The economic and nutrient loss impacts of constructing and running cow housing facilities -a case study of five South Island freestall barns

Matthew Newman[1] and Phil Journeaux[2]

[1] Dairy NZ
[2] AgFirst Waikato

Contributed paper prepared for presentation at the 59th AARES Annual Conference, Rotorua, New Zealand, February 10-13, 2015

AARES Conference Paper, February, 2015

The economic and nutrient loss impacts of constructing and running cow housing facilities -a case study of five South Island freestall barns

Matthew Newman (Dairy NZ) and Phil Journeaux (AgFirst Waikato)

Key points

- The objective of the study was to investigate the financial and nitrogen leaching impacts of constructing and running a free stall barn system in the South Island.
- The main reasons for building the barns were for management purposes, such as to prevent pasture pugging, improved conditions for cows and staff, and reduce the reliance on winter grazing contracts, not for financial or environmental reasons.
- In general, farms with barns are trading some of the climatic risks for financial risks.
- Incorporating a barn changes the farm system with more detailed management required, particularly around nutrition. Most farmers reported taking two-three years to adjust the system to a level they felt was appropriate.
- Three of the five farms had a positive Internal Rate of Return (IRR) but only one had a positive NPV, meeting the 8% discount rate.
- The capital costs, milk prices and feed prices all impact significantly on the financial outcome.
- The intensification of the farm system post-barn have resulted in increased or similar nitrogen leaching for most farms.

Introduction

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, particularly during the wet winter months, 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 require considerable capital investment and as a result farms usually intensify in order to justify the investment. This paper discusses the economic costs and benefits of constructing and running free stall barns on five case study dairy farms in the South Island. In particular it outlines the capital costs, changes in farm systems (production, 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®.

The analysis is an investment cost-benefit approach based on calculating the NPV and IRR over a 20 year cash flow, using a base discount rate of 8% real. Pre and post barn information was gathered from each of the five South Island free stall barn farms and used in the cost benefit analysis.

Reasons for building a barn

The reasons given by the farmers for building the barn, listed below, were predominantly farm management orientated and not due to financial or environmental reasons:

- Reduction of pugging in wet weather, particularly over the winter;
- Better utilisation of supplementary feed – reduced wastage of feed;
- Better control of grazing management and feeding;
- To eliminate the cost of wintering cows off-farm, and the problem of sourcing good grazing;
- As shelter for stock – in winter and summer;
- Better pasture recovery after a drought;
- Better cow condition – increased production;
- Less fertiliser required; and
- More pasture grown on-farm (from less pugging).

Methodology

The study involved five case study farms in the South Island; two in Southland and three in Canterbury. These farms were chosen as they were known by DairyNZ staff and were not considered at the extreme in terms of production systems. However, it is fair to say these farmers are better than average.

The farms were visited on two occasions. The first was to collect a range of information (described below) on the farm for two scenarios, pre and post barn:

- 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.

The analysis carried out was based on a 20 year investment analysis as discussed below, plus an analysis on any change in nitrogen leaching using Overseer® Version 6.1.3.

OVERSEER® is a farm decision support tool that assists in examining nutrient use and movements within a farm system and helps to analyse the impacts of on-farm changes on environmental parameters to optimise production and environmental outcomes.

Key assumptions

The investment analysis used a discounted cashflow approach over a 20 year period. This involved consideration of the capital costs of the barn, other infrastructure and additional machinery and equipment required to run the farm with the barn, plus the marginal costs and benefits associated with the barn, for example increased production offset by the increased feeding level and operating costs. These costs and benefits are described in more detail below.

The base discount rate used was 8% real (deflated for inflation and tax). This is the Treasury Guideline Rate, based on the "government opportunity cost of capital" (Treasury, 2008) which is generally recommended as the default discount rate in New Zealand. Sensitivity around this rate is shown in a later section.

The 8% real is calculated as follows;

WACC(real) = [(1+WACCn)/(1+i)]-1

Where:

WACCn = [RFR x (1-Tc) + (Ep x βa)] / (1-Te)

Tc (corporate tax rate) = 30%

Te (effective tax rate) = 20%

Ep (equity risk premium) = 7%

RFR (risk free rate) = 6.4%

i (inflation rate) = 3%

βa (asset beta) = 0.67

The base milk price used in the analysis is $6.50 per kilogramme of milksolids (kg/MS). This is the eight year average from 2008-09 though to, and including, 2014-15. Impacts of changing the milk price are discussed in the sensitivity section.

