The Economics of Total Mixed Ration Systems in Australia

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ABSTRACT

An increasing proportion of dairy farmers in Australia are looking to transition from pasture-based systems (**PB**) to confinement, zero-grazing or Total Mixed Ration systems (**TMR**) in response to climatic pressures, market volatility or growth opportunities. However, there is little understanding of the economics of these systems under local conditions, and therefore, farmers have typically had to rely on information from overseas to support their decision-making. This study, conducted as part of the DairyUP Program (https://www.dairyup.com.au), aimed to compare the performance of commercial dairy farms operating TMR with those operating PB. Physical and economic data from TMR (n = 7) and PB farms (n = 58) were collected across different regions in New South Wales over five financial years (2016/2017 to 2020/2021) using the Dairy Farm Monitor Project methodology. The TMR farms operated a range of confinement systems (drylots, compost barns or freestalls) and were in different phases of the transition towards zero-grazing (all had transitioned the milking herd to zero-grazing by 2020/2021). Prices were adjusted by inflation and expressed in Australian dollars per kg of milk solids ($/kg MS). Differences between systems were analysed using linear mixed models with farm and year as random effects. Compared to PB farms, the TMR had larger herd sizes (564 vs 356 cows) and total usable area (604 vs 291 ha) and produced more milk per cow (608 vs 491 kg MS/cow). Despite gross farm income ($9.30/kg MS) and earnings before interest and tax ($1.22/kg MS) being similar between both systems, profitability, when measured as return on total assets, was greater for TMR (5.3% vs 2.4%). On average, variable costs, including feed, herd and shed, were similar between TMR and PB ($4.98/kg MS). Both TMR and PB farms had similar total overhead costs ($3.08/kg MS), including total labour costs, depreciation and repairs & maintenance. This research is the first in Australia to investigate the differences in performance between TMR and PB systems. Insights from this study can help improve planning and decision-making of dairy farmers considering or operating TMR systems.

Keywords: confinement, zero-grazing, pasture-based, farm business analysis

INTRODUCTION

Dairy farming systems in Australia are predominantly pasture-based (**PB**), with most farmers relying on grazed pastures for at least nine months of the year (Dairy Australia, 2021). An increasing proportion of these farmers are looking to transition their production systems toward confinement, zero-grazing or Total Mixed Ration systems (**TMR**). Some of the motivations for investing in TMR include opportunities to grow the business, productivity increases, reduction of climatic risk or market volatility, availability of water and labour and animal welfare issues (R. Nettle, University of Melbourne, personal communication).

However, the information available on the economics of these systems is limited. Up to date, there are no studies in Australia that use comprehensive commercial dairy farm data to evaluate the performance of TMR systems. Therefore, farmers have had to rely on farm models or information from overseas to support their decision-making (Pinheiro et al., 2021).

The objectives of this study were to compare the physical and economic performance of commercial dairy farms in New South Wales (**NSW**) operating TMR systems with those operating PB systems.

MATERIALS AND METHODS

Data Collection

This study was conducted as part of DairyUP (https://www.dairyup.com.au), a research and development program in NSW, to

improve dairy farm productivity and profitability, de-risk the industry and develop new markets. Physical and economic data from TMR (n = 7) and PB farms (n = 58) were collected across different regions in NSW (Australia) over five financial years (from 2016/2017 to 2020/2021). Some TMR farms participated in the five years of the study (n = 2), while others participated in three years (n = 3) or in two years (n = 2). The final dataset comprised a total of 184 observations from 65 TMR and PB dairy farms over five years. Data were collected following the Dairy Farm Monitor Project (**DFMP**) farm business analysis methodology adapted from Malcolm et al. (2005). Variables analysed included different key physical and economic indicators. Physical indicators refer to production outputs, physical inputs, productivity, and production efficiency measures (e.g., total milk production, number of cows, labour efficiency or milk/ha). Economic indicators refer to income, costs, and business profitability measures (e.g., gross farm income, variable and overhead costs, earnings or return on assets). Prices were expressed in Australian dollars per kg of milk solids (**$/kg MS**) and adjusted by inflation using the Consumer Price Index.

Statistical Analysis

Data collation and statistical analyses were performed with R software version 4.1.2. Linear mixed models were used to compare the differences in predicted means between TMR and PB for each variable. Mixed models were chosen due to their ability to deal with unbalanced datasets, repeated measures, and datasets with hierarchy. Farm and year were included in the models as random effects; however, region was not included as it did not improve the overall accuracy. All models were checked for assumptions of linearity, normality, and homoscedasticity. Significance was determined at $P < 0.05$.

