THE PRINCIPLES OF FEED ALLOCATION: HOW MUCH FEED IS IN THE PADDOCK? HOW MUCH SHOULD I GIVE THEM?

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Introduction

Dairying in New Zealand is dependant on pasture. Pasture is the cheapest source of feed and therefore forms the bulk of the cow's diet. The level of grazing management determines pasture production, animal performance, and farm profitability.

Managers of pastures and livestock require skills and understanding about:

- How plants grow
- How they respond to grazing
- The factors that influence pasture growth and quality
- The factors that determine cow intake and feed demand
- The seasonal variations between feed supply and demand
- Identifying surpluses and deficits in feed supply
- Grazing management strategies such as round lengths, grazing residuals, and average pasture covers.

The Pasture Plant

Plant Growth

Plants grow by a process called photosynthesis. Sunlight is captured by the leaves, which enable the plant to grow. Plants absorb carbon dioxide from the air, and water and nutrients from the soil.

The following factors affect plant growth:

- Sunlight – sunlight is important for photosynthesis. In the winter low sunshine hours result in reduced growth rates. Plants in the shade also grow more slowly
- Temperature – plants are adapted to particular temperature ranges. Temperate grass species e.g. ryegrass, grow best in the 16-20 ºC range. Clovers prefer more heat (24 ºC), while tropical grasses such as kikuyu (found in Northland and coastal land) prefer it even hotter (28 ºC)
- Moisture – all plants need water to maintain strength and for the process of photosynthesis. Lack of water causes reduced growth rates and may cause wilting or even death. Conversely, too much water can drown the plant roots
- Nutrients – plants require nutrients if they are to grow successfully. Chemical nutrients such as potassium, phosphorus and sulphur come from the soil. Carbon, hydrogen and oxygen come from

the atmosphere. Nitrogen becomes available through the soil through nitrogen fixation by legume plants such as clover.

Leaves arise from a growing point located close to ground level. The location of the growing point allows the plant to continue to produce leaves after grazing. When the leaves are cut or grazed the growing point produces new leaves. Each new leaf arises from within the older leaves and continues to grow from tissue at the base. Leaves can continue to grow rapidly even after the tips have been removed. The different parts of the plant are illustrated in Figure 1.

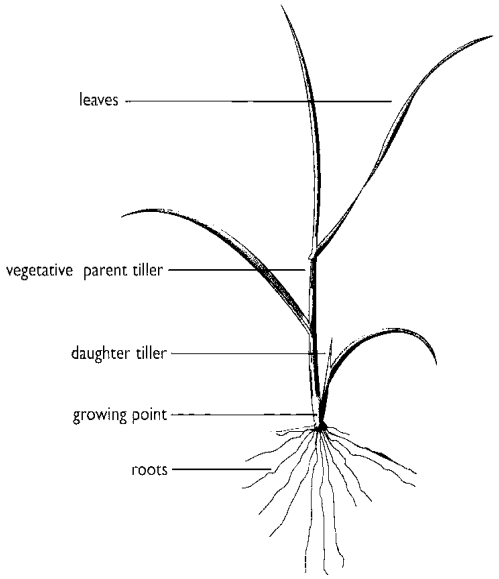


Figure 1: The pasture plant

Tillering

An important feature of the grass plant is that it replicates itself. When the plant has grown several leaves then new shoots, called tillers, begin to grow from buds at the growing point. Each tiller is a replica of the original plant with its own growing point, leaves and roots. This process is called tillering and enables grass to spread. Grazing promotes tillering.

Root system

The root system plays a very important role in the growth of the plant. After the leaves have been grazed the roots provide the energy source for new leaves to begin to grow. When the leaves are large enough photosynthesis sustains the energy requirement. In ryegrass there is usually just one leaf emerging from the plant at one time. Once three or four leaves are present old leaves begin to die as new leaves are formed, so that the number of live leaves on a tiller remains at 3-4 all the time.

Flowering

At flowering the stem lengthens and the growing point elongates. Flowering is initiated by changing day length (time of year), and is influenced by the weather.

