# The Nutrition Process

## Optimising productivity within New Zealand sheep and beef farming systems

September 2025

Each individual farm situation is different with different farm infrastructure, feeds, stock classes, performance expectations. One is not better or worse than another, it is just different. The intention of this resource is to guide the reader about how to apply The Nutrition Process. There are no straight forward answers for complex systems, but working through the process can help provide a deeper level of understanding to inform management and feeding decisions.

## Key Take Home Points:

**1. Nutrition starts from the paddock up!**
- Evaluate pasture covers
- How much feed do we have?

**2. Test for feed quality**
- Nutrients cannot be seen with the naked eye

**3. Calculate nutrient supply**
- Pasture Quantity x Quality

**4 Determine the nutrient requirements for the designated stock class**
- A mature bull needs different nutrients than a triplet bearing ewe
- A triplet bearing ewe needs different nutrients to a hogget

**5. From the pasture up determine which nutrients are limiting**
- Are the stock "fully fed"? Is feed quality (e.g. fibre levels) limiting intake?
- Is the feed protein or energy deficient?

**6. Does the nutrient assessment make sense**
- Do the nutrient intake calculations match with productivity (i.e. average daily gain) and with the behaviour of the stock?

**7. Fill the gap**
- The right nutrient at the right time to fill the right gap will ALWAYS be profitable and environmentally sustainable!

## The Nutrition Process

**Step 1**
**Feed quantity**
Pasture yield and intake

**Step 2**
**Feed quality**
Extended feed test

**Step 3**
**Calculate nutrient supply**

**Step 4**
**Nutrient demand**
Describe stock to determine nutrient requirements

**Step 5**
**Pasture up**
Determine limiting nutrients

**Step 6**
**Believe nothing**
Check the stock

**Step 7**
**Fill the gap**


## Water

Before we get carried away with the detail of the nutrition process, it is important to acknowledge that the first most limiting nutrient is WATER! Regardless of stock class or farm system, ensure all animals have free choice access to clean, palatable water. The more they drink, the more they will eat. If water intake is limiting, all other nutrient intake will be compromised.

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# Step 1 – Feed quantity
## Pasture yield and intake

We feed what we can grow. Nutrition starts from the paddock up (not from the supplement down). So, the first step in the nutrition process is to determine pasture yield. How much feed can we offer the stock today AND maintain pasture covers going forward through the season?

Measuring pasture yield and calculating what the stock are offered to eat is an essential step in the Nutrition Process. There are several methods to determine pasture yield; everything from the "eye-ometer", to a plate meter, to a sward stick, to satellite measurements from space. Quite frankly, it does not really matter which method is employed as long as the observations are taken consistently and recorded.

### Determining pasture and crop yield

Beef + Lamb New Zealand have several resources about how to determine pasture and crop yield. Here are a few links of interest:

**www.knowledgehub.co.nz**

- **Factsheet:** Measuring pasture covers using the sward stick
- **Factsheet:** Measuring pastures on hill country
- **Resource book:** A guide to feed planning for sheep farmers

### Utilisation

A utilisation factor is different to the residual pasture height. While it is a nice idea to think that our stock eat every last blade of pasture in the break, the fact of the matter remains that animals will not graze manure and urine patches, nor where animals have salivated. To accurately determine the total dry matter intake Down the Throat (DTT), a factor for utilisation needs to be applied. On a good day, in a good paddock, the default figure is 85%. This can be influenced by several factors including but not limited to: the plant species in the paddock, the weather on the day, the amount of pugging, the method of feed out. The utilisation factor applied needs to be adjusted accordingly. Ultimately, the objective is to understand the nutrient intake of the stock. To do that we need to know not just what is offered, but what nutrients are going down the throat.

**How many kg DM of pasture are my stock eating in a day?**

Pre-graze cover (kg DM/ha) less the Post-Graze residual cover (kg DM/ha)

= pasture offered (kg DM/ha)

x area offered per 24 hours (ha)

÷ Number of stock in the paddock

x % Utilisation

Examples

| **Rising 2 year old cattle weighing 450kg<br>Mob of 300 head in Paddock 146 (3 ha) for one day** | |
|---|---|
| Pre-graze cover | 2,800 kgDM/ha |
| Post-graze residual | - 1600 kgDM/ha |
| Pasture offered per ha | 1200 kgDM/ha |
| Paddock area per 24 hours | x 3 ha |
| Pasture offered per paddock | 3600 kg DM/ paddock |
| Stock numbers | ÷ 300 head per mob |
| Pasture offered per head | 12 kg DM / head |
| Utilisation | x 85% |
| Pasture per head Down the Throat | 10.2 kg DM / head / DTT |
| **Pasture per head Down the Throat** | **10.2 kg DM / head DTT** |

| **Hoggets weighing 40kg<br>Mob of 800 head in Paddock 13 (3 ha) for one day** | |
|---|---|
| Pre-graze cover | 2,200 kgDM/ha |
| Post-graze residual | - 1600 kgDM/ha |
| Pasture offered per ha | 600 kgDM/ha |
| Paddock area per 24 hours | x 3 ha |
| Pasture offered per paddock | 1800 kg DM/ paddock |
| Stock numbers | ÷ 800 head per mob |
| Pasture offered per head | 2.25 kg DM / head |
| Utilisation | x 85% |
| Pasture per head Down the Throat | 1.9 kg DM / head / DTT |
| **Pasture per head Down the Throat** | **1.9 kg DM / head DTT** |

# Step 2 - Feed quality
## Extended feed test

### What nutrients do we have in the paddock?

**Pastures are not all created equally.** There are differences in feed quality between plant species and their components (i.e. leaves, stems, roots or tubers). In turn, the nutritive value of these components differs according to stage of maturity and the conditions under which they are grown. Daily dry matter intake (DMI) is also affected by the components of the pasture sward that are selected by the grazing animal, plant water content and time spent grazing. The rate at which forage is digested is a key determinant of dry matter intake and largely influenced by the fibre concentration of the feed on offer.

### Why feed quality is important

Feed intake is influenced by the amount of feed on offer only when dry matter availability, supply and palatability are limited. Feed quality is the primary driver of feed intake and animal productivity.

The quality of the feed on offer also informs the type and amount of supplement required.

