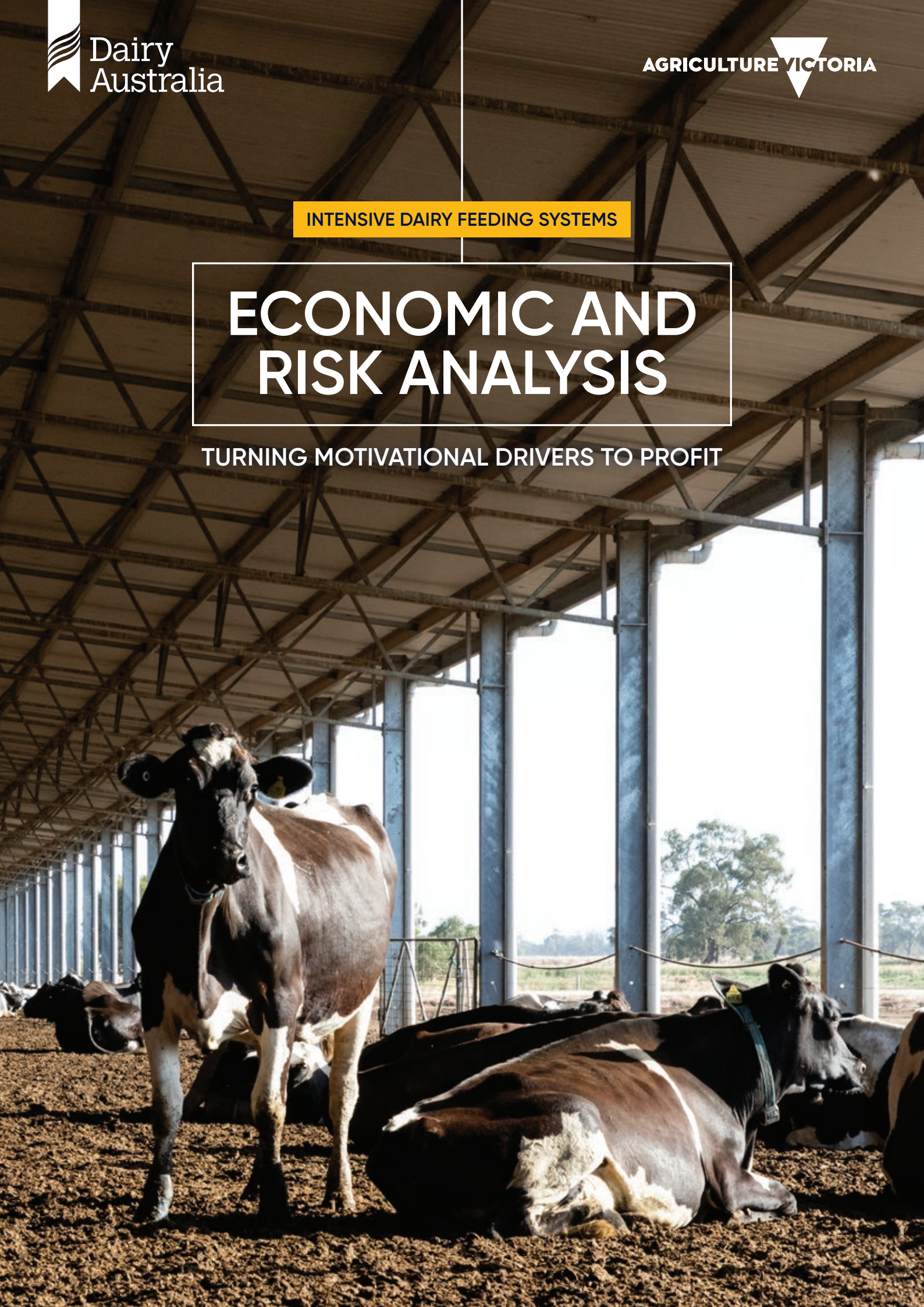
Dairy Australia

AGRICULTURE VICTORIA

INTENSIVE DAIRY FEEDING SYSTEMS

ECONOMIC AND RISK ANALYSIS

TURNING MOTIVATIONAL DRIVERS TO PROFIT



ECONOMIC AND RISK ANALYSIS OF INTENSIVE DAIRIES – KEY MESSAGES

Many northern Victorian dairy farmers are transitioning their production system towards intensive, zero-grazing systems in response to the pressures of climate change, irrigation water availability and pricing and market volatility.

A new study has collated and analysed the financial performance of seven total mixed ration (TMR) farms in northern Victoria over a five-year period from 2016/17 to 2020/21. The analysis provided foundational knowledge of the factors contributing to making these systems profitable and identified areas for future analysis.

The TMR farms in the study received a milk price premium and, in later years (2018/19 to 2020/21), a less variable milk price which covered higher feed costs, compared to farmers in the northern Victoria sample of the Dairy Farm Monitor Project (DFMP).

The TMR farms were also found to be more profitable compared to the northern Victoria DFMP farms. Herd size was not an indicator of farm profitability for the surveyed farms with the most profitable TMR farms ranging from 450 to 1,200 cows.

Individual profiles of TMR farms reflect a range of challenges, opportunities, pathways and infrastructure investment. Most TMR farmers navigated their transition as a progression over many years to determine the most appropriate feeding system to suit requirements. They also highlighted the need to understand the risks associated with implementing zero-grazing systems successfully.

The in-depth risk modelling found that if a combination of benefits was achieved, the return (profit) and risk (variability in profit) of a TMR system can be comparable with a conventional grazing system (the base farm). However, if such benefits are not achieved, the variation in profit and financial risk associated with the capital expenditure can become difficult to manage.

Important factors to manage the variability in profit and financial risk were found to include:

- A strong and stable milk price: a milk price premium ($0.50 per kilogram of milk solids above the average price) and reduced variability between years (half the range of the base farm).
- Achieving high feed conversion efficiency through the transition and beyond: return from investment in a TMR system can be affected if the target feed conversion efficiency is not met soon after implementation.
- Resources and management skills for homegrown feed production can limit the exposure to the purchased feed market: the quantity of homegrown fodder that can be produced should be a key factor when planning a TMR development and used to help determine the number of cows to be milked.
- A decrease in purchased feed prices: a decrease in average grain price ($15 per tonne dry matter) and the same range as the base farm.
- A high initial equity position: the risk from a low initial equity position (65 per cent) can be managed, however the business would become vulnerable if it invested in a TMR system without achieving the above benefits that help manage variability in profit.

The economic performance of the TMR system examined had limited sensitivity to grain, fodder and irrigation water prices to due relatively low exposure to the purchased feed market.

Areas for future research were identified and included measuring and monitoring TMR farm performance over time, more accurate representation of the feedbase, disaggregating cost categories and understanding how TMR farms manage less favourable operating conditions. Future work for the risk modelling could involve investigating the risk and return of other farm development options.

These findings will be used to design a framework that supports dairy farmers currently changing their feeding system or considering a change.

This project does not advocate one type of feeding system over another. Rather the findings and conclusions presented in this report can be used as another source of information for those farmers considering and/or operating a TMR system to assist in evaluating their options.

TURNING MOTIVATIONAL DRIVERS TO PROFIT

Many northern Victorian dairy farmers are transitioning their production system towards intensive, zero-grazing systems in response to the pressures of climate change, irrigation water availability and pricing, and market volatility.

Qualitative research by Nettle *et al.* (2021) found that dairy farmers in the region who had intensified their business were motivated by maximising efficiencies in feeding and milk production, which was made possible by exploring contained housing options. Other motivators were a changing water situation in northern Victoria, an ongoing process of farm and business growth, animal welfare benefits (particularly in heat wave and flooding events) and addressing farm workforce issues.

