TO BARN OR NOT TO BARN, THAT IS THE QUESTION

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Cow housing and off paddock infrastructure have become the latest trend in intensification for various reasons. Matthew Newman Senior Economist and Kim Mashlan Senior Developer Feed and Farm Systems at DNZ, will shed light on the barn debate. Implications of building and running a barn system with regards to drivers for change, profitability, hidden costs, benefits and nutrient loss will be discussed. A number of farmer case studies will be presented and DairyNZ decision support tools will be discussed so you will leave the session knowing what questions to ask and what to look out for when making your assessment of whether a barn is right for you.

Key points

- DairyNZ has gathered information and built decision support tools to aid farmers considering investing in off paddock infrastructures (barns).
- The main reasons farmers invest in barns is for management purposes, such as prevention of pasture pugging or overgrazing, improve conditions for cows and staff, and reduce the reliance on winter grazing contracts, not necessarily for financial or environmental reasons.
- In general, farms with barns are trading some of the climatic risks for financial risks, especially as all intensified their systems post barn.
- Incorporating a barn tended to change the farm system with more feed typically imported and more detailed management required, particularly around nutrition and stock management. Many farmers reported taking two-three years to adjust the system to a level they felt was appropriate.

Notes:

- 12 of the 14 farms in the financial analysis had a positive Internal Rate of Return (IRR) but only six had a positive Net Present Value (NPV), meeting the 8% (or greater) real return on capital. The IRR ranged from -10% to 15% (figure 1 below)
- The capital costs, milk prices and feed prices all impact significantly on the financial outcome.
- Overall, the intensification of the farm system post-barn resulted in little change in nitrogen leaching for half the farms. Four farms showed a reduction larger than 10% in nitrogen losses while four recorded increases.

