vary in the amount of fibre, soluble carbohydrates, protein and minerals they contain. These amounts also vary with plant species, age of the components, and environmental conditions.

Predicting pasture quality

Predicting pasture quality from its components

We can estimate the quality of a pasture by combining knowledge about:

- The type of plants (botanical composition).
- Plant structure (dead, green, stem, leaf).
- Plant age.
- The conditions in which the plants are growing.

Many grasses have similar quality features

Grasses are made up of two families that are usually referred to as temperate (C3) and tropical (C4). New Zealand pastures are made up mainly of temperate grasses (e.g. ryegrass, cocksfoot, browntop) with some tropical grasses (e.g. paspalum, kikuyu) in the northern North Island.

The component parts of all grasses are usually of similar quality when they are the same age and are grown at the same temperature. However, tropical grasses have a slightly lower quality because of the nature of their fibre, which is more slowly digested than that of temperate grasses.

There are some deviations from these rules. Italian and hybrid ryegrasses and tetraploid ryegrasses are of higher quality than normal diploid perennial ryegrasses because of their lower fibre and higher soluble carbohydrate concentrations.

Browntop is a member of a group often thought of as "low quality" grasses, which also includes danthonia, Yorkshire fog, crested dogstail and sweet vernal. These are tolerant of low soil fertility so occur in predominantly poor growing conditions .When grown in conditions in which "high quality" grasses thrive, the leaf of these

grasses is of similar quality. What often varies, however, is the amount of stem, and the age of the leaf. These features are discussed later and are the true cause of quality variations for these species.

Legumes are digested faster than grasses

Legumes and herbs generally have higher feed quality than grasses. An extreme example showed that sheep grazing white clover grew 90% faster than sheep grazing perennial ryegrass. This was a result of not only higher nutritive value but also a higher rate of voluntary intake.

The nutritive value of legumes and herbs is greater than that of grasses, especially in summer when temperatures are high. This is because the structure inside legume and herb leaves is less affected by increases in growing temperature than grasses.

The higher intake rate comes through both the higher nutritive value and because the leaves are more easily broken into small pieces. This allows the animal to eat more as the food travels through the digestive tract more quickly.

Dead matter is very low quality

Dead matter usually has very low nutritive value (<8 MJME/kg DM).As cells die, the soluble contents decline leaving only the cell walls. The older the dead matter, the less of the cell wall remains as microbes digest it .Therefore, although dead matter looks similar in form to the original leaf, it is very low quality.

The onset of drought can cause young leafy pasture to die off rapidly. This pasture will retain its quality, as it is still young pasture, in contrast to "old" dead matter. However, its quality declines rapidly after rain. Throughout this programme young pasture that has died during drought is referred to as "snap-dried" dead.

Stem reduces feed quality in late spring and summer

Stem increases in the pasture in spring as grasses go to seed. This leads to a build-up in stem (including seedhead) in late spring and early summer. This stem can live on into the summer, lowering pasture quality.

The nutritive value of the stem is generally lower than that of the leaf in green material (e.g. 10.5 versus 11.5 MJME/kg DM) at the same age .This is because the increase in stem strength is due to more lignin and a more orderly cell structure, which lowers digestibility. The effects of age are also apparent in stem as it matures with seedhead production.

Changes in pasture quality during the year

There are several factors that affect the average quality of pasture besides botanical and structural composition.

These include:

- Age of the herbage.
- Temperature during regrowth.
- Fertiliser.
- Soil moisture.
- Anti-quality agents.

An old leaf is of lower quality than a young leaf

Nutritive value of pasture decreases as it ages. The reason for this is that, as green plant tissue ages, both the cell wall/cell contents ratio and the degree of lignification increase. Pasture spelled for six weeks therefore has a lower nutritive value than pasture spelled for three weeks.

The decline in quality with tissue age is minor in clover leaves, significant in grass leaves, and greatest in stem tissue. Quality decline continues through to death, at which stage clover leaves rapidly disappear from the pasture but grass leaves and stems tend to accumulate, particularly in summer.

Increases in temperature cause a decrease in quality

Nutritive value drops as ambient temperature increases. This is caused by a combination of increase in cell wall/cell content ratio, increased lignification of the cell wall, and decreased leaf/stem ratio.

Pastures that have been spelled for long periods in warm conditions, even if leafy, are of lower nutritive value than pastures spelled for a short time.

Tropical pastures often have lower nutritive value than temperate pastures because they grow in regions where higher temperatures occur. They also inherently have lower quality.

The decline in nutritive value is around 0.03 MJME/kg DM/day for grass leaf, and 0.06 MJME/kg DM/day for stem, when the daily mean maximum air temperature is 20°C. Although this appears to be a small change, it is the equivalent of 0.9 MJME/kg DM over 30 days. This translates into a decline in potential lamb growth rate of 90 g/d.

The rate of decline is negligible in leafy pasture at temperatures below 12°C, as in winter for much of New Zealand.

Increases in ambient temperature during summer are often associated with an increase in clover growth, because clover grows better than temperate grasses at high temperatures. This means that the botanical composition of a pasture may improve, but the temperature effect on the grasses is still present and quality of most of the pasture i.e. the grass component is reduced.

Fertiliser may change pasture composition and mineral content

Most of the apparent positive effects of raising the fertility level on nutritive value and intake are indirect.

These effects are associated with increased pasture content of legumes, "easier to manage" grass species and faster pasture growth. Better pasture utilisation may result, leading to decreased build-up of stem and dead material. Improved activity of soil organisms (including earthworms and microbes) may also increase the decay and disappearance of dead matter.

Well-fertilised pastures will generally be able to be re- grazed after short periods of spelling and the components of the pasture will therefore be younger.

Fertiliser has only small direct effects on feed quality, with nitrogen fertiliser having the greatest effect through lifting protein concentration. However, protein is often in surplus supply in green swards.

Application of elements such as magnesium, selenium, cobalt and copper in fertiliser can help remedy specific animal health problems by raising concentrations in herbage.

Soil moisture has little effect on quality

Lack of soil moisture has a relatively small effect on pasture quality compared to its effects on growth. Small increases in pasture quality can be measured in moderate droughts. Digestibility may be slightly increased due to raised concentrations of cell soluble constituents – a mechanism the plant uses to "suck" more moisture from the soil during soil moisture deficits.

Severe drought decreases pasture quality. Prolonged soil moisture deficits decrease legume content in pastures and hasten death of plant tissue. The invasion of low quality weeds after drought also lowers pasture quality.

Saturation of the soil has the indirect effects of decreasing pasture utilisation levels and increasing soil ingestion. Small amounts of soil ingestion can increase trace element supply while large amounts suppress intake.

Prolonged saturation of the soil, particularly in winter, can increase pasture iron content, leading to direct lowering of intake and indirect depression of copper and zinc balance in the animal.

Other factors can alter animal performance on pasture

While the pasture quality factors of energy (ME), and in some cases protein, will have the greatest influence on nutrition, other pasture factors can affect animal performance. The most common of these are trace element deficiencies, internal parasites and fungal toxins.

Minerals, trace elements and vitamins

Ruminants require minerals for normal function. The amount available to the animal is influenced by many factors including the levels in pasture, the diet selected, the rate of pasture intake, the amount of soil eaten, the efficiency of absorption from the digestive tract, and interactions with other minerals in the digestive tract.

Magnesium deficiency is common in some situations. Minerals that are present in very small amounts are known as "trace" elements. Common trace element deficiencies in New Zealand livestock include selenium, cobalt, copper (often related to high molybdenum and sulphur levels), and iodine.

Vitamin levels in fresh herbage are generally adequate for grazing livestock in New Zealand. Rumen microbes synthesise vitamin B_{12} using cobalt in the diet. Low cobalt availability can lead to vitamin B_{12} deficiency.

If mineral deficiencies are suspected, pastures should be tested and expert advice sought.

Parasites

Internal parasites have two effects on the growth of young animals. Firstly, the presence of parasite larvae on the pasture eaten causes the animal to mount an immune response that uses energy and protein. Secondly, parasitised animals have a depressed appetite, increased maintenance energy and protein requirements, and impaired protein and mineral nutrition.

Nutritional options to manage parasite burdens include providing high quality pasture or using tannin-containing plants. Management techniques that reduce the level of parasite larvae on the pasture, and use of anthelmintics are commonly key parts of parasite management programmes.

Anti-nutritional factors and toxins

Many perennial ryegrasses (and wild tall fescue) contain a "live in" fungus, or endophyte, which produces toxins. In ryegrass one of these toxins, peramine, reduces the damage that Argentine stem weevil and some other pests may inflict. However, another endophyte toxin, lolitrem B, causes ryegrass staggers and a third toxin, ergovaline, causes reduced intake and heat stress. These toxins are produced largely during late summer and autumn and animals prefer not to eat pastures containing them.

Endophyte-free ryegrasses and ryegrasses containing a non toxic endophyte (AR1) are now available.

