# final report

Project code: B.PUE.0105

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New South Wales Department of Primary Industries

Date submitted: May 2014

ISBN: 9781740362665

PUBLISHED BY
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# An assessment and benchmarking of phosphorus nutrient use efficiency and industry management practice in southern Australia

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government and contributions from the Australian Meat Processor Corporation to support the research and development detailed in this publication.

# Abstract

Previous studies identified opportunities to improve productivity and environmental benefits through strategic application of phosphorus fertiliser. This study examined and benchmarked industry understanding of nutrient management and current nutrient management practices, including the use of soil testing. Awareness and understanding of industry-agreed critical phosphorus values among both advisors and producers is poor, and the linkage between soil fertility, pasture production and livestock production is not well understood. Results support previous reports of low uptake of soil testing by producers - < 25% of producers across all sectors are likely to have soils tested, and <15% of all tests submitted are derived from pasture paddocks. Most producers apply a traditional standard rate of fertiliser, spasmodically, irrespective of stocking rate. When pasture is fertilised it is most likely to be at the standard rate of 11kg/ha of P fertiliser. The project also examined all available soil test databases to benchmark current fertility status of pastures of the southern region. This review highlighted risks associated with using large datasets with limited metadata to draw farm or paddock level conclusions on fertility status. Datasets containing adequate metadata indicated opportunities to improve economic and environmental benefits to the red meat industry in cases of both under-fertilising and over-fertilising. The study identified opportunities to improve nutrient use efficiency through routine use of soil testing and application of critical soil test values to develop farm level nutrient management strategies.

# Executive summary

This MLA project “An assessment and benchmarking of phosphorus nutrient use efficiency and industry management practice in Southern Australia” (B.PUE.0105) undertook to benchmark and assess industry understanding and management of pasture nutrition, with a particular emphasis on phosphorus (P), in the southern mixed farming and medium to high rainfall grazing zones of southern Australia and to review the fertility status of soils. Part 1 reports on the consultation phase of the project, benchmarking and assessing current nutrient management practices, industry attitudes and perception of soil testing, producer and advisor involvement in training and extension programs and uptake of nutrient management guidelines and decision support tools. Part 2 of this project is a desktop review of existing and commercial soil test data obtained via a survey of ASPAC laboratories, benchmarking and assessing the fertility status of soils.

**Consultative phase**
This study indicates poor penetration of industry-agreed critical soil test values (CVs) among producers and advisors. In addition there is an apparent low level of understanding among many producers and advisors of pasture management principles and the importance of nutrient management in driving enterprise profitability. There are multiple information providers who provide contradictory messages on the role of traditional fertilisers in sustainable agricultural production systems. This has contributed to confusion and reduced confidence amongst producers in analysing and applying fertiliser recommendations. In the current climate of uncertainty (seasonal variability, fluctuating commodity prices and generational change) access for producers and advisors to evidence-based information and economic analysis is necessary.

Although 90-93% of producers participating in this study indicated that they use soil testing, most do not use soil test results to refine nutrient management decisions and many maintain traditional nutrient management strategies. Fertiliser application decisions are primarily influenced by cash flow and fertiliser price. ABS (2010) data indicates that less than 25% of the wider population of livestock producers are likely to have soils tested. Industry consultation suggests this is often spasmodic, and used as a means to check specific values (most commonly P and pH) and to diagnose ‘problem’ paddocks.

The study indicates that 87% of producers seek advice on soil test interpretation and 58% seek advice on fertiliser recommendations. However, industry knowledge stocks are in decline and next generation producers and advisors have had limited exposure to pasture management extension or training programs. Producer and advisor awareness of the critical P soil test values and guidelines that relate soil fertility levels to stocking rate is poor. There is also a generally poor understanding of the link between soil fertility status, plant production (quality and quantity) and livestock production. Extension of these guidelines has been limited to red meat producers attending targeted nutrient management programs recently developed by DAFWA (Whole Farm Nutrient Mapping) and NSW DPI and CSIRO (Five Easy Steps), delivered with funding from NRM organisations in regions where nutrient load from agricultural land poses an environmental threat. Delivery of nutrient management programs to the broader livestock producer population has been ad hoc and although NRM organisations provide a number of soil-related programs there is no coordinated approach to the delivery of information on nutrient management in pastures. It is reasonable to conclude that the majority of producers have a poor understanding of nutrient management principles needed to effectively use soil testing as a tool to manage soil fertility and improve nutrient use efficiency. Education of both producers and the advisory sector is necessary to ensure practice change and improvement of nutrient use efficiency across the livestock sector.

Most next generation advisors have limited exposure to pasture nutrition or livestock system field trials or demonstrations and lack confidence in their ability to provide economic rationale for fertiliser recommendations based of livestock production targets. The Fertcare® accreditation program delivered by the private sector (Back Paddock Company, Incitec Pivot Limited and

CSBP) provides a mechanism of quality assurance that ensures that advisors are making paddock level recommendations on the basis of industry-agreed soil test CVs. The rigour of the Fertcare® program must be supported to ensure industry-agreed guidelines and up-to-date data is incorporated into the nutrient recommendation decision support systems (DSSs) used by accredited advisors. Although most advisors working for larger agribusiness companies are accredited under the Fertcare® program, only 7% of independent advisors and consultants are accredited. Advisors also need training in the Five Easy Steps principles to build capacity and confidence to use soil tests and develop whole farm nutrient management strategies on the basis of soil tests linked to livestock production targets and enterprise profitability.

Adoption by advisors and producers of DSSs is low. Some DSSs have a role in training of early career advisors, but these are not widely used by experienced advisors. Most producers favour simple calculator tools that provide information on a component of the system (e.g. livestock prices or pasture growth); consultants and advisors estimate that considerably less than 10% of producers are sufficiently confident to use complex DSSs, with many deterred from using them by the time needed to develop and maintain a level of competency. Producers lack confidence in the underlying assumptions and calculations leading to the outputs of complex models unless they are promoted and supported by a reputable 'champion'. Required tools include a database and interrogator tool of pasture nutrition trials with expansion of the BFD database, modelled on GRDC's Better Fertiliser Decisions in Cropping Systems and an economic calculator to provide long-term outcomes for various P strategies over a range of production systems. The development of such tool is aimed at addressing the lack of knowledge and experience among the next generation of advisors (and producers) of applied nutrient management R&D.

**Desktop review**

Soil test results, most derived from soils collected between 2008 and 2012, were obtained from (some) ASPAC accredited soil test laboratories throughout Australia. An analysis of these test results was undertaken to identify soil fertility levels in relation to critical values. The results presented are derived from a composite of soil samples, and are not reflective of the livestock production sector alone. Of all samples included in this review, when assessed against industry-agreed soil test standards, 52%, 81%, 55%, and 61% of data from WA, VIC, NSW, and SA, respectively, exceeded critical soil test P values to achieve 95% of maximum pasture production ($P_{95}$). It is unknown how these test results were used on-farm. However, the high critical values that were obtained suggests that there is an opportunity amongst the group of producers submitting soils for testing to improve nutrient use efficiency and achieve economic and environmental benefits.

However, laboratories providing data for analysis estimate that less than 15% of all soil samples submitted to the laboratories involved in this project came from the grazing sector. Therefore, conclusions drawn from analyses of the datasets reflect a small sub-set of sheep and beef producers who have a demonstrated interest in nutrient management and are unlikely to reflect the livestock industry overall.

Analysis of the large datasets, where land use was known, suggest that, for those samples submitted, less than 10% of cases for dairy grazing are below critical $P_{95}$ values for optimal production while less than 35% of cases for beef and sheep grazing are below critical $P_{95}$ values.

The review highlights the need for caution when interpreting aggregated datasets that have limited metadata to extract data for small scale (region, farm or paddock) assessment of soil fertility status. Assessment of spatially referenced and landuse data from NSW and additional dairy industry data identified wide variation in soil P fertility status, which is attributable to climate, topography and landuse. The analysis conducted here can only be used to highlight broad economic and environmental opportunities that might be derived if the grazing sector were to routinely use soil testing as a tool to develop farm level fertiliser strategies. This is particularly the case for the beef and sheep grazing sector where ABS (2010) data indicates there is significant

under-utilisation of soil testing. Increased adoption of soil testing and informed interpretation of results will assist in addressing instances of under or over-fertilisation by matching fertiliser inputs to production targets.

The overall study identified opportunities to improve nutrient use efficiency in the red meat industry through extension and training mechanisms that provide access to industry-agreed, evidence-based technical information. Many principles of pasture nutrient management established in past research hold, but need to be revisited and applied to current livestock production systems. Proven extension programs such as the Triple P Program, Prograze®, Landscan™, Wholefarm Nutrient Management (WFNM) and Five Easy Steps provide key principles and learning components required for the understanding of pasture management and linkage to livestock production. These require revision and delivery in the context of modern production systems with consideration of the diverse technical background of producers and advisors.

Uncertainty due to seasonal conditions, commodity prices and declining terms of trade has reinforced the need for producers to focus on efficiency of their production systems and whole farm profitability rather than production *per se*. Most producers or advisors do not understand the complexities of nutrient cycling, and are not able to quantify the impact of change in nutrient management practices. There is a strong case for past RD&E to be presented in a whole of system economic framework which is relevant to current production systems. This information would highlight the 'relative advantage' of changed practice and the role that nutrient management plays in overall profitability of livestock production systems in the study area.

Effective extension of existing and future technologies to producers and advisors requires consistency and coordinated delivery of scientifically based information. Investment that builds industry knowledge stocks is required to ensure sustained adoption of best management options. The study identified the willingness of public and private sector stakeholders to participate in a National Networking Group and support for a coordinated whole of industry approach aimed at providing clarity of guidelines for producers and advisors. This creates opportunities for joint projects, ensures more effective use of resources and provides a solid framework for the delivery of future research outcomes.

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# 1 Introduction and objectives

Meat and Livestock Australia (MLA) has invested in a major Phosphorus Use Efficiency program. This project sits within that program under the *Productive and Sustainable Pastures* 'pillar' of MLA's Feedbase Investment Plan (FIP) (2012 -2017). The findings of this study will inform MLA investment aimed at improving the efficiency of the extensively managed red meat production systems of southern Australia while meeting environmental sustainability expectations.

This study covers the agricultural regions of NSW and VIC, and TAS with long-term annual rainfall of above 450 mm per annum, and above 400 mm for SA and WA (Figure 1). The consultation phase of this study targeted producers managing beef, sheep, and mixed farming enterprises within these regions.

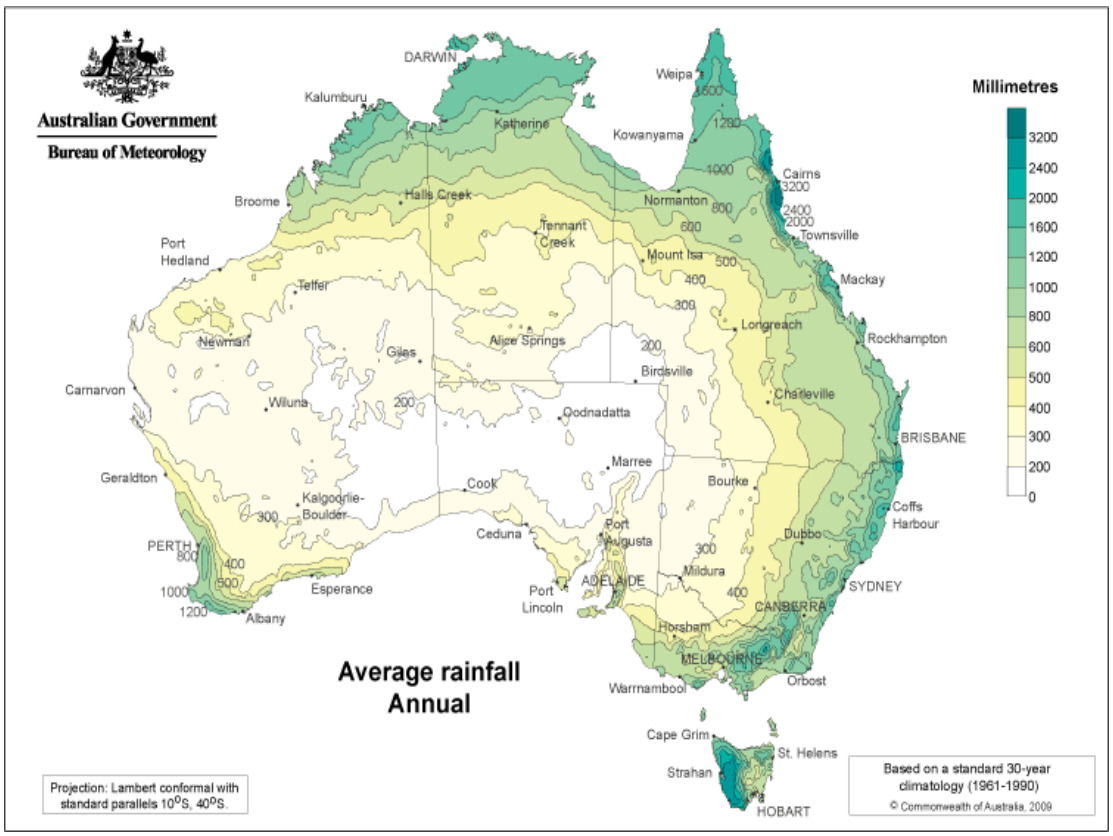


**Figure 1.** The regions included in the current study are those within the isohyets of more than 450 mm for NSW, Victoria and TAS and above the 400 mm isohyets of SA and WA.
*Source:* Bureau of Meteorology

The project collated and used base line data to develop an understanding of the industry nutrient management practices and the drivers behind nutrient use. It also aims to identify the potential for developing a national networking group with a shared industry objective to optimise nutrient use efficiency and to promote environmentally sustainable practices. This report concentrates on the specific purpose of this study, i.e. to benchmark and assess:

1. industry attitudes, perceptions and understanding of the value of soil testing, nutrient management , and the cycling of nutrients across pasture and mixed grazing systems of southern Australia
2. current nutrient management practices and decision support tools in use across the southern region
3. limitations in the knowledge base of the industry, and the potential to develop relevant and targeted extension and training material

4. the fertility status of soils in the southern grazing zones using available and legacy data.

The project was undertaken in two parts and this report is presented accordingly:

**Part 1** reports on the consultation phase of the project, benchmarking and assessing current industry attitudes, perceptions and understanding, and management practices. This provides:

(i) a base line which can be used to monitor changes in uptake of soil testing and nutrient use efficiencies, and

(ii) an assessment of industry knowledge limitations that may be addressed to improve capacity and confidence of producers and their advisors.

**Part 2** is a desktop review which accessed existing and commercial soil test data from 16 laboratories responding to a survey of Australasian Soil and Plant Analysis Council (ASPAC) certified laboratories. The review aims to benchmark and assess the fertility status of soils in the mixed farming and grazing zones of southern Australia (excluding the pastoral zone).

# 2 Background

The conclusions and recommendations from the 2010 MLA review of P availability and utilisation in pastures (Simpson et al, 2010) provided the framework for this project. The review reported wide variations in P use efficiency (PUE) between and within enterprise types with values of 19% for beef cattle and 15% for sheep grazing systems. Within these systems the data indicated instances of (i) high P efficiency measures for low or nil P input systems that may be mining P soil reserves, and (ii) very low P efficiency, which possibly reflect unnecessary use of P based fertilisers. It was proposed production efficiencies could be achieved through effective use of soil testing and critical P values to manage soil fertility within boundaries set by production targets. Simpson et al (2011) presented management interventions that can alter PUE, including better targeted P-fertiliser use, removing other yield constraints, organic amendments, zone management and modified farming systems, but stressed that an understanding of the agroecology of plant P nutrition within farming systems was essential to achieve improvements in PUE.

Industry-wide improvement of PUE requires an understanding of why a large proportion of livestock producers appear to be failing to adopt best practice when past RD&E investment clearly demonstrates that a well-planned pasture nutrient management program has potential to lift farm production and profitability (Watson et al, 2000). Hence this project benchmarks practices and the understanding of producers and advisors of the value of soil testing and nutrient management. Consultation with producers and advisors sought to gain an insight into how nutrient management decisions for pastures are made, who is involved in the decision process, and the factors that influence nutrient management decisions and the fertiliser application program.

The project also explores the opportunities for, and industry interest in the development of a whole of industry network, to build on successful collaborative programs and address challenges facing current extension and training delivery mechanisms across the southern region, with a view to develop strategic soil testing, extension and training packages for producers and advisors with an overall objective of improving nutrient use efficiency in extensively managed pastures.

## 2.1 Situation analysis

The extensively managed pastures of southern Australia support a diversity of livestock production systems, the location and structure of which depends on a number of biophysical and social factors. Much of south-eastern Australia was affected to varying degrees by the Millennium Drought for the eight year period from April 2002 to March 2010 (Figure 2). SA advisors consulted in this study reported severe drought conditions from 2005 to 2007. Drought

conditions and 'extreme seasonal variability' were nominated by producers and advisors participating in this study as having fostered a level of conservatism, which is likely to have long lasting implications for pasture nutrient management.

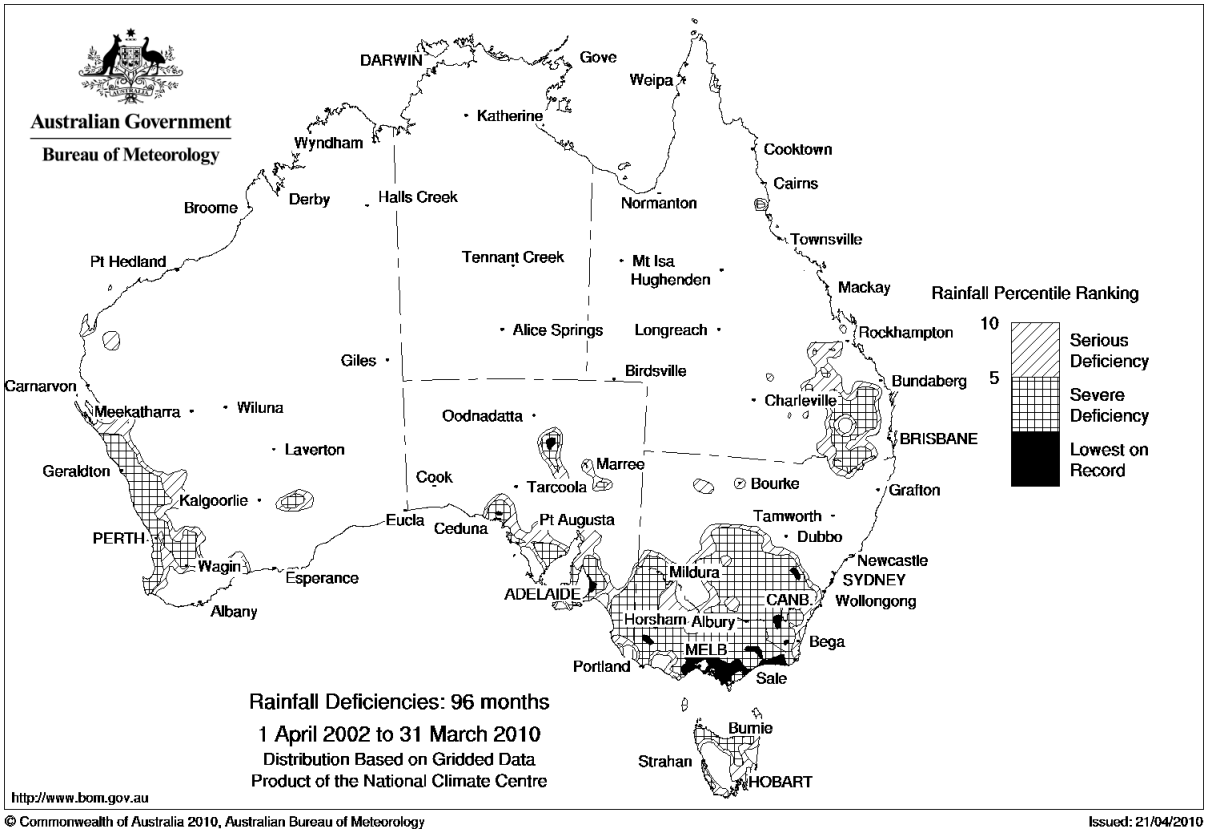


**Figure 2.** A large proportion of the study area in southern NSW, Victoria, TAS, south east SA and the north of south west WA was affected by serious rainfall deficiencies from 2002 to 2010.
*Source:* Bureau of Meteorology (2012).

The study revealed a number of biophysical, management and attitudinal changes attributed to the drought, which appear to have had a significant impact on producers' approach to nutrient management and their confidence in their ability to make economically sound nutrient management decisions for pastures. These included:

- reduced cash flow, which has contributed to reduced fertiliser applications to pasture
- reduced stocking rates and delay in re-building numbers to pre-drought levels
- excessive paddock feed as a result of two years (2010 to 2012) of exceptional rainfall in the eastern states and reduced stocking rates
- loss of legume content in pastures
- grass dominant pastures
- a conservative approach to stocking rate (many producers have reassessed and lowered their production goals in response to the prolonged drought)
- an increased focus on efficiency by some producers, which has involved the adoption of strategic fertiliser applications.

Concern over the persistence of desirable pasture species and in particular a decline in the legume content of pastures was a recurring topic of discussion at producer focus meetings across the study area and also for advisors, with a general view that fertiliser is more likely to be applied if pastures have an 'adequate' level of desirable species. There appears to be a 'Catch 22' situation: the drought is seen as the major cause of legume decline and lack of desirable species is being used as a guide to prioritising fertiliser inputs, however many of the experienced advisors interviewed believe the underlying reason for lack of legume component may be the

result of low P levels. The study suggests the prolonged drought has impacted on quality of improved pastures, in particular the persistence of introduced species; this has been compounded by poor cash flow, which has reduced fertiliser inputs and investment in pasture improvement programs.

## 2.2 Enterprise trends

The main agricultural enterprises of the study area are beef, wool, prime lamb and winter cropping. Uncertain seasonal conditions and fluctuating commodity prices have affected production and profitability, and influenced shifts in the relative significance of these key enterprises. The major drivers of landuse change in the last 10-15 years have been:

- declining wool prices from the peak of 1987-88
- increase in lamb prices from the late 1990s
- the Millennium Drought, resulting in significant destocking in the eastern states, escalating from 2005 until 2010
- excellent seasonal conditions from 2010; stock numbers were reported to be 'approaching pre-drought levels' by late 2012.

General landuse trends across the study area include:

- the land area dedicated to beef production area remains relatively unchanged
- a shift in emphasis from wool production to prime lamb production
- the cropping area on mixed farms of SA and WA has increased marginally at expense of sheep and beef enterprises
- a marginal increase (estimated at <10%) in the area sown to semi-permanent pastures for prime lamb production in the high rainfall mixed farming zones of NSW and VIC as a result of uncertain seasonal conditions . These 'true' mixed farming systems are flexible and the ratio of crop to livestock fluctuates in response to seasonal conditions and confidence in commodity markets
- an increase in the area sown to dual purpose crops or forage crops (Donald, 2012)

The traditional wool production and mixed farming areas are most affected by the shift in landuse. During this period the proportion of Merino ewes joined to terminal sires increased, and cross-bred ewe numbers also increased (Curtis, 2009) as indicated in Figure 3.

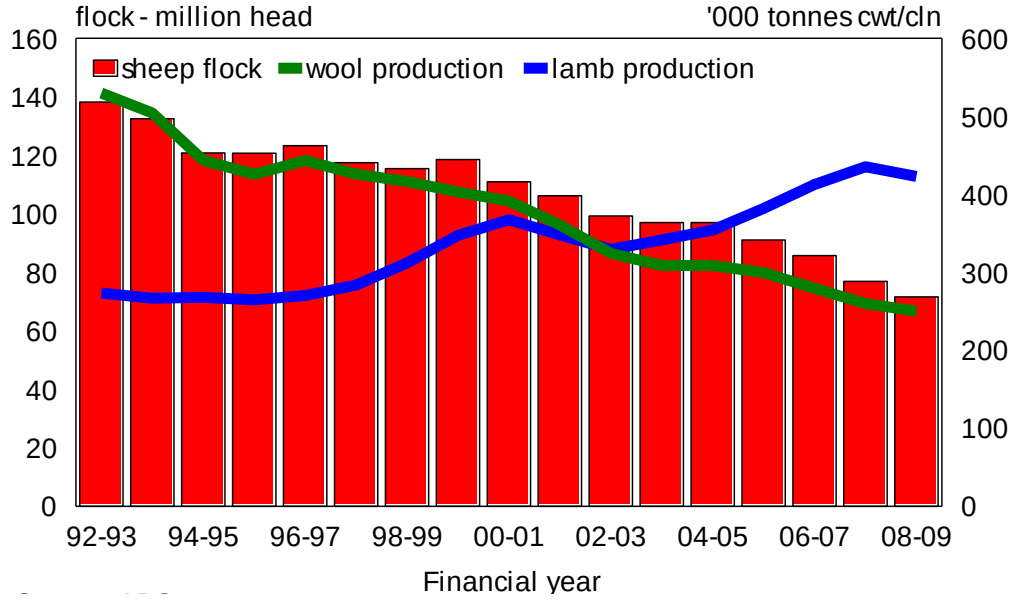


**Figure 3.** Australian sheep flock and lamb and wool production

*Source:* Apps (undated)

The consultation process indicates that for most regions the changes in landuse are the result of diversification, with producers changing enterprise emphasis rather than completely moving out of an enterprise. However, advisors working in the Northern Tablelands of NSW report significant adjustment with some wool producers, with flock sizes up to 3,000 breeding ewes, moving from wool to beef production. Wool price volatility and management issues associated with barber's pole worm (*Haemonchus contortus*) were identified as determining factors (C. Edwards, pers. comm.).

The shift in emphasis from wool production to prime lamb production and the move to beef production has implications for demands on the feedbase and requires a re-evaluation of pasture production targets. This reinforces the need for targeted fertiliser programs that improve nutrient use efficiency of extensively managed pastures.

# 3 Part 1. Industry consultation – Benchmark and assess industry attitude to nutrient management and current practices

## 3.1 Introduction

The consultative component of this project investigated the current industry nutrient management practices adopted for red meat production systems within the mixed farming and medium to high rainfall zones of southern Australia. The project draws on the legacy of many years of RD&E in nutrient management in pastures and sought input from producers, researchers, public and private sector advisors, agribusiness and industry.

## 3.2 Approach and methods

The consultation component sought to gauge:

- producer attitude to soil testing and the relevance of soil tests to the nutrient management decision process
- producer attitude, perception and understanding of nutrient management (in particular P)
- the factors driving nutrient management decisions
- the sources of the information that inform the decisions
- knowledge limitations - the resources and information delivery mechanisms that producers and advisors use and value.

The five instruments used during the consultative phase were designed to ensure representation from relevant industry sectors across the study area. These instruments are listed below:

1. **An online survey** – *Nutrient management in pastures – phosphorus survey*: All livestock producers in the medium to high rainfall zones were invited to participate; of the 598 registered entries to the survey website, 449 provided usable responses, representing 704,000 ha.
2. **Producer focus meetings:** These were held to evaluate and build on the information gathered from the online survey: 170 producers participated in 16 meetings (2 in SA, 3 each in WA and VIC, and 8 in NSW).
3. **Producer surveys (face to face):**
   (i) A survey of producers attending the above focus meetings: 105 responses, representing 139,000 ha.
   (ii) Additional data was accessed from a survey of producers in north eastern NSW, conducted in 2011 by NSW DPI, designed to identify factors influencing fertiliser decisions and use: 150 respondents attending Lanscan™ courses, and nutrient management field days and meetings; included both intensive and extensive livestock

producers, with 58% nominating beef as their main livestock enterprise and 34% nominating dairy.

4. **Telephone and face–to–face interviews** with:
   (i) Advisors (52 public sector extension officers, private sector retail agronomists, consultants). Experienced advisors referred to in this report are those with approximately 10 years of experience in extensive livestock production systems.
   (ii) Industry (35 producers, researchers, private sector technical specialists, fertiliser industry representatives, chairs of farmer groups and landcare organisations, and NRM officers and managers) contributed to the industry consultation process; (*33 NRM officers and managers contributed to the review of CMA / NRM Board investment in nutrient management – presented in Appendix 2*).
5. **National networking workshops:** Two National Networking Workshops were held and these involved representatives from CSIRO, the fertiliser industry, RDCs, the commercial sector and researchers and extension officers from state government agencies.

**The online survey: *Nutrient management of pastures – Phosphorus survey***

The online survey was available through the MLA website and was open for 7 weeks from 1st July, 2012. The survey questions are presented in Appendix 3. Although all red meat producers in the study area were invited to participate in the online survey, the responses indicate that the majority of respondents have a demonstrated interest in nutrient management of pastures. The survey results therefore represent the attitudes, perceptions and understanding of a biased sample of producers who are likely to have a greater understanding and motivation to manage nutrients in pastures than the broader population of red meat producers. This bias was considered in the interpretation of the online survey results presented in this study.