RESULTS

The TMR farms operate using a range of confinement systems, which included drylots, compost barns or freestalls. Over the five year period of analysis, the TMR farms were in different phases of the transition toward zero-grazing; however, all had transitioned to zero-grazing for the milking herd by 2020/2021. On average, the TMR had larger herd sizes (+200 cows), total usable area (+300 ha), and produced 24% more kg of milk solids (**kg MS**) per cow than the PB farms (**Table 1**). Milk solids produced per usable area (kg MS/ha) and labour efficiency (measured as kg MS per full-time equivalent [**FTE**]) were similar between the two systems. When measured as gross income per FTE, labour efficiency tended to be higher for TMR farms ($ 349,632/FTE vs $ 417,873/FTE; $P = 0.058$). On average, the proportion of homegrown feed in the diet was almost 20 percentage points greater for PB farms. No differences were found between systems in gross or milk income; however, TMR farms had 68% higher livestock trading profit and feed & water sales (**Table 2**). All variable costs, including herd, shed, and feed, were similar for TMR and PB farms. Except for imputed labour, no differences were found in overhead costs (including total labour, depreciation or repairs & maintenance). Profit before and after taxes (expressed as earnings before interest and tax [**EBIT**] and net farm income) were similar for PB and TMR. Overall farm profitability, measured by return on total assets (**RoTA**), was almost three percentage points greater for TMR farms.

Table 1. Physical indicators evaluated

Item	PB[1]	TMR[2]	SED[3]	P-value
Cows (n)	356	564	65	0.039
Usable area (ha)	291	604	67	0.003
Total MS (kg)	179,090	346,590	38,570	0.005
Litres/cow	6,693	8,595	329	<0.001
[4]kg MS/cow	491	608	21	<0.001
kg MS/FTE[5]	38,474	44,820	3,026	0.168
kg MS/ha	665	696	62	0.738
Homegrown feed (%)[6]	59	40	4	<0.001

[1]**PB** = pasture-based systems, [2]**TMR** = Total Mixed Ration systems, [3]**SED** = average standard error of the difference, [4]**kg MS** = kilograms of milk solids, [5]**FTE** = full-time equivalent (2,400 h/yr, calculated as 48 h/wk for 50 wk), [6]Proportion of homegrown feed in the diet.

Table 2. Economic indicators evaluated. Prices are expressed in Australian dollars per kilogram of milk solids ($/kg MS)

Item	PB[1]	TMR[2]	SED[3]	P-value
Gross income	9.19	9.41	0.36	0.540
Milk income	8.21	7.88	0.31	0.262
Livestock trading profit	0.80	1.17	0.11	0.017
F&W sales[4]	0.02	0.21	0.02	0.020
Variable costs	4.79	5.17	0.28	0.221
Herd costs	0.38	0.34	0.04	0.470
Shed costs	0.29	0.35	0.03	0.165
Feed costs	4.12	4.49	0.27	0.185
Overhead costs	3.31	2.85	0.21	0.149
Labour costs	2.04	1.73	0.14	0.151
Imputed labour	1.05	0.41	0.17	0.016
Employed labour	1.00	1.35	0.14	0.094
R&M[5]	0.48	0.43	0.04	0.461
Depreciation	0.38	0.37	0.04	0.868
Other overheads	0.31	0.25	0.04	0.279
Farm insurance	0.11	0.08	0.01	0.119
EBIT[6]	1.07	1.37	0.37	0.497
Lease costs	0.19	0.00	0.07	0.066
Interest costs	0.43	0.51	0.09	0.545
Net farm income	0.48	0.86	0.38	0.387
RoTA[7] (%)	2.42	5.34	0.93	0.009

[1]**PB** = pasture-based systems, [2]**TMR** = Total Mixed Ration systems, [3]**SED** = average standard error of the difference, [4]**F&W** = feed and water, [5]**R&M** = repairs and maintenance, [6]**EBIT**= earnings before interest and tax, [7]**RoTA** = return on total assets.

DISCUSSION AND CONCLUSIONS

This research aimed to compare the physical and economic performance of dairy farms operating TMR and PB systems.

