FEEDSMART 2

FEED SHEEP AND CATTLE SMARTER
WORKSHOP RESOURCE BOOK

in Association with

agresearch

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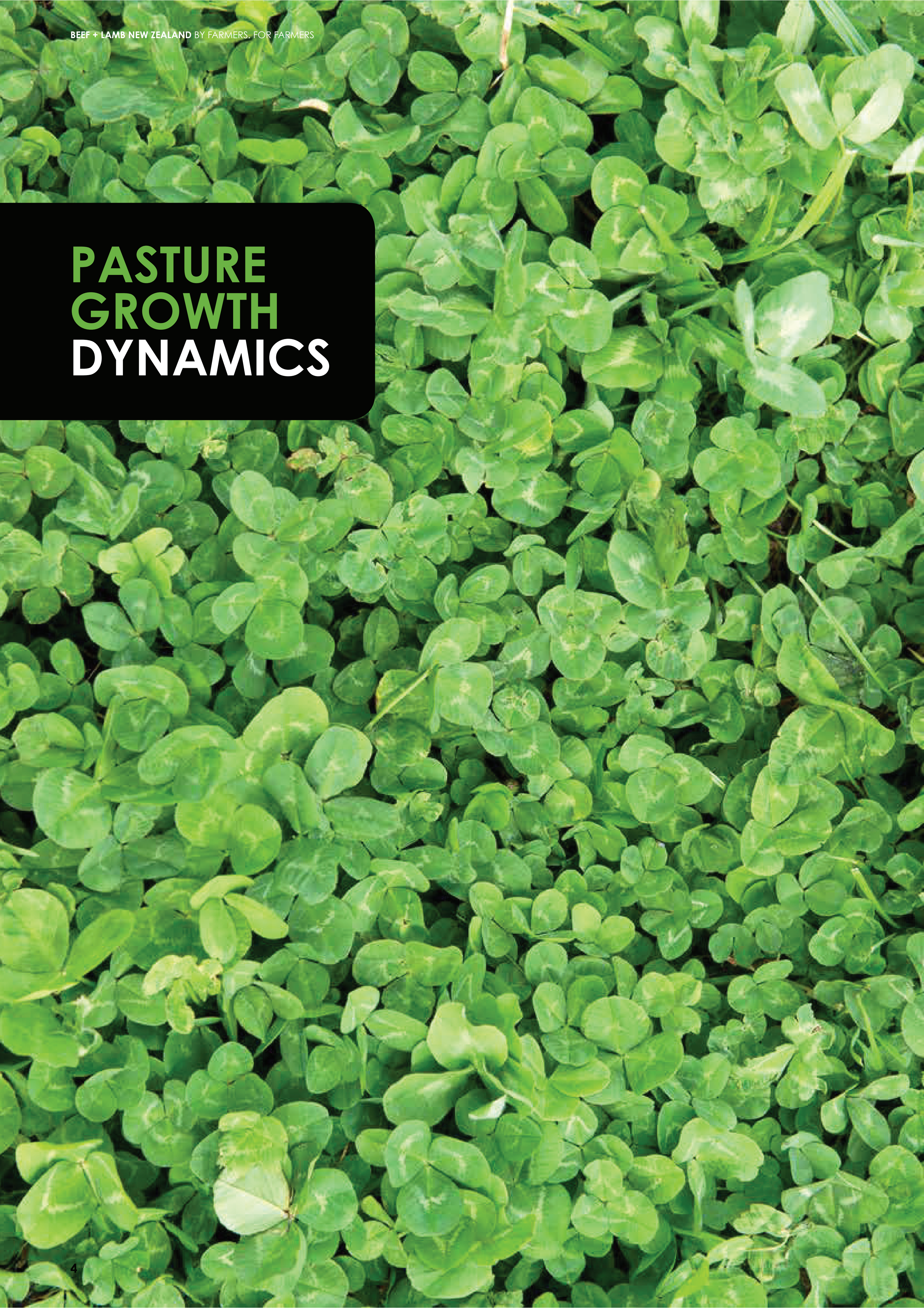
INTRODUCTION

FeedSmart 2 is a Feed Planning programme which aims to assist sheep and beef farmers to better manage feed supply and demand, increase feed utilisation and enhance the value of feed consumed.



PASTURE GROWTH DYNAMICS

Pasture grasses are comprised of hundreds of sub-units known as tillers.

Each tiller is comprised of shoot (made up of leaves and a structure of tightly wrapped leaf bases called a pseudostem) and root tissue. At the base of the shoot is a growing point from which new leaf and stem material originates. These growing points are typically located at or beneath the soil surface. New tillers develop from existing tillers. This continual replacement of tissue, and the fact that the growing points are protected from damage, makes grasses ideal plants for grazing.

