

# COW HOUSING SYSTEMS– AN ECONOMIC ANALYSIS

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## **Abstract**

Farming within limits is the new reality for New Zealand's dairy industry. Dairy farmers in New Zealand are challenged with lifting the overall environmental performance and compliance of their farm systems. At the same time, there is a need to maintain or increase productivity and profitability. This paper identifies that changing farm systems through additional infrastructure investment is a compliant yet profitable approach to farming with the limits of regulation. Cow housing systems using woodchip bedding and slatted concrete flooring are identified as compliant farm system infrastructure investments. Both housing systems incorporate duration controlled grazing, supplementary feeding systems and nutrient management ability.

Financial analysis of these farm systems has been performed using data provided by case farmers, academic publications and industry sources. The analysis showed per cow cost of installing housing infrastructure ranging between \$900 for the woodchip system and \$1750 for a concrete slatted system. Analysis of the financial benefits indicates the annual benefit ranges between \$200 and \$400 per cow subject to on-farm management decisions.

Ten Year Financial modelling within the parameters of 300 cows each fed 500kg of maize silage and a \$6.50 proxy farm gate milk price was used to calculate the net present value of investment in cow housing infrastructure with a 6% discount rate. The net present value of a woodchip bedding system excluding financing cost was \$236,346. The concrete slatted flooring had a net present value excluding financing cost of \$239,572. End of year cash flows modelled under the same parameters show the woodchip floor to return \$32,112 and the concrete slatted floor to return \$32,551 in the first year of operation. Return on invested capital for the first year of operation was 11.34% for the woodchip bedding and 7.20% for the concrete slatted floor. Overall net present value of ten-year revenues increased by 5.00% and 4.91% for the woodchip bedding and concrete slatted systems respectively when compared to the status quo farm system. This paper recommends the use of cow housing systems as cash positive farm systems capable of generating both increased production and environmental performance under regulation.

## **Introduction**

The need to adapt farming systems for environmental compliance and profitability has been a leading driver of recent shifts by the dairy industry to incorporate cow housing systems. This paper analyses the use of woodchip bedding and slatted floor cow housing systems for the Waikato region, giving cross case analysis of the associated economic costs and benefits for installing these cow housing systems as environmental compliance infrastructure. The challenge facing dairy farmers is maintaining or increasing their on farm profitability whilst achieving a high standard of environmental performance, specifically nutrient management. Cow housing systems have been identified as suitable infrastructure investments for maintaining or lifting profitability while reducing the loss of nutrient to both water and atmosphere within the Waikato region. The cost of environmental compliance in

implementing suitable farm systems has significant and lasting effects on farm profitability. The following analysis models ten year cash flows associated with the woodchip and slatted floor housing to justify investment in a compliant yet profitable dairy farm system.

### **Context**

The 2008 Environment Waikato report, *The condition of rural water and soil in the Waikato region- risks and opportunities*, states: “Monitoring shows that important aspects of soil and water quality are deteriorating across intensively farmed areas of the region.” Specifically nutrient concentration in water is increasing” (Environment Waikato 2008). It is from these monitoring surveys that heavier regulation and compliance structures have been placed on agriculture within the region in accord with the National Policy Statement for freshwater. Underpinning this shift toward increased environmental regulation is the additive effect of intensification. With larger herd sizes and a higher concentration of cows per hectare, traditional farming practices used under traditional dairy systems now compound the environmental impact of dairy causing a declining trend across key performance indicators such as nitrogen loss per hectare. Adding profitable farm system infrastructure has been identified (Wheeler et al., 2006) as an effective way to adapt whole farm systems for compliance. The economic cost of adding compliance infrastructure can be a catalyst for farmers to change the on-farm management regime outside the intended infrastructure planning as options to increase production per cow and per hectare occur. For cow housing infrastructure, management of the farming system with regard to stocking rate and supplementary feeding must be in accord to the intended design specifications of the housing system. Failure to do so results in unintended cost and greater nutrient loss. This emphasises the need to understand the long term physical and financial implications of cow housing infrastructure specifically with regard to the intended compliance benefits.

### **Assumptions**

Analysis of the two cow housing systems was conducted using a scenario model of a typical Waikato farm system. Ten year financial modelling was performed within the parameters of 300 cows each fed 500kg of maize silage and a \$6.50 proxy farm gate milk price. These parameters were used to calculate the net present value of investment in the two cow housing systems using a 6% discount rate.

### **Cow housing and duration controlled grazing systems**

A reduction in the ecosystem interaction can be achieved through duration controlled grazing therefore positioning the practice as a key component in a compliant dairy system. These systems have been shown to reduce nitrogen leaching by ~50% on dairy farms (de Klein & Ledgard, 2001; Christensen et al., 2011). This is achieved by limiting the grazing window in which cow urine is able to be deposited on pasture, instead directing this to the controlled collection and storage area within housing system. Collecting and controlling this effluent represents a greater environmental control for the farm system and the nutrient value of this effluent can be applied to land evenly, avoiding high concentration patches as well as targeting the nutrient toward areas of lower fertility on the farm.