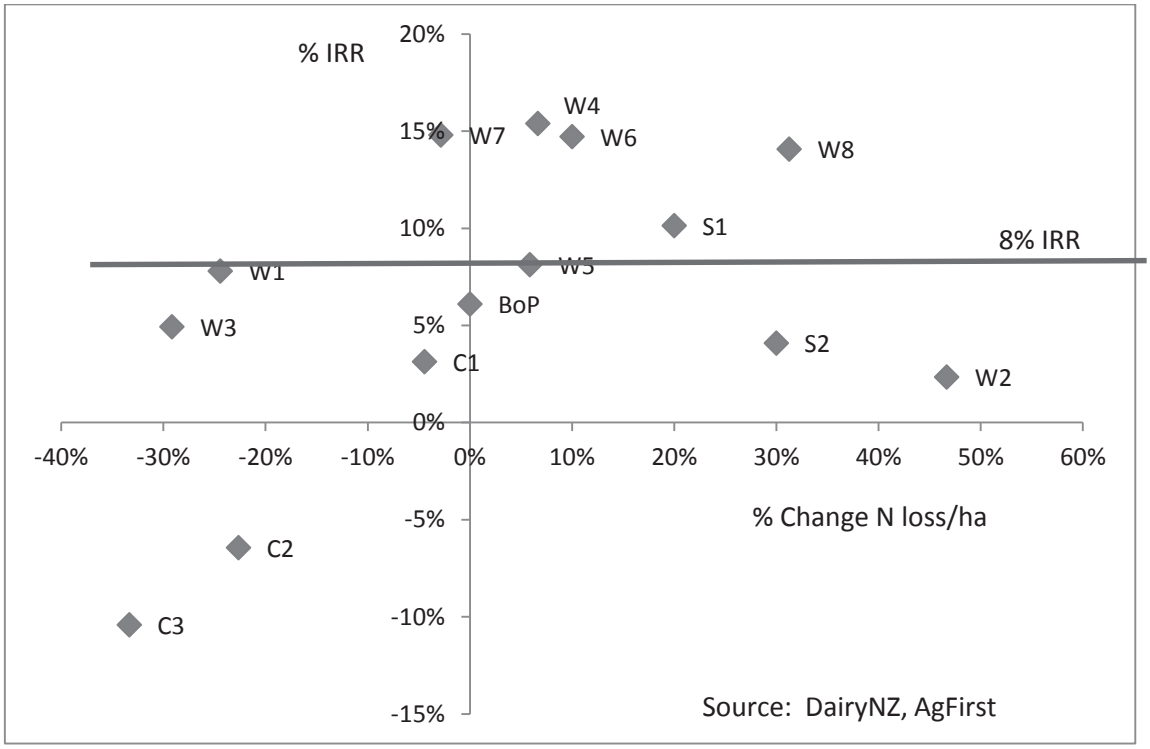

Figure 1: Summary of IRR and Change in N loss

Introduction

DairyNZ has developed a programme of work to investigate the drivers for investing in off paddock infrastructure (barns and various forms of cow housing) and to collect and analyse information from a range of farms with barns. This information, including the reasons for investing in barns, the advantages and disadvantages, as well as the financial and nutrient leaching impacts of constructing and running a farm with different types of barns has allowed DairyNZ to provide information for those farmers thinking about similar investments. A decision framework, including farmer case studies and tools to help farmers evaluate and determine whether investing in these structures might be beneficial or not has been constructed.

Regional Councils in New Zealand are required under the National Policy Statement (NPS) on Freshwater to introduce policies to improve water quality. A significant component of

this will involve reducing nutrient losses from farms, and hence the focus is moving to implementing on-farm mitigation strategies. This in turn will have economic impacts for farmers and may change the way they choose to farm. Removing cows from pasture or crop, in autumn and/or winter, is one mitigation option. To do this effectively infrastructure is required, such as a stand-off pad or some sort of cow housing facility. These can require considerable capital investment and as a result farms usually intensify (add cows or additional feed) in order to justify the investment.

This paper discusses the drivers for investing in barns and the economic costs and benefits of constructing and running different types of barns on several case study dairy farms in the South Island (freestalls) and in the Waikato (loose housed barns with deep litter bedding such as Redpath or concrete slatted floors such as Herd Home shelters). In particular it outlines the capital costs, changes in farm systems (production, cows, inputs and machinery) adopted as a result of the construction of the barn, as well as detailing the change in nutrient loss, particularly nitrogen via Overseer®.

Farmer meetings held in Southland, Canterbury and Waikato/Bay of Plenty provided information on drivers and motivations for investing in barns and this was further supported by 15 semi structured interviews conducted by AgResearch with farmers in each of these three regions.

In addition, seven key benefits farmers identified as important when evaluating barns were investigated with relevant research trials reviewed to provide science based cost/benefit data.

Reasons for building a barn

A total of 35 farmers with barns were interviewed across the project with 15 of these undergoing a semi structured interview with AgResearch/DairyNZ, 14 were part of the financial analysis and a further 6 were interviewed separately by DairyNZ.

The number of farmers interviewed in each region is highlighted in Table 1.

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Table 1: **Number of farms interviewed with barns**

Type of system	Southland	Canterbury	Waikato/BOP
Freestall	7	7	0
Loose housed with slatted floor	2	1	9
Loose housed with deep litter	1	1	5
Mix of barn types	1	0	1
Total farmers interviewed in region	11	9	15

The benefits listed by the farmers for building the barn were predominantly farm management orientated and not due to financial reasons, very few listed environment as a reason and only if prompted. Reasons given for considering barns included:

- Frustration with managing wet soils and pugging damage
- Reduced wastage of feed
- To make the system simpler
- To make it more resilient – eg control over production, winter grazing
- Provide more options (eg winter milking, extend lactation, expand without buying more land)
- Control over animal welfare (hot, cold and/or wet conditions) and grazing management and feeding
- Peace of mind
- More pleasant working conditions (not out in cold wet mud)
- Better cow condition – increased production and
- Less fertiliser required.

Benefits tended to be qualitative and few could articulate what this meant in terms of any financial return.

Consequently DairyNZ has reviewed many research papers reporting on these benefits and summarised what they have indicated in the following table.