The probable bias of the survey results will not affect the recommendations arising from this study. Strategies adopted to balance the bias include: interviews with advisors and consultants who interact with a broad population of livestock producers, and reference to related studies.

**Producer focus meetings and focus meeting survey**

The objective of the focus meeting process was to ground truth and build on the information gathered through the online survey. Sixteen producer focus meetings were undertaken across the target area (8 in NSW and 3 each in VIC and WA, and 2 in SA). These were strategically located to highlight variation in soil type, climate, topography and landuse. In addition, producers attending the meetings were also asked to complete a shortened version of the online survey.

**Advisor consultation**

The project agreement required that four advisor focus meetings be held across the study area. However, following discussion with staff managers from a number of agribusiness companies, individual contact with advisors via telephone or face-to-face interview was considered a more reasonable and effective option. Fifty-two (52) advisors were interviewed, including independent consultants, retail agronomists aligned to rural suppliers or fertiliser companies and public sector advisory officers, to build on the information gathered from the online survey and producer focus meeting process. Advisors interviewed were selected to ensure geographical spread, range of affiliations and years of experience in an advisory role. The same core questions were asked of all advisors, as presented in Appendix 4.

**Industry consultation**

Thirty-five (35) individuals were interviewed as part of the industry consultation process. These included producers, researchers, private sector technical specialists, fertiliser industry representatives, chairs of farmer groups and landcare organisations. People invited to participate were selected to validate and clarify issues arising and provide more detail on issues arising from the surveys, meetings and interviews. Questions were open-ended with the goal of eliciting deeper insight to clarify issues that had arisen during the course of this project.

**National Networking Workshops**

National Networking Workshops were held in June 2012 and February 2013. A reason for conducting these workshops was to engage key stakeholders from across southern Australia in the scoping study process and to explore the possibility of establishing a National Networking Group for future collaboration to establish a whole of industry approach to strategic soil testing, extension and training packages beyond the term of the current project.

## 3.3 Results and discussion

The results of the online survey and feedback from the focus meetings relate to a biased sample of producers with a demonstrated interest in nutrient management of pastures. Observations or data from advisors and individuals working with the wider population of growers, along with referenced literature, is presented where results from producers participating in the study are in contrast with those from the wider population.

### 3.3.1 Current use of and attitude to soil testing

Producers' attitudes to soil testing and the relevance of soil tests to the nutrient management decision process were investigated, specifically the:

- proportion of producers using soil tests
- frequency of soil tests
- pasture paddocks prioritised for soil testing
- features of soil testing services favoured by producers
- components of the soil test of interest to producers

**Results**

Producers and advisors who are confident in their ability to optimise nutrient use efficiency nominated soil tests as the most important decision support tool for their nutrient management program. However, although more than 90% of producers participating in this study have soils tested most:

- do not test paddocks routinely to monitor soil fertility levels
- do not link soil test results to livestock production targets

What proportion of producers are testing soils?

- 93% of producers responding to the online survey use soil tests
- 90% of producers who completed the focus meeting survey use soil tests

The proportion of producers participating in this study indicating that they have soils tested is considerably higher than suggested by data from ABS, soil testing service providers and the observations of advisors:

- ABS (2010) reported 25% of farms' soil test
- consultation with soil testing laboratories participating in the desktop review component of this project estimating that 10-15% of sampling effort was directed towards grazing enterprises
- <10% of 300 livestock producers attending pasture management field days or meetings in north-eastern VIC since 2011 indicated they use soil tests, with less than 1% having a regular testing program to monitor fertility trends (N Phillips, pers. comm.).

Advisors suggest that many producers only submit samples on advice. Incentive programs through NRM programs are also credited with prompting producers to undertake soil testing, although there is no evidence that one-off programs lead to long-term adoption of soil testing.

Frequency of soil testing

- 42.1% of producers responding to the online survey who soil test indicated that they test representative paddocks every 2-3 years; 10.6% submit soil tests less frequently than once every 5 years (Table 1)
- mixed farmers were most systematic in their approach to soil testing, with representative paddocks tested at the beginning of the cropping phase; very few mixed farmers test soils during the pasture phase
- for the majority of livestock producers, soil testing of pasture paddocks is spasmodic and usually occurs prior to sowing pasture or forage crops, or in long-term sown pastures.

The surveys and interviews indicate that the frequency of soil testing is highly variable and few producers routinely test the same paddock to monitor fertility levels. The focus meeting and interview process indicates that producers with a systematic approach, such as those with a routine crop:pasture rotation or high input red meat production system, will test representative pasture paddocks every 2-3 years, while the balance test spasmodically, usually focusing on 'problem' paddocks or prior to sowing crop or pasture. Advisors interviewed suggest that testing every 2-3 years is reasonable and a more achievable objective than aiming for an annual monitoring program.

**Table 1.** Frequency of soil testing – from online survey.

| **Frequency of soil testing** | **Frequency (%) n= 378** |
|---|---|
| Represented paddocks tested every year | 16.4 |
| Represented paddocks tested every 2-3 years | 42.1 |
| Represented paddocks tested every 4-5 years | 31.0 |
| Soil testing occurs at intervals of more than 5 years | 10.6 |

Cost of soil tests limited the number submitted for 61% of producers responding to the online survey. Cost was also the main reason 48% producers attending the focus meetings gave for not soil testing or for reducing their frequency of soil testing (Table 2). Accuracy of soil test results and credibility of laboratories was raised at several VIC and southern NSW meetings, with reference to Weekly Times (Hunt, 2009) and Kondinin articles that reported inconsistency results between and within laboratories. Interpretation of the soil test measures appeared to be confused by industry reference to both Colwell and Olsen tests for P, and poor understanding among growers of the difference between plant-available P and Total P.

**Table 2.** Reasons given by producers at focus meetings for reluctance to use soil testing – from focus meeting survey. (Respondents could select more than one option)

| **Reason for not using soil testing** | **Percent of cases (%)** |
|---|---|
| Cost | 48.0 |
| Lack of confidence in accuracy of tests | 16.0 |
| My advisor knows my farm | 12.0 |
| Nutrients inputs are balanced by accounting for product removal | 12.0 |
| Soil tests do not provide new information | 8.0 |
| The soil test service is provided by the fertiliser agent – the results cannot be trusted | 4.0 |

Paddocks prioritised for soil testing

- the online survey indicates that 54% of pastures tested are sown pastures

- pasture paddocks most likely to be tested are established pastures (27.2%), non-performing (problem) paddocks (22.6%) and prior to sowing pasture (20.3%)

The online survey results (Table 3) suggest that introduced pasture species (i.e. sown pastures) are the pasture types most likely to be tested (54% of pastures tested by online survey respondents). Although 65% of respondents indicated they tested long-term perennial pastures, this figure is likely to overestimate the practice of the wider producer population as 76% of survey responses were from the eastern states where long-term perennial pastures comprise a much larger proportion of the pasture area than in SA or WA.

**Table 3.** Pasture types from which soil tests are taken – from online survey. (Respondents could select more than one option)

| **Pasture type** | **Percent of cases (%)** |
|---|---|
| Sown long-term perennials | 65.1 |
| Sown annual pasture species | 25.3 |
| Sown short-term perennials | 23.2 |
| Forage crops | 21.9 |
| Fertilised native grasses | 21.6 |
| Fertilised native legumes | 14.3 |
| Naturalised annual legumes | 13.3 |
| Other | 12.2 |
| Natives | 10.9 |
| Timbered grazed area | 1.6 |

The online survey results presented in Table 4 indicate that respondents are most likely to test established pastures (51%), non-performing (problem) paddocks (42%) and prior to sowing pasture (38%). Advisors suggest that testing of non-performing paddocks and paddocks prior to sowing is often on the recommendation of an advisor or retail agronomist.

**Table 4.** Reason or stage of pasture rotation given by producers for soil testing pasture paddocks – from the online survey. (Respondents could select more than one option)

| **Reason for testing** | **Percent of cases (%)** |
|---|---|
| Established pasture | 51.2 |
| Non-performing paddocks | 42.4 |
| Before resowing to pasture | 38.1 |
| At the end of the pasture phase, before cropping | 27.2 |
| The most productive paddocks | 18.1 |
| Other | 10.9 |

Note that only 18.1% of respondents participating in the online survey test their most productive paddocks. There appear to be conflicting views on the importance of testing the more productive pastures. While producers at the focus meetings indicated that testing these high input paddocks is a priority, advisors suggest a notable proportion of producers do not use soil tests on high input areas. This is a concern given that most livestock producers are not able to accurately estimate nutrient levels (Smith, 2012 and N. Phillips, pers. comm.). Monitoring of high input paddocks should be a priority for all producers to avoid exceedence of critical P values.

The widespread adoption of traditional practices without reference to objective measurements was raised by many advisors interviewed; advisors working in north-east VIC reported that 90-95% of livestock producers apply lime and P independent of soil test information.

The features of soil testing services favoured by producers

The cost and convenience of the soil testing service and recommendation of an independent advisor were all important considerations in the selection of a soil testing service (Table 5). The relatively low value placed on the recommendation from rural suppliers and fertiliser agents reinforces the message coming from the focus meetings, i.e. many producers prefer to use a service independent of commercial interest in fertiliser sales.

**Table 5.** Factors that influence the selection of soil testing service – from online survey.

| Considerations when selecting testing service | Relative weighting* |
|---|---|
| Cost of soil test package | 3.71 |
| Convenience of service | 3.61 |
| NATA accreditation | 3.61 |
| ASPAC certification | 3.45 |
| Recommendation of independent advisor | 3.33 |
| Recommendation from rural supply store | 2.6 |
| Recommendation of fertiliser agent | 2.53 |
| Recommendation of a farmer | 2.51 |

*Respondents were asked to select the relative importance of factors that may influence their decision: Very important, Important, Unsure, Not important and Not at all important, with each allocated a score 1 to 5 respectively to calculate the relative significance of each statement.

Although NATA accreditation and ASPAC certification appear to be important criteria for producers selecting a soil testing service (Table 5), of the online survey respondents 42% and 52% had no opinion or placed no value on NATA accreditation or ASPAC certification, respectively. Many producers rely on their advisor or agent to organise testing. Most producers at the focus meetings indicated that they assume the methodology used by laboratories recommended or used by advisors meet industry standards.

Components of the soil test of interested to producers

The online and focus meeting surveys asked producers to select components of the soil test they use (Table 6). The measures of greatest interest to producers were:

- checking pH levels for lime requirement is a common motivation for testing soils
- P is a priority of the fertiliser program for 85% of producers responding to the online survey and 86% from the focus meeting survey
- S is of equal or higher priority than P on basalt-derived soils
- the interest in N may reflect the legume decline reported at many of the focus meetings.

The study suggests that red meat producers testing pasture paddocks are most likely to use soil testing as a tool to diagnose ‘problem’ paddocks or to check the need for fertiliser or soil ameliorants (particularly lime), rather than using soil test results to fine-tune fertiliser applications. Clearly, while some producers nominate soil testing as the most valuable decision support tool that guides their nutrient management program, for the majority of producers it appears that test results are under-utilised.

There is considerable opportunity to increase nutrient use efficiency if producers and advisors develop the skills to use soil test results to fine-tune nutrient management and link soil test critical values to stocking rate and livestock production targets.

**Table 6.** Components of the soil test report producers use.

| Soil test measure | Frequency (%) | |
|---|---|---|
| | Online survey | Focus meeting survey |
| Phosphorus | 98.6 | 100.0 |
| pH | 97.9 | 96.3 |
| Sulphur | 95.5 | 95.0 |
| Potassium | 81.0 | 91.6 |
| Aluminium | 83.6 | 85.9 |
| Trace elements | 83.4 | 83.3 |
| Nitrogen | 81.8 | 84.3 |
| Carbon | 80.1 | 80.0 |

Both producers and advisors questioned the narrow focus of the current study, emphasising the importance of balanced nutrition that accounts for macro and micro nutrients. Phosphorus and pH are the priority soil fertility issues for most advisors, with S a priority for those covering basalt-derive soils. N and K are elements being monitored by many advisors in pastures, and 'trace elements' is an area for which most advisors indicated a need for more information.

### 3.3.2 Nutrient management practices

This study benchmarks and assesses current practice and the factors that influence nutrient management decisions, specifically:

- nutrient management strategies under various pasture systems
- factors that influence P management programs implemented by producers
- individuals influencing producers' nutrient management decisions

**Results**

Producers' approach to nutrient management varies widely. The study indicates that:

- previous reviews and industry statistics indicate a downward trend in fertiliser application to pastures since the late 1990s
- the majority of livestock producers from the wider population are making fertiliser decisions in the absence of soil test information
- the industry-agreed critical values presented in the Better Fertiliser Decision (BFD) project (Gourley et al, 2007) have limited penetration among producers or advisors
- most livestock producers from the wider population do not have a fertiliser strategy
- a traditional fertiliser rate of 125 kg/ha of single superphosphate (or equivalent) is commonly used across all pasture and soil types of the study area
- the majority of producers are unlikely to change their nutrient management program unless alternative nutrient management strategies are presented that include risk considerations and economic implications.

Nutrient management strategies under various pasture systems

- 16% of producers responding to the online survey who apply fertiliser do not have a set fertiliser program for pastures
- 80.2% of survey respondents had changed their fertiliser program in the last 5 years: 28.7% had reduced their fertiliser program, while 34.7% used a similar amount of fertiliser, but did so more strategically were buying less fertiliser; 16.8% had increased their fertiliser program (Table 7).

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From the online survey 71.3% of producers indicated that they had maintained or increased fertliser application to pasture in the last five years, which is contrary to feedback from the focus meetings and consultation with industry. The people consulted noted there has been a downward trend in pasture fertiliser inputs. This is supported by the reviews of McGivor (2005) and Shovelton et al (2011), which attributed the decline to reduced cash flow since 2002, which was compounded by the 2008 fertiliser price hike. Advisors interviewed in SA, VIC and NSW reported a decline in P applications, supported by commercial sales data presented in Figure 4 and declining soil P levels in extensively managed pastures in the study zone.

**Table 7.** The proportion of producers reporting changes to fertliser programs since 2007 – from online survey.

| **Change to fertiliser program** | **Frequency (%) n = 351** |
|---|---|
| Apply similar amount of fertiliser, but more strategic with applications | 34.7 |
| Reduced fertiliser program | 28.7 |
| Apply a similar amount to a similar plan | 19.8 |
| Increased fertiliser program | 16.8 |

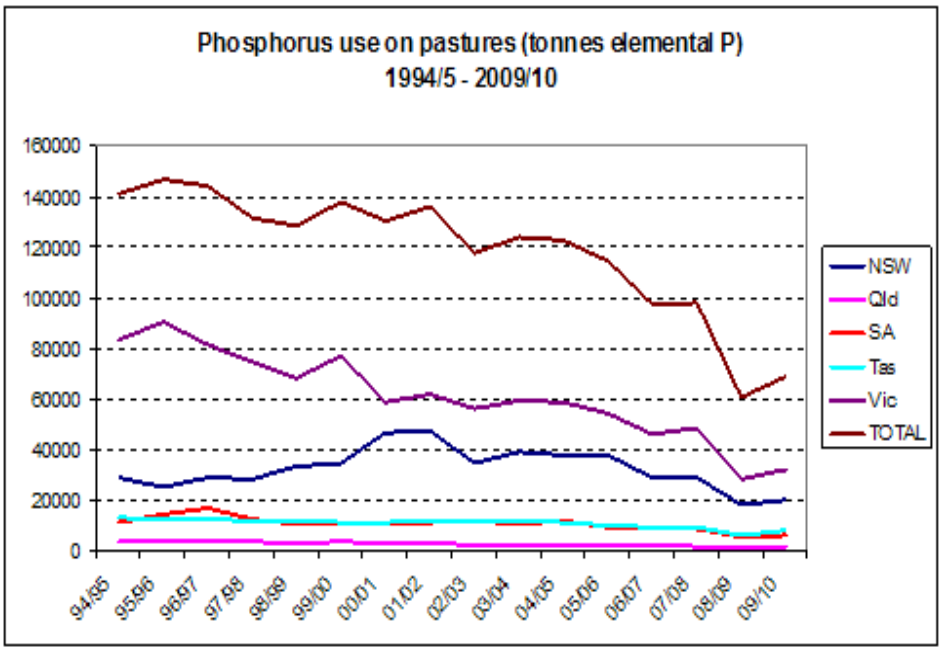


**Figure 4.** Fertiliser use on pasture shows a downward trend, reflecting the impact of the 2002 Millennium Drought from 2002 to 2010 and the sharp price rise in 2008.

*Source*: Incitec Pivot Limited (unpublished data)

Producers responding to the online survey who had indicated that they had changed their fertiliser program were asked to rate the impact of a number of factors on their decision (Table 8). Soil test results, understanding of the benefits of fertiliser and understanding the nutrient requirement of soil types and pasture types and fertiliser cost were considered most important in prompting change.

**Table 8.** The relative importance of factors that influence the decision to make changes to the fertiliser management– from the online survey.

| Factors affecting decision to change fertiliser program | Relative weighting* |
|---|---|
| Guided by soil test results | 4.31 |
| Increased understanding of benefit of fertiliser to pasture production | 4.16 |
| Increased understanding of nutrient requirements of different soil types on farm | 4.14 |
| Increased understanding of nutrient requirements of different pastures on farm | 4.10 |
| Higher fertiliser prices – buying less | 3.99 |
| Money redirected to other parts of farm operation | 3.62 |
| Money allocated to other priorities | 3.58 |
| Surplus feed due to understocking and/or good seasons | 3.53 |

*Respondents were asked to select whether a number of statements were Not at all important, Not important, Unsure, Important or Very important, with each allocated a score 1 to 5 respectively to calculate the relative significance of each statement.

Advisors, agribusiness representatives and researchers consulted proposed:

- most producers have a traditional approach to fertiliser application, with the standard rate of 125 kg/ha of single superphosphate commonly used on pastures of all types across southern Australia
- a blanket fertiliser application across all of the managed pasture area is common practice
- most producers do not adjust P inputs on the basis of soil test results, pasture type or production targets, with the majority of producers (and many advisors) unable to prioritise expenditure, estimate return on investment or link soil fertility to pasture production or the profitability of their livestock production systems
- fertiliser application to pasture is most likely to occur at sowing
- topdressing of established pasture appears to be sporadic and dependent on cash flow
- most producers are reluctant to change nutrient management practices: fertiliser is viewed as a discretionary cost; compelling economic evidence is needed to prompt practice change; there is also reluctance to make significant changes at a farm operational level.

<u>Factors that influence P management programs for pastures</u>

- 83.5% of producers responding to the online survey indicated that soil test results influence which pasture is to be fertilised (Table 9). This contrasts with the opinion of advisors and technical specialists consulted, which reinforces the presumed bias of the sample of producers attracted to respond to a survey investigating *nutrient management in pastures.*
- focus meetings and advisor interviews suggest that fertiliser programs are affected by poor cash flow, fertiliser prices, terms of trade and volatility of livestock markets.

**Table 9.** The relative importance of factors that influence the decision to fertilise a pasture – from the online survey.

| Factors affecting prioritisation of fertiliser application | Relative weighting* |
|---|---|
| Guided by soil test results | 3.90 |
| Guided by advisor recommendations | 3.41 |
| Fertiliser costs dictate my fertiliser program | 3.27 |
| Guided by the stocking rate of each paddock | 3.23 |
| Balance nutrient removal | 3.18 |
| I have no set fertiliser strategy | 2.07 |

*Respondents were asked to select whether they Strongly disagreed, Disagreed, Were unsure, Agreed or Strongly agreed with the statements, with each allocated a score 1 to 5 respectively to calculate the relative significance of each statement.

Additional information from a 2011 NSW DPI survey of 150 producers attending Lanscan™ courses, and nutrient management field days and meetings indicate that while 89% used soil tests, only 32% used soil test results to guide fertiliser strategies. They were asked to rate the importance of a number of factors in their choice of fertiliser (Table 10). *Soil test results* were ranked ninth behind *Cost, Safety, Availability* and *Risk of nutrient run-off*.

Findings of the current study indicate that while producers may use soil tests to indicate which paddocks need fertiliser inputs, they are not being used by the majority of producers as a tool to guide fertiliser decisions: product, rate or to prioritise expenditure. This is consistent with findings from Weaver and Reed (1998) and conclusions from a detailed survey of 110 producers within WA (Lavell et al, 2004), which indicated that:

(i) soil test results are often used to diagnose a problem or deficiency and once that is confirmed by an advisor, producers follow standard district practice, and
(ii) while most producers are unable to interpret soil tests, they question the affordability of recommended rates and/or are not convinced of the economic benefit of the recommended rates. In other words the people making the recommendations have not convinced the producers of any advantage in changing from current practice.

**Table 10.** The importance of a number of issues when deciding which fertiliser amendment or additive to use – from 2011 NSW DPI survey

| | Relative weighting |
|---|---|
| Nutrient requirements | 4.16 |
| Cost | 3.88 |
| Impact on environment | 3.88 |
| Safety | 3.85 |
| Availability | 3.65 |
| Risk of runoff | 3.55 |
| Ease of use | 3.54 |
| Organic classification | 2.38 |
| **Soil test results** | **1.86** |
| Smell | 1.78 |

*Source:* N. Griffiths, NSW DPI (unpublished data)

Respondents to the current study's online survey were asked to select statements to describe their P management program. Of the producers responding to this question, 57.7% nominated

'*adjust P application rates according to soil test information'* and 49.4% nominated *'critical target value'* (Table 11).

**Table 11.** Guidelines and strategies producers use to guide their P fertiliser program – from the online survey. (Respondents could select more than one option)

| **Pasture type** | **Percent of cases (%)** |
|---|---|
| P rates are adjusted according to soil tests | 57.7 |
| Lift P level to critical target value | 49.4 |
| The profitability of the livestock enterprise | 20.5 |
| No set P management program | 14.7 |
| Rule of thumb – single superphosphate rate of 125kg/ha (1cwt/acre) | 13.8 |
| Rule of thumb - 1 kg of P /DSE | 12.2 |
| Currently running down high P levels | 11.2 |
| P rates are the same across all paddocks every year | 9.0 |

Advisors involved in delivery of soil and nutrient training workshops suggest that the proportion of producers nominating critical values as a guide to fertiliser decisions (49.4%) is inflated. In fact, they consider that awareness and uptake by producers and advisors of the published and industry supported critical P soil test values in the BFD project (Gourley et al, 2007) is limited. In designing the survey question there was an assumption was that producers are aware of the BFD industry-agreed critical values. However, wider consultation suggests that critical values being used are likely to be a perceived soil test value-pasture response relationship specific to their location, either developed from their own or their advisors' experience and or knowledge.

Fertiliser expenditure on pastures appears to be viewed as a discretionary cost by the majority of producers and is one of the first expenditures affected by budget cuts in response to poor cash flow (Scott and Cacho, 2000). Most producers and advisors are not able to quantify the economic benefits of fertiliser applications to their livestock enterprises although both groups expressed a need for economic data to justify fertiliser inputs or a change to fertiliser strategies.

Individuals who influence nutrient management decisions

- 87% of online survey respondents who use soil tests seek advice from advisors to interpret the analyses, in most cases from multiple sources
- 58% of respondents seek advice on fertiliser recommendations, from multiple sources
- advice on fertiliser recommendations is more likely to be sought for type of fertiliser to apply (i.e. nutrient requirements to assist in prioritising management decisions) rather than rate
- producer and advisor feedback indicate that fertiliser rate recommendations are more likely to be implemented if producers are confident that the rate matches their production targets and/or financial capability
- recommendations that are linked to local research trials or demonstrations are important in influencing practice change among producers who have limited understanding or experience in strategic nutrient management.

As shown in Table 12, 63% of producers indicated that they could interpret soil tests. Further analysis indicates that of these producers 13% are confident and do not seek assistance, 50% of producers are able to interpret soil tests but also seek input from others, 37% cannot interpret soil tests and rely on advice. The majority of producers seek assistance in interpreting test results from multiple sources.

**Table 12.** Sources of information for soil test interpretation – from online survey. (Respondents could select more than one option)

| Individuals providing interpretation of soil test results | Percent of cases (%) |
|---|---|
| Self (with or without assistance of others) | 63.2 |
| Consultant | 39.6 |
| Retail agronomist | 30.5 |
| Public sector advisor | 21.2 |
| Fertiliser agent | 18.7 |
| Soil testing company | 13.2 |
| Others, including other farmers or family member | 8.0 |

The main sources of recommendations for the 58% of producers responding to the online survey, who seek advice on their fertiliser program, are consultants (50%), retail agronomists (34%), fertiliser agents (24%), and soil testing services (17%). Feedback from the producer focus meetings and advisors indicates that producers seek advice from multiple sources, particularly when recommendations are derived remotely. The 2011 NSW DPI survey (N Griffiths, pers. comm.) also highlighted the influence of field trials and farmer experience of nutrient responses in influencing fertiliser decisions (Table 13), with these considered more influential than consultants or peers. The importance of locally relevant research data and demonstration sites, supported by technical experts, in prompting practice change was raised at a number of producer focus meetings.

**Table 13.** The relative importance of a number of factors or individuals in guiding nutrient management decisions. (Producers could select more than one option)

| Source of information | Relative weighting |
|---|---|
| Own experience - seeing or measuring benefit | 4.08 |
| Trial results | 3.77 |
| Consultant | 3.49 |
| Other farmers | 3.32 |
| Farmer groups/societies | 2.47 |
| Agribusiness | 2.20 |

*Source:* NSW DPI survey data, N. Griffiths (unpublished data)

From the online survey, producers who seek advice on fertiliser recommendations were asked if they followed advisor recommendations on type and rate of fertiliser to apply (Table 14). Responses indicate that a slightly higher proportion of respondents follow advice on fertiliser type than on rate. This is in agreement with the feedback from the focus meetings. However, as identified previously, financial considerations are a significant component of the decision process, so it is not surprising that although soil test results identify needs and assist in prioritising inputs, budget determines how much fertiliser is ultimately applied, which may not be seen as an area of expertise of the agronomic advisor. This may be a fair assumption on the part of the producers as the study also indicates that although many advisors are confident to make fertiliser recommendations on the basis of the soil fertility status as presented in the soil test results, they are not confident in their ability to prioritise fertiliser inputs to optimise return on investment.

**Table 14.** Response by producers seeking advice on fertiliser recommendations.

| Recommendation | Frequency (%) n = 159 | | | |
|---|---|---|---|---|
| | Never | Sometimes | Most of time | Always |
| Recommendation on type of fertliser | 0.6 | 13.8 | 56.0 | 28.3 |
| Recommendation on rate of fertliser | 1.3 | 20.0 | 54.2 | 22.6 |

The WA Peel-Harvey study (Lavell et al, 2004) reports that recommendations that are at odds with a producer's production targets and/or financial capability can result in a proportion of producers opting to 'not bother' soil testing and to revert to traditional fertiliser rates. This is in line with comments from advisors operating in areas most affected by poor cash flow as a result of low wool prices and drought conditions (e.g. Tablelands of NSW). However, the relatively lower use of advisors for fertliser recommendation advice may reflect the confidence of the producer in the advisor.

The online survey indicates that 40% of respondents use the services of a consultant (i.e. pay for advice on nutrient management issues). However, advisors consulted suggest that this is an over-estimation as a relatively low proportion from the broader livestock producer population pay for pasture nutrient management advice. Retail agronomists who offer a range of services indicate that even mixed farmers who pay for agronomic advice for the cropping component of their operation, are reluctant to pay for pasture or livestock management advice and so even established and well-recognised advisors often have limited involvement in pasture management programs.

Advisors report that they are often asked to make fertiliser recommendations on the basis of minimal information (e.g. soil test results alone) and are rarely able to develop nutrient management programs in the context of feedbase management. The advisors most likely to influence practice change are those with a long standing relationship with their client, who are familiar with the business operation. This is significant given that agribusiness report a turnover rates for new graduates of 2 ½ to 3 years (M Pedlar, pers. comm.).

Advisors highlighted the significant influence of operators of commercial fertiliser spreading services on producers isolated or not willing to seek technical advice. Although the fertiliser industry is actively engaging commercial services through their Fertcare and Accu-spread accreditation programs, advisors report that some commercial and private farm spreaders have settings corroded and locked at the standard rate of 125 kg/ha so that producers do not have the option to stipulate a different rate.

With the recent prolonged drought seriously impacting on cash flow, advisors highlighted the influence of other factors and players in the nutrient management decision process. These include conflicting household expenditure and competing business costs, accountants and financial managers. It follows that family members and financial service providers should be targeted in future nutrient management extension programs.

### 3.3.3 P fertility status, geographical zones and landuse

The study undertook to gauge the trends in the P fertility status of land managed for extensive red meat production, taking into account the impact of geographical zones and land use.

