

# Getting the balance right – managing protein and energy ratios in feed for reduced livestock emissions

Tas Farming Futures  
Case Study 2015

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## At a glance

### Owner & location

Andrew & Kate Beven  
Cranston, Campania TAS

### Property size

200 ha

### Enterprises

Mixed farming : 650 head  
prime lamb operation and a  
90 ha cropping program  
including poppies, cereals,  
lucerne and fodder crops

### Average annual rainfall

500 mm

## On farm greenhouse gas emissions at Cranston

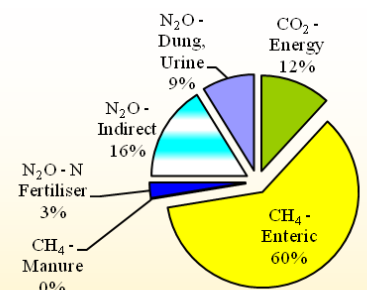
In Tasmania it is common for lush pasture and fodder crops in autumn, winter and spring to have very high protein levels, often exceeding livestock requirements. This can result in an imbalance in the protein and energy provided in the livestock diets when grazing in these situations and may effect livestock performance.

Campania farmer Andrew Beven has used feed testing as a tool to measure the nutritional balance of pasture and fodder crops grown on his Coal River Valley property to improve grazing nutrition for his sheep. By identifying risk periods where the crude protein levels in the feedbase are very high, Andrew can tailor strategies that will increase livestock performance and help to combat greenhouse gas (GHG) emissions from his livestock operations.

Andrew has been participating in the Tas Farming Futures (TFF) project to understand the sources of GHG emissions from his property and ways that they can be reduced. Andrew worked with a project extension officer to estimate the baseline GHG emissions derived from his livestock and cropping operations for his property in the spring of 2014.

*"I am interested to see what impact I can make on GHG emissions", Andrew Beven, Cranston.*

Figure 1 shows emissions sources at Cranston. Total property GHG emissions were 278 t CO<sub>2</sub>e/year<sup>1</sup> or 1.39 t CO<sub>2</sub>e/year/hectare. These were calculated using the Australian Sheep Greenhouse Accounting Framework (S-GAF) calculator available from the University of Melbourne website. The majority of Cranston's emissions are from the livestock enterprise. Enteric methane, which is largely released through livestock burping, accounts for 60% of total farm emissions.



**Figure 1: Estimated GHG emissions from prime lamb and cropping operations at Cranston were 278 t CO<sub>2</sub>e/year.**

**A majority of emissions are from the livestock enterprise**

<sup>1</sup> CO<sub>2</sub>e (Carbon dioxide equivalent) - a measure of global warming potential of greenhouse gases such as nitrous oxide compared to carbon dioxide (CO<sub>2</sub>). E.g., nitrous oxide has a global warming potential of 298, which means that 1tonne of nitrous oxide (t N<sub>2</sub>O) in the air has the same global warming impact as 298 tonnes of carbon dioxide (t CO<sub>2</sub>) over a 100-year time frame.

# Sources of GHG emissions from Livestock

## Methane (CH<sub>4</sub>)

Methane is a gas that has a global warming potential of 21 times that of carbon dioxide and is the major form of GHG emissions from livestock production.

Ruminants emit methane gas as a byproduct of their digestive process. It is produced by the bacteria that live in the rumen (first stomach) as they break down carbohydrates into hydrogen, carbon and oxygen. The hydrogen is either used directly as energy, combines with nitrogen in protein to form ammonia which is then excreted or combines with carbon to form methane which is belched by the animal.

Methane is energy rich and when belched it is a loss to the system. This energy, which could otherwise be used for producing meat, wool, milk or producing offspring, is wasted. There are management options that livestock producers can implement to reduce methane losses from stock which will result in better livestock performance and productivity as well as having a positive impact in reducing GHG emissions. These include improvements to feed efficiency, animal nutrition and the type of fodder on which animals graze, these points are discussed in the 'Managing methane emissions' section.

As methane accounts for 60% of the total emissions at Cranston, reducing these emissions could present a significant opportunity to improve production efficiency.