In summary, grasses are well adapted to grazing. New leaves grow from an undamaged growing point near the ground. New tillers are constantly initiated. Root reserves enable new leaves to grow after grazing, and flowering allows new plants to be produced each season.

Pasture Swards

Pasture swards are mainly made up of grass and clover plants. Perennial plants can be grazed or cut year after year without the need for frequent re-seeding. In comparison annual crops are grown from seed every year e.g. turnips.

Dairy farmers aim to maximize the amount of pasture grown. Pasture production can be increased by:

- Improving soil structure and fertility
- Encouraging clover growth which fixes nitrogen
- Drainage and liming
- Irrigation
- Regrassing with improved cultivars
- Eliminating pests and diseases e.g. grass grub
- Subdivision, i.e. more fencing which allows more intensive management
- Grazing management, in particular post grazing residuals, and flowering management

Pasture Growth

Pastures grow in distinct phases; these are illustrated in Figure 2.

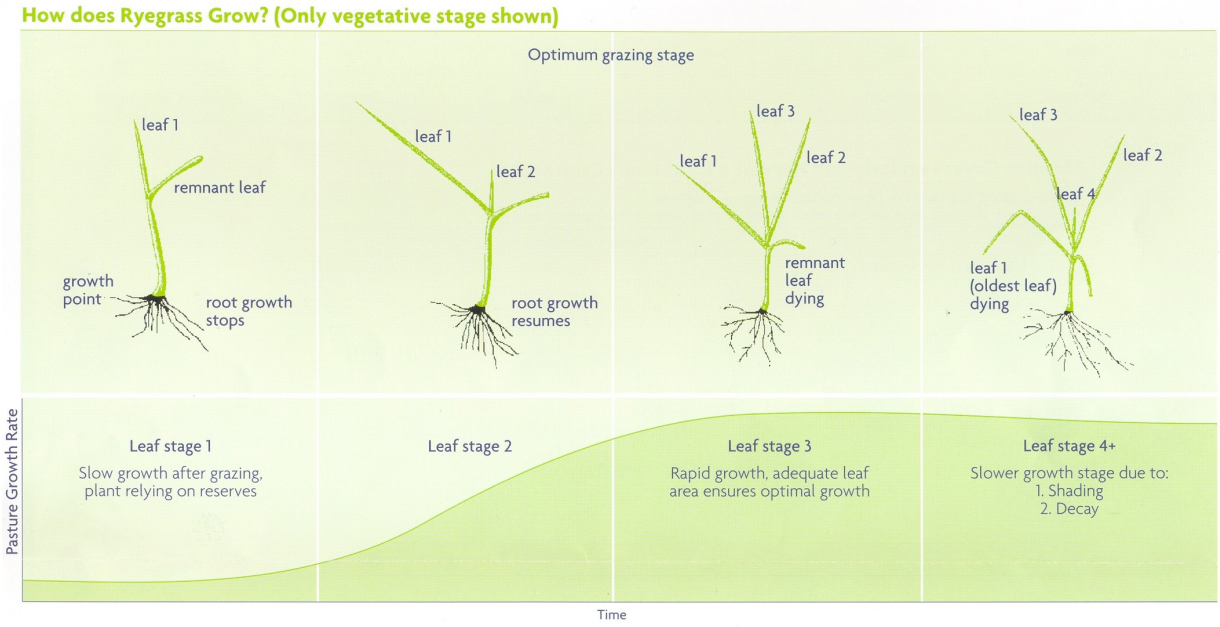


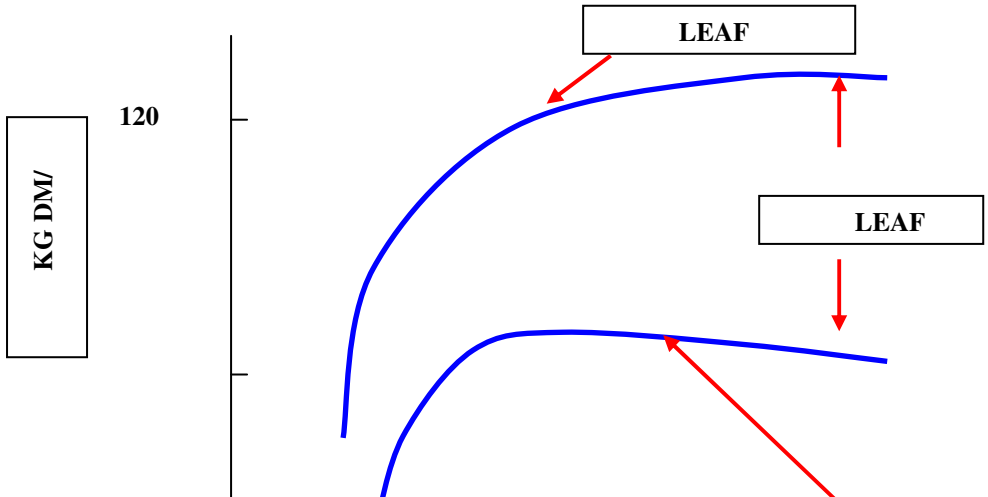
Figure 2: Time sequence of herbage accumulation

Leaf stage 1: After grazing growth is slow. A large amount of leaf area has been eaten therefore photosynthesis is low. It takes a long time to get a small amount of growth.

Leaf stages 2 & 3: Growth rate increases because leaf area is increasing. Maximum leaf area ensures that most of the sunlight is utilised for photosynthesis.