Pastures also accumulate dead matter in summer and autumn. A Pithomyces fungus that grows on dead matter causes facial eczema. Fusarium fungi growing on dead matter produce a range of toxins including zearalenone and trichothecenes, which affect reproductive performance and possibly liveweight gain.

These fungal toxins are more important in warmer parts of New Zealand and during summer and autumn, especially in moist conditions. The presence of toxins may reduce pasture palatability.

Some perennial grasses are susceptible to rust and this may reduce grass palatability.

Various legumes, such as varieties of red and subterranean clover, contain oestrogenic compounds that interfere with reproductive function.

High herbage nitrate concentrations can cause nitrate poisoning. This may occur in many types of forage but is most common in brassicas, Italian ryegrass, greenfeed cereals, and rapidly growing pasture after drought or during dull overcast conditions. The risk is reduced if animals are full before grazing forage with high nitrate levels or have been adapted onto the feed.

Acidosis can occur on low fibre forages particularly during the period when there is rapid change in the fibre content of the diet. This may occur at any time of the year but is more common in spring on rapidly growing pasture, especially on more digestible ryegrasses, and on brassica crops, particularly with cattle.

Tannins

Condensed tannins are compounds in some plant species, including sulla and lotus, which reduce the digestibility of plant proteins in the rumen. This results in a greater supply of protein to the small intestine and can improve animal performance.

Tannin-containing crops may improve production in high- performing or parasitised animals if protein quantity or quality is limiting animal performance. Tannins also protect ruminants against bloat and may have a direct negative effect on internal parasites. Lambs grazing tannin-containing crops also have a lower incidence of dags.

SUMMARY:

Principles of pasture quality

- Pasture quality can be assessed in the paddock using the field indicators of dead matter, clover content and green grass leaf content.
- The major field indicators of quality reflect changes in botanical and structural composition, and the environment in which the pasture is growing.
- Intake and nutritive value of pasture are major determinants of liveweight gain, milk production, health and reproductive performance of livestock.
- Legume leaf has higher quality than grass leaf, leaf has higher quality than stem, and dead material has very low quality.
- Herbage grown at cooler times of the year has higher quality than when grown in hot conditions, and in cool temperatures quality declines more slowly with age.
- Grass leaf declines in quality as it ages, as does stem to an even greater extent.
- Potential intake of high quality herbage is greater because of its rapid speed of passage through the animal.
- Soil moisture has only minor direct effects on quality.
- Fertiliser application has direct effects such as increasing protein (by fertiliser nitrogen use) or trace element concentrations (if added to the fertiliser).
- Fertiliser use can change botanical and structural composition.
- Digestibility and metabolisable energy concentration are the two most commonly used measures of quality in New Zealand.
- In some situations, protein, soluble carbohydrate, and mineral and trace element concentrations are also important.
- Parasite larvae, fungal toxins, or other deleterious compounds, lower pasture quality by compromising animal health and/or reducing intake.

Managing for Pasture Quality

How to achieve pasture quality

Managing pasture quality may now be the biggest opportunity sheep and beef farmers have to improve financial performance.

There are a wide variety of techniques available for increasing pasture quality. Some are paddock based and relatively easy to implement, while others affect large areas, or even the whole farm and require a farm-systems approach.

The main methods of achieving high pasture quality are summarised below. They are in no particular order of importance, and a combination of several at any one time is recommended.

Estimating the economics of maintaining pasture quality

The economics of maintaining pasture quality will vary greatly from farm to farm, depending on:

- The cost of the method used to attain quality (e.g. topping costs more than good grazing management).
- The quality improvement resulting from using the method.
- The financial return from the animal type that utilises the higher quality feed that has been produced.

As a guide, decreasing the dead content of a pasture from 40% to 5% can double the liveweight gain in weaned lambs. Likewise, if the legume content of a pasture is increased from 10% to 45%, lamb growth rates can also double.

When dead matter percentage is decreased together with an increased level of legume content, improvements in lamb growth rate is additive and can result in growth rates over 300g per day in ideal conditions.

The economics of liveweight gain improvements need to be calculated for each individual situation to be sure that the benefits of gaining or maintaining pasture quality out- weigh the costs of implementation.

Methods of achieving high pasture quality

These include:

- Manipulating whole-farm feed demand throughout the year to match feed supply.
- Using specific grazing strategies.
- Topping and mowing.
- Cropping and re-grassing.
- Fertiliser application.
- Weed and pasture pest control.
- Pasture conservation and feeding supplements.
- Irrigation, drainage and aeration.
- Monitoring, predicting and planning pasture growth.

Manipulating whole-farm feed demand throughout the year to match feed supply

Managing pasture quantity throughout the year, so that build-up of stem and dead material in the base of the sward is avoided, is the single most important method for achieving pasture quality.

Management methods to match pasture supply and pasture demand revolve around practices that enable seasonal feed demand to be controlled.

Practises to increase demand relative to supply include:	Practises to decrease demand relative to supply include:
Buying stock	Selling stock
Selling grazing	Grazing off-farm
Increasing lambing percentage	Early weaning
Delaying weaning	

Changing the starting and mean date of lambing can also be used to increase or decrease demand relative to supply.

The spring growth period is the most critical control time to manage quantity and hence pasture quality. Spring pasture cover is the most important cornerstone of whole farm pasture quality and performance. Pasture quality declines rapidly if spring pasture cover is too high, and pasture growth declines when cover is too low. Both outcomes limit animal production and stocking rate.

FARMER COMMENT:

"Managing quantity is the key to managing quality."

"If spring/summer management is under control winter looks after itself."

Specific grazing strategies

Sub-division

Subdivision provides the opportunity to create high pasture quality in the future through clean-up grazing, and the preferential allocation of high quality feed to high priority stock.

Subdivision according to both aspect and contour can allow grazing to better fit the natural pattern of pasture production. The result can be more even grazing, decreased fertility transfer and an increased ability to more easily clean up rank pasture.

Subdivision increases whole farm grazing control by increasing the management options for what stock graze what pasture, when, and how quickly.

There is no one recommended level of subdivision, but the amount of subdivision on a farm should increase with increasing amounts of different stock classes, variability in land class, level of farming intensity (e.g. finishing), and if a smaller mob size is required (e.g. bull finishing).

Grazing management

In periods of feed surplus it is important to maximise the ability of animals to eat the greatest amount of pasture as close to when it is grown as possible.

Set stocking e.g. over ewe lactation (or other high pasture growth periods) gives better control of pasture cover as intake is maximised and seed head development is minimised.

Rotational grazing provides the easiest way to control grazing pressure. Fast rotations give the highest level of animal intake and increase the potential for high levels of pasture utilisation during periods of fast pasture growth. This leads to improved pasture quality as seed head and dead matter development is minimised.

Long rotations are a good way to clean up pastures in comparison to fast rotations or set stocking, as they provide high utilisation while allowing precise control of animal feeding levels. Longer rotations can cause pasture soiling and decreased palatability, and may cause physical soil damage during winter.

Deferred grazing, or temporarily retiring parts of the farm from grazing, increases grazing pressure on the area remaining in grazing, thereby maintaining quality on that area. Provision needs to be made to ensure that appropriate stock is available to clean up the deferred pasture.

Integration of different classes of livestock

The integration of sheep, goats and cattle, and different stock classes within species, is a common way of managing pasture quality. At any one time, all stock classes are ranked by what pasture quality and quantity they require and are manipulated around the farm system to achieve this ranking.

Shorter post-grazing pasture length generally leads to better pasture quality and prevents pastures going to seed. This may be achieved by a following mob of stock that has a lower quality requirement such as well-conditioned ewes or cows in summer. Planning must be in place well in advance to have stock in the appropriate condition for this job.

Pasture and animal management strategies commonly conflict, and a balance often has to be reached between the two so there is often a cost to another stock class in producing a high quality pasture.

FARMER COMMENT:

"Taking the top off a high quality pasture is not managing quality sustainably, as you are leaving low quality behind for other animals."

Topping and mowing

Topping with a mower or using Roundup® can be used to control poor quality pasture components such as removal of seed-heads and thistles or prevention of their occurrence. A rule of thumb is that lamb growth is not expected to decrease significantly until seed-head density is above 200 seed-heads/m^2.

Mowing gives greatest benefit when seed-heads are fully emerged and when mowing height is low. Mowing can leave a large amount of dead material in the base of the sward, so it is advisable to remove as much herbage as possible with grazing animals before mowing takes place.

A common management technique is to increase stocking rates in periods of rapid growth on paddocks that can't be mown to control pasture quality, and then to harvest the other areas released from grazing (pasture conservation). Roundup® topping (application of very low rates of Roundup® Renew Xtra) is also used in some areas to control reproductive growth and promote clover dominance. Average lamb growth improvements of 30 g/d have been measured during January and February following November applications of 200 ml/ha of Roundup® Renew Xtra. Some pasture production is lost with this technique.