Legumes, such as white clover, incorporate atmospheric nitrogen into plant tissue through their association with Rhizobia bacteria that live in their root nodules. This gives them an advantage in low fertility environments but can be a disadvantage in high fertility environments because of the sugar (energy) loss to the bacteria. On the whole, legumes are beneficial because they can increase overall soil nitrogen.

A new white clover plant establishing from seed is comprised of a taproot and shoot material. As the plant develops, it sends out a horizontal stem, called a stolon, which grows along the surface of the soil. White clover can regenerate itself and spread through a pasture via these stolons. Clover's main growing point is at the tip of this stolon and it moves as new stolon material is created. The oldest stolons eventually die, particularly during winter if they become buried beneath the soil surface. The original plant becomes separated into several daughter plants. Hard grazing and high stock densities, especially during winter, leads to high stolon death and many fractured small plants. These are particularly vulnerable to competition for light from grasses during spring. White clover is also sensitive to dry conditions. Summer dry areas will have considerably lower white clover content (typically 0-10% of pasture) than summer wet (typically 15-20% of pasture).

Plants grow through the process of photosynthesis which converts the energy in sunlight into biochemical form as carbohydrates (cellulose and simple sugars), fats and proteins. Plant growth also requires the uptake of different molecules from soil through plant roots. Growing and maintaining roots requires energy but because they are in the soil their energy has to come from respiration. This process requires oxygen so good plant growth is not only dependent on sunlight, water, and adequate nutrients, but also a well-aerated soil.

The ratio of leaf area to soil area in a pasture is known as the leaf area index (LAI). A high LAI indicates that most of the incoming light is intercepted by leaves with less light falling on the soil. However, shading of older lower leaves by younger higher leaves slows their growth and eventually the rate of emergence and growth of new leaves is balanced by the rate of death (senescence) of older leaves. This point is termed ceiling yield.

Pasture mass and pasture growth are commonly used terms in discussing pasture accumulation. Pasture mass is the dry weight of pasture above ground level for a specified area, often expressed as kilograms of dry matter per hectare (kg DM/ha). Pasture growth is the daily rate of accumulation of pasture mass for a specified area and period, often expressed as kg DM/ha/d. Gross pasture growth is the production of new plant material by pasture. Net pasture growth is the difference between gross pasture growth and senescence and is the figure most commonly used and also most relevant to animal feeding.

The objective of good grazing management is to keep pasture mass in an optimum zone of approximately 1500 and 2500kg DM/ha where net pasture growth rate is near its maximum.

Summary

- Feed planning is about maximizing the profitable conversion of the sun's energy to animal product
- Pasture mass is the dry weight of pasture above ground level, expressed as kg DM/ha
- Photosynthesis converts the sun's energy into a chemical form that can be utilised by animals
- Bacteria in clover roots fix atmospheric nitrogen, a very valuable attribute
- Leaf area index (LAI) describes the ratio of leaf area to bare soil and the ability of pastures to capture sunlight
- Net growth describes the accumulation of dry matter (DM)
- Net growth is a combination of new growth and pasture decay
- Maintain pasture mass between 1500 and 2500kg DM/ha for maximum growth

FACTORS THAT CAN AFFECT PASTURE

New Zealand's mild temperate climate is ideal for pasture growth and gives our agricultural production systems a competitive advantage. Seasonal temperature variation is one of the key factors driving pasture growth. The optimum temperatures for ryegrass and white clover are 20 and 25°C, respectively.

Soil moisture is vital for growth. About 80% of green pasture leaf is water which keeps the leaves erect. Moisture is vital for transporting nutrients, hormones and sugars and helps cool the plant.

Soils influence pasture growth through their ability to hold water and their fertility. In New Zealand there is considerable variation between soil types because of the many different soil parent materials and landscapes.

Aspect is important on hill country: south-facing slopes are colder in winter but retain moisture better in summer. The reverse applies to north-facing slopes.

Grazing animals can affect pasture growth through treading or pugging damage. The effects are worst under heavy stocking or large stock in wet conditions.

Soil nitrogen (N) usually has the largest impact on growth due to effects on the plant's ability to create photosynthetic proteins. Most N in soil is contained in organic matter which breaks down to provide N that is available to plant roots either as nitrate or ammonium molecules.

Fertiliser N can dramatically increase plant growth but the response can vary (0 to 30 kg DM/kg applied N).