Feed quality factors of major importance include:
- Metabolisable Energy (ME) (a calculated figure)
- Crude Protein (CP)
- Neutral Detergent Fibre (NDF)
- Acid Detergent Fibre (ADF)
- Minerals and trace elements

### How to determine feed quality

*"Take a feed test"*

Green pasture is of higher quality than dry pasture. However, beyond these extremes, visual estimation of feed quality can be unreliable and inaccurate, particularly when animal performance is important (such as during pre-mating, pre-lambing, and pre-weaning).

Testing pasture, silage, baleage, hay and crops is a cost-effective exercise. Knowledge of what nutrients are available on farm helps determine which feeds are best suited for which stock classes for the desired outcome. For example, which feeds are better to hold condition on pregnant cows in good body condition vs feeds required to optimise lambing performance of high fecundity ewes.

## Key Nutrients Explained

### Dry Matter and Wet Weight

Dry matter (DM) is determined by using an oven to dry the feed sample until all of the moisture has been evaporated. This measure can also be done on farm using the microwave method.

The nutrients an animal needs from the feed are contained in the dry matter (DM) portion of the feed. As such, the nutrient **requirements** of the different stock classes are reported on a DM basis. There is such a wide variability in the moisture content of forages it would be impossible to compare different feeds without using dry matter as a baseline. The higher the water concentration of a pasture or silage, the more the animal must consume to reach the daily dry matter intake requirement. For example, green winter pasture could be 12% DM (88% water) and pasture silage could be 35% DM (65% water). For a ewe to consume 1 kg DM of the two feeds, she would need to consume 8.3 kg of green winter pasture (1 / 0.12) or 2.9 kg of pasture silage (1 / 0.35).

Dry matter is also critically important when it comes to preserving forages (making silage). The moisture content of the feed standing in the paddock provides insight into how well a forage will be preserved when stored as baleage or in a stack. If the forage is too dry or too wet the fermentation of the ensiling process will be affected.

### On Farm Microwave Method to Determine Dry Matter

**Equipment**

- Microwave oven (do not use the one in your kitchen)
- Microwave safe dish
- Kitchen scales with a capacity of at least 500 grams accurate to 1 gram
- Cup of water in a microwave safe container
    - This will prevent the sample from burning when the sample is dry
- DO NOT LEAVE UNATTENDED WHILE MICROWAVING

**Method**

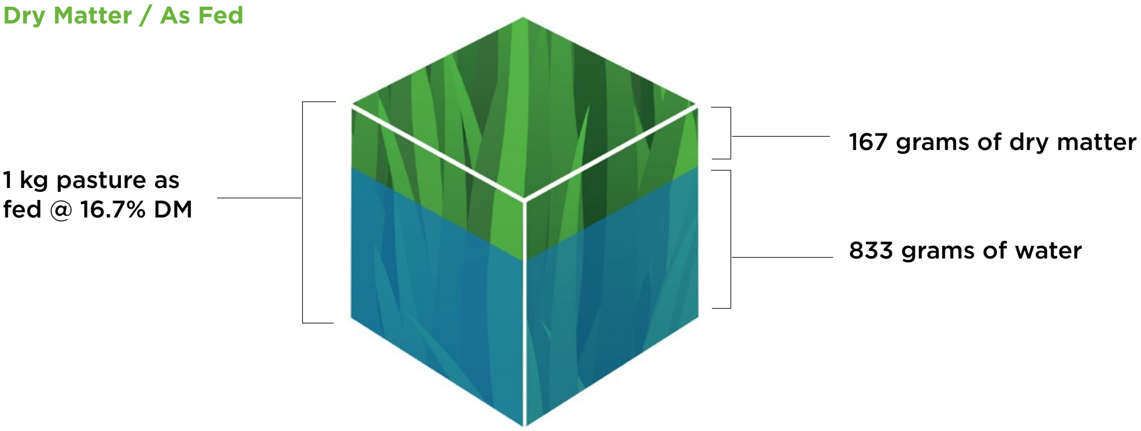
1. Weigh the empty dish and record the weigh
2. Place about 100 grams of chopped forage on the dish and record dish + sample weight.
3. Place in the microwave on high for approximately 4 minutes.
4. After 4 minutes record the dish + sample weight
5. Place back in the microwave on high for another 2 minutes
6. Again record dish + sample weight
7. Repeat Step 5 until the dish + sample weight remains unchanged (+/- 1 gram) – sample is now completely dried
8. Subtract the dish weight from the dish + sample weight

**Pasture Example**

- Empty microwave safe dish = 250 grams
- Fresh weight sample + dish = 370 grams
- Completely dried sample + dish = 270 grams
- % dry matter

| | | |
|---|---|---|
| End weight | 270 – 250 = | 20 grams |
| Start weight | 370 – 250 = | 120 grams |
| | (20 / 120) x 100 = 16.7% DM | |

### Dry Matter / As Fed



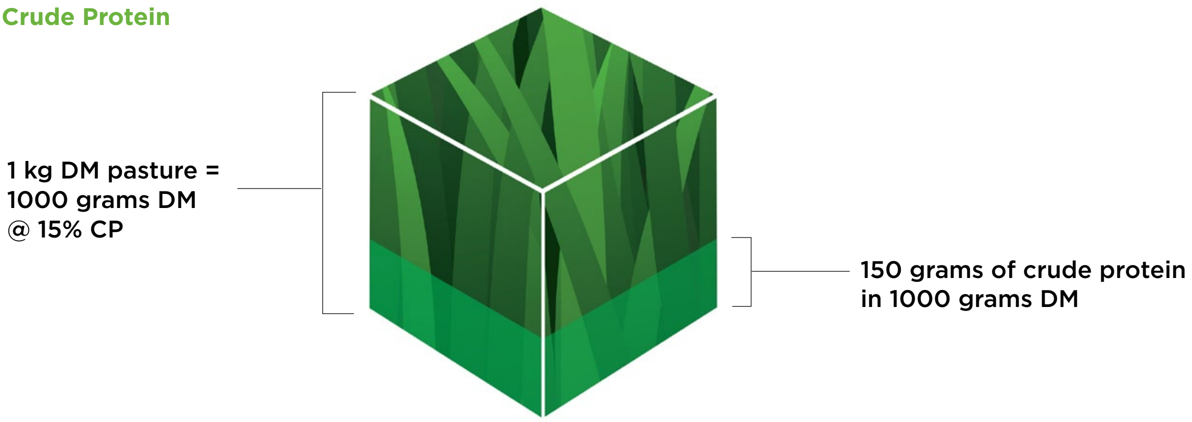
## Crude Protein

Crude Protein (CP) is a measure of the nitrogen content of a feed, including true protein (amino acids) and non-protein nitrogen (e.g. urea). Ruminant animals can utilise both components of protein. The total nitrogen measured at the lab is multiplied by 6.25 to arrive at the crude protein value for the forage.