**Results**

The consultation phase of this project identified wide variations in P fertility levels between and within enterprise types. Inherent variation can be attributed to soil types, climate and topography, but management practices also vary widely among a diverse producer population with differing production targets and perceptions of best practice nutrient management. In general:

- there is a downward trend in P applications to pastures with advisors warning that P deficiency is limiting production from pastures managed for red meat production systems
- the only portion of the study area for which advisors report stable fertiliser application is the higher rainfall areas of the south west WA, an area least affected by the Millennium Drought
- the impact of drought has affected producer confidence and reinforced a conservative attitude to nutrient management that lacks objectivity
- high P fertility levels are most likely to occur in pastures of the crop dominant mixed farming zone and in areas with a history of intensive industries
- nutrient management strategies are predominantly traditional; P is commonly applied at a standard rate of 125 kg/ha across the study area, across all soil and pasture types
- very few producers match their fertiliser strategies to production targets
- N deficiency occurs in areas once dominated by legume-based pastures; persistence of legumes was raised as an issue of concern at most focus meetings and by advisors.

P fertility status

Responses to the online survey did not provide sufficient information on soil P levels to allow estimation of P status for the study area. Only 25% of respondents provided a P level and feedback at the producer focus meetings indicated that many producers are not able to calculate their annual stocking rate. Therefore, any estimate of fertility status derived from the survey responses calculated from P level and stocking rate was unlikely to be reliable. Thus, the following conclusions relating to P fertility status are drawn from commercial datasets, other studies and research findings, and via consultation with researchers, advisors and industry specialists:

- advisors suggest a generalised trend for the mixed farming zone: P levels are likely to be adequate or high in arable areas, while soils in non-arable areas are likely to be deficient
- 80-90% of pastures on dairy properties are likely to exceed critical soil test P values ($P_{95}$) (Weaver and Wong, 2011 and C. Gourley and N. Griffiths, pers. comm.).
- soil P levels in the livestock dominant areas are highly variable and therefore the following assessment of P fertility levels are very broad:
  - advisors from NSW, VIC and TAS indicated that 80-90% of pastures on extensive grazing properties and livestock dominant mixed farming properties are likely to be running at a nutrient deficit and have low soil pH
  - 90% of actively managed soils in the Armidale district of NSW are deficient in P (Edwards and Duncan, 2000)
  - pastures supporting wool enterprises are likely to have the lowest nutrient levels, which aligns with the TAS experience (Smith et al, 2012) and NSW DPI Landscan™ data (N Phillips, pers.comm.)
  - prime lamb producers are more focused on nutrient management of pastures than beef or wool producers (Victorian Department of Primary Industries, 2010)

The reported drop in soil P levels is supported by P fertiliser use data presented in Figure 4, which shows a downward trend in fertiliser sales, particularly in response to the spike in rock

phosphate price in 2007-2008 (of the order of 800%). This trend is in agreement with observations by Shovelton et al (2011) that 'fertiliser use on pastures has been decreasing at an alarming rate', and advisor feedback, including reports from the NSW Northern Tablelands of a 60 to 75% drop in fertiliser sales from 2002 levels.

Advisors from across the study area consider that soil P levels under extensively managed pastures are below pre-drought levels. They predict that continued reduced P inputs and 'downward spiral' of P levels will have consequences on long-term production capacity if the return to positive cash flow conditions is delayed.

P fertility status, geographical zones and landuse

The soil test records from Landscan™ (LS) courses conducted in NSW by NSW DPI and collected from 2009 to 2012 enabled analysis of P fertility from a large dataset (2,728 samples) on the basis of both geographical zone and landuse. Segmenting the LS data into geographical sub-sets makes it possible to align these with dominant landuses, which may then be linked to P fertility indices. The LS data includes some broad landuse and spatial attributes that provide context that supports the need for caution when applying the general findings from aggregated large datasets of the state level data at farm and paddock scale.

A spatial concordance between the LS courses and Interim Biogeographic Regions for Australia[1] (IBRA) subregions was used to spatially reference the LS dataset (Figure 5). The IBRA7 sub-region boundaries were slightly modified to align with local knowledge around dominant landuses.

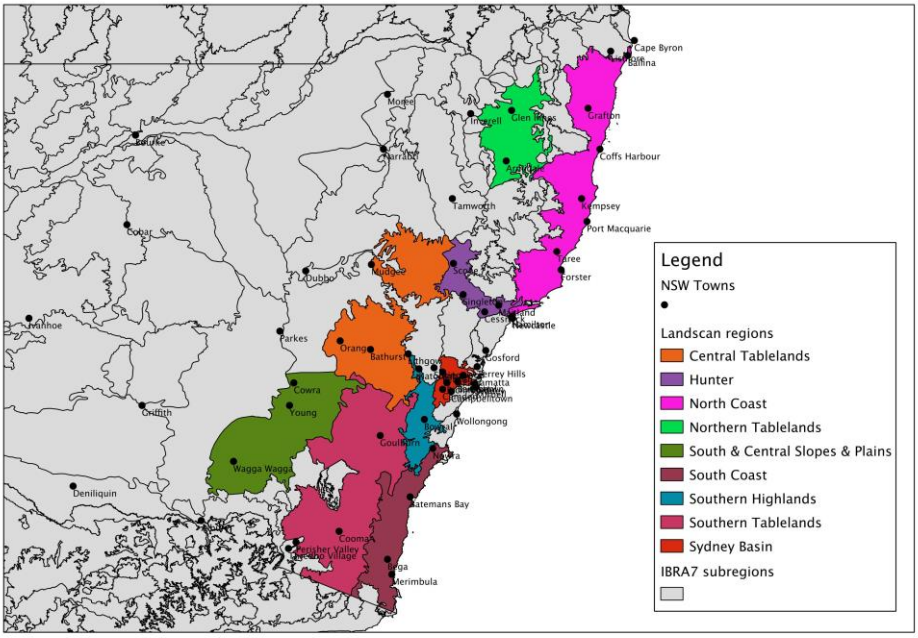


**Figure 5.** Spatial units of the Landscan™ dataset based on IBRA7 subregions.

A combination of climate, topography and soils drives the differences between these regions, which in combination determine the type of agricultural enterprises that persist and the subsequent management practices that go with them. This holds true across the study area, and although the LS data only covers a portion of the area, the diversity in landuse represented and the broad soil fertility trends identified are in agreement with other regional datasets and expert observations. An accurate determination of the drivers of soil fertility can only be achieved with a

[1] Interim Biogeographic Regions for Australia: IBRA7; http://www.environment.gov.au/parks/nrs/science/bioregion-framework/ibra/ibracode7.html (accessed 8.04.2013)

good on-the-ground understanding of the agricultural production practices. This is not usually available with large datasets, as is evidenced by the limited comparative analysis possible with commercially derived datasets analysed in this report and presented in Section 4.

The soil P data from each LS spatial unit was converted into a P fertility index by dividing reported Colwell P values by the $P_{90}$ critical Colwell P values for the LS data. On this basis, P fertility index values <1 have less P than is required to achieve 90% of maximum pasture production, whilst values >1 would achieve more than 90% of maximum production.

Figure 5 and Table 15 show the variation in P fertility indices for spatial and landuse units within the LS dataset compared to the whole LS dataset. The data is presented as the results for the entire data set (All) and a range of geographical regions. The Dairy sub-set represents all participating dairy farms from a wide geographic area extending from the South Coast to the mid North Coast of NSW. There are clearly significant variations in P fertility associated with parts of the landscape associated with more intensive grazing landuses such as dairy.

**Table 15**. $P_{90}$ fertility index for spatial and landuse units within the LS dataset expressed as the median for the whole dataset, the median for indexes > 1, and the median for indexes <1.

| Data | Median P fertility index | Median P fertility index (>1) | Median P fertility index (<1) |
|---|---|---|---|
| All | 1.46 | 2.44 | 0.59 |
| Central Tablelands | 0.48 | 1.40 | 0.27 |
| Dairy | 3.63 | 4.00 | 0.77 |
| Hunter | 4.40 | 4.80 | 0.52 |
| North Coast | 3.57 | 4.00 | 0.83 |
| North Tablelands | 1.12 | 1.79 | 0.68 |
| South and Central Slopes and Plains | 2.00 | 2.17 | 0.69 |
| South Coast | 1.39 | 1.84 | 0.49 |
| South Tablelands | 0.89 | 1.73 | 0.59 |
| Southern Highlands | 0.91 | 1.38 | 0.52 |
| Sydney Area | 1.03 | 2.04 | 0.60 |

Analysis of the whole data set (All) demonstrates large variability but presents a picture of soil P fertility that is often above the critical level. An extension message based on this result alone may lead producers to conclude that they are all over-fertilising. However, when the data is segmented into geographical sub-sets the picture can be quite different (Table 15 and Figure 6). Coastal production areas demonstrate a tendency towards soil P fertility well in excess of the critical values. Similarly, the Slopes and Plains demonstrate a tendency for soil P fertility to be in excess of the critical values. By contrast, Tableland areas demonstrate a tendency towards soil P fertility below the critical values. The extension messages for each of these areas would be markedly different and not always consistent with that coming from analysis of the combined data set. Whilst the finer spatial and enterprise stratification of the LS data provides improved insight, there is still potential for misinterpretation of extension messages based around assessments of P fertility at this scale.

The IBRA sub-regions were matched with the LS datasets to identify trends in soil fertility that can be spatially referenced and then related to landuse and landscape attributes (Figure 6). These are presented in Table 16, along with the main livestock production enterprises undertaken in each of the LS regions. Although this level of detail is not available for all extensively managed grazing regions of the study area, producers, advisors and others

consulted during this study report similar trends in other regions where similar biophysical, landuses and social factors apply.

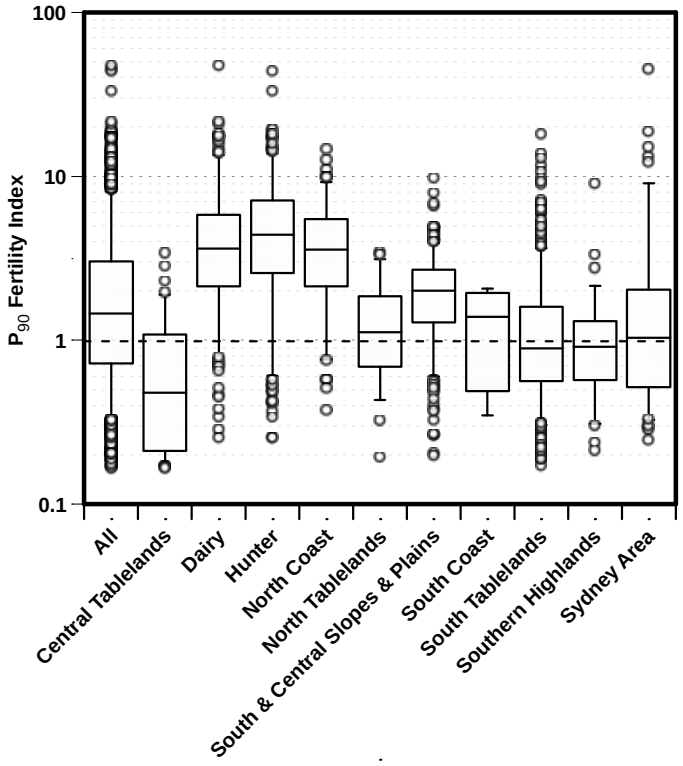


**Figure 6.** Box and whisker plots showing the $P_{90}$ fertility index for identified spatial and landuse units in the LS data. Whiskers show the 5th and 95th percentiles, with outliers shown as circles.

Landuse in the coastal strip is dominated by dairy production and intensive grazing industries. The very high P levels for most soil tests reflect a long history of high fertiliser use. There appear to be opportunities to significantly reduce P inputs with subsequent financial and environmental benefits. It should also be noted that agricultural production in these areas is mostly confined to the coastal plains and valleys. Limited agricultural production occurs on the hills and escarpments so it is incorrect to assume that all soils within the coastal zones are over fertilised or have high P fertility.

The Southern and Central Slopes and Plains is a mixed farming zone with at least 60% of land used for cropping at any season, in rotation with pasture. Heavy use of high analysis fertiliser in the cropping phase in recent decades has had strong positive influence on soil P levels in this zone. The soil results from the LS dataset would be representative of the bulk of farms in this zone.

The Tableland areas are defined by highly variable topography, dominated by shallow soils with limited arable areas. The LS results show that there is significant variability in soil P fertility and some opportunities exist to reduce P inputs. However, there are a large proportion of paddocks tested that are below the critical soil P level, particularly in the Central Tablelands, where the median $P_{90}$ fertility index in P deficient soils was 0.27 (Table 15). The Central and Southern Tablelands have large areas dominated by native-based pastures. From the data it could be assumed that poor P management practices are limiting agricultural production in much of this area. However, while this may be true for a proportion of paddocks, the P levels may be entirely appropriate if other factors, such as soil water holding capacity, limit the producer's ability to increase profitability through improved P fertility.

**Table 16.** The dominant enterprises in the bioregions targeted for Landscan™ courses conducted in NSW between 2009 and 2012 and the median $P_{90}$ fertility indexes for the spatial and landuse units.

| **Landscan™ region** | **IBRA7 bioregion** | **Dominant enterprises and trends** | **Median $P_{90}$ fertility index (>1)** |
|---|---|---|---|
| Central Tablelands | South East Highlands | Extensive grazing, predominantly wool with some beef and shift to sheep meat and lamb production | 1.40 |
| Hunter | Sydney Basin | Dairy history, being replaced by beef, horse breeding | 4.80 |
| North Coast | NSW North Coast | Dairy history – being replaced by beef | 4.00 |
| Northern Tablelands | New England Tablelands | Extensive grazing, beef and wool | 1.79 |
| South & Central Slopes & Plains | NSW South Western Slopes | Mixed farming zone range from 50-70% cropping; wool and lamb production, some beef | 2.17 |
| South Coast | South East Corner | Dairy history – being replaced by beef | 1.84 |
| Southern Tablelands | South East Highlands | Extensive grazing – traditional wool and beef, increasingly lamb production and sheepmeats | 1.73 |
| Southern Highlands | Sydney Basin | Extensive grazing, wool, and beef production. Increasingly small landholdings and peri-urban areas | 1.38 |
| Sydney Area | Sydney Basin | Peri-urban area | 2.04 |

Livestock industries, particularly those close to the coast, and where the annual rainfall is greater than 600mm, present the greatest opportunity for both positive economic and environmental outcomes by adhering to the recommendations derived from critical soil test values. This is because proximity of these industries to sensitive waterways limits opportunity for nutrient assimilation within stream networks.

Cereal cropping systems, despite having higher P fertility indices than pasture systems, tend to be situated further away from sensitive coastal waterways, and because of lower annual rainfall, the risk of nutrient leaching and runoff is lower. Cropping systems present the greatest economic opportunity via adherence to the recommendations derived from critical soil test values because of the extent of this industry compared to pasture based systems in southern Australia.

This study indicates differences between producers (and advisors) in their attitude to information and learning, and inclination, capacity and opportunity to access and translate key principles into knowledge. The qualitative research component of this project indicated that livestock producers could be segmented on the basis of (i) enterprise focus and (ii) attitude to information. This is reported in Appendix 5. Segmentation of the broad livestock producer population is important to allow an understanding of factors affecting attitude to nutrient management of pastures and production targets. It follows that such an understanding will ensure extension programs are designed with a focus on the ‘hooks’ and ‘triggers’ needed to prompt practice change.

### 3.3.4 Current knowledge and training opportunities

Experienced advisors stressed that although much of the information on nutrient management is 'out there', understanding of nutrient management and management of pastures in general has declined in the last 10 to 15 years.

**Producer knowledge and training opportunities**

- Feedback from the producer focus meetings and from advisors indicate that very few producers are sufficiently confident in their understanding of nutrient management to prioritise paddocks, with many viewing fertiliser as a discretionary cost, adhering to traditional practices and applying single superphosphate at rates of 125 kg/ha, when funds are available.
- Knowledge and understanding is variable and very few producers (or advisors) have a grasp of key principles and how to apply them to livestock production systems (e.g. the relationship between the BFD critical P soil test values and stocking rate). The BFD critical P values, published in 2007 are disseminating very slowly, with particularly poor penetration among producers and advisors in the extensively managed pasture areas.
- Generational change has resulted in a loss of knowledge and experience, including a lack of appreciation of the role of legumes as a key driver of pasture production PLUS a loss of appreciation of the economic benefits of applying fertiliser. This signals the need for re-education of the next generation of producers and advisors.
- Producers want fetiliser/nutrient management to be delivered in an economic context; producers are seeking advice on return on investment to the business.
- Decline in investment in pasture nutrient management development and extension by industry or state departments of agriculture in the last two decades has limited the exposure of producers and advisors to on-ground trials, demonstrations and extension programs.
- Multiple information providers add confusion to the nutrient management message. Producers (and advisors) with limited understanding of nutrient management principles, and those who do not have access to a technical support network, are likely to be confused by the volume and often conflicting information. Under such circumstance inaction or reversion to traditional practices is a probable response for the majority of producers (Lavell et al 2004). The term 'decision paralysis' was raised by a number of producers and advisors interviewed.
- The majority of soil nutrient programs available to livestock producers are either delivered by NRM organisations, or by state agencies or private service providers with funding support through NRM organisations. Consequently much of the extension effort is focused in areas where nutrient discharge is impacting on environmentally sensitive areas or affecting catchments of metropolitan water supplies. A *Review of nutrient management actions for Catchment Management Authorities* conducted as part of this project is presented in Appendix 2. This review indicated that funding for extension initiatives in southern Australia is generally aligned to NRM regions with an environmental asset or waterway of significance, for example the Glenelg Hopkins CMA in south west VIC, the NRM Boards in the South West Catchment Council area of south west WA and the Sydney Catchment Authority in NSW.
- The majority of red meat producers operate extensively managed pasture areas outside environmentally sensitive catchments and do not have access to targeted nutrient management programs (i.e. the DAFWA Whole Farm Nutrient Mapping program, Five Easy Steps, developed by NSW DPI and CSIRO and piloted in southern NSW, and the Nutrient Budgeting in Extensive Grazing Systems project developed and delivered by TIAR through the NE NRM Board in TAS).

This project is benchmarking industry knowledge, therefore it is important to consider whether existing programs simply deliver information and create awareness or if they build knowledge, skills and capacity of producers (and advisors) and prompt practice change. This study does not

have the scope to evaluate the effectiveness of specific programs and relies on feedback from producers and advisors regarding the penetration and influence of current programs on nutrient management practices.

Producers who attended the focus meetings and those interviewed highlighted the contribution of key learning components embedded in a number of extension programs in building their skills, understanding and capacity. These influenced their attitude to nutrient management of pastures. One producer referred to these as the 'building blocks' that had provided him with a level of understanding that gave him the skills to recognise signals and confidence to make timely and tactical decisions. The programs commonly raised by producers as having provided essential learning components were:

(i) The AWI-funded Triple P Program (Paired Paddock Program; 1996 - 2004), run in VIC, NSW, SA and TAS was mentioned at the focus meetings in VIC and NSW as having a lasting impact on understanding of the interaction between soil fertility, pasture and livestock production. Producers who had participated in this program stressed the importance of the monitoring, measuring and witnessing the impact of changed nutrient management practice on their production system in facilitating change in management strategies.

(ii) Prograze® was credited with highlighting the importance of pasture quality to livestock production and building knowledge and skills to optimize livestock production through pasture management.

(iii) Five Easy Steps was credited with linking soil fertility to production targets and giving producers the confidence to change management strategies and adjust soil fertility according to production targets.

The producers likely to be aware of the BFD critical P values and principles are those who have participated in formal pasture nutrient management sessions, delivered by an informed advisor, at *ad hoc* field days and meetings or workshops, such as the Five Easy Steps pilot workshops, the WA Whole Farm Nutrient Mapping program in or the TAS Nutrient Budgeting in Extensive Grazing Systems project in the Northern Midlands region of TAS. Follow-up with producers who participated in some of these awareness activities indicates that very few producers then applied the new principles to their fertiliser decisions. Advisors delivering targeted programs indicate follow-up and reinforcement over a number of seasons is necessary to prompt sustained change to their nutrient management practices (N Phillips, pers comm.).

**Advisor knowledge and training opportunities**

Experienced advisors suggest that there are *'only a handful of advisors'* in southern Australia with the experience and skills to provide advice on whole farm nutrient management programs. Lack of experienced advisors is compounded by the reluctance of many livestock producers to pay for advice. This reluctance to pay is very significant given the decline in availability of public sector advisors and the increasing reliance on the private sector. Private consultants operating in the livestock dominant areas report that low demand requires that they supplement their income with funded projects. In the absence of demand, private consultancies and agribusiness firms are reluctant to invest in the development of skills specific to grazing systems.

- Awareness and uptake of the industry-agreed critical P soil test values for pastures proposed in the BFD project is not widespread among advisors servicing livestock producers. The findings of the BFD project, published in 2007, and resources and extension material developed from those principles do not appear to have penetrated beyond the advisors, technical experts and researchers who have a particular focus on nutrient management of pastures.

The technical specialists interviewed as part of this project suggest that very few advisors (or producers) are familiar with the critical P soil test values as proposed in the BFD project:

- 21 advisors from a major agribusiness firm attending a training session in NSW were all familiar with PBI and soil variability across the landscape, but no advisors knew of the BFD project findings, had knowledge of critical values or how they vary with PBI.
- a technical specialist over-seeing field agronomists from another major NSW agribusiness firm indicated no agronomists in that organisation are likely to be to be familiar with the BFD findings.
- 13 Victorian advisors representing a range of organisations were asked to nominate the target for soil test results as part of a telephone interview for this study, 11 of the advisors *'… targeted Olsen P levels in excess of the critical levels defined from the Better Fertilizer Decisions project. In some cases the target levels were almost double those recommended* (according to the BFD guidelines)' (J Shovelton pers.comm.).

- The advisor interview process indicates that beyond formal university training there is an expectation of a degree of self-directed learning, particularly for independent advisors. Although the public and private sector offer opportunities for professional development, these must be strategic and contribute to 'the business'.
- The larger agribusiness companies have in-house programs that cover soil, plant nutrition and fertiliser products. Most of these are delivered by one of three private companies (Incitec Pivot Limited, CSBP and Back Paddock Company) and include Fertcare® Level C accreditation, agronomy and nutrition courses and training in nutrient recommendation software (DSSs). The content tends to focus on plant nutrient requirements for production maximisation (i.e. plant yield) rather than a grazing systems approach that considers the impact of dry matter quality and quantity on livestock production.
- Training programs for advisors are delivered by the private sector. The content is linked to industry agreed critical standards and guidelines. However, most programs are not developed with specific reference to pasture nutrient management.
- There are currently no training programs that include a financial analysis component that provides advisors with the confidence to provide an economic justification for their nutrient recommendations.

Producer demand and expectation has a role in driving advisor training and development priorities. The study indicates that advisor training is sought for new technologies or new products in response to producer demands.

Most senior advisors consulted for this study attribute their knowledge of pasture nutrient management and grazing systems to a technical background, often as employees of state agencies or fertiliser companies. Confidence in their knowledge and understanding of grazing systems was developed through exposure to research and scientific principles (explicit knowledge) and on-ground experience (tacit knowledge). This background also provided them with a large professional network of credible private and public sector technical experts. This network is seen as being vital for staying up-to-date with new technologies.

Very few private sector advisors are actively involved in trials or demonstrations relating to nutrient management of pastures. While the larger agribusiness firms may have pasture variety demonstrations and/or trials, most companies do not have the capacity to conduct and analyse complex pasture nutrition trials. Private sector advisors have relied on linking with state departments for exposure to these and livestock production demonstrations. The main learning opportunities for private sector advisors are in-house product comparison trials (e.g. fertiliser or pasture variety plots), in-house training days, and attendance at industry field days. Early career

advisors interviewed for this study nominated interaction with peers (often within their organisation) and links with technical experts as important in building their confidence and capacity.

Most advisors expressed a need for economic data to justify recommendations, with very few sufficiently confident in providing nutrient management recommendations with financial analysis that linked fertiliser inputs to business performance. An understanding of the short, medium and long term financial implications of recommendations is considered essential in building the confidence of next generation advisors.

| |
|---|
| Development of knowledge, technical skills and confidence of next generation advisors requires exposure to RD&E and development of professional networks. |

Access to and awareness of credible information was an issue raised by the majority of advisors interviewed, and of particular concern to early career advisors. The GRDC advisor update series was proposed as a potential model by early career and experienced advisors, to improve exposure to pasture information and to assist early career advisors in developing links with researchers, technical specialists and peers.

As is the case with producers, advisors are inundated with information, from which they have to filter out the 'muck and magic'. Access to key sources of information and an effective means to assist in filtering information was raised by advisors. A central repository and coordinated approach to collating relevant and credible information was proposed as a possible solution.

Industry stakeholders attending the project's National Networking Workshops endorsed expansion of the BFD database and development of an interrogator tool, modelled on GRDC's Better Fertiliser Decisions in Cropping Systems to assist in addressing the accessibility of advisors (and researchers) to applied nutrient management R&D. This was identified as a priority at the June 2012 National Networking Workshop and included in Milestone 3 report submitted to MLA:

> 'Workshop participants stressed the importance of a single repository and interrogator tool for pasture nutrition trial data, modelled on the GRDC-funded BFDC database and interrogator tool and capitalising on the soil test – pasture response functions for P, K, S and N fertilisers developed in the Better Fertiliser Decision project.'

Subsequent consultation, with approximately 80 commercial agronomists, supported the development of a single repository for pasture nutrition data and also supported the model developed by GRDC. This industry consultation process also recommended that MLA and GRDC investigate and negotiate the potential to have the proposed pasture tool and the crop interrogator tools operate through a single interface. Benefits from such a database and interrogator tool included:

- a single repository for pasture nutrition data
- improved access to statistically analysed data with standardised response relationships with potential to be presented as response curves (i.e. have true response functions)
- ability to access and incorporate the most recent data into nutrient recommendation systems
- value adding and building on the very significant previous investment by government and industry in nutrient management research.

### 3.3.5 Uptake of decision support systems and best management practice guidelines

Below is a summary of a comprehensive report on the uptake of decision support tools (DSSs) and best management practice guidelines (BMPs) by red meat producers of the study area and

advisors servicing those producers, which conducted as part of this project. The full report is presented in Appendix 6.

**Decision support tools**

The study indicates poor uptake by producers of complex DSSs with advisors and consultants indicating that very few have the inclination and/or capacity to use complex DSSs independently (estimated at 1 to 3% of producers). Producers who use DSSs are likely to be:

(i) confident in the accuracy of the assumptions and calculations behind the model
(ii) familiar with the terminology used
(iii) in the habit of monitoring and measuring production indicators
(iv) able to recall details of their livestock business, such as annualised stocking rate
(v) confident in the accuracy of the data they enter and the DSS outputs.

Discussion at several producer focus meetings highlighted the importance producers placed on support by trusted advisors to validate inputs and to discuss interpretation of outputs from DSSs Access to technically competent, reputable advisors familiar with the DSS and the production system being interrogated is often limited but was highlighted by producers as being essential for uptake and ongoing use of DSSs by producers. In addition, producers, advisors and researchers stressed that in order to remain relevant and valuable, organisations managing DSSs must implement strategies to ensure that DSS are regularly reviewed and updated to incorporate new information and modified in response to changes in the system they reflect.

Simple decision support tools and calculators are more widely accepted by producers, but reputation of the organisation developing the tool, relevance of outputs and confidence in the assumptions and default figures used in the calculations was considered important. Advisors suggest that if producers are not engaged and confident in their ability to effectively use a DSS within 10 minutes they will log off and not return.

Tools identified as being valuable in improving capacity to make informed nutrient management decisions include:

- A database and interrogator tool to enable access to statistically analysed pasture nutrition trials, i.e. expansion of the BFD database, an interrogator tool modelled on GRDC's BFDC. The tool would increase exposure of early career advisors to historic pasture nutrition research, and build their confidence and capacity to provide fertiliser recommendations specific to production systems. Advisors and research stressed the importance of a common interface for the pasture and crop database and interrogator tools.
- A revised and updated Five Easy Steps 'P Tool' with critical values for a wide range of PBI levels. This will increase the geographical relevance of the tool.
- Temporal and spatial representation of soil test data: a tool that allows producers to enter soil test data and display spatial and temporal variation in soil fertility over time. Colour coded nutrient maps were first introduced by the dairy industry and are being used in extensive grazing systems to highlight soil fertility variation across the farm.
- Producers and advisors requested economic analysis for a range of fertiliser strategies, including a range of production targets and fertility objectives, e.g. building, maintaining or running down soil P levels, and including sensitivity analysis for varying fertiliser and commodity prices. Given the diversity of production systems, case studies of a range of 'typical' operations would provide a framework. Economic modelling needs to reflect long-term implications of nutrient management decisions on the viability of the whole livestock enterprise.
- An economic calculator with sensitivity analysis for variable fertiliser price and capacity to present impact of changed fertiliser application on pasture growth, stocking rate and profitability.

**Best management practice guidelines (BMPs)**

A number of BMPs that inform nutrient management of pastures were provided by researchers or NRM organisations. These were either developed and/or delivered in joint programs with NRM organisations.