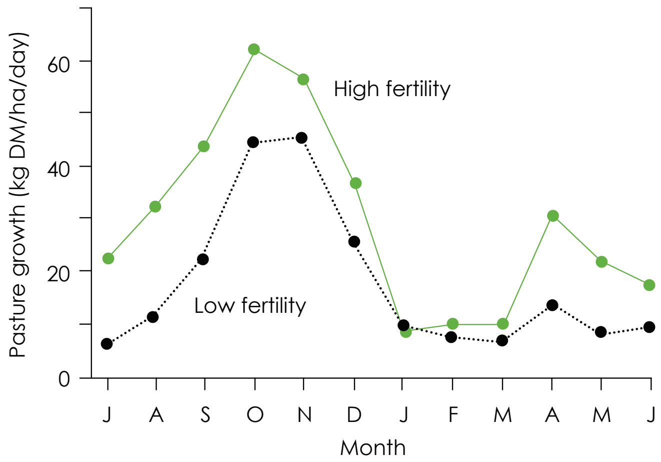
Climate, soils and fertility

Evapotranspiration is the sum of water loss from transpiration and evaporation from plant and soil surfaces and is usually expressed in mm/day. If climatic variables, such as temperature, solar radiation, relative humidity and wind speed are known, then potential evapotranspiration can be calculated. By comparing potential evapotranspiration to long-term rainfall, the timing and magnitude of soil water deficits/excesses can be predicted.

Soil fertility affects pasture growth (Figure 1) and species composition. Soil nutrient testing is the best way to determine soil fertility.

To shift a soil from low to high fertility status requires the application of capital fertiliser. For example, ash soils, which are very common in the North Island of New Zealand, require up to 2 tones super phosphate/ha as an initial application after which maintenance levels are adequate.

Figure 1: Example pasture growth rate pattern for a low fertility (Olsen P level less than 12) and a high fertility farm (Olsen P level greater than 20) in the same location



Another feature of hill country soils is aspect. South-facing slopes receive less solar radiation and so are colder and more shaded than north-facing slopes and are typically slower growing, especially in winter and early spring. In summer, however, north-facing slopes can dry out more than south-facing slopes.

Effects of Grazing management on Pasture Growth

Grazing management can influence both pasture growth and quality. Pastures grazed too hard have low growth due to low leaf area, and pastures grazed too laxly have low growth and poor quality due to high leaf death. As mentioned previously, to maximise pasture growth, pasture mass should be maintained between approximately 1500 and 2500 kgDM/ha for sheep grazed pastures and approximately 1500 and 3000 kgDM/ha for cattle grazed pastures.

Summary

- Temperature, solar radiation and soil moisture are key drivers of pasture growth
- Evapotranspiration describes evaporation from soil and respiration losses through leaves
- Soils also influence pasture growth through their ability to hold water and their fertility
- Soil fertility affects pasture growth and species composition
- Climate, seasonal change, weather, slope and aspect all affect pasture growth
- Nitrogen (N) affects growth because photosynthesis is N dependent. N is obtained from soil through roots.
- The average response to N fertiliser on sheep and beef farms is 15 kg DM/kg N

FACTORS AFFECTING PASTURE QUALITY

Pasture quality describes the energy density of pasture and also the availability of energy via digestion. Pasture quality is described by the metabolisable energy (ME) content of the DM, the digestibility of the DM or by the green DM as a % of the total pasture DM. Animals will not perform well on poor quality pasture, regardless of how much they are offered. This is because animals have a maximum amount of forage that they can consume over a set amount of time (voluntary intake) and so the amount of energy they ingest is capped.

Pasture quality is influenced by the structure of plant tissues with respect to cell contents, cell walls (fibre) and cell wall digestibility. These determine the chemical make-up and digestibility of the plant, and hence the energy available to the animal.

Dead matter content of pastures explains around 70% of the variation in quality. As cells die, their soluble contents decline leaving only the fibrous cell walls. Although dead matter looks similar in form to the original leaf, it is very low quality with a nutritive value of less than 8 MJ ME/kg DM (similar to hay). If the onset of drought causes young leafy pasture to die off rapidly the "snap dried" pasture will retain its quality although it then declines rapidly after rain.

Stem content in pasture increases in spring-summer as grasses go to seed. The nutritive value of the stem is lower than that of the leaf because it contains a greater proportion of structural fibre.

Nutritive value also drops as temperature increases. This is primarily caused by a change in leaf: stem ratio with its associated increase in cell wall: cell content ratio and increased lignification of the cell wall.

The effects of soil fertility on nutritive value and animal intake are largely indirect and are associated with increased pasture content of legumes, "easier to manage" grass species and faster pasture growth

Lack of soil moisture has a relatively small effect on pasture quality compared to its effects on growth.

Nutritive value

Pasture quality is affected by the structure of plant tissues with respect to cell contents and cell wall (fibre) digestibility. 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. The animal turns the feed into energy by digesting these plant tissues.

Energy is far and above the most commonly limiting nutrient for animal performance for NZ grazing animals. The other digestion products, such as protein and minerals, are only of concern when they are either limiting or too high, both of which are rare.

Nutritive value of feed is a combination of the digestibility of pasture eaten by the animal, and the efficiency with which the digestion end products are used. Metabolisable (ME) 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 units that can be used in allocating feed.