Leaf stage 4: As the pasture gets long and rank, shading of the leaves and clover occurs and growth slows. The base of the plant begins to die reducing feed quality.

Pasture mass influences both pasture growth and pasture decay. As pasture mass increases the decay of pasture, in the base of the sward, sharply increases to a stage where there is more decay than growth. Total pasture grown minus decay results in net pasture produced. The effect of pasture mass (height) on growth rates is illustrated in Figure 3.



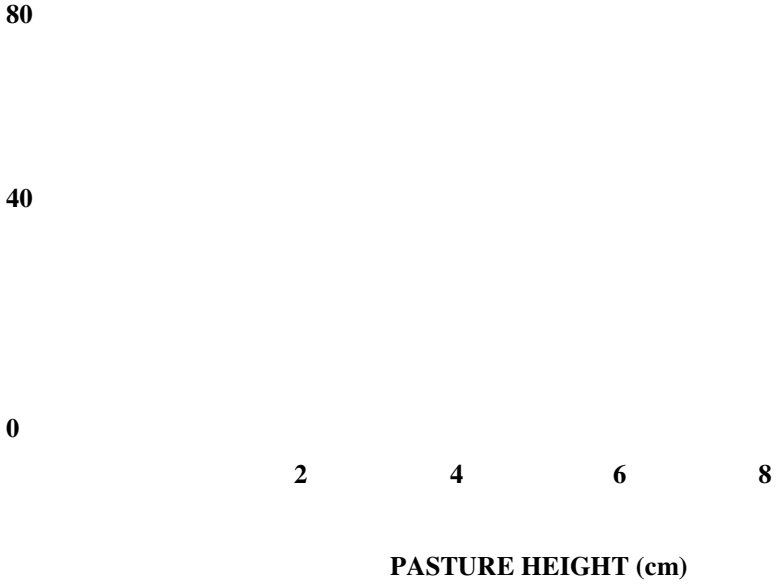


Figure 3: Effect of pasture height on pasture growth rate

The rate of leaf appearance and death are closely related. In perennial ryegrass, each tiller will have three viable leaves at any one time, only one of which will be actively growing. The rate of leaf appearance in spring is faster than in winter, with new leaves appearing every 7 days in spring compared to 30 days in winter. Consequently, the life span of a tiller can vary from 21 days in spring to 90 days in the winter.

Measuring pasture

We can use several tools to measure how much feed is in a paddock at any one time, such as plate meters, pasture probes, satellite mapping and visual assessment methods.

Rising Plate Meters (RPM) are commonly used for pasture assessment. The RPM measures 'compressed height' of pasture in half centimetre units. In research trials these heights have been calibrated against pasture samples of a known mass and dry matter. Therefore each RPM height is correlated to a certain kg DM/ha.