Capital Costs

Barn

The main capital cost was for the barn itself, accounting for 60-80% of the total capital cost. This cost includes resource consent, land preparation, and for a number of the farms the effluent system as this was an integral part of the barn.

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

Effluent system

This was included as a separate cost if not already included as part of the barn cost. If separate to the barn cost, the capital cost of the effluent system was included in the "other farm infrastructure" and again depreciated (at the IRD "Shed & Yard" rate of 6% diminishing value) to arrive at a salvage value in the 20th year.

Other farm infrastructure

This varied between farms, but included additional features such as:

- Concreted feed storage bunkers;
- Concreted 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

All farms with the exception of Southland 1 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:

- 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. The cost against the barn was calculated as: replacement cost less [original cost less depreciation] x proportion of time involvement in the barn.

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

In most 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.

Dairy Company Shares

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.

Again 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 are provided in Table 1:

Table 1: Summary of analysis at 8% discount rate [using Contractors' values for feed]

	Total barn and machinery cost $/cow[1]	Peak cows milked (post barn)	milksolids/cow (post barn)	NPV	IRR
Southland 1	$2,300	852 (+52)	568 (+11%)	$51,760	8%
Southland 2	$3,300	572 (+21)	559 (+20%)	-$762,308	3%
Canterbury 1	$3,600	1,150 (0)	565 (+6%)	-$1,054,575	1%
Canterbury 2	$3,900	540 (+40)	661 (+12%)	-$2,559,189	-7%
Canterbury 3	$5,800	950 (+100)	463(+22%)	-$8,754,479	-17%

The farms visited for this analysis ranged in size from 540 cows to 1,150 cows after the barn was constructed. The number of cows increased from 4-12% (+20-100 cows) on all but the Canterbury 1 farm which held numbers similar to pre-barn levels. Milk production per cow increased between 6 and 22% reflecting increased feed levels and longer lactation period. Overall, with the exception of Southland 1, all the farms had a negative NPV, indicating they were not achieving the 8% real return on capital. All but the Canterbury 2 and 3 farms were returning a positive Internal Rate of Return (IRR). The initial expenditure on capital had a strong influence on the NPV.

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.

This would indicate that the "breakeven" milk price level is in the order of $7.50+/Kg MS, in the sense that at this price level, the majority of the farms are returning a positive IRR, and many are achieving the 8% discount rate or better. At the current milk price levels of around $5/Kg MS only Southland 1 has a positive IRR.

[1] Excluded from this column is the capital associated with the additional cows and milk company shares. The number of cows is the capacity of the barn which will not necessarily be the same as Peak cows milked

Environmental Impact

The case study farms were analysed using Overseer® V6.1.3 to determine the impact of the barn on nutrient losses, particularly nitrogen, comparing the pre barn versus post barn situation. 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. This is discussed further below.

A caveat is also required; in its current form Overseer is not well set up to handle wintering barns, and some anomalies arose as discussed below. 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.

The results from the analysis are as follows:

Table 2: Kilogrammes Nitrogen loss per hectare from the Milking Platform

	Pre Barn	**Post Barn**	**Difference**
Southland 1	15	19	27%
Southland 2	11	13	18%
Canterbury 1	43	56	30%
Canterbury 2	28	27	-4%
Canterbury 3	8	7	-13%

Comment

1. The Canterbury farms incorporated their run-offs directly into the farm operation, mostly by growing crops on the run-off which were then transported to and fed out within the barn.

   In this respect a truer picture of nitrogen losses would require incorporation of the run-off within the analysis. Unfortunately there was not sufficient information to readily do this for the Canterbury farms.

2. All but Canterbury 1 and to a lesser extend Southland 1 show not much change in nitrogen loss from pre-barn to post-barn.

3. Canterbury 1 and Southland 1 have both shown an increase in nitrogen losses in the post-barn situation. One of the reasons for this, apart from an increase in the intensity of farming, was that they incorporated a cropping regime as part of the supplementary feed plan for the barn.