The percentage of the pasture eaten which is digested (55-85%) is known as its digestibility. The remainder is excreted as faeces. Some of the energy in this digestible material is lost as urine and as methane. The energy from the plant that as used by the animal is termed metabolisable energy (ME). Typical ME values for pasture herbage are 8-13 MJ ME/kg DM. The ME is used with differing efficiencies depending on the purpose for which the energy is used (maintenance, growth, lactation and pregnancy).

Water and dry matter

Pastures contain a high proportion of water, with a DM content of 10-50%. Only the DM has nutritive value. In general, high quality pastures have low dry matter concentrations

Soluble carbohydrates

Protein and soluble carbohydrate are the major components of the plant cell contents. These are usually rapidly or readily digested. Protein makes up 7-30% of the dry matter, decreasing as the cell ages. Soluble carbohydrates (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. There is normally a seasonal peak in soluble carbohydrates just before flowering in spring. Levels then drop over summer and autumn before rising again in winter. Soluble carbohydrate concentrations are influenced by sunlight, with the highest levels being measured in late afternoon. Overcast conditions will reduce potential soluble carbohydrate concentrations.

Fibre

Cell walls are mainly carbohydrate fibre which increases as the cell ages. The two main components are the slowly digested carbohydrates hemicellulose and cellulose, which make up 35-70% of the DM.

Ruminants (sheep, cattle and deer) can digest this by fermentation in their rumen. An unfortunate by-product of this process is methane which is a greenhouse gas.

A third important component of fibre is lignin, which is indigestible and contributes 3-6% of the DM. Lignin binds the cell wall carbohydrates together in a process called lignification, reducing the digestibility of the other components.

The total cell wall content of herbage is measured as neutral detergent fibre (NDF) while the cellulose plus lignin content is measured as acid detergent fibre (ADF). The difference between the two (NDF – ADF) is the hemicellulose. The proportion of slowly or non degradable cell wall (ADF) is closely related to ME. The higher the proportion of ADF, the lower the ME.

Leaves, stem and dead matter vary in the amount of fibre, soluble carbohydrates, protein and minerals they contain which therefore affects their feed quality.

Stem

The nutritive value of green stem is lower than that of green leaf by about 1.0MJ ME/kg DM. This is because it contains a greater proportion of lignin. The amount of stem in the pasture increases seasonally as grasses go to seed in late spring and early summer. This stem can remain through the summer, lowering pasture quality

Dead matter

Dead matter content explains around 70% of the variation in pasture quality. As cells die, their soluble contents decline, leaving only the less digestible fibrous cell walls. Therefore, although dead matter looks similar to the original leaf, it is of very low quality and nutritive value of <8 MJ ME/kg DM. The onset of drought can cause young leafy pasture to die off rapidly. This "snap dried" pasture will retain a lot of its quality as it is still young pasture, relative to "old" dead matter. However, its quality declines rapidly after rain.

Grasses

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 grown in the same conditions as temperate grasses are lower quality because they have greater fibre content. They also contain lower protein and soluble carbohydrate levels.

Italian and hybrid ryegrasses and tetraploid ryegrasses are higher quality than normal perennial ryegrasses because of their lower fibre and higher soluble carbohydrate concentrations.

Browntop, danthonia, yorkshire fog, crested dogstail and sweet vernal are often referred to as "low fertility" grasses. They are tolerant of low soil fertility and occur in predominantly poor growing conditions. When grown in conditions in which "high quality" grasses thrive, they are less competitive but the leaf of all these grasses is of similar quality. However, the amount of stem, and the age of the leaf often varies and the low fertility grasses are harder to manage because they usually "run to seed" relatively quickly.

Legumes and herbs

Legumes and herbs generally have higher feed quality than grasses, especially in summer when temperatures are high. This is because the fibre structure of legume and herb leaves is lower and less affected by temperature than grasses.

Age

The nutritive value of pasture decreases as it ages. As green plant tissue ages, it contains proportionally more stem material and the degree of lignification increases. Therefore pasture spelled for six weeks has a lower nutritive value than pasture spelled for three weeks – especially over summer

Temperature

Nutritive value also drops as temperature increases. This is mainly due to a change in leaf/stem ratio, cell content/cell wall ratio and increased lignification of the cell wall.

Moist summers are often associated with an increase in clover growth because clover grows better than temperate grasses at high temperatures. This means that the species composition of a pasture may improve, but the temperature effect on the grasses is still present and the overall quality of the pasture is still reduced.

Fertiliser

The effects of raising the fertility level on nutritive value and animal intake are dramatic but largely indirect. These are associated with the increased content of clover and ryegrass species, benefiting both pasture quantity and quality.

