How should we value feed for sheep, beef and deer farms?

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Introduction

New understanding of feed requirements and the importance of current feeding practices on future productivity has changed the way we need to value feed when we must add more to the system.

There have been a wide range of approaches used to determine the impacts of changing feed supply. These range from simple conversion of dry matter increases into potential feed requirements for a stocking unit (Malcolm *et al.* 2014) at the marginal value of increasing stocking rate, through to whole farm modelling (Heard *et al.* 2013). Intermediate approaches may include converting the feed quantity and quality into a potential animal performance parameter such as liveweight gain (Stevens *et al.* 2015), or milk production (Stevens and Knowles 2011) and valuing those changes. Further expansion of the approach is to model standard farm systems and estimate the value of extra dry matter production in different seasons when added as a marginal improvement (e.g. the forage value index, Chapman *et al.* 2012, McEvoy *et al.* 2011). Finally an approach may be taken to investigate the optimal farm system that may use the new technology, potentially implementing new or different enterprises than are currently being employed (Rendel *et al.* 2015).

Each of these approaches has different outcomes and different levels of impact. A simple conversion of dry matter and quality data to animal performance provides a first step in understanding the potential of a technology. An optimisation approach may result in completely new farm configurations to capture the benefits. Simple methodologies may overstate the potential as they do not take into account the integration within the whole farm (Stevens and Knowles 2011). Even whole farm analyses may make the wrong recommendations if factors such as capital structure and investment are not included.

Valuing feed has taken on new emphasis as production systems have changed. As covered by Stevens (this volume) feed budgeting has changed significantly as production goals shifted from low lamb production and high wool production. The energy reserves of the animal are now recognised as important in the production process, rather than the previous position of being used to support maintenance during winter. This then implicates these reserves in a much more valuable part of the farming cycle, contributing directly to ewe and lamb survival and ewe milk production. While these contributions are hard to quantify in the face of the variable nature of climate and pasture production, they provide an opportunity to reduce the variability of the production of the farm, and to add to productivity overall, both now and in the future.

Methods for valuing feed

There are many ways to value feed and many reasons why. Each method must be applied to the right situation to ensure that an appropriate decision is made. These options range from simple input/price comparisons to whole farm systems analysis. They can be done on a net potential value approach or a relative marginal cost level.

Valuing feed has several elements and is done for many reasons. One is to compare the relative cost of supplementation. This is a simple approach to answer the question – How can I minimise the cost to fill my feed deficit?

However, valuing feed goes well beyond this simple approach. Questions may include:

- What is the best use for my feed?
- What will the value of producing more feed be?
- What are my trade-offs when choosing between feed sources?
- Should I supplement or sacrifice productivity?
- Am I better supplementing now or then?
- What are the relative values of my farm enterprises?
- How do I value the application of a new technology?

Once we get beyond the simple question, the methodologies become more complicated.

Problems with valuing feed in New Zealand pastoral situations

The major issue with valuing feed in the New Zealand pastoral context are both the variable and seasonal nature of pasture production. This then becomes translated into a variable demand for feed throughout the year. Often the benchmark for determining the value of feed is the price someone is willing to buy it for as grazing. Feed is deemed cheapest in the late spring when there is a surplus, and most expensive in late winter when there is a general shortage. While supply and demand methods are one way to provide a value for the trading of feed as pasture, it becomes problematic when developing or changing whole farm systems.

One approach has been to analyse the whole farm and place a value on the enterprises within the farm, comparing the net return from feed utilised in each enterprise. Unfortunately this may confound whole systems analysis with marginal analysis. One example of this is the undervaluing of beef cows on hill country properties. Their net return is traditionally relatively low when selling weaner calves, but they utilise low quality feed that other stock classes cannot, and add value by increasing the overall feed quality on the farm. Therefore, they are viewed as a stand-alone enterprise when they are really an integral part of the whole. Another example is that of dairy grazing. Often winter grazing of dairy cows is identified as the most profitable option on a hill country farm. Unfortunately, winter grazing is a marginal activity, rather than a whole systems activity. That is, it is very hard to build a whole farm system around winter grazing of dairy cows. There are usually too many constraints around land use, cropping and feed conservation for this to occupy the whole farm. To effectively compare winter dairy grazing with, for example, the ewe flock, then a similar marginal approach should be used, rather than comparing a whole system with a marginal activity.

Another issue that arises is the temporal scale of cause and effect. Even at a whole farm systems analysis this may not be recognised. Increasing feed during the autumn tupping period increases ovulation rate and potential lamb production. However, this outcome relies on several steps through different environmental conditions before value is realised. Therefore, the value of feed eaten in autumn may or may not change the outcome. Another factor in this outcome is that producing more lambs may not result in greater profit, as it has flow-on effects on feed supply during spring and summer. In a common scenario, more lambs would mean lower weaning weights and lower pasture covers going into summer, extending finishing time and lowering carcase weights, reducing the pasture cover next autumn, resulting in less lambs born the following year. These time scales and interactions result in a significant masking of realising value of feed at any one time point.

