Economic Analysis (Aggregate Consulting Pty Ltd)

Data from the three major sites has been used to demonstrate a methodology for analysing the financial benefits that might be gained by using containment feeding over summer and autumn for a June lambing merino ewe flock.

Consistent with PDS aims, the sites were not set up as experiments but rather to demonstrate the practices and the outcomes from containment feeding and allow discussion of the benefits that should arise.

As is reported in the results producers maintained higher ground cover and reported higher individual animal production that had been achieved in previous years. The difficulty for economic analysis is how to attribute the changed outcomes to the confinement feeding practices that were employed.

To help attribute likely benefits to their source, expected differences in animal production from the containment feeding were taken from the 5-year experiment at the Kybybolite Research Station in the early 1970's (Brown 1977).

The Kybybolite deferred grazing experiment was run on annual pastures, using ewes at 13 different stocking rates (from 4.9 ewes per hectare to 19.8 ewes per hectare).

The key findings of the Kybybolite experiment were

1) Whilst deferred grazing created ~500kg of extra dry matter availability over the winter period it did not lead to increased annual pasture production.
2) The extra dry matter available from deferred grazing "had little or no effect on wool production in ewes and lambs, on the number of lambs born and weaned, or on lamb growth rates." (Brown 1977). This occurred at levels of dry matter available like the PDS sites.
3) "Although the quantities of dry pasture residue ranged from 100 to 4000 kgDM/ha at the break of the season, there was no significant relationship in any year between the quantities of dry pasture residue present and the pasture growth rate."

The Kybybolite experiment results were that deferred grazing and the subsequent increase in dry matter available over the winter did not enable higher stocking rates through addition pasture production over the whole year and did not lead to any additional production from ewes at any given stocking rate.

There are some confounding factors when comparing the results of the Kybybolite research station to the animal and pasture conditions at the PDS sites.

Most obviously is that the locations are different and therefore you might expect slightly different weather outcomes and risks.

The percentage of ewes bearing twins was higher at two of the main PDS sites with the Kybybolite experiment ewes averaging ~98% lambs weaned to ewes joined whereas two of the three sites analysed averaging ~125%. This means that there would have been substantially more twin lambs born at these sites.

The Kybybolite experiment locked sheep up from the opening rains for six weeks. This translated into locking pastures up from mid-April to early June in most years.

In the Kybybolite experiment (whether contained or continuously grazed on pasture) sheep were fed for 'survival only' which meant ewes were getting down to 45kg liveweight before feeding commenced with supplements increased if they fell below these levels. The rules however meant that except for the driest year (1972) and the heaviest stocking rates (>17 ewes per hectare) the continuously grazed sheep did not receive any supplementary feed.

By contrast, the three main PDS sites had sheep enter containment as early as November (but more typically entry in January or February) and no later than March in any of the three years. Also, sheep were fed to maintain much higher condition scores (>CS 3) than those in the Kybybolite experiment.

Whilst the PDS site ewes had more twin bearing ewes they also maintained ewes in higher condition score which would have increased survival of the twin born lambs independent of feed on offer through lambing.

The PDS did not measure differences in FOO between containment feeding and a comparable continuously grazed pasture. Estimates of the differences in FOO for the three main sites were made by using satellite imagery comparisons of the host farms and surrounding farms.

Differences in lambs weaned

Analysis of the PDS data from the three main sites showed that two sites had estimated FOO differences between continuously grazed (neighbouring farms) and the deferred grazing treatments areas over June and July (Table 1) consistent with those found in the 5-year comparison of a deferred grazing system and a continuously grazed system on annual pastures.

Table 1: Increased FOO over winter from deferred grazing and FOO levels of continuously grazed pastures.

	Site 1	Site 2	Site 3
Average Difference in FOO (KgDM/HA) through June-July	435kg	263kg	-152kg
FOO Level of continuously grazed pastures (Jun-Jul)	1245kg	1327kg	1124kg
FOO Level of continuously grazed pastures (Jan-Apr)	1553kg	1941kg	2285kg

The third site had less dry matter available through June and July in the deferred grazing areas than the continuously grazed site. This result was confounded by very different stocking rates on the two different properties.

Lamb survival in merino ewes, and in particular twin lamb survival, has been shown to be influenced by ewe condition score at lambing and the FOO at lambing. The sites averaged ~1250 kgDM/Ha through the lambing months (range 1125 kgDM/Ha to 1325 kgDM/Ha) which was 182 kgDM/Ha higher (range from -152 KgDM/Ha to 435 kgDM/Ha) than surrounding farms (Table 1). These results are slightly lower than what was achieved in the Kybybolite experiment which may reflect ewes not being locked up for as long post the autumn break.