Through minimising pugging damage (winter) and overgrazing (summer) cow housing systems preserve both the quality and quantity of pasture grown. Removing cows from pasture at key times is shown to increase annual dry matter production by 0.5-2.0 tonnes per hectare annually. Within these systems, financial benefit is derived from the value of additional pasture grown and reduced undersowing cost of 90%. For the average Waikato farm with cow housing a \$5400 reduction in pasture renovation cost was calculated.

Improved feeding infrastructure is shown to improve feed utilized by 15% under best management practices. For a farm feeding 500kg of maize silage per cow annually a 15% increase from 70% utilization to 85% results in an additional 75kgDM of feed available.

Nutrient value of effluent for the two housing systems was assumed to be the value of nutrient above that which was cycled within the existing farm system. In essence this was the value of nutrient imported in supplement feed and the increased value from the improved utilization of the nutrient in growing a maize crop. An additional cost of maintenance fertilizer of \$1200 annually was applied to replace the transfer of nutrient in effluent from the milking platform in the existing system to the cropping block under a capture and spread housing system.

### **Woodchip bedding system**

Woodchip bedding systems are predominately a cow standoff facility used to house the dairy herd away from pasture in a duration controlled grazing system. The design of a woodchip bedding system gives each cow 6-10 square meters of loafing space ensuring sufficient space for extended periods of housing off pasture. An untreated woodchip based product is used as soft floor bedding for cows in which effluent is captured and absorbed. A clear roofing system protects both cows and the bedding product from moisture and allows sunlight to enter the shelter enabling drying of the flooring product. Further, sunlight encourages micro-organism activity to break the effluent down. Woodchip flooring is replaced between one and three years of use allowing the farm to distribute the current high carbon, nutrient rich bedding as fertilizer to either the milking platform or maize/cropping ground. The nutrient value of the bedding is further increased with many shelters utilizing concrete feed strips to add supplementary feed grown off-farm to the cows. The import of nutrient adds to the concentration of existing nutrient, improving value of effluent above that cycled within the existing farm system.

Animal welfare within a woodchip bedding system is improved with 6-10 square meters offered per cow. Trial work (Verkerk, 2011) shows a higher portion of the herd to loaf on woodchip bedding when compared to standoff on concrete surfaces. The benefit of cows resting during stand-off results in higher pasture uptake once returned to the paddock as the cow does not require time sitting down to recover (Verkerk, 2011). Mastitis concerns from loafing on damp woodchip during peak use are eliminated through the use of teat sealing.

### ***Financial Analysis***

The woodchip bedding system has an installed cost of \$900-\$1000 per cow. At an industry average stocking rate of three cows per hectare the shelter has an initial cost of \$2850/ha. Annual interest expense calculated on a per cow basis totals \$57.00 at 6.00%. Of the total installation cost, 'consent and consultancy' (2.1% of total cost) is the only fixed cost. The remaining total cost is proportionate to the scale of the project as a multiple of cow numbers. Bedding product is purchased as a by-product of the forestry sector at \$15-\$25 per cubic meter (m<sup>3</sup>) on-farm. Under the woodchip bedding system each cow requires 8m<sup>2</sup> loafing space with a bedding depth of 450mm. Per cow bedding requirements therefore equate to 3.6m<sup>3</sup>. The per cow cost for this (assume \$20/m<sup>3</sup> average price) is \$72. At 18-month replacement intervals bedding has an annual cost of \$48/cow while a 24-month interval reduces this cost to \$36/cow annualised.

Application of bedding to land as an effluent fertilizer product by contractor incurs a cost of \$155/per hour. At 3.6m<sup>3</sup> of bedding per cow, contractors can spread the bedding of nine cows per hour. This results in a per cow application cost of \$17.20. At 18-month intervals this incurs an annualised per cow cost of \$11.50/cow or 24-month intervals at \$8.60/cow. Production efficiency is gained through feed conversion efficiency. The use of a woodchip bedding system keeps cows warmer and cooler seasonally, reduces walking demand and reduces overall maintenance feeding required. Combined, these benefits result in feed conversion efficiency between 5 and 15 grams of milk solid per kilogram of feed eaten, lifting overall production.

Analysis of the effluent within housed stand-off pad bedding shows each cubic meter of bedding to contain 3.0kg of N, 1.5kg of phosphorus (P) and 1kg of potassium (K) after 18 months of use. With 3.6m<sup>3</sup> per cow, the per cow nutrient value of effluent within a woodchip bedding system is 10.8kg of N, 5.4kg of P and 3.6kg of K.

### ***NPV calculations***

Investment in a woodchip bedding system at this scale generates an internal rate of return of 14.46% Initial borrowings of \$283,000 repaid over 10 years result in discounted annualized repayment cost of \$38,415. Net cash inflows after borrowing and repayment cost specific to the woodchip bedding system provide the farm system with a ten year cash balance from investment of \$331,924. Annual return on investment for the first year is calculated as 11.34%. Comparing total revenue between status quo and woodchip bedding, the ten year net present value of revenues increases from \$4,879,737 to \$5,123,788 an increase of 5.00%.