Our study showed that TMR farms were more profitable than PB when measured by RoTA. The level of profitability achieved by TMR systems was above the historical DFMP average and also greater than the 5% target that would sustain industry growth (Australian Dairy Plan, 2020). Profitability was particularly stronger in the years 2019/2020 and 2020/2021, aided by higher milk prices due to intense processor competition for milk. Variability in RoTA, however, was higher for TMR farms, something probably explained by these systems having more exposure to the purchased feed market (data not shown). Despite TMR farms having higher profitability, EBIT was similar for both systems. This is reflective of PB farms being located predominantly along the coastal region of NSW, which typically sees increased asset values and therefore reduces RoTA.

One of the motivations for transitioning to a confinement system is the potential to scale up the business. In fact, our results showed that TMR farms typically managed larger farm areas, had more cows and produced more milk solids than PB farms. The TMR farms were predominantly distributed in the inland or central and southern inland regions of NSW, where large tracts of land are more available. In contrast, and as mentioned before, the PB farms were mainly located in the coastal or hinterland areas of the state, where land is usually more expensive due to competition with other industries, urbanisation and the presence of 'lifestyle' blocks.

Another characteristic of these systems is the potential to increase productivity. In our study, we found that litres and kg MS produced per cow were 28% and 24% higher for TMR, respectively. This can be explained by cows in a TMR usually achieving higher dry matter intake and a more consistent diet (Kolver and Muller, 1998). On the other hand, and contrary to expected, we found no apparent improvements in labour efficiency (kg MS/FTE) for TMR farms, which also appeared to be lower than in previous studies conducted overseas (Caraviello et al., 2006, Salfer et al., 2018). However, it is important to mention that labour efficiency calculated using gross income ($/FTE) tended to be higher for TMR farms. The TMR farms had a larger proportion of the income coming from livestock trading and feed & water sales. This is indicative of labour being used in other areas of the business not directly related to milk production and is not captured when using kg MS/FTE as an indicator. Also, it may indicate a business diversification strategy for some of the TMR farms.

In general, there were no major differences in the cost structures between TMR and PB farms. Variable costs, including feed costs, were similar for both systems; however, we found that TMR farms spent more on purchased feed ($/kg MS), particularly in the 2019/2020 year (data not shown). This was due to a

prolonged drought and limited irrigation, which heavily impacted those farms more exposed to the purchased fodder market. Also, it is worth mentioning that despite both systems having similar overhead costs (including total labour costs), TMR offset lower imputed labour costs by a trend to higher employed labour.

This research is the first in Australia to investigate the differences in performance and cost structures between TMR and pasture-based systems. Caution should be taken with these results, as the number of TMR farms is relatively small, not all farms participated in every year of the study, and some were in different stages toward zero-grazing. Additionally, the TMR and PB farms were located in contrasting regions with differences in weather, access to irrigation and feed availability. Nonetheless, insights from this study provide a starting point for dairy farmers considering zero-grazing systems and could help them improve planning and decision-making. Future work will focus on increasing the number of observations and including a social research component to better understand the motivators, challenges, and information gaps related to investing in these systems.

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CONFLICT OF INTEREST DECLARATION

There are not real or perceived conflicts of interests.

REFERENCES

Australian Dairy Plan. 2020. Measurement of profitability on Australian dairy farms: Historical trends and future targets.

Caraviello, D. Z., K. A. Weigel, P. M. Fricke, M. C. Wiltbank, M. J. Florent, N. B. Cook, K. V. Nordlund, N. R. Zwald, and C. L. Rawson. 2006. Survey of Management Practices on Reproductive Performance of Dairy Cattle on Large US Commercial Farms. Journal of Dairy Science 89(12):4723-4735.

Dairy Australia. 2021. Dairy Situation and Outlook: March 2021. Dairy Australia.

Kolver, E. and L. Muller. 1998. Performance and nutrient intake of high producing Holstein cows consuming pasture or a total mixed ration. Journal of dairy science 81(5):1403-1411.

Malcolm, B., J. Makeham, and V. Wright. 2005. The Farming Game: Agricultural Management and Marketing. Cambridge University Press, New York, NY, USA.

Pinheiro, J. S., A. De Vries, J. P. P. Rodrigues, and M. I. Marcondes. 2021. Production costs, economic viability, and risks associated with compost bedded pack, freestall, and drylot systems in dairy farms. Animal 15(12):100404.

Salfer, J. A., J. M. Siewert, and M. I. Endres. 2018. Housing, management characteristics, and factors associated with lameness, hock lesion, and hygiene of lactating dairy cattle on Upper Midwest United States dairy farms using automatic milking systems. Journal of Dairy Science 101(9):8586-8594.