The impact of ~400kg additional dry matter available on lamb survival is also dependent on the average chill index at lambing. Using LTEM tables on predicted survival rates of twin born lambs with a chill index ranging from 900 to 1100 the impact of the additional feed on offer on twin lamb

survival would be between 2% to 5% for 3.3 condition score merino ewes. For singles born lambs it is predicted to be 0.5% to 3%.

Modelled chill index using Grassgro at Temora in NSW (similar latitude, rainfall, maximum and minimum temperatures for the month of June as Keyneton) with 39 years of weather records for the period from May through to October showed the median weekly chill index "rarely exceeding 1000 kJ/m2.h" (Broster et al 2012). The tablelands environments (higher altitude) commonly exceeded 1000 kJ/m2.h from June onwards.

Consideration of what benefits are likely would also need to consider the amount of shelter in the lambing paddocks which can substantially reduce chill index by lowering wind speeds.

Average chill index data for the lambing period at each site each year is not recorded. It is estimated that over several years it might average ~1000 KJ/m2.h for the lambing period in which case the increased twin lamb survival would be predicted to be ~3.5% for 400kg to 500kg additional dry matter available through lambing, and ~1.5% in single born lambs.

Care should be taken with the expectation that these outcomes will be achieved in practice given that experimental data at Kybybolite and other similar experiments have not record differences.

Using predicted impacts on lamb survival, the total predicted increase in lambs weaned where the outcome is 125% lambs weaned is 3% extra lambs weaned. If the outcome is 100% lambs weaned the total predicted increase in lambs weaned is 1.6% because there are far fewer twins.

The three sites analysed recorded 5% - 20% more lambs weaned in the mobs that were containment fed than they had achieved in previous two years before the PDS started. Most of the difference in weaning percentage are likely to have come from differences in condition scores of ewes at lambing rather than containment feeding and higher FOO on offer through lambing. This implies better management of the ewes.

Difference in cost of feeding

The differences in the management decision as to when ewes should go into containment meant that over the three years across the three analysed sites the average FOO on pastures that were destocked were between 2000kg FOO and 2600kg FOO. Across the 3 continuously grazed sites the FOO over the same period averaged between 1500kg DM to 2200kgDM (Table 1). The FOO availability in the continuously grazed sites will affect the cost to maintain ewes at a higher condition score.

Differences in annual carrying capacity of pastures

Given the findings of the Kybybolite experiment that total annual pasture production was not increased by containment feeding from the autumn break it is not possible to attribute the higher stocking rate on any property to the management practice of containment feeding and its impacts on pasture growth.

That does not rule out that containment feeding may give management more comfort that they can control nutrition at a higher stocking rate, thereby enabling the decision to run a higher stocking rate.

Differences in mortality rates in ewes

The Kybybolite experiment recorded low average annual death rates in ewes (<2.2%) but higher +~1% in the deferred grazing system than in the continuously grazed system. The additional deaths were largely incurred through the lambing period rather than the feeding period.

Amongst the PDS sites only one site in two years compared death rates of containment fed ewes to continuously grazed ewes. In this site there were 1% additional deaths in one of the years and 6% additional deaths in the other year.

The year where the difference was considerably higher was a year where all sites had high (>6% deaths in containment and over lambing)

It should not be assumed that higher death rates are inevitable, but it should be considered a risk.

Costs and benefits

The method of calculating the costs and benefits of containment feeding is via the following steps.

Step 1: Calculate the additional rations costs of using containment whilst above minimum target FOO levels remain on pasture.

Step 2: Account for any differences in operational costs associated with containment feeding versus feeding on pasture.

Step 3: Attribute benefits from more FOO over lambing

Step 1 – Additional Ration Costs

Down to a low level (500 to 1000kg of available dry matter depending on quality of the dry feed) there is opportunity cost in not using available pasture dry matter as part of the ration.

Feed quality measurements of the paddock available FOO were not taken during this PDS. A guide as to the potential ration cost saving has been created using a simple GrazFeed comparison of required barley to maintain a 60kg ewe 45 days pregnant with twins on varying levels and digestibility of dry feed. The two levels of digestibility were 45% digestible (6.7 MJME/Kg DM) or 40% digestible (5.8 MJME/Kg DM).

Table 2: Estimate of additional ration requirement at different levels of pasture digestibility and availability.