This temporal issue can also be influenced by the physiology of the animal. For example, the appetite of red deer is driven by daylength. This has implications for the potential performance of growing weaners, and their response to added feed inputs. The most extended example of temporal responses is that of the nutrition of the dam in early pregnancy influencing the reproductive performance of her offspring several years into the future.

Examples of comparative methods of valuing feed

Simple cost comparisons can be done on a dry matter basis, but are more accurately done on an energy basis. In special circumstances they may be done on a protein or even metabolisable protein basis.

An example would be valuing a supplement to fill a feed deficit. I have determined first that I have a deficit to fill, and have decided to buy feed to do it. My choices are baleage or grain. Cost per unit of both dry matter and metabolisable energy are easily calculated (Table 1). On an energy basis, grain will be the cheapest. Additions to this method would be to apply a utilization factor (which depends on feeding method, the form of the feed (e.g. chopped, unchopped or pelleted) and the quality). A feeding out cost can also be applied. All costs for feed should be checked for local and annual variations in price.

Table 1. Estimated costs of some winter feed options, including direct costs such as purchase or establishment as well as feeding out and opportunity costs (adapted from Stevens and Pearse 2015).

	Costs of different feed types					
	Grass baleage	**Self-fed silage**	**Hay**	**Brassica crop (10t/ha)**	**Fertiliser N (10:1 response)**	**Barley grain**
Growing/ making and harvesting cost	21.4	13.4	13.4	9.9	21.7	39.0
Feeding out cost	12.5	0.7	10.8	3.7	-	1.2
Opportunity cost	9.2	9.2	9.2	11.3	-	-
Total cost (c/kgDM)	43.1	23.3	33.4	24.9	21.7	41.2
Energy concentration (MJME/kg DM)	9.5	10.2	8.5	12	11.5	13
Total cost (c/MJME)	4.54	2.28	3.92	2.08	1.89	3.17

Costs of feed grown and fed in situ can be calculated from the input costs to grow the feed. With a crop then seed, fertiliser, cultivation, sowing, chemicals, application and contractors costs can all be added. Again, additions to the method can include the feeding out costs and utilization factors. An opportunity cost can be added when land is taken from another purpose. This often depends on whether the feed grown is business as usual, or is a new addition to the business. If business as usual requires the crop, then adding an opportunity cost is not necessary. However, if the crop is a new addition then using the opportunity cost provides a higher threshold against which to evaluate the new state of the system. The higher threshold ensures that the outcome of this new state is more profitable than the old state.

More complex examples come from conversations with farmers. Two examples are provided that look at feed in different ways. They investigate potential costs and the value of the potential outcomes. The first example looks at a simple value of protecting a crop against disease, and the second examines the value of winter feed used in two competing enterprises.

The first example of valuing feed came from a conversation with a farmer about whether or not spraying a crop to protect against aphid and mildew attack was cost-effective. The farmer recognised the cost of the spray and its application as the greatest issue, and weighed that up against the potential of the crop to grow another 1t of dry matter when faced with the onset of autumn and winter conditions. In this scenario, the farmer values the crop at 20c/kg DM, so 1t DM equals $200, and the probability of growing 1t is 0.5. The cost of the spray is $60/ha and the application cost another $60/ha. So overall the farmer suggests that he will be worse off. The alternate approach would be to suggest that if the crop is left in this state, he will actually lose dry matter (say 0.5t). He also is short of silage, so he has no buffer to fill the deficit, except to lose weight of ewes or cows during winter. Under this scenario he has to replace 1t DM (05t that doesn't grow and 0.5t lost). He will have to buy in bailage, so will pay at least $100/bale (and then have to feed it out). So rather than the lost dry matter valued at the cost of the crop, he must value the price of replacement of that dry matter, either as baleage, or the opportunity cost of future production. As baleage the potential cost to replace the feed, at 200kg DM/bale is $500/ha. This provides a short term marginal analysis of the value of feed for this farmer.

Another conversation, this time from a merino farmer provides an example of trying to balance winter lambs with feeding the ewe flock. This illustrates the conundrum of short versus long term responses and pay-backs. This potential method of valuing feed is not restricted to merino farmers as the same conversation applies to all sheep farmers.

The cost of grass is an interesting question, and can be calculated a few different ways. However, the numbers that you are collecting are enough to be able to calculate your own cost of grass. The relative cost of grass is often only important if you are buying feed. Then you can cost grazing off with other feed sources. What is important to you is the cost of one enterprise compared to another on your farm. So we need to know the weaning weight of the lambs and then we can calculate what the value of feed to maintain condition is worth compared to the value of using the feed for winter lambs.

So for example, maintaining winter condition at 3.0, instead of the traditional system of letting BCS decline to 2.0, on our ewes will result in an increase in docking percentage by 10% per 100 ewes (Everett-Hincks *et al.* 2013), and decrease ewe deaths by 4% (down from 10 in past experience, Morgan-Davies *et al.* 2008), and we increase weaning weight (at 100 days of age) by 3kg (Stevens *et al.* 2011).