Protein drives animal performance and is an important nutrient for growth, reproduction, muscle development, immune function, milk and wool production. The non-protein nitrogen fraction is a key nutrient required by the rumen microbiota. Prolonged grazing of low protein pasture or feeding low protein hay or silage can decrease rumen microbial populations reducing efficiency of fibre digestion and the supply of microbial protein to the abomasum (true stomach) for absorption and utilisation by the animal itself. At the other end of the spectrum, too much non-protein nitrogen from lush pastures can also be problematic because energy is required to remove excess nitrogen from the rumen to the blood, and excreted via milk, urine and manure.

When evaluating silages, if excessive heating has occurred in the stack due to poor fermentation, a portion of the crude protein may become "cooked" and unavailable for digestion by the animal. Brown silages with a tobacco or caramel smell may be indicators of such overheating. The crude protein analysis on a feed test gives no indication that excessive heating may have rendered a portion of the protein unavailable to the animal. If heating is known to have occurred other laboratory testing is required to determine the available crude protein.

### Crude Protein




Crude protein is typically reported as a percentage of dry matter. But animals don't eat percentages, they eat grams so converting lab results to grams of protein is an important step to determine if we are meeting the animals' protein requirements.

**Protein Supply Examples**

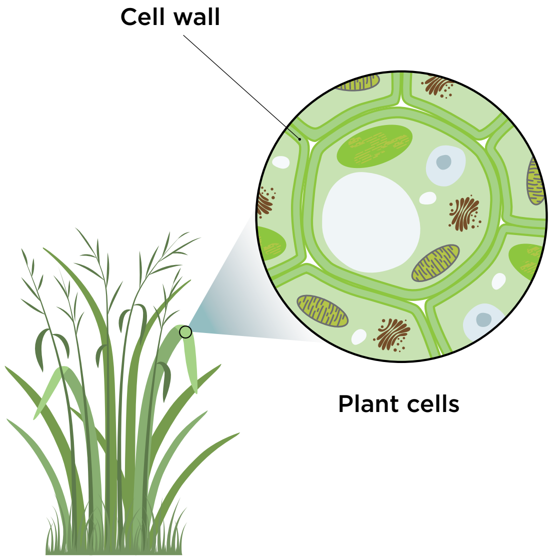
| Scenario | 1 | 2 |
|---|---|---|
| Pasture supply | 16 kg DM Down the Throat (DTT) | 10 kg DM DTT |
| CP<br>tested at the lab | 15%<br>150 grams of protein per<br>1 kg DM of pasture | 22%<br>220 grams of protein per<br>1 kg DM of pasture |
| Total Pasture Intake | 16 kg DM DTT x 150 grams/kg DM<br>2400 grams of protein | 10 kg DM DTT x 220 g / kg DM<br>2200 grams of protein |
| CAUTION: Just because the CP test in scenario 2 reported a higher % of CP, does not mean that the animals are consuming more protein. We need to understand both the quantity of feed AND the quality of feed to determine the nutrient intake / nutrient supply. | | |

### Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF) and Lignin

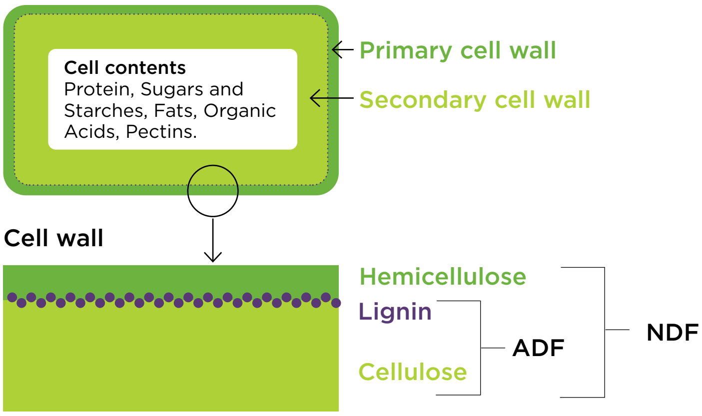
To understand forage quality, we can gain a better understanding of the plant cell structure as described by Van Soest.

In the middle of the cell are the contents: proteins, sugars, starches, organic acids, and pectin. All of these nutrients are protected by the plant cell wall. Forages contain significant portions of plant cell wall material. The amount and type of cell wall is important because it influences how a forage is utilised by the animal.

A young plant cell has a single outer layer referred to as the primary cell wall. As the plant matures, a second layer is laid down on the inside of the cell. This is called the secondary cell wall. As the plant continues to mature towards the reproductive phase an additional layer of non-carbohydrate material known as lignin, acting like mortar between the primary and secondary cell walls, is laid down to provide tensile strength and rigidity within the plant to support the reproductive phase and hold up the seed head.