Table 2: Benefits of barns

Benefit	*Range based on research*	*Example/comment*
Reduced pasture pugging	1-2% of annual pasture production	Pugging damage on the affected area can seem quite large but as a percentage of the farms annual growth the damage would have to be across more than 20% of the farm to be any more than 1-2% of annual pasture grown. At 16T DM/ha/yr annual production this would equate to 160 to 320kg DM/ha /yr
Reduced heat stress	1 unit increase in THI above the threshold drops MS by 10 g/cow/day	Only of note in northern NI. Assuming THI exceeds threshold on 20% of lactation days this would equate to $20/cow/yr at $5/kg MS
reduced walking (only applies if less trips to paddocks)	Walking requires 2 MJ ME/km on flat land and 6 MJ ME/km on hilly	3 km/day x 270 day lactation = 4860 MJ ME/year (hills) and 1620MJME/year flats. Saving this energy could produce 63kg MS/cow on hills and 21kgMS/cow on flats
Reduced feed wastage	This is one of the major benefits of using feedpads or other off paddock infrastructure.	A reduction in wastage from 30% to 10% for maize silage, or from 25% to 5% for PKE, is an extra 200kg DM eaten/tonne DM fed. This eqates to approx $80 of milk income per tonne of DM fed at a $5 payout. Note if feedpads or in shed feeding are already being used, very little improvement in feed utilisation can be expected.
Reducing or preventing overgrazing	Overgrazing (<3cm) or undergrazing (11 clicks versus 7-9 on a plate meter) on a regular basis (4-5 grazings) is estimated to reduce operating profit by around $300-600/ha	Assuming a 30 day rotation in Jan and Feb, a paddock will receive two grazings in which it could be potentially overgrazed in a dry summer. This would equate to a loss of $150-300/ha
Reduced nutrient loss	Research indicates 25-55% reduction in nitrogen losses possible if no intensification occurs. Actual farm info does not show same benefits because most farms add feed and cows to the system	24/7 or duration controlled grazing (cows off paddock for several hours per day in autumn/winter) could potentially decrease Nitrogen losses. Varied responses depending on time off paddock, soil types, feed changes and effluent practises such as storage and time it is returned.
Less fertiliser required	Chemical fertiliser can be offset by nutrients brought onto the farm as feed	Offset ususally by the increased cost of nutrients in feed compared to fertiliser and increased application costs,
Better fed cows are more efficient	Well fed cows do have better feed conversion eficiency at a per cow level. On a farm where pasture is still the bulk of the diet, farm FCE is more important.	Well fed cows usually do not have better reproductive performance, are selective about what they eat, resulting in high levels of substitution, tend to grow and utilise less pasture per hectare resulting in lower farm FCE and profit

Methodology of financial analysis

The financial analysis involved five case study farms in the South Island; two in Southland and three in Canterbury and nine in the Waikato/BoP. These farms were chosen as they were known by DairyNZ staff and were not considered at the extreme in terms of

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production systems. However, it is fair to say these farmers are better than average. Most of the barns were only 2-3 years old and in some cases farmers were still altering the system to optimise returns from the barn. The farms were visited on two occasions. The first was to collect a range of information (described below) both pre and post barn so we could determine the changes and quantify them:

- Reasons for building the barn;
- Physical parameters on the farm; farm size, peak cows milked, milksolids production, change in labour units, etc;
- Machinery used on the farm and any new equipment bought as a result of the barn;
- Fertilisers applied;
- Stock grazing management throughout the year;
- Amounts of supplementary feed made on-farm and purchased in;
- Barn feeding management;
- Any changes in animal health, animal welfare, and pugging levels; and
- The capital and operating costs involved with the barn.

The second visit was to show the farmers the draft analysis, check that the figures used were accurate, and to obtain any additional information required.

There are some limitations with the analysis. Most of the case study farms have fairly recently incorporated the barn into their farming system and therefore the post-barn data is limited. These farms are in a transition period particularly around feeding levels, feed types, and feed costs. Many farms were still adjusting their system two-three years after the construction of the barn. Therefore, it would be worthwhile re-visiting the farms in another couple of years to analyse the costs/benefits once the farms have reached a new equilibrium.

The financial analysis is an investment cost-benefit approach based on calculating the Net Present Value (NPV) and Internal rate of Return (IRR) over a 20 year cash flow, using a base discount rate of 8% real and a milk price of $6.50 per kilogram milksolids. Pre and post-barn information was gathered from each of the 14 farms and used in the cost benefit analysis. Overseer® Version 6.2 was used to analyse any change in nitrogen, phosphorous leaching as well as greenhouse gases.