Roundup® topping is recommended only in summer-moist environments under experienced guidance, or on small areas to gain experience. It requires a high degree of precision and results can be influenced by weather conditions.

Fertiliser application

Fertilisers only have small direct effects on pasture quality, but indirectly make large changes to paddock and whole farm pasture quality.

Removing soil nutrient limitations by applying fertilisers (commonly phosphate, sulphur, potassium and molybdenum) encourages clover growth. The resultant increase in nitrogen fixation and available soil nitrogen encourages the dominance of grasses, such as ryegrass, that respond to high fertility. A shift to ryegrass-based pastures aids management. Pastures are more confined in their seed-head production making control by grazing more achievable. Regular grazing of faster-growing pasture leads to lower dead matter accumulation.

An increase in soil fertility also increases the amount of pasture grown during cooler times of the year more than it increases spring growth. This response reduces the difference between winter and spring growth. The trough and peak of seasonal pasture supply is therefore reduced and the problem of matching pasture supply with demand becomes easier. Pasture control in spring also becomes easier to achieve.

Nitrogenous fertilisers can indirectly increase pasture quality because they produce a quantity of pasture, which in turn reduces the grazing pressure on other parts of the farm when pasture supply is limiting. This reduces over-grazing and soiling effects, therefore increasing pasture quality.

Pasture growth boosted by spring nitrogen application may improve pasture quality by increasing the leaf to stem ratio and delaying heading in some situations. Pasture quality may decline if the extra pasture is not utilised.

Autumn-applied nitrogen can increase frost-tolerance of pasture, which can be "held" in the growing state for longer periods of time, which reduces the reliance on silage. Care must be taken to apply autumn nitrogen well in advance of frosts to achieve this effect.

Changing the soil pH by liming can alter trace element availability/toxicity and also have other effects (e.g. effects on soil moisture relationships, biological activity and nutrient release), which vary with the particular situation. Liming can therefore affect pasture quality.

Fertilisers can be a source of trace elements for animal health, thereby increasing pasture quality.

FARMER COMMENT:

"Fertilisers and lime 'sweeten' pastures making them more acceptable to stock."

Weed and pasture pest control

Weeds compete with desired pasture species for soil moisture, fertiliser and growing space. Weed invasion may lower pasture quality.

Weeds have a direct negative effect by preventing clean grazing and allowing poor pasture quality areas to develop, and they can be poisonous to stock.

Weed control methods will depend on the weed species. Anything can be classified as a weed if it is a plant growing where it is not wanted, for example, cocksfoot may be a weed in some instances but a valued drought tolerant species in other situations.

Pests such as porina, grass grub, Argentine stem weevil and black field crickets, reduce pasture production and hence increase grazing pressure. They also remove desirable plants or parts of plants. Low-quality species are often left or invade, and pasture quality is reduced. Pest management has to be balanced with the economics of control.

Pasture conservation and feeding supplements

Making hay and silage reduces the requirement for spring pasture control, and increases whole farm pasture quality by intensifying grazing on the area left for grazing. Conserved feed could be thought of as a by-product of pasture quality management.

All methods of conserving pasture involve some loss of pasture quality. This loss is offset by increased pasture quality on the areas not conserved and by higher winter stocking rates due to the conserved feed. This in turn enables greater spring pasture control to be exerted.

Concentrate supplements (e.g. grains) directly raise the quality of the grazing animal's diet, but the economics have to be considered carefully.

Irrigation, drainage and aeration

These practices enhance pasture quality in some situations by improving the plant growth environment, for example, improved root penetration, increased or decreased soil moisture, reduced weeds, reduced impact of pests, increased microbial activity, and improved botanical composition. In some situations these practices can have major effects on pasture quality and quantity, and pasture utilisation.

Monitoring, predicting and planning pasture growth

A recommended approach to achieve high quality pasture production is shown below.

Timing of management decisions is important, and decisions to manage pasture quality often conflict with other important decisions (e.g. buying stock when prices are high). Good decisions can only be made with good information, and this has to be gathered over time.

Information collecting activities to improve decision making include:

- Doing feed budgets (actual versus budgeted).
- Visually assessing pasture quality
- Measuring pasture metabolisable energy (ME).
- Measuring spring pasture growth rate.
- Using climate prediction information.
- Testing for toxins.
- Soil testing.
- Using individual paddock historical records.
- Analysing animal growth and stocking rate records.

In most instances, planning for pasture quality will be on a whole farm scale, with farm business implications inter-twined. Enlisting the help of an expert in collecting and making use of the information can help the process.

FARMER COMMENT:

"Timing of opening and shutting gates is important."

Grazing management for white clover

Managing pastures for white clover growth can provide extra high quality feed during summer. The principles for managing white clover are outlined. White clover is particularly responsive to shading and soil fertility, so it's management is often difficult.

Spring

White clover occurs as small plants in spring after some stolon (stems that creep over the ground) dieback in winter. Stolons develop quickly but don't like shading. The growing points on the new spring stolons provide the leaf growth in late spring and summer. Ryegrass is very competitive in spring and may become dominant if pastures are long.

Controlling growth through fast rotations or set stocking is one of the best options to ensure good white clover stolon development in spring.

Summer

Ryegrass is less competitive in summer as it is recovering from going to seed. Temperatures are also often higher than optimum for ryegrass growth.

Summer temperatures are close to optimum for white clover. The amount of stolon that grew in spring will determine how much white clover is grown in summer. White clover does not like being exposed to UV radiation and high surface temperatures, especially under drought conditions.

Grazing management in summer should attempt to maintain some pasture cover to protect the clover stolons.

Autumn and winter

The grazing requirement of white clover is not strict at this time of year. Clover is not dormant, but is less active.

Soil compaction and soil disturbance in winter will further reduce over-wintering numbers of white clover plants. This means that the clover plant will take longer to recover in spring. Avoid severe treading damage in the winter.

Grasses are more tolerant than clover of low soil phosphate, sulphur and potassium levels, and low molybdenum availability severely limits clover performance. Alleviating soil fertility limitations is the key to strong white clover growth.

Forage crops, pasture renewal and specialist pastures

Cropping and renewal in spring reduces the pasture area under grazing at a period of high pasture growth. Grazing control of the remaining pastures is improved and production of high quality feed is moved into late spring and summer.

Planting specialist pastures or crops, such as chicory, white clover, lucerne, brassicas or red clover, alone or in mixtures, can provide large amounts of high-quality forage over a specific period. These crops have lower levels of dead material, parasite larvae and fungal toxins, and are ideal to finish young growing stock. Their success depends on good establishment, good growth and correct management/utilisation.

New pastures have similar benefits to specialist crops, having low dead matter and toxins, and are parasite-free. Benefits could include low endophyte status, increased palatability, and later or low seed-head production, which makes pasture control much easier.

Also consider other management options (e.g. spring pasture control, fertiliser, subdivision) for improving animal performance as well as cropping.

The crop's role in your farming system

Decide on the flexibility you require in a crop including factors such as lamb and/or cattle finishing, flushing, facial eczema control, and drought performance.

Target poor performing pastures for replacement

Paddocks that contain "poor quality pasture species", little clover, lots of weeds, dead matter mats, are pugged, have high fungal toxins or have parasite larvae will be the most economic to replace provided they are not limited by other environmental constraints such as poor drainage or low soil fertility. However, in some cases (e.g. for crops that are expensive to establish or have a high $ return), it may be better to put replacement pastures on the best soils on the farm in order to maximise dry matter production.

Paddock down time

There is always a production loss associated with reseeding a paddock – the magnitude of this varies between crops and sowing technique. When this down time is in spring when your farming system is not utilising all pasture that is growing, having a paddock out of grazing may improve pasture control on other areas of the farm. Don't forget that short-term crops also have a "down time" when the paddock must be reseeded again at the end of the cropping cycle.

Risk of crop failure

To reduce the risk of crop failure and where necessary, seek advice on establishment from farmers, consultants, or contractors regarding the suitability of a crop for your environment, cultivation techniques (drill type, harrowing), timing of establishment (temperature, soil moisture, pests) and germination requirements (sowing rates, seed treatment, depth, seedbed preparation).

Dry matter production and seasonality of new forage

Be clear about your reason for sowing a crop and choose appropriately. Some crops must be grazed as soon as they are ready if animal performance is to be maximised, but others may allow feed to be carried forward from periods of surplus to times of high need.

Quality improvements over resident sward

Crops improve pasture quality by changing the components of the sward (less dead matter and stem, more leaf) and by offering a better quality of green leaf (non-grass crops in summer). Improved forage quality increases potential liveweight gain and feed conversion efficiency.

Utilisation

Improvements in crop palatability can lead to greater utilisation than is possible in a permanent pasture. This is seen as a reduction in dead matter of the sward. Dead matter is unutilised green matter.

Animal health

Turning a pasture over disrupts parasite larvae and fungal toxin cycles. Some crops reduce the effects of parasites and reduce dags and flystrike incidence. The speed at which stock adapt to crops can vary and some crops contain anti- nutritional compounds which reduce stock intakes and liveweight gain.