An economic and risk analysis of dairy farm systems transitioning towards zero-grazing was undertaken to increase the understanding of the factors contributing to making these systems profitable. Farm data were collated and analysed from seven total mixed ration (TMR) farms in northern Victoria over a five-year period from 2016/17 to 2020/21. The performance of the TMR farms was compared to the northern sample of the Victorian Dairy Farm Monitor Project (DFMP). An analysis of converting a grazing farm to a zero grazing TMR system was conducted using a case study farm to identify the important factors to successfully manage the variability in profit and financial risk associated with the change to a TMR system. This is complementary to the retrospective farm data collection and analysis of the seven TMR farms.

The key findings from the two studies were:

- The TMR farms were found to be more profitable compared to the average northern Victorian DFMP farms as measured by return on total assets. However, compared to the Top 25% of DFMP farms in northern Victoria, the TMR farms had lower returns.
- The case study farm analysis found that the variability in profit associated with a TMR system can be managed if a combination of benefits is achieved with a strong and stable milk price, a decrease in average grain price and high feed conversion efficiency.
- Both studies highlighted the importance of a high initial equity position before moving to TMR feeding system.

These findings will be used to design a framework that supports dairy farmers currently changing their feeding system or considering a change. It also provides a basis for monitoring ongoing performance, that will reveal further valuable insights, and help inform other farmers in the region with their transition to a TMR system.

This project does not advocate one type of feeding system over another. Rather the findings and conclusions presented in this report can be used as another source of information for those farmers considering and/or operating a TMR system to assist in evaluating their options.

Comparative analysis of TMR and northern Victorian DFMP farms

Profit

Profitability of the TMR farms analysed generally increased over the last five years (Table 1), as measured by earnings before interest and tax and return on total assets. The exception was 2018/19, a particularly challenging seasonal and operating environment for northern Victoria dairy farms. Farm profit for northern Victorian DFMP[1] dataset followed the same trend.

The TMR farms had higher profit than the average northern Victorian DFMP farms (measured by return on total assets). The TMR farms also had a higher tenth and ninetieth percentiles in each year which helped minimise the losses in the challenging years. Compared to the Top 25% of DFMP farms in northern Victoria, TMR farms had lower profit. The Top 25% of DFMP farms had lower feed costs, mostly due to positive changes in feed and inventory reserves as cash costs were higher.

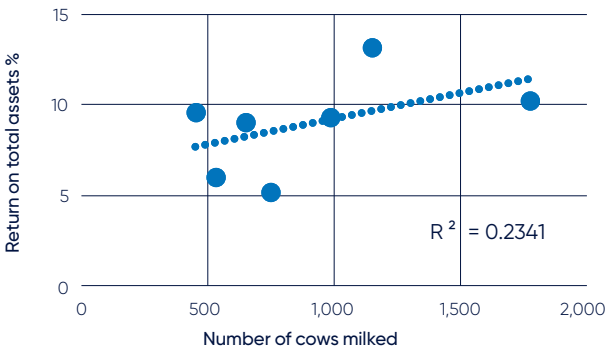
There were no clear economies of size between the profitability of the TMR farms and herd size nor milk production (Figure 1). The relationship between profit and herd size for smaller scale farms (less than 450 cows) could not be assessed due to the low number of farms selected for the analysis.

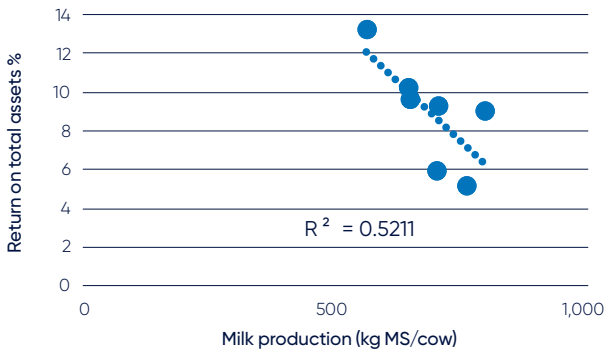
Table 1 Average profitability of Victorian TMR and northern Victorian DFMP farms between 2016/17 and 2020/21

	2016/17	2017/18	2018/19	2019/20	2020/21
TMR farms Earnings before interest and tax ($/kg MS)	0.46 (-0.60 to 1.64)	1.16 (0.64 to 1.98)	0.80 (-0.06 to 1.65)	1.16 (0.66 to 1.68)	2.07 (1.43 to 2.60)
DFMP northern Victoria Earnings before interest and tax ($/kg MS)	0.37 (-1.16 to 1.39)	0.67 (-0.25 to 1.54)	-0.51 (-2.7 to 1.2)	1.27 (0.16 to 2.27)	1.75 (0.85 to 2.74)
DFMP northern Victoria Top 25% Earnings before interest and tax ($/kg MS)	1.51 (0.86 to 2.41)	1.68 (1.31 to 2.22)	1.50 (1.00 to 2.25)	2.10 (1.47 to 2.68)	2.39 (1.43 to 3.27)
TMR farms Return on total assets	2.0% (-2.2% to 6.5%)	5.2% (2.6% to 8.7%)	3.5% (-0.3% to 8.6%)	5.2% (2.3% to 9.3%)	8.9% (5.6% to 11.4%)
DFMP northern Victoria Return on total assets	0.9% (-4.2% to 4.9%)	2.5% (-0.8% to 6.3%)	-1.9% (-8.7% to 3.1%)	4.1% (0.1% to 7.7%)	5.8% (3.0% to 10.1%)
DFMP northern Victoria Top 25% Return on total assets	5.3% (3.9% to 7.2%)	6.3% (4.9% to 7.9%)	3.9% (2.8% to 5.7%)	7.7% (6.2% to 9.2%)	10.3% (8.2% to 12.2%)

Corrected for inflation. The data in the brackets shows the tenth and ninetieth percentiles

Figure 1 Relationship between number of cows milked (left) and milk production (right) and farm profit as measured by return on total assets, for TMR farms in 2020/21





1 DFMP northern Victorian farms refer to all participants in the Project, excluding TMR farms
Top 25% refer to the top 25 per cent in the DFMP northern Victorian farms, excluding TMR farms.

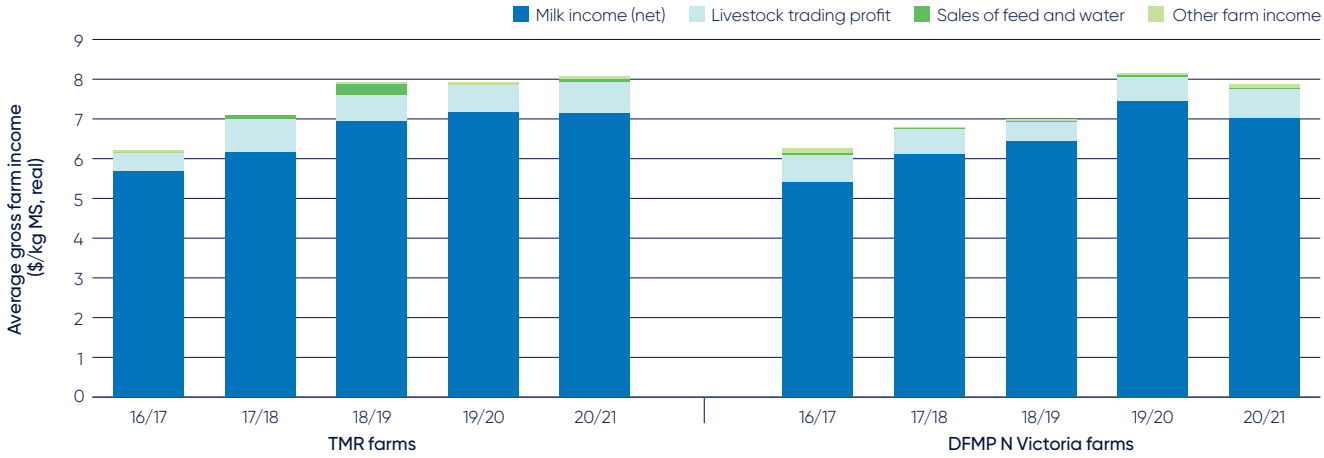
Income

The TMR farms in the study received a milk price premium and, in later years (2018/19 to 2020/21), a less variable milk price which compensated for higher feed costs, compared to the northern Victorian DFMP farms. In two of the five years, TMR farms reported higher milk income and gross farm income compared to the Top 25% northern Victorian DFMP farms.