Neither producers nor advisors interviewed were able to nominate specific BMPs developed to guide nutrient management of pastures. Most advisors consulted consider that the scope of most BMPs is too broad to be of use in extending nutrient management information or in making targeted recommendations to clients. Although advisors working with cropping clients saw the value of BMPs for cropping systems, the greater complexity of extensive grazing systems means BMPs can only provide basic guidelines and are often simplistic and so tend to be ineffective.

### 3.3.6 Strategies to improve nutrient use efficiency of grazing systems

Improved nutrient use efficiency in extensive grazing systems can be achieved via targeted use of fertiliser across the landscape. A whole of industry approach is needed to achieve this, including promotion and adoption of industry-agreed standards and delivery of a consistent, evidence-based and technically sound message to producers and advisors. Because many of the basic nutrient management principles are common for red meat, grain, wool and dairy industries, and as many researchers, technical experts and experienced advisors work across industries, collaboration between key industry bodies will improve efficiencies through shared investment and production of generic primary resources.

This report highlights the reliance of producers on advisors for soil test interpretation and guidance on nutrient management decisions. Increased understanding of key nutrient management principles amongst all producers who use fertiliser on pastures is needed to direct nutrient management recommendations made by advisors, but also to prompt advisors to build capacity, i.e. producers need to be sufficiently informed to 'ask the right questions' of their advisors. This report also highlights the need for advisor exposure to on-ground application of nutrient management best practice and training that provides a grazing system context for nutrient recommendations. The following section presents potential strategies to facilitate improved nutrient use effieiciency within extensive grazing systems. A comprehensive report on potential extension and delivery pathways conducted for this study is presented in Appendix 7.

Previous research, existing extension and training resources and programs, and existing collaborative links provide a solid platform for a whole of industry approach that will optimise nutrient use efficiency and achieve economic and environmental benefits for the red meat industry. It is essential that whole of industry:

(i) presents a consistent, evidence-based, scientifically sound message
(ii) endorses industry agreed standards
(iii) promotes generic resources, and
(iv) promotes the role of ASPAC certification for soil testing laboratories and the Fertcare® accreditation program for advisors.

**The next step for industry:**

- publish in scientific literature a review and update of BFD guidelines (Gourley et al, 2007), integrating critical P value relationships for very low PBI
- undertake further research to refine CVs for high PBI categories (i.e. PBIs of >600)
- develop the BFD interrogator tool and merge the existing BFDC database with an updated BFD pasture equivalent, with MLA and GRDC to negotiate the potential to have both interrogator tools operating with a single interface
- in the absence of an updated BFD interrogator tool that would allow advisors (and lead producers) to set a critical level for specific production systems, it is recommended $P_{95}$ [2] is

[2] $P_{95}$ - the critical soil test value reference point that defines where 95% of maximum pasture production occurs

recommended as the standard reference point for critical P soil test values, and should be presented as a range to reflect the intrinsic variability of soil testing
- ensure that newly derived and industry-agreed data, such as the updated CVs for all PBI categories, is rapidly incorporated into nutrient recommendation software systems
- publicise industry-agreed standard CVs through all stakeholder networks
- promote Fertcare® as an industry mechanism for quality assurance of fertiliser recommendations
- develop resources that include economic implications of fertiliser strategies to the livestock system, in the first instance as a series of industry case studies
- review existing advisor training packages and develop packages that emphasise the link between soil fertility, livestock productivity efficiency, including an economic analysis component
- deliver train-the-trainer programs to develop a network of industry champions and to ensure knowledge is captured and passed on to the next generation of advisors
- create opportunities for collaboration across states and agro-ecological zones – through linked field sites, regional forums and a national pasture network (to encompass more than nutrient management)
- increase exposure of advisors and lead producers to industry-agreed standards and research data through common factsheets and links to industry endorsed resources
- cement industry partnerships to ensure all participants adopt agreed standards and deliver a common message
- establish regular, focused symposia that bring together researchers, advisors and lead producers to disseminate research information, up-skill advisors; to identify information gaps and develop consensus on investment priorities and to also serve as a feedback mechanism for researchers and industry
- investigate potential for soil datasets to sit with ASRIS, and as a matter of urgency engage with CSIRO to ensure datasets are collated so as to maximise their future value.

**The next step to engage producers:**
- promote soil tests among producer networks as a tool to guide nutrient management decisions
- increase awareness of industry standard critical soil test values
- improve access to evidence-based information for all producers through a central repository
- revisit ‘old research’ and revive key messages that link soil fertility to production efficiency – promote the concept of nutrient use efficiency as a driver of the farm business
- develop economic models and industry ‘case studies’ for current production systems
- promote the Fertcare® accreditation process as a mechanism of industry quality assurance
- review and refine existing extension programs (e.g. WFNM and Five Easy Steps) to match needs and capacity of the target audience(s). The primary objectives should be to increase producer awareness of CVs and ability to match standard CVs to production level and improve capacity to ask informed questions of advisors. However, further investment is needed to achieve sustained practice change and increased nutrient use efficiency through promotion, education and training aimed at building producers’ understanding of nutrient management and their capacity to prioritise nutrient applications, match fertiliser inputs to stocking rate and adjust inputs across a variable landscape.

**The next step to engage advisors:**
- increase awareness of and confidence in industry standard CVs as presented in the to-be-revised BFD guidelines
- provide training programs to introduce the Five Easy Steps principles – deliver packages to meet the diverse needs and capacity of advisors, with minimal outcome being

appreciation of soil fertility as the key driver of production efficiency of the livestock system
- improve access to evidence-based information through a central repository
- develop opportunities to access and disseminate industry endorsed resources
- facilitate participation in professional networks prompted by symposia for researchers, advisors and lead producers
- encourage participation in Producer Demonstration and Producer Research Sites (and a proposed Focus Farm model) as learning opportunities
- facilitate agribusiness mentoring program – modelled on the GRDC advisor updates
- develop targeted soil training days for advisors (linked to other industries)

There is a need to concurrently educate both producers and their advisors on;

(i) the role of soil fertility as the driver of profitability of livestock production systems
(ii) the link between soil fertility and stocking rate
(iii) the role of soil testing as a key decision tool to refine fertiliser decisions.

While the study indicates that approximately 50% of producers could be engaged in extension programs (Appendix 5), such as WFNM and Five Easy Steps, from an environmental perspective there is also a need to engage the balance of producers. The challenge is to simplify the key messages to achieve a level of awareness of the CVs with those producers, who are not prepared to invest much time or intellectual capital in understanding key principles. A tiered extension program that takes into account the learning objectives of the different segments of producer and advisor populations is required to extend nutrient management principles and build capacity and confidence of the diverse groups of producers and advisors.

Revision of the pilot nutrition management extension programs indicated that sustained adoption requires the learning experience to straddle several seasons to enable:

(i) reinforcement of basic principles
(ii) for producers to appreciate the impact of fertiliser and livestock system on pasture response and trends in P levels
(iii) to quantify the relative advantage of management change. These were all raised at the focus meetings as essential learning outcomes needed to build confidence of producers (and advisors) and so facilitate practice change and achieve nutrient use efficiency.

Recommendations regarding engagement of producers and industry are discussed in more detail in Section 5.2 and Appendix 7, which also reports on feedback from producers, advisors and those who have provided technical and administrative support for producer demonstration sites.

# 4 Part 2. Desktop review – Benchmark and assess soil fertility status in the southern grazing zone

## 4.1 Introduction

A review of the fertility status of soils in the southern mixed farming and grazing zones of southern Australia was undertaken by the Department of Agriculture and Food WA (DAFWA). With a focus on P and based on the available data from ASPAC accredited laboratories, fertility status was determined at a state level for WA, VIC, NSW and SA. When assessed against industry-agreed soil test standards, 52%, 81%, 55%, and 61% of data from WA, VIC, NSW, and SA, respectively, exceeded critical soil test P values to achieve 95% of maximum pasture production ($P_{95}$).

The low involvement of the grazing sector in soil sampling (<15% of all samples submitted annually), and the observed high proportional exceedance of critical P values and fertility index

suggests that there is an opportunity for the grazing sector to concurrently improve its economic and environmental performance, and improve nutrient use efficiency through the use of soil testing to guide fertiliser use. However, it is important to recognise that there is likely to be bias in the proportional exceedance of the critical P values and fertility index, derived from the current analysis. One potential source of bias is that the soil test data is reflective of producers who are motivated to soil test regularly and pay attention to their soil nutrition. In addition the analysis provides a point-in-time benchmark of the fertility status for southern region, based on test results relevant to this sub-set of producers. Therefore it cannot be assumed that the datasets analysed are indicative of the true fertility status of soils of the study area under extensively managed grazing systems. Furthermore it is impossible to capture the dynamic nature of nutrient status in this review and there is insufficient background or follow-up information associated with individual soil tests to provide insight into the landholders' response to the test results.

## 4.2 Approach and methods

### 4.2.1 Datasets

A phone survey of ASPAC accredited laboratories was undertaken to identify potential and recent commercial soil test datasets that could be compiled to assess the fertility status in southern mixed farming and grazing zones of Australia.

Of the 30 laboratories contacted, 16 provided data that was in a format that was readily analysed for this review. In addition, the level of detail pertaining to records held by laboratories varied with much of the data provided having no spatial data and variable metadata for submitted samples. For any meaningful assessment of available data to be made, the acquired data must have common elements. As a result, data limited to key analyses with a spatial identifier of State was compiled for assessment. Therefore any conclusions drawn from this analysis relate to a State and not to a particular industry.

The available data consisted of approximately 118,000 soil test records. The majority of samples originated from CSBP (109,000 samples from WA only from the 2008/2009 and 2009/2010 soil sampling seasons), IPL (4,500), from the 2011/2012 soil sampling seasons, Rural Solutions SA (198) from 2010, NSW DPI Landscan™ (LS) courses from 2009 to 2012 (2,728) and dairy industry data (2,160 samples) from the national Accounting for Nutrient on Dairy Farms (A4N) project collected in 2007/2008. The combined IPL and Rural Solutions datasets resulted in 2,892 samples for VIC, 1,202 samples for NSW and 400 samples for SA. TAS and ACT samples were not included in the analysis because of insufficient numbers.

**Stratification**

The CSBP, IPL and Rural Solutions data was stratified geographically for comparison into western (WA) and eastern (VIC, NSW, SA) subsets, and further by state where sufficient data was available. State was the finest resolution spatial identifier common to the available datasets. The A4N and LS datasets were analysed independently of the state level stratified data as they included some spatial and landuse attributes that aided the interpretation of the state level data.

### 4.2.2 Standards

**Phosphorus**

Soil P status is defined by a combination of Colwell P and phosphorus buffering index (PBI) (Bollard et al, 2010). Soils with higher PBI require higher Colwell P values to achieve the same relative production level because the soil has a high demand for P (Figure 7).

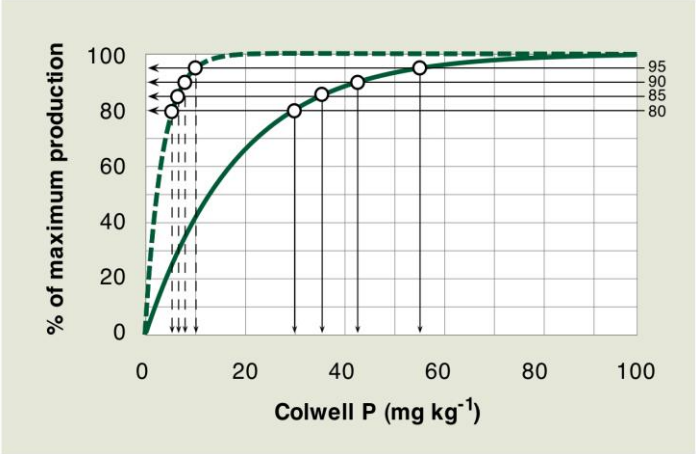


**Figure 7.** Stylised P response curves for sub-clover based pastures grown on low (<5; dashed line) and high (280-840; solid line) PBI soils**.**

Table 17 and Table 18 show the critical Colwell P values required to achieve 95% and 90% of maximum production, respectively, if the combination of PBI and Colwell P in the column classified as high is achieved. These have been derived from Gourley et al (2007) and are referred to as $P_{95}$ and $P_{90}$. The Colwell P values classified as low and medium are arbitrarily assigned to ensure there is no overlap between classes when moving from one PBI group to the next. The low and medium classifications provide some sense of whether a soil might be P deficient (low P status) or close to the desired Colwell P level for a specific production target (medium P status). Tables are provided for two production levels ($P_{95}$, $P_{90}$) to provide options for different grazing industries with differing production goals. For example, pasture systems for dairy are likely to aim at $P_{95}$, whilst beef and sheep graziers may aim for $P_{95}$ to $P_{90}$, depending on their production targets, in which case their pasture biomass requirements will vary.

The chosen standards against which to assess soil P status vary slightly from those published for Better Fertiliser Decisions (BFD). This was necessary in order to provide standards more widely relevant to areas that have low PBI. The standards in Table 17 therefore provide finer resolution in the PBI classes below 15 than those provided by BFD. The current BFD standards only allow for a minimum Colwell P value of 20 mg P $kg^{-1}$, which is not achievable on many sandy soils with low PBI. For these soils a minimum value of 20 mgP $kg^{-1}$ would pose serious water quality problems, and may not be economically achievable.

**Table 17.** Colwell P values (mg $kg^{-1}$) within PBI groups to determine P status (low, medium, high). Colwell P values classified as high will achieve 95% or more of maximum pasture production assuming there are no other production constraints.

| PBI Group | P status | | |
|---|---|---|---|
| | Low | Medium | High |
| <5 | <7 | 7-10 | >10 |
| ≥5-10 | <10 | 10-15 | >15 |
| ≥10-15 | <15 | 15-20 | >20 |
| ≥15-35 | <20 | 20-25 | >25 |
| ≥35-70 | <25 | 25-29 | >29 |
| ≥70-140 | <29 | 29-34 | >34 |
| ≥140-280 | <34 | 34-40 | >40 |
| ≥280-840 | <40 | 40-55 | >55 |

**Table 18.** Colwell P values (mg $kg^{-1}$) within PBI groups to determine P status (low, medium, high). Colwell P values classified as high will achieve 90% or more of maximum pasture production assuming there are no other production constraints.

| PBI Group | P status | | |
|---|---|---|---|
| | Low | Medium | High |
| <5 | <6 | 6-8 | >8 |
| ≥5-10 | <8 | 8-11 | >11 |
| ≥10-15 | <11 | 11-15 | >15 |
| ≥15-35 | <15 | 15-20 | >20 |
| ≥35-70 | <20 | 20-22 | >22 |
| ≥70-140 | <22 | 22-25 | >25 |
| ≥140-280 | <25 | 25-30 | >30 |
| ≥280-840 | <30 | 30-42 | >42 |

**P fertility index**

The soil P data was transformed into a P fertility index by dividing reported Colwell P values by the $P_{90}$ critical Colwell P values for the state level and LS data, or by the $P_{95}$ critical Colwell P values for the A4N data. On this basis, P fertility index values <1 have less P than is required to achieve either 90% or 95% of maximum pasture production, whilst values >1 would achieve more than 90% or 95% of maximum production.

## 4.3 Results and discussion

### 4.3.1 Sampling frequency

The interviews with representatives of the participating laboratories indicated that trends in soil sampling demand varied between laboratories, the 2 largest providers of soil testing services in Australian reported static demand. Typically, clients submitted 2 to 5 samples each, with 10-15% of sampling effort directed towards grazing enterprises, with the balance (85-90%) directed towards cereal cropping.

The interviews also identified diversity in sampling strategies for those submitting soil samples. A variety of sampling implements, sampling protocols, and samplers was used, and typically 10 to 30 sub-samples were collected to make a representative composite sample for analysis.

The results suggest that there is significant room for improvement in soil sampling technique and effort across extensive agricultural sectors so that fertilization programs are based on an evidence-based approach.

### 4.3.2 Phosphorus buffering index

Phosphorus Buffering Index (PBI) is a single point measurement used to classify the potential for a soil to adsorb P. When compared to a large dataset from south west WA, the samples from the eastern states had a much higher proportion of high P fixing soils (Table 19). This was influenced by data from VIC.

**Table 19.** PBI profiles of data from different sources

| PBI Group | | Percent | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | PBI Class | Eastern States | WA | VIC | NSW | SA | LS | A4N |
| <5 | Exceedingly Low | 0.3 | 2 | 0.3 | | 1.2 | | 0.1 |
| ≥5-10 | Exceptionally Low | 0.4 | 8.4 | 0.4 | 0.1 | 1 | 0.04 | 0.1 |
| ≥10-15 | Extremely Low | 0.6 | 10.8 | 0.4 | 0.3 | 2.5 | 0.2 | 0.1 |
| ≥15-35 | Very Very Low | 6.1 | 42.7 | 2.9 | 10.2 | 15.3 | 6.6 | 0.8 |
| ≥35-70 | Very Low | 18.5 | 22.4 | 9.6 | 34.2 | 34.5 | 34.8 | 9.1 |
| ≥70-140 | Low | 29.9 | 8.7 | 30.1 | 31.9 | 27.2 | 29.6 | 26.0 |
| ≥140-280 | Moderate | 30.6 | 3.8 | 40.4 | 13.7 | 14.3 | 17.4 | 31.7 |
| ≥280-840 | High | 12.5 | 1.2 | 15.1 | 7.7 | 4 | 9.0 | 29.9 |
| >840 | | 1.2 | | 0.7 | 1.9 | | 2.4 | 2.3 |
| Median PBI | | | **27.4** | **150** | **75** | **75** | **81** | **180** |

Around 60% of WA soils in the dataset had low P retention reflected by PBI<35. Less than 10% of eastern states soils had PBI<35, whilst SA had around 20%. Since it has previously been reported that soils with higher PBI tend to show higher exceedance of critical Colwell P values (Weaver and Reed, 1998; Weaver and Wong, 2011), it would be expected that soils from the eastern states, particularly from VIC, should show higher exceedance than other states. Understandably the LS and NSW datasets had similar PBI profiles. The A4N data, whilst similar to the PBI profile for VIC, had >60% of samples with moderate to high PBI, possibly reflecting a spatial coincidence of the dairy industry with more productive soils across Australia.

### 4.3.3 Phosphorus status

Table 20 and Table 21 show the percentage of soils within each production class that are classified as low, medium or high P status when compared to the critical Colwell P values. High P status soils will not respond to applications of P as there is already sufficient P in the soil to supply plant needs. When assessed against the $P_{95}$ critical values, 52% of the samples from WA were classified with high P status, whilst 71% from the eastern states were classified as high P status (Table 20). Victoria had 81%, whilst NSW, SA, LS and A4N had 55%, 61%, 54% and 91% respectively. The proportion of high P status soils increases as the production target decreases, with 74% of the WA soils, and 81% of the eastern states soils above the critical values for 90% of maximum production respectively (Table 21). At a state level, VIC had the highest exceedance, with 80% and 88% above the $P_{95}$ and $P_{90}$ critical values, respectively. The A4N data showed the highest exceedance, with 91% and 96% above the $P_{95}$ and $P_{90}$ critical values, respectively, suggesting that P deficiency would be very difficult to find in the Australian dairy industry.

These exceedances are not surprising when considered in the light of historical reports of soil P status and traditional fertiliser practices. Shovelton (1986) reviewed the nutrient status of soils in the Wodonga district (VIC) from samples collected from 1958 to 1982. The report indicated that around 20% of samples had high P status, mainly due to superphosphate history. Weaver and Reed (1998) reviewed soil P status of 8,000 soil samples collected on the south coast of WA in 1987 and 1988. Fifty six percent of these samples were considered to have high P status when assessed against $P_{95}$ critical values. A review of the soil nutrient status data from the National Land and Water Resources Audit (Anon, 2002) and using the average Colwell P in each state, and the median PBI in this assessment (Table 19) for each state shows an exceedance of the $P_{90}$ critical value by 15%, 100%, 53% and 13% in WA, NSW, VIC and SA respectively. Whilst these are general assessments based on average values calculated from large datasets, they are consistent with the findings of high P fertility in this report. They are also consistent with

expected changes in P fertility given traditional fertiliser practices, and the relatively short time periods over which this can occur (Figure 8).

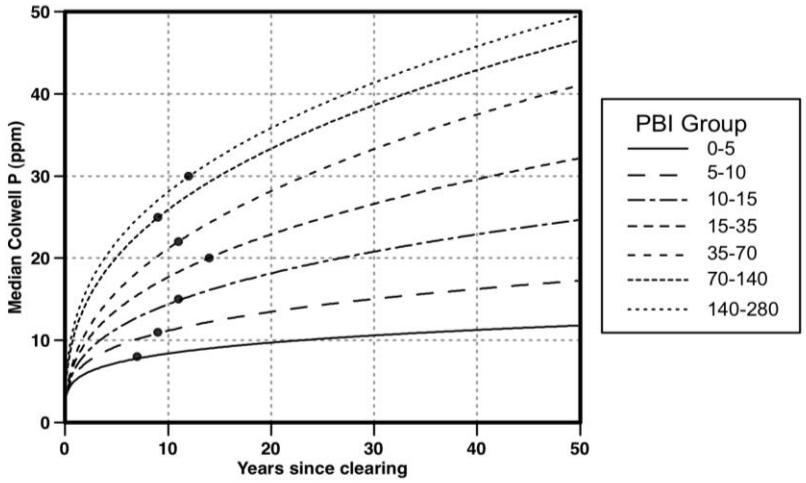


**Figure 8.** Fitted power curves showing temporal changes in Colwell P (Colwell 1965) for soils in different PBI groups (adapted from Weaver and Reed 1998). Overlain points show critical Colwell P values to achieve 90% of maximum production for pasture (● adapted from Gourley et al, 2007). Assumes P input of 14 kg P ha-1 yr-1. (Adapted from Weaver and Wong, 2011)

**Table 20.** P status assessed against $P_{95}$ critical values in different PBI ranges, percent of soils classified as low, medium and high P status, and percent of soils within each P status class for each PBI group

| **95% maximum production** | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Eastern States** | | | **WA** | | | **VIC** | | | **NSW** | | | **SA** | | | **LS** | | | **A4N** | | |
| **PBI Group** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** |
| <5 | 14.3 | 7.1 | 78.6 | 12.5 | 31.3 | 56.1 | 11.1 | 11.1 | 77.8 | | | | 20.0 | | 80.0 | | | | | | 100 |
| ≥5-10 | 29.4 | 17.6 | 52.9 | 13.9 | 38.2 | 47.9 | 27.3 | 9.1 | 63.6 | | | 100 | 50.0 | 25.0 | 25.0 | | 100 | | | 100 | |
| ≥10-15 | 57.1 | 17.9 | 25.0 | 22.1 | 33.0 | 44.9 | 66.7 | 25 | 8.3 | | 33.3 | 66.7 | 60.0 | 10.0 | 30.0 | 20 | 40 | 40 | | | 100 |
| ≥15-35 | 29.0 | 16.3 | 54.7 | 21.2 | 23.2 | 55.6 | 36.1 | 10.8 | 53.0 | 23.6 | 14.5 | 61.8 | 24.6 | 27.9 | 47.5 | 36.9 | 12.3 | 50.8 | 11.1 | 5.6 | 83.3 |
| ≥35-70 | 30.1 | 7.5 | 62.3 | 31.1 | 15.8 | 53.2 | 22.6 | 7.3 | 70.1 | 35.0 | 5.7 | 59.3 | 23.9 | 12.3 | 63.8 | 44.1 | 7.7 | 48.2 | 3.1 | 1.5 | 95.4 |
| ≥70-140 | 23.4 | 7.7 | 68.9 | 39.5 | 15.2 | 45.3 | 14.4 | 7.0 | 78.6 | 42.3 | 9.6 | 48.1 | 21.1 | 8.3 | 70.6 | 39.2 | 6.19 | 54.6 | 1.8 | 0.2 | 98.0 |
| ≥140-280 | 14.4 | 5.3 | 80.3 | 42.3 | 14.1 | 43.6 | 9.9 | 4.0 | 86.2 | 35.6 | 10.1 | 54.4 | 28.1 | 14.0 | 57.9 | 32.4 | 5.88 | 61.8 | 3.1 | 1.3 | 95.6 |
| ≥280-840 | 14.8 | 8.5 | 76.7 | 41.3 | 25.5 | 33.3 | 9.2 | 8.6 | 82.2 | 32.5 | 7.2 | 60.2 | 25.0 | 12.5 | 62.5 | 35 | 8.54 | 56.5 | 8.9 | 11.7 | 79.5 |
| Total | 21.3 | 7.7 | 71.0 | 25.4 | 23 | 51.6 | 13.5 | 6.2 | 80.3 | 36 | 8.7 | 55.4 | 25 | 14 | 61 | 39.1 | 7.4 | 53.5 | 4.6 | 4.3 | 91.1 |

**Table 21.** P status assessed against $P_{90}$ critical values in different PBI ranges, percent of soils classified as low, medium and high P status, and percent of soils within each P status class for each PBI group

| **90% maximum production** | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **PBI Group** | **Eastern States** | | | **WA** | | | **VIC** | | | **NSW** | | | **SA** | | | **LS** | | | **A4N** | | |
| | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** | **L** | **M** | **H** |
| <5 | 7.1 | 14.3 | 78.6 | 8.1 | 18.1 | 73.8 | | 22.2 | 77.8 | | | | 20.0 | | 80.0 | | | | | | 100 |
| ≥5-10 | 11.8 | 23.5 | 64.7 | 6.0 | 19.2 | 74.9 | 18.2 | 9.1 | 72.7 | | | 100 | | 75.0 | 25.0 | | | 100 | | | 100 |
| ≥10-15 | 28.6 | 32.1 | 39.3 | 7.6 | 19.4 | 73.0 | 25.0 | 50.0 | 25.0 | | | 100 | 30.0 | 30.0 | 40.0 | 20 | | 80 | | | 10 |
| ≥15-35 | 12.7 | 19.9 | 67.4 | 8.1 | 16.7 | 75.2 | 12.0 | 25.3 | 62.7 | 11.8 | 13.6 | 74.5 | 8.2 | 24.6 | 67.2 | 23.5 | 14.5 | 62 | | 11.1 | 88.9 |
| ≥35-70 | 20.8 | 5.5 | 73.7 | 16.3 | 8.6 | 75.1 | 15.3 | 5.1 | 79.6 | 24.8 | 4.9 | 70.4 | 13.0 | 7.3 | 79.7 | 35.7 | 5.27 | 59.1 | 2.1 | | 97.9 |
| ≥70-140 | 15.8 | 3.8 | 80.4 | 20.2 | 10.9 | 68.9 | 9.5 | 2.2 | 88.3 | 29.3 | 7.8 | 62.9 | 10.1 | 2.8 | 87.2 | 30.2 | 5.45 | 64.4 | 0.5 | 1.1 | 98.4 |
| ≥140-280 | 8.5 | 4.2 | 87.4 | 22.7 | 12.6 | 64.7 | 5.1 | 2.9 | 92.0 | 26.2 | 9.4 | 64.4 | 12.3 | 10.5 | 77.2 | 23.1 | 7.35 | 69.5 | 0.6 | 0.9 | 98.5 |
| ≥280-840 | 10.4 | 6.0 | 83.6 | 24.1 | 24.5 | 51.4 | 6.0 | 4.6 | 89.4 | 25.3 | 7.2 | 67.5 | 12.5 | 18.8 | 68.8 | 24.4 | 12.6 | 63 | 4.7 | 5.8 | 89.6 |
| Total | 13.6 | 5.8 | 80.6 | 11.5 | 14.8 | 73.6 | 7.9 | 4.1 | 88.0 | 25.0 | 7.5 | 67.4 | 11.8 | 10.8 | 77.5 | 29.9 | 7 | 63.2 | 2.0 | 2.4 | 95.6 |

### 4.3.4 P fertility index

There are some general, but inconsistent trends that suggest that a greater proportion of the high P status soils are associated with soils with higher PBI values. In some instances, the percentage of high P status soils seems to fall for the highest PBI group. This may be because it takes longer for soils with higher PBI to reach critical values than soils with low PBI (Weaver and Wong, 2011). There are more consistent trends for the P fertility index (Figure 9 and Table 22) in relation to the PBI profile in each dataset (Table 19). The A4N and VIC datasets for example have the highest PBI soils and the highest P fertility indices, while WA has the lowest PBI soils and the lowest P fertility index.

