Greener pastures 1 - The greener pasture project: managing nutrients in dairy pastures

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Introduction

Welcome to this series of Greener Pastures Bulletins. The Greener Pastures project has been a partnership between the Department of Agriculture and Food Western Australia (DAFWA) and industry to assist dairy farmers make smarter use of nutrients, especially nitrogen (N) and also phosphorus (P).

The Greener Pastures project has spanned eight years, with planning and consultation with industry commencing in 2003, experimental work from July 2005 until April 2010, and the project conclusion in late 2011.

Greener Pastures findings can be used by the Australian dairy industry to improve the efficiency of nutrient inputs, a major cash cost, and also address growing community expectations that modern dairy farm systems are environmentally sustainable.

Each Bulletin is focussed on a specific aspect of nutrient management and/or grazing management that was investigated during the Greener Pastures project (Table 1). The Bulletins provide practical messages for farmers, together with the major research findings.

This first Bulletin in the series provides an introduction to the Greener Pastures project, explaining its rationale and genesis, the methods that were used and introducing some of the main people behind the project.
Table 1. The series of DAFWA Greener Pastures Bulletins cover the following aspects of intensive dairy pasture systems.

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<tr>
<td>Managing sulfur in dairy pastures</td>
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<tr>
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Dairy farming intensification

As dairy farmers have strived to maintain profitability, many have farmed more intensively. More cows are milked and increasing inputs of fertiliser and purchased feed are used per hectare. However, these increased nutrient inputs have far exceeded the increase in nutrient output in milk production. The increasing nutrient surplus (inputs minus outputs) from intensification on dairy farms has met with increasing community concern about the environmental footprint of the dairy industry. In some other countries, dairy farmers who have intensified by increasing nitrogen inputs are now faced with legislation controlling the amount of fertiliser nitrogen that they can use.

The Greener Pastures project was set up to assist the Australian dairy industry meet the two major challenges managing high performing pasture systems: maintaining profitability while meeting the expectations of a community that is increasingly sensitive to environmental issues.

Dairy in Western Australia

The dairy industry in Western Australia (WA) is located in the southwest, between Perth in the north and Albany in the south. Since deregulation in 2000, there has been an increase in stocking rates, accompanied by increased fertiliser use to produce more home grown feed and by increased use of purchased feeds.

The Greener Pastures research was centred at DAFWA's Vasse Research Centre (VRC) near Busselton, in the heart of WA's dairy region. The climate is Mediterranean, with an average rainfall of 750 mm (range 550 to 1000 mm), of which 90 per cent falls in the months of May to November (1991 to 2010 data).
Figure 1. The south-west of Western Australia showing the location of Vasse Research Centre (blue dot) and the four Partner farms (red dots).
Figure 2. Mean minimum (blue line) and maximum (red line) monthly temperatures and total monthly rainfall (green bars) for Vasse Research Centre from 1991 to 2010 inclusive.
Why Greener Pastures?

The concept for the Greener Pastures project was developed by the DAFWA dairy team over a period of nearly two years from 2003-2005, in close collaboration with industry stakeholders in WA and with Dairy Australia. Extensive modelling of alternative farm systems was undertaken to assess their strengths and weaknesses. This highlighted the importance of a continued focus on pasture and grazing management and the potential role of more efficient use of nitrogen fertiliser to increase farm profitability, which would also reduce nutrient losses off farm, thereby reducing environmental impact.

In an earlier farming systems project, the Vasse Milk Farmlets, the performance and profitability of six dairy systems of increasing intensity were investigated, from low intensity-low input systems (1.2 cows/ha and 900 kg concentrate/cow/year) through to more intensive, high input systems (2.4 cows/ha and 2700 kg concentrate/cow/year). The project identified that all systems could be profitable provided that high pasture utilisation was maintained.

The Vasse Milk Farmlets also confirmed international research that nitrogen losses from intensively managed dairy farms were high and that these increased with further intensification. It highlighted opportunities for increasing efficiency of nutrient use on dairy farms, with benefits for farm profit and reduced environmental impact.