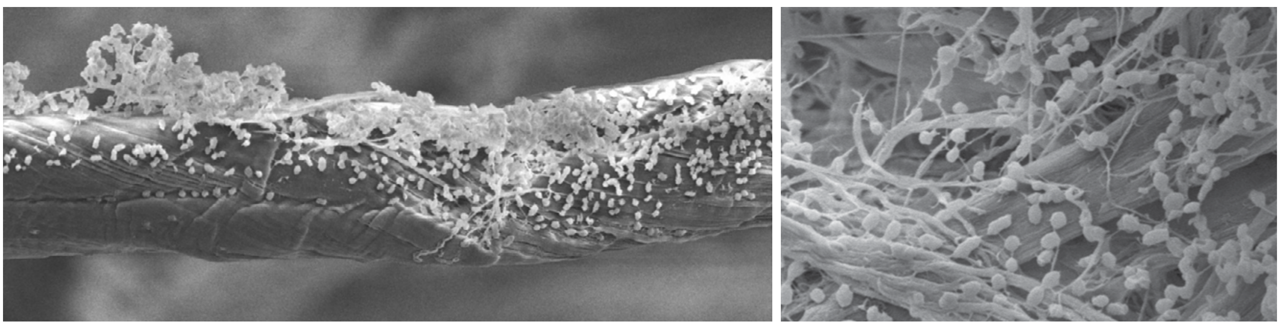

### Cell Structure and Fibre Fractions




*As ADF increases energy density decreases.*

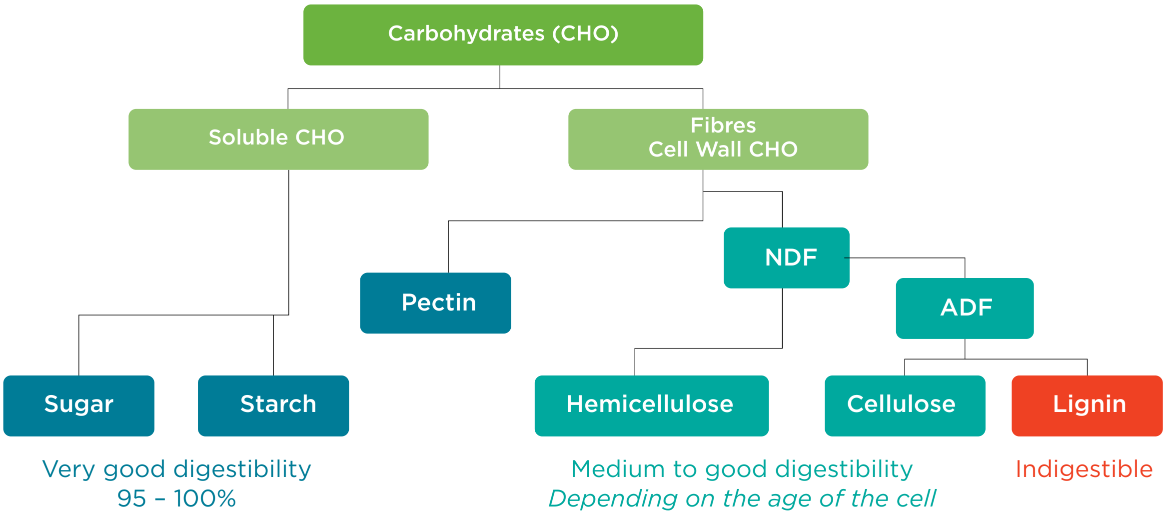
*As NDF increases Dry Matter Intake (DMI) decreases.*

Ruminant animals such as beef and sheep have microflora (bacteria, protozoa and fungi) within the rumen that can partially digest the hemicellulose of the primary cell wall and the cellulose within the secondary cell wall. Microbial breakdown of the fibre fractions provides energy to the host animal. Lignin is not digestible, and its presence will inhibit the digestibility of the hemicellulose and cellulose within the cell walls. When feeding ruminants, it is important to have enough fibre to stimulate cud chewing and salivation (minimum 30% NDF), but not too much fibre to limit dry matter intake.



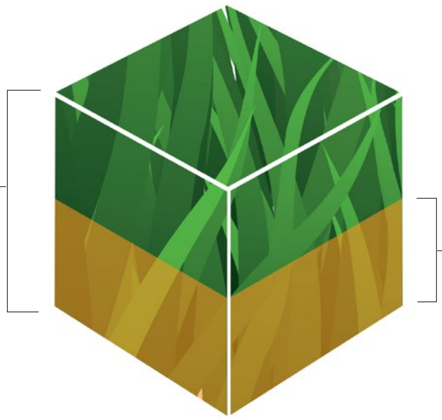
Rumen microbes colonising forage for degradation of fibre to release volatile fatty acids for the animal.
Image credit: Lydia-Marie Joubert

## Detergent of Van Soest Method of Cell Wall Determination




As a rule of thumb, ruminants are able to consume a maximum of 1.2 – 1.5% of their body weight as NDF. For example, a 450 kg steer has the potential to consume a maximum of 6.75 kg as NDF; a 40 kg hogget has the potential to consume a maximum of 0.60 kg as NDF.

## Neutral Detergent Fibre




Max DMI based on NDF intake for cattle

450 kg steer * 1.5% = 6.75 kg as NDF

If the pasture is 38% NDF, there are 0.380 kg of NDF in every kg of DM. So a 450 kg steer could eat (6.75 / 0.38) 17.8 kg of that pasture.

Max DMI based on NDF intake for ewes

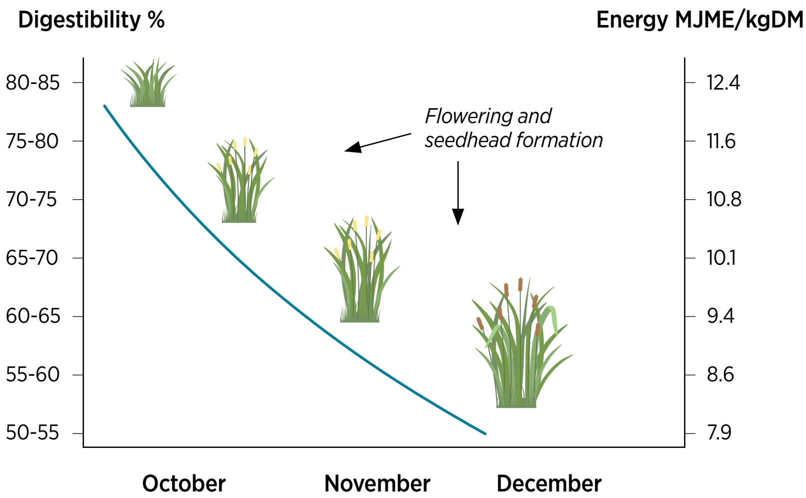
40 kg hogget * 1.5% = 0.60 kg as NDF

If the pasture is 38% NDF, there are 0.380 kg of NDF in every kg of DM. So a 40 kg hogget could eat (0.60 / 0.38) 1.58 kg of that pasture.

| Feed | NDF | Potential intake for a 450 kg steer | Potential intake for a 40 kg hogget |
|---|---|---|---|
| **Potential Intake** | → | 6.75 kg as NDF | 0.60 kg as NDF |
| **High quality pasture** | 38% | 6.75 / .38<br>17.8 kg DM DTT | 0.60 / 0.38<br>1.58 kg DM DTT |
| **Poor quality pasture** | 45% | 6.75 / .45<br>15.0 kg DM DTT | 0.60 / 0.45<br>1.33 kg DM DTT |
| **Good quality silage** | 48% | 14.1 kg DM DTT | 1.25 kg DM DTT |
| **Poor quality silage** | 55% | 12.3 kg DM DTT | 1.10 kg DM DTT |
| **Good quality Hay** | 54% | 12.5 kg DM DTT | 1.11 kg DM DTT |
| **Cereal Straw** | 80% | 8.4 kg DM DTT | 0.75 kg DM DTT |

## Digestibility

Reported as Digestibility of Organic Matter in Dry Matter (DOMD). This is a calculated value which states the percentage of the feed swallowed (into the digestive tract) that is digested and absorbed into the body. Digestibility is a function of the fibre fractions within the forage and is negatively correlated with plant maturity. As maturity and pasture cover increases, digestibility decreases. For example, immature leafy lucerne may be 80 – 90% digestible, while stalky, over mature Lucerne may be as low as 60%.