Soil moisture

Lack of soil moisture has a relatively small effect on pasture quality compared to its effects on growth

Summary

- Metabolisable energy (ME) and digestibility are the two main attributes of nutritive value
- ME is expressed as megajoules ME/kg DM. ME is energy in feed that can be utilised by the animal
- Plant cells contain protein and soluble carbohydrates
- Cell walls contain cellulose, which ruminants digest by fermentation
- Dead matter content explains 70% of the variation in pasture quality
- Legumes have higher nutritive value than grasses
- Nutritive value of pasture declines with age
- The decline in quality with tissue age is minimal in clover leaves
- Nutritive value falls as temperature rises. Dead matter content also rises in warm, dry conditions
- Fertiliser improves pasture quality through its effects on species composition

MEASURING PASTURE QUALITY

Pasture quality is more difficult to measure than pasture mass even though it is the main limitation to animal performance over summer and autumn. Unfortunately there is currently no device which measures pasture quality immediately and directly on farm. Instead, farmers must rely on either informal or formal visual assessment systems.

Dead matter content provides a useful indirect assessment of pasture quality. Its impact on animal performance is often underated because it is largely hidden in the base of the pasture. Using visual assessment, dead matter content is often underestimated in summer and autumn. Clover content improves pasture quality but its presence is usually over-estimated.

Alternatively, samples can be sent away for laboratory measurements of quality including metabolisable energy (ME), digestibility, fibre and protein content.

The Q-Graze computer model uses assessments of maximum daily temperature, quality and quantity of herbage mass, animal type and number to estimate the ME content of pasture, diet ME, animal intake, and sheep or cattle live weight gain for different durations of grazing in a paddock

Informal pasture quality assessment

Most farmers informally monitor pasture quality by looking at easily seen indicators such as greenness, presence of seed head and clover content. However, dead matter, the major determinant of quality, is often ignored because it is largely concealed in the base of the pasture. To be effective, informal assessment must consider dead matter.

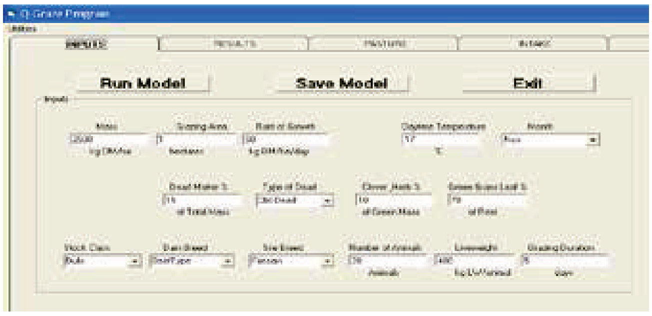
With experience and benchmarking against known values, farmers can assess pasture quality.

Q-Graze and visual assessment of pasture quality

The Q-Graze model uses visual assessments of quality and quantity of herbage mass, animal type and initial liveweight to predict the ME content of pasture, animal intake, and liveweight gain for different durations of grazing in a paddock (Figures 4.1 a, b, and c). In this system the amounts of dead matter, legume content, grass leaf and grass stem are visually assessed to ground level. These eye estimates, along with the maximum daily temperature and the month over which they grew are used by the model to estimate ME of the pasture and of the animal's diet. The user can vary the inputs to see how this affects performance and in this way, can learn how pasture quality affects performance

Figure 2: Input and output screens from the Q-Graze model

(a) Input screen of Q-Graze model



Visual assessment of pasture quality

The following are important points to remember when visually assessing pastures for quality and using Q-Graze:

Step 2. Sample with dead matter removed

This sample contained 16 % dead of total sample

Clover content of pasture is assessed as a percentage of green DM rather than total dry matter. All legume and highly edible herbs (e.g. chicory, plantain) are included in the assessment of clover content.
Clover is usually overestimated because of its flat leaf, especially in long pastures. The clover content of sheep and beef pastures on a green basis is 13% on average and rarely exceeds 30%.

Step 3. Sample with legume and herbs removed

This sample contained 23 % of legume and herb of the total green component

Leaf:stem ratio is the proportion of grass that is green leaf relative to green flowering stem e.g. 95% leaf: 5% stem. Poorly palatable weeds (eg docks) are included in the visual assessment as flowering stem. Green flowering stem is normally present in the sward only from November to February. After this time the stem dies and is included in the dead component.

Step 4. Sample with stem removed

This sample contained 86 % of green grass leaf of the green grass component.

For the pasture sample in Step 1 the visual components for entry into QGraze would be as follows

Dead	16 %
Legume and herb	23 %
Green grass leaf	86 %

Sampling a paddock

To visually assess a paddock select a representative part of the paddock and make the visual assessments

When sampling a paddock for laboratory measurement thought needs to be given to whether the sample is estimating diet quality or standing quality cut to ground. A sample collected to simulate diet quality must replicate both the diet selectivity and grazing height. This is more difficult to collect but is more likely to relate to animal performance. Samples of standing herbage mass are easier to collect and are best used in association with Q-Graze estimates. These samples will have been cut to ground level.