Greener Pastures was developed to complement a suite of national Dairy Australia funded projects focussing on increasing dairy farm returns through the increased use of home grown forage, such as 3030 in Victoria and 2012 in Tasmania.
Greener Pastures stakeholders

The Greener Pastures project has been a true team effort, with DAFWA staff collaborating with leading WA dairy farmers and service providers, as well as a number of eastern states colleagues, to develop the research questions and design the project.

Various organisations have supported the Greener Pastures project, including:

- DAFWA
- Western Dairy
- Dairy Australia
- CSIRO
- Chemistry Centre of Western Australia
- Natural Heritage Trust
- Land & Water Australia

Greener Pastures—Phase I
(July 2005 to December 2008)

During Phase I, a farmlet study was conducted at Vasse Research Centre to compare the performance of pasture and dairy cows when annual ryegrass pastures were top-dressed with one of five rates of nitrogen fertiliser (0 to 2 kg/ha/day).

An extensive monitoring program provided a sound understanding of the magnitude of the pathways of nitrogen and phosphorous leaching/ runoff from intensive dairy pasture systems.

Greener Pastures—Phase II
(January 2009 to March 2010)

Phase II consisted of a farmlet study to investigate whether delaying grazing from the 2 to 3 leaf stage provides a real productivity boost on farm when nitrogen is applied at the recommended rate.
Project Design

Five Nitrogen Response Farmlets

Five Nitrogen Response Farmlets (NRF) were set up at VRC and compared from June 2005 to December 2008 to define pasture use, milk production and profit responses to increasing levels of fertiliser nitrogen (0, 0.5, 1, 1.5, 2 kg/ha/day). Nitrogen fertiliser was applied within three days after each grazing. Stocking rate increased as nitrogen fertiliser use increased (see Table 2).

Table 2. Nitrogen fertiliser use, stocking rates, and pasture area for each Nitrogen Response Farmlet.

<table>
<thead>
<tr>
<th>Nitrogen Response Farmlet</th>
<th>Target N fertiliser</th>
<th>Annual N fertiliser*</th>
<th>Stocking rate</th>
<th>Pasture area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kg/ha/d</td>
<td>kg/ha/yr</td>
<td>cows/ha</td>
<td>ha</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1¼</td>
<td>15.8</td>
</tr>
<tr>
<td>2</td>
<td>½</td>
<td>100</td>
<td>1½</td>
<td>13.3</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>200</td>
<td>1¾</td>
<td>11.7</td>
</tr>
<tr>
<td>4</td>
<td>1½</td>
<td>300</td>
<td>2</td>
<td>10.2</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>400</td>
<td>2¼</td>
<td>9.0</td>
</tr>
</tbody>
</table>

* For a typical annual pasture growing season of 200 days.
Two Leaf-Stage Farmlets

Two ‘Leaf-stage’ farmlets were set up at VRC and compared from January 2009 to March 2010 to compare farm performance under two grazing management strategies, both using nitrogen fertiliser at a rate of 1 kg/ha/day. Each farmlet comprised eight hectares of pivot sprinkler irrigated pasture and nine hectares of dryland ryegrass pastures, stocked with 40 cows each.

The two grazing management strategies were:

1. Rotational grazing when ryegrass reached the 2 leaf stage, with nitrogen fertiliser applied at 1 kg/ha/day. This may be similar to traditional grazing practice across much of Australia and New Zealand with grazing at a fixed pre-grazing pasture height or biomass.

2. Rotational grazing when ryegrass reached the 3 leaf stage, with nitrogen fertiliser applied at 1 kg/ha/day. It is common practice on dairy farms to graze well before 3 leaves when moderate to high amounts of nitrogen fertiliser are used if canopy closure is perceived to be an issue. In our study, grazing was maintained at 3 leaves at all times (excluding reproductive annual pastures), regardless of pre-grazing pasture height or biomass.

