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Summary

The dairy industry along with key stakeholders in government and the fertiliser industry have taken the initiative to develop a number of programs that contribute to improving the efficiency of nutrient use and minimise the likelihood of environmental losses to the environment. The need for a coordinated approach to improved nutrient management on dairy farms involving farmers, advisors, fertiliser companies and policy organisations has underpinned a strategic approach to this issue. Two key projects, ‘Better Fertiliser Decisions’ (2003-2007), and ‘Accounting for Nutrients on Australian Dairy Farms’ (2006-2010), have formed the basis of this approach. By engaging all these stakeholders, the relevance, rigour, and adoption of the information and tools arising from these projects will be maximised.

The BFD project delivered the most comprehensive collation and summary of soil test calibration studies for pasture production ever undertaken in Australia as well as a new ‘Farm Nutrient Loss Index’ (FNLI) to assist farmers and advisors identify areas of environmental risk on their farms and enable steps to be taken that reduce nutrient losses from farms.

The complexity of the task, both from a technical and stakeholder relationship perspective, was considerably greater than the project team envisaged. However, the inclusiveness of the National Network team from across Australia, and stakeholder support, particularly from the partnership with the Fertcare® leadership team, ensured that all the key players worked together, objectives were met and that the project information and tools will be used effectively in the future.

The changing nature of Australian dairy operations, the increasing societal pressure on dairy farmers to reduce nutrient losses to water and air, and the need to provide evidence that farm practices are meeting environmental standards has provided the impetus to develop and implement a standard nutrient budgeting approach. Nutrient budgeting will assist farmers to meet production goals and identify opportunities for improvements in nutrient use efficiencies, decrease nutrient surplus and accumulation on dairy farms and reduce the risk of off-farm nutrient losses. A standardised and widely adopted nutrient budgeting approach will enable the Australian dairy industry to take a pro-active approach in addressing nutrient management issues using strong science outcomes rather than waiting to be driven by environmental policy. As with the Better Fertiliser Decisions project, the ‘Accounting for Nutrients on Australian Dairy Farms’ project has the support and involvement of a wide range of stakeholders including the fertiliser industry that will maximise the opportunities for its success and subsequent adoption of its findings and tools.
Introduction

Fertilisers containing N, P, K and S continue to be a key requirement for the Australian grazing industries. However, increased community concerns about excess nutrients in water and the atmosphere means that farmers and service providers need to have access to, and use, the best possible information regarding optimum nutrient management practices for environmental as well as productivity benefits. A more tailored approach to nutrient management, based on the best available information for soil test targets, a greater understanding of potential nutrient loss processes and pathways and pools and fluxes of nutrients on farms (and the associated inefficiencies) will lead to improved nutrient efficiency on farm (and hence the best return on fertiliser $) and reduce the risk of losses of nutrients to the environment.


The Better Fertiliser Decisions project (BFD) was conducted to provide comprehensive information to improve fertiliser decisions for grazing industries across Australia. National in scope, the BFD project compiled and interpreted results from pasture-fertiliser experiments and information on nutrient loss processes from all pastoral regions in Australia (Figure 1).

The objectives of the Better Fertiliser Decisions project were:

(i) To provide regionally specific relationships for soil test - pasture response functions for phosphorus, potassium, sulphur and nitrogen fertilisers (and where possible animal production responses) from existing data for extensive and intensive pasture systems across Australia, through an interactive database.

(ii) To review and develop tools that identify landscape characteristics, soils and farm management practices that contribute to impacts on the environment, and to integrate Environmental Risk Assessment and nutrient response functions.

(iii) To disseminate consistent and regionally specific nutrient response relationships and Environmental Risk Assessment tools to regional industry and government networks including fertiliser company advisers, consultants, extension officers and farmers to provide greater skills and confidence in fertiliser decision-making.
To this end, the BFD project, through a National Network team (NN) of leading scientists and fertiliser agronomists from all states of Australia, identified and collated a comprehensive set of Australian pasture and animal production fertiliser response data. The response relationships are based on a large amount of data collated from an extensive national review of soil test – pasture response experiments, conducted over the past 50 years. Sources of this information included peer-reviewed scientific publications, government and industry reports, as well as unpublished data. All experimental data used in the development of the response relationships were standardised and met rigorous quality assurance criteria.