Persistence of dry matter and quality changes

Pasture persistence determines the length of time which costs of establishment can be spread. It will depend on plant characteristics (annual, biennial or perennial), susceptibility to non-sown competitor species (weeds, insect attack), susceptibility to over-grazing, and suitability of the forage species for your environment.

Cost of establishment

Crops have different establishment costs due to variations in seed cost, requirements for spraying and seedbed preparation. Costs of establishment will vary depending on your access to equipment but, if putting in the crop yourself, build in a cost for your time and equipment depreciation.

Cost of crop maintenance

Some crops require annual spraying or under-sowing to maintain high crop purity. There are also often higher fertiliser requirements for higher dry matter production crops and specialist pastures.

Product returns

When carcass returns are high then higher feed costs can be economic. Crops may be used to reduce the risk of not meeting supply contracts. However, when returns are lower, the threshold establishment cost at which cropping becomes profitable will be higher.

Managing crops

Animal adaptation

Animals adapt slowly to a change from pasture to some crops and 2 to 3 weeks may pass before stock achieves maximum intakes. The microbes in the rumen must change to use the new feed and this takes time.

- Lambs are 'naïve' grazers and will take time to accept any new crop, needing continued access to the old feed for up to 3 weeks.
- Cattle may exhibit the opposite behaviour by gorging and creating acidosis in the rumen.
- Allow the animals to adapt gradually over 7-10 days, maybe longer, by providing access to the feed the animals were on before beginning the crop.
- Cattle may need to be introduced to a crop with limited grazing time initially to prevent gorging and potential acidosis problems.
- Feed hay or straw first then move stock onto a break with a full stomach or alternate between a grass paddock and a small break in the crop paddock.
- This period of adaptation is important for many aspects of crop management including potentially high nitrate levels, SMCO and glucosinolate levels, and is particularly important where flowering brassica plants are appearing in the crop.
- The time of introduction of animals relative to crop maturity is important.
- A green, lush forage that has low fibre content can limit rumen function. Fibrous feed can be offered at 0.2 kg/lamb per day or 1-2 kg/cattle per day to maximise animal growth.
- Once animals are adapted to a crop the best results are achieved by leaving the animals on until the crop is finished or the animals are at slaughter weights.
- Monitor stock closely while adapting to the crop.

Animal health on crops

Grazing crops have the potential for high animal growth rates, but come with a range of potential animal health problems. The following guidelines give a practical guide for managing the animal health issues of crops but should not replace the advice of experts.

- Brassicas contain anti-nutritional compounds such as sulphur storage compounds that contribute to kale anemia (SMCO), and goitre (glucosinolates). SMCO's increase as the crop ages and stalk contains higher SMCO's and nitrates.
- Minimise the use of sulphur fertilisers on brassicas, as this will increase the level of SMCO's. See your consultant or fertiliser representative for advice.
- Brassica and short term pasture crops are highly responsive to nitrogen fertiliser but excessive use of nitrogen may increase nitrate levels in the crop (see Italian ryegrasses).
- Crops should not have nitrogenous fertilizers applied within 4 weeks of grazing.
- Nitrate testing before grazing is cheap compared to animal losses. Nitrate poisoning can be best avoided by ensuring stock are full when going on to potentially high nitrate crops. Well-adjusted animals will tolerate quite high nitrate levels.
- A laboratory test will identify the actual levels and give the opportunity to manage the proportions of crop and other feed sources in the diet. An indication of a potential nitrate problem can be seen from a quick litmus test from your vet.
- Brassica crops can have low copper, selenium, iodine, cobalt and zinc. If stock are likely to have marginal levels of any of these minerals then mineral supplement will be warranted. Check animal copper and selenium levels, supplementing at least two weeks before animals enter the crop.
- Lambs are unlikely to be deficient in copper unless the grazing crop contains high concentrations of Mo.
- Young stock may benefit from a 5 in 1 vaccine before they go on to a crop to prevent losses from pulpy kidney and other clostridial diseases.
- Remember to continue to feed hay or silage supplements as a proportion of the diet, once animals are adapted.
- Use regular shifts to maximum crop utilisation and minimise variations in intake.
- The use of small breaks will reduce the risk of animals having excessive intake of anti-nutritional factors. This will ensure animals eat all parts of the plant together (stem, leaf and flower head if present).

SUMMARY:

Managing for pasture quality

- Improved pasture quality can be achieved by accurately matching pasture supply and pasture demand.
- Spring is the most important time to control pasture quantity and hence pasture quality.
- Pasture quality can only be achieved with a high level of grazing control.
- Greater grazing control can be gained by sub-division, grazing methods, using stock classes, taking areas out of the system for re- grassing, cropping, and hay/silage making at times of rapid pasture growth.
- Cropping and re-grassing can provide large amounts of high quality forage over a specific period.
- Topping and mowing can be used to clean up poor quality pasture areas or remove seed-head that has been left, but should be viewed as a "late fix" method.
- Roundup topping can be used to prepare pastures that are high quality.
- Fertilisers only have small direct "plant" effects on pasture quality, but have large indirect effects on whole farm pasture quality.
- Addition of fertiliser is essential for achieving pastures of high quality as long as the extra pasture grown is utilised.
- Pasture weeds and pests should be monitored and controlled when necessary.
- Monitoring, predicting and planning pasture growth is the most fundamental and important process for achieving pasture quality, as this means that accurate management decisions on manipulating pasture quality/quantity can be made.
- Managing crops is an important part of realising their high quality potential.

The Q-Graze Manual

Q-Graze is a stand alone computer package that uses visual pasture quality assessments to predict the quality of the pasture, the intake of young growing sheep and cattle, and their liveweight gain.

Q-Graze will help to make effective grazing management decisions and provide information on factors governing pasture quality. Q-Graze was developed by the AgResearch under contract to Beef + Lamb New Zealand.

What Q-Graze does

Q-Graze will:

- Interpret visual assessments of pasture quality to provide estimates of the potential growth rate of young sheep and cattle.
- Convert visual botanical composition assessments into metabolisable energy estimates.
- Simulate changes in pasture dry matter yield and quality on a paddock basis over time.
- Predict liveweight gain in young growing sheep and cattle.

How Q-Graze works

Q-Graze works by:

- Estimating pasture metabolisable energy (ME) per kilogram of dry matter from visual assessments of pasture quality and mean maximum daily temperature readings.
- Predicting the intake of dry matter and ME from pasture botanical components, pasture ME and pasture dry matter yield. Estimating pasture intake using grazing factors such as diet selection, bite size, bite rate, time of grazing, chewing and rumination.
- Estimating the drive to eat using animal factors such as breed, gender, and hybrid vigour.
- Calculating liveweight gain from ME intake using energy requirements for maintenance, grazing and growth or liveweight loss.

The conversion of ME intake to liveweight gain or loss is based on equations from feeding standards for Australian livestock, CSIRO, Australia, 1994.The following factors are used in this model:

- Maintenance requirements are higher for male versus female animals, for cattle compared to sheep, and young compared to old.
- The energy required for grazing is higher for lower quality feed, high intake level, low pasture dry matter yield and heavy animals.
- Maintenance levels are increased as the animals grow.
- The efficiency of energy use for maintenance and growth improves as feed quality improves.
- The energy required for the growth of 1 kg of liveweight is higher when animals are growing faster and when animals are closer to their mature weight.

Training courses

This manual assumes you have a basic knowledge of computers and that you have attended the Beef + Lamb New Zealand FeedSmart 2 Workshops.

The Beef + Lamb New Zealand FeedSmart 2 Workshop provides tuition in both the visual estimation of pasture composition and the estimation of pasture dry matter yield. It also gives background reading that familiarises the operator with the terms used in the software, the economic effects of pasture quality, and the principles of and management of pasture quality. It also provides a pasture visual assessment protocol.

Q-Graze as a decision support tool

In addition to predicting pasture ME and animal liveweight gain, Q-Graze can be used to run a range of scenarios that you can use to investigate future pasture quality decisions. Some examples include:

- What is the impact on animal performance of having high amounts of flowering stem in late spring pastures?
- What is the impact on animal performance of increasing dead matter content in summer?
- What is the impact on animal performance of grazing to low residuals in spring with pastures with little dead matter, and summer pastures with high dead matter contents?
- What type of pastures do I need to achieve target liveweight gains in various seasons?
- What is the fastest rate I can expect animals to grow given the type of pastures I have on farm in summer?
- At this time of year, what aspects of pasture quality should I focus on to improve animal performance?