Two Innovation Farms

From the start of the development of Greener Pastures, project partners were of the view that the project design must incorporate a ‘learning platform’ that ensured the research findings could be assessed for practicability.
To accommodate this, two Innovation Farms were established at VRC in 2005, one irrigated and one dryland with around 80 cows each, to trial and test the best strategies for nutrient management identified from the NRF and Partner Farm trials (see below). Cows were fed between 1500 and 2000 kg concentrate/cow/year, depending on seasonal conditions.

These Innovation Farms were managed as ‘semi-commercial farms’, free of the need for strict scientific rigour such as was required for the Nitrogen Response Farmlets. This provided opportunities for industry to have input into designing management practices to increase whole-farm efficiency and sustainability of nutrient use. In addition, management rules for nutrients such as phosphorous, potassium and sulfur, based on results from the Partner Farm studies, were incorporated.

A management committee comprising farmers, service providers and DAFWA officers directed the management of the Innovation Farms.

Support Research

In addition to the major components of the Greener Pastures project, a range of smaller supporting experiments were conducted to investigate other aspects of nutrient and pasture manipulation. These included:

- Monitoring of milk urea levels as a management tool to maintain rumen sugar and protein balance when cows are fed pastures with high nitrogen content.
- The effect of nitrogen fertiliser rate and cutting frequency on irrigated perennial ryegrass grown in pots over summer.
- Quantify the impact of waterlogging on annual ryegrass growth rates over winter.
- Feasibility of nitrification inhibitors applied in summer and autumn to reduce nitrogen losses from urine and increase pasture growth rates.
- Feeding of low nitrogen forages such as maize silage to improve nutrient balance in the rumen.
Partner Farmers

The DAFWA dairy team has a long track record of working successfully with industry and our peers to deliver dairy RD&E. The relative small size of the WA dairy industry has ensured a strong and productive working relationship between all sectors of the industry.

An integral part of the Greener Pastures project was the collaboration with four highly successful and respected commercial dairy farmers. The farmers included the 2008 and 2010 WA regional category winners of the Dairy Business of the Year competition. The farmers volunteered to work with the Greener Pastures dairy team. Each Partner Farmer had intensified their dairy business to increase profitability and production per hectare in the previous decade, including increased fertiliser nitrogen to increase pasture growth and utilisation.

While commercial Partner Farms have been used before in WA dairy research projects in an extension role to achieve industry practice change, the role of the Partner Farmers was somewhat different in our project. In Greener Pastures, the farmers themselves were a partner in the overall research program, contributing as co-developers of knowledge.

The Greener Pastures Partner Farmers were an integral component of the Greener Pastures project, contributing

1. A co-researcher role through their knowledge, skills and ideas adding to the research undertaken at VRC, and
2. A co-extension role by testing and validating innovations developed on the Innovation Farms in a real life commercial farm environment; providing dairy farmers the opportunity to 'look over the fence' at the impact of the adoption of some of the Greener Pastures recommendations under local commercial conditions.
Also, fertiliser (phosphorous, potassium and sulfur) experiments were conducted on Partner Farms to determine critical soil test values for application of fertiliser and the application frequency on intensively grazed ryegrass pastures.

The Partner Farmers are introduced below:

**Grant and Peter & Sue Evans — North Jindong**  
Dryland dairy farm with an 800 cow herd

‘Making the most of our pastures is an integral part of our business, so any research that helps us use nutrients more efficiently is of vital interest to us,’ said Grant. ‘We are aware that we farm in a high public profile area of the state and as such we need to be able to demonstrate that we farm environmentally responsibly, so this project is critical to the future of our business and the whole WA dairy industry’.
Dale & Leanne Hanks — Harvey
Flood and sprinkler irrigation dairy farm with a 300 cow herd

‘Our involvement in the Greener Pastures project was an extension of our interest in cost savings through more efficient use of nutrients across the whole farm,’ said Dale. ‘We farm in an area close to the ocean and are being surrounded by urban developments so it is important that we ensure we farm in a sustainable way’.