Pasture Availability (KgDM/Ha)	**45% Dig. pasture**	Herbage Intake	Grain	% Of Full Ration Saved by Herbage	**40% Dig. pasture**	Herbage Intake	Grain	% Of Full Ration Saved by Herbage
	2000	0.74	0.34	39%	**2000**	0.54	0.46	18%
	1500	0.65	0.39	30%	**1500**	0.46	0.5	11%
	1000	0.52	0.47	16%	**1000**	0.37	0.55	2%
	500	0.31	0.56	0%	**500**	0.22	0.61	-9%

There was significant variation between sites and between years but the average dry matter available across three sites and three years was just shy of 2000kg of DM.

On all three of the sites dry mater levels fell from Jan through to April in the first year indicating senesced pastures. In the second year FOO levels did not start falling until March and in the third year it was not until April. This indicates that there was some pasture growth in the 2nd and third years through summer which would have meant that the pasture quality was better until later in those year on those sites.

It is not possible to know exactly what the difference in feed cost was from the results of these demonstrations. Given the amount of feed on offer in both the destocked pastures and the pastures that were not destocked a conservative estimate of ~18% is used to allow a demonstration of the methodology.

In practice it would be worth feed testing to understand exactly what the containment feeding is adding to costs of feeding when residual dry matter levels are above 1250 kgDM/Ha.

The actual ration costs per head per year varied between $14 per head and $57 per head (Table 3) and therefore the gross additional cost of feeding in containment over in the paddock varied between $2.45 per head and $10.19 per head if the containment cost 18% more in ration costs.

Table 3: Ration costs per ewe fed and marginal ration cost from being containment fed over fed on pasture ($/Ewe Fed).

	Total Ration Cost			Marginal Ration Cost @ 18%		
	Site 1	Site 2	Site 3	Site 1	Site 2	Site 3
2020	$37	$24	$23	$6.75	$4.40	$4.12
2021	$57	$24	$22	$10.19	$4.33	$3.87
2022	$27	$14	$21	$4.86	$2.45	$3.76

Step 2: Account for differences in operational costs

There are however also some savings from containment feeding in the feeding operation. Estimated time saved varied from 2hrs per week to 12 hours per week which is in part dependent on the number of sheep and the size of farm. At a cost of $45 per hour this translated to a difference in labour of between $0.85 per ewe to $4.05 per ewe which was dependent on the number of days fed as well.

The marginal vehicle costs saved from containment feeding versus feeding in the paddock varied between $60 per week in fuel to $100 per week in fuel and wear and tear on vehicles. This translated to between $0.25 per head to $0.80 per head saved on vehicles costs. Fuel estimates were given by each site owner and where kilometres differences were given a $1.20 per kilometre rate was applied to each kilometre.

Table 4: Estimates of labour and vehicle cost savings from containment feeding ($/Ewe Fed)

	Labour Saved from Containment Feeding			**Vehicle Costs Saved from Containment Feeding**		
	Site 1	**Site 2**	**Site 3**	**Site 1**	**Site 2**	**Site 3**
2020	-$4.05	-$1.17	-$3.21	-$0.49	-$0.81	-$0.81
2021	-$3.45	-$0.85	-$2.00	-$0.42	-$0.59	-$0.51
2022	-$2.05	-$0.89	-$2.40	-$0.25	-$0.62	-$0.61

The estimated marginal cost of feeding from containment (extra ration cost less savings in labour and vehicle costs) averaged over the three years for each site came to $0.74 per head per year to $3.70 per head per year.

Table 5: Marginal cost of containment feeding ($/Ewe Fed)

	Marginal Cost of Feeding		
	Site 1	**Site 2**	**Site 3**
2020	$2.21	$2.41	$0.10
2021	$6.32	$2.89	$1.36
2022	$2.57	$0.94	$0.75
Average	**$3.70**	**$2.08**	**$0.74**

Step 3: Work out the net benefit in production from additional FOO at lambing

Unless all additional lambs weaned are sold at weaning, increasing reproduction rates in a wool flock changes flock structure. Where a farm is already optimally stocked, increased lambing percentages will decrease ewes joined as more replacement ewe weaners (and possibly wether weaners) are retained through to 1 year of age.

The extra lambs also incur extra costs associated with marking, animal health, shearing and crutching and selling costs. The gross benefits of additional lambs as a % of ewes joined do not correlate directly to a value on those lambs.