Running Q-Graze

Running the programme

1 Insert the supplied usb flashdrive.

2 Go to the start menu and click on My Computer.

3 In this folder click the removable disc icon (normally the E drive)

4 Double click on the Q-Graze 2012 file and follow additional instructions on the screen.

5 Once installed Q-Graze will be available in your programs

6 Double click on the icon to run the programme and use the following guide.

Input page

The input page is the page where you enter the data required for Q-Graze to run (see Figure 1):

- Enter visual assessment data using the slides or buttons on the right of each cell.
- Enter pasture dry matter yield, paddock area and rate of growth.
- Enter daytime temperature as the mean maximum of the growth period.
- Choose stock type and input number, liveweight and grazing duration.
- Ensure all input cells have a value.
- Ensure that the cursor is on the green area, not in a blue input cell.

Click the "Run Model" button, which will update the output screens and take you to the "Results" window.

The programme will not run unless all input cells are full. If you input data directly the arrow keys will then be inoperable.

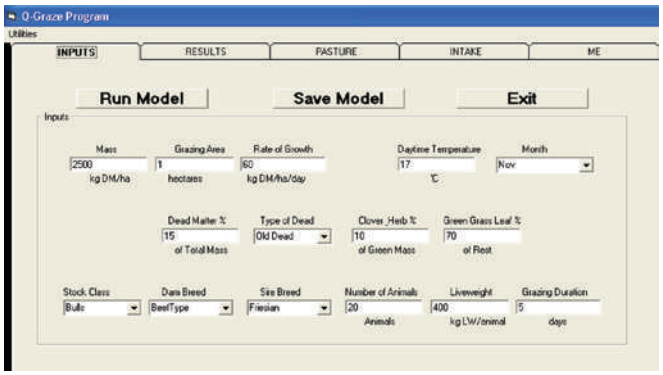


Figure 1: The Q-Graze input page.

The definitions for each input cell are as follows:

Pasture Mass: Pre-grazing total pasture dry matter yield (kg DM/ha) cut to ground level of the paddock/break.

Grazing Area: Paddock or break area in hectares (acres x 0.404 = hectares).

Rate of Growth: Estimated pasture growth rate (kg DM/ha/d) of the paddock during grazing (see Appendix 1 for an estimate of local growth rates).

Daytime Temperature: The average daily maximum temperature for the period since the pasture was last grazed. Commonly this is the 3 o'clock temperature reported in the media. Monthly summaries of temperature given in the local paper for your region can be used with possible corrections for your farm. This factor is used to decrease the quality of green grass when the temperature is above 12°C. Temperature becomes a seasonal, latitude and altitude correction factor.

Dead Matter %: Percentage of total dry matter yield that is dead*. Click on the up or down arrow to change the value in 5% increments.

Type of Dead: Choose either old dead or snap dried dead*. Snap dried dead only occurs when high temperature and no rain have resulted in premature pasture death. Click on the up or down arrow to change the value.

Clover & Herb %: Percentage of legume and high quality weeds/herbs as a percentage of green dry matter yield*. Click on the up or down arrow to change the value.

Green Grass Leaf %: Percentage of the grass and low quality weeds that is grass leaf* e.g. 70% grass leaf implies 30% is grass seedhead and inedible weeds. Click on the up or down arrow to change the value in 5% increments.

Stock Class: This offers gender categories for sheep and cattle e.g. ewe, ram, wether, mixed lambs (mixed sexed lambs), heifers, bulls, steers. This defines the animals' potential for growth through different potential mature liveweights based on gender. It also increases maintenance requirements for male animals. The net effect is that males will grow faster than castrates that, in turn, grow faster than females. If you have the wrong combination of breeds e.g. Bulls + Romney, the programme will not run.

Dam Breed: Pick one of the 15 sheep breeds or 12 cattle breeds that most closely represent the dam breed of your animals. Choose the dam breed closest in size to the dams of your animals. The dam and sire breeds establish the animals' potential mature liveweight. High mature liveweight animals have a greater potential to grow faster than lower mature liveweight breeds. An animal at a lower percentage of its mature weight also puts on more lean tissue and less fat than an animal approaching its mature body weight. Fat is an energetically expensive tissue to produce so leaner animals are more efficient converters of grass to liveweight gain. Click on the down arrow and select the required option.

Sire Breed: Pick the sire breed that most resembles your animals' sire breed in mature liveweight. When the sire and dam breed differ, hybrid vigour factors increase their potential to grow.

Number of Animals: Input the number of animals in the mob.

Liveweight: Average liveweight of the mob in kg at the start of the grazing period. This defines the size of the animal relative to its mature weight and the amount of feed required for maintenance.

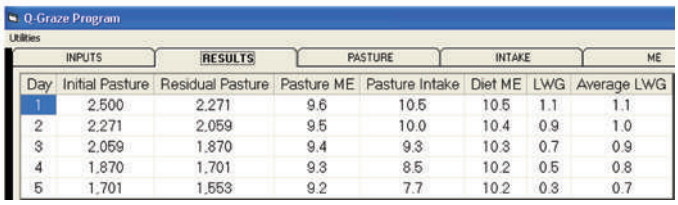
Grazing Duration: Input the number of days you anticipate the animals being in the paddock. You cannot exceed 28 days.

Run Model: When all cells are full, single click with your mouse on "Run Model" to implement the calculations. You must be out of input cells before "Run Model" will work. You will be automatically returned to the tabular "Results Sheet". The other sheets will also be automatically updated.

Results Screen

The first output screen shows a result sheet like Figure 2.

- View the results sheet either by clicking on the "Results" tab or by using the "Run Model" button on the input data sheet.
- From eight days, only every second or fourth day is shown on the result sheet up to a maximum of 28 days.
- This screen can be used to monitor the overall result of the plan you enter, including pasture disappearance (pasture dry matter yield), pasture quality, daily intakes, and daily and average gains.



Day	Initial Pasture	Residual Pasture	Pasture ME	Pasture Intake	Diet ME	LWG	Average LWG
1	2,500	2,271	9.6	10.5	10.5	1.1	1.1
2	2,271	2,059	9.5	10.0	10.4	0.9	1.0
3	2,059	1,870	9.4	9.3	10.3	0.7	0.9
4	1,870	1,701	9.3	8.5	10.2	0.5	0.8
5	1,701	1,553	9.2	7.7	10.2	0.3	0.7

Figure 2: The Q-Graze results sheet.

The definitions for each result item are outlined below:

Initial Pasture: Total pasture dry matter yield to ground level in kg DM/ha. This is the pasture dry matter yield present at the start of each day's grazing. The pasture dry matter yield declines based on the amount of pasture the animals consume.

Residual Pasture: The total pasture dry matter yield to ground level that is left at the end of each day's grazing. When the paddock continues to be grazed the next day, the initial pasture dry matter yield will be the residual from the day before.

Pasture ME: Metabolisable energy (MJME/kg DM) of the total pasture. This prediction of pasture ME is based on the various pasture components (e.g. dead matter) and the temperature at which the pasture grew. The value on Day 1 is the ME of the pasture before stock has grazed the pasture and before death or growth of the pasture has occurred. As a result, stock is assumed to have selectively grazed higher quality pasture components, leading to a drop in the remaining pasture ME.

Pasture growth and death are modelled during the grazing period and this also changes pasture ME. Death rates of pasture are higher at higher temperatures and are higher from November to April than during the cooler winter months. Death rates are also higher when pasture dry matter yield is higher.

Pasture Intake: Intake of dry matter in kilograms per animal. This is estimated using an intake model that considers pasture dry matter yield and components and estimates bite size, bite rate, and the time taken for grazing, biting, chewing and rumination. It integrates all these factors repeatedly over the day to get average daily intake.

Diet ME: Metabolisable energy (MJME/kg DM) of the diet.

It is calculated from the quantities of different components that are eaten each day. Animals select the higher quality components from the pasture so the diet quality is always higher than the whole pasture.

LWG: Liveweight gain in kilograms per day. For a description of how LWG is estimated see "How Q-Graze works".

Average LWG: Cumulative average liveweight gain in kilograms per day for the preceding days.

Graph Screens

Pre-Grazing Pasture Mass

This screen graphs the change in pasture dry matter yield (kgDM/ha) with each successive day's grazing (Figure 3).

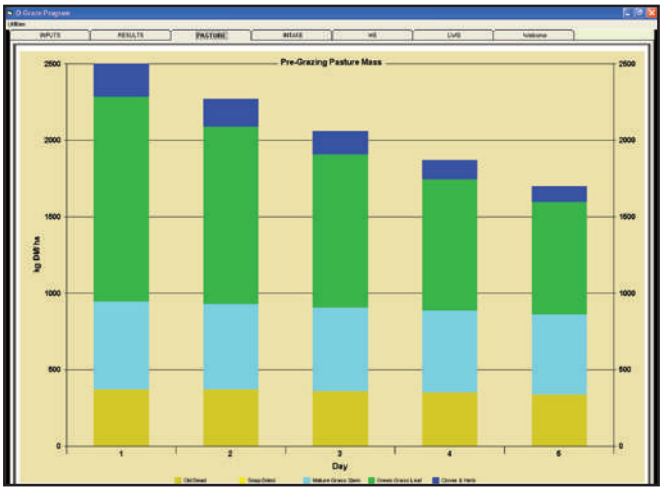


Figure 3: The Pre-Grazing Pasture Mass screen.