The NPV is the value of the cash-flows over 20 years, discounted to today's dollars. A positive NPV indicates the project can more than meet the cost of capital. The IRR indicates the return the investment provides over 20 years. A negative NPV but positive IRR shows the investment is profitable, but only up to the level indicated by the IRR, but not to the required discount rate (8%).

Capital costs

The capital cost of the barn is only part of the story; additional costs around machinery and other farm infrastructure added a further 20-40% to the overall cost. If the cost of additional cows and dairy company shares is also included, the capital required increased 25-70% of the cost of the barn. In this respect farmers contemplating constructing a barn also need to consider these wider costs as well.

Barn and other farm infrastructure

The barn structure accounted for 60-80% of the total capital cost on average. This cost includes resource consent, land preparation, and for many farms the effluent system as this was an integral part of the barn.

The barn and effluent system were depreciated at the relevant IRD rate (Barns - 8.5% diminishing value. IRD 2014, effluent system 6% diminishing value) over the investment period in order to derive a salvage value in the 20th year.

Other infrastructure varied between farms, but included additional features such as:

- Concrete feed storage bunkers
- Concrete raceway between the barn and the milking shed
- Increased water supply/troughs
- Water storage for rainwater off the barn roof, and
- Widening and/or strengthening of races around the barn/milking shed.

All concrete items were depreciated at the IRD "Shed & Yard" rate to arrive at a salvage value in the 20th year.

Machinery and equipment

Most South Island farms purchased additional machinery to assist with supplementary feeding in the barn. The capital cost of machinery or other equipment purchased as a result of the barn included:

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- New or upgraded tractors
- Telehandlers
- Feed mixer wagons
- Generators
- Feed robots, and
- Pumps.

If the machinery in question was used exclusively for the barn, 100% of their costs were counted against the barn. In many situations, while the case study farmers had bought in an extra tractor, its time was not always exclusively allocated to the barn, as it is also used for other tasks around the farm. In this situation a proportion of time was calculated based on running times, with that proportion of the capital and operating cost charged against the barn.

Farmers were asked as to their replacement policy with machinery, which was often based on total running time. In the analysis the machines were depreciated at the relevant IRD rate, and a replacement cost was calculated in the relevant year and again charged against the barn. This process was also used to determine the salvage value of any machinery. For new machines such as telehanders and feed wagons, the assumption was that they would last the 20 years of the analysis, but with no salvage value.

Capital cost of increased cow numbers and shares

In a number of the case study farms, cow numbers increased after the construction of the barn. The capital cost of this was assumed as the five year average of the IRD Herd Scheme (IRD_2), for the relevant breed. This increase in cow numbers would remain through the life of the analysis, therefore the original capital cost was also assumed as a salvage value.

The increase in milksolids production would require an increase in the shareholding in the relevant Dairy Company. For Fonterra shareholders the shares were valued at $6/share, and whatever the nominal value currently is for the other Dairy Companies. Given the increased share numbers would still be held at the end of the 20 years, the above values were also used as salvage values. A dividend of $0.30/Kg MS was also assumed for Fonterra suppliers.

Results

A summary of the results of the analysis is provided in Table 3. The number of cows increased on eight of the farms, after the incorporation of the barn. Milk production per cow increased between 6-22% for South Island farms and 8-38% for Waikato/BoP farms reflecting increased feed levels and longer lactation period. Overall, with the exception of Southland 1, all the South Island farms had a negative NPV, indicating they were not achieving the 8% real return on capital. All farms except the Canterbury 2 and 3 farms were returning a positive IRR.

The initial expenditure on capital and the additional operating expenditure in relation to additional milk production (marginal cost/Kg MS) had a strong influence on the NPV.

Four Waikato farms recorded an IRR of 14-15%. They tended to have lower initial capital outlay to the other farms and lower increased marginal costs (increased operating expenses/Kg MS).