Miles & Dionne Mottershead — Witchcliffe
Dryland dairy farm with a 700 cow herd

It was the big issues identified as part of the Vasse Milk Farmlets project at VRC that started Miles thinking about opportunities on their farm. ‘After seeing the big nutrient surpluses at the VRC, we have made many changes that have saved dollars and reduced nutrient surpluses,’ said Miles. ‘We have reduced our fertiliser rates and at the same time increased our stocking rate and pasture utilisation; our biggest profit drivers’.
Victor & Denise and Kath Rodwell — Boyanup
Sprinkler irrigated dairy farm with an 800 cow herd

Our involvement as a Partner Farm will ensure we stay at the edge and continue our learning process,’ said Victor. ‘We are already working with high nitrogen levels and we have seen that we can reduce costs of production by changing our grazing management to make better use of our nitrogen fertiliser. This is better for animal health and the long term environmental sustainability of both our business and the whole industry’.
Dr Martin Staines

Martin is the research leader of the dairy group and was involved in all aspects of the Greener Pastures project. Current areas of work include dairy systems research, ruminant nutrition, systems modelling and grazing management.

Mr John Lucey

John is the dairy group leader and has been responsible for consultation with industry, ongoing liaison, and dissemination of the many project findings. Current responsibilities also include working closely with the beef industry in WA as many of the Greener Pastures findings are also relevant to that sector.
Mr Don Bennett

Don is a hydrologist with experience across all of WA. He conducted the nutrient leaching and runoff research at Vasse Research Centre, and more widely across the coastal plain in the southwest of WA.

Dr Mike Bolland

Mike is a plant nutrition specialist who led the development of the new fertiliser guidelines and worked closely with the Partner Farmers to develop more efficient fertiliser practices.
Ms Tess Casson

Tess is a dairy researcher who specialised in the grazing management of the farmlets at Vasse Research Centre. She also has previous experience in saline cropping and perennial species in medium rainfall areas of WA.

Mr Ian Guthridge

Ian is a Research Centre manager who conducted the Partner Farm trials across the southwest with Mike Bolland. He currently manages the Horticulture Research Institute at Manjimup.
Mr Richard Morris

Richard is a dairy researcher who managed the Greener Pastures farmlets at Vasse Research Centre. Other areas of work include farm systems modelling, grazing management and forage conservation.

Mr Bill Russell

Bill is a dairy extension specialist with extensive experience in nutrient management and fertiliser use. Bill played a major role in the work conducted on the Partner Farms, development of the new fertiliser guidelines as well as providing plant nutrition advice for the farmlets.
Greener Pastures legacy

The Greener Pastures project has contributed significantly to the Australian dairy industry’s understanding of the profitable and sustainable management of intensive dairy pasture systems.

Specifically in WA, outcomes include:

1. More strategic and, in many instances, reduced fertiliser use on WA dairy farms.
2. Incorporation of Greener Pastures findings into the Fertiliser Action Plan including the National Fertcare recommendations.
3. Improved farmer skills to manage pasture systems for higher productivity without disproportionate increases in nitrogen fertiliser use or nitrogen leaching/runoff.
4. Adoption of increased nutrient accounting practices that has enabled more effective management of nitrogen at the farm level and demonstrated industry’s ability to meet community targets for nitrogen leaching/runoff.
5. Engagement with Natural Resource Management agencies and supply of Greener Pastures findings to develop appropriate models of nutrient flow and management in southwest catchments.
Application to other industries

The majority of the findings from the Greener Pastures project are applicable to any ryegrass-based grazing industry. Many of the bulletins contain specific recommendations for other industries such as beef that may be less reliant on nitrogen fertiliser and graze less intensively.

Further information

DAFWA Website: http://www.agric.wa.gov.au/greenerpastures

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Notes