## Nitrous Oxide (N<sub>2</sub>O)

Nitrous oxide is a very powerful greenhouse gas with a global warming potential of 298 times that of carbon dioxide making controlling nitrous oxide emissions important.

Soil nitrogen (e.g. nitrogen from urine, manure, legumes, bacteria or fertiliser) can be emitted as nitrous oxide from the soil when the soil is warm and waterlogged in a process of denitrification. Whilst water logging is not a significant issue at Cranston, careful management of irrigation during warmer months to avoid over watering and potential water logging will reduce possible nitrous oxide emissions from this source. Andrew has taken remedial actions in low lying areas through mole draining on heavy soils, which also helps to mitigate the risks posed by waterlogging.

Very high protein diets in livestock can increase the amount of nitrogen in urine and manure and therefore influence the 'indirect' emissions of nitrous oxide from livestock operations.

Nitrous oxide accounts for 28% of the total emissions at Cranston. This includes both the direct and indirect (via volatilization, leaching, runoff) emissions from dung, urine, and fertiliser.



## Carbon dioxide (CO<sub>2</sub>)

Carbon dioxide is the most abundant GHG. Animals breathe out carbon dioxide as part of aerobic respiration, although the amount is much less significant than their methane and nitrous oxide emissions.

Carbon dioxide accounts for 12% of the total emissions at Cranston, the majority of which are associated with diesel and electricity usage.





## Investigating feed efficiency at Cranston

Given that livestock is the major source of GHG emissions at Cranston, it makes sense that this source of emissions should be the focus for any emissions reduction activities on the property. Improving feed efficiency, managing animal nutrition and resultant impacts on the nitrogen concentration in urine and manure provides a good first step for emissions reduction on extensive livestock properties.

The sheep flock at Cranston is run on a pasture, lucerne and fodder crop grazing system. Lucerne and fodder crops are a major component of the feedbase at Cranston. This provides high quality feed in a dry climate (500mm rainfall) and irrigation can be used to water during dry periods.

*“We have always hung our hats on getting an autumn break. We get our crops in early in summer to get the crops out of the ground. The climate has changed and we can’t rely that we will get a break now.”*

Managing the feedbase through autumn and into winter is crucial at

Cranston to provide adequate nutrition for the ewe flock that lamb in early spring.

*“We need to have feed available at the right time and make sure we have a feed bank going into winter that is right to get us through the 8 week period of no [pasture] growth.”*

*“We got caught out last year as we carried lambs until April and therefore had little feed going into winter.”*

Andrew was keen to look at options for improving the feedbase and grazing management at Cranston. He saw an opportunity to measure the nutritional balance across the range of fodders grazed as a way of identifying where improvements could be made for the benefit of livestock productivity and reduced GHG emissions. In conjunction with his Serve-Ag Agronomist and the Tas Farming Futures project, he undertook some feed tests of different crops and pastures at the point of grazing during the spring and autumn of 2014-15.

Using FeedTest Near Infrared (NIR) Technology fodder / feed analysis, Andrew was able to determine the nutritional value of his grazed pasture and fodder crops. The baseline results are shown in Table 1.

The feed testing results at Cranston showed high to very high crude protein levels that were in excess of animal requirements for all classes of stock (see Table 3 for a list of protein and energy requirements for different classes of stock), in the feed tests taken in spring and autumn, ranging from 24.7 % to 33.7% crude protein.

Energy levels in the feeds were good ranging from 11.9 to 13 MJ/kg DM.

The feed test results suggest that the spring feeds at Cranston were very ‘rich’ and that protein and energy ratios were out of balance in relation to the animal requirements, (protein and energy ratios and animal requirements are discussed on the next page).

These results are not unusual for Tasmanian pasture and fodder in spring, winter and autumn or for irrigated situations.