The relationship between plant maturity, digestibility and energy density.

## Metabolisable Energy (ME)

Metabolisable Energy is the amount of energy produced from the digestion of feed and available for productive purposes after accounting for energy lost in faecal material (proportion of feed not digested), energy lost in urine and as methane (gas) loss from fermentation in the rumen.

Metabolisable energy supply is expressed in total megajoules per kg of DM of feed (MJ ME/kg DM). Metabolisable energy demand is is expressed in total megaloules per head per day (MJ ME/head/day).

It is important to note that ME / kg DM reported by the feed testing laboratories is a calculation based on the proximate analysis of the feed and the digestibility. The actual energy metabolised by the animal will be influenced by stock class, the type of feeds being fed and the passage rate of feeds through the animal.

## Macro-Minerals & Trace Elements

Mineral deficiencies are often the first place farmers look when stock productivity is lower than expected. However, in the vast majority of cases, it is an imbalance between the nutrient supply vs the nutrient requirement for dry matter, protein and/or energy in the ration that is the problem. That is not to discount the importance of mineral deficiencies where and when they do occur.

Macro minerals are defined as minerals supplied to the animals in macro amounts, i.e. grams per head per day. The most important macro-minerals in ruminant diets are calcium, phosphorus, magnesium and sodium.

- Calcium deficit can negatively influence milk production in cows and ewes
- Phosphorous deficit can negatively influence energy balance and if very severe can influence reproductive performance and bone strength
- Magnesium deficit can lead to grass tetany
- Sodium deficit can be related to reduced appetite, reduced water intake, and ill-thrift

Trace elements or micro-minerals are defined as minerals supplied to the animals in micro amounts, i.e. milligrams per head per day. Essential trace elements likely to be deficient in New Zealand pastures include copper, cobalt, iodine, selenium and zinc.

*Pasture testing is strongly recommended to determine the supply of nutrients from the paddock up.*

Visual assessment can provide information about the relationship between different plant components, i.e. ratio of leaf to stem to dead material. But a visual assessment will not give us detail about the nutrient supply of a feed.

# Step 3 – Calculate nutrient supply

**To determine the nutrient supply, we multiply the amount of feed (kg DM) going down the throat by the nutrient parameters provided by the feed test results.**

In the beef example from Step 1, we calculated that the mob of 300 Rising 2 year old cattle weighing 450 kg in Paddock 146 (3 ha) were getting 10.2 kg DM/head/ DTT. The feed test for Paddock 146 has come back as follows:

**R2 Cattle Paddock**
Sample Name: Paddock 146[1]
Sample Type: Mixed Pasture

| Analysis (Step 2) | | Level Found |
|---|---|---|
| Dry Matter | % | 16.8 |
| Crude Protein | %DM | 25.7 |
| Acid Detergent Fibre | %DM | 20.3 |
| Neutral Detergent Fibre | %DM | 35.5 |
| Lignin | %DM | 6.3 |
| Ash | %DM | 10.5 |
| Organic Matter | %DM | 89.5 |
| Soluble Sugars | %DM | 20.0 |
| Starch | %DM | <0.5 |
| Crude Fat | %DM | 4.2 |
| Digestiblity of Organic Matter in Dry Matter (DOMD) | % | 78.8 |
| Metabolisable Energy | MJ/kgDM | 12.6 |

With the pasture quantity information and the feed test analysis it is now possible to determine CP, NDF and ME supply.

| Step 3 | DMI DTT (kg) | Lab Test Result | Calculation | Nutrient Supply |
|---|---|---|---|---|
| Crude Protein | 10.2 | 25.7%<br>or 0.257 kg CP/kg DM | 10.2 kg DMI x 0.257 kg CP | 2.62 kg CP |
| Neutral Detergent Fibre | 10.2 | 35.5%<br>or 0.355 kg NDF/kg DM | 10.2 kg DMI x 0.355 kg NDF | 3.62 kg NDF |
| Metabolisable Energy | 10.2 | 12.6 MJ/kg DM | 10.2 kg DMI x 12.6 MJ | 129 MJ ME |

[1] *Example of an actual pasture test as analysed by Hill Laboratories Ltd.*

In the sheep example from Step 1, we calculated that the mob of 800 head of 40 kg hoggets in Paddock 13 (3 ha) were getting 1.90 kg DM/head/ DTT. The feed test for Paddock 13 has come back as follows:

### Hogget Paddock

Sample Name: Paddock 13[2]
Sample Type: Mixed Pasture, Dry Stock

| Analysis (Step 2) | | Level Found |
|---|---|---|
| Dry Matter | % | |
| Crude Protein | %DM | 27.9 |
| Acid Detergent Fibre | %DM | 22.7 |
| Neutral Detergent Fibre | %DM | 43.5 |
| Lignin | %DM | 5.9 |
| Ash | %DM | 11.4 |
| Organic Matter | %DM | 88.6 |
| Soluble Sugars | %DM | 9.7 |
| Starch | %DM | < 0.5 |
| Crude Fat | %DM | 3.9 |
| Digestiblity of Organic Matter in Dry Matter (DOMD) | % | 69.5 |
| Metabolisable Energy | MJ/kgDM | 11.1 |

With the pasture quantity information and the feed test analysis it is now possible to determine CP, NDF and ME supply.

| Step 3 | DMI DTT (kg) | Lab Test Result | Calculation | Nutrient Supply |
|---|---|---|---|---|
| Crude Protein | 1.9 | 27.9%<br>or 0.279 kg CP/kg DM | 1.9 kg DM x 0.279 kg CP | 0.530 kg CP |
| Neutral Detergent Fibre | 1.9 | 43.5%<br>or 0.435 kg NDF/kg DM | 1.9 kg DM x 0.435 kg NDF | 0.827 kg NDF |
| Metabolisable Energy | 1.9 | 11.1 MJ/kg DM | 1.9 kg DM x 11.1 MJ/kgDM | 21.09 MJ |

[2] *Example of an actual pasture test as analysed by Hill Laboratories Ltd.*

# Step 4 - Nutrient demand
## Describe stock to determine nutrient requirements

### Dry Matter Intake - How much can stock eat?

Dry matter intake is a factor of body weight, physiological stage, level of productivity (i.e. average daily gain), and forage quality.