   Using Canterbury 1 as an example, if the cropping regime is removed, the nitrogen losses post barn are very similar to the pre-barn losses (45 vs 43kgN/ha)

Table 3: Canterbury 1 N losses per hectare under different options

	Pre barn		**Post barn**		**Difference**	
	Cows grazed off	**Cows grazed on**	**With Crop**	**No crop**	**Cows on vs with crop**	**Cows on vs no crop**
Canterbury 1	37	43	56	45	+30%	+5%

The heavier soil types (Southland 1 & 2, Canterbury 3) show markedly lower nitrogen losses. Canterbury 3, with a heavy soil type and low rainfall showed a particularly low leaching level.

Impact of the barn on nitrogen losses

Research (Christensen et al, 2010, De Klein and Ledgard, 2010) has shown that the use of wintering barns, in the absence of intensified systems, can have a significant benefit in reducing nitrogen losses from dairy farm systems, of up to 41%.

Modelling work by Journeaux (2013) using Overseer showed the inclusion of a barn on a typical Tararua farm, in the absence of farm system intensification, gave a 34% reduction in nitrogen losses.

A key component of this reduction was the use of the barn as part of an off/on grazing system over the summer and autumn, to reduce nitrogen build-up within the soil over this period. All the case study farmers used this grazing system as part of their overall management system.

Within this analysis a scenario was modelled using Overseer to consider nitrogen losses where a barn was incorporated into the farm, but in the absence of any intensification (i.e. more cows/supplementary feeding). The results of this are as follows:

Table 4: Kilogrammes Nitrogen losses per hectare with the advent of a barn, without any intensification of the farming system.

	Pre Barn	**Barn, no extra cows/feed**	**Difference**
Southland 1	15	15	0%
Southland 2	11	13	18%
Canterbury 1	43	34	-21%
Canterbury 2	28	27	-4%
Canterbury 3	8	6	-25%

Why the nitrogen losses have increased or remained static for Southland 1 and 2 as illustrated in Table 4, is unknown; the only difference was the inclusion of a barn in the Overseer file – all other parameters, e.g. number of cows, production, feed and fertiliser inputs, remained the same, while the effluent area was expanded proportionally to handle the barn waste. The issue has been referred to the Overseer help service, but no comment has been received. It appears to be linked to the drainage sensitivity and these farms are all low drainage soils ('heavy soils'), as is Canterbury 3.

Phosphorous Losses

Similar to the nitrogen situation, the Overseer analysis showed the following impacts on phosphorous losses:

Table 5: Modelled P losses (kg/ha)

	Pre Barn	Post Barn	Difference	Barn, no extra cows/feed	Difference
Southland 1	0.9	1.1	22%	0.9	0%
Southland 2	2.1	2.6	24%	2.6	24%
Canterbury 1	0.8	0.7	-13%	0.8	0%
Canterbury 2	0.9	1.1	22%	1.0	11%
Canterbury 3	0.6	0.8	33%	0.7	17%

As can be seen from Table 5, phosphorous losses have generally risen (Canterbury 1 excepting) following the construction and use of a barn; possibly the reduction in pugging is offset by a general increase in treading as a result of increased cow numbers, and increased cropping on many of the farms.

The barn/no intensification scenario has either shown an increase in phosphorous losses (3 farms), or neutral (2 farms), relative to the pre-barn situation. It is not clear why this has occurred.

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 increased milksolids production was valued at the base milk price of ($6.50/Kg MS) less the variable costs associated with the increased cow numbers. If these variable costs were unavailable for the farm, the average 2012-13 Dairy NZ Economic Survey figures for the relevant regions, were used for:

- Animal health;
- Breeding;
- Dairy shed costs; and
- Electricity.

Less pugging

This was valued in two ways;

(i) 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

(ii) 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 re-grassing, nor the stress of pugged paddocks on the farmer.

Less fertiliser cost

This benefit relates to the increased effluent capture from the barn, compounded by the increased feeding level, and the return of this effluent to the farm, thereby reducing the need for other fertiliser input.

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. In the non-barn situation 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 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;

(i) The increased number of cows run and therefore a corresponding increase in the number of cull cows, and
(ii) 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 a run-off, while paying to graze their replacement heifers' off-farm. With the advent of the barn, the cows are now wintered in the barn and the heifers on the run-off. 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/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) but were held out this value throughout the analysis. The dividend (for those Fonterra farmers) was also included as a benefit, at a value of $0.30 per share per year.