Gross farm income on the TMR farms has been increasing and mirrored the trend in milk income, except in 2020/21 (Figure 2). The TMR farms had an advantage in gross farm income ($0.19/kg MS in 2020/21) compared to the northern Victorian DFMP farms in nearly all years. The proportion of income from milk sales was similar between the two groups (about 90 per cent). Some farms were able to diversify their income through livestock trading, sales of feed and/or water, and other farm income. This varied between TMR farms and contributed between $0.20/kg MS and $1.71/kg MS in 2020/21.

The TMR farms generated higher gross farm income than the Top 25% northern Victorian DFMP farms in 2018/19 and 2020/21 but lower in other years. The differences between the two groups were across all income categories. Refer to the Appendix for average, tenth and ninetieth percentiles for TMR, northern Victorian DFMP farms and the Top 25% northern Victorian DFMP farm performance.

Figure 2 Average gross farm income of TMR and northern Victorian DFMP farms between 2016/17 and 2020/21



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Cost structures

Herd and shed costs

There was little difference in herd or shed costs between the TMR farms and the average DFMP farms and these costs were not a large proportion of total costs.

Feed costs

In most years, the TMR farms spent more on feed cash costs (homegrown and purchased feed), relative to the northern Victorian DFMP farms. Some of the higher expenditure on feed cash costs were offset by increasing feed and water inventories.

The greatest variation amongst the TMR farms was seen in a year with high feed costs (2018/19). This was a particularly challenging year in northern Victoria for dairy farms, with dry seasonal conditions, and high supplementary feed costs and irrigation water prices.

Within the feed costs categories, purchased feed costs represented the greatest cost and variability on the TMR farms (Figure 3). Purchased feed costs fluctuated but decreased as a proportion of total feed costs in 2017/18 to 2018/19.

The lower expenditure indicated improved operating conditions and greater focus on growing and conserving feed on-farm, thereby reducing exposure to fodder markets. Many of the TMR farms sought to secure the homegrown feedbase, rather than relying on purchased feed, as an important consideration in their transition.

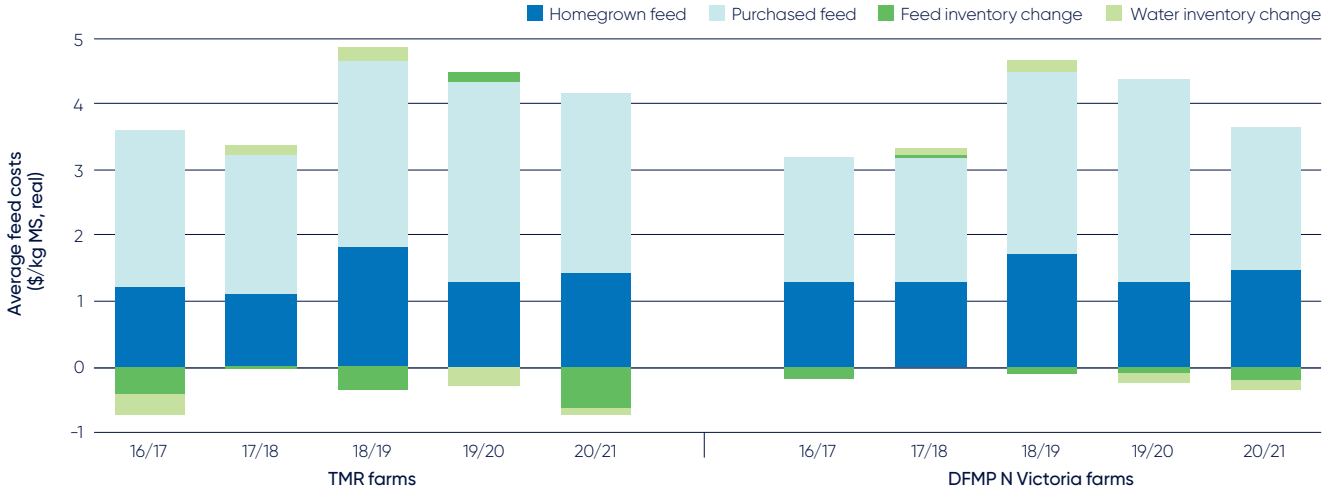
Homegrown feed costs are associated with growing and conserving feed on-farm. In 2018/19, the increase in homegrown feed costs can be attributed to an increase in irrigation allocation (temporary) water price. With improved water availability and a lower allocation water price in 2020/21, farmers spent more on these categories than in 2019/20 to grow and harvest as much feed as possible.

On average, feed reserves increased on TMR farms, as indicated by the negative feed inventory which decreased costs. Negative feed inventory change means the farm had more feed at the end of the year than at the start and therefore lowers the cost. One TMR farmer commented that they like to have at least two-years' worth of feed on-hand as a buffer for future high feed prices and poor seasonal conditions. Water inventory reserve was another risk management strategy for those with permanent water holdings. In the last two years (2019/20 and 2020/21), many farmers had more water on-hand at the end of the year, than at the start.

The TMR farms paid more for their purchased feed per kg MS than the northern Victorian DFMP farms. The difference was as high as $0.56/kg MS (in 2020/21) against the average northern Victorian DFMP farms and $0.86/kg MS (in 2018/19) against the Top 25% northern Victorian DFMP farms.

The cost of their purchased feed per t DM was lower, owing to the lower price of concentrates (2018/19 to 2020/21) and hay (2016/17 to 2019/20). The purchase price of concentrates for the seven TMR farms was $20/t DM lower than the average northern Victorian DFMP farms from 2018/19 to 2020/21. Purchased silage was more expensive per t DM than the northern Victorian DFMP farms. Compared to the Top 25% of DFMP farms in northern Victoria, their purchased feed per t DM also cost less (2018/19 to 2020/21).

Figure 3 Average feed costs of TMR and northern Victorian DFMP farms between 2016/17 and 2020/21



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Overhead costs

The TMR farms had lower overhead costs than the average northern Victorian DFMP group on a per kg MS basis. While their total overhead costs were higher, the increased milk production was sufficient to maintain similar overhead costs per kg MS.

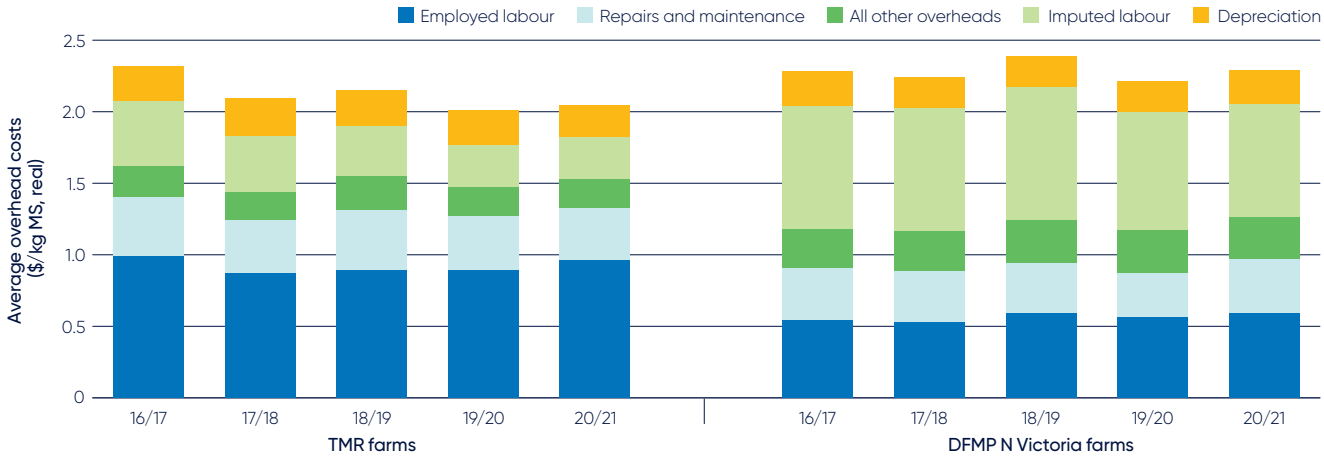
On the TMR farms, overhead costs remained around $2.00/kg MS for the last four years (Figure 4). This was largely due to all overhead cost categories remaining stable during the analysis period and suggests that the TMR farmers had kept tight control of these costs relative to their production.