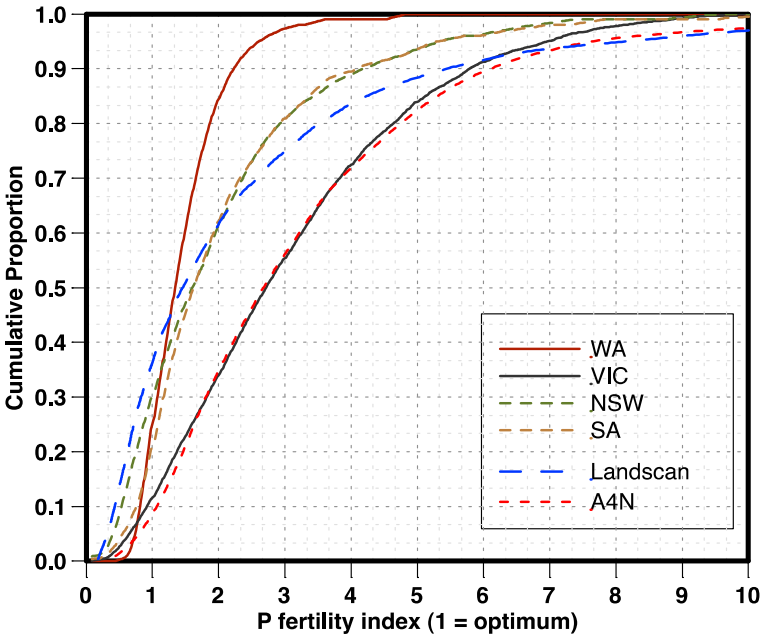


**Figure 9.** Cumulative frequency histograms of $P_{90}$ fertility index for each dataset. A4N dataset assessed at $P_{95}$

High proportions of each dataset exceed a P fertility index of 1 (Figure 9), and the median P fertility index where indices are <1 is greater than 0.6. This suggests that the P deficiency in those soils defined as P deficient is likely to be marginal rather than severe. For example, in WA, the P deficient soils on average are within 15% of the required P values to achieve the $P_{90}$ critical values. The LS dataset shows the greatest severity of P deficiency, with a deficit of around 40% of the required P values where soils are declared P deficient (Table 22).

The A4N and LS data provide an indication of the impact of landuse on soil fertility. As discussed in Section 3.3.3, P exceedence is most likely to occur on land managed for dairy or grain production, land supporting red meat production systems will have a lower median fertility status, while land dedicated to wool production is likely to have the lowest median P fertility status. The analyses of the datasets provide a 'point in time' benchmark of soil fertility status, which may be used to assess future trends in nutrient use efficiency across regions.

**Table 22.** $P_{90}$ fertility index for each dataset expressed as the median for the whole dataset, the median for indexes > 1, and the median for indexes <1.

| Data | Median P fertility index | Median P fertility index (>1) | Median P fertility index (<1) |
|---|---|---|---|
| WA | 1.33 | 1.53 | 0.84 |
| VIC | 2.70 | 3.04 | 0.68 |
| NSW | 1.58 | 2.19 | 0.64 |
| SA | 1.63 | 1.97 | 0.76 |
| LS | 1.46 | 2.44 | 0.59 |
| A4N* | 2.69 | 2.91 | 0.74 |

* assessed against $P_{95}$

It is important to recognise that while these large soil test datasets do not necessarily provide useful insight at a farm or paddock level, they are very useful at an industry level. Analysis of the large datasets suggest that, for those samples submitted, less than 10% of cases for dairy grazing are below critical $P_{95}$ values for optimal production while less than 35% of cases for beef and sheep grazing are below critical $P_{95}$ values. This indicates that there is potential opportunity for improved productivity by addressing low P fertility levels of under-fertilised pasture in the broadacre sector. There is also potential in systems at or above critical levels to adopt nutrient management practices to better match nutrient needs to production targets.

Industry groups and bodies, and those providing fertiliser advice and recommendations should be encouraged to ensure that sufficient, useful data is captured at a scale to make sound paddock based fertiliser recommendations. Clearly there are opportunities for agronomists to recommend fit for purpose, element specific, solutions to address production constraints. Industry groups and bodies, and those providing fertiliser advice and recommendations should also be advised of the general findings of high P fertility identified in these datasets, the economic and environmental opportunities that exist for industry members, and that their members should undertake routine soil testing to identify individual opportunities.

# 5 Conclusions and recommendations

## 5.1 Conclusions

### 5.1.1 Industry consultation

The study suggests that red meat producers who soil test pasture paddocks are likely to use testing as a tool to diagnose 'problem' paddocks or to check the need for fertiliser or soil ameliorants (particularly lime), rather than using soil test results to fine-tune fertiliser applications. Clearly, while some producers nominate soil testing as the most valuable decision support tool that guides their nutrient management program, for the majority of producers it appears that soil test results are under-utilised.

Key points from industry consultation

- While the majority of producers (85% of OS respondents) consider P is a priority for their pastures, there is a downward trend in P applications to pastures.
- Producers nominate poor cash flow as a result of the drought, seasonal variability, continuing decline in terms of trade and volatility of livestock markets as factors impacting on fertiliser programs.
- Nutrient management strategies are predominantly traditional; with P commonly applied at a standard rate of 125 kg/ha across all pasture types in the study area.

- 87% of producers responding to the online survey who have soils tested seek advice on interpretation of soil tests; 58% of producers who apply fertiliser to pasture seek advice on fertiliser recommendations.
- While advisor input is sought for fertiliser recommendations, the rate of fertiliser applied is invariably a budgetary decision.
- Most producers are reluctant to change nutrient management practices in the absence of compelling evidence of 'relative advantage', including economic benefit. There is limited nutrient management information available that includes economic analysis of red meat production systems.
- Understanding of principles of pasture nutrition is highly variable among producers who attended the focus meetings. The 2007 BFD critical P values are disseminating very slowly to producers and advisors.
- Producers request economic information on fertiliser options, but very few producers appear to prioritise fertiliser inputs on the basis of economic return. The study suggests that most do not have sufficient understanding of nutrient management or the impact of fertiliser application on profitability of their livestock enterprises to prioritise fertiliser inputs.
- Multiple information providers add confusion to the nutrient management message and the result is a tendency for producers to maintain practices that that they are familiar with or are perceived to be working, rather than trying to decipher the information.
- Decline in the legume component of pastures was reported at many of the focus meetings, in all states and is generally considered by producers to be a symptom of drought. However, subsequent discussion suggests that several factors including soil fertility issues (P, S, K and pH in various combinations), variety selection, effective nodulation, poor understanding of clover requirements for establishment and seed set and poor grazing management are likely to have contributed to the decline.
- Livestock producers are less likely to pay private sector advisors than 'croppers'. Even mixed farmers who pay for agronomic advice for their cropping enterprise, are reluctant to pay for pasture management advice. This has implications for the number of private sector advisors operating in the livestock sector and the opportunities and incentive for next generation advisors to gain experience.

### 5.1.2 Desktop review of commercial soil datasets

Analysis of existing and new commercial soil datasets identified through a survey of ASPAC laboratories suggest there is a high proportional exceedance of critical soil test P values. When assessed against industry agreed soil test standards 52%, 81%, 55%, and 61% of soil test data from WA, VIC, NSW, and SA, respectively, exceeded critical soil test P values to achieve 95% of maximum pasture production ($P_{95}$). This proportionally high P exceedance and the low involvement of the grazing sector in soil sampling (calculated to be <15% of all samples submitted annually), suggests that there is an opportunity for the grazing sector to address over and under-utilisation of fertiliser and improve nutrient use efficiency and concurrently improve economic and environmental outcomes. However, due to insufficient background data to enable the identification of factors impacting on soil fertility, the analysis conducted for this study can only be used to highlight broad economic and environmental opportunities that might be derived if the grazing sector were to routinely undertake soil testing.

Livestock industries, particularly those closer to the coast, and where the annual rainfall is greater than 600mm, present the greatest opportunity for both positive economic and environmental outcomes by adhering to the recommendations derived from critical soil test values to address issues of both under- and over-fertilisation.

Key points from the desktop review

- Caution is required when applying the general findings in large datasets of high P fertility in the development of farm and paddock level fertiliser strategies.
- Farm level fertiliser strategies are best determined through the use of routine soil testing, particularly in the beef and sheep grazing sector where there appears to be low use of soil testing to support fertiliser strategies.
- There appear to be opportunities to improve production efficiency through targeted use of fertiliser in situations of both under and over-fertilisation, but this requires a detailed understanding of what is happening on the ground.
- The key message is that if producers don't soil test, they are guessing with respect to their soil fertility.

## 5.2 Recommendations

Optimisation of nutrient use efficiency in red meat production systems requires:

1. Coordination across industry by an independent lead organisation
2. Adoption of published critical soil test values and guidelines by the whole industry
3. Adoption of a consistent, evidence-based message on nutrient management across industries (red meat, grain, wool, dairy)
4. Whole of industry support and promotion of the independently audited Fertcare® accreditation program as a quality assurance mechanism for advisors
5. Development of collaborative opportunities across industries (red meat, grain, wool, dairy)
6. Coordination and a whole of industry approach for the promotion and dissemination of information and delivery of training and extension programs
7. Promotion of soil testing as a tool to identify nutrient requirements and monitor trends over time
8. Training programs to build the capacity and confidence of advisors
9. Extension programs to build the capacity and confidence of producers
10. Improved access to resources (including research outputs) through a central repository, hosted by an independent coordinating organisation, with utilisation of generic resources across industries (red meat, grains, dairy, wool)
11. Development of a national networking mechanism to cultivate collaboration between private and public sector, government agencies, NRM organisations and RDCs.

It is proposed that the recommendations are rolled out in three phases, as presented in Figure 9:

- Phase 1 will target all red meat producers and aims to increase awareness of best practice required to optimise nutrient use efficiency.
- Investment in Phase 2 will build on Phase 1 to increase industry awareness and understanding of the principles and practices and will result in a level of practice change.
- Investment in Phase 3 provides the economic analysis sought by advisors and producers consulted during this study, with Focus Farm sites providing context and validation of the principles. Investment in all three phases will provide the basis for sustained adoption of best practice that will result in optimum nutrient use efficiency. This investment in capacity and knowledge of producers and advisors creates a platform for adoption of new technologies emerging from future research investment.

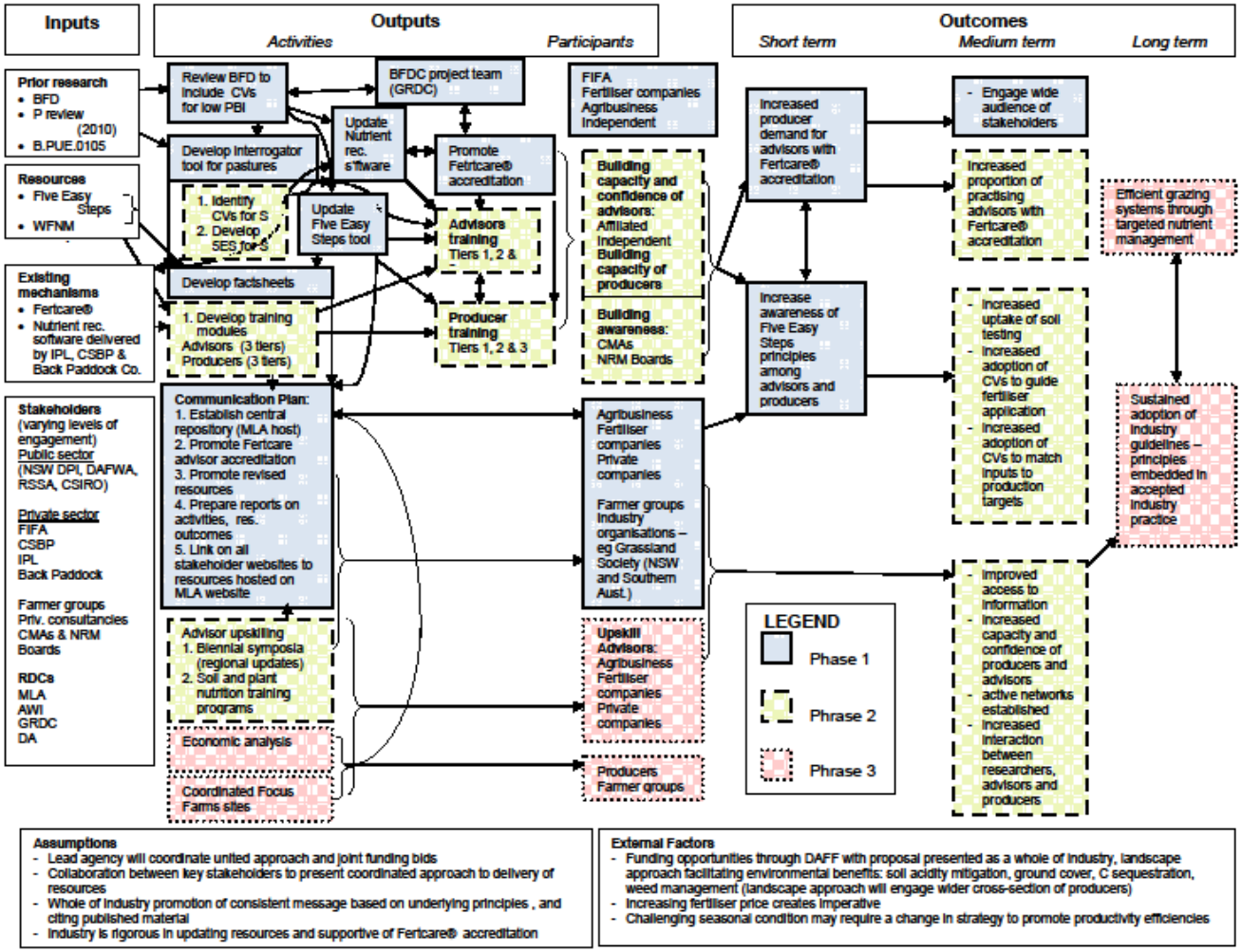


**Figure 9.** Development of resources and delivery of extension and training to producers and advisors to improve nutrient use efficiency in extensively managed grazing systems.

### 5.2.1 Phase 1

Phase 1 builds on existing resources and will be relatively easy to achieve in the short-term. A whole of industry approach is required, with a concerted effort to promote updated guidelines and mechanisms. Completion of all components will result in increased awareness of the guidelines and tools that are available to optimise phosphorus use efficiency, but is not likely to result in widespread practice change.

Investment in Phase 1 will establish a whole of industry approach to optimising nutrient use efficiency for red meat production systems by:

- identifying an independent coordinating organisation
- reviewing and promoting existing resources
- promoting the Fertcare® accreditation program and the APAC certification scheme

1. To build on previous investment in soil and plant nutrition R & D:
   (i) Publish in the scientific literature a review and update of BFD guidelines (Gourley et al, 2007), integrating critical P value relationships for very low PBI categories (D Weaver, DAFWA). This step is critical to justify the 'evidence base' for the proposed recommendations.
   (ii) Invest in research to clarify critical P value relationships for very high PBI categories (PBI values > 600)
   (iii) Update the pasture research trial database and develop an interrogator tool for pastures, modelled on the BFDC database and interrogator tool
   (iv) Negotiate with GRDC to ensure the grain and pasture interrogator tools have a common interface
   (v) Ensure the most recent CVs are incorporated into commercial nutrient recommendation software

2. Review and modify pilot Five Easy Steps and Whole Farm Nutrient Mapping (WFNM) programs through the following activities:
   (i) Review and modify both programs to include recommendations from the pilot process, incorporating revised CVs into a single program
   (ii) Develop factsheets, incorporating modifications
   (iii) Revise online Five Easy Steps modules
   (iv) Revise the P tool and include updated CVs

3. Develop a Communication Plan for whole of industry
   (i) Establish a central repository for industry-agreed publications and resources; promote revised resources and ensure access - hosted on the website of the coordinating organisation
   (ii) Encourage all stakeholders to link their websites to industry guidelines and resources
   (iii) Promote Fertcare® as the industry supported accreditation mechanism for quality assurance
   (iv) Promote ASPAC certification of soil testing laboratories

Five Easy Steps has an industry reputation as a program developed specifically for acid soils of southern Australia. The revised model that incorporates components of WFNM should be renamed to eliminate the legacy of a regional model. *There are more than five steps and it is not easy*.

### 5.2.2 Phase 2

Phase 2 involves capturing existing research and resources, developing the skills of advisors and producers to interpret and apply key principles, and building the knowledge stocks of the next generation by:

- Increasing the awareness of critical soil test values and the role of soil testing among advisors and producers not already engaged
- Building the capacity and confidence of producers to adopt industry guidelines and change nutrient management practice
- Building the capacity and confidence of advisors making whole farm nutrient management recommendations

1. Develop extension modules for producers, to cater for different levels of understanding and needs:
   (i) Tier 1: An awareness program for producers who do not want detail, but want a level of understanding; it will introduce the role of soil sampling, soil test interpretation, nutrient removal and transfer, critical soil test values and the link to stocking rate. The objective is for participants to monitor soil P levels over time so as to avoid over- and under-use of fertiliser
   (ii) Tier 2: Aims to reinforce the role of effective soil testing procedure, introduces the concept of CVs, linkage of soil fertility to livestock production targets and P inputs to match production targets across a variable landscape
   (iii) Tier 3: Aims to build the capacity of producers with a high level of understanding of their grazing system and so optimise both enterprise profitability and nutrient use efficiency. Producers targeted for these workshops are unlikely to require specific nutrient management advice, are proactive in seeking and developing networks in order to keep up-to-date with information. Producers participating in Tier 3 workshops have potential to become industry champions.

2. Develop and deliver training modules for advisors based on a composite of the revised Five Easy Steps and WFNM programs, with a recommendation to include aspects of Landscan™ and Prograze®:
   (i) Tier 1: Introduce the principles of critical soil test values and the linkage of soil fertility, pasture production and livestock profitability – aimed at advisors with limited expectation to deliver pasture nutrition recommendations
   (ii) Tier 2: Build the capacity and confidence of advisors on all Five Easy Steps principles – aimed at advisors who provide whole farm nutrient management recommendations to livestock producers
   (iii) Tier 3: Develop train-the-trainer modules to cultivate the next generation of champions, technical experts and advisor mentors

3. Regional technical updates (symposia) provide a scientific forum that would integrate soil, pasture and livestock components of the red meat production system and bring together researchers, advisors and lead producers to develop consensus, disseminate research information, up-skill advisors, and provide a feedback mechanism for researchers and industry. The benefits of this approach would be to:
   (i) Maintain or build knowledge stocks of all participants
   (ii) Create an opportunity for open debate, with the potential to establish an agreed scientific position
   (iii) Encourage the cross-fertilisation of ideas and linkages, and capture scientific thinking in a readily accessible form (published proceedings)
   (iv) Promote partnerships that meet the needs of all players

(v) Identify R,D&E gaps and opportunities, capitalising on the potential for diverse thinking from participants who are likely to represent multiple disciplines
(vi) Satisfy key performance indicators for researchers through the delivery of peer-reviewed papers would, while lifting the public profile of research

4. Develop resources for the efficient use of S in livestock production systems
   (i) Revise the BFD guidelines for S
   (ii) Develop resources, training and extension modules for S, modelled on the modified version of Five Easy Steps

### 5.2.3 Phase 3

Phase 3 provides the basis for the sustained adoption of best practice and will result in optimum nutrient use efficiency for an estimated 50% of producers. This will occur through:

1. The development of economic case studies for red meat production systems that consider the long-term implications of a range of fertiliser management scenarios on whole farm viability; with the potential for development as decision support tools for advisors. This will include:
   (i) An economic analysis of the implications to whole farm viability of different fertiliser management scenarios
   (ii) The development of sensitivity analysis decision support tools for advisors

2. Establish regional Focus Farms (see Appendix 7) to demonstrate the implications of fertiliser management scenarios on whole farm business. Sites could be linked by issues common across all regions of southern Australia. These sites will:
   (i) Provide on-ground experience for the next generation of producers, advisors and service providers to build tacit knowledge and capacity to identify and measure key business performance indicators, and to understand the interaction between: soil fertility, pasture production (quality and quantity) and livestock production
   (ii) Identify knowledge and skills gaps of producers and advisors
   (iii) Identify research gaps

3. Develop on-going training opportunities for advisors, including:
   (i) Soil and nutrition training programs, which are likely to be a combination of online modules and face-to-face workshops

## 5.3 Future funding opportunities

The project clearly identifies that delivery of a uniform, scientifically based extension message is essential to facilitate wide scale adoption of nutrient management best practice. Much of the information already exists and revising, refreshing and disseminating this to the next generation of producers and advisors is an imperative, but also an extension challenge for all agricultural industries. Collaboration in the development of generic, primary resources across industries is not only an efficient use of resources (funds and technical expertise), but reinforces the evidence-based, uniform message producers and advisors clearly want and need.

Collaboration with NRM organisations is also essential for the delivery of a uniform message. The premise for this project is the potential for *10% improvement in cost efficiencies, plus environmental benefits in more strategic application of….fertiliser*. This reflects the efficiency-based definition of productivity (physical outputs relative to

physical inputs), which is more compatible with natural resource management objectives than the production-based definition that is driven by increased gross farm income. Presenting strategic nutrient management with a whole of landscape approach that leads to improved efficiencies and environmental outcomes (soil acidity mitigation, ground cover, carbon sequestration and weed management) creates opportunities for collaboration with NRM organisations and has the potential for engagement of a wide range of stakeholders and producers. Such an approach could highlight the potential for payback at the landscape and community level and would be strengthened by embracing a whole of industry approach that highlights the International Plant Nutrition Institute (IPNI) 4Rs framework and the Fertcare® process as demonstrated by Dairy Australia Fert$mart program.

This study provides a point-in-time benchmark of the current nutrient management practices and industry knowledge, as well as the biophysical, social and economic factors that influence the on-ground nutrient management practices in pastures. The impact of future investment aimed at increasing nutrient use efficiency can be assessed by instruments such as those employed in this study (surveys, focus meetings and interviews with key stakeholders) to measure awareness among producers and advisors of published critical soil test values, the uptake of soil testing in livestock production systems, the use of soil testing as a tool to manage fertility trends and guide fertiliser decision strategies over time, and the capacity to link soil fertility to production (economic) and environmental targets.

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# 7 Appendices

## 7.1 Appendix 1 - Abbreviations

| | |
|---|---|
| A4N | Accounting for Nutrients on Australian Dairy Farms |
| ABS | Australian Bureau of Statistics |
| ANRA | Australian Natural Resources Atlas |
| ASPAC | Australasian Soil and Plant Analysis Council |
| ASRIS | Australian Soil Research Information System |
| AWI | Australian Wool Innovation |
| BFD | Making Better Fetiliser Decisions in Pastures |
| BFDC | Better Fertiliser Decisions for Cropping Systems |
| CMA | Catchment Management Authority |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| CSU | Charles Sturt University |
| CV | critical value |
| DAFWA | Department of Agriculture and Food Western Australia |
| DSS | decision support systems |
| DST | decision support tools |
| FIFA | Fertiliser Industry Federation of Australia |
| FIP | Feedbase Investment Plan |
| GPP | Grasslands Productivity Program |
| GRDC | Grains Research and Development Corporation |
| IBRA7 | Interim Biogeographic Regions of Australia: Version 7 |
| IPNI | International Plant Nutrition Institute |
| IPL | Incitec Pivot Limited |
| LS | Landscan™ - NSW DPI PROfarm course |
| NAA | Nutrient Advantage Advice |
| NATA | National Association of Testing Authorities |
| NRM | natural resource management |
| PBI | phosphorus buffering index |
| PDS | participatory demonstration site |
| PIRSA | Department of Primary Industries and Regions South Australia |
| PUE | phosphorus use efficiency |
| RD&E | research development and extension |
| RDC | Regional Development Corporations |
| RSSA | Rural Solutions South Australia |
| SARDI | South Australian Research and Development Institute |
| SCA | Sydney Catchment Authority |
| TIAR | Tasmanian Institute of Agricultural Research |
| TP | Total Phosphorus |
| WFNM | Whole Farm Nutrient Mapping program (WA) |

## 7.2 Appendix 2 - Review of nutrient management actions for NRM Boards and CMAs

### 7.2.1 Background and objectives

This component of the study focuses on the governance structure of natural resource management (NRM) organisations across southern Australia and the nutrient management actions of these organisations.

Within each state of Australia natural resources are managed by an NRM organisation. In NSW and VIC these groups are referred to as the Catchment Management Authorities (CMAs), while SA, WA and TAS are divided into natural resource regions managed by an NRM Board or Catchment Council. These organisations serve as the organisation responsible for natural resource management at the local catchment level and provide regional communities with the opportunity to contribute to natural resource management in their local area. Key roles of these organisations include the preparation of Catchment Action Plans (CAP) or equivalent NRM strategies, and implementation of the plans through on-ground programs. The CMAs and NRM organisations work with a number of different agencies to deliver these programs that cover issues such as soil health, biodiversity and water quality. It is through such programs that information regarding nutrient management may be delivered to community members and agriculture producers.

The NRM groups are very diverse, both in their governance and the NRM priorities they face, therefore it is necessary to review the plans and strategies of each NRM organisation across southern Australia to determine the nutrient targets being used, how they have been derived and whether agricultural practices have been taken into account when determining the targets and in the implementation of the plans. The level of detail given to nutrient management within the plans and the specific nutrient management activities undertaken by the NRM organisations can give an indication of the nutrient management information producers may be receiving through these organisations.

A review of the governance structure of NRM in each state is necessary to gain an understanding of the operation of the CMAs and NRM Boards.

Gaining an understanding of the governance structure of the organisations, the nutrient management targets, related programs and level of activity, may present opportunities for collaboration in the delivery of nutrient programs where objectives and target audiences overlap. Collaboration would increase the efficient use of resources and assist to ensure a consistent, evidence-based and technically sound nutrient management message is delivered to all agricultural land managers, not just red meat producers. Inconsistency and lack of scientific evidence in soil related programs is a significant concern raised by producers and advisors consulted for this study.

**Objectives**

The objective of the current report is to review the structure of NRM organisations in NSW, VIC, SA and WA and the nutrient management targets of these organisations, and specifically to:

- Identify national and state level plans that dictate the development of local/regional and catchment-based plans and determine how the policies relating to soil health and nutrient management are derived within each of the catchments or NRM regions

- Review environmental nutrient targets, nutrient management actions and expected outcomes from investment in those actions through a review of each of the CAPs and NRM strategies across southern Australia and identify the level of consideration given to nutrient management by each NRM organisation
- Identify the on-ground programs undertaken by NRM organisations, to determine the level and the priority of activity towards soil nutrients
- Establish whether it is agricultural production or environmental protection that drives the CMAs and NRM Boards in their planning and development of programs and their CAPs or NRM strategies
- Identify any NRM organisations that conduct soil testing through their soil programs and those that maintain a database of the soil test results
- Gain an understanding of the messages provided to producers and the wider community regarding the importance of nutrient management.

### 7.2.2 Approach and methods

As the focus of the current review is on the governance structure of land and soil health NRM for NSW, VIC, SA and WA and on nutrient management of the CMAs and NRM Boards, only the actions and targets and activities of the NRM organisations specifically relating to nutrient management and the land and soil health NRM governance components were reviewed. The review did not take into account other natural resource focus areas of the NRM organisations and, therefore, does not provide an indication of the level of consideration or amount of detail presented in the plans or on-ground programs for any issues other than nutrient management.

The current review was undertaken in three parts. The first part considered the NRM governance structure, while the second part reviewed NRM plans of each NRM organisation that were then ranked according to the 'Tier' system which is described below. The third component of the review involved identifying on-ground soil health and nutrient management related programs of each NRM organisation.

**Review of natural resource management governance structure**
The NRM governance structure for each of the four states of interest: NSW, VIC, SA and WA, was reviewed. This involved an internet search of the relevant government departments as well as soil health and water quality plans and strategies. The CAPs and NRM strategies of each individual NRM organisation were used to identify any organisations, plans or strategies that influence NRM in that state.

The federal, state and regional levels of governance were reviewed by identifying government NRM programs and the relevant Australian, state or regional departments and organisations responsible for the delivery of the programs. The websites and associated documents of these programs and departments were reviewed to identify any targets, plans or strategies relating to water quality (nutrient loads) and soil health and the role of each organisation in the overall structure.

A draft diagram of the governance structure was prepared for each state, based on the internet search. The draft was referred to key staff in the NRM organisations across southern Australia for review. Modifications were made according to the feedback provided.

**Review of natural resource management plans**
The organisations reviewed for this component of the project included the 11 NSW CMAs that remained after the October 2012 restructure, and the VIC, SA and WA

NRM organisations lying within the medium to high rainfall grazing and mixed farming zones targeted for this project. The CAPs and NRM strategies were identified and obtained from the websites of each of the CMAs and NRM boards. Additional plans and strategies were identified through consultation and research.

The plans were reviewed according to the criteria listed in Table A.1 and each NRM region was assigned to a 'Tier' ranking according to these criteria. The NRM organisations with plans containing detailed information about specific nutrient targets and the contribution of agriculture to nutrient management received a higher ranking (Tier 4) than those with non-specific statements. The guidelines used for ranking the NRM organisation into Tiers are provided in Table A.2.