The plant tissue may continue to respire after sample collection, using up soluble carbohydrate. To prevent this, samples should be cooled rapidly. The sample should be cool and dry (avoid collecting wet grass) when packaged in a sealed plastic bag for immediate mailing to the laboratory

Summary

- Farmers can informally determine pasture quality by visual assessment
- Q-Graze: a tool that predicts pasture quality and animal performance
- Q-Graze allows the user to learn about the impacts of quality on animal performance
- When taking samples for lab assessment of quality, select representative parts of the paddock, cool the sample and get it to the lab as soon as possible

MEASURING PASTURE MASS

Pasture mass (kg DM/ha), is measured or assessed to estimate how much feed might be available to grazing animals. Animal performance is dependent on both the quality and quantity of pasture offered to them.

Pasture mass estimates are useful for building and testing feed budgets, identifying pasture deficits or surpluses and even estimating net pasture growth rate.

Pasture mass within a paddock is often very variable.

The gold standard for measuring pasture mass is cutting to ground level. The process can be costly and time consuming.

Although it is difficult to measure pasture mass accurately, assessment with the provision of some information is better than no information. It is possible to measure pasture mass to within 200kg DM/ha. Various means of indirect assessment all have their proponents and weaknesses. The methods include:

- Visual assessment
- Rising plate meter
- Pasture probe or capacitance meter
- Pasture ruler or sward stick.
- C Dax

Visual assessment is usually calibrated against any of the other four assessment techniques above.

For sheep and beef farmers, the most practicable calibration tool is probably the pasture ruler or sward stick.

The main strength of the techniques listed above lies in their objectivity. Their main weakness is in their inability to adjust for different pasture conditions or composition especially as season changes, e.g. from spring to summer. Even so, most of them have a range of calibration equations that attempt to deal with this problem.

Visual assessment

Visual assessment is a useful method of assessing pasture mass for the following reasons:

Calibration can be achieved in 1 or 2 half hour sessions using another experienced visual assessor, the rising plate or the pasture ruler.

Experienced individuals can mentally adjust for variation in sward composition, sward density, season and the proportion of dead DM in the sward. In this regard, it is superior to the other indirect devices above.

Visual assessment is the quickest and most convenient method available. It can be used for “broad brush” type assessments of whole paddocks from some vantage point (such as a motorbike seat!). While accuracy suffers with this type of approach, it may be satisfactory for grazing management purposes and is better than nothing.

Because it is so easy, farmers are more likely to use it and it can be surprisingly accurate.

When visually assessing pasture there are a few common biases:

- High dead matter pastures are under-estimated
- High mass paddocks are under-estimated
- Low fertility swards with a “mat” are under-estimated
- Upright, low-density swards are over-estimated
- Swards with high legume content are over-estimated
- When the pasture is highly variable the eye will be drawn to the longer pasture
- Pastures look longer when the sun is low because of the shadows
- Pastures appear to have higher mass when viewed from the top of a slope because of the appearance of camp and track areas
- Clumps create the impression of more pasture than is actually present

Importantly, individuals can drift away from their visual assessment calibration over time. Regular calibration using the pasture ruler or one of the other devices is a good idea.

Many people graduate to using visual assessment after gaining confidence from a period of using the rising plate or the pasture ruler.

Summary

- Cutting to ground level and drying the sample is the ‘gold standard’ of assessing pastoral mass but is laborious
- Visual assessment, use of the rising plate, pasture probe and pasture ruler are all useful indirect techniques for measuring pasture mass
- Pasture mass in a paddock is quite variable
- Visual assessment is a good system but it does have its biases
- Use one of the other tools to recalibrate the assessor from time to time

ANIMAL FEED REQUIREMENTS

Feed requirements vary depending on animal weight, expected mature weight, gender, productive status, grazing environment (easy or steep contour etc) and quality of feed. Traditionally, rather simple feeding standards for grazing livestock have been used. These failed to take all the above factors into consideration, producing inaccurate estimates of feed requirements as a result. This chapter outlines a more complex system for calculating animal requirements which include all these factors.

The feed requirements of animals for their different metabolic activities are added together to determine total feed requirements. Metabolic activities include:

- Maintenance
- Liveweight gain or loss
- Pregnancy
- Lactation
- Gender

Requirements for maintenance or liveweight change can vary depending on gender and whether the animal is pregnant or lactating.

The ME content of the feed will affect the animal's feed requirements.

Other factors such as parasitism, fungal toxins in the feed and trace element status will affect feed requirements.