In excess of 300 experimental data sets were collated consisting of approximately 2500 sites and over 4500 experimental trial years. The data sets were standardised and compiled in a specifically designed National Database, where the data could be explored and interpreted. Importantly, disparate datasets have been integrated to derive the most appropriate response relationships for different soil textural classes, at a regional, state, and national scale. The database serves as a comprehensive resource for information about previous pasture-fertiliser response experiments and provides the capacity to accommodate new data in the future.

The Farm Nutrient Loss Index (FNLI) was developed by collating regionally specific information on nutrient loss processes from scientific publications and existing data. The FNLI uses easily quantifiable inputs such as landscape features, climatic conditions, and pasture and stock management practices to calculate the risk of nutrient loss at the

Figure 1. Pasture-based grazing regions of Australia, defined by climate, pasture type and irrigation.
paddock scale and evaluate the effects of different management practices. The FNLI predictions compare favorably with known water and nutrient loss measurements.

The regionally specific FNLI is based on a review of Australian and overseas literature and knowledge harnessed from National Network participants. A series of 9 regional technical review workshops, as well as farm assessments, across all grazing regions of Australia, were used to refine the FNLI for regional differences in nutrient loss pathways and processes. These participatory workshops involved over 90 technical experts in nutrient management including researchers, educators, extension officers, fertiliser industry agronomists and natural resource managers. The FNLI operates as both a paper based version and a Visual Basic software version.

The communication-related activities within the BFD project importantly maintained a strong link and focus with the next users, most notably the fertiliser industry. Discussions and regular industry meetings have facilitated a common understanding, improvements and acceptance of project tools and information. There was also information directed to farmers and the broader community through the media so that the industry groups are ‘primed’ for project outputs. The project outputs are also receiving national and international review from scientific peers, through national and international conferences and journal papers.

An additional year of funding for the ‘Better Fertiliser Decisions Technology Exchange Year’ (2006-2007) was supported as a way to gain maximum industry impact from the outcomes of the Better Fertiliser Decisions (BFD) project, which was completed in June 2006. An important part of this process in gaining industry-wide acceptance of the BFD project products has been critical analysis and discussion of the outcomes with industry specialists to generate trust and more fully understand the implications of the project outputs for the grazing industries.

Key achievements from the Better Fertiliser Decisions project include:

- Quality checking of all soil test and pasture response data.
- Thorough statistical analysis and interpretation of soil test – pasture response relationships to develop a consistent and relevant approach to identify appropriate soil test levels for each soil type, region and enterprise.
- Discussion and revision of the soil test – pasture response relationships to address concerns of agronomists.
- The final soil test – pasture response relationships and FNLI made available at www.asris.csiro.au and hardcopies distributed to key stakeholders.
- Agreement with FIFA to incorporate the soil test – pasture response relationships and FNLI into courses and FIFA’s accreditation program.
- Major Australian fertiliser companies have expressed interest in using project outputs in their fertiliser recommendation systems and software.
- Formal training sessions delivered to state extension staff from DPI NSW, DPIV, and DPIF WA.
- Project results presented at 6 industry conferences
- More than 100 farm advisors that expressed interest in the results of the project.
- Project results featured in 6 industry newsletters and 2 commercial rural press articles.
• Numerous awareness-raising presentations both nationally and internationally with other stakeholders such as Regional Dairy Boards, CMAs, research and industry groups.

Figure 2. The products developed during the better fertiliser decisions project (2003-2007): a website containing the results and publications, a technical booklet containing the soil test – fertiliser response relationships and an introduction to the FNLI, with accompanying CD containing the FNLI program and User Manual, and a National Database containing the data submitted to the project with a flexigraph interface.

Soil test – pasture response relationships

Soil test – pasture response calibrations define the relationship between pasture production and soil test value. The relationship allows users to predict the pasture production response if the soil nutrient level is altered by the addition of fertiliser.

Researchers from the pasture-based grazing industries of Australia provided experimental results to develop the newly defined pasture response relationships. Over 3,000 experimental years of research results were compiled, some dating back 50 years, including in excess of 250 experiments involving approximately 1,600 field sites, and more than 48,000 individual pasture yield measures.

Experiments had to meet certain design, data collection and quality criteria to be included in the analysis. This included a zero application (control) and high application treatment of either P, K or S, where all of the other nutrients were present at sufficient levels so as not to limit pasture growth.