The Tier system and criteria for each were developed after an initial scan of the CAPs and strategies of various NRM organisations. The Water Quality Improvement Plan (WQIP) for the Rivers and Estuary of the Peel-Harvey System - Phosphorus Management (Anon, 2008a), prepared by the WA Environment Protection Authority (EPA), was used as a benchmark for Tier 4. Initially, a selection of CAPs and NRM Strategies were compared with this benchmark plan to develop the Tier system. However, once the system had been derived the plans for each NRM organisation were assessed in isolation, so the comparative quality of other plans did not influence the result obtained. The large number of plans reviewed and the variability in the level of consideration given to nutrient management in the plans meant it was necessary to draw up a set of guidelines to ensure consistency in the allocation of the Tiers (Table A.2).

**Table A.1.** Assessment criteria for plans of NRM organisations for Tier ranking.

| Tier | Criteria: | Level of detail in NRM Catchment Action Plans or Strategies |
|---|---|---|
| **1** | 1 | The plans mention the word 'nutrient' with no mention of specific nutrients |
| | 2 | There is no mention of agricultural practices in conjunction with on-farm nutrient issues or nutrient management |
| | 3 | There is no link between land practices or land management and water nutrient and quality issues |
| | 4 | Actions are simple with generic mitigation measures that do not address the cause or source of the problem; e.g. 'groundcover' as the solution |
| | 5 | The plans contain non-specific, generic statements concerning nutrients |
| | 6 | There is no reference or scientific justification for the nutrient targets and actions |
| | 7 | There are no critical soil test values or critical water levels presented |
| | | |
| **2** | 1 | The plans mention specific nutrients, for example: P, S, N |
| | 2 | The plans mention fertiliser use on agricultural lands |
| | 3 | The link between nutrient issues and agricultural practices is rudimentary |
| | 4 | The plans describe very basic mechanisms for nutrient loss from the landscape |
| | 5 | The plans relate water nutrient issues with nutrients movement from the land, but do not link this to agricultural practices |
| | 6 | The actions provide more specific detail on nutrient issues and are linked to the targets, but only mitigation rather than addressing the source or cause |

| Tier | Criteria: | Level of detail in NRM Catchment Action Plans or Strategies |
|---|---|---|
| | 7 | The statements made and targets are specific for addressing nutrient issues |
| | 8 | The plans make very broad reference to scientific research |
| | 9 | No critical soil test values or critical water levels are presented |
| | | |
| **3** | 1 | The plans mention specific nutrients, for example: P, N, K, and their source |
| | 2 | The plans link nutrients with agricultural practices and/or fertiliser use |
| | 3 | Agricultural practices and fertiliser use are given as a source of nutrient loads |
| | 4 | The plans address nutrient loss from the landscape |
| | 5 | The plans relate water nutrient issues with nutrients from the land, with reference to agricultural land practices |
| | 6 | The plans contain actions that address nutrient management and fertiliser use on agricultural lands. These actions aim to prevent rather than mitigate |
| | 7 | The actions appear to be justified to achieve the desired targets |
| | 8 | The statements made are detailed and address environmental nutrient issues, with actual targets presented for nutrients |
| | 9 | Reference is made to scientific research |
| | 10 | The plans make reference to scientific data that is relevant to the environmental nutrient issues |
| | 11 | The plans present critical soil test values or critical levels for nutrients in water |
| | 12 | The plans state specific environmental governance targets for nutrient levels |
| | | |
| **4** | 1 | The plans mention specific nutrients, for example: P, K, N, the source of these and the potential environmental impact of the individual nutrients |
| | 2 | The plans state agricultural practices and fertiliser use is the source of the nutrient problems |
| | 3 | The plans detail specific production operations that have a major impact on environmental nutrient levels for example: intensive production, dairy farms, horticulture, or practices that may contribute, such as over-fertilising |
| | 4 | The plans address nutrient loss from the landscape and provide detail about specific processes and risk areas |
| | 5 | The plans provide specific detail about water quality issues arsing from nutrient run-off as a consequent of particular agricultural landuse and practices |
| | 6 | The actions directly address the source/cause of the problem |
| | 7 | The plan indicates how proposed actions will address the source of the problem and achieve the targets |
| | 8 | The statements refer to specific nutrients, backed by research data and evidence |
| | 9 | The targets are based on the findings of scientific research |

| Tier | Criteria: | Level of detail in NRM Catchment Action Plans or Strategies |
|---|---|---|
| | 10 | Research has been undertaken specifically for the development of the plans, to increase knowledge of the issues, to develop the targets and to derive appropriate actions to achieve the targets |
| | 11 | The targets and actions are scientifically valid |
| | 12 | Critical soil test values and nutrient limits in water are provided for specific nutrients |
| | 13 | The plans provide environmental governance targets for nutrients in soils and waterways |

**Table A.2.** Guidelines for Tier ranking of NRM organisations.

| Tier | Criteria Fulfilled |
|---|---|
| 1 | Meets from 1 to 7 criteria within Tier 1; and only, |
| | Maximum of 2 criteria from Tier 2 (or above) |
| 1-2 | Meets from 1 to 7 criteria within Tier 1; and |
| | Meets a minimum of 2 and a maximum of 5 criteria from Tier 2 (or above) |
| 2 | Greater than 5 criteria from Tier 2 (or above) fulfilled; and only, |
| | Maximum of 3 criteria from Tier 3 (or above) |
| 2-3 | Greater than 5 criteria from Tier 2 (or above) fulfilled; and, |
| | Meet a minimum of 3 criteria and a maximum of 6 criteria from Tier 3 (or above) |
| 3 | Meet greater than 6 criteria from Tier 3 (or above); and only, |
| | Maximum of 3 criteria from Tier 4 |
| 3-4 | Meet greater than 6 criteria from Tier 3 (or above); and |
| | Meet a minimum of 3 criteria and a maximum of 7 criteria from Tier 4 |
| 4 | Meet greater than 7 criteria within Tier 4 |

Once the guidelines for Tier ranking were established individual plans were evaluated on the basis of their nutrient management components relevant to this project. This included the detail on specific nutrients, the source of nutrients, consideration of agricultural practices, the targets and actions and the level of scientific justification. After a preliminary review all plans fell into four distinct groups. Specific criteria for each of the four Tiers were then developed for a thorough review of the plans to enable each NRM organisation to be ranked.

The CMAs and NRM regions for each state included in this review are listed in Table A.3.

**On-ground programs and projects undertaken by NRM organisations**

The on-ground programs and projects of each of the CMAs, NRM Boards and Catchment Councils in the study area were initially identified via an internet search. Subsequently, the telephone number of each of the NRM organisations and contact details of a staff member involved in the on-ground activities relating to soil health and nutrient management was identified.

The details of the contacts provided were followed up through both telephone calls and emails until the appropriate contact was found. This person was provided with details of the project and invited to participate in a structured telephone interview as part of the review.

A telephone questionnaire was prepared to gather background information about the on-ground programs and the preparation of the action plans and development of policies, actions and targets. The questions were emailed to the contact prior to the telephone interview being conducted. Due to the large number of organisations in the study area (33) and the level of duplication in some CAPs, a sub-sample of 7 NRM organisations of early respondents was selected for interviews to represent a different Tier and state. This was required as follow-up on of all organisations was not possible within the project timeframe.

A shortened version of the questionnaire was prepared in an attempt to engage NRM organisations that had not responded to the first contact, specifically to gather information about on-ground programs and whether soil testing is conducted and whether the results are stored in a database by the NRM organisation.

**Nutrient management focus for NRM organisation**

The questionnaire responses were collated and each NRM organisation was categorised as ‘High’, ‘Moderate’ or ‘Low’, based on the nutrient management focus of the programs. NRM organisations classed as ‘High’ had programs that were strongly focused on nutrient management, while those that were ‘Low’ had very little or no focus on nutrients. The NRM organisations that fell into ‘Moderate’ were those that had programs providing information on nutrient management but this was not the main focus of the program.

The overall level of activity of each NRM organisation in nutrient management related programs was assessed based on the content of the CAPs and the on-ground programs conducted. The NRM organisations were grouped as ‘Actively Involved’, ‘Moderately Involved’ or ‘Little Involvement’ with regards to nutrient management within their catchment or NRM region. Those that were classed as ‘Actively Involved’ were those that gained a high Tier ranking and had a greater focus on nutrient management in their on-ground programs. The NRM organisations with plans containing some information on nutrients and included nutrient management as an indirect component in their programs were classed as ‘Moderately Involved’. Those groups that had lower ranking plans and had little focus on nutrient management in their programs were classed as having ‘Little Involvement’.

**Natural resource management plans**

The plans obtained for each NRM organisation included in this study were reviewed according to the criteria developed (Table A.1). All NRM organisations were allocated a Tier ranking based on the criteria achieved. Table A.3 shows the final Tier ranking of each NRM organisation reviewed. The plans included in the assessment of the criteria for each are listed, with those unable to be obtained indicated in italics. The NRM organisations with a higher Tier ranking have more detailed information about nutrients and a greater consideration for agricultural practices in their plans. The NRM organisations with a lower Tier ranking have less consideration for nutrient management in the plans reviewed.

**Table A.3.** Plans reviewed and Tier ranking for each NRM organisation.

| NRM Organisation | Plans reviewed | Tier |
|---|---|---|
| **NSW** | | |
| Border Rivers-Gwydir CMA | Old CAP, Draft New CAP | 2 |
| Central West CMA | New CAP (2011-2021), Old CAP (2006-2016) | 1-2 |
| Hawkesbury-Nepean CMA | Old CAP (2007-2016), HN River Health Strategy (2007) | 2 |
| Hunter-Central Rivers CMA | Old CAP (2006-2015), Draft New CAP (2013-2023) | 2 |
| Lachlan CMA | Old CAP (2006), Draft New CAP (2013-2023) | 2 |
| Lower Murray Darling CMA* | CAP (2008), River Frontage Action Strategy | 1-2 |
| Murray CMA | Indi River Management Plan (2008), CAP (2007) | 2 |
| Murrumbidgee CMA | Old CAP- *new unavailable* | 1 |
| Namoi CMA | New CAP (2010-2020) | 1 |
| Northern Rivers CMA | Draft New CAP (2013-2023), Old CAP | 1 |
| Southern Rivers CMA | Draft New CAP (2013-2023), Illawarra NRM Action Plan, Old CAP, SR CMA 09-2010 Investment Program | 1-2 |
| Sydney Metropolitan CMA † | Draft New CAP (2012), Old CAP (2009) | 1-2 |
| Western CMA | CAP (2006-2016) | 1 |
| **VIC** | | |
| Corangamite CMA | RCS (2003-2008), RD&I Strategy (2006-2010), River Health Strategy (2006-2011), Soil Health Strategy (2006-2012), Wetland Strategy (2006-2011), Marine and Coastal Biodiversity Strategy (2009)<br>*Unable to access Regional Nutrient Management Plan* | 3-4 |
| East Gippsland CMA | Draft RCS (2012-2018), Old RCS (2005-2010), Regional River Health Strategy (2005-2010), Gippsland Water Quality Action Plan (2005) | 3 |
| Glenelg Hopkins CMA | Draft RCS (2012-2018), Estuary Management Plans-(Fitzroy, Glenelg, Hopkins, Merri, Surry, Yambuk), GH River Health Strategy (2004-2009), GH Soil Health Strategy + Plan (2009-2014), GH Nutrient Management Plan (2002) | 3-4 |
| Goulburn Broken CMA | Dryland Landscape Strategy (2009-2011), RCS (2003), Water Quality Strategy- Addendum to Draft Strategy (1997), Water Quality Strategy- Nutrients from Dryland Diffuse Sources Addendum, Soil Health Action Plan (2006), Draft Soil Health Strategy (2002), Regional River Health Strategy (2005-2015) | 3 |
| North Central CMA | Draft RCS (2012-2018), River Health Strategy (2005), RCS (2003-2007), Catchment Action Plan for the Coliban Catchment (2006), Upper Avoca River- CAP (2007), Draft North Central Dryland Region Management Plan (2007**)**<br>*Unable to access Loddon, Campaspe, Avoca, Avon-Richardson Nutrient Management Strategies & Action Plans* | 3 |
| North East CMA | RCS, Ovens Basin Water Quality Strategy (2000), Regional River Health Strategy (2006), Upper North East Water | 3 |

| NRM Organisation | Plans reviewed | Tier |
|---|---|---|
| | Quality Strategy (2001), Wetland Management Strategy- Summary (2009) | |
| Port Phillip & Westernport CMA | RCS (2004-2009), Regional River Health Strategy (2007), Better Bays and Waterways- A Water Quality Improvement Plan for Port Phillip Bay and Westernport (Melbourne Water + EPA)<br>*Unable to access Werribee Nutrient Management Strategy, Werribee Catchment Nutrient Management Plan* | 3 |
| West Gippsland CMA | Gippsland Water Quality Action Plan (2005), Bunurong Catchment Ecosystem Strategic Directions Statement (2010), Corner Inlet & Nooramunga Catchment- Strategic Directions Statement (2008), Macalister Land and Water Management Plan (2007), River Health Strategy (2005), RCS, Wetlands Plan (2007) | 3 |
| Wimmera CMA | Wimmera Wetlands Asset Strategy (2011), Wimmera Waterway Health Strategy (Summary), RCS (2003-2008), RCS (2012-2018), Wimmera Water Quality Strategy (2002), | 3 |
| **SA** | | |
| Adelaide & Mt Lofty Ranges NRM Board | NRM Plan: A-State of the Region Report (2008), B- Ten Year Plan for the Region (2008), C-Investment Plan (2011/12-2013/14), D-Regulatory and Policy Framework (2008), Bungala Estuary Action Plan (2010), Hindmarsh Estuary Action Plan (2010), Inman Estuary Action Plan (2010) | 2-3 |
| Eyre Peninsula NRM Board | Regional NRM Plan: Strategic Plan (2009), Draft NRM Behavioural Change Framework (2009), State of Natural Resources Plan (2009) | 1-2 |
| Kangaroo Island NRM Board | NRM Plan (2009): State of the Region (2009), Strategic Plan (2009-2019), Implementation Part A- Regulatory and Operational Policy (2009) | 1-2 |
| South Australian Murray Darling Basin NRM Board | Regional NRM Plan: Vol 1- Strategic Plan (2009-2019), Vol 2- State of the Region (2009), Vol 3- Regulatory and Policy Framework (2009), Vol 4- Business Plan (2009-2012), Business Plan (2012/13- 2014/15) | 2-3 |
| Northern & Yorke NRM Board | Regional NRM Plan A- State of the region (2008), B- Strategic Plan (2009-2018), C- Business Plan (2009-2012), Draft C- Business Plan (2012-2015), D- Regulatory and Policy Framework | 2-3 |
| South East NRM Board | Blue Lake Management Plan (2006), Regional NRM Plan: Part 1- Regional Description (2010), Part 2- Strategic Plan (2010), Part 3- Business Plan (2011-12), Part 3- Business Plan (2012-2013), Draft Pt 3- Business Plan (2013-2014), Part 4-NRM Policy (2010) | 2 |
| **WA** | | |
| Northern Agricultural Catchments Council<br>Sub regions/councils:<br>• West Midlands Group<br>• Moore Catchment Council<br>• Yarra Yarra Catchment Management Group<br>• Greenough | Moore Catchment Strategy (2001), Regional NRM Strategy (2005) | 3 |

| NRM Organisation | Plans reviewed | Tier |
|---|---|---|
| Perth (Swan) Region NRM<br>Sub regions/councils:<br>• North East<br>• East<br>• South<br>• North<br>• Coastal | Region NRM Strategy (2012) | 2 |
| South Coast NRM<br>Sub regions/councils:<br>• Albany Hinterland<br>• Kent Frankland<br>• North Stirlings Pallinup<br>• Esperance Mallee<br>• Esperance Sandplain<br>• Fitzgerald Biosphere<br>• Torbay Inlet Catchment Group<br>• Wilson Inlet Catchment Committee<br>• Oyster Harbour Catchment Group | Southern Prospects- Regional Strategy for NRM (2011-2016), Culham Inlet Management Plan (2008), Southern Shores (2009-2030), Southern Prospects - Regional Strategy for NRM (2004-2009), Wilson Inlet Foreshore Reserves Management Plan (2008) | 2-3 |
| South West Catchments Council<br>Sub regions/councils:<br>• Peel Harvey Catchment Council<br>• Blackwood Basin Group<br>• Cape to Cape Catchments Group<br>• Geographe- GeoCatch<br>• Leschenault Catchment Council<br>• Warren Catchments Council | Boodjidup Brook Act. Plan - 2009, Bramley Brook Act. Plan - 2011, Capes Catchment Management Strategy -2007, Cowaramup Creeks Action Plan -2008, Peel Harvey Catchment Council Draft Subcatchment Implementation Plan -2012, Ellen Brook Action Plan -2005, Geographe Catchment Management Strategy -2008, Gunyulgup Brook Action Plan - 2005, RAP for Gynudup Brook and Tren Creek -2004, Tributaries of the Lower Margaret River Action Plan -2009, Margaret River Action Plan -2003, Catchment Condition and Priorities: Peel-Harvey Catchment -2011 Science Strategy for the Peel-Harvey Estuary -2010, Peel-Yalgorup System Ramsar Site Management Plan: Peel-Harvey Catchment Council -2009, RAP for the Brunswick River -2006, RAP for the Lower Collie River -2008, RAP for the Upper Preston River -2007, RAP for the Sabina, Abba and Ludlow Rivers - 2002, Draft South West Regional NRM Strategy -2012 to 2020, Vasse Wonnerup Wetlands and Geographe Bay Water Quality Improvement Plan -2010, Wilyabrup Brook Action Plan -2006, Yallingup Brook Action Plan -1999, Water Quality Improvement Plan for the Rivers and Estuary of the Peel-Harvey System - Phosphorus Management -2008 | 4 |
| Wheatbelt (Avon) NRM<br>Sub regions/councils:<br>• Avon<br>• Yilgarn<br>• Lockhart | Avon NRM Strategy (2005), Avon River Catchment Water Quality and Nutrient Monitoring Program for 2007 (2009), Nutrient Management for the Avon River Basin (2009) | 3 |

* Lower Murray Darling CMA merged with the Murray and Western CMAs in October 2012
† Sydney Metropolitan CMA merged with the Hawkesbury Nepean CMA in October 2012

### 7.2.3 Results and discussion

**Natural resource management governance structure**

Representation of the NRM governance structure for each state is presented in Figure A.1 for NSW, Figure A.2 for VIC, Figure A.3 for SA and Figure A.4 for WA. These are indicative of the governance structures as they were when the review was completed in October 2012 and do not reflect any changes that may have occurred since that time. Federal Government NRM programs, including the Natural Heritage Trust (NHT) and National Action Plan for Salinity and Water Quality (NAPSWQ), which ceased in 2008 and the associated Joint Steering Committees have been presented as these superseded components of the structure have influenced the current standing of the NRM organisations.

The review indicates considerable variation in NRM governance across states. In NSW the CMAs are the sole agency that manages NRM issues at the regional level and are responsible for the delivery of programs and outcomes either directly or through external organisations. Each CMA has a CAP, which is the main document outlining the management actions and targets for the catchment. The CAPs are influenced by state NRM targets and standards, which are themselves influenced by the national standards and targets (Figure A.1). The Natural Resources Commission (NRC) advises on the state standards, targets and progress towards achieving these standards and targets, while the State Government provides the policy and direction. The main targets for the CAPs are, however, derived from the Australian Government NRM programs, specifically the Caring for our Country (CFOC) targets and priority issues.

VIC has a similar system to that of NSW (Figure A.2), with the CMAs being the main regional organisation that manages natural resources. Organisations and councils, such as the VIC Coastal Council, work collaboratively with the CMAs in VIC. Each VIC CMA has a Regional Catchment Strategy (RCS) which functions as the overarching plan for NRM within the catchment. This RCS provides an overview of the key natural resource issues for each catchment, with more detailed investment plans developed for 'sub strategies' and priority issues, for example, sub-catchment and nutrient management plans. The Department of Sustainability and Environment (DSE) pay for the implementation of the investment plans evolving from the RCS. The RCS is influenced, similarly to NSW, by VIC state plans and strategies and Federal Government CFOC targets and priority issues. The key advisory organisation on catchment management in VIC is the Victorian Catchment Management Council (VCMC).

Within the SA NRM system, natural resources are managed at the regional level by the NRM Boards. In 2012 the eight NRM Boards became part of the Department of Environment, Water and Natural Resources (DEWNR). The Boards work with a number of different organisations in the management of the natural resources including sub-regional and local NRM groups, state level departments, the State NRM Council, and a variety of private companies. Rural Solutions SA (RSSA) is the main government organisation that the NRM Boards collaborates with on soil health and nutrient management related activities and projects. Each NRM Board develops a Regional NRM Plan that addresses the natural resource issues and needs of the local region. As is the case in VIC, each region may have more specific plans and regional investment strategies under the Regional NRM Plans. Guidance for the development of these plans is provided by state government departments, the State NRM plan and Federal Government NRM programs. The SA NRM Council is responsible for the preparation of the State NRM Plan which contains the policy for

the management of natural resources and provides a framework for NRM activities across the state (Figure A.3).

The WA governance structure for NRM appears to support collaboration across the various organisations active in NRM. Each WA NRM group is an individual entity, while such groups have a statutory role in SA, VIC & NSW. The state organisations facilitating this collaboration include the WA NRM Ministerial Council, NRM Senior Officers Group (NRM-SOG) and NRM Regional Leaders Group (Figure A.4), drawing together various organisations concerned with NRM to enable a coordinated approach to NRM delivery across the state. At the regional level, the NRM organisations and Catchment Councils work with numerous state departments and external organisations on natural resource issues. In addition, within each NRM region there are a number of sub-region groups and catchment councils that identify key issues and develop management programs for local areas. The six NRM regions have their own regional NRM strategies and investment plans that are supported by the plans and strategies developed by the subregions and catchment councils. Plans and strategies for significant issues are also developed collaboratively by a number of state departments and organisations. For example, the projects undertaken as part of the Australian Government's Coastal Catchment Initiative in the development of the WQIP involved input from a number of organisations including the WA EPA, Peel Harvey Catchment Council, Department of Environment and Conservation (DEC), Department of Water, Department of Agriculture and Food WA (DAFWA), Peel Development Commission, Peel Waterways Centre, WA Planning Commission and the Department for Planning and Infrastructure. As with NSW, VIC and SA, the plans and strategies at the regional level are guided by the plans and priorities at the state and federal levels.

The development of policies relating to soil health and nutrient management appear to be derived in a similar manner by each state. The policies at the regional level for each individual CMA or NRM organisation are influenced both by issues within the catchment or NRM region, as well as by the governing state and federal plans and targets. This approach to policy development ensures alignment with the state and federal priority areas, which is essential to secure funding, while allowing a degree of autonomy to address issues relevant to the local region.

The NRM governance structures for NSW (Figure A.1), VIC (Figure A.2), SA (Figure A.3) and WA (Figure A.4) are presented on the following pages.