- The graph shows how the components of the pasture change with each successive grazing day.
- These changes indicate the animals' selection of the more favourable pasture parts (legume and green leaf).
- The amount of clover and green grass leaf declines faster than the amount of dead matter.

Intake Composition

This graph shows the components of feed intake by an animal progressively over the grazing period (Figure 4).

Figure 4: The Q-Graze Intake Composition screen.

- Over the first few days the animals have selected a lot of clover.
- Towards the end of the grazing period less clover and more dead matter are eaten.
- As the dry matter yield of the pasture decreases, the animal's mouth is not as full at each bite and overall intake drops.
- In some cases (high stem and dead matter pastures), the decrease in quality of what is eaten as grazing continues will also decrease animal feed intake.

ME (energy value of Pasture and Diet)

This graph (Figure 5) shows the progressive decline in pasture and diet ME as grazing progresses.

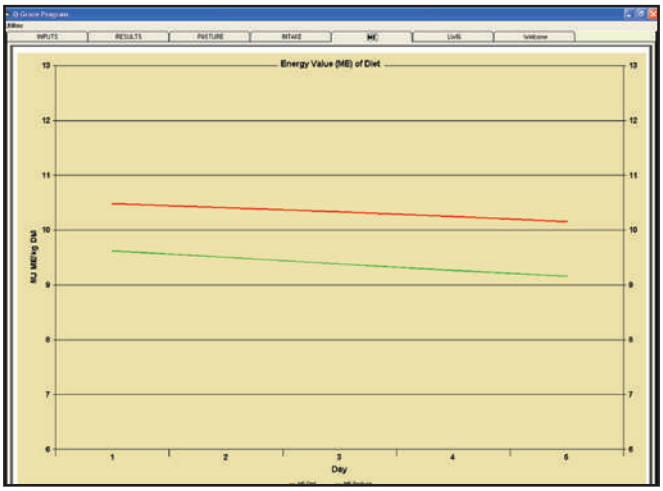


Figure 5: The Q-Graze ME of Pasture and Diet screen.

- Diet ME is higher than pasture ME because the animals are selecting the higher quality portions of the pasture and rejecting the lower quality dead matter (predominantly in the base of the pasture and in the grass stem).

Liveweight Gain

This screen shows the daily liveweight gain with each progressive day's grazing (Figure 6).

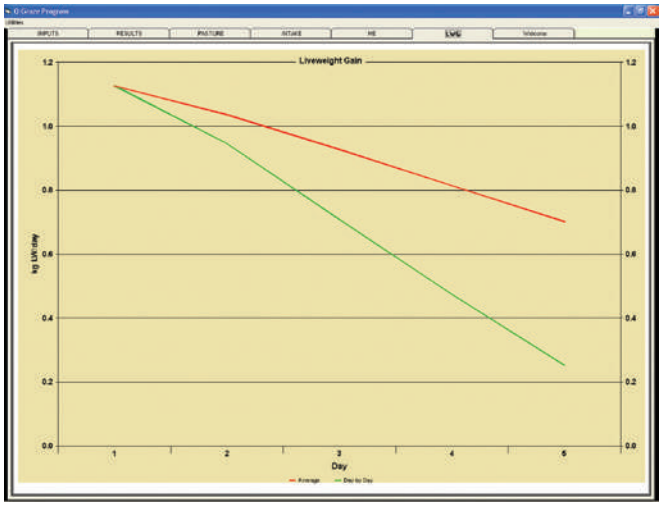


Figure 6: The Q-Graze Liveweight Gain screen.

- The lower line shows the gain for each day.
- The upper line shows the running average liveweight gain. This indicates the average liveweight gain for the grazing period up to a particular day of grazing.
- This graph is useful in showing where animal performance substantially decreases or where performance drops below a particular target.

Interpreting the output from Q-Graze and checking predicted with actual results

Q-Graze should be used in combination with careful monitoring of liveweight gain – it is not an alternative to weighing animals.

Care should be taken in interpreting the results especially in the following areas:

Only growing animals: Q-Graze predicts the liveweight performance of growing sheep and cattle. It does not predict the performance of pregnant or lactating sheep or cattle or other ruminant species. It also does not predict the performance of suckling lambs and calves.

Flat and warm: Q-Graze makes no correction for steepness of topography or adverse climate conditions. Steep topography may increase maintenance requirements by 10%. Shorn sheep have increased energy requirements for two weeks after shearing. Friesian bulls and young lambs can have increased maintenance requirements in very cold, wet and windy conditions.

Breed: The breed option on the input page uses theoretical mature liveweights for different breeds to adjust for the animals' potential to grow. It does not reflect any changes that may exist in the efficiency of growth between breeds or selection improvements in a particular breed.

Crossbreeds: There are limited breed combinations available in Q-Graze and the selection of various combinations changes the potential for sheep and cattle growth. Monitoring liveweight gains, especially in spring (less risk of animal health problems), on your own farm and comparing the results with Q-Graze may help in scaling your animals' growth potential relative to the values in Q-Graze.

Healthy Animals: Q-Graze assumes that your animals are not affected by subclinical or clinical animal health problems (e.g. internal parasites, minerals, fungal toxins). These may be suppressing the liveweight gain of your animals. If Q-Graze suggests that your animals should be growing substantially faster than they are, then you may consider contacting your local veterinarian to check for potential animal health problems.

Protein Deficiency: Q-Graze makes the assumption that energy and not protein is the main limitation to animal performance. In most (>90%) sheep and beef animals, this will be the case. The exceptions will be in very poor quality pastures where both energy and protein are likely to be reducing animal performance. Q-Graze also ignores the potential for high protein/low carbohydrate/low fibre problems in early spring.

Crops: Q-Graze makes no allowance for specialist crops.

High quality crops such as legumes and chicory could be included into the input page as legumes. It is assumed that the grasses are perennial grasses. Tetraploid and/or annual ryegrasses will have higher energy contents than used in this software.

Supplements: There is no capability for including supplements into Q-Graze.

Questions to ask if animals are growing below predicted values

Was my liveweight measurement accurate?

- Did I check the scales before weighing?
- Was the gutfill of the animals similar at both weighings?
- Did I weigh over a long enough interval?

Are the estimates of pasture dry matter yield and pasture components accurate?

- Have I corrected my pasture dry matter yield measurement device for the right season?
- Should I review my visual assessment protocol?

Are the breed selections I made the most appropriate?

- Check the mature body weights of your choice and compare with your own animals.

What is the genetic potential of my animals?

- Check ram and bull records to see what potential they may have.

Were the animals grazing steep paddocks or was the weather particularly cold and wet recently?

- Animals grazing steep hills may grow slower than the model because of the extra energy needed to move around.
- Weather considerations are especially important in two situations:
- When the diet quality of cattle is low and this restricts intake. The heat of digestion is greater when intake is higher, helping to protect against cold.
- For shorn lambs which will respond in variable ways depending on the severity of the conditions and the availability of shelter.

Do my animals have an animal health problem?

- Check for parasite burdens or drench resistance. Monitor for fungal toxins.
- Check on the endophyte status of the pasture.
- Monitor the trace element status of the animals and pasture.
- Check with your veterinarian or consultant.

Appendix 1: Approximate pasture growth rates around New Zealand (kgDM/ha/d)

REGION	SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Northland	Dargaville	60	61	49	43	33	24	24	30	48	57	63	75
	South Kaipara	31	30	30	36	27	17	18	29	35	52	50	44
Waikato	Hamilton	18	19	21	23	15	9	10	30	48	53	48	45
	Central Plateau Wairakei (Flat)	20	14	13	8	11	4	4	6	18	30	35	32
	Wairakei (Hill)	35	17	25	18	15	7	6	10	29	45	40	52
Taranaki	Waimate West	38	25	31	30	22	11	12	19	33	45	45	44
	Stratford	38	30	34	30	16	8	7	15	23	42	42	43
Gisborne	Manutuke	29	28	32	29	25	18	17	33	45	50	41	38
	Waerenga o Kuri (Hill)	53	38	38	33	21	11	7	16	25	41	51	52
Hawkes Bay	Hastings	9	12	16	15	23	10	10	23	30	40	15	15
Manawatu	Flock House	17	18	16	13	15	13	5	9	20	26	30	22
	Marton	31	39	32	25	20	11	11	26	44	52	45	35
Wairarapa	Masterton	15	12	23	18	28	16	16	38	55	65	70	35
Nelson	Motueka	18	10	28	30	15	13	17	25	55	55	52	35
Canterbury	Winchmore (irrigated)	49	43	35	22	10	5	5	12	30	41	40	47
	Winchmore (dryland)	13	13	14	17	8	5	4	10	29	40	30	19
Westland	Westport	52	41	31	26	10	10	10	11	17	30	52	53
	Hokitika	31	33	33	21	12	7	3	6	22	32	51	32
	Reefton	36	35	34	23	10	6	4	11	32	51	51	34
	Central Otago Arrowtown (irrigated)	55	51	43	28	8	0	0	0	12	30	60	55
	Cromwell (irrigated)	40	65	26	13	5	0	0	0	15	40	48	52
	Poolburn (irrigated)	43	42	30	20	5	0	0	0	20	45	40	45
	Poolburn (dryland)	12	7	7	6	3	0	0	0	12	22	20	12
Otago	Owaka	31	28	18	16	12	9	8	10	28	49	56	50
	Stirling	54	50	35	28	14	6	6	8	25	53	48	51
	Taieri Plain (Invermay)	42	33	30	21	8	5	5	12	35	55	50	46
	Dunedin Hill (Invermay)	36	32	25	16	9	5	5	9	25	45	47	44
	Hindon	35	31	26	23	8	2	2	2	20	42	58	45
	Waitaki plains (irrigated)	62	53	48	32	17	5	5	15	32	68	64	64
	Windsor	24	16	18	15	8	2	1	8	19	44	34	27
	Palmerston	28	20	23	14	9	2	2	10	22	50	55	40
Southland	Mona Bush	58	58	49	30	13	7	5	8	30	55	70	68
	Woodlands	56	46	42	26	15	7	7	10	25	50	60	52
	Winton	53	52	42	25	13	9	10	12	25	52	55	55
	Te Anau	42	30	35	25	11	5	4	5	15	42	59	47
	Gore	62	52	40	28	14	6	5	10	20	55	75	70