Throughout the season the relationship between RPM reading and kg DM/ha varies. For this reason a number of equations have been developed to convert the pasture height assessments to kg DM/ha. These equations account for seasonal changes of the pasture, seed head emergence, different fibre and dry matter levels, sward density and rate of leaf senescence.

Recent research has shown that in the South Island the winter equation is applicable all year round. Many farmers assess pasture by experience, but there is value in calibrating this visual assessment to the RPM from time to time.

Monitoring growth rates and pasture covers is critical to pasture management. It is recommended to walk the farm fortnightly from April to July and weekly or at 10 day intervals from

August through to December. At less critical times of the year, a more convenient method might be to assess the three longest growth and three shortest growth paddocks to estimate an average.

Pasture Quality

Milk production from grazed pasture is determined by pasture quality and intake. High quality pasture contains a high proportion of green leaf (grass and clover) and a small proportion of stem and dead matter. It has high digestibility and a high metabolisable energy concentration. Energy is the key driver of milk production.

Principles of grazing management

The objectives of pasture management are to:

- Maximize pasture growth rates
- Maintain pasture quality
- Achieve high pasture utilization
- Ensure average pasture covers are achieved at critical times of the year i.e. calving and dry off
- Feed cows to their requirements.

Round length

Round length is defined as the amount of area grazed per day as a proportion of the whole farm; it is expressed as a number of days e.g. 25 day round. For example, a 200 ha farm has 42 equal paddocks, if the herd is grazing one paddock during the day and one at night i.e. 2 paddocks per 24 hour grazing, the round length is 21 days. Alternatively, 2 paddocks = 9.52 ha/200ha = 4.7% of the farm = 1/21 = 21 day round. This means that if you maintained the same rotation around the farm, that same paddock will be grazed again in 21 days.

The round length is usually matched to pasture growth rates. In the spring a new leaf emerges every 7 days, in order to graze the plant at the 3-leaf stage, this requires 21 days growth. Therefore typical round lengths in the spring are 21 days, summer 30 days, and winter 100 days. In principal as pasture growth rates increase the round length is shortened and when growth slows rounds are lengthened.

Rotation

The rotation is the number of days since the paddock was last grazed. This is not the same as round length, you can stay on the same round length (proportion of farm grazed) but be rotating the paddocks in a different order. It is unlikely that all paddocks will grow at the same rate; therefore some will be grazed more often than others.

Pre-grazing cover

This is the amount of feed in the paddock before grazing; it is expressed in kg DM/ha. To determine the amount of feed in the paddock for the herd you must know the paddock size, and the post grazing residual. For example; a 4.76 ha paddock has a pre grazing cover of 2700 kg DM/ha, the herd is expected to leave a residual of 1500 kg DM/ha. This means there is 2700-1500 x 4.76 = 5712 kg DM available to the herd. If the herd has 600 cows then each cow is allocated 9.52 kg DM.

The equation for calculating the target pre-grazing cover is: Pre grazing cover = (stocking rate x intake x round length) + residual.

Post grazing residual

This is the amount of feed that is left in the paddock after grazing. The amount of feed left in the paddock has the most influence on pasture quality. If the herd requirements are known, and a target residual is required than a target pre-grazing cover can be determined. If the herd grazes a paddock greater then this target than a greater residual will be left. If the herd grazes a paddock below the target, then the residual will be lower, milk production will be compromised.

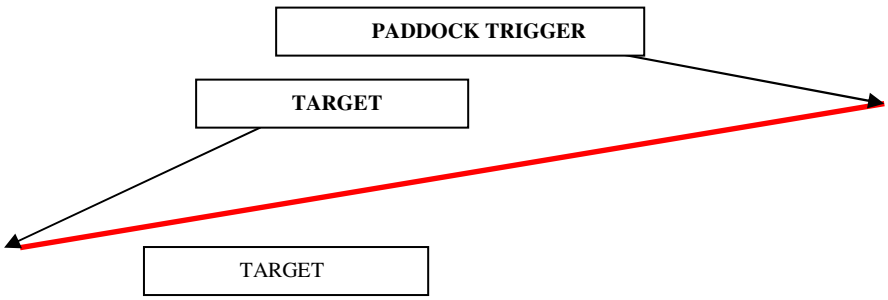
Average pasture cover

The average pasture cover is calculated by determining the pasture cover in every paddock and dividing by the number of paddocks. If pasture growth rates exceed herd demand levels then average pasture cover will increase and visa versa. Seasonal pasture management requires critical levels of pasture cover at calving and drying off, e.g. 1800 kg DM/ha average cover at drying off.