**Table 1: Results of feed tests taken at Cranston in spring (2014) and autumn (2015)**

Crop / pasture tested	Time of sample	Dry Matter (DM) %	Crude Protein (CP) % of DM	Neutral Detergent Fibre (NDF) % of DM	Digestibility (DMD) % of DM	Metabolisable Energy (ME) MJ/kg DM
Rycorn &	September 14	18	24.7	39.4	84.1	12.9
Lucerne	October 14	21.9	31.9	29.9	78.5	11.9
Pasture	Oct 14	20.4	27	41.6	85.0	13.0
Lucerne	May 15	22.9	33.7	22.3	79.4	12

# Reducing emissions from livestock production

## Protein: energy ratios in feed

High protein fodder is common in Tasmania during the autumn, winter and spring months. The problem with high to very high protein feeds is that extra energy is required to enable the animal to process and break down the excess protein. As a result less energy is available for maintenance functions or production of meat, wool, milk or reproduction. This can be described in a simple formula;

$$\text{1\% of crude protein (in excess of requirements)} \\ = \text{0.18 ME (to process the excess protein)}$$

(Source: Productive Animal Nutrition presentation, 2012)

The feed budget example listed (right) using the Cranston Feed test values demonstrates how the equation can be used.

## Managing methane emissions

Understanding and managing energy and protein levels in feeds are important for managing methane losses. Energy density of pasture and other feeds are important. Low energy feeds such as straw, end up producing more methane and achieve less animal growth than a vigorous ryegrass and clover pasture (Blaxter & Clapperon, 1965).

Matching protein intake also has an impact, as high levels of feed protein tend to dilute energy levels in the rumen and result in higher methane emissions.

## Managing nitrous oxide emissions

High protein feeds also impact on nitrous oxide emissions. There's a lot of nitrogen in protein, so high protein feeds mean more nitrogen coming 'out the back' and leads to more nitrogen lost to the animal. The high nitrogen in manure and urine lead to higher nitrous oxide emissions, so reducing the crude protein concentration in the diet when in excess of animal requirements can also reduce these emissions.

'Best bet' for productivity: Matching feed protein and energy to the animals' requirements will help to optimise feed usage as well as minimise nutrient losses and emissions.



## Protein energy ratio example: Cross bred lambs grazing on spring lucerne at Cranston

A lucerne feed test taken in spring found that the crop had a crude protein level of 31.9% and metabolisable energy level of 11.9 MJ (see Table 1).

It was to be grazed by crossbred lambs, which have a daily crude protein requirement of 16% and a metabolisable energy requirement of 10.8 MJ per day (see Table 3).

Therefore the feed is providing 15.9% protein in excess of the animal's requirements.

Use the protein energy formula to work out the extra energy required;

$$\text{15.9 (\% CP in excess of requirements)} \times \text{0.18 ME} \\ = \text{2.9 MJ ME per day is needed to process the excess protein.}$$

If the animals are not fed extra energy to compensate, the resulting energy intake derived from lucerne crop will drop from a potential of 11.9 MJ/kg DM to 9.1 MJ/kg DM, which is below the lambs daily energy requirements. This will result in poor performance and potential weight loss whilst grazing this crop and higher emissions through increased methane from diluted energy levels in the rumen and high nitrogen concentrations in urine and manure from excess protein.

[This was calculated by 11.9 MJ (lucerne feed test result) - 2.8 MJ (extra energy needed) = 9.1 MJ potential energy intake.]

The new potential energy feed value is now comparable to lower value feeds such as cereal hay (see Table 2).

This suggests a reason why stock often do not perform as well as expected on 'lush' feeds when the protein and energy ratios are not balanced. Low fibre content and rich feed can also cause animal health problems such as 'red gut' in young lambs when grazing Lucerne (Grain and Graze, 2006).

## How do I balance protein and energy in the animals' diet?

**Table 2: The protein and energy content of some commonly used feeds**

### Step 1: Understand the feed value of your fodder

In Tasmania it is common for lush pasture and fodder crops in autumn, winter and spring have very high protein levels, far exceeding what the animal requires. Understanding when the high risk periods are on your property is the first step in managing this.

Feed testing provides a simple and accurate measure of the feed value of your pasture or crop at a single point in time. If you are not familiar with the nutritional feed values of crops on your property it can be a good first step.

Livestock producers can also use regional guides and averages for different types of feed to help understand the expected protein and energy ratios of feeds, such as Table 2.