The TMR farms had lower overhead costs than the northern Victorian DFMP group in the last four years. While employed labour cost was about $0.36/kg MS higher for the TMR farms, this was offset by $0.50/kg MS lower imputed labour costs. Other overhead costs (include items such as insurance, rates and administration) were lower (per kg MS basis) for the TMR group, contributing the greatest difference between the groups.

The TMR farms generally had higher repairs and maintenance costs and depreciation due to the higher infrastructure costs and capital required to operate a TMR system. The TMR farms had higher total overhead costs, mostly due to their scale. These farms also had higher milk production (total kg MS) so that overhead costs could be diluted and remain similar to the northern Victorian DFMP group on per kg MS basis.

The TMR farms had higher overhead costs than the Top 25% northern Victorian DFMP farms, except in 2018/19). The biggest difference was in labour costs; TMR farms had higher employed labour and lower imputed labour.

Figure 4 Average overhead costs of TMR and northern Victorian DFMP farms between 2016/17 and 2020/21



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Risk analysis of a TMR development option on a case study farm

Background and introduction

Farmers considering zero grazing TMR systems have highlighted the need to understand potential implications for risk when implementing these systems.

Modelling of TMR systems has frequently indicated that there will be more variation in profit in a TMR system compared with traditional production systems (Ho 2017). However, there are options for risk management that become more feasible for a large TMR farm e.g. locking in a higher or more stable milk price contract.

The analysis described here aimed to address the general research question 'What options can be adopted to help manage risk in a TMR system?'

The specific questions that the project aimed to address were:

- Can the milk price risk and the supplementary feed cost risk be managed?
- How can the land and water resources be used most efficiently?
- How important is the efficiency of how resources are put together (particularly FCE)?
- How important is the transition period to a TMR system?
- What impact does the initial equity position have on financial risk?

Approach

The approach used built on work previously completed as part of the Dairy Businesses for Future Climates (DBFC) project (Harrison *et al.,* 2017).

One of the development options analysed in the DBFC project was converting to a TMR System. The analysis reported here focused on using the modelled TMR option to further analyse risk.

An irrigated dairy farm located in northern Victoria was selected as a case study farm (base farm). The farm business was irrigated with 724 usable hectares of land, grew most of their own fodder and grain, and had a split calving herd of 475 milking cows. The feedbase on the milking area was predominately annual pasture (Persian clover, ryegrass) (Table 2). The farm had 1,300ML of high reliability water share (HRWS). There was significantly more land developed for irrigation than was irrigated in a typical year, so the irrigated area could be increased without capital expenditure. Further details on the case study farm can be found on the **Dairy Australia** website.

The TMR option involved an increase in herd size to 800 milking cows and year-round calving. Total capital expenditure was $3.63 million (M), which comprised $2.8M on a freestall barn, feed storage facilities and a young stock barn, $350,000 to upgrade the mixer wagon and tractor, and $480,000 for additional cows.

Assumptions related to the TMR development option included the following:

- High yield per ML of irrigation water was targeted with no grazing by milking cows
- The homegrown feedbase relied on a maize-wheat double crop, with lucerne and cereal silage
- Wastage was reduced to 5 per cent when feeding out hay and/or silage.
- Herd, shed, fuel and oil, repairs and maintenance, and labour costs were kept the same per kg of milk solids as the base farm i.e., they were increased in proportion to the amount of milk produced.

Table 2 Key features of the base farm and TMR development option

	Base farm	TMR option
Milking herd size	475	800
Calving pattern	60% spring, 40% autumn	Year round
Feed consumption (ex. wastage)		
Concentrate	1.7	3.0
Grazed pasture (t DM/cow)	3.0 (2.2 to 3.4)	0
Silage/hay (t DM/cow)	1.3 (0.9 to 2.0)	4.0
Milk solids production (kg/cow)	556	700
Milking area irrigation applied (ML)	1,056 (702 to 1,331)	1,347 (787 to 1608)
Total farm irrigation applied (ML)	**1,861 (1,350 to 2,348)**	**1,902 (1,203 to 2,232)**

Values in brackets represent the range simulated by the model

The TMR development options were evaluated using discounted net cash flow budgets over a 10-year, wet or dry, period. The key measure used in comparing the profitability and performance of the alternative development options was the internal rate of return (IRR) from the investment (the average annual earning rate for the investment over the 10–year period).

This analysis involved using @Risk and adjusting the distributions (such as milk supplementary feed prices and temporary irrigation water price) to find what reduction in price variability was required to provide equivalent variability in profit to a traditional/conventional grazing farm. The distributions were constructed from historical and unpublished data, and the experiences of expert working groups.

Results

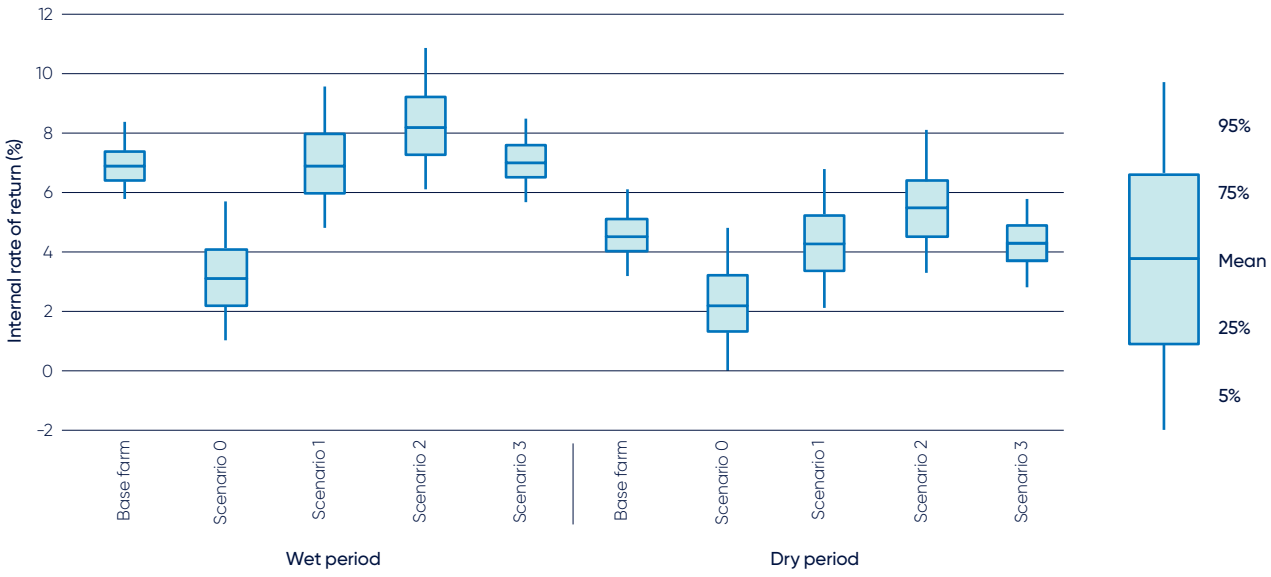
Sensitivity of profit to milk price

The TMR option had significantly higher variability/risk than the base farm and the predicted profit would not justify the additional risk if the milk price was the same as the base farm. However, the flatter milk supply with year-round calving and the larger volume of milk produced would enable a more attractive milk price to be negotiated.