Table 3: Summary of cost-benefit analysis

		Barn + Machinery Cost $/cow	Peak cows	Kg MS/cow	Increased Operating Expenses/Kg MS	NPV	IRR
Southland 1	Freestall	2,329	852 (+52)	568 (+11%)	$5.87	$378,072	**10%**
Southland 2	Freestall	3,345	572 (+21)	559 (+20%)	$8.19	-$633,236	**4%**
Canterbury 1	Freestall	3,648	1,150 (0)	565 (+6%)	$9.45	-$809,121	**3%**
Canterbury 2	Freestall	3,918	540 (+40)	661 (+12%)	$7.31	-$2,480,644	**-6%**
Canterbury 3	Freestall	5,788	950 (+100)	463 (+22%)	$9.56	-$7,076,558	**-10%**
Waikato 1	Herd Home	1,756	450 (0)	447 (+30%)	$4.94	-$17,401	**8%**
Waikato 2	Redpath	2,480	250 (0)	526 (+25%)	$6.61	-$347,552	**2%**
Waikato 3	Herd Home	2,824	350 (+60)	362 (+13%)	$5.09	-$143,803	**5%**
Waikato 4	Herd Home	1,658	355 (+20)	428 (+28%)	$2.96	$559,489	**15%**
Waikato 5	Herd Home	2,150	214 (-9)	489 (+29%)	$5.26	$9,292	**8%**
Waikato 6	Herd Home	1,778	210 (-2)	495 (+38%)	$3.50	$292,114	**15%**
Waikato 7	Redpath	952	215 (0)	526 (+8%)	$4.30	$117,434	**15%**
Waikato 8	Redpath	1,475	280 (+10)	371 (+27%)	$4.01	$316,938	**14%**
BoP	Compost	1,966	455 (+55)	451 (+24%)	$4.70	-$240,244	**6%**

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Milk prices

Varying the milk price by $0.50/Kg MS alters the IRR by approximately 2 percentage points. This indicates that the IRR is sensitive to changes in milk prices. At $7.00/Kg MS all the Waikato/BoP farms except Waikato 2 achieve a positive NPV. The milk price would need to be considerably higher for the majority of the South Island barns to achieve a positive NPV, due to the higher capital costs of the freestall barns.

Environmental impact

The case study farms were analysed using Overseer® V6.2 to determine the impact of the barn on nutrient losses, particularly nitrogen, comparing the pre barn versus post barn situation. The farms were not aiming to reduce nitrogen leaching and the analysis was simply to compare pre leaching levels with those resulting post barn including changes to the system. Some of the case study farms had previously grazed cows off the farm over winter.

The analysis was on the milking platform only. This caused some issues on some farms, as they tended to incorporate grazing on the run-off from time to time, depending on circumstances, or transfers of feed and effluent, which was difficult to incorporate into Overseer.

A caveat is also required; in its current form Overseer is not well set up to handle wintering barns, and some anomalies arose. It would appear that nitrogen leaching in Overseer is largely driven by rainfall and soil type (= drainage), and as such doesn't readily capture the benefit of the barn. In addition, the pre-barn and post-barn analysis is difficult due to the change in system, including effluent management, cropping and wintering management and therefore the Overseer nitrogen loss figures are not entirely due to the barn.

Notwithstanding some of the anomalies with using Overseer, the general pattern would appear to be:

a) Inclusion of a barn without intensification of the farming system will result in a reduction in nitrogen losses, but at a significant cost.
b) The investment in a barn can be profitable conditional on intensifying the farming system (more cows/more feed), but dependent on milk price, feed costs, and capital costs.
c) Intensifying the farm system to make the barn profitable often results in a rapid erosion of the environmental benefits.

The results from the analysis are as follows:

Table 4: Kilogrammes Nitrogen loss per hectare (from the Milking Platform)

	Pre Barn	Post Barn	% change N Loss
Southland 1	15	18	20%
Southland 2	10	13	30%
Canterbury 1	45	43	-4%
Canterbury 2	53	41	-23%
Canterbury 3	9	6	-33%
Waikato 1	45	34	-24%
Waikato 2	15	22	47%
Waikato 3	24	17	-29%
Waikato 4	45	48	7%
Waikato 5	17	18	6%
Waikato 6	10	11	10%
Waikato 7	35	34	-3%
Waikato 8	16	21	31%
Bay of Plenty	45	45	0%

The main reason for the increase in nitrogen losses on a number of farms appear to be due to the intensification that occurred post barn i.e. more cows and/or more supplementary feed.