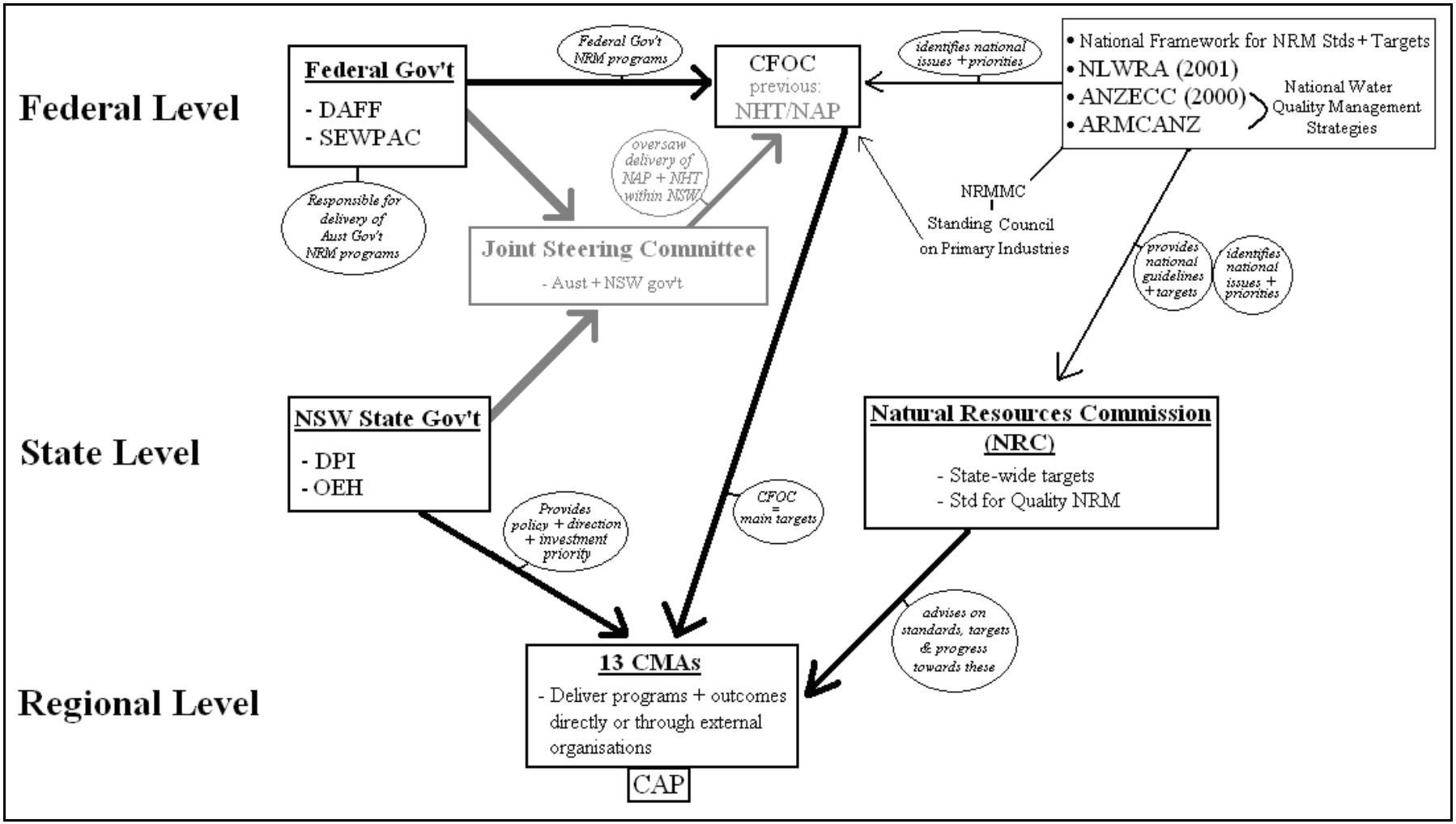


**Figure A.1.** Natural Resource Management governance structure for New South Wales.

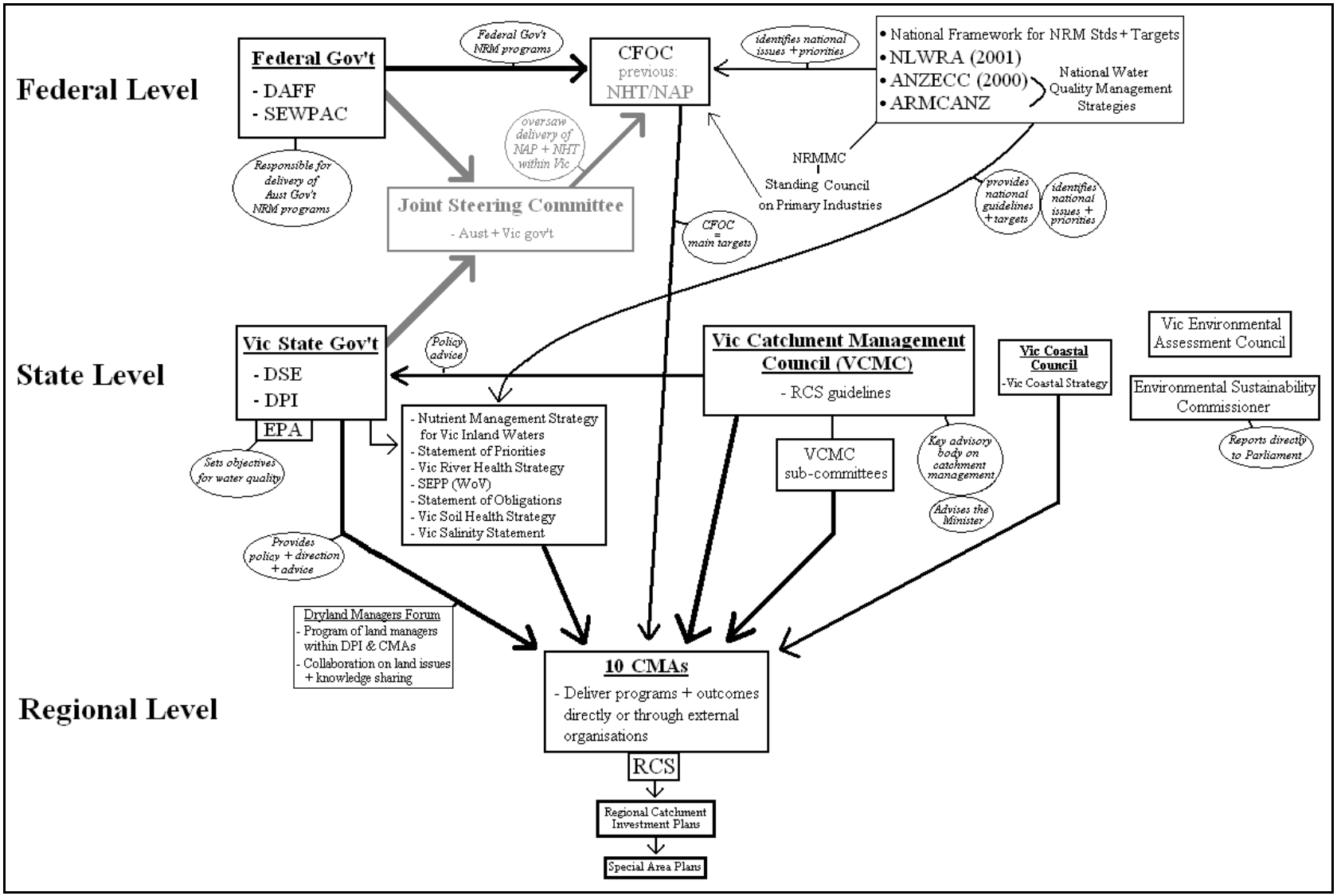


**Figure A.2.** Natural Resource Management governance structure for Victoria.

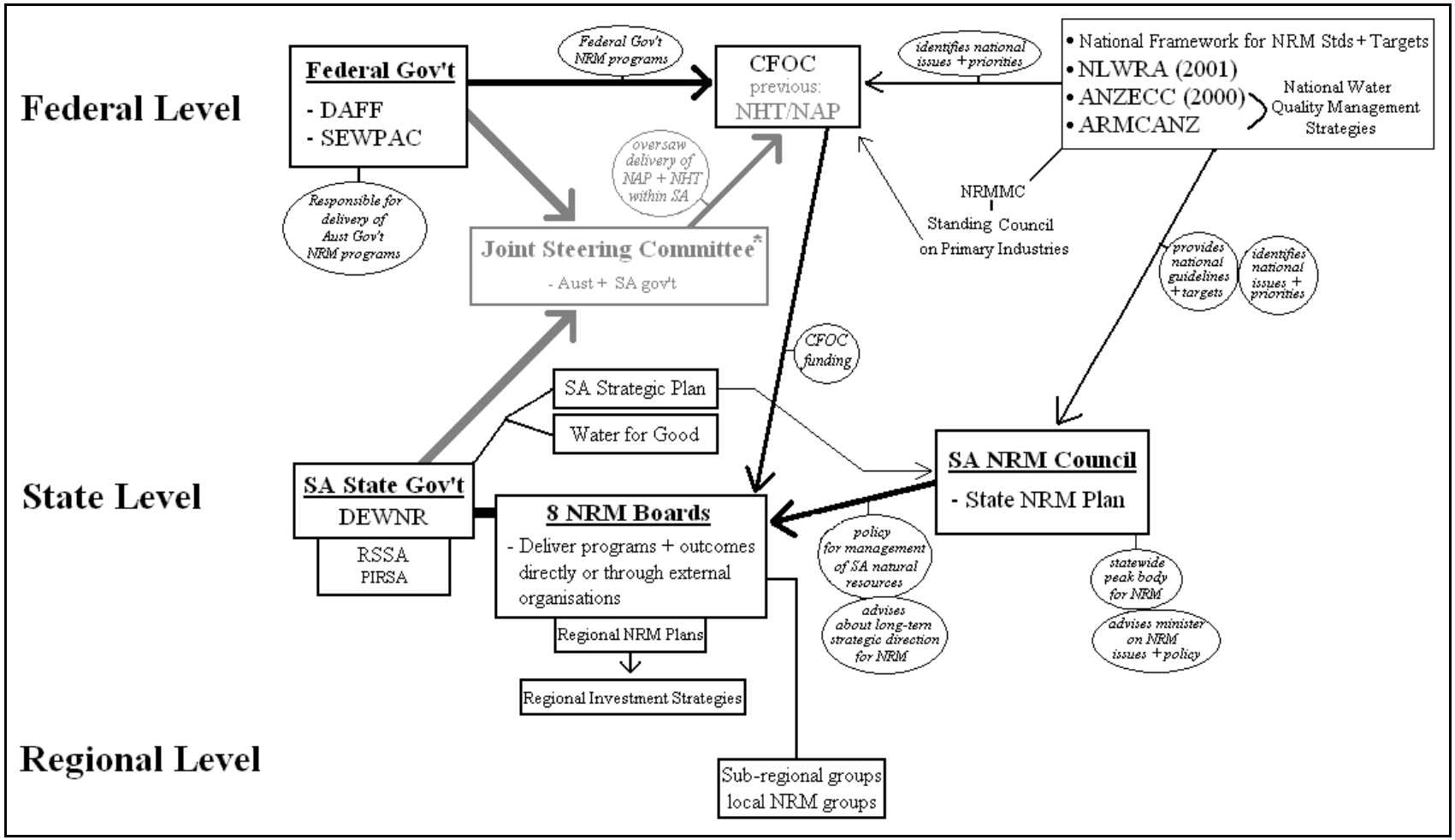


**Figure A.3.** Natural Resource Management governance structure for South Australia

* The Joint Steering Committee ceased operating after the change from NHT/NAP to CFOC.

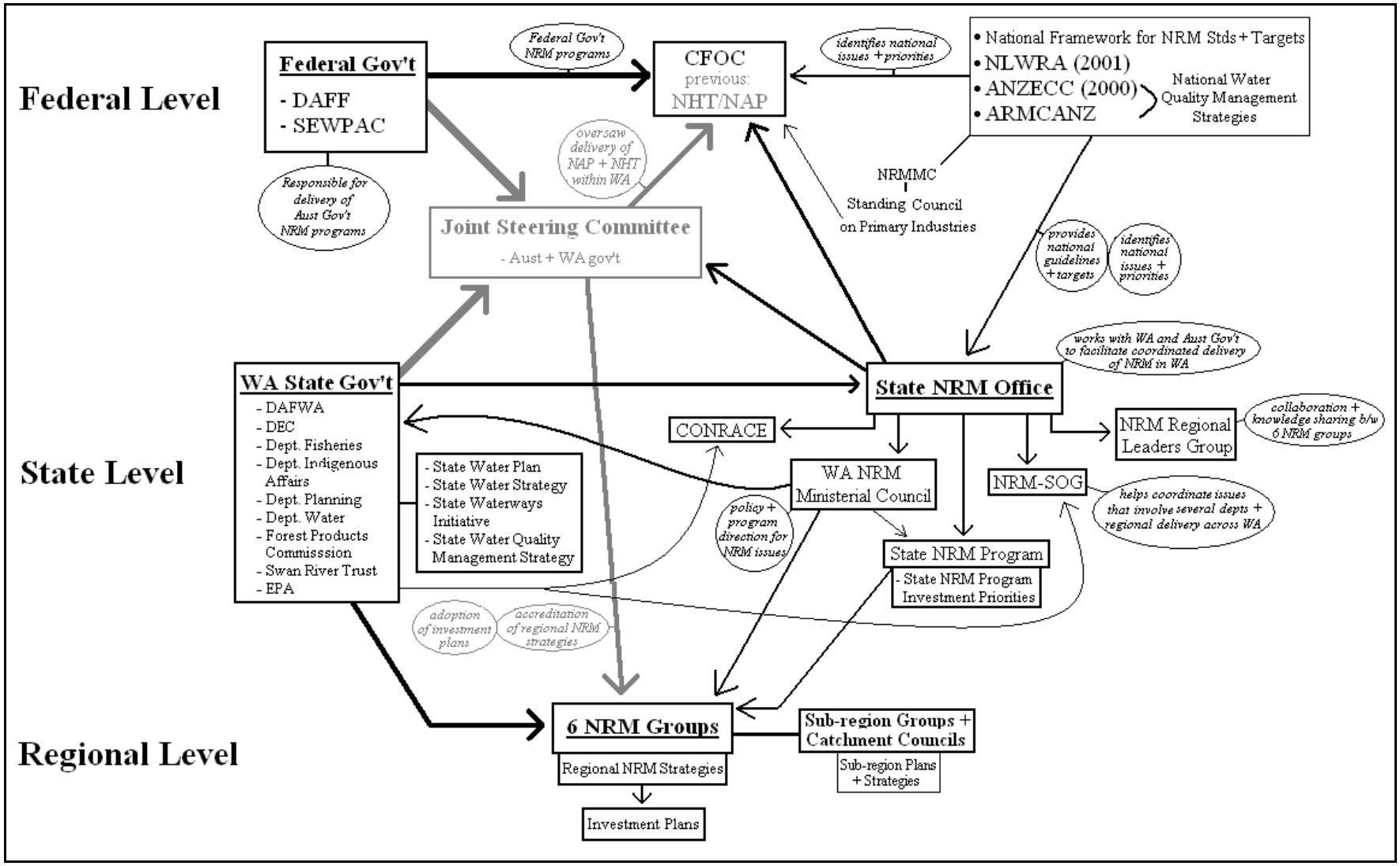


**Figure A.4.** Natural Resource Management (NRM) governance structure for Western Australia

**Natural resource management plans of southern Australia NRM organisations**

The Tier ranking achieved by each NRM organisation provides an indication of the level of consideration given to nutrient management in each CAP and the subsequent on-ground programs. Generally, NRM organisations that had specific and justifiable nutrient targets and linked these to agriculture landuse were ranked in Tiers 3 to 4. The CMAs and NRM Boards with limited detail for nutrient actions and targets and scientific justification were allocated Tier 1 to 2 rankings.

An example of the level of detail and how the criteria were achieved for a Tier 1 NRM organisation (NSW Murrumbidgee CMA) is presented in Table A.4. An example of a higher ranking (Tier 3-4) NRM organisation (Glenelg Hopkins CMA) is presented in Table A.5 showing examples of the nutrient management focus and the clear targets and actions addressed by organisations allocated the higher Tiers. In general, the plans and therefore the Tier ranking reflect the priority issues and environmental assets of the region and the perceived threats to the assets. Only the South West Catchment Council Sub regions of WA (Tier 4) and the Corangamite and Glenelg Hopkins CMAs of VIC (Tier 3-4) achieved high Tier rankings.

**Table A.4.** Tier 1 NRM organisation - Murrumbidgee CMA, NSW.

| Tier | Criteria | Details and examples |
|---|---|---|
| 1 | 1 | The CAP cites 'nutrient loads' as a water quality issue with no indication of specific nutrients or the source of these. 'Soil chemistry' and 'soil health' is discussed but there is no mention of soil nutrients. |
| | 2 | Agricultural production is mentioned but non-specific statements are made that may include nutrient issues, but this is not indicated directly: "improving soil health by focusing on the physical, chemical and biological properties of soils and implementing management practices that have a positive impact on these parameters"[1]. |
| | 3 | There is no link between land practices or land management and water nutrient and quality issues. |
| | 4 | In the 'Water' section of the CAP the actions relating to nutrient loads and nutrient run-off are simple with strategies targeting mitigation rather than identification and action on the source of the problem,:<br>**"Water Management Target 1:** Stream bank revegetation. By 2016 protect and enhance 1,500 kilometres of stream bank using native riparian vegetation for bank stabilisation and run-off filtration."*<br>"**Water Management Target 2:** Structures for river bank stability. By 2016 control stream bank and gully erosion using structural control works along 50 kilometres of those stream reaches that yield the highest sediment and nutrient loads."*<br>The land management targets take the simple, mitigation approach to managing nutrients rather than addressing the source of the problem:<br>"**Land Management Target 8:** Perennial vegetation for saline recharge. By 2016 increase by 10,000 hectares the spatial area of perennials across the catchment to reduce recharge and improve soil health parameters."*<br>To "improve soil condition…. Attainment of this target will have a positive impact on soil salinity, acidity and nutrient movement."* |
| | 5 | In both the 'Water' and 'Land' sections the statements are not specific when dealing with the soil nutrients. Broad statements are made that could be interpreted to encompass soil nutrient issues rather than providing details about the nutrient issues and specific actions to address the problems. The management targets do not specifically address soil nutrient issues. |

| | | |
|---|---|---|
| | 6 | There is no reference to scientific justification for the nutrient targets and actions. |
| | 7 | There are no critical soil test values or critical water levels presented. |
| 2 | 3 | Allocated 0.5 score for this as nutrient issues may be indicated in the broad statements but not directly stated when discussing agricultural practices. |
| | 6 | Allocated 0.5 score for this criterion.<br>In the 'Land' section the actions do not specifically relate to soil nutrient issues. However, the actions suggest implementing programs that involve soil testing to gain an idea of the conditions of the soil, "ongoing soil testing to determine change in soil chemistry"*, as well as addressing the problem by educating farmers, "training programs promoting appropriate farming and land management practices"*. |

[1] Murrumbidgee CMA Catchment Action Plan (Anon, 2008b)

Comparison of the NSW Murrumbidgee (MBD) CMA and the Glenelg Hopkins (GH) CMA demonstrates the difference in the priority of nutrients and the amount of consideration given to the nutrient management. Additional information was obtained through an interview of appropriate staff members from each of the CMAs. The background information gained reveals the underlying reasons for the amount of detail and priority given to nutrients and suggests the plans are a strong indication of the level of nutrient management activity undertaken and the subsequent detail of information provided to producers.

The interviews revealed that there is much less focus on nutrient management in the MBD CMA plans, as nutrient run-off is not a priority issue in the catchment and there are few intensive agricultural industries in the region that impact on waterways. In contrast, the GH CMA plans contain considerable detail with respect to the management of nutrient run-off from intensive agricultural industries, in particular dairying, which impact on water quality and the 'health' of the regions estuaries. Hence, nutrient management is a high priority for the GH CMA.

**Table A.5.** Tier 3-4 NRM organisation - Glenelg Hopkins CMA, Victoria.

| Tier | Criteria | Details and Examples |
|---|---|---|
| 3 | 3 | The plans state agriculture as a source of the nutrient problems, and imply that fertiliser use is a source indicating that nutrient management on farm and fertiliser run-off contribute to the problems. For example, the Fitzroy Estuary Management Plan (2006) states:<br>"The main source of nutrient loads into the estuary is from landuse practices in the catchment. Loss of nutrients from agricultural land into waterways probably represents the greatest cause of high nutrients"<br>and in the Glenelg Hopkins Nutrient Management Plan (2002),<br>"In the south of the region, where more intensive agriculture is practiced, manure and fertiliser run-off (where nutrients are in solution) contribute significantly to nutrient migration." |
| | 4 | The plans address nutrient loss from the landscape but do not provide detail about specific processes and risk areas. For example, in the Glenelg Hopkins Nutrient Management Plan (2002):<br>"Current data on phosphorus (P) loss have been collected in paddocks but it is unclear how phosphorus availability changes from paddock to stream and then along wetlands and streams. Action 4.1.2 offers an opportunity to better understand this process, which, in turn, may uncover improved ways to prevent phosphorus migration to waterways."<br>"Action 4.1.2: Support current nutrient program on nutrient loss from pastures" |

| Tier | Criteria | Details and Examples |
|---|---|---|
| | | |
| | 5 | The plans relate water nutrient issues with nutrients from the land, suggesting landuse practices including agriculture are a contributing factor to water quality decline. The plans, particularly the Estuary Management plans, the Glenelg Hopkins River Health Strategy (2004-2009) and the Nutrient Management Plan (2002), provide specific detail about water quality issues arising from nutrient run-off, i.e. eutrophication and algal blooms are highlighted as an important consequence of excess P and N levels. Nutrient run-off from the land is strongly linked to agricultural practices and nutrient management on farm, however, there is no detail provided of specific practices, for example, over-fertilising, that may lead to high levels of nutrients in waterways. |
| | 6 | The Glenelg Hopkins River Health Strategy (2004-2009) provides actions that address nutrient management from the source, including the agricultural sources:<br>"Action: RH-GR-6 and RH-HI-1, Threat: Poor Water Quality and algal blooms, Activities Required: NMP1.4.1 100% adoption of waste management on dairy farms. Reduction of 0.7 tonnes of total P over 5 years"<br>Other actions in the plans address the source of the problems through education and raising awareness of landholders about nutrient issues arising from farming practices. For example, the Soil Health Strategy (2009-2014) outlines a "Community education and communication" program involving actions including:<br>"1.1 Accomplish targeted soil health forum(s) for landholders and land managers to inform of threats and identify best management practices (cropping, grazing sheep and cattle, forestry, dairy) as well as attitudes and current knowledge about soil health"<br>"1.4 Targeted awareness raising through electronic and printed materials (websites, newsletters, and flyers), field days, demonstration sites, workshops and other information sessions."<br>The Nutrient Management Plan (2002) similarly addresses nutrient issues at the source:<br>"1.5 Farm Nutrient Management: 1.5.1 Apply extension programs to encourage adoption of better nutrient management on farms. Emphasis on dryland agriculture, dairy farms and horticulture, 1.5.2 Landholder adoption and implementation of BMPs on farms in the region." |
| | 7 | The actions appear to be justified in terms of achieving the desired targets; however, the plans provide more detail on how it is addressing the source of the problems than on how the actions will specifically achieve each of the targets. For example, in the Glenelg Hopkins Nutrient Management Plan (2002):<br>"Action: …extension programs to encourage adoption of better nutrient management on farms… Outcomes: Increased adoption of BMP on farms. 4 tonne reduction in total P." |
| | 9 | Reference is made to scientific research that has been conducted looking into the health of the waterways of the catchment. This research is the basis for the current levels of nutrients in waterways, with the targets and actions to achieve these levels within the suggested guidelines. In addition, the Nutrient Management Plan (2002) identifies the background studies that were used in the development of the plan:<br>"BACKGROUND STUDIES: Identifying Nutrient Hotspots in the selected sub-catchments in the Glenelg, Hopkins and Portland Coast Basins…; Benefits and Costs for Reducing Frequency of Algal Blooms in the Glenelg-Hopkins CMA …; Development of a Catchment Management Support System (CMSS) model for the Glenelg-Hopkins CMA region …<br>The CMSS model estimated nutrient contributions for different sources in the Glenelg-Hopkins region. Each landuse has been assigned a nutrient export rate. The model provides an overall load of P and N for each sub-catchment and final load exiting the system at the river mouth." |
| | 10 | The studies on the health of waterways, used to inform the plans, provide information on level of nutrients within waterways at monitoring points, and how these compare with |

| Tier | Criteria | Details and Examples |
|---|---|---|
| | | national and/or state exceedence guidelines for healthy waterways.<br>Water quality guidelines and critical levels are sourced from the Victorian Environment Protection Authority (EPA) State Environment Protection Policy (Waters of Victoria) (SEPP - WoV)) and the Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines, based on relevant data for environmental nutrient issues. |
| | 11 | The plans present critical levels for nutrients in water, including both current levels and targets levels for specific nutrients such as P and N. There are no critical soil nutrient test values presented in the plans. |
| | 12 | The plans state specific environmental governance targets with respect to nutrient levels, providing the guidelines for nutrient levels in waterways from the Vic EPA (SEPP (WoV)) and the levels recommended by the ANZECC guidelines as the Catchment targets. |
| 4 | 1 | The plans mention specific nutrients, including N and P, identifying the landuse sources. Dryland grazing is identified as a diffuse sources of nutrients, including P (169 t/ha/yr) and N (3,190 t/ha/yr). The point source of the nutrients is also identified. Also provided are potential environmental impacts of the individual nutrients, such as eutrophication and algal blooms (Glenelg-Hopkins Catchment Nutrient Management Plan, 2002). |
| | 2 | Allocated 0.5 score for this as certain plans state agricultural practices as the source of the problem being discussed, although there are no plans developed specifically with agriculture as the source of the problems. (See Tier 3, Criteria 3) |
| | 3 | The plans do detail specific production operations that have an impact on the environmental nutrient levels. The Nutrient Management Plan (2002) provides pie charts showing the contribution of P and N from different land practices. |
| | 5 | Allocated 0.5 score for this as it presents more details than required for Tier 3 as specific details are provided about the water quality issues arising from agricultural landuse, however, there is little detailed included about specific practices. (See Tier 3, Criteria 5) |
| | 8 | The statements made are detailed and address environmental nutrient issues with actual targets presented for nutrients, such as Total Phosphorus (TP) limits in waterways. The impacts and values presented are backed by scientific research and evidence through investigations into water quality of different rivers and waterways within the catchment. |
| | 10 | Allocated 0.5 score for this as studies were conducted to aid development of the plans and provide the targets and actions. For example, the background study to the Nutrient Management Plan, allowed nutrient contributions for different sources within the region to be estimated. Hence actions and targets specific to the nutrient situation in the Glenelg Hopkins region could be developed. |
| | 12 | Allocated 0.5 score for this as it provides critical levels in water for specific nutrients such as P and N. |
| | 13 | Allocated 0.5 score for this as the plans provide environmental governance targets for nutrients in waterways from the Vic EPA (SEPP (WoV)) and the ANZECC guidelines. |

Water Quality Improvement Plan (WQIP) for the Rivers and Estuary of the Peel-Harvey System - Phosphorus Management (Anon 2008a), which was used as the Tier 4 benchmark for the Tier ranking system for this study, includes more detail than most plans reviewed. The plan includes work conducted by a number of organisations under the South West Catchment Council (SWCC). The level of detail, specific targeting of agricultural practices and provision of scientific justification in the WQIP, prepared by the WA EPA, is indicative of a high level of activity relating to nutrient management in the Peel-Harvey Estuary Catchment. The plan contains

significantly more details regarding control measures to reduce P loads into waterways, the environmental impacts of high P loads, the agricultural practices that contribute heavily to nutrient loads, and scientific justification and background work undertaken to develop the actions and targets of the plan, than any other plan reviewed.

The Tier ranking for CMAs of NSW were all lower than the CMAs of VIC (Table A.3), suggesting state priorities may influence the level of priority given to nutrient management and reflect the impact of state-based policies and targets on the activity of the NRM organisations at the regional levels. However, the ranking for all NRM Boards is also likely to reflect the consequence of geographic location and biophysical factors such as climate, topography, soil type, as well as landuse as indicated in Section 3.3.3 of this study and the environmental assets impacted by poor water quality, for example, Ramsar wetlands.

**On-ground Programs**

Not surprisingly, assessment of on-ground programs revealed that the level of focus on nutrient management through on-ground activities of the NRM organisations corresponds with the level of consideration and detail provided for nutrient management actions and targets in the plans. Generally, the NRM organisations with a high Tier ranking had a greater focus on nutrients in their programs and projects. However, for a number of CMAs and NRM Boards the level of on-ground activity was greater than that suggested by the plans, which may reflect the skill sets and interests of individual staff members and collaborating organisations.

Regions with nutrients as a priority issue, such as the GH CMA, have a compelling case to attract funding for projects to mitigate pollution of waterways by nutrients and, subsequently are able to undertake significant nutrient focused activities. The majority of on-ground nutrient management projects of the GH region involve raising producer awareness and providing them with support and the necessary skills and knowledge to make informed decisions that will benefit the environment, while acknowledging the need for sustainable agricultural systems.

The on-ground soil health and nutrient management related programs identified for each NRM organisation are listed in Table A.6, with categories (‘High’ - H, ‘Moderate’ - M or ‘Low’ - L), assigned to each NRM organisation according to the level of apparent focus on nutrient management in the programs. The NRM organisations where the information could not be obtained are not listed in Table A.7.

**Table A.6.** On-ground soil health and nutrient management programs administered by NRM organisations (Programs scheduled for funding period 2007-2013).

| NRM Organisation | Soil programs related to nutrient management | Category |
|---|---|---|
| **NSW** | | |
| Central West CMA | • Farming Systems, includes expert speakers<br>• Working with farmers to increase soil carbon<br>• SAL- Salt Affected Lands<br>• Farm Planning, includes workshops, training & education<br>• Soil Carbon (Water Ponding) Project<br>• Other projects that address riparian land/sediment and nutrient management include:<br>- Warren to the Barwon<br>- Aquatic Biodiversity<br>- Riverine Rehabilitation<br>- Fish River (Biodiversity Fund) | M |
| Hawkesbury-Nepean CMA | • Soil and Land Program:<br>- No programs specifically focussed on nutrient management<br>- Soil Microbes/Biology Project, includes the effects of fertiliser and nutrient management on soil biology and BMP's<br>- Incentives to decrease amount of run-off into rivers (i.e. fencing off waterways)<br>- Maintaining groundcover programs<br>- Improving Land Management Practices<br>- Catchment Protection Scheme, includes bad erosion and nutrient run-off<br>- Compost program, includes soil testing<br>- Soil Carbon Workshop<br>• River Health Program:<br>- Managing Nutrients<br>- Protection and Improving Rivers and Creeks | M |
| Hunter-Central Rivers CMA | • No programs specifically focussed on nutrient management or fertiliser use<br>• Grazing Management<br>• Farm management, includes farm planning with holistic approach<br>• Increasing Soil Carbon, CFOC funding<br>• R & D Project, includes field days and small activities<br>• Salinity<br>• Erosion<br>• Incentives based funding project, producers can apply for earthworks funding<br>• Waterwatch program, includes P awareness week | M |
| Lachlan CMA | • Boorowa River Recovery<br>• Lachlan River Revival- Upper Wetland Protection<br>• Conservation Grazing<br>• Soil Carbon Project<br>• Catchment Health and Soil Monitoring<br>• Conservation Farming | L* |
| Murray CMA | • No programs specifically focussed on nutrients<br>• On-ground incentives for practices to improve soil health<br>• Conservation Farming Practices | M |

| NRM Organisation | Soil programs related to nutrient management | Category |
|---|---|---|
| | • Eastern Murray Erosion Control Program, includes control of nutrients entering into waterways<br>• Soil Carbon research project<br>• Soil Benchmarking Project<br>• GRDC Soil Biological Initiatives Project<br>• Delivered through DPI<br>- Soil Carbon Workshop<br>- Soil Life Workshop- Soil Biology | |
| Murrumbidgee CMA | • Delivered through NSW DPI<br>- Soil Carbon Workshop<br>- Soil Life Workshop- Soil Biology<br>• Conservation Farming Project includes erosion, paddock sub-division, ground cover, land/water management planning | L |
| Namoi CMA | • No programs specifically focussed on nutrients<br>• There is a Precision Ag Program running that includes trials with some reference to nutrients but not directly<br>• Increasing ground cover program<br>• Funding received for point source pollution in 2008<br>• Soil Carbon Program, finished June 2012 | M |
| Northern Rivers CMA | • Soil Health Workshops and Field Days<br>• Soil Health for Horticulture Program<br>• Conservation Farming Program<br>• Extension and communications, quarterly newsletter- 'All the Dirt'<br>• Most extension services contracted out to Landcare<br>• Several networks:<br>- State-wide NSW soils network (Aim of the network is to share information, products, knowledge, and strategies and build skills to facilitate collaboration on soil & land management across CMAs.)<br>- Local network, North Coast Soils Advisory Council<br>- Floodplain network, manage acid sulphate soils<br>• Investment strategies<br>• Soil Health – grazing, cover cropping, groundcover<br>• Soil Conservation and Erosion, includes incentives for farmers<br>• Acid Sulphate Soils<br>• SoilWatch Monitoring program- sampled 400-500 sites, provides snapshot of soil health across sites<br>• Conservation Tillage Project | M |
| Southern Rivers CMA | • Previously conducted projects with the dairy industry, including nutrient mapping<br>• Work with smaller landholders educating about soil condition<br>• Delivered through NSW DPI:<br>- Soil Carbon Workshop<br>- Soil Life Workshop- Soil Biology | M |
| **VIC** | | |
| Corangamite CMA | • Land Health Program: State funded and CFOC funded<br>- State program funds an on-ground works program to reduce the impacts on high priority natural assets. Key activities include: | M |