With a milk price that is $1.00/kg MS higher than the other options (an average of $7.00/kg MS) the TMR option was predicted to generate returns that was commensurate with the extra risk and could make it an attractive investment (Figure 5). A milk price premium of $0.75/kg MS for the TMR option resulted in a mean IRR that was similar to the base farm but, with substantially more risk. A milk price premium of $0.75/kg MS and a halving of the range in the milk price distribution for the TMR option resulted in a similar average IRR with similar risk to the base farm.

The milk price sensitivity showed a similar pattern in the wet and dry periods. However, there was a substantial difference between the predicted IRR if the transition to a TMR system occurred in a dry period as opposed to a wet period.

Figure 5 Sensitivity of internal rate of return (real) to variation in milk price for the total mixed ration option



Base farm: Pasture based
Scenario 0: TMR system – milk price the same as the base farm (expenditure on infrastructure).
Scenario 1: TMR system – milk price $0.75/kg MS higher, same range as the base farm.
Scenario 2: TMR system – milk price $1.00/kg MS higher, same range as the base farm.
Scenario 3: TMR system – milk price $0.75/kg MS, half the range as the base farm.

The figures show an internal rate of return (IRR real) relative to the Base Farm if each scenario was implemented at the start of a 'wet 10–year period' (similar rainfall to 1986–87 to 1995–96 and below average supplementary feed prices) and the start of a 'dry 10-year period' (similar rainfall to 2000–01 to 2009–10 and above average supplementary feed prices). The IRR represents the average annual earning rate of each investment over each decadal period (in real terms, i.e. corrected for inflation). The bigger the box in the graph, the more variability is likely (or predicted). The boxes cover 50 per cent of the variability, while the lines (or whiskers) cover 90 per cent of the variability that is predicted.

Sensitivity of profit to grain price

There was a substantial increase in the quantity of grain purchased in the TMR option compared with the base farm. The base farm required about 850 t DM of concentrate (1.75 t DM/cow) and generally grew about 750 t DM of their own grain. The TMR development option was assumed to require about 2,400 t DM of concentrate (3 t DM/cow for 800 cows) and the available land and water was used to produce sufficient fodder for the herd and rather than homegrown grain.

The IRR of the TMR option was less sensitive to grain price than milk price when decreases of up to $30/t DM were applied (Table 3). The impact of reducing the range in grain price also had much less impact on the overall variability in profit. However, the TMR option is more sensitive to grain price than the base farm with a greater amount of purchased grain.

Narrowing the range in grain price appeared to provide limited benefit in terms of profit as the missed opportunities for additional profit when grain was cheap appears to balance the negative impact on profit when grain is expensive.

Sensitivity of profit to temporary irrigation water price

There was little difference in the quantity of irrigation water required for the base farm (about 1,860ML) and the TMR option (1,900ML). The base farm owned 1,300ML and was not highly exposed to purchasing irrigation water. A $30/ML decrease in temporary irrigation water price had a relatively small impact on the IRR as the base farm was predicted to purchase about 600 to 650ML of temporary irrigation water in most years. The profitability would be much more sensitive to the temporary irrigation water price if the case study farm did not own any HRWS. It is unlikely that the TMR option would provide much scope to procure temporary irrigation water at a cheaper rate than the base farm system.

Sensitivity of profit to hay price

There was rarely a need to purchase hay or silage either for the base farm or the TMR option. Hence, a $30/t DM decrease in hay price had little impact on the IRR of the TMR option. If the case study farm had less land or irrigation water available for fodder production, then hay price would be a more important factor.

Sensitivity of profit to fodder yields

The IRR of the TMR option was sensitive to the amount of fodder that could be harvested (conserved), particularly in a dry period when the price of purchased fodder is high (Table 4). A 20 per cent decrease in the total tonnes dry matter of fodder conserved is predicted to result in a reduction in IRR from 0.5 per cent to -0.3 per cent in a dry period (or approximately $150,000 decrease in annual earnings before interest and tax).

A 20 per cent increase in the total tonnes of dry matter of fodder conserved is predicted to result in an increase in IRR from 0.5 per cent to 0.8 per cent in a dry period.

Growing more homegrown fodder may also provide greater control and consistency in feed quality. The quantity of fodder that can be produced should be a key factor when planning a transition to a TMR system and determining the number of cows that will be milked.

Sensitivity of profit to feed conversion efficiency (FCE)

The IRR of the TMR option was sensitive to the FCE. The initial assumption for the TMR system was that 700 kg MS/cow could be produced from 7 t DM/cow during lactation (for cows of 550kg liveweight). This was about a 7.5 per cent higher FCE than the base farm where the cows produced about 555kg MS/cow from 6 t DM/cow during lactation. A 15 per cent improvement in FCE from what was initially assumed for the TMR option, would result in a higher average IRR for the TMR farm than the base farm, but with greater variability (Table 5). While a 15 per cent increase in FCE could be likely, it may still be achievable with good management (805kg MS/cow from 7 t DM/cow).

A 5 per cent improvement in FCE would increase the IRR from 2 per cent to 4 per cent in a wet period and have a similar impact in a dry run of years (this equates to 735kg MS/cow from 7 t DM/cow).

Feed conversion efficiency is impacted by a range of factors including ration balance, feed quality, wastage, herd health, genetics, stage of lactation etc. It is difficult in a whole farm 10–year development budget to analyse these factors individually and in detail, but the FCE measure provides an indication of the combined impact of all these factors. Investigation of the contribution from individual factors would most likely require integration with a more sophisticated cow nutrition model.

Table 3 Sensitivity of internal rate of return to variation in grain price for the TMR option

	Base farm	TMR 0 – Grain price and range same as base farm	TMR – Grain $15/t DM cheaper, same range as base farm	TMR – Grain $30/t DM cheaper, same range as base farm	TMR – Grain $30/t DM cheaper, half the range as base farm
Wet period	6.9% (5.8% to 8.4%)	3.1% (1.0% to 5.7%)	3.4% (1.3% to 6.1%)	3.8% (1.7% to 6.4%)	3.9% (1.9% to 6.4%)
Dry period	4.5% (3.2% to 6.1%)	0.4% (-1.8% to 3.0%)	0.7% (-1.4% to 3.4%)	1.0% (-1.1% to 3.7%)	1.2% (-0.9% to 3.7%)

Values presented are the median (mid-point) and those in brackets represent the range (fifth percentile to ninety-fifth percentile)

Table 4 Sensitivity of internal rate of return to variation in homegrown fodder yield for the TMR option

	Base farm	TMR 0 – Fodder yield same yield as base farm	TMR – Fodder 10% lower than base farm	TMR – Fodder 20% lower than base farm	TMR – Fodder 20% higher than base farm
Wet period	6.9% (5.8% to 8.4%)	3.1% (1.0% to 5.7%)	2.6% (0.5% to 5.2%)	2.2% (0.1% to 4.8%)	3.5% (1.4% to 6.2%)
Dry period	4.5% (3.2% to 6.1%)	0.4% (-1.8% to 3.0%)	0.3% (-1.8% to 3.0%)	-0.4% (-2.6% to 2.2%)	0.7% (-1.4% to 3.3%)

Values presented are the median (mid-point) and those in brackets represent the range (fifth percentile to ninety-fifth percentile)

Table 5 Sensitivity of internal rate of return to variation in feed conversion efficiency for the TMR option

	Base farm	TMR 0 – FCE same as base farm	TMR – FCE 5% higher than base farm	TMR – FCE 10% higher than base farm	TMR – FCE 15% higher than base farm	TMR – FCE 5% lower than base farm
Wet period	6.9% (5.8% to 8.4%)	3.1% (1.0% to 5.7%)	5.0% (2.8% to 7.7%)	6.5% (4.2% to 9.4%)	8.0% (5.6% to 11.1%)	2.4% (0.3% to 4.9%)
Dry period	4.5% (3.2% to 6.1%)	0.4% (-1.8% to 3.0%)	1.9% (-0.3% to 4.6%)	3.4% (1.1% to 6.3%)	4.9% (2.6% to 8.0%)	-0.7% (-2.8% to 1.9%)

Values presented are the median (mid-point) and those in brackets represent the range (fifth percentile to ninety-fifth percentile)

Sensitivity of profit to labour efficiency

The IRR and annual earnings before interest and tax were sensitive to the assumptions relating to labour efficiency. The labour cost in the TMR system and base farm was assumed to be $1.30/kg MS. If labour costs increased to $1.40/kg MS for the TMR option, annual earnings before interest and tax decreased by about $55,000, or five to 10 per cent depending on the scenario.