Local agronomists and animal nutritionists will be able to advise on feed value expectations from different types of grazed crops and pastures.

### Step 2: Understand the protein and energy requirements of your stock

Animal protein and energy requirement tables (see Table 3) can be found from a range of industry sources and literature and can be used as a guide for producers to identify the daily requirements for different classes of stock. These can be accessed through the websites including

- State Government departments of agriculture (DPIPWE Tas, NSW DPI, Vic DEPI) and
- Industry programs such as Making More from Sheep

Please note that animal nutritional requirements will vary with live-weight, breed, growth rate and seasonal demand.

Once you know what the protein and energy requirements of your stock are you can compare these to the values in the feed you will offer them (from feed tests or regional averages). If there is an imbalance in the ratio then producers may need to provide a supplementary form of energy on order to achieve livestock performance targets.

Feed Type	Dry Matter (DM%)	Crude Protein (% of DM)		Metabolisable Energy (ME) MJ/kg DM	
		Range	Av.	Range	Av.
<b>Grazed pastures &amp; crops</b>	Av. / Range	Range	Av.	Range	Av.
Grass dominant - Young	23	1 - 37	25	3 - 14	11
- Mature	40	1 - 37	5	3 - 14	7
Clover dominant - Young	15	1 - 35	30	4 - 12	11
- Mature	30	1 - 35	7	4 - 12	4
Lucerne - Young, immature	17	3 - 41	30	4 - 13	11
Lucerne - Full bloom	24	3 - 41	15	4 - 13	8
Grazed barley / oats - Vegetative	19	3 - 33	20	7 - 13	9
- Post bloom	21	3 - 33	8	7 - 13	10
<b>Hay / silage</b>					
Mixed pasture	Hay: 80-85 Silage: 45	5 - 19	11	6 - 10	8
Lucerne	Hay 85-90 Silage: 51	16 - 25	20	8 - 10	9
Clover	Hay: 85 Silage: 44	14 - 21	18	8 - 11	10
Cereal	Hay: 58-90 Silage: 46	5 - 10	7	7 - 9	8
<b>Pellets</b>	<b>90</b>	11 - 16	12	10 - 14	12
<b>Cereal grains</b>					
Oats	90	5 - 15	9	9 - 12	11
Barley	90	7 - 15	10	12 - 13	12
Wheat	90	8 - 16	11	12 - 13	13
Triticale	90	7 - 16	11	12 - 13	13
<b>Grain legumes</b>					
Lupins	90	28 - 36	32	12 - 13	13
Peas	90	20 - 27	24	12 - 13	13
Faba beans	90	25 - 27	26	12 - 13	13

Source: Adapted from Feedtest, 2014 and DPI Vic, Drought Feeding and Management of Beef Cattle 2007

**Table 3: Energy and protein requirements of different classes of stock.**

Class of stock	Dry Matter Intake (DMI) % of liveweight	Crude Protein (CP) % of DM	Neutral Detergent Fibre (NDF) % of DM	Metabolisable Energy (ME) MJ/kg DM
Cow - Late pregnancy	2.5	12	48	9
Cow - Lactation	2.8	15	43	10.5
Ewe - late pregnancy - single	2.8	9	43	9.5
Ewe - late pregnancy - twin	2.8	11	43	10.5
Weaner calf - autumn drop	3	14	40	10.2
Weaner calf - spring drop	3.5	16	34	10.8
Weaner lamb - merino	5	16	27	11
Weaner lamb - cross-bred	4	16	30	10.8

Source: A guide to daily nutrient requirements (adapted from NRC, 2007), Productive Nutrition



## How do I balance protein & energy in the animals' diet? (Cont.)

### Step 3: Implement strategies to 'restore the balance' in high risk periods

When an imbalance of protein and energy is detected the best way of correcting this is to provide an additional source of energy to meet the livestock's requirements. Choose high energy supplements that are ideally low in protein. Feed value tables can be a useful way of comparing potential supplements (see Table 2).

Supplements may include (but not limited to) oats, pellets, wheat, barley, high quality silage / hay, energy lick blocks, molasses. It is advisable to calculate which supplementary feed provides the cheapest form of energy and is available in your region.

