Increasing profit on dairy farms

G R. Olney
Warren Standing

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Farmers continually make decisions on all aspects of their farms that influence profit. For dairy farmers these include number of cows, calving pattern, level and type of supplementary feeding, area of each pasture type and fodder crop, and the areas for hay or silage, or both. The extent and type of the beef sideline operations also influence the overall profitability of the farm.

The Western Australian Dairy Farm Model (WADFM) is a whole farm model developed by the Western Australian Department of Agriculture to help farmers maximize profit by considering all the effects of such decisions on the farm.

The model has been used to highlight areas in which changes in management would give the greatest financial benefit to farmers. Researchers and advisers can use the WADFM to determine priorities for their work programmes, and to see how the results of their work can best be applied on farms. The effects of industry policy on farms can also readily be estimated.

The profit foregone by not adopting particular management strategies can be assessed by the model.

The model has shown that dairy farmers in Western Australia could increase their profit by calving more of their cows in summer and feeding higher levels of concentrates in summer and autumn. Research has started to ensure there are no unforeseen problems associated with increased calving in summer. The increases in milk yield obtained from feeding high or low levels of concentrates to cows in summer are also being tested.

Dairy farmers could increase their profit by calving more of their cows in summer and feeding higher levels of concentrates in summer and autumn.
Development of the model

The first stage in the development of the dairy farm model was to represent the separate parts of the whole farm system as accurately as possible in a mathematical format. These parts include animal nutrition, herd structure, pasture production, grazing, fodder conservation, purchase of feeds, milk sales, stock sales, labour and finance. Information was included for irrigated and non-irrigated dairy farms in the south-west of Western Australia.

A documentation of the assumptions used in the model was prepared (Olney and Falconer, 1985) and circulated to people with expertise in particular disciplines. Comments on the documentation were invited and discussions held with various specialists on the biological assumptions in the model.

The model was run using data for farms at Harvey and Margaret River. These results were used to determine the most profitable whole farm management, and to test predictions from the model. Additional data on milk production, animal liveweights, pasture growth and losses incurred in fodder conservation were obtained to assist with the testing of the model.

Some revisions were made following these discussions, the review of comments received, and the work on the particular farms.

Overview of the model

The most profitable management practices determined by the model include:

• the total number of cows to milk;
• the number of cows to calve in each two-month period;
• the number of heifers and steers to rear;
• the age to sell surplus heifers and steers;
• the quantity of milk to produce throughout the year;
• the milk yield for cows in each calving group and stage of lactation;
• the most profitable ration for each calving group and stage of lactation required to obtain the optimum milk yield;
• the area of pasture to irrigate;
• the areas to conserve for hay and silage;
• the area to sow to fodder crops; and
• the quantity of concentrates to buy.

The year is divided into six two-monthly periods. Cows may calve in any period and the total number of cows can be any number up to the maximum specified. The most profitable milk yield is determined for each stage of lactation. Heifers can be sold as calves, reared as herd replacements or sold as mated heifers. Male calves can be sold as calves or reared to be sold as steers at various ages. The nutritional requirements for animals have to be met from the available feeds, such as pastures, conserved fodder, fodder crops and purchased feeds.

Land can be used for annual pasture, irrigated pasture or fodder crops. The expected growth rate and use of pasture and fodders for each period are included, together with their expected quality. Hay and silage can be made from pasture at appropriate times. Pasture not used in a particular period can be deferred to the next period, but the losses incurred in both quantity and quality are taken into consideration.

Operation of the model

The WADFM is run on microcomputers. The data, contained in a series of spreadsheet files which are revised as required, include information on:

• pasture growth and irrigation requirements;
• hay and silage yields and quality;
• costs associated with pasture and fodder conservation;
• concentrates used;
• liveweights of cows, heifers and steers;
• costs associated with livestock;
• maximum milk yields, milk prices and quotas; and
• other farm costs.

Uses of the model

The model is used to assist in the development of extension and research programmes, and can help decide industry policy.

Information on the most profitable management strategies, and the profit foregone by not adopting particular changes in management, will help advisers determine priorities for extension in their districts. Examples in which comparisons have been made between the most profitable management selected by the model and that commonly used by farmers include:

• feeding levels of concentrates to cows in summer;
• calving patterns;
• rearing of heifers and their age at first calving;
• the use of nitrogen on pastures; and
• the role of early germinated pastures in irrigation areas.

Current applications

Here are some examples of the way in which the WADFM has been used to help plan extension and research programmes and policy.
Table 1. Percentage of cows calving each two months during 1987-88 in the Busselton-Margaret River area

<table>
<thead>
<tr>
<th>Cows calving in</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>two-monthly period</td>
<td></td>
</tr>
<tr>
<td>January - February</td>
<td>23</td>
</tr>
<tr>
<td>March - April</td>
<td>19</td>
</tr>
<tr>
<td>May - June</td>
<td>28</td>
</tr>
<tr>
<td>July - August</td>
<td>16</td>
</tr>
<tr>
<td>September - October</td>
<td>7</td>
</tr>
<tr>
<td>November - December</td>
<td>7</td>
</tr>
</tbody>
</table>

Source: Herd Improvement Service of W.A.