Only experiments that used the following Australian soil tests: Olsen and Colwell P; Colwell, Skene and exchangeable K; and CPC and KCl-40 S, were analysed because there were insufficient data to analyse less commonly used tests. It was not possible to develop soil test – pasture response relationships for N since there is no reliable soil test for N. Soil test sample depth was standardised to 10 cm.

Soil test – pasture response relationships were prepared, where possible, for P, K and S, nationally and differentiated by state, region, soil texture, PBI and cation exchange capacity categories. Insufficient quality data regarding pasture species, pasture
composition, and grazing enterprise meant that soil test – pasture response relationships could not be differentiated by these factors.

The response relationships were statistically compared and significant differences identified. Where no statistical differences occurred, data were pooled to increase the precision of the final response relationship. The pooled national data set provides superior soil test – pasture response relationships for each nutrient. These response relationships are relevant across all grazing regions and livestock enterprises.

**How the response relationships were developed?**

Pasture production data (kg dry matter/ha) were standardised to percentage maximum pasture yield to allow comparison of differences in pasture productivity between locations, seasons and climatic conditions. For each field experiment, the ‘percentage of maximum pasture yield’ was calculated from the zero and high nutrient treatments based on the following equation:

\[
\text{Percentage of maximum pasture yield} = \frac{\text{Pasture yield with no nutrient applied}}{\text{Maximum pasture yield when non-limiting nutrient is applied}} \times 100
\]

Percentage maximum pasture yield and initial soil test value for each experiment were then used to define soil test – pasture response relationships. These response relationships can be used to determine the likely pasture response at any particular soil test value. Response relationships were specified to have a zero yield at zero soil test levels, and to reach maximum potential yield (100%) at a very high soil test level.

**Critical soil test values**

A ‘critical soil test value’ is defined as the soil test value where 95% of maximum pasture production occurs. These values were established from the soil test – pasture response relationships. The 95% critical soil test value is a simple, commonly used reference point to define where further applications of nutrients are unlikely to provide worthwhile increases in pasture production. The confidence interval around the critical value indicates the reliability of the estimate.

**Phosphorus**

The bicarbonate extraction procedure of Olsen (Olsen P test), and the further modification by Colwell (Colwell P test) are the two most commonly used P soil tests in Australia. These tests differ in the ratio of soil and extracting solution and the length of time of agitation. These factors jointly affect the release of soil-bound ‘fixed’ P. The Colwell P test, with a larger soil extractant ratio and longer agitation time, extracts more fixed P than the Olsen P test. As a result, it is well recognised that Colwell P tests need to be interpreted in association with an estimate of the soil’s P fixing capacity. While soil texture or other measures have long been used as surrogates for soil P fixing capacity, the recently developed phosphorus buffering index (PBI) is now the national standard for estimating soil P capacity.

**Olsen Phosphorus**

There were no significant differences between the Olsen P soil test – pasture response relationships when experimental data was differentiated according to state, region, soil texture and PBI categories. Therefore the relationship based on the entire national Olsen P dataset (Figure 3) is recommended to guide fertiliser decisions (Table 1).
Figure 3. The relationship between percentage maximum pasture yield and Olsen P soil test value from nationally collated experiments. The critical Olsen P soil test value at 95% of pasture production is indicated by the dashed line.

Table 1. The critical Olsen P soil test value and equation describing the relationship between Olsen P soil test value and percentage maximum pasture yield, derived from the national data set.

<table>
<thead>
<tr>
<th>Critical value1 (mg/kg)</th>
<th>Confidence interval2</th>
<th>Number of experiments</th>
<th>Equation3</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>14 - 17</td>
<td>303</td>
<td>% maximum yield = 100 × (1 – e (^{0.202 \times \text{Olsen P}}))</td>
</tr>
</tbody>
</table>

1 Soil test value at 95% of predicted maximum pasture yield.
2 95% chance that this range covers the critical soil test value.
3 \(e\) = Euler’s constant (approx 2.71828).

**Colwell Phosphorus**

There were no statistically significant differences between the Colwell P – pasture response relationships when experimental data was differentiated by state, region or soil texture. However, the Colwell P – pasture response relationship did show significant dependence on PBI.