The average labour cost for Victorian DFMP farms was approximately $1.20/kg MS. This suggests that the assumption for labour cost is reasonable (at about $1.30/kg MS), given that there was no capital expenditure required for improving milk harvesting facilities.

Sensitivity of profit to combinations of potential benefits

The impact on IRR if various combinations of potential benefits from the TMR system were achieved, is shown in Figure 6. Combination 3 is likely to be a realistic scenario for many TMR farms and results in a similar average IRR and variability to the base farm. Combination 3 comprises:

- Milk price premium of $0.50/kg MS above the average price and half the range of the base farm,
- Decrease in the average grain price $15/t DM, but with the same range as the base farm,
- Feed conversion efficiency of five per cent higher than was initially assumed (735kg MS/cow from 7 t DM consumed).

Sensitivity of profit to FCE during the transition to a TMR system

With most major farm systems changes, it takes some time before the new system operates at optimal efficiency. The efficiency during the transition period to a TMR system is challenging to manage and limiting the time until optimal (or close to optimal) efficiency is important. If the FCE in the Combination 3 scenario (from previous section) is not achieved for the initial three years of the development, then the overall profit of the investment decreases by over one per cent and the TMR option becomes a less attractive investment than the base farm.

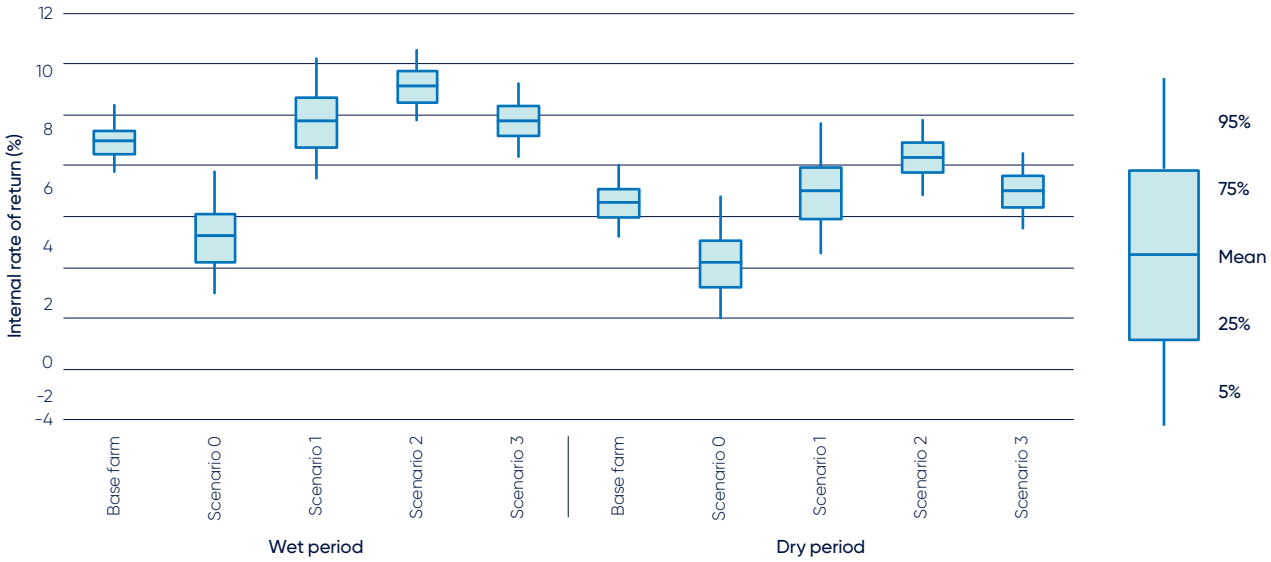
Balancing financial risk and business risk – sensitivity to equity levels

Overall risk exposure is a combination of farm system variability and financial risk (debt/equity). Business risk is often included when analysing changes to farm systems, but it is also important to consider financial risk. The impact of the ratio of debt-to-equity in the composition of total capital, has long been recognised (Heady 1952; Malcolm 2011). The TMR option highlights the overall risk exposure associated with combining low equity (high financial risk) with a farm system that has large variability in profit between years (Sinnett, *et al.*, 2016).

The initial equity position assumed for the base farm and the TMR option was 65 per cent. This is manageable for the base farm but, the business would become vulnerable if they invested in the TMR option (total capital investment of $3.63M) without achieving some of the benefits (TMR 0) that are assumed in the TMR-Combination 3 scenario (Table 6). If the set of benefits from TMR-Combination 3 are achieved, the financial risk is likely to be manageable with an initial equity of 65 per cent, particularly in a wet period. However, if the initial equity position was 50 per cent, the peak debt and number of years to positive net cash flow were concerning (even with all the benefits assumed in Combination 3), particularly in a dry period.

An interest rate of seven per cent (long-term average) was applied to all scenarios in Table 6. If interest rates doubled (to 14 per cent) when the initial equity level was 65 per cent and the benefits in TMR-Combination 3 were achieved, peak debt would increase by about $800,000 and payback period would not change markedly. However, in the less efficient TMR 0 scenario, a 14 per cent interest rate peak debt would increase by $4M when combined with a dry sequence of years. While it would be possible to obtain a loan with a lower interest rate than seven per cent in the current environment, the long-term average interest rate was considered reasonable for the long-term nature of this investment.

Figure 6 Sensitivity of the Internal Rate of Return for the TMR option to various combinations of potential benefits



Base farm: Pasture based
Scenario 0: TMR system, all prices the same as the Base Farm (expenditure on infrastructure)
Combination 1: TMR – milk price premium of $0.50/kg MS (same range as Base Farm), grain price $15/t DM cheaper (same range), FCE 5% higher than TMR
Combination 2: TMR – milk price premium of $0.75/kg MS (half range as Base Farm), grain price $15/t DM cheaper (same range), FCE 5% higher than TMR
Combination 3: TMR – milk price premium of $0.50/kg MS (half range as Base Farm), grain price $15/t DM cheaper (same range), FCE 5% higher than TMR

Table 6 Sensitivity of the various TMR scenarios to the initial business equity level

	Base farm	**TMR 0 – All prices same as base farm**	**TMR combination 3**		
Initial equity (%)	65	65	65	80	50
Wet period – peak debt	$2.7M	$6.2M	$5.7M	$3.9M	$7.4M
Wet period – years to break-even*	5	10 or more	6	5	7
Dry period – peak debt	$2.7M	$6.8M	$6.0M	$4.3M	$7.7M
Dry period – years to break-even*	7	10 or more	8	6	10 or more

**Years to break-even is calculated as the time it would take to recoup the initial capital expenditure*

Conclusions

An economic and risk analysis of dairy farm systems transitioning towards zero-grazing has provided an understanding of the factors contributing to making these systems profitable and identified options to manage risk when converting a grazing farm to a zero grazing TMR system.

TMR farms can be profitable. The analysis from seven TMR farms found that they had higher profit than the average northern Victorian DFMP farms in most years. However, compared to the Top 25% DFMP farms in northern Victoria, the TMR farms had lower profit mainly due to their higher feed and overhead costs.