The profitability of applying nitrogen to annual pastures

Nitrogen can increase pasture production for grazing in winter and on areas closed for hay or silage in spring. The model was used to estimate the increase in profit from applying 110 kg of urea per hectare to:

- one-third of the annual pasture following germination in autumn,
- all of the area closed for hay and silage in spring, and
- the same areas as indicated previously in both autumn and spring.

The increase in pasture growth from applied urea was based on the average response obtained from experiments in the south-west. The farm was assumed to be in the Busselton-Margaret River area, have 200 ha of pasture, and market milk and special milk products quotas of 400 and 200 litres per day respectively.

Runs were conducted in which the proportion of cows calving each month was restricted to that commonly used in the area (Table 1); hay and silage each limited to no more than 60 ha; and total fodder conservation limited to a maximum of 90 ha (restricted management). Additional runs were carried out in which the most profitable strategies for these activities were allowed to be used (optimum management).

Urea increased profit in all cases, but the autumn application increased profit more than the spring application to hay and silage areas (Figure 1). If the calving pattern and area conserved for hay and silage were optimized, profit increased more than from the application of urea in both autumn and spring with the restricted management. The benefit from applying urea was also much greater when calving pattern, number of cows milked, and area conserved were allowed to be changed so as to obtain the greatest increase in profit from the increased pasture production.

The calving pattern selected as the most profitable had all cows calving in January-February and November-December, and the most profitable area for fodder conservation was about 75 ha of silage and 25 ha of hay. The number of cows calving in the two periods and the area for fodder conservation varied slightly between the various urea applications. They would also vary for individual farms, but these results show calving pattern and area conserved for hay and silage can have a large effect on profit.

Figure 1. Increase in profit from applying nitrogen in autumn, spring and autumn and spring with restricted and optimum management.

The model identifies all the changes in management that will take full advantage of the nitrogen applied to the pastures. In the runs in this example the most profitable level of other farm operations, for example proportion of hay and silage, quantities of concentrates purchased, and times and rates for feeding hay, silage and concentrates, were also selected by the model for the particular times of applying nitrogen.
Calving pattern

The calving patterns used by farmers tend to be related to their milk quotas, and whether or not they have irrigation. Farmers south of the irrigation areas frequently use calving patterns similar to that given in Table 1. These farmers usually have smaller milk quotas than farmers closer to Perth. Farmers in irrigation areas, and those without irrigation between Perth and Waroona, who normally have larger quotas, tend to have similar numbers of cows calving each month. The difference between districts in average quotas is however being reduced now that auctions of quotas are held every few months.

Calving pattern is one of the major influences on profit according to the model. The model has therefore been used to make comparisons in expected profit between calving patterns normally used and those selected by the model as the most profitable.

Runs were carried out for typical farms in the irrigation area (assumed near Harvey) and non-irrigation area (assumed near Margaret River). In both cases market milk quotas of firstly 400 litres, and then 1000 litres per day were used in the comparisons. The special milk products quota was assumed to be 200 litres per day in all cases. The area of pasture was assumed to be 200 ha with no irrigation for the farm at Margaret River, and 150 ha, of which up to 80 ha could be irrigated if it were profitable to do so, for the farm at Harvey. In all cases the most profitable management could be selected. The seasonal milk price incentives also affect the most profitable calving pattern, so all runs were carried out using both the 1988-89 and expected 1989-90 milk prices.

The calving patterns selected for the farm at Harvey had most cows calving in January-February, with the remainder in November-December for the 1988-89 milk prices. Fewer cows calved in January-February, with a large number calving in September-October for the 1989-90 milk prices (Table 2).

The calving patterns selected for the farm at Margaret River had all cows calving in January-February and November-December excepting in one case (Table 3). The majority calved in January-February with the 1988-89 milk prices, and more in November-December with the 1989-90 prices. These calving patterns take full advantage of the summer/autumn incentives in milk prices paid by factories.

Further comparisons were made in which the calving pattern was restricted to a uniform number of cows calving in each period for the typical farm at Harvey, and the percentage

### Table 2. Calving patterns selected for herds with small and large milk quotas for an irrigated farm near Harvey

<table>
<thead>
<tr>
<th>Market milk quota (L/day)</th>
<th>400</th>
<th>400</th>
<th>1,000</th>
<th>1,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>January - February</td>
<td>119</td>
<td>51</td>
<td>99</td>
<td>32</td>
</tr>
<tr>
<td>March - April</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>May - June</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>July - August</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>September - October</td>
<td>0</td>
<td>89</td>
<td>0</td>
<td>81</td>
</tr>
<tr>
<td>November - December</td>
<td>30</td>
<td>36</td>
<td>55</td>
<td>65</td>
</tr>
<tr>
<td>Total number of cows</td>
<td>149</td>
<td>176</td>
<td>154</td>
<td>178</td>
</tr>
</tbody>
</table>

### Table 3. Calving patterns selected for herds with small and large milk quotas for a non-irrigated farm near Margaret River

<table>
<thead>
<tr>
<th>Market milk quota (L/day)</th>
<th>400</th>
<th>1,000</th>
<th>1,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>January - February</td>
<td>113</td>
<td>59</td>
<td>84</td>
</tr>
<tr>
<td>March - April</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>May - June</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>July - August</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>September - October</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>November - December</td>
<td>37</td>
<td>106</td>
<td>71</td>
</tr>
<tr>
<td>Total number of cows</td>
<td>150</td>
<td>165</td>
<td>155</td>
</tr>
</tbody>
</table>

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calving in each period as indicated in Table 1 for the farm at Margaret River. These restricted calving patterns are similar to those commonly used in each district.