The feeding tables in Appendix 1 allow the requirements of livestock to be systematically built up to account for the above factors.

Maintenance requirements

Maintenance requirements are those needed to keep the animal at a static liveweight in its particular productive state.

Maintenance requirement is affected by a large number of factors including:

Species; 40% higher requirement for cattle and deer than sheep.

Liveweight; higher for heavier than lighter animals.

Age; 8% higher for young compared to adult animals.

Gender; 15% higher for males than females and castrates at the same weight.

Shearing; if weather conditions are cold immediately following shearing then maintenance can be 40-60% higher.

Pasture mass; 5% less on higher pasture mass compared to lower masses due to increased energy costs of grazing shorter pastures.

Slope; up to 20% more energy is required to graze steep compared to flat land.

Feed quality; up to 20% higher requirement on feed of low compared to high ME concentration because ME is being used less efficiently. DM maintenance requirements can be up to 65% higher on low compared to high quality diets.

Liveweight gain or loss

The ME requirement for liveweight gain (LWG) is mainly determined by the proportion of fat and protein (or muscle) being laid down in the gain. Fat requires 1.7 times more energy than an equivalent weight of protein.

Energy requirements for growth are affected as follows:

Mature weight of animal; animals closer to their mature weight put down more fat and less protein. For old versus young animals, sheep require 50% and cattle, 250% more energy per unit of growth.

Gender; males at the same weight as females require up to 25 % less energy for growth because they lay down less fat.

Rate of growth; faster growing animals put down more fat and less protein requiring 5% more energy per unit of growth.

Maintenance costs: fast growing animals require more energy for maintenance. This is included into the costs of production and is 10% of energy for growth.

Feed quality; animals grazing high compared to low quality feed require 30% less energy for a unit of growth because the ME is being used more efficiently for growth.

Feed source; energy from consumption of milk is used 56% more efficiently than energy from pasture.

Lactation state; ewes require 20% less energy to grow when lactating compared to when they are dry.

Liveweight loss (LWL) can be used to meet maintenance, pregnancy and lactation requirements. In both sheep and cattle 1 kg LWL generates approximately 30 MJ ME for maintenance depending on the composition of the liveweight lost.

The replacement of this kg of lost weight requires approximately 55 MJ ME. However, on farms, a period of LWL is often associated with a decline in farm pasture mass and in some seasons this will result in subsequent improvements in pasture quality.

In finishing stock, faster growing animals have better conversion of feed to saleable product and greater profit because they use proportionately more feed for LWG and less for maintenance .

Pregnancy

Pregnancy requirements are calculated from total lamb output at birth and therefore are not directly affected by the live weight of the ewe. The ME requirements for pregnancy are dependent on:

Stage of pregnancy; requirements for pregnancy increase exponentially as birth date approaches. Pregnancy requirements are approximately 3 times higher at birth than at 6 weeks before birth.

Number of offspring; a ewe carrying triplets requires 50% more energy for pregnancy than a ewe carrying a single lamb.

Birth weight; higher birth weights require higher pregnancy requirements. These are in proportion to the birth weight difference.

Lactation

Lactation requirements of the dam include the pasture intake of the suckling lamb/calf. During lactation the lamb/calf starts to eat increasing amounts of pasture as it grows, thereby increasing the requirements from pasture of the dam + offspring combination as lactation progress. The ME requirements of the dam for lactation are also dependent on:

Stage of lactation; requirements for milk production vary according to stage of lactation. These are 80% higher at peak milk production compared to the end of lactation.

Milk production of ewes is increased by 20-50% for additional offspring and is greater in well-fed and/or well conditioned dams.

Feed quality; milk produced from high compared to low quality feed requires 10% less energy because ME is used more efficiently for lactation.

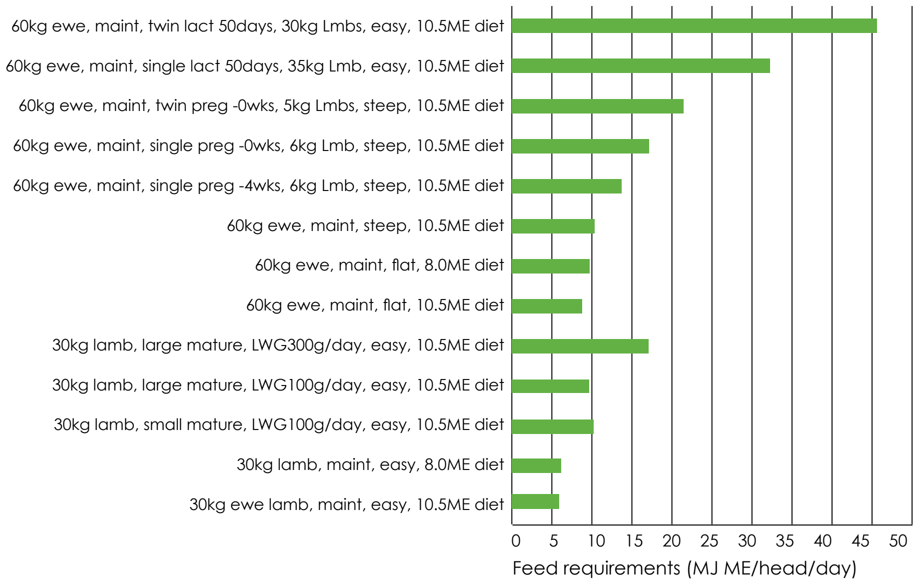
Other factors affecting animal performance