#### Theoretical Guidelines

**Theoretically stock can consume 4% of their live weight as dry matter**
For example, a 450 kg Rising 2 Heifer can consume 18 kg DM

- **Does she need to eat 18 kg DM?**
  The answer depends on the target level of performance.
- IF the target is 2 kg average daily gain as a finishing animal – **YES**.
- IF the target is to maintain body condition in the months leading up to her first calving – **NO**.
  This animal may only need 10 kg to meet maintenance requirements.

**Theoretically stock can consume 1.2 – 1.5% of their live weight as NDF**
For example, a 450 kg R2 heifer could consume 6.75 kg as NDF

- IF she is consuming highly digestible pasture, at 35.5% NDF she could theoretically consume 19 kg
- IF she is consuming stalky summer dry pasture at 45% NDF she would likely be limited to 15 kg of intake
- IF she is consuming poor quality silage at 55% NDF DMI would likely be limited to 12 kg of intake

### The importance of forage quality

The higher the digestibility of feed, the less an animal needs to eat to meet daily protein and energy requirements. Therefore, it follows that the higher the expected stock class performance, the greater the importance of high-quality forage availability. For example, feeding lambs to achieve 300 grams average daily gain will require more highly digestible forages (i.e. Lucerne), than mature bulls on a maintenance diet (i.e. standing hay). Another example are high fecundity ewes in the last trimester of pregnancy. The smaller the ewe (60 kg hogget vs 80 kg mixed age ewe) the less she is able to eat to meet her daily nutrient requirements, so pasture quality is particularly important. This may be compounded for cows and particularly ewes in late pregnancy when there is a degree of ruminal compression due to the space taken up by the pregnant uterus. This limits the capacity of the ewe or cow to increase intake to meet an increasing nutrient demand. And due to the complexities of parturition, dry matter intake may actually go down in the days leading up to calving or lambing.

### Dry Matter Intake and Energy Requirements

The Beef + Lamb New Zealand FeedSmart calculator calculates the energy and dry matter intake requirements for sheep and beef cattle. The calculator is excellent because it is interactive, and as such can predict DMI and ME requirements based on a variety of factors. **www.feedsmart.co.nz**

### Protein, and Mineral Requirements

As with DMI, protein, energy and mineral requirements change based on stock class, body weight, physiological state (i.e. stage of pregnancy and/or lactation) and expected productivity level (i.e. milk production, body condition gain and/or growth - average daily gain). The most complete compendium of nutrient requirements cay be found in resources published by The National Academies Press:

- Nutrient Requirements of Small Ruminants (NRC, 2007)
- Nutrient Requirements of Beef Cattle, Eighth Revised Edition (NRC, 2016)
- Nutrient Requirements of Dairy Cattle, Eighth Revised Edition (NASEM, 2021)

The following tables outline the nutrient requirements of a selection of representative stock classes. Protein and mineral requirements are typically reported on a percentage of dry matter intake basis. The following tables, used in association with the DMI requirement predictions from the FeedSmart tool can add an additional layer of nutritional understanding.

Nutrient Requirements[3] of a selection of representative beef classes.

| BEEF | Productivity | % CP (min)* | %Ca | %P | %Mg |
|---|---|---|---|---|---|
| **Growing Heifers[4]** | | | | | |
| | 6 – 12 mo | 20 to 18 | 0.41 | 0.28 | 0.11 |
| | 18 mo | 18 to 14 | 0.37 | 0.23 | 0.11 |
| | > 18 mo | 14 to 11 | 0.37 | 0.18 | 0.11 |
| **Growing and finishing heifers and steers[5]** | | | | | |
| 300 kg | 1 kg ADG | 11 – 13 | 0.42 | 0.27 | 0.10 |
| 400 kg | 1 kg ADG | 10 – 12 | 0.34 | 0.22 | 0.10 |
| 500 kg | 1 kg ADG | 10 - 12 | 0.28 | 0.18 | 0.10 |
| **Gestating beef cows** | | | | | |
| | 11 | 0.25 – 0.29 | 0.15 - 0.18 | 0.12 – 0.13 | |
| **Lactating beef cows** | | | | | |
| | 13.5 - 16 | 0.26 – 0.31 | 0.18 – 0.20 | 0.17 – 0.20 | |

*NOTE that when CP in the whole ration exceeds 22%, Nitrogen utilisation within the animal becomes inefficient and the animal must spend energy to eliminate excessive levels of N via milk, manure and urine.

It is recommended that salt be offered free choice to all growing and lactating stock. Salt should be removed from the stock in the 21 days leading up to calving.

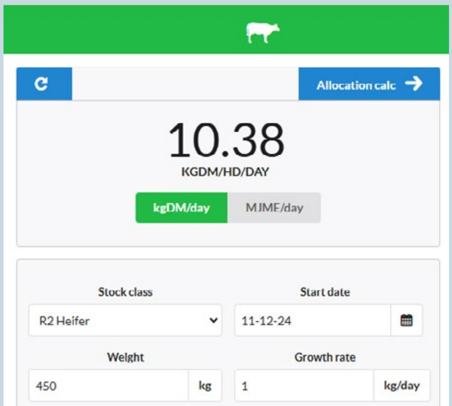
**Example – mob of 300 Rising 2 year old cattle weighing 450kg in Paddock 146 (3 ha) gaining 1 kg ADG:**

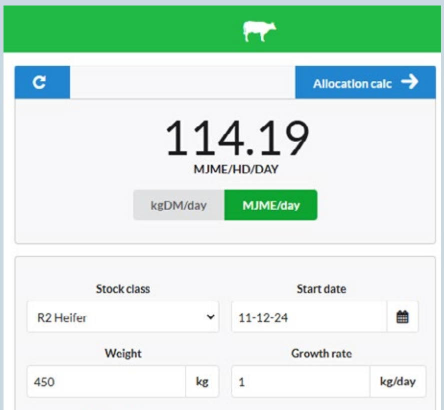
**Step 1** Pasture Supply 10.2 kg DM DTT