Twelve PBI classes with equal numbers of experimental data were used to derive Colwell P – pasture response relationships and associated critical Colwell P values. The equation in Figure 4 describes the relationship between the critical Colwell P and PBI values. This equation enables the critical Colwell P value to be calculated when the PBI of a soil is known (Table 2).
Figure 4. The relationship between critical Colwell P value and soil PBI value. The critical Colwell P value is the soil test value predicted to produce 95% of maximum pasture yield.

Table 2. Predicted critical Colwell P soil test values for standard PBI categories, derived from the national data set.

<table>
<thead>
<tr>
<th>PBI category</th>
<th>Critical value (mg/kg) for mid point of PBI category (range)(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;15</td>
<td>Extremely low 23 (20 – 24)</td>
</tr>
<tr>
<td>15-35</td>
<td>Very very low 26 (24 – 27)</td>
</tr>
<tr>
<td>36-70</td>
<td>Very low 29 (27 – 31)</td>
</tr>
<tr>
<td>71-140</td>
<td>Low 34 (31 – 36)</td>
</tr>
<tr>
<td>141-280</td>
<td>Moderate 40 (36 – 44)</td>
</tr>
<tr>
<td>281-840</td>
<td>High 55 (44 – 64)</td>
</tr>
<tr>
<td>&gt;840</td>
<td>Very high n/a 2</td>
</tr>
</tbody>
</table>

\(^1\) Critical Colwell P value at the mid-point of PBI class. Values in parenthesis are critical Colwell P values at the lowest and highest PBI values within the range.  
\(^2\) Insufficient data to derive a response relationship.

Potassium

The commonly used Colwell, Skene and exchangeable K soil tests are strongly correlated with one another. Therefore the national K soil test data were standardised to Colwell K values.

There were no statistical differences in the Colwell K – pasture response relationships when the data were differentiated according to state, region and cation exchange capacity class. However, the Colwell K – pasture response relationship did show significant dependence on soil texture class.

The national data were differentiated into five soil texture classes based on clay percentage, and were used to derive Colwell K – pasture response relationships and associated critical Colwell K values. Figure 5 shows the Colwell K – pasture response
relationships for four soil texture classes. There were insufficient data to define a response relationship for the clay texture class. The critical Colwell K values and the equations which describe these relationships are provided in Table 3.

Table 3. The critical Colwell K soil test values for four soil texture classes and the equations describing the relationship between Colwell K soil test value and percentage maximum pasture yield, derived from the national data set.

| Soil texture    | Critical value\(^1\) (mg/kg) | Confidence interval\(^2\) | Number of experiments | Equation\(^3\)%
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>126</td>
<td>109-142</td>
<td>50</td>
<td>(100 \times (1 - e^{-0.024 \times \text{Colwell }K}))</td>
</tr>
<tr>
<td>Sandy loam</td>
<td>139</td>
<td>126-157</td>
<td>122</td>
<td>(100 \times (1 - e^{-0.022 \times \text{Colwell }K}))</td>
</tr>
<tr>
<td>Sandy clay loam</td>
<td>143</td>
<td>127-173</td>
<td>75</td>
<td>(100 \times (1 - e^{-0.021 \times \text{Colwell }K}))</td>
</tr>
<tr>
<td>Clay loam</td>
<td>161</td>
<td>151-182</td>
<td>194</td>
<td>(100 \times (1 - e^{-0.019 \times \text{Colwell }K}))</td>
</tr>
</tbody>
</table>

\(^1\) Soil test value at 95% of predicted maximum pasture yield.
\(^2\) 95% chance that this range covers the critical soil test value.
\(^3\) \(e\) = Euler's constant (approx 2.71828).

**Sulfur**

Due to the historical widespread use of superphosphate, which has generally provided adequate S for plant growth, there have been fewer S experiments conducted compared with P or K. The two main soil S tests used in Australia are CPC (calcium phosphate
plus charcoal) and KCl-40 (potassium chloride heated to 40°C for 3 h). The two S tests are not correlated and therefore experimental data could not be pooled.

The use of each S soil test tended to be regionally specific, and most S experiments were conducted on clay loam or sandy loam soils. Therefore there were insufficient data available to investigate whether soil S test – pasture production response relationships differed between soil texture, states or regions.