### **Slatted floor system**

Slatted floor technology is used on farm as a feed platform, standoff area and effluent storage facility. Installing slatted floor housing is an effective way to improve farm infrastructure where one or many of the above systems do not exist. Implementing a slatted floor system involves using the shelter as a farm management tool to achieve reduced environmental impact, enhanced animal welfare, improved staff management and increased profitability. Slatted floor standoff commonly uses clear roof structures setting the design apart from traditional cow housing and allows a cleaner, drier and lighter housing environment.

The slatted floor system provides a self-contained, self-managed effluent system. A bunker below the slatted floor collects all farm dairy effluent created during stand-off periods without the need for pressured water wash down or scraping. In adding a slatted floor system to the farm, the effective effluent storage requirement is decreased by both the storage within the slatted floor system and the diversion of rain water from the stand off area and the feeding area. The concrete design of the slatted floor system bunker future proofs the effluent system and meets council requirements for a sealed and compliant farm dairy effluent storage facility. Effluent is captured in the bunker and later applied evenly when the soils can handle the nutrient loading without risk of run off or over application.

Production efficiency is achieved by the slatted flooring system through managing the cow environment. The use of ventilation, roof design and shade cloth allow the slatted floor system to manipulate the temperatures within the shelter reducing heat stress in the summer and diet requirements for warmth in the winter. Farmers observed greater improvements in cow condition since using the slatted floor housing compared to beforehand. These farmers reported that average cow condition scores improved by 0.5 over winter months.

### ***Financial Analysis***

The slatted floor system, like all cow housing, is built and scaled per cow rather than per hectare. This allows the system to function under the correct stocking rate for maximum efficiency. Slatted floor systems range in cost from \$1000-\$1750 per cow installed. At a stocking rate of three cows per hectare, this incurs a cost of \$4500 per hectare. At a standard installed cost of \$1500 per cow the annual interest expense expressed per cow equates to \$90 at a 6% interest rate. Slatted floor systems have limited on-going season costs beyond the cost of removing and spreading effluent. With standard use, the under-floor bunker requires emptying annually. The cost of emptying the bunker is dependent on the on-farm management of effluent consistency. Assuming best practice the cost to remove and spread effluent from the bunker is \$20/cow annually.

The imported nutrient value of effluent is considered a financial advantage for the slatted floor system with effluent able to be managed in liquid, slurry and solid form. Integrating maize and other crop rotations into the farm system, the imported and captured nutrient value can be utilized as fertilizer and therefore reducing the on farm fertilizer costs. The economic benefit of nutrient is calculated as the value of nutrient above that which is cycled and transferred through the existing farm system. Managing the nutrient status of 'blocks' within the farm system is crucial to maximizing the financial benefit of nutrient with a slatted floor system.

### ***NPV calculations***

Annual operating cost of the slatted floor system of \$7400 are offset by \$101,363 of benefit giving a net annual benefit of \$93,963 excluding financing costs. Borrowings of \$452,000 result in annual repayment costs of \$61,412. Net annual increase in cash flow after borrowing and repayment cost totals \$32,551 for the first year giving an annual return on investment of 7.20%. The ten year internal rate of return was 9.55%. This gives a ten year residual cash balance from investment of \$325,507. For the farm system to remain at status quo the annual revenue as a function of farm gate milk price is \$663,000. Using a discount factor of 6%, the ten year net present value of revenue is \$4,879,738. Analysis of a farm with slatted floor system installed shows ten year discounted revenue of \$5,119,341, an increase of 4.91%.

### **Discussion and conclusion**

***Table: Summary Statistics***

	<b>Woodchip</b>	<b>Slatted Floor</b>
<b>Total cost @ 300 cows</b>	\$283,000	\$452,000
<b>IRR</b>	14.46%	9.55%
<b>Yr 1 ROI</b>	11.34%	7.20%
<b>Increase in 10yr NPV</b>	5.00%	4.91%

Investment for compliance can be conducted in two key ways: as compulsory investment in compliant infrastructure or as an investment into a farm system. The woodchip bedding and slatted floor systems are classified as an investment into a farm system. Both the woodchip bedding and the slatted floor system provide farms with technology and infrastructure to address compliance issues regarding effluent management and control of nitrogen losses within a profitable farm system. The ability of dairy farmers to adapt their farm systems

sustainably to proposed regulation will be a key determinant of dairy's continued strength in the national economy as well as the industry's perception to the New Zealand public. Two farm systems the woodchip bedding system and the slatted floor system have proven the cost of compliance is a recoverable cost when invested in a whole farm system. Differences between the two housing systems are predominately the initial capital cost and the operating expenditure requirements. Matching the cow housing system to the requirements and parameters of the farm and farmer will be a determinant for future investment in housing systems. Sector profitability will inevitably influence the move to compliant cow housing systems describe above as the initial cost to these systems remains high. An environmentally compliant yet profitable dairy industry is highly achievable through considered investment in sustainable farm systems. Sustainable farm systems such as the woodchip bedding and slatted floor housing systems change environmental compliance from a cost to a benefit.

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