Labour

The vast majority of the case study 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 of fed 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:

(i) 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 25c/kg DM.

The different impacts of these costings are discussed in the results section.

Any bought-in feed was charged at the actual cost.

(ii) 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.

Non-Economic Factors

All of the case-study farmers expressed a high degree of satisfaction around having the barn, apart from any economic considerations. Possibly, having just made a multi-million dollar investment they weren't keen to criticise it, but all spoke in a similar vein around:

- The ease and flexibility of management the barn provided, especially when dealing with adverse weather;
- Better working conditions for the farmer and staff, e.g. not picking calves up in mud, wading through muddy paddocks, warmer/drier within the barn;
- More content cows, both with respect to being in better condition (from better feeding), and being able to shelter from the weather, with shelter from the summer sun as important as from winter storms; and
- Less treading damage to pastures.

In this respect therefore, the farmers were definitely putting a high intangible value on the barn. This is perhaps illustrated by a comment from one of the farmers, when queried about the cost of a loafing area component as part of the barn complex: "*Bugger the cost, I wouldn't do without it*".

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.

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].

They felt that any increase in the value of the farm would be proportional to the increase in production resulting from the barn system. For example, if production increased from (say) 1,500kg MS/ha to 2,000kg MS/ha, then the farm value would increase proportional to the value of the extra 500kg MS/ha, but that this extra value would also be proportional to the marginal value of the extra production, given the extra cows and supplementary feed required for the extra production [e.g. if the farm was worth $50/kg MS prior to the barn, the extra 500kg MS/ha would not necessarily be valued at $50, but at the marginal value of the extra 500kg].

There was definitely a feeling that having a barn on a farm would be likely to result in a quicker sale.

In many respects the “adding value” aspect would relate to the individual circumstances of the farm and the performance of the barn system.

Summary

The objective of the study was to investigate the economics of wintering barns, and their environmental footprint measured in terms of nitrogen leaching via Overseer®.

Most farmers were motivated to build a wintering barn for farm management reasons; for example to prevent pugging, to improve working conditions, to improve the flexibility of grazing management, provide shelter for cows during adverse weather, and to reduce the cost and loss of control of wintering cows off-farm.

In many respects these objectives have been met by the case study farmers. There were also other objectives, albeit not readily stated; the desire to make a return out of the investment, and to reduce the environmental footprint of the farming system.

The results show that while three of the five study farms were making money, in the sense of returning a positive IRR, only Southland 1 was 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 operating a System 4-5 programme, 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. As noted in the commentary, many farmers were reporting the cost of feed harvested on-farm at the direct cash cost to themselves; in any analysis it is important to consider “hidden” costs such as depreciation and time involvement as well.

Similarly, capital costs are also very important in the farms ability to return a positive result. Of particular note is that the capital cost of the barn is only part of the story; additional costs around machinery and other farm infrastructure added a further 10-40% 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.

This total cost is also important in that relative to the increased milksolids production, the total cost of the barn per kg milksolids is, for most of the South Island farms, equivalent to the purchase price of more land.

An important feature mentioned by a number of the case study farmers was the level of management necessary. With the incorporation of a barn and a more intensive system, the farmer or the sharemilker needs to be able to step up to manage this.

There are some limitations with the analysis. A key aspect of this is that for most of the case study farms the incorporation of the barn into their farming system is at an early stage and therefore the post-barn data is limited. All the farms in this situation are in a transition period as the farmers learn about optimising the barns, 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. 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 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, Canterbury 1 (+30%) and Southland 1 (+27%) recorded moderate increases. For phosphorous losses, four of the case study farms had increased losses, with one declining.

In the situation where a barn was modelled but no intensification of the farm system was attempted, most farms had little change in nitrogen loss compared to the pre-barn situation. However, Canterbury 1 recorded a 21 per cent (9 Kg N/ha) reduction.

Notwithstanding some of the anomalies with using Overseer (which are difficult to explain), the general pattern would appear to be:

(i) Inclusion of a barn without intensification of the farming system will result in a reduction in nitrogen losses, but at a significant cost.

(ii) 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.

(iii) Intensifying the farm system to make the barn profitable often results in a rapid erosion of the environmental benefits.

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. It was related to management reasons which give peace of mind and control of feed. In essence, the farmers are trading some climatic risks for financial risks.