The S soil test – pasture response relationships for CPC S and KCl-40 S, derived from the national data set, are presented separately (Figure 6 and Table 4).

![Figure 6](image_url)

**Figure 6.** The relationship between percentage maximum pasture yield and soil test value for CPC S and KCl-40 S tests, derived from the national data set. The critical S soil test values at 95% of pasture production are indicated by the dashed lines.

### Table 4. The critical CPC S and KCl-40 S soil test values and equations describing the relationship between CPC S and KCl-40 S soil test value and percentage maximum pasture yield, derived from the national data set.

<table>
<thead>
<tr>
<th>Sulfur test</th>
<th>Critical value¹ (mg/kg)</th>
<th>Confidence interval²</th>
<th>Number of experiments</th>
<th>State³</th>
<th>Equation⁴ % maximum yield =</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPC</td>
<td>3</td>
<td>2-4</td>
<td>94</td>
<td>Vic, NSW, Qld</td>
<td>100 × (1 – e⁻¹.⁰¹⁴ × CPC S)</td>
</tr>
<tr>
<td>KCl-40</td>
<td>8</td>
<td>6-10</td>
<td>37</td>
<td>NSW, SA</td>
<td>100 × (1 – e⁻⁰.³⁸⁸ × KCl-40 S)</td>
</tr>
</tbody>
</table>

¹ Soil test value at 95% of predicted maximum pasture yield.
² 95% chance that this range covers the critical soil test value.
³ The two soil S tests were largely calibrated in different states.
⁴ e = Euler’s constant (approx 2.71828).
**Interactive database**

There is also an interactive database with a ‘Flexigraph’ facility that includes all of the raw data from experiments and serves as a comprehensive resource for field information and data about all previous pasture – fertiliser response experiments and provides the capacity to accommodate new data in the future. Access to this database is available to all contributors to the database and to some other scientists by application.

**Nutrient loss from farms to the environment**

Nutrient loss from farms to the off-farm environment can be costly and cause degradation of waterways, groundwater and add to greenhouse gases. The grazing and fertiliser industries in Australia identified a need for a simple and practical tool to help farm advisors identify nutrient loss issues within individual farms.

Understanding the principles of nutrient loss is an important component of integrated nutrient management. The Farm Nutrient Loss Index (FNLI) computer program was developed for nutrient management advisors to use in conjunction with soil fertility testing and nutrient budgeting so that they can make informed decisions about how to maximise nutrient use efficiency, and therefore minimise negative environmental impacts. The FNLI can also be used to demonstrate the principles of N and P loss from pasture-based grazing systems to the wider environment.

Over 90 nutrient management researchers, extension staff and fertiliser company representatives were consulted in the development of the FNLI. A participatory workshop approach was used to harness regionally-specific scientific knowledge of nutrient loss processes. Focus group meetings and field assessments were conducted to provide technical review and to develop the utility of the FNLI for existing nutrient management advisory services. The FNLI risk outcomes were also validated against measured nutrient loss data from 17 field experiments across Australia.

A User Manual that provides background information on how to navigate through the FNLI software, how the FNLI calculates risks and the scientific principles of nutrient loss that underpin the Index, is also available from the ASRIS website.

**How the FNLI works?**

The FNLI identifies the risk of N and P loss from individual paddocks to the wider environment via four nutrient loss pathways: runoff across the soil surface (runoff), drainage past the root zone (deep drainage), lateral flow within the root-zone of the soil profile (subsurface lateral flow) and emission of nitrous oxide, which is a powerful greenhouse gas (gaseous emission) (Figure 7). The FNLI is not designed to estimate actual loads of nutrients lost from farms.
Risk of nutrient loss is the combination of the likelihood and magnitude of nutrient loss occurring from a paddock on an average yearly basis. The risk of nutrient loss is influenced by climate, features of the landscape and management of the land. The FNLI identifies the key factors that influence the availability of nutrients (‘source’ factors), and the transport and delivery of nutrients (‘transport’ factors). If source and transport factors occur together, nutrient loss is likely to occur. The source and transport factors identified as important for nutrient loss from the grazing regions of Australia are shown in Figure 8.