So the value is 14% more lambs to sell (10% more lambs total and 4% less replacements) or 1.4 lambs per 100 ewes. The value of the weaning weight depends on the system but is easiest calculated by the value of the lamb sold store at weaning. This is usually the minimum value in a breeding/finishing system. If we are attempting to sell the lambs before the winter then we can calculate the reduction in summer feed requirement as well, and add that to the potential feed resource for winter. A higher BCS of the ewe at weaning can also be valued as we won't need feed to flush the ewe (or we can weather out a drought more readily).

So value is (85 lambs x 3kg x $2.00/kg) + (14 lambs x 25kg x $2.00/kg) = $510 + $700 = $1310 per 100 ewes or $13.10/ewe.

This costs the feed required to maintain 1 BCS over winter compared to losing the same condition score. So 1 BCS in merinos is probably 5-6kg (about 10% of their liveweight at BCS 3) 5kg LW =100 MJME or 12.5kg DM over the winter (at an ME of 8 MJ/kg).

So the value of the feed to maintain BCS in ewes =$13.1/12.5kg DM = $1.05/kg DM fed

Taking a lamb (about 35kg) through the winter will cost about 1kg DM/d without liveweight gain, and will take about 1.4kg DM/d in the spring so if we suggest that a winter lamb is kept from May to September (150 days) of which 100 are at 1kg DM/d and 50 at 1.4kg DM/d then a total of 170kg DM. This may improve its value from $70 (as a 35kg store in May) to $170 ($140 lamb and $30 wool (2kg x $15/kg)) so net $100 per lamb.

Value of feed for winter lambs = $100/170kg DM = $0.59/kg DM fed

You can add values that you think are appropriate to that scenario. If you dig into it in real detail then you find that the benefits of BCS maintenance are even greater. We can value the feed with a slightly more systems focus and investigate how much extra feed is generated by the change. This then gives us other ways of evaluating the change.

So 1 BCS greater at weaning = 5kg LW that we don't have to gain which spares 6kg DM/kg over the summer so releases 30kg DM/ewe for other enterprises.

3kg more weaning weight of the lambs (at 4.5kg DM/kg LW) means that lambs don't need to gain as much weight over summer so at 0.97 lambs/ewe saves 13kg DM.

A heavier lamb means they are potentially on the farm for less time and so lower the maintenance requirement over summer (let's say they average 35kg at 0.7kg DM x 30 days earlier kill date by 0.5 lambs sold) = 10.5kg DM saved.

Total summer feed saved/ ewe = 53.5kg DM for the investment in winter of 12.5kg DM. However, we know from the Freestone example (Johns *et al.* 2016) that the amount of feed needed to truly keep BCs on is probably about twice the 12.5kg DM/ewe for twins, but even then we are getting a 2 for 1 return. An alternative argument is that we have released a potential 40kg DM for other enterprises, or to increase the robustness/resilience of the system in the face of other challenges such as drought. This summer feed saving is the biggest game-changer for the sheep system and future profitability depends on what you do with it.

There are future benefits of better feeding that won't be seen until the ewe replacements from this crop of lambs start entering the flock, so keep as many of them as you can. Don't expect miracles out of the current ewes as they have the wrong nutritional background (foetal programming) to rise much above where they are.

A final example examines seasonal production values for a deer farm. This illustrates the impacts of seasonal intake and liveweight gain on the value of feed. This example comes from the South Canterbury/North Otago Deer Focus farm programme and is supported by data from the focus farm and from research (Stevens *et al.* 2003).

The seasonality of the intake of red deer (including elk and elk cross) impacts directly on the value of providing supplements. This interacts with the seasonal variation in carcase value, driven by market demand.

An example of the use of grain as an addition to the diet (Table 2) demonstrates the impacts of using grain in winter or early spring when feeding New Zealand red or elk cross weaners. Because the elk cross weaners respond more to the added grain in winter, this becomes a highly profitable use of bought-in feed. The more profitable use of grain supplementation for the NEW ZEALAND red weaners is to feed it during the early spring when they have the ability to respond to the higher feed quality.

Table 2. Calculated value of different feeding regimens for Red or Elk cross weaners in winter or spring based on the relative responses to extra feeding in each season (using grain prices from Table 1).

Season	Red deer	Elk cross
Winter		
Extra LWG	+20 g/d	+90 g/d
Supplement (g/d)	100	200
Cost (100 days @ $412/t)	$4.12	$8.24
Gross value/head @ $7.70/kg	$8.65	$38.80
Net value/head	$4.53	$30.56
Spring		
Extra LWG	+80 g/d	+100 g/d
Supplement (g/d)	200	200
Cost (60 days @ $412/t)	$4.94	$4.94
Gross value/head @ $7.70/kg	$20.70	$25.80
Net value/head	$15.76	$20.86

Conclusions

These examples demonstrate how complex the question of value is in a farming system. Past reasoning was appropriate for past levels of performance and past expectations. As we work towards greater productivity and a better understanding of temporal scales of impact we need to work towards more complete and future-focused ways of valuing our feed. Current near-sighted approaches are leading to short term decisions that favour marginal costing over full benefit analysis. This will continue to promote short term decisions to engage in cash flow positive options like dairy grazing, rather than those involved in changing the way we farm sheep, beef and deer.

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