The case study farm analysis found that the variability in profit associated with a TMR system can be managed if a combination of benefits was achieved. When a combination of benefits was achieved, the TMR option had a similar average IRR and variability to the base farm. These benefits were mostly realised on the seven TMR farms.

- **A strong and stable milk price.** The risk analysis assumed a milk price premium ($0.50/kg MS above the average price) and reduced variability between years (half the range of the base farm). The TMR farms had a higher milk price than the DFMP farms in northern Victoria in some years. Several more years of data (with low and high milk prices) will be required to establish whether the TMR farms are realising a more stable milk price.
- **A decrease in the average grain price**. The risk analysis assumed a decrease $15/t DM in grain price. The purchase price of concentrates for the seven TMR farms was $20/t DM lower than the average northern Victorian DFMP farms from 2018/19 to 2020/21.
- Being able to **achieve high feed conversion efficiency through the transition period and beyond.** The type of data collected makes it difficult to draw clear conclusions about the FCE and investigating this issue will require additional data.
- **Homegrown feed production can limit the exposure to the purchased feed market.** The quantity of homegrown fodder that can be produced should be a key factor to consider when planning a TMR development. Farms with a different resource base (less land and water) to the case study farm will have different exposure to risk. The economic performance of the TMR option examined had limited sensitivity to grain, fodder and irrigation water prices due to relatively low exposure to the purchased feed market.

  Many of the TMR farms sought to secure the homegrown feedbase, rather than relying on purchased feed, as an important consideration in their transition. However, data from the TMR farms need to be monitored over time to evaluate this thoroughly.
- **A high initial equity position is important.** The case study analysis of the TMR option highlighted the risk of moving to a TMR system with a low initial equity position. An initial equity position of 65 per cent was manageable if the above benefits were achieved. However, lower initial equity positions make the business vulnerable particularly in a dry period. The equity positions of the TMR farms are not reported for privacy reasons but, in general the results are consistent with the findings from the case study analysis.

The results from these two studies provided a basis to monitor ongoing performance and can be used to inform dairy farmers in their transition to TMR systems in this region. Ongoing analysis will provide further valuable insights.

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Appendices

Appendix A Farm income summary

Table A1 Average income for Victorian TMR farms between 2016/17 and 2020/21

	2016/17 $/kg MS	2017/18 $/kg MS	2018/19 $/kg MS	2019/20 $/kg MS	2020/21 $/kg MS
Milk income (net)	5.68 (5.21 to 6.37)	6.15 (5.80 to 6.45)	6.93 (6.72 to 7.08)	7.16 (7.03 to 7.34)	7.13 (6.77 to 7.47)
Livestock trading profit	0.47 (0.08 to 0.73)	0.85 (0.63 to 1.04)	0.66 (0.32 to 0.88)	0.69 (0.44 to 0.84)	0.79 (0.27 to 1.28)
Sales of feed and/or water	0 (0 to 0)	0.08 (0 to 0.27)	0.29 (0 to 0.73)	0 (0 to 0.01)	0.08 (0 to 0.24)
Other farm income	0.07 (0.01 to 0.14)	0.01 (0 to 0.04)	0.03 (0 to 0.08)	0.06 (0.01 to 0.11)	0.06 (0.01 to 0.11)
Gross farm income	**6.22 (5.52 to 6.73)**	**7.10 (6.60 to 7.48)**	**7.90 (7.55 to 8.41)**	**7.91 (7.65 to 8.14)**	**8.06 (7.58 to 8.59)**

Corrected for inflation. The data in the brackets shows the tenth and ninetieth percentiles

Table A2 Average income of northern Victorian DFMP farms between 2016/17 and 2020/21

	2016/17 $/kg MS	2017/18 $/kg MS	2018/19 $/kg MS	2019/20 $/kg MS	2020/21 $/kg MS
Milk income (net)	5.41 (5.08 to 6.07)	6.11 (5.83 to 6.38)	6.44 (6.04 to 6.81)	7.45 (6.99 to 7.86)	7.01 (6.50 to 7.51)
Livestock trading profit	0.68 (0.06 to 1.24)	0.64 (0.44 to 0.82)	0.47 (0.22 to 0.90)	0.60 (0.38 to 0.91)	0.75 (0.46 to 1.06)
Sales of feed and/or water	0.04 (0 to 0.06)	0.01 (0 to 0.06)	0.05 (0 to 0.17)	0.05 (0 to 0.05)	0.01 (0 to 0)
Other farm income	0.13 (0 to 0.21)	0.04 (0 to 0.09)	0.03 (0 to 0.07)	0.05 (0 to 0.10)	0.10 (0 to 0.21)
Gross farm income	**6.26 (5.67 to 6.88)**	**6.80 (6.42 to 7.26)**	**6.98 (6.57 to 7.58)**	**8.16 (7.66 to 8.74)**	**7.87 (7.29 to 8.57)**

Corrected for inflation. The data in the brackets shows the tenth and ninetieth percentiles

Table A3 Average income of Top 25% northern Victorian DFMP farms between 2016/17 and 2020/21

	2016/17 $/kg MS	2017/18 $/kg MS	2018/19 $/kg MS	2019/20 $/kg MS	2020/21 $/kg MS
Milk income (net)	5.70 (5.10 to 6.28)	6.38 (6.25 to 6.51)	6.62 (6.44 to 6.80)	7.30 (7.08 to 7.52)	6.95 (6.72 to 7.23)
Livestock trading profit	0.74 (0.56 to 0.88)	0.72 (0.59 to 0.88)	0.56 (0.33 to 0.85)	0.72 (0.38 to 1.07)	0.71 (0.54 to 0.91)
Sales of feed and/or water	0 (0 to 0)	0.02 (0 to 0.06)	0.11 (0 to 0.33)	0.02 (0 to 0.05)	0.05 (0 to 0.15)
Other farm income	0.06 (0 to 0.10)	0.03 (0 to 0.07)	0.03 (0 to 0.07)	0.04 (0 to 0.08)	0.11 (0.06 to 0.17)
Gross farm income	**6.50 (5.95 to 7.13)**	**7.15 (6.96 to 7.30)**	**7.32 (7 to 7.54)**	**8.08 (7.90 to 8.34)**	**7.81 (7.42 to 8.27)**

Corrected for inflation. The data in the brackets shows the tenth and ninetieth percentiles

Appendix B Farm costs summary

Table B1 Average feed costs of Victorian TMR farms between 2016/17 and 2020/21

	2016/17 $/kg MS	2017/18 $/kg MS	2018/19 $/kg MS	2019/20 $/kg MS	2020/21 $/kg MS
Home grown feed cost	1.24 (0.83 to 1.68)	1.11 (0.56 to 1.61)	1.83 (1.16 to 2.46)	1.29 (0.69 to 1.75)	1.44 (0.63 to 1.98)
Purchased feed	2.36 (1.57 to 2.87)	2.12 (1.38 to 2.79)	2.84 (1.81 to 3.87)	3.07 (2.35 to 4.10)	2.74 (2.27 to 3.36)
Feed inventory change	-0.42 (-0.62 to -0.13)	-0.02 (-0.19 to 0.19)	-0.35 (-1.30 to 0.73)	0.12 (-0.25 to 0.50)	-0.61 (-1.25 to -0.08)
Water inventory change	-0.29 (-0.58 to -0.03)	0.12 (0.04 to 0.23)	0.19 (-0.05 to 0.46)	-0.27 (-0.84 to 0.05)	-0.12 (-0.19 to -0.01)
Total feed costs	**2.89 (2.05 to 3.46)**	**3.33 (2.88 to 3.89)**	**4.51 (3.60 to 5.62)**	**4.20 (3.56 to 4.76)**	**3.45 (2.95 to 4.00)**

Corrected for inflation. The data in the brackets shows the tenth and ninetieth percentiles