Pasture growth is maximised at various pasture covers. Below 1200 kg DM/ha and above 2500 kg DM/ha pasture growth slows, as a result of the plant growth phases, as shown in Figure 2. For this reason farmers aim to maintain average pasture covers between 1800- 2200 kg DM/ha throughout the season.

Pasture wedges

A continuum of pasture covers exists from the paddock with the longest growth (next to be grazed) and the shortest (most recently grazed). All the paddocks of the farm will fit between these extremes and can be visualized as a wedge. Pasture wedges are useful tools to identify surpluses and deficits in pasture supply. A typical wedge is illustrated in Figure 4.



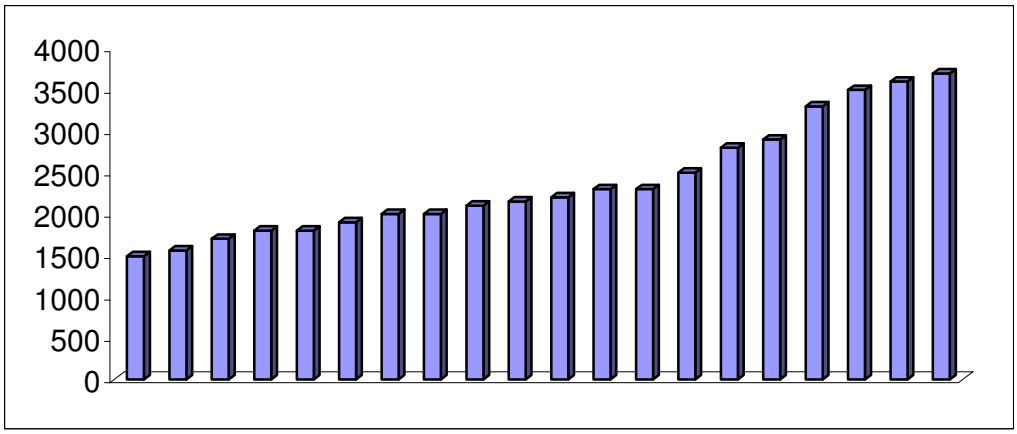


Figure 4: A typical pasture feed wedge

Identifying a surplus

When pasture supply exceeds demand a surplus emerges. The first indication is that grazing residuals are higher because pre grazing covers are higher. The normal practice is to remove paddocks that are above the pre grazing target and make them into silage. This allows one to maintain the round length and maintain pasture quality by controlling residuals.

Paddock trigger level

Another way to identify a surplus is to calculate the paddock trigger level. Paddocks with pre grazing covers above the paddock trigger level are surplus.

Paddock trigger level = (stocking rate x intake x rotation) + optimum residual.

For example (3 cows/ha x 18 kg DM/cow x 21 days) + 1500 kg DM/ha = 2634 kg DM/ha.

Optimum average pasture cover

To assess if you have a true surplus i.e. over the whole farm and not just that paddock assess the average pasture cover. If it is increasing above the calculated optimum APC, then supply is greater than demand, leading to a surplus.

Paddock trigger level + optimum grazing residual / 2 = optimum APC

For example (2600 + 1500) / 2 = 2050 kg DM/ha

Pasture quality

Pastures can be managed to ensure high quality feed. The main way is to achieve an optimal grazing residual (1400 – 1500 kg DM/ha). If pastures are not grazed sufficiently hard, then dead material accumulates and pasture quality will drop.

An easy way to assess pasture quality is by the amount of milk in the vat. If cows have grazed poorer quality grass, then milk production declines. Visually high quality pastures have higher clover content, actively growing green leaves, and very little dead material in the base of the plant. Pasture samples can be analysed in a laboratory. Good quality pasture would have metabolisable energy values greater than 11 MJ ME/kg DM.