It is common, especially over the summer and autumn, to have levels of animal performance that are lower than should be achieved, given the quantity and quality of feed offered. These animals are said to be suffering from "ill-thrift", which is normally due to reduced intake or an increase in maintenance associated with a toxicity effect. Some key causes of this ill-thrift are parasitism, toxins and trace element deficiency.

Summary

- Feed requirements for sheep and cattle are based on energy because this is the dominant limiting driver of animal performance
- Energy requirements for different activities are added together to provide a total (MJ ME/head/day)
- ME describes the energy requirements of animals. For convenience, this is often converted to DM
- Maintenance describes the energy required to keep the animal at static liveweight, and is affected by many factors
- Energy requirements for growth are also affected by many factors
- Weight loss produces usable energy and weight gain requires energy
- Fast growing animals use proportionately less energy for maintenance and are more efficient
- Energy for pregnancy depends on stage of pregnancy, number of offspring etc
- Parasitism increases energy requirements due to the energy costs of mounting an immune response
- Fungal toxins suppress LWG, mainly in autumn
- Facial eczema can severely depress liveweight gain
- Co, Se, CU deficiency can all reduce LWG in growing animals

Table 1: Examples of feed requirements of sheep (MJ ME/head/day) in various metabolic states, on feed of varying ME content

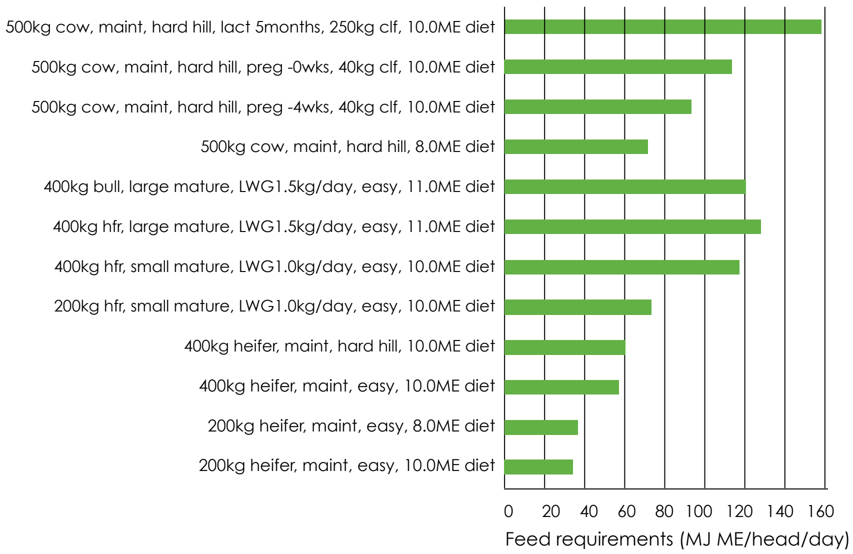


Key to abbreviations in Table 1;

examples:

- Third bar from bottom describes a 30kg lamb, small mature size, liveweight gain 100g/day, on rolling/easy contour land, eating pasture with an ME content of 10.5MJ ME/kg DM
- Third bar from top describes a 60kg ewe, maintaining her conceptus-free liveweight, 0 weeks before twin lambing, will give birth to 5kg lambs, grazing on steep country eating pasture with 10.5MJ ME/kg DM
- Top bar describes a similar ewe with twin lambs at day 50 of lactation; expected lamb weaning weight 30kg/head.

Table 2: Examples of feed requirements of cattle (MJ ME/head/day) in various metabolic states, on feed of varying ME content



Key to abbreviations in Table 2; examples:

- Fifth bar from bottom describes a 200kg small mature size heifer, liveweight gain 1.0kg/day, on rolling/easy contour land, eating pasture with an ME content of 10.0MJ ME/kg DM
- Third bar from top describes a 500kg cow on hard hill country, maintaining her conceptus-free liveweight, 4 weeks before calving, will give birth to a 40kg calf, grazing pasture with ME content 10.5MJ /kg DM
- Top bar describes a similar cow in the fifth month of lactation; expected calf weaning weight 250kg.

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