The expected profit from the selected calving pattern, as indicated in Table 2, was $15,000 to $20,000 per year greater than for a uniform calving pattern for irrigated farms. For non-irrigated farms the expected increase in profit from the selected calving pattern (Table 3) was $20,000 to $25,000 per year above that obtained with a typical calving pattern indicated in Table 1.

The increase in profit with the selected calving pattern was similar for the 400-litre and 1000-litre quotas for both the irrigated and non-irrigated farms. The percentage increase in profit was however greater with the 400-litre quotas because of the lower income from total milk sales.

In the comparisons of calving patterns, all other variables, including the total number of cows milked, could be adjusted to provide the most profitable solution in each case. In the above examples, profit was increased by milking more cows when the 1989-90 milk prices were used, and when the most profitable calving patterns could be selected. Farmers, however, may not wish to or may not be able to milk more than a particular number of cows. Comparisons can be made with a restricted number of cows. The profit foregone by restricting the number milked can then also be predicted from the model.

Practical implications. Changing the calving pattern is a major change which requires long term planning. Considerable costs are involved and farmers would not change the calving pattern in their herds before carefully considering all the implications.

We also need to be sure there are no adverse effects from summer calving not allowed for in the model before recommending this practice to farmers. A research project has started at Vasse Research Station in which January-February and May-June calving are being compared. These results will test the predictions of the model, and greatly assist in the extension of this practice if there are no unforeseen problems with summer calving.

Two levels of feeding cows concentrate in summer (8 and 4 kg/cow/day) in both early and late lactation are also being compared in the experiment, as high levels of grain feeding in summer are always selected by the model for summer-calving cows in non-irrigation areas. The increase in profit with feeding up to 8 kg/cow/day in summer compared to 4 kg/cow/day was between $7,000 and $8,000 per year with the model's selected calving pattern, and $2,000 to $3,000 per year with the calving pattern commonly used.

Making the most of incentives for seasonal milk prices

There is a shortage of milk supplied to factories in summer and autumn each year. Farmers receive higher prices for manufacturing milk (that is milk supplied above their quotas) between February and May than they do for the other months, and in 1989/90 higher prices will also be paid in December and January. The model has been used to show the effect on farm profit of various pricing strategies, and the changes farmers would need to make to obtain the full benefit of price incentives.

Warren Standing sampling pasture at Vasse Research Station
Some of these changes, such as changes to the calving pattern, require long term price signals, and farmers are only likely to make these adjustments to management if they have long term assurances of the incentives to be paid.

The milk prices used for the above comparisons of calving patterns included the summer/autumn incentives paid in 1989, and expected in 1990, which are much higher than in previous years.

When the lower incentives paid in previous years were used, similar calving patterns to those indicated for the 1988-89 prices were selected as the most profitable, but the increase in profit obtained from the selected calving patterns was less.

When no incentives were allowed for, that is the same price for manufacturing milk was assumed for the whole year, the selected calving pattern for non-irrigated farms changed to about two-thirds of cows calving in January-February and one-third of cows calving in March-April. The main calving period selected for irrigated farms was between March and June when no seasonal price incentives for manufacturing milk were included. The differences in profit between the selected calving patterns and those commonly used were much less, that is between $3,000 and $4,000 per year for both irrigated and non-irrigated farms when no seasonal price incentives were used.

The main strategy used by farmers if they wish to take advantage of the summer-autumn price incentives is to feed higher levels of grain to cows milking at the time. Farmers have not been prepared to change their calving pattern, or consider other long term changes in management because they receive less than six months notice of the incentives to be paid. Without making these changes in management, farmers are only able to obtain a small part of the potential increase in profit that could be obtained from seasonal incentives. Factories have also only been partly successful in overcoming the shortage of milk in summer and autumn.

Other applications

In addition to calving pattern and fodder conservation, levels of feeding concentrates to cows, number of cows milked, age of heifers at calving, and the beef sideline options have all been shown by the model to have large effects on profit. The area irrigated, and the proportion of this area used for permanent and early germinating pastures, are also important for farmers with irrigation. The model can determine the relative importance of these and other management changes on profit, thus helping farmers to review their whole farm management, and Departmental and private advisers to plan their extension programmes.

There are many limits on what strategies can be adopted by farmers in practice, and these can be allowed for in the model.

Acknowledgements

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