The class of stock, target market and time of the year, will influence decisions to supplementary feed. For example priority may be given to lambs to increase growth rates and finish them sooner or to ewes to increase condition prior to mating compared to wethers or non reproductive stock.

Supplements should be introduced gradually over a period of 2 weeks to allow for the rumen to adjust to the new feed. A sudden change in feed can cause animal health issues such as acidosis.

Seek advice from your agronomist or animal nutritionist when choosing the best form of supplementary feed.

## Implementing changes at Cranston Current and future steps

The baseline modeling of calculating GHG emissions and feed testing at Cranston was a good starting point for identifying areas for improved livestock efficiency. Andrew then discussed options for reducing emissions through improving livestock nutrition at Cranston with a Tas Farming Futures Extension Officer and his Serve-Ag agronomist. These strategies included the use of energy supplements whilst grazing stock on high protein feeds (crops or pasture).

Andrew is keen to look at changes to get his livestock finishing system right, including the use of cereal grains or other feeds as a supplementary form of energy for stock when grazing 'lush' crops at high risk times when protein is in excess of animal requirements (autumn, winter / spring).

He explained that in recent years, *"It is taking longer to finish lambs than we would expect"*. Given what was found through the spring feed testing results and feed calculations (see Example), the results would support Andrew's observations.

As a result of what he has learnt through the Tas Farming Futures project, Andrew trialed the use of oats as a supplement for the last of his 2014 lamb drop whilst grazing lucerne crops in the autumn of 2015.

*"We did feed the last of the lambs oats while on lucerne. This was only short lived as they were the last of this seasons drop."*

*"They were provided oats ad lib in an open feeder. I weighed out what I was feeding them. Consumption was higher than expected approximately 360 gms per day, (110 lambs consuming 40kgs oats daily)."*

*"This coming lamb season we will be looking to have supplementary feeding to offset the protein energy imbalance. This could consist of a pellet."*

In conjunction with Serve-Ag, Andrew is also trialing different fodder crops including forage oats (Tucana), grazing barley (Moby), a ryegrass and ryecorn blend (Powerpack winter blend) and a medic (Cavalier) to compare feed grown and nutritional value of these feeds (through feed testing).

Andrew has found the project activities to be a useful learning activity for him and his business and provided an opportunity to help him identify areas for improvement for his livestock operation.

*"The work we have done through this project has explained the nuts and bolts of what we are trying to counteract."*

*"In a growers mind you have a high protein feed and imagining it is the best feed to be providing your stock. The feed testing and calculations have shown that it is not meeting their requirements and helped in understanding the protein and energy levels."*

*"Initially the supplementary feeding in this example has been considered counter intuitive. In the context that this program has help clarify and explain why it is necessary."*



## Summary

Reducing methane and nitrous oxide emissions from livestock through tailored feedbase planning is good for business and the environment. Andrew Beven's experience in calculating his GHG emissions and undertaking feed testing on his spring and autumn pastures / crops has enabled him to identify where improvements can be made. Through providing an additional energy source (in the form of a grain supplement) Andrew can make a big difference to the performance of stock whilst grazing rich feeds and provide economic and environmental wins for his business. He has commenced making changes at Cranston during the autumn of 2015 in finishing lambs grazing on lucerne and will use supplementary feeding during in the coming spring lamb season on high risk feeds.

## References

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- FeedTest (2014) FeedTest data (see <http://www.feedtest.com.au>).
- Grain and Graze (2006) Increasing lamb growth rates on lush lucerne through supplementation – Winchelsea, Victoria.
- National Research Council (NRC) (2000), Nutrient Requirements of Beef Cattle, USA.
- Proactive Nutrition Presentation (2012) (adapted from NRC, 2007) A guide to daily nutrient requirements.
- S-GAF Sheep Greenhouse Gas Accounting Framework (2012) Excel-based tool available for download at the University of Melbourne: <http://www.greenhouse.unimelb.edu.au/Tools.htm>

## Like to know more?

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[www.rmcs.com.au](http://www.rmcs.com.au)



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