**Step 2** Nutrient Supply Paddock 146
25.7% CP
35.5% NDF
12.6 MJ ME/kg DM

**Step 3** Calculate Nutrient Supply
10.2 kg DM DTT
2.62 kg of CP
3.62 grams of NDF
129 MJ ME/day

**Step 4** Determine Nutrient Requirements
450 kg gaining 1 kg ADG
FeedSmart predicts 10.38 kg DM and 114.19 MJ ME /day
(assuming forage quality is 11 MJ ME/kg DM)
NDF max = 1.5% of BW
450 kg x 0.015 = 6.75 kg as NDF
CP requirement
Minimum 10.38 kg DM x 10 – 12% = 1.038 – 1.246 kg of CP
Maximum 10.38 kg DM x 22% = 2.284 kg of CP




[3] *NRC, 2016 Beef Cattle; NASEM, 2021 Dairy Cattle*
[4] *Note that as the heifers grow, the crude protein requirement decreases as their DMI increases.*
[5] *Assuming mature live weight of 500 kg*

Nutrient Requirements[6] of a selection of representative sheep classes.

| SHEEP (Early Maturing) | Productivity | % CP (min)* | %Ca | %P | %Mg |
|---|---|---|---|---|---|
| **20 kg lamb** | 200 g ADG | 12 - 13 | 0.40 | 0.33 | 0.12 |
| **40 kg lamb** | 250 g ADG | 9 - 10 | 0.31 | 0.25 | 0.12 |
| **70 kg mature ewe maintenance** | | | | | |
| | 0 g ADG | 7 – 8 | 0.20 | 0.17 | 0.11 |
| **70 kg ewe - late gestation** | | | | | |
| | Single | 8 – 9 | 0.34 | 0.24 | 0.15 |
| | Twin | 9.5 – 10.4 | 0.48 | 0.29 | 0.15 |
| | Multiple | 9.7 – 10.7 | 0.52 | 0.31 | 0.15 |
| **70 kg ewe - early lactation** | | | | | |
| | Single | 10.6 - 12 | 0.30 | 0.28 | 0.20 |
| | Twin | 14 - 16 | 0.40 | 0.34 | 0.20 |
| | Multiple | 15 - 16 | 0.42 | 0.37 | 0.20 |

*NOTE that when CP in the whole ration exceeds 22%, Nitrogen utilisation within the animal becomes inefficient and the animal must spend energy to eliminate excessive levels of N via milk, manure and urine.

It is recommended that salt be offered free choice to all growing and lactating stock. Salt should be removed from the stock in the 21 days leading up to lambing.

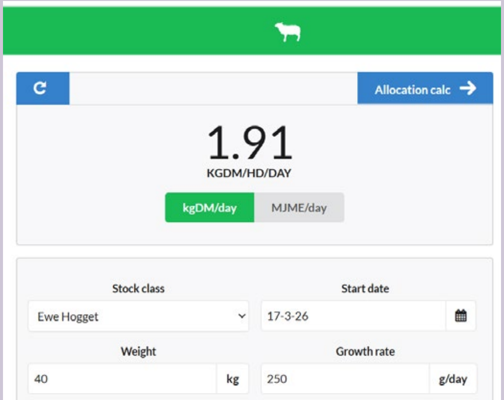
**Example – Hoggets weighing 40 kg to gain 250 g ADG:**

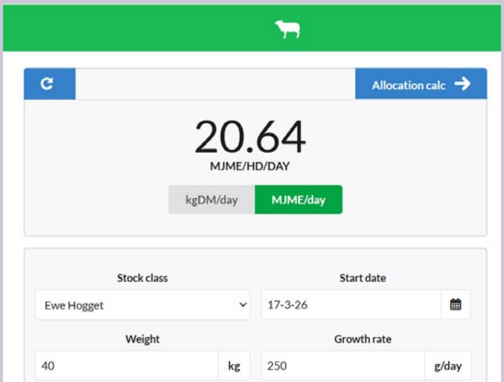
**Step 1** Pasture Supply 1.9 kg DM DTT

**Step 2** Nutrient Supply Paddock 13
27.9% CP
43.5% NDF
11.1 MJ ME/kg DM

**Step 3** Calculate Nutrient Supply
1.9 kg DM DTT
0.530 kg CP
0.827 kg NDF
21.1 MJ ME/day

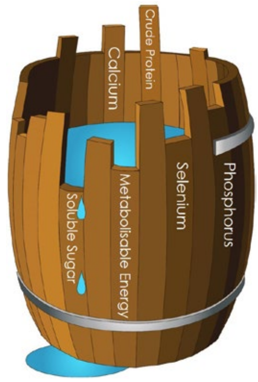
**Step 4** Determine Nutrient Requirements
40 kg hogget gaining 250 g ADG
FeedSmart predicts 1.9 kg DM and 20.64 MJ ME /day
(assuming forage quality is 11 MJ ME/kg DM)
CP requirement
Minimum 1.9 kg DM x 9 – 10% = 0.171 – 0.190 kg of CP
Maximum 1.9 kg DM x 22% = 0.418 kg of CP
NDF max = 1.5% of BW
40 kg x 0.015 = 0.6 kg as NDF




[6] *Adapted from NRC, 2007 Small Ruminants*

# Step 5 - Pasture up
## Determine limiting nutrients




How does the nutrient supply compare to the nutrient demand of the stock class?

Leibig's Law of the Minimum states, *"if one essential nutrient is deficient, performance will be poor even when all other essential nutrients are abundant."*

To optimise stock health and productivity we must first identify which nutrient is limiting. Using the barrel analogy, each stave in the barrel represents the nutrients provided by the pasture. The top of the barrel represents the production potential; in the working example 1 kg ADG for a 450 kg Rising 2 year-old heifer.

### Beef example

| Nutrient → | DMI | ME | CP | NDF |
|---|---|---|---|---|
| **Pasture Supply**<br>Steps 1, 2, 3 | 10.20 kg | 129 MJ | 2.621kg | 3.601 kg |
| **Nutrient Demand**<br>Step 4 | 10.38 kg | 114 MJ | Min 1.038 kg<br>Max 2.284 kg | Max<br>6.750 kg |
| **Balance**<br>Step 5 | 10.2 - 10.38 =<br>- 0.18 kg | 129 – 114 =<br>15 MJ | 2.621 – 2.284 =<br>0.337 kg | 3.601 – 6.750 =<br>- 3.149 kg |
| | Slight deficit | Excess | Excess | Well below the threshold to limit DMI |

The nutrient analysis says that the heifers are getting more energy and protein than required and that NDF is not limiting DMI. Theoretically this mob would be gaining 1 kg ADG.