Pasture quality is also affected by seed emergence. At the time the plant changes from a vegetative to reproductive stage, energy is transferred into the flower. This lowers the quality of the pasture.

Cow feed requirements

The amount of feed a cow requires is a function of live weight, milk production, stage of lactation, stage of pregnancy, body condition, and walking distance. These requirements are readily available at www. dexcel. A summary is provided in Figure 5.

	Kg MS/cow/day			
Kg LWT	1.6	1.8	2.0	2.2
350	14.0	-	-	-
400	14.5	15.5	-	-
450	15.0	16.0	17.5	-
500	15.5	16.5	18.0	19.0
550	16.0	17.0	18.5	19.5
600	16.5	17.5	19.0	20.0

Figure 5: Dry matter requirements at different live weights and milk production

Grazing residual versus intake

The residual to which cows are required to graze has an impact on intake. This is illustrated in Figure 6.

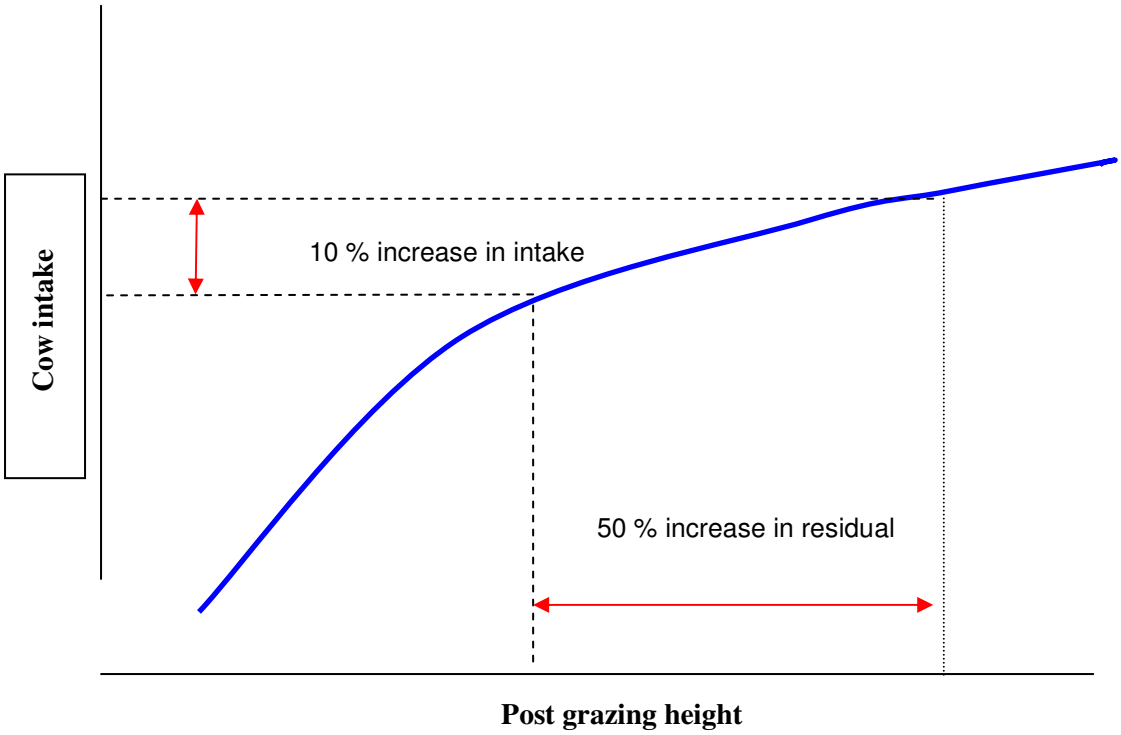


Figure 6: The effect of grazing residual on intake

In order to increase intake by 10 %, pasture residuals need to rise by 50 %. Although per cow milk yields will be high, pasture quality is likely to be limiting at the next grazing. A compromise always exists between quantity and quality. Successful pasture management seeks a balance between the extremes.