To use the FNLI computer program, a series of questions about the paddock of interest need to be answered. Users select the options that best match their paddock characteristics and management. The questions can be readily answered from farm records and observation. For each paddock assessed, the FNLI identifies factors that pose a significant risk of nutrient loss and calculates a risk rating of N and P loss (low,
medium, high or very high) for each loss pathway. The inputs required for the FNLI are listed in the report (Figure 9).

**Interpreting FNLI results**

High or very high risk ratings indicate aspects of the grazing system that may need to be modified to minimise potential nutrient loss. Where a high or very high risk rating is indicated, the main contributing factors are listed. These factors are either intrinsic features of the landscape, such as surplus water and soil type, or imposed by management, such as stocking rate. Alternative management practices can be tested to check strategies aimed at lowering the risk of nutrient loss. A summary of the risk results for each paddock can be saved and printed for future reference (Figure 9).

Since the potential for nutrient loss depends on a combination of characteristics specific to each paddock or land management unit, the appropriate management for each paddock can vary. For example, Paddock A and B both have a very high soil fertility (Figure 10), but have a different risk of nutrient loss because paddock B has a surface drain. The FNLI can help land managers identify the risks of nutrient loss on different...
parts of their farms, explain why these risks occur, and explore nutrient management options which can minimise nutrient losses.

Figure 10. The combinations of transport and source factors across a farm influence the nutrient loss risk.
'Accounting for Nutrients on Australian Dairy Farms' (2007 – 2010)

**Project background**

Along with most other dairy producing countries, the Australian dairy industry continues to undergo significant change. The number of dairy farms has declined over the last 25 years, from over 22,000 in 1980 to around 10,000 in 2005. Over the same period, average farm herd size has increased from 84 cows in 1980 to 205 in 2005 whilst average annual milk production per cow has increased from 2,850 L to 5,163 L.

A key driver of increased per cow productivity over the past 25 years has been the increase in supplementary feeding and increasing forage yields and quality due to fertiliser use, particularly N. In 1980 most dairy farms were totally reliant on ‘home grown’ pasture and conserved forage. In 2004/5, 91% of all dairy farms used imported concentrates or grain, with the average dairy farm supplementation greater than 1.1 tonne /cow.year, mostly barley or wheat. The other major supplement brought on to dairy farms in Australia is hay, usually fed in equivalent amounts to grain. As expected, there is considerable variation in the amount and type of diet supplementation of lactating dairy cows, with grain inputs varying from 0 to 2.5 tonne DM/cow.year and forage inputs varying from 0 to 1.4 tonne DM/cow.year.

While nitrogen (N) and phosphorus (P) inputs are required for most dairy operations, when used in excess, they can significantly degrade air and water quality. Phosphorus losses from dairy farms occur mainly through surface water transport and to a lesser extent leaching to ground water, leading to eutrophication of water storages, lakes and rivers. Nitrogen losses include nitrate leaching into surface water and ground water, the volatilization of ammonia (NH₃), resulting in particulate formation (haze) in the atmosphere and subsequent re-deposition, acidification and eutrophication of surface waters and the emission of potent greenhouse gases.

The risk of nutrient pollution from a dairy farm increases when nutrient inputs exceed the amount of nutrients leaving the farm in products. Total N and P inputs onto dairy farms, mainly in the forms of feed, fertiliser and N fixation by legumes, are usually much greater than the outputs of P and N in milk, animals, and crops. These surpluses tend to increase as farms intensify and stocking rates increase. Excess P on dairy farms can result in increasing soil P levels beyond agronomic requirements, which may also increase the concentration of dissolved P in surface runoff and leachate. Unlike P, N is not significantly buffered by soils, and where N is applied in high concentrations such as in dung, urine or fertiliser, losses through volatilization and leaching can be high. Excess potassium (K) can accumulate in soil and feed, and can cause metabolic disorders in ruminants.

Over the past 20 years, a range of environmental policies have been developed and implemented in Europe and the US, and more recently in New Zealand, with the aim of reducing nutrient losses from dairy farms to the environment. Central to many of these policy approaches has been the development and on-farm implementation of nutrient budgeting tools.