### Sheep example

| Nutrient → | DMI | ME | CP | NDF |
|---|---|---|---|---|
| **Pasture Supply**<br>Steps 1, 2, 3 | 1.90 kg | 21.1 MJ | 0.530 kg | 0.827 kg |
| **Nutrient Demand**<br>Step 4 | 1.90 kg | 20.64 MJ | Min 0.171 kg<br>Max 0.418 kg | 0.600 kg |
| **Balance**<br>Step 5 | 1.9 – 1.9 = 0 | 0.46 MJ | 0.530 – 0.418 =<br>0.112 kg | 0.827 – 0.600<br>0.227 kg |
| | On target | On target | Excess<br>Are the hoggets daggy? | Excess<br>**RISK!!!** |

At first glance the sheep ration looks good: DMI and ME intake is on target. BUT is it? Based on the NDF levels of the tested pasture, theoretically the maximum pasture intake based on fibre is 1.40 kg.

If the hoggets are able to eat 1.4 kg DMI, energy intake would be 15.5 MJ – not enough to gain the target 250 g ADG. What are the actual growth rates?

# Step 6 - Believe nothing!

Does the nutrient analysis make sense?

Feed testing and nutrient analysis is only as good as the paper on which it is printed. How do the results compare or contrast with the observation of the stock in the paddock? This is where stock handling and observation skills become critical.

**Paddock Observations include but are not limited to:**

**Are the stock equally dispersed around the paddock?**

**Are the stock quiet? Alert? Active?**

**Can all of the stock eat at the same time?**

**How is water intake?**
- Check urine
- Are eyes bright and alert or sunken?

**How well have the stock eaten in the past month?**
- Check body condition score

**How well have the stock eaten in the past week to 10 days?**
- Check gut capacity

**How well have the stock eaten in the past 24 hours?**
- Check rumen fill

**How is rumen health?**
- How many animals at rest are chewing their cud?
- How many chews of the bolus before swallowing?

**Manure?**
- Consistency
- Observation of undigested fibre or grain?
- Evidence of parasites

**Coat / Wool Condition**
- Poll smooth or scruffy
- Coat/wool colour
- Bloom

**Feed / Legs / Locomotion**
- Any arched backs or limping stock

**Tail position and cleanliness of the pelvic region**
- Dags
- “Runny bum”

**Is there anything that catches the eye about the stock appearance or attitude?**

**Using the Rising 2s example we need to observe the stock and consider:**
- Calculations show there is more energy and protein than required to gain 1 kg ADG – theoretically we might predict that the stock are gaining faster than the prediction. What is the ACTUAL ADG?
- What are the potential explanations for any variance observed between the calculations and the actual?

**Using the Hoggets example we need to observe the stock and consider:**
- Calculations show there is more fibre than they can consume.
- How is utilisation of the pasture? Are the hoggets cleaning up, or is there pasture being wasted?
- Based on NDF defined by NDF limitations, energy required to gain 250 g ADG is limiting. What is the ACTUAL ADG?
- What are the potential explanations for any variance observed between the calculations and the actual?

# Step 7 - Fill the gap

Only after the limiting nutrient(s) have been identified and validated can we consider how to fill the gap. Feed supplements are best used to compliment the farm grown pasture and/or crop.

The more information we have about the nutrients available on farm, the better supplementary feeding decisions we can make to fill the gap.

## Conclusion

Nutrient supply cannot be assessed by eye. Testing and quantifying the supply of nutrients such as protein, energy and NDF components and comparing that to the nutrient requirements for the desired level of productivity allows us to make informed decisions about the forages grown on farm and how to determine if and when complementary supplementation is required.

**What nutrients can we grow?**

**What nutrients can we source?**

**How can we feed it out?**

*Filling the right gap at the right time, with the right nutrient will always be profitable, and environmentally sustainable!*

**APPENDIX** - 300 kg Rising 2-year old heifer to gain 1 kg ADG.

| Feed | Kg DM Offered | % Utilisation | Kg DM DTT | MJ ME /kg DM | MJ ME intake | % CP | Kg CP Intake | % NDF | Kg NDF Intake | % Ca | Grams Ca Intake | % P | Grams P Intake |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SUPPLY**<br>Steps 1, 2, 3 | | | | | | | | | | | | | |
| *Pasture* | *8* | *85%* | *8 * 0.85*<br>*6.8* | *11* | *6.8 * 11*<br>*74.8* | *26* | *6.8 * 0.26*<br>*1.77* | *42* | *6.8 *0.42*<br>*2.9* | *0.5%* | *6.8 **<br>*0.005*<br>*34 g* | *0.20%* | *6.8 x 0.002*<br>*13.6 g* |
| **DEMAND**<br>Step 4 | | | | | | | | | | | | | |
| | | | *8* | | *88.8** | *min*<br>*14 –*<br>*18%*** | *8 kg x 0.14 =*<br>*1.12*<br>*8 kg x 0.18 =*<br>*1.44* | | *NDF Max*<br>*300 kg x*<br>*0.015 =*<br>*4.5 kg* | | *8 x 0.0037*<br>*29.6 g* | | *8 x 0.0023*<br>*18 g* |
| | | | | | | *Max*<br>*> 22%* | *8 kg x 0.22 =*<br>*1.76* | | | | | | |
| **BALANCE**<br>Step 5 | | | | | | | | | | | | | |
| | | | *6.8 - 8*<br>*= - 1.2*<br>*kg* | | *74.8 – 88.8*<br>*= - 14 MJ* | | *1.77 – 1.76*<br>*= 0.01 kg* | | *2.9 < 4.5*<br>*NDF max* | | *34 – 29.6*<br>*= 4.4 g* | | *13.6 – 18*<br>*= - 4.4 g* |
| **COMMENT**<br>Step 6, 7 | | | | | | | | | | | | | |
| | | | *DMI is limiting* | | *Energy is limiting ADG – check actual ADG.* | | *Protein is not limiting and may be in excess – check manure scores.* | | *NDF is not limiting intake – check cud chewing.* | | *Ca is not limiting* | | *P is limiting* |

* From FeedSmart Calculator
** From NRC table above

**Template** - On farm scenario

| Feed | Kg DM Offered | % Utilisation | Kg DM DTT | MJ ME /kg DM | MJ ME intake | % CP | Kg CP Intake | % NDF | Kg NDF Intake | % Ca | Grams Ca Intake | % P | Grams P Intake |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SUPPLY** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| **DEMAND** | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | |
| **BALANCE** | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
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| **COMMENT** | | | | | | | | | | | | | |
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beef+lamb
new zealand