Feed Budgeting Principles

The principle of feed budgeting is to match feed supply (pasture grown and supplements) with feed demand (cow intake). Both supply and demand can be manipulated to achieve a balance.

The number of cows (stocking rate) that can be farmed depends on the amount of pasture grown plus any brought in feed. Supply is expressed as kg DM/ha/day and so is demand (cow intake * stocking rate). A typical feed budget for a South Island dairy farm is illustrated in Figure 7.

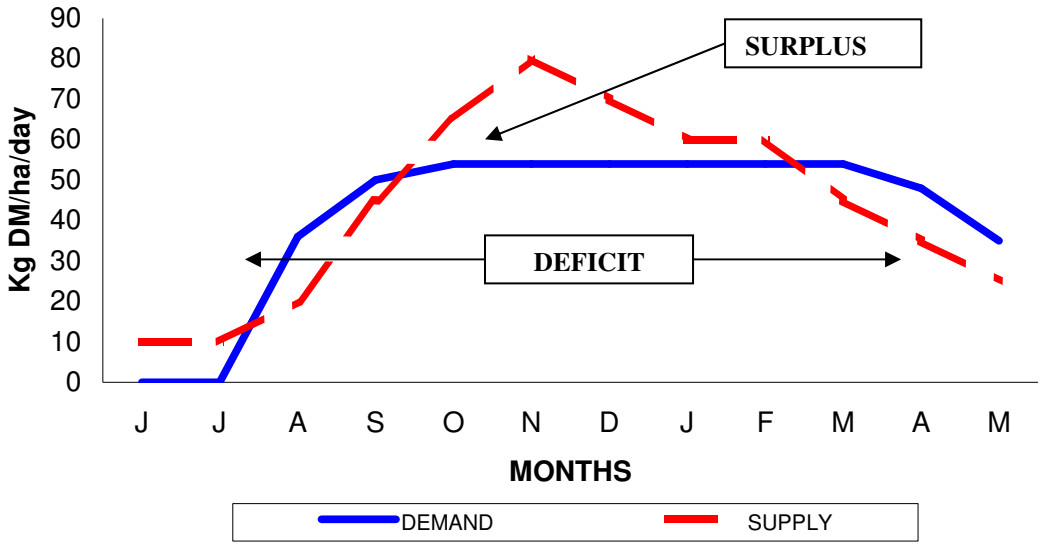


Figure 7: Dairy farm feed budget

The vertical position of the demand curve is influenced by stocking rate; the higher the stocking rate, the greater is the feed demand throughout the year. The left to right position of the demand curve is determined by calving and dry off date. The slope of the demand curve is determined by the calving spread. The position of the supply curve is determined by pasture growth rates.

Factors influencing supply:

- Pasture growth rate
- Level of nitrogen use
- Amount of supplement available.

Factors influencing demand:

- Numbers of cows i.e. stocking rate
- Feed requirements of individual cows at different times of the year
- Level of desired production
- Calving date

- Wintering policy.

Although the total demand and supply for the year can be balanced, there are variations during the year that lead to surpluses and deficits through the season. These variations can be managed by:

- Increasing supply by applying nitrogen
- Increasing supply by introducing supplements e.g. grain or silage
- Manipulating supply by changing the round length
- Decreasing surpluses by conservation
- Decreasing demand by removing animals
- Increasing or decreasing average pasture cover
- Decreasing demand by reducing cow demand to maintenance levels i.e. winter
- Increasing or decreasing average pasture covers.

The success of the New Zealand dairying grazing system relies on matching the grass growth curve to the lactational demands of the herd. In this way large differences in demand and supply are minimised, which reduces the need to conserve surpluses and provide more expensive supplements. The strategies employed by grazing farmers to achieve this are:

- Knowledge of levels of feed demand and supply
- Regular monitoring of pasture growth
- Reacting to seasonal fluctuations in pasture growth rates and taking appropriate action
- Grazing management through the manipulation of grazing rounds and average pasture cover.

Feed Allocation

On a daily basis managers must manage cows and feed. This requires knowledge of how much cows need, and how much feed is available. The current feed situation is a result of the previous months grazing management, and the future feed situation is determined by the decisions made today. There is always a compromise between what is required today and consideration for the future.