Financial benefits

Increased milk production

The main financial benefit from incorporating the barn was the increase in milksolids production, as a function of the increased feeding levels, and longer lactation period (which generally increased from circa 280 days to circa 300 days). This was both through earlier calving dates and extended lactation at the end of the season.

This increased milksolids production was valued at the base milk price of ($6.50/Kg MS) less the variable costs (animal health, breeding, dairy shed costs and electricity) associated with the increased cow numbers.

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Less pugging

This was valued in two ways:

1. The reduction in pugging (often assessed by the farmers at 10-20%) resulted in increased pasture production, which is captured via the increase milksolids production, and
2. The reduction in pugging often resulted in a reduction in the need for re-grassing. The value of this was captured via the reduction in area required to be regrassed or undersown and the cost of this as reported by the farmers (often around $700/ha).

Note: we did not include a value for the farmers' time and effort required for regrassing, nor the stress of pugged paddocks on the farmer.

Less fertiliser cost

In many respects a significant component of this fertiliser "saving" is in fact the transfer of nutrients into the farm system via the increased supplementary feed. This supplementary feed is bringing more nutrients onto the farm with a proportion of this being used as effluent. In the pre-barn situation (i.e. no barn) most effluent is deposited onto the paddocks anyhow; in a barn situation it is collected from the barn and deposited mechanically, often achieving a more even spread.

While all the farmers noted a saving in fertiliser usage, often the documentation of this was limited, and largely based on the farmers' assumptions. Never the less the value of the saving was directly entered into the analysis. However, the increased cost of spreading the additional effluent was included, reducing the cost saving of the lower fertiliser use.

Improved animal health/welfare

All farms reported an increase in cow condition, with many improving Body Condition Score by 0.5 – 1.0, and some South Island farms reported they had to make a conscious effort to reduce feeding levels to dry cows as they were getting too fat.

But apart from better condition scores and "happier" cows, direct animal health and welfare benefits varied but were not significant to the overall findings:

- Some farms reported an increase in lameness, others less
- Some farms reported an (at least initial) increase in mastitis and/or cell counts, others less
- Few reported any reduction in the proportion of empty cows or the proportion of cull cows
- Some reported a drop in the number of inductions necessary. Possibly due to better body condition score, but also possibly due to other management factors designed to phase them out anyhow given the industry directions
- Some reported better submission rates and a tighter calving spread, and

- Some farmers noted no real change in animal health issues post-barn.

All the farmers commented on the value of the barns as shelters during adverse weather, particularly cold wet winters. Within the analysis an allowance was made for this factor, in discussion with the farmer as to what value they thought reflected the benefit. This varied from $0 to $30 per cow.

Increased cull cow returns

This benefit related to two factors;

1. The increased number of cows run resulted in a corresponding increase in the number of cull cows, and
2. Given the improvement in body condition score, the cows were generally heavier (upwards of 50kg liveweight in many instances) and therefore the cull cows would kill out at a heavier rate.

This was incorporated into the analysis via an allowance for the heavier weight across all the cull cows, plus the full value of the extra cull cows. The value of this was based on the five year average manufacturing cow schedule.

This increased return from cull cows, was offset by the cost of rearing an increased number of replacement heifers to make up the number by which the herd had been increased. The cost of this was based on an allowance for rearing, plus the cost of grazing the animal for 18 months, totalling $876/animal.

Reduction in winter grazing costs

A number of the case study farmers grazed their cows off over the winter; these are now being wintered on-farm in the barn, and hence the grazing-off cost is now a saved cost, and included as a benefit.

Similarly, a number of the farmers grazed their cows on support block, while paying to graze their replacement heifers' off-farm. With the advent of the barn, the cows are now

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wintered in the barn and the heifers on the support block. Again this is a saved grazing cost, and included in the analysis.

Milk premiums

With the inclusion of the barn, associated elevated feeding levels and longer lactation meant that in all cases their production curve was relatively flat. In addition, many had altered their protein/fat ratios due to the feeding regime.

The result was that most were receiving a premium above the average milksolids price as a result of this flatter curve and/or higher protein:fat ratio. This varied from $0.00 to $0.09/kg MS, and was incorporated into the analysis. Several farmers were receiving premiums higher than this (up to $0.30/kg MS), some of which related to winter milk contracts. But these were in place prior to the barn, and hence did not constitute a "benefit" to the barn. However, having the barn does allow for the option of autumn calving and the production of winter milk if desirable.