Table B2 Average feed costs of northern Victorian DFMP farms between 2016/17 and 2020/21

	2016/17 $/kg MS	2017/18 $/kg MS	2018/19 $/kg MS	2019/20 $/kg MS	2020/21 $/kg MS
Home grown feed cost	1.29 (0.91 to 1.74)	1.29 (0.77 to 1.94)	1.72 (1.15 to 2.41)	1.30 (0.81 to 1.78)	1.46 (1.02 to 2.01)
Purchased feed	1.90 (1.06 to 2.68)	1.88 (1.42 to 2.57)	2.75 (1.91 to 3.80)	3.07 (2.14 to 4.12)	2.18 (1.44 to 3.00)
Feed inventory change	-0.17 (-0.67 to 0.20)	0.04 (-0.19 to 0.29)	-0.10 (-0.47 to 0.26)	-0.10 (-0.56 to 0.24)	-0.20 (-0.58 to 0.14)
Water inventory change	Included in feed inventory	0.12 (0 to 0.24)	0.17 (-0.15 to 0.76)	-0.13 (-0.39 to 0.08)	-0.13 (-0.29 to 0)
Total feed costs	**3.03 (1.95 to 3.89)**	**3.33 (2.50 to 3.92)**	**4.54 (3.02 to 5.62)**	**4.14 (3.28 to 5.09)**	**3.31 (2.48 to 4.16)**

Corrected for inflation. The data in the brackets shows the tenth and ninetieth percentiles

Table B3 Average feed costs of Top 25% northern Victorian DFMP farms between 2016/17 and 2020/21

	2016/17 $/kg MS	2017/18 $/kg MS	2018/19 $/kg MS	2019/20 $/kg MS	2020/21 $/kg MS
Home grown feed cost	1.18 (0.88 to 1.56)	1.19 (0.90 to 1.58)	1.29 (1.05 to 1.52)	1.32 (1.03 to 1.65)	1.59 (1.22 to 1.93)
Purchased feed	1.69 (0.74 to 2.32)	1.78 (0.90 to 2.45)	1.98 (1.03 to 2.83)	2.51 (1.27 to 3.30)	2.22 (1.09 to 3.22)
Feed inventory change	-0.21 (-0.54 to 0.06)	-0.11 (-0.23 to 0)	-0.16 (-0.59 to 0.33)	-0.23 (-0.58 to 0.10)	-0.51 (-0.96 to -0.01)
Water inventory change	Included in feed inventory	0.1 (0 to 0.22)	0.01 (-0.13 to 0.18)	-0.04 (-0.22 to 0.17)	-0.15 (-0.31 to -0.01)
Total feed costs	**2.66 (2.01 to 3.43)**	**2.96 (2.41 to 3.58)**	**3.12 (2.63 to 3.82)**	**3.56 (2.67 to 4.42)**	**3.15 (2.36 to 3.87)**

Corrected for inflation. The data in the brackets shows the tenth and ninetieth percentiles

Table B4 Average overhead costs for Victorian TMR farms between 2016/17 and 2020/21

	2016/17 $/kg MS	2017/18 $/kg MS	2018/19 $/kg MS	2019/20 $/kg MS	2020/21 $/kg MS
Employed labour	0.99 (0.61 to 1.38)	0.87 (0.43 to 1.21)	0.89 (0.59 to 1.20)	0.89 (0.41 to 1.27)	0.96 (0.66 to 1.33)
Repairs and maintenance	0.41 (0.17 to 0.57)	0.37 (0.29 to 0.44)	0.42 (0.31 to 0.55)	0.38 (0.25 to 0.50)	0.37 (0.28 to 0.51)
All other overheads	0.22 (0.11 to 0.33)	0.20 (0.12 to 0.27)	0.24 (0.19 to 0.28)	0.20 (0.14 to 0.26)	0.20 (0.12 to 0.28)
Imputed labour	0.45 (0.16 to 0.72)	0.39 (0.14 to 0.65)	0.35 (0.10 to 0.61)	0.30 (0.09 to 0.54)	0.29 (0.09 to 0.53)
Depreciation	0.25 (0.12 to 0.41)	0.26 (0.16 to 0.37)	0.25 (0.13 to 0.35)	0.24 (0.11 to 0.38)	0.23 (0.12 to 0.34)
Total overhead costs	**2.32 (1.70 to 3.06)**	**2.10 (1.53 to 2.80)**	**2.14 (1.74 to 2.62)**	**2.02 (1.62 to 2.51)**	**2.06 (1.70 to 2.47)**

Corrected for inflation. The data in the brackets shows the tenth and ninetieth percentiles

Table B5 Average overhead costs of northern Victorian DFMP farms between 2016/17 and 2020/21

	2016/17 $/kg MS	2017/18 $/kg MS	2018/19 $/kg MS	2019/20 $/kg MS	2020/21 $/kg MS
Employed labour	0.54 (0.15 to 1.01)	0.53 (0.12 to 0.94)	0.59 (0.26 to 0.86)	0.56 (0.18 to 0.99)	0.59 (0.17 to 0.93)
Repairs and maintenance	0.37 (0.24 to 0.51)	0.35 (0.18 to 0.49)	0.35 (0.17 to 0.54)	0.31 (0.19 to 0.46)	0.38 (0.26 to 0.53)
All other overheads	0.27 (0.17 to 0.44)	0.28 (0.16 to 0.45)	0.30 (0.17 to 0.52)	0.30 (0.17 to 0.46)	0.29 (0.19 to 0.42)
Imputed labour	0.86 (0.44 to 1.54)	0.86 (0.43 to 1.56)	0.93 (0.42 to 1.77)	0.83 (0.39 to 1.54)	0.79 (0.35 to 1.58)
Depreciation	0.24 (0.11 to 0.48)	0.22 (0.12 to 0.38)	0.22 (0.11 to 0.38)	0.21 (0.12 to 0.30)	0.24 (0.14 to 0.36)
Total overhead costs	**2.29 (1.65 to 2.90)**	**2.24 (1.68 to 2.89)**	**2.39 (1.72 to 3.25)**	**2.21 (1.59 to 3.13)**	**2.30 (1.73 to 3.07)**

Corrected for inflation. The data in the brackets shows the tenth and ninetieth percentiles

Table B6 Average overhead costs of Top 25% northern Victorian DFMP farms between 2016/17 and 2020/21

	2016/17 $/kg MS	2017/18 $/kg MS	2018/19 $/kg MS	2019/20 $/kg MS	2020/21 $/ MS
Employed labour	0.58 (0.43 to 0.81)	0.74 (0.56 to 1.03)	0.60 (0.49 to 0.72)	0.58 (0.21 to 0.83)	0.63 (0.33 to 0.86)
Repairs and maintenance	0.28 (0.17 to 0.37)	0.32 (0.17 to 0.44)	0.42 (0.27 to 0.64)	0.30 (0.23 to 0.39)	0.29 (0.23 to 0.34)
All other overheads	0.21 (0.15 to 0.26)	0.22 (0.15 to 0.31)	0.26 (0.23 to 0.30)	0.26 (0.13 to 0.38)	0.22 (0.19 to 0.28)
Imputed labour	0.60 (0.50 to 0.72)	0.42 (0.20 to 0.6)	0.60 (0.42 to 0.90)	0.59 (0.35 to 0.94)	0.47 (0.32 to 0.68)
Depreciation	0.15 (0.10 to 0.21)	0.25 (0.11 to 0.40)	0.28 (0.09 to 0.55)	0.22 (0.13 to 0.28)	0.19 (0.12 to 0.26)
Total overhead costs	**1.82 (1.57 to 2.15)**	**1.95 (1.58 to 2.45)**	**2.16 (1.74 to 2.73)**	**1.95 (1.48 to 2.40)**	**1.81 (1.60 to 2.00)**

Corrected for inflation. The data in the brackets shows the tenth and ninetieth percentiles

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