The amount of feed a herd needs depends on:

- The number of cows in the herd
- The intake required by each animal.

The amount of feed available is:

- Pasture as assessed by a RPM or other method
- Supplements on hand.

Practical exercises

The following practical exercises demonstrate the principles of allocating feed.

1. A farmer has a pre grazing cover of 2500 kg DM/ha, and wishes to achieve a residual of 1500 kg DM/ha. The paddock is 3 ha and the herd size is 320 cows. What will be the intake of each cow grazed in that paddock?
2. If the same farmer wants to feed the cows 15 kg DM/ha how much supplement must be supplied for the herd. If the silage is 35% dry matter, and the silage wagon holds 2.5 wet tons, how many loads need to be fed out?
3. A herd of 500 cows are eating 18 kg DM/day on a 160 ha dairy farm. The farmer is on a 22 day round. What pasture growth rate is needed to fully feed the cows and maintain the average pasture cover?
4. If the above farmer only grows 40 kg DM/ha/day how much will cover drop in 30 days by staying on the same round?
5. A feed deficit has been identified and amounts to 10,000 kg DM. A farmer can apply nitrogen to 25 ha and expects a growth response of 10 kg DM: 1 kg N. How much urea must be applied to correct the feed deficit?
6. A 6 ha paddock has 1500 kg DM/ha available. For how many days can 120 heifer calves requiring 5 kg DM/day be grazed on this paddock?
7. A swede crop yields 12 tons DM/ha. A farmer winters 300 cows, requiring 12 kg DM/day/head on a 3 ha paddock. How long will the crop last?
8. If the above farmer has an additional 300 kg DM of silage per cow, how much longer will the crop last?
9. A 5.76 ha paddock has 2500 kg DM/ha available. A herd of 600 cows require 18 kg DM each. Where should the fence be put up?
10. A farmer is wintering 800 cows on a diet of chou and straw and wants to feed them 15 kg DM/cow with 2/3 crop and 1/3 straw. The winter is 90 days and there is a 45 ha crop. What crop yield is needed and how many 200 kg DM straw bales must be bought?

Model answers

11. 2,500 – 1,500 = 1,000 x 3 = 3,000
    3,000/320 = 9.37 kg DM/cow
12. 15 – 9.37 = 5.63 x 320 =1,801
    1,801/0.35 = 5147 wet tonnes = 2 loads
13. (500 x 18)/160 = 56 kg DM/ha/day
14. 56 – 40 = 16 x 30 = 480 kg DM/ha
15. 10,000 /10 = 1,000 kg N/0.46 = 2.1 tonnes urea
16. 1,500 x 6 = 9,000
    9,000/ (120 x 5) = 15 days

17. 12,000 x 3 = 36,000

    36,000/ (300 x 12) = 10 days

18. 300 x 300 = 90,000+ 36,000 = 126,000

    126,000/ (300 x 12) = 35

    35 – 10 = 20 days longer

19. 5.76 x 2,500 = 14,400

    (600 x18) = 10,800

    800/14,400 = 0.75 = ¾ of the paddock

20. 800 x 10 x 90 = 720,000

    800 x 5 x 90 = 360,000

    720,000/45 = 16 tonnes DM crop yield

    360,000/200 = 1,800 straw bales

Further Information

Roche. 2001. Getting cows to peak and holding them. Proceedings of the South Island Dairy Event: 187-200.

Hainsworth & Thomson. 1997. Identifying a feed surplus. Proceedings of the Ruakura Dairy Farmers Conference 49: 100-105

Kolver et al. 1999. Mowing pasture to improve milk production. Proceedings of the Ruakura Dairy Farmers Conference 51: 95-96.

Holmes et al. 2002. Milk production from pasture: principles and practices. Massey University, Palmerston North, New Zealand

Langer, 1990. Pastures: their ecology and management. Oxford University Press, Auckland

www.dexcel.co.nz	Pasture and feed requirement information
	FeedPlan : feed budgeting software
	Managing Spring pastures
	Farm Facts
www.agresearch.co.nz	Agfacts