Share dividends

More dairy company shares were required reflecting the increased milk production which was incorporated as a capital cost. The increased shares were valued at current prices ($6 for Fonterra shares at the time of the analysis) but were held at this value throughout the 20 year period. The dividend (for those Fonterra farmers) was also included as a benefit, at a value of $0.30 per share per year.

Labour

Some farms had increased the amount of labour on the farm as a result of the barn, typically by around 0.5 FTE, but varying from 0 – 1.0 FTE. This was charged at the current level of annual payment for a general farm worker at around $40,000.

While it was reported there is an increase in management ability required to run the barn system, this was not included as an additional cost in the analysis.

Supplementary feed

All the case study farms had increased the amount of supplementary feed being fed to the cows; a combination of supplementary feed/crops grown on-farm, and feeds purchased in.

The amounts and types of feed were collated for both the pre and post-barn situation, with the latter being the last full season (2013/14) so that they could be correlated with the level of milksolids production.

There were two aspects to the costing of this:

1. For any supplements harvested or crops grown on the milking platform or run-off, these were usually costed by the farmer at the actual cash cost at the time. While this is fine, the cost should include other factors such as time involvement and machinery depreciation. Within the analysis a function was included which allowed for both costings; the "farmer cost" which usually equated to between 10-20c/kg DM, and a "contractors" cost set at 20c/kg DM.

   Any bought-in feed was charged at the actual cost.
2. One of the major advantages for barn feeding cited by the farmers was the reduction in feed wastage. In most cases this reduced from 15-20% when fed in the paddock, to 2-5% when fed in the barn. This benefit is reflected in the increased milk production.

Operating costs

These operating costs related to two main factors; the operating costs for the barn, and the machinery used for feeding out etc. For the barn, the main costs were, repairs and maintenance, electricity and insurance.

As noted, the discount rate used was real, and therefore cashflows were not adjusted for inflation. The initial R&M costs for most barns were relatively low as the barns were fairly new. Therefore, this initial R&M cost was increased by 2% a year in recognition of the ageing of the barns, and the very likely increase in R&M as a result.

For machinery, operating costs included: fuel and oil, repairs and maintenance and insurance.

Adding value to the farm

Another factor relating to the value of a barn is the value it creates for the farm business; i.e. the construction of a barn would increase the capital value of the farm business/land & buildings.

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Discussion with some Real Estate Agents and Valuers indicated that they felt that this would be the case, but not necessarily directly proportional to the cost of the barn [e.g. if a $2 million barn is constructed on a $10 million farm, the farm is not then worth $12 million].

There was definitely a feeling that having a barn on a farm would be likely to result in a quicker sale but additional value would depend on the individual circumstances and performance of the farm.

Summary

All the farmers interviewed indicated the reasons for building a farm were related to management reasons which give peace of mind and control of feed, as opposed to financial or environmental reasons. All farms intensified post barn with either more cows and/or more supplementary feed.

An important feature mentioned by a number of the case study farmers was the level of management necessary, particularly around nutrition. With the incorporation of a barn and a more intensive system, the manager needs to have more attention to detail in feeding and stock management.

The results show that while 12 of the 14 financial study farms were making money, in the sense of returning a positive IRR, only six were meeting the discount rate of 8%. Two of the Canterbury farms were running at a negative IRR, a direct result of higher capital costs and higher feed costs.

The sensitivity analysis indicates that the two key drivers of profitability are milk price and feed costs; given that most of the farms are high input, and many were already operating a high feed input system prior to the barn, the marginal profitability of the extra supplementary feeding becomes very significant.

Similarly, capital costs are also very important in the farms ability to return a positive result.

The nitrogen leaching on most of the case study farms showed little overall change, the result of a more intensive system, and cropping regimes on some farms. However, none of the farms were currently aiming to optimise for environmental reasons or to achieve particular nitrogen leaching targets.

Overall the decision around a barn tends to be either/or: either you make money out of it, or you reduce the environmental footprint of the farm. It is difficult to achieve both. However, neither of these were the main reasons the farmers invested in the barn. In essence, the farmers are trading some climatic risks for financial risks.