In a flock model where the farm is optimally stocked and it costs $14.60 to run a lamb from marking through to one year of age inclusive of (marking, shearing, crutching, and animal health treatments) then if wether lambs are sold for $100 off shears at 6 months of age, but ewe weaners are run through to 1.5 years of age before the cull portion is sold for $160, the increase in gross margin per ewe joined is only ~$5.65 for every 5% increase in lambs weaned. This allows for flock structure changes, and additional costs incurred on lambs and finally selling costs.

On a gross income basis where flock structure is not changed and 50% of extra lambs are wethers with 50% ewes (av. sale price of $130) the increase in income per ewe joined would be $6.50 for every 5%.

A 1% increase in survival would therefore be worth $1.13 per ewe joined. If 3% extra lamb survival is obtained, then it would have offset the marginal cost of feeding at each of the sites.

Consider risks

Attention should be paid to the risks around mortality. If as per the Kybybolite experiments deaths of contained ewes. Where the sale price of CFA ewes is $120 then every 1% increase in mortality is a cost of ~$1.70 per ewe joined. Where the sale price of CFA ewes is $180 it is ~$2 per ewe joined. If mortality rates in ewes are not controlled consistently then they could easily swamp potential benefits from lamb survival.

More accurate management of sheep

Increased production from containment feeding may not come from containment feeding, but rather from improved management of the sheep (more accurate management allowing ewes to be in better condition through hitting target levels of nutrition). For instance, had the sheep not been contained and monitored as closely the target condition score may have been missed.

High condition score ewes at lambing will have better lamb survival, and those lambs will have a higher lifetime fleece value.

In this analysis the assumption is that the benefits of additional fleece weight in the ewe fed to a higher condition score will either be largely, or wholly, offset by the increased fibre diameter of the fleece. The impact on the fleece value of the ewe is subsequently ignored.

More significant benefits of maintaining higher condition score of ewes through mid to late pregnancy will come through better lamb survival and then the lifetime fleece value of merino progeny.

If we assume 5% more lambs weaned because of being +0.5 condition score, then @ $100 per wether lamb weaned lamb and $160 per extra ewe lamb weaned that is $5.60 of additional gross margin per ewe joined from the additional lambs weaned as per the analysis in the previous section.

The progeny would also have 100g heavier fleece weights that are 0.2 micron finer at each shearing. The value of this will be very varied according to fibre diameter of the sheep and the markets at the time. For this analysis, we have used a base fleece weight of 3.5kg clean and $20 per kilogram clean as the price. We have then assumed a $1.50 per micron premium as the fleece get finer.

The value attributed to the ewe that is fed depends on how many times the progeny is shorn. For the purposes of this calculation, we have used 3 full fleeces per lamb (1 for wether progeny and 5 for the ewe progeny). Calculating that out equates to a nominal ~$10 for lifetime fleece value of progeny.

The additional 0.5 of a CS has therefore yields ~$15.60 of increased income from progeny.

At a ration cost of $400 per tonne and 3.5kg of ration per 1kg of liveweight maintained the additional feed cost is ~$5 per ewe. This leaves ~$10.60 per ewe of benefit from the additional feeding.

Containment feeding, allowing more control over the feeding process and more frequent monitoring of the sheep may be a more reliable way to ensure that the CS objectives are met. If that is the case, then for it to be profitable, the marginal costs of feeding in containment need to be less than the net benefit from being in better condition at lambing. It also requires that the same average result cannot be achieved out of containment.

Based on the 3 main PDS sites, and an assumed 40% digestibility of pasture from Jan to April, the marginal cost of containment was $0.74 to $3.70. Under the assumption that the containment fed ewes were 0.5 of a CS better off than had they not been fed, and that containment feeding was going to be a more reliable way to achieve that outcome, the net benefit of the additional CS maintained in ewes from the progeny would therefore be between ~$8 per ewe and ~$5.30 (deduct the additional cost of containment feeding from the net benefit of ewes being 0.5 of a CS better at lambing).

The economic analysis has not attempted to quantify any additional benefits to pasture persistence or soil preservation that may also accrue from containment. If these are going to occur it will be a very low dry matter levels and will be particular to soil types, soil fertility and pasture species.

Brown T. H. (1977). A comparison of continuous grazing and deferred autumn grazing of merino ewes and lambs at 13 stocking rates. Australian journal of Agricultural Research Vol 28, pg 947-61.

Broster J. C., Robertson S. M., Dehaan R. L., King B. J. and Friend M. A. (2012). Evaluating seasonal risk and the potential for windspeed reductions to reduce chill index at six locations using GrassGro. Animal Production Science Vol 52 (10), pg 921-928.