Appendix 2: Estimated pasture ME from botanical components

The diet selected by the animal will have a higher ME than shown in the tables below.

Pastures with no reproductive stem

Dead %DM	Clover % green	Grass leaf %rest	ME when cold	ME when warm	ME when hot
0	0	100	11.6	10.7	9.7
0	10	100	11.6	10.8	9.8
0	20	100	11.7	10.9	10.0
0	30	100	11.7	11.0	10.2
0	40	100	11.8	11.1	10.4
10	0	100	10.9	10.1	9.1
10	10	100	11.0	10.2	9.3
10	20	100	11.0	10.3	9.4
10	30	100	11.0	10.4	9.6
10	40	100	11.1	10.5	9.8
20	0	100	10.3	9.5	8.5
20	10	100	10.3	9.5	8.7
20	20	100	10.3	9.6	8.8
20	30	100	10.4	9.7	9.0
20	40	100	10.4	9.8	9.1
30	0	100	9.6	8.8	8.0
30	10	100	9.6	8.9	8.1
30	20	100	9.7	9.0	8.2
30	30	100	9.7	9.1	8.4
30	40	100	9.7	9.1	8.5
40	0	100	9.0	8.2	7.4
40	10	100	9.0	8.3	7.5
40	20	100	9.0	8.3	7.6
40	30	100	9.0	8.4	7.7
40	40	100	9.1	8.5	7.9
50	0	100	8.3	7.6	6.8
50	10	100	8.3	7.6	6.9
50	20	100	8.3	7.7	7.0
50	30	100	8.4	7.7	7.1
50	40	100	8.4	7.8	7.2
60	0	100	7.6	7.0	6.3
60	10	100	7.7	7.0	6.3
60	20	100	7.7	7.0	6.4
60	30	100	7.7	7.1	6.5
60	40	100	7.7	7.1	6.6

Cold: less than 12°C

Warm: around 18°C

Hot: around 25°C

Temperature is average maximum daily temperature at which pasture grew.

Pastures with reproductive stem

Dead %DM	Clover % green	Grass leaf %rest	ME when cold	ME when warm	ME when hot
10	0	90	10.8	9.9	8.9
10	10	90	10.9	10.0	9.1
10	20	90	10.9	10.1	9.3
10	30	90	11.0	10.3	9.5
10	40	90	11.0	10.4	9.7
10	0	80	10.7	9.8	8.7
10	10	80	10.8	9.9	9.0
10	20	80	10.9	10.0	9.2
10	30	80	10.9	10.2	9.4
10	40	80	11.0	10.3	9.6
20	0	90	10.2	9.3	8.4
20	10	90	10.2	9.4	8.5
20	20	90	10.3	9.5	8.7
20	30	90	10.3	9.6	8.9
20	40	90	10.4	9.7	9.1
20	0	80	10.1	9.1	8.2
20	10	80	10.2	9.3	8.4
20	20	80	10.2	9.4	8.6
20	30	80	10.3	9.5	8.8
20	40	80	10.3	9.6	9.0
30	0	90	9.5	8.6	7.8
30	10	90	9.6	8.7	8.0
30	20	90	9.6	8.8	8.1
30	30	90	9.7	8.9	8.3
30	40	90	9.7	9.0	8.4
30	0	80	9.5	8.5	7.7
30	10	80	9.5	8.6	7.9
30	20	80	9.6	8.7	8.0
30	30	80	9.6	8.8	8.2
30	40	80	9.6	8.9	8.3
40	0	90	8.9	8.0	7.3
40	10	90	8.9	8.0	7.4
40	20	90	9.0	8.1	7.5
40	30	90	9.0	8.2	7.7
40	40	90	9.0	8.3	7.8
40	0	80	8.8	7.9	7.2
40	10	80	8.9	8.0	7.3
40	20	80	8.9	8.1	7.4
40	30	80	8.9	8.1	7.6
40	40	80	9.0	8.2	7.7

Appendix 3: Average maximum daily temperatures around New Zealand (°C)

REGION	TRIAL SITE	MET SITE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Northland	Dargaville	Dargaville	23.4	24.2	23.0	20.4	17.8	15.7	14.9	15.3	16.3	17.8	19.6	21.4
	South Kaipara	Woodhill Forest	22.5	23.2	22.1	19.6	17.2	15.0	14.1	14.7	15.9	17.3	19.1	20.9
Waikato	Hamilton	Rukuhia	23.6	24.4	22.6	19.6	16.3	13.8	13.2	14.2	16	17.7	19.6	21.7
Central Plateau	Wairakei	Wairakei Res. Stat.	23.3	23.6	21.7	18.3	14.4	11.7	11.3	12.5	14.2	16.8	19	21.4
Taranaki	Waimate West	Manaia Dem Farm	20.8	21.2	20.2	17.7	15	12.9	12.2	12.8	14.1	15.8	17.4	19.3
	Stratford	Stratford Dem Farm	20.7	20.9	19.6	16.8	13.9	11.6	10.9	11.7	13.4	15.2	16.9	19
Gisborne	Manutuke	Manutuke Gisborne	23.7	23.8	22.3	19.8	17.0	14.5	13.9	14.7	16.6	18.6	20.6	22.3
	Waerenga o Kuri	Waerenga o Kuri	21.5	21.7	20.1	17.4	14.5	12.1	11.3	12.1	14.1	16.4	18.2	20
Hawkes Bay	Hastings	Hastings	24.5	24.0	22.7	20.0	16.6	13.9	13.5	14.5	16.7	18.9	21.0	22.8
Manawatu	Flockhouse	Flockhouse	21.5	22.1	20.9	18.2	15.6	13.2	12.4	13.3	14.9	16.6	18.3	20.2
	Marton	Marton	21.3	21.9	20.1	17.3	14.6	12.1	11.3	12.2	13.9	15.9	17.6	19.8
Wairarapa	Masterton	Waingawa, Masterton	23.7	23.6	21.7	18.7	15.1	12.6	11.8	13.0	15.3	17.7	19.7	22.1
Nelson	Motueka	Moutere Hills	22.1	22.3	20.7	17.5	14.3	12.0	11.5	12.1	14.2	16.3	18.1	20.5
Canterbury	Winchmore	Winchmore	21.8	21.7	19.4	16.5	12.9	10.3	9.9	11.3	13.9	16.4	18.6	20.2
West Coast	Westport	Westport Airport	19.5	19.8	18.9	16.8	14.5	12.5	12.0	12.7	13.8	14.9	16.3	18.2
	Hokitika	Hokitika Airport	19.2	19.7	19	16.7	14.1	12.2	11.7	12.6	13.8	14.8	16.4	18.2
	Reefton	Reefton	22.4	22.8	20.6	17	12.7	9.3	9.3	12	14.2	16.5	18.3	21.1
Central Otago	Arrowtown	Queenstown	21.7	21.6	19.4	15.4	11.2	8.2	7.7	10.0	13.0	15.8	17.9	20.4
	Cromwell	Cromwell	24.4	24.2	21.4	17.2	12.0	7.9	7.7	10.9	14.9	17.8	20.2	22.9
	Poolburn	Moa Creek	22.2	22.3	19.7	15.8	11.2	7.0	6.3	10.0	13.1	15.8	17.5	21.1
Otago	Hindon	Hindon Farm	17.5	18	16.3	13.2	9.4	6.9	6.8	8.5	10.7	12.6	14.4	16.2
	Windsor	Oamaru Airport	19.7	19.8	18.3	15.7	13	10.4	10	11.1	13.3	15.1	16.8	18.3
	Palmerston	Palmerston	20.1	20.4	18.9	16.6	13.3	10.9	10.8	11.6	14	15.4	17.3	18.9
	Invermay	Invermay	20.2	20.5	18.8	16.1	12.8	10.3	10	11.7	14.1	16	17.6	18.9
	Stirling	Finegand, Balclutha	19.7	20	18.6	15.7	11.9	9.3	9.1	11	13.4	15.3	16.9	18.8
	Owaka	Owaka	18.2	18.5	17.7	15.6	12.1	9.7	9.8	11.2	12.4	14.3	15.6	17.3
Southland	Mona Bush	Invercargill Airport	18.4	18.6	17.3	14.8	12.0	9.5	9.4	11.1	13.0	14.6	16.0	17.5
	Winton	Winton	19.7	20	18.5	15.4	12.2	9.7	9.6	11.3	13.2	14.9	16.7	18.7
	Woodlands	Woodlands	18.9	19.2	18.1	15.5	11.6	9.2	9.4	10.8	13.2	14.8	16.6	18.6
	Gore	Gore	19.1	19.2	17.8	14.9	11	7.9	8.3	9.8	12.5	14.4	16.2	18.4
	Te Anau	Te Anau	20.1	21	18.9	15.1	11.3	8.4	8	10	12.8	14.4	16.1	19.1