The changing nature of Australian dairy operations, the increasing societal pressure on the farming community to reduce nutrient losses to water and air, and the need to provide evidence that farm practices are meeting environmental standards, justifies the need for the development and implementation of a nutrient budgeting approach to improve nutrient management practices on Australian dairy farms. Nutrient budgeting will assist farmers to meet production goals and identify opportunities for improvements.
in nutrient use efficiencies, decrease nutrient surplus and accumulation on dairy farms and reduce the risk of off-farm nutrient losses. A standardised and well adopted nutrient budgeting approach will enable the Australian dairy industry to take a pro-active approach in addressing nutrient management issues using strong science outcomes rather than waiting to be driven by environmental policy.

The Accounting for Nutrients project will develop a nationally agreed framework for nutrient accounting for N, P, K, S, Ca and Mg for the Australian Dairy Industry. The nutrient accounting framework will improve the dairy industry’s understanding and management of nutrient requirements and nutrient flows, and reduce nutrient losses from dairy farms.

**Progress to date**
In the development year of this four year project, the project team has reviewed world’s best practice and technical approaches for improved nutrient management on dairy farms, developed detailed project protocols, consulted a range of stakeholders on these approaches, and built partnerships with national and international players and funding agencies.

Key outcomes include:

- The establishment of the Project Advisory Committee (PAC) and 2 meetings;
- The establishment of the technical National Network (NN) group and 2 workshops;
- Gaining additional funding support from key dairy Regional Development Programs;
- The completion of a scientific review paper on nutrient budgeting approaches, and acceptance for publication in the Australian Journal of Experimental Agriculture;
- The participation of Professor Quirine Kettering, Cornell University, New York, USA as a keynote speaker at the May national workshop, and subsequent media articles;
- Arranging a formal collaboration and 12 month scientific visit by Professor Mark Powell, USDA Dairy Forage Research Center, to DPI Ellinbank to work with project team members;
- Completion of the ‘working’ communication, evaluation and next-use plans, including the production and distribution of a major media story in a number of dairy industry publications, and evaluation of the project objectives, direction and progress in the first 10 months;
- Development and endorsement of methodology for detailed nutrient management monitoring for ‘case study’ dairy farms;
- Development and endorsement of the process for selecting dairy farms to be involved in detailed nutrient management monitoring.

**Future activities**
Preparations are now underway to commence detailed monitoring of nutrients on 48 farms across Australia. This monitoring will serve to refine the proposed nutrient
accounting methodology, benchmark nutrient accounting in the industry and demonstrate the potential benefits arising from nutrient accounting. The detailed monitoring of farms as part of this project will involve keeping records of farm activities and sampling a wide range of nutrient pools and sources every 3 months over 2 years. This will be the largest study of its type in Australia and will involve farmers, staff from all state Primary Industry agencies, consultants, the dairy industry and the fertilizer industry.

**Delivering outputs to the fertiliser industry**

The BFD project team recognised that the fertiliser industry, including the network of agribusinesses supplying fertiliser, fertiliser spreaders, individual fertiliser companies, the Fertiliser Industry Federation of Australia (FIFA) and the Fertcare® program, is the key next-user of information and tools delivered from the BFD project.

The fertiliser industry and other related stakeholders have continued to play an active role in directly using project outputs, and distributing information from the project to their networks. Fertcare® has agreed to incorporate the BFD project outputs within the next 12 months as part of their training and delivery tools. Additionally, the Fertcare® program will use the new national soil test response relationships from the BFD project as the benchmark for comparison of soil test recommendations from all fertiliser companies seeking Fertcare® accreditation. Additionally, the key fertiliser industries across Australia have committed to incorporate the new national soil test response relationships into future revisions of their fertiliser decision support systems. They have also committed to using the FNLI, and integrate both the refined response relationships and the information provided by the FNLI within their day-to-day fertiliser recommendations.

The BFD project team has worked with individual companies and Fertcare® training staff in formal ‘train the trainer’ sessions so that the soil test – pasture response relationships and the FNLI can be embedded into industry and Fertcare® training programs. Individual companies and Fertcare® training staff have gained experience and expertise in using, explaining and delivering these tools and information.

The ‘Accounting for Nutrients’ project team is also working closely with stakeholders to ensure that the findings and tools that arise from this project are integrated into decision making relating to nutrient management on dairy farms. A number of these key stakeholders – including FIFA – form part of the ‘Accounting for Nutrients’ Project Advisory Committee. Additional stakeholders that are being engaged by the project have been identified as part of the development of the project’s formal ‘Communication, evaluation and next users’ plan.