Appendix 4: Terms and Definitions

Acidosis: A rapid drop in the pH of the rumen that occurs when very digestible feeds such as brassicas or grain are fed. It causes a decrease in feed intake and, in severe cases, can cause death. Feeding straw, hay or other effective fibre can alleviate acidosis.

ADF: Acid detergent fibre. This is the slowly digested fibre and is the cellulose and lignin from the cell wall.

Carbohydrates: Any compound made up of sugars. These can range from soluble sugars such as sucrose to structural carbohydrates such as cellulose.

Cell wall: The structural part of the cell that is made of the carbohydrates hemicellulose and cellulose, as well as lignin.

Cellulose: A long chain, slowly digested, carbohydrate found in the cell wall.

Crude protein: The protein in feed is termed crude protein. This can be used in two ways in the animal. Firstly, it can be digested by the rumen microbes and converted into microbial protein. This has some inefficiencies and some protein is lost into the urine. Secondly, it may be undigested in the rumen and be available for digestion in the lower gut. This protein is termed bypass protein and can improve the overall protein supply to the animal.

Dead material: The product of leaf aging or sudden death. It is brown and is avoided by animals and has very low quality.

Digestibility: How much of the plant can be digested by the animal. It is expressed as a percentage of the dry matter, or in g/kgDM. Sometimes it is expressed in organic matter terms, which removes variation caused by changes in the mineral (ash) content of the plant.

Goitrogen: A compound that interferes with iodine in the animal and can induce iodine deficiency.

Grasses: Monocotyledons that have a single leaf blade.

Hemicellulose: A long-chain carbohydrate found in the cell wall.

Intake: What the animal eats, commonly expressed as kg of dry matter per day.

Leaf: The green blade and basal leaf sheath.

Legumes: Nitrogen-fixing dicotyledons, often with a trifoliate leaf.

Lignification: The process of strengthening a cell wall by adding lignin.

Lignin: A compound found in cell walls that binds the structural carbohydrates together as the plant ages or is grown at high temperatures.

Metabolisable energy (ME): A quantitative measure of the amount of energy in a feed that an animal can use. It is often directly related to the digestibility. Its units are mega joule per kilogram of dry matter (MJME/kg DM).

Microbial protein: Protein that is produced by the growth of microbes in the rumen as they digest the feed. It is the main source of protein that gets into the intestine of a ruminant.

NDF: Neutral detergent fibre. This is the cell wall component of the plant and includes hemicellulose, cellulose and lignin.

Nutritive value: The quality of a feed to the grazing animal, combining the metabolisable energy concentration and the efficiency of use of digestion end products.

Oestrogenic: The ability of a feed to mimic the oestrogen hormones of an animal. These are of greatest importance to animals during the reproductive period of the year.

Physiological state: The driving force behind the responses of an animal in any given situation.

Protein: The building blocks of muscle, bone and enzymes.

Certain physiological states require different amounts of protein in the diet. Proteins are made up of amino acids.

Protein quality: The balance of the amino acids within a protein. A certain balance is required to maximise animal performance.

Soluble carbohydrate: The carbohydrate that is readily digested from within the cell. This includes glucose, sucrose, fructans, pectins and starch, and commonly also is taken to include organic acids.

Stem: The true stem of a grass or? legume that holds the seed-head.

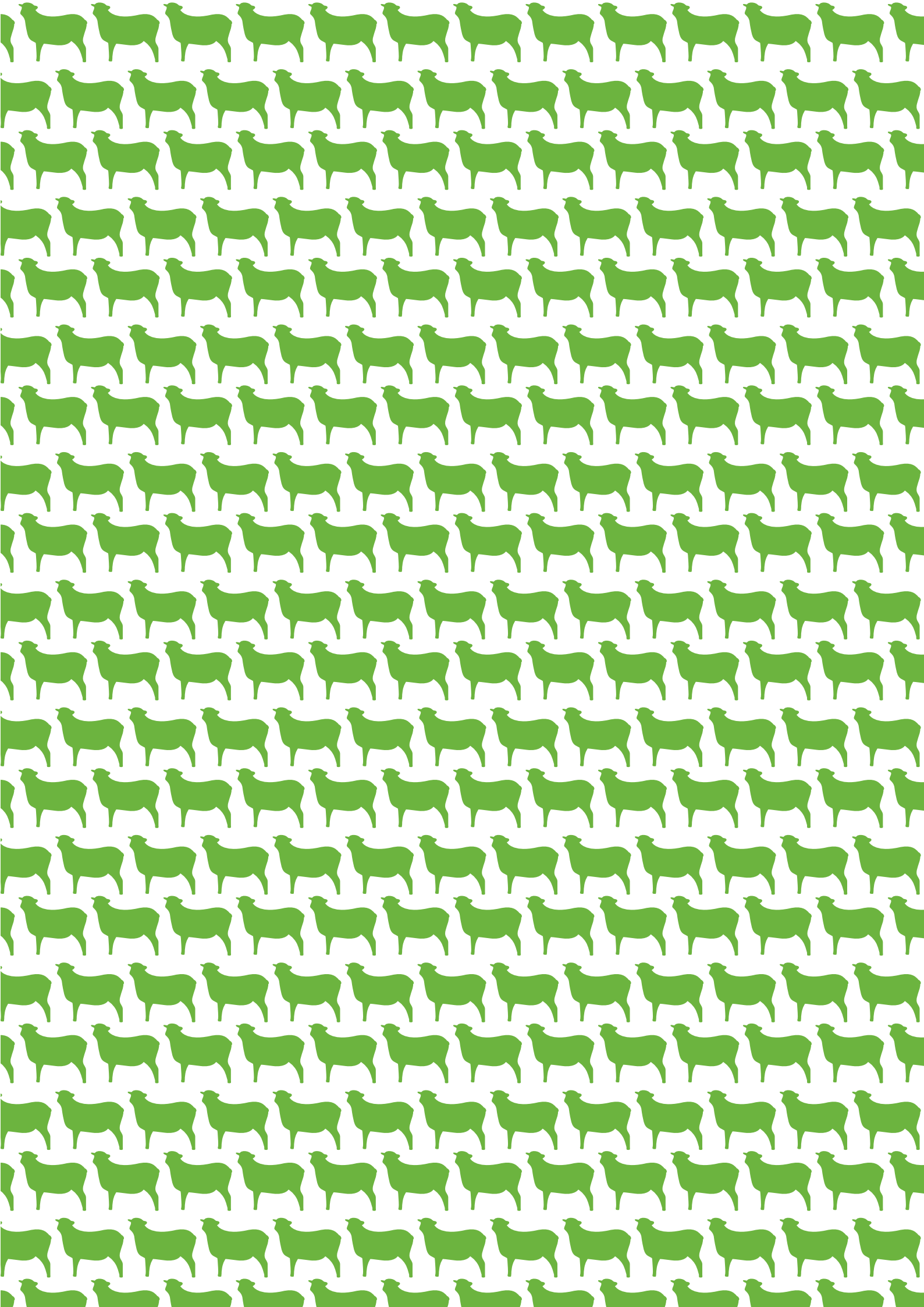
Tannin: A range of compounds found in plants that bind to proteins and alter protein digestion and palatability.

Temperate (C3): Grass and legume species that grow well in cooler climates because of their photosynthetic system.

Toxins: A wide range of compounds that interfere with animal health.

Tropical (C4): Grass and legume species that grow well in warmer climates because of their photosynthetic system.

Volatile fatty acids: The product of the microbial digestion of feed in the rumen of the animal. These become the major energy source for a ruminant.




beef+lamb
new zealand