| NRM Organisation | Soil programs related to nutrient management | Category |
|---|---|---|
| | ○ Fencing remnant vegetation and wetlands<br>○ Management of sites<br>○ Encouraging natural regeneration<br>○ Revegetation<br>○ Soil conservation activities<br>- CFOC program funds on-ground works involving landholders developing perennial pasture demonstration sites to address soil acidity and build soil carbon. Involves soil testing and the application of lime<br>• Capacity building programs | |
| East Gippsland CMA | • Soil Erosion Management Plans (DPI VIC)<br>• Erosion control structures (DPI VIC)<br>• Whole Farm Planning, which includes a unit about soil description and basic soil parameters (East Gippsland Landcare Network)<br>• Various soil health seminars (Far East Landcare Network, East Gippsland Landcare Network, DPI BetterBeef Network/Best Wool Best Lamb) | M |
| Glenelg Hopkins CMA | • Land Health Program- to improve soil health and farm productivity while protecting natural resources<br>• Estuary Management and Monitoring- ongoing monitoring of physiochemical parameters of estuaries<br>• Soil Acidification Project<br>• Raising Awareness and Education of nutrient management<br>• Capacity Building and Training Programs- involving nutrient management and fertiliser use | H |
| Goulburn Broken CMA | • Healthy Soil Healthy Food Field Day (1)<br>• Soil Pit Field Days<br>• Soil Test Interpretation Workshops<br>• 'Beyond Soil Care' Project<br>• Support DPI VIC 'Soil Health Management Program | H* |
| North Central CMA | • Farming for sustainable soils<br>• Adopting sustainable farming practices | M* |
| North East CMA | • Soil Carbon Program<br>• Sustainable farming systems<br>• Soil Biology management | M* |
| Port Phillip & Westernport CMA | • Landscape restoration programs aiming to improve the quality of land, water and native habitat in the Yarra Valley – under banner of Yarra4Life program<br>• Ramsar Protection Program<br>• Little information in this region about soils. They were never a NAP region which historically received funding for soil projects | L |
| West Gippsland CMA | • Waterwatch<br>• Healthy Soils, Sustainable Farms- Building soil carbon and managing pH | L* |
| Wimmera CMA | • Property Management Planning<br>• Project that focuses on management of nitrogen nutrition with a focus on reducing nitrous oxide emissions from cropping, involves on-ground demonstrations and communications with | H |

| NRM Organisation | Soil programs related to nutrient management | Category |
|---|---|---|
| | farmers and agribusiness<br>• Project on potential to build soil carbon through application of compost, involves on-ground demonstrations and communications with farmers and agribusiness | |
| **SA** | | |
| Adelaide & Mt Lofty Ranges NRM Board | • Education and awareness program - workshops dedicated to nutrients<br>• Soil testing incentives<br>• Field Days and Events related to soil health and nutrients<br>• Soil acidity is the big issue<br>• Healthy Soils and Carbon Farming Workshops | H |
| Eyre Peninsula NRM Board | • Mainly undertake projects on soil erosion mitigation<br>• Support other farmer based groups in region: Lower Eyre Agricultural Development Association (LEADA) and Eyre Peninsula Agricultural Research Foundation (EPARF)<br>• Project technical delivery undertaken through contracts with RSSA<br>• Projects concluding June 2013:<br>- Targeted Land Management Change to Increase Adoption of Cover on High Risk Soils- addresses issues associated with farming high erosion risk areas<br>- Building Soil Carbon by Addressing Hostile Soils on Lower Eyre Peninsula- addresses soil constraints including soil acidity, compaction and loss of fertility<br>- Planning Multiple Use Landscapes on Farms<br>- EP Farming Systems 3- focuses on water use efficiency, carbon and nitrogen interactions<br>- The 20:20 Carbon Challenge: Increasing Soil Organic Carbon of Sandy Soils<br>• Projects continuing after June 2013:<br>- Improving Nitrogen Efficiency Across Biophysical Regions of Eyre Peninsula<br>- Increasing Carbon Storage in Alkaline Sodic Soils Through Improved Productivity and Greater Organic Carbon Retention | M |
| Kangaroo Island NRM Board | • Provided subsidies to landowners to undertake:<br>- Clay spreading to address water repellent sands<br>- Lime sand spreading to address soil acidity<br>- Planting perennial pastures<br>(not offered this financial year as no CFOC funding in final year)<br>• Projects through Agriculture KI (funding through CFOC, State NRM, GRDC):<br>- Soil testing, providing subsidised soil testing service for landholders including technical advice on soil test interpretation<br>- Reducing soil acidity in irrigated horticulture- encouraging the uptake of soil moisture monitoring, monitoring soil and water nitrate and pH levels<br>- Sub-soil manuring- trial work looking at the impacts of deep placement of lime, gypsum and organic matter<br>- Soil acidity- education/extension, monitoring and trial work focusing on greater awareness of impacts of soil acidity and its treatment | H |

| NRM Organisation | Soil programs related to nutrient management | Category |
|---|---|---|
| | - Perennial pasture trial work- for multiple benefits including increasing soil cover<br>- Soil pits- educating landholders about soil- its limitations and management<br>- Crop trial work- timing of nitrogen, water logging management (engineering and soil nutrition) | |
| South Australian Murray Darling Basin NRM Board | • Whole Farm Planning<br>• Delivered by Mallee Sustainable Farming:<br>- Stubble management<br>- Working with farmer groups<br>- Some projects specific to nutrients- in areas where nutrients are a problem | H |
| Northern & Yorke NRM Board | • Fund farming systems groups- run demonstration trials (through private companies)<br>• Soils for Life Program<br>• Work through Landcare | M |
| South East NRM Board | • Enhancing Soil Health Project<br>• Sustainable Agriculture<br>• Saltland agronomy project | M* |
| **WA** | | |
| Northern Agricultural Catchments Council | • West Midlands Group:<br>- Subsoils acidity amelioration trial<br>• Yarra Yarra Catchment Management Group:<br>- Water Quality Monitoring<br>• Mingenew-Irwin Group:<br>- New Conservation Farming Systems | M* |
| Perth (Swan) Region NRM | • Swan Canning Tributaries Restoration - Eastern Metropolitan Regional Council, South East Regional Centre of Urban Landcare – wetland restoration and water quality program, focusing on managing nutrient loads<br>• Swan River Trust - Swan Canning Cleanup Program | M* |
| South Coast NRM | • Coordination of Soil Health Extension in Western Australia<br>• Torbay Inlet Catchment Group - Rivercare<br>• Soil/fertiliser workshop covering topics such as<br>- Soil sampling<br>- Soil test interpretation<br>- Advice on P, K and S<br>- Soil acidity<br>- Nutrient leaching<br>- Nutrient management<br>These have been run by a local CMA (Wilson Inlet Catchment Committee, Watershed Torbay or Oyster Harbour Catchment Group) with input from specialists | H |
| South West Catchments Council | • Sustainable Agriculture Program<br>• Sustainable Landscapes Project<br>• Sustainable Soils Program<br>• Geographe- Geocatch:<br>- Lower Vasse River Clean Up<br>- Catchment Monitoring<br>- Smart Soils | H |

| NRM Organisation | Soil programs related to nutrient management | Category |
|---|---|---|
| | - Dairy Effluent Improvement Program<br>• Leschenault Catchment Council:<br>- Sustainable Agriculture Through Healthy Living Soils<br>- Dairy Effluent Improvement Program<br>• Peel Harvey Catchment Council:<br>- Filtering the Nutrient Storm<br>- Peel Harvey Water Quality Recovery Program<br>- Sustainable Agriculture<br>• Nutrient smart- Fertiliser Action Plan (now Fertiliser Partnership) | |
| Wheatbelt (Avon) NRM | • Sustainable Agriculture Program<br>• Soil Conservation Incentives Program- supporting farm practice change to improve soil condition and reduce wind erosion in the Avon River Basin<br>• Supporting farm practice to increase soil organic carbon<br>• Supporting local famers decisions for saltland management and soil protection | M* |

The on-ground activities and projects managed by the NRM organisations are commonly undertaken in partnership with external organisations and state departments, with workshops and field days often delivered under contract by public and private sector providers. Table A.6 is therefore unlikely to be a complete list of the programs and projects the NRM organisations are associated with, rather it is a sample of the type of projects conducted, based on the information available. This is particularly so for the SA and WA NRM organisations, where many organisations are involved in the development and delivery of on-ground projects. For example, additional contacts provided to obtain information pertaining to the SA Murray Darling Basin NRM Board, including Mallee Sustainable Farming, Department of Primary Industries and Regions SA (PIRSA), RSSA and Landcare. The information required for the current report was obtained from numerous people across a number of different organisations as a consequence of the cross-agency approach of NRM in SA and WA. It was not possible to make contact with all that were provided within the project timeframe.

In NSW, the Sydney Catchment Authority (SCA) works in conjunction with several CMAs and other organisations in the delivery of soil-based projects and programs that may involve a nutrient management component. For example, NSW DPI works in collaboration with the SCA on a number of projects and delivers training courses and workshops focused on agricultural practices. The Sustainable Grazing Program is one such program through which training courses are provided for livestock producers. The courses and workshops include: Prograze®, Landscan™, Five Easy Steps and Managing your Farm Dam. It is through such training courses and workshops that on-farm nutrient management information is delivered to producers.

It was not possible to review all the resources and materials used in nutrient management extension programs, although it is apparent that the content and context does depend on the knowledge and experience of the individuals preparing and/or presenting material. The sources of information and therefore the critical soil test nutrient values are known to vary. For example the CVs included in the NSW DPI material draws on the BFD (Gourley et al, 2007). These CV guidelines are widely adopted by industry and included in industry nutrient recommendation software, but

not all currently available P specific guidelines include or reference the BFD guidelines, for example Bayley and Brooksby (undated).

Many of the on-ground programs delivered by NRM organisations also involve the collection of soil testing information. The NRM organisations that conduct soil testing within their region as part of their on-ground programs or in partnership projects are presented in Table A.7. Also indicated are the NRM organisations for which the soil test results originating from programs are stored in a database owned by an external organisation. Included in the table are the NRM organisations for which no information could be obtained.

**Table A.7.** NRM organisations that conduct soil testing as a component of their on-ground programs.

| NSW | Vic | SA | WA |
|---|---|---|---|
| Central West CMA[*]<br>Hawkesbury-Nepean CMA<br>Hunter-Central Rivers CMA[*]<br>Murray CMA[*]<br>Murrumbidgee CMA<br>Namoi CMA[*]<br>Northern Rivers CMA[*]<br>Southern Rivers CMA[*] | Corangamite CMA<br>East Gippsland CMA[*]<br>Glenelg Hopkins CMA<br>Wimmera CMA[*] | Adelaide & Mt Lofty Ranges NRM Board<br>Eyre Peninsula NRM Board[*]<br>Kangaroo Island NRM Board[*]<br>SA Murray Darling Basin NRM Board<br>Northern & Yorke NRM Board | N/A[†] |

[1] Soil test results stored in a database belonging to an external organisation or other department.
[†] N/A = information unable to be obtained

Soil testing is undertaken by many of the NRM organisations responding to this study as a major focus of soil 'health' programs. Only those providing information about their soil testing program are listed. In the majority of cases, the soil test results were not kept by the NRM organisations and were retained by producers for their own records. Several of the NRM organisations indicated they undertook soil testing as part of a partnership project and the results were stored in a database belonging to an external organisation. This includes the NSW CMAs that conduct soil testing for the SoilWatch program, a partnership program between the Office of Environment and Heritage (OEH), Soil Science Division and the NSW CMAs. The aim of that program is to monitor change in soil condition across NSW over time, with results stored in the Soil and Land Information System (SALIS) database of the OEH. The analyses recorded include pH, electrical conductivity, total carbon, organic carbon, gravel content, soil stability, soil colour, bulk density and an estimate of porosity.

Contacts from other NRM organisations indicated soil test data are kept by departments including the DPI VIC and PIRSA. Several of the contacts from the NRM organisations that do not currently maintain a database stated they previously did, however, this storage of data was discontinued as the organisations lacked the capacity and justification to maintain it. A number of the contacts expressed interest in having access to such a database.

**Ease of finding appropriate contact**

The information sought for the current report was unable to be obtained from a number of NRM organisations due to the difficulty in finding an appropriate contact (Table A.8). An appropriate contact was unable to be identified for a small number of

the NRM organisations, including the majority in WA. This may be indicative of the collaborative approach taken towards NRM in this state, as the referral process was tortuous and involved several agencies and organisations. In fact, the WA Government has established the Fertiliser Partnership (2012-2016), which supersedes the Fertiliser Action Plan (2007), as a voluntary program to ensure coordination of private and public sector agencies involved in rural fertiliser management in the Swan and Scott Coastal Plains regions.

SA has a similar strong cross-agency approach to NRM and although a contact was identified for many of the SA NRM Boards, redirection across a number of different organisations occurred. Many additional contacts and organisations that may have been able to provide additional information could not be contacted due to the difficulty and time taken to locate the prime contact. This may be symptomatic of the funding model for many NRM projects, which are invariably managed by short-term appointees, so that specifics of projects may not be retained and corporate knowledge is often lost as a result.

**Table A.8.** Ease in contacting an appropriate staff member in each of the NRM organisations.

| State | Immediately found contact | Contact found with effort | Unable to identify contact |
|---|---|---|---|
| NSW | Hawkesbury-Nepean CMA<br>Hunter-Central Rivers CMA<br>Murray CMA<br>Murrumbidgee CMA<br>Namoi CMA<br>Northern Rivers CMA | Border Rivers-Gwydir CMA*<br>Central West CMA<br>Southern Rivers CMA | Lachlan CMA<br>Western CMA |
| Vic | Corangamite CMA<br>East Gippsland CMA<br>Glenelg Hopkins CMA<br>North Central CMA*<br>North East CMA*<br>West Gippsland CMA*<br>Wimmera CMA | Goulburn Broken CMA*<br>Port Phillip & Westernport CMA | |
| SA | Adelaide & Mt Lofty Ranges NRM Board†<br>Kangaroo Island NRM Board† | Eyre Peninsula NRM Board†<br>SA Murray Darling Basin NRM Board†<br>Northern & Yorke NRM Board†<br>South East NRM Board*,† | |
| WA | | Perth (Swan) Region NRM*, † | Northern Agricultural Catchments Council<br>South Coast NRM<br>South West Catchments Council<br>Wheatbelt (Avon) NRM |

* Contact was identified although the required information was unable to be obtained from the contact.

† Contact provided additional contacts as collaborative nature of organisations meant all required information could not be obtained from the one contact.

In addition to being redirected to various organisations, the process of identifying the contacts for the NRM organisations was complicated by variation in position titles across the associated NRM organisations. The position titles of prime contacts include Catchment Coordinator, Soil Officer, Field Officer, Landcare Facilitator,

Leader - Strategy and Investment and Sustainable Agriculture and Training Coordinator.

The timeframe allowed for consultation with key personnel did not take this cross-agency collaboration into account and, therefore, did not cater for the time required to acquire the necessary information from multiple contacts for a single NRM organisation.

**NRM organisation involvement in nutrient management activities**

An overall assessment of the level of involvement of each of the NRM organisations in nutrient management activities, based on the results of the current report are presented in Table A.9. The NRM organisations listed as 'Actively Involved' in nutrient management are those that have programs with a particular focus on nutrient management.

The 'Moderately Involved' category includes the NRM organisations that have less focus on nutrients in their plans and conduct on-ground programs that have a nutrient component, although it is not the main focus of the program. As shown in Table 62, the 'Moderately Involved' category represents the majority of NRM organisations included in the current review (58%). Nutrient management is included in the plans and programs of these as a component of land management and soil health, but nutrient loads are not considered a significant environmental threat and so are not a priority issue. The plans and programs of NRM organisations classed as having 'Little Involvement' had very little focus on nutrient management and are indicative of the extensive mixed farming regions where nutrient issues are not a priority.

**Table A.9.** Assessment of involvement of each NRM organisations in nutrient management activities.

| State | Actively Involved | Moderately Involved | Little Involvement |
|---|---|---|---|
| NSW | | Border Rivers-Gwydir CMA, Central West CMA, Hawkesbury-Nepean CMA Hunter-Central Rivers CMA, Murray CMA, Southern Rivers CMA | Lachlan CMA Murrumbidgee CMA Namoi CMA Northern Rivers CMA Western CMA |
| Vic | Corangamite CMA, East Gippsland CMA Glenelg Hopkins CMA Goulburn Broken CMA North Central CMA North East CMA Wimmera CMA | Port Phillip & Westernport CMA West Gippsland CMA | |
| SA | | Adelaide & Mt Lofty Ranges NRM Board Eyre Peninsula NRM Board, Kangaroo Island NRM Board, SA Murray Darling Basin NRM Board, Northern & Yorke NRM Board, South East NRM Board | |
| WA | South West Catchments Council | Northern Agricultural Catchments Council, Perth (Swan) Region NRM South Coast NRM, Wheatbelt (Avon) NRM | |

It is important to note that the results may not be an accurate representation of the involvement of all the NRM organisations in nutrient management as all the required information may not have been available at the time of collating the current report. Despite this, the assessment does provide an indication of the importance placed on nutrient management by the majority of NRM organisations reviewed.

The NRM regions that are most actively promoting nutrient management have an environmental asset or waterway of significance within their region that is being impacted upon by high nutrient loads. This is the case for the Glenelg Hopkins CMA and the NRM Boards in the South West Catchment Council area of south west WA. In NSW the Sydney Catchment Authority in NSW provides funding for nutrient management extension programs across multiple CMAs. On-farm nutrient management is promoted to minimise nutrient loss, mitigate impact on environmental assets while aiming to ensure efficient agricultural production.

In the last decade most soil programs administered by the NRM organisations have been aligned to the national and state priorities, which have focused on salinity, soil health parameters, erosion mitigation and soil carbon rather than nutrient management or nutrient use efficiency. In NRM regions where nutrient management is not a priority, investment in on-ground activities has been minimal. This includes many of NSW CMAs on the western slopes of the Great Dividing Range where extensive agriculture enterprises dominate often at some distance from primary watercourses.

The activity and involvement in nutrient management assessed in Table A.9 also provides an indication of the level of importance, perception and understanding of nutrient management by livestock producers in each of the NRM regions. This is supported by the assessment of management practices and the extension programs and resources currently available for producers as discussed in Section 3.3.4 It is clear not all livestock producers have been exposed to or have had the opportunity to participate in programs that deliver the latest evidence-based information on nutrient management and nutrient use efficiency in grazing systems.

**Reference list**

Anon (2008a) *The Water Quality Improvement Plan (WQIP) for the Rivers and Estuary of the Peel-Harvey System - Phosphorus Management (2008).* Environmental Protection Authority. http://www.epa.wa.gov.au/EPADocLib/Peel_Harvey_WQIP151208.pdf (accessed 1.08.2012)

Anon (2008b) *Murrumbidgee CMA Catchment Action Plan (2008)* http://www.murrumbidgee.cma.nsw.gov.au/downloads/pdf_docs/MCMA009_CAP_Web_P1_01.pdf (accessed 1.09.2012)

Bayley G and Brooksby T (undated) Soil - Fact Sheet *Phosphorus*. SA Government and South East Natural Resources Management Board http://senrm.sa.gov.au/Portals/10/PDF/saltland/Soil%20FSheets/Mackillop%20Phosphorus%20Hand%20Out.pdf (accessed 13.02 2013)

Gourley CJP, Melland AR, Waller RA, Awty IM, Smith AP, Peverill KI and Hannah MC (2007) *Making better fertiliser decisions for grazed pastures in Australia*. Victorian Government Department of Primary Industries. pp.20. http://www.asris.csiro.au/downloads/BFD/Making%20Better%20Fertiliser%20Decisions%20for%20Grazed%20Pastures%20in%20Australia.pdf. (accessed 1.08.2011)

## 7.3 Appendix 3 - The online producer survey


# WELCOME TO THE NUTRIENT MANAGEMENT IN PASTURES - *PHOSPHORUS SURVEY*

*Once you have completed and submitted the survey it will be taken to mean that you have consented to be part of this study. Your participation in this survey is completely voluntary and if you decide not to continue with the survey you can withdraw at any point.*

Note: *Questions marked with an asterisk * must be answered to complete the survey*

THE FARM OPERATION

1. What position do you hold in the farm business?
   a) Owner not actively involved
   b) Owner - Manager
   c) Manager
   d) Other (please specify) _____

2. For how many years have you managed and / or owned the business

[ ] years

3. *What is the location of your main farm? Please enter your *postcode* in the box below. For farm businesses with more than one farm, please give the postcode for the farm which supports the highest livestock numbers over the whole year.

[ ]

4. What is the total area (hectares) operated by your farm business? This includes the total area of all farms that are owned, managed or leased, etc. by your business.

[ ]

5. Is your farm business your primary source of income?
   a) Yes
   b) No
   c) Not sure

6. What are your future plans for your farm business? *(Please select only one response)*
   a) Currently expanding the business
   b) Will expand the business as funds become available

c) Plan to retire, sell out or lease farm out in the short term (i.e. in the next 5 years)
d) Plan to retire, sell out or lease farm out in the longer term (i.e. in the next 5 - 10 years)
e) Not planning to change in the short term (i.e. in the next 5 years)
f) Not planning to change in the longer term (i.e. in the next 5 - 10 years)
g) Stay in agriculture but move out of livestock production
h) Other (please specify) _____

7. *Which of the following best describes your farm enterprise mix?
a) Mixed farming - approximately half cropping, half livestock
b) Crop dominant mixed farming
c) Livestock dominant mixed farming
d) Livestock production with minor cropping program (for grazing and a small proportion harvested for seed and on-farm use)
e) Livestock only

8. For an average year, please estimate the percentage of gross farm income for each of the enterprises that make up your farm business.

| | Percentage (%) contribution to gross farm income |
|---|---|
| Beef cattle | |
| Meat sheep | |
| Dual purpose meat and wool sheep | |
| Wool production | |
| Grain | |
| Fodder | |
| Dairy | |
| Other | |

9. What is the stocking rate of your main farm? Please estimate the average DSE/ha carried over the whole year. If you have a large grain cropping area, ignore this in your stocking rate estimation.
a) Less than 2.5 DSE/ha
b) 2.5 - 5 DSE/ha
c) 5 - 7.5 DSE/ha
d) 7.5 - 10 DSE/ha
e) 10 - 15 DSE/ha
f) 15 - 20 DSE/ha
g) 20 - 25 DSE/ha
h) More than 25 DSE/ha
i) I'm not sure

10. Compared to the district average, is your current stocking rate:
a) Higher than the district average
b) Lower than the district average
c) About the same as the district average
d) I'm not sure

11. Do you aim to change your stocking rate during the next five years?
    a) Increase stocking rate
    b) Reduce stocking rate
    c) Keep stocking rate about the same
    d) I'm not sure

12. What pasture types are on your farm(s) and what is the percentage contribution of each of these types to the total pasture area?

| | Percentage (%) of total pasture area |
|---|---|
| Native pasture | |
| Fertilised native (includes naturalised and / or introduced species) | |
| Naturalised annual pasture (not sown and no perennial species, with or without legumes) | |
| Sown annual pasture species (no perennial species, with or without legumes) | |
| Sown short-term perennial-based pasture species (<3-5 year pasture phase; may also include annual species) | |
| Sown long-term perennial-based pasture species (>5 year pasture phase; may also include annual species) | |
| Timbered grazing area | |
| Forage crops | |
| Other | |

13. Approximately how long is the typical length of the growing season for the pasture?

*To work this out, estimate the number of consecutive months in a year when there is green feed (that is, from break of season to brown pasture)*
    a) less than 5 months per year
    b) 5 months per year
    c) 6 months per year
    d) 7 months per year
    e) 8 months per year
    f) 9 months per year
    g) 10 months per year
    h) 11 months per year
    i) 12 months per year
    j) Not sure

14. How do you rate the level of each of the following for the main soil type on your farm(s) i.e. the soil of the land management unit which is most important to your livestock operation.

| | Very Low | Low | Adequate | High | Very High | Not Sure |
|---|---|---|---|---|---|---|
| Phosphorus | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ |
| Nitrogen | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ |
| Sulphur | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ |
| Potassium | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ |
| Carbon | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ |
| pH | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ |

15. Whether you use soil testing or not, do you agree or disagree with the following statements?

| | Strongly Disagree | Disagree | Not Sure | Agree | Strongly Agree |
|---|---|---|---|---|---|
| I don't need soil tests because my local advisor knows my farm | ❑ | ❑ | ❑ | ❑ | ❑ |
| I don't need soil tests because I know the approximate soil test values for the soils in my area | ❑ | ❑ | ❑ | ❑ | ❑ |
| I have records of product removal and nutrient inputs so I don't need soil tests | ❑ | ❑ | ❑ | ❑ | ❑ |
| I don't need to use soil tests because I know my farm | ❑ | ❑ | ❑ | ❑ | ❑ |
| I manage my pasture nutrition by how the pastures look | ❑ | ❑ | ❑ | ❑ | ❑ |
| The number of paddocks I have tested is limited by the cost of the tests | ❑ | ❑ | ❑ | ❑ | ❑ |
| Soil testing provides me with valuable information | ❑ | ❑ | ❑ | ❑ | ❑ |

16. Do you use soil testing?
a) Yes
b) No *(Please go to question 33)*

17. Please select the years soil testing was undertaken. *(You may select more than one response)*
a) 2012
b) 2011
c) 2010
d) 2009
e) 2008
f) Soils tested in one or more years before 2008
g) Not sure

18. Has the number of soil tests you do annually changed in the last 5 years?
a) Increased
b) Decreased
c) No change
d) Unsure

19. *For which pasture types do you usually have soil tests done? *(Please select all of the pasture types you test)*
a) Native pasture
b) Fertilised native (includes naturalised and / or introduced grasses)
c) Fertilised native (includes naturalised and / or introduced legumes)
d) Naturalised annual pastures (i.e. not sown and no perennial species, with or without legumes)
e) Sown annual pasture species (no perennial species, with or without legumes)
f) Sown short-term perennial-based pasture species (<3-5 years); may also include annual species
g) Sown long-term perennial-based pasture species (>5 years); may also include annual species
h) Timbered grazing area

i) Forage crops
j) Other (please specify) _____

20. Which of the following describes how often you soil test paddocks?
a) I test representative paddocks every year
b) I test representative paddocks every 2-3 years
c) I test representative paddocks approximately every 4-5 years
d) I test less frequently than above

21. Which of the following best describes when you have soils tested? *(You may select more than one response)*
a) I test paddocks before I re-sow them with pastures
b) I test at the beginning of the cropping phase, coming out of the pasture phase
c) I test established pastures
d) I test the most productive paddocks
e) I test non-performing paddocks
f) Other (please specify) _____

22. *How do you use the various components of your soil tests? *(Please select all that apply)*

| Test measure | I am not interested in this measure | I use this measure to regularly monitor changes over time | I use this measure to check levels |
|---|---|---|---|
| pH | ❑ | ❑ | ❑ |
| Aluminium | ❑ | ❑ | ❑ |
| Phosphorus | ❑ | ❑ | ❑ |
| Nitrogen | ❑ | ❑ | ❑ |
| Sulphur | ❑ | ❑ | ❑ |
| Potassium | ❑ | ❑ | ❑ |
| Carbon | ❑ | ❑ | ❑ |
| Trace elements | ❑ | ❑ | ❑ |

23. What do you estimate is the soil test result that best represents the Phosphorus (P) level on the land management unit that is most important for your livestock enterprise? *(Please enter the P soil test result in the box below. If you are unsure of the answer, please enter 'not sure')*

24. Please select the soil test method you refer to above.
a) Colwell (mg P/kg)
b) Bray (mg P/kg)
c) Olsen (mg P/kg)
d) Not Sure
e) Not Relevant
f) Other (please specify) _____

25. What is the approximate Phosphorus Buffering Index (PBI) value of this soil?
    a) Less than 15
    b) 15-35
    c) 36-70
    d) 71-140
    e) 141-280
    f) 281-840
    g) More than 840
    h) Not sure

26. Do you know the name of the soil testing service you last used?
    a) Yes
    b) I'm not sure, my soil tests were organised by my rural supply agent *(Please go to question 28)*
    c) I'm not sure, my soil tests were organised by my fertiliser supplier *(Please go to question 28)*
    d) I'm not sure, I can't remember their name *(Please go to question 28)*

27. Which of the following soil testing services did you use last time you had soils tested? *(You may select more than one response)*
    a) Aglab Services Pty. Ltd.
    b) AgVita Analytical
    c) Analytical Reference Laboratory (WA)
    d) Australian Laboratory Services - Brisbane Lab
    e) Australian Perry Agricultural Laboratory Pty. Ltd.
    f) BSES Limited
    g) ChemCentre
    h) CSBP Soil and Plant Analysis Laboratory
    i) East West EnviroAg
    j) Environmental Analysis Laboratory (EAL), Southern Cross University
    k) EP Analysis
    l) Farmright
    m) Hortus Technical Services
    n) Nutrient Advantage Laboratory (Incitec Pivot)
    o) Lanfax Laboratories
    p) Mark Wainwright Analytical Centre - University of NSW
    q) Nutrilab Pty. Ltd.
    r) Phosyn Analytical
    s) SGS Agritech
    t) State Department soil testing laboratories
    u) SWEP Analytical Laboratories
    v) Tweed Laboratory Centre
    w) University of Melbourne School of Forest and Ecosystem Science
    x) University of Western Australia, School of Earth and Environment
    y) Waite Analytical Services
    z) Other (please specify)

28. Some soil testing laboratories are audited for quality control and may be certified with the Australasian Soil and Plant Analysis Council Inc. (ASPAC) or accredited with the National Association of Testing Authorities (NATA).

Do you know if the soil testing laboratory used by your testing service has NATA accreditation?
    a) Yes
    b) No

29. Do you know if the soil testing laboratory used by your testing service is ASPAC certified?

a) Yes
b) No

30. How important are the following factors to you in deciding which soil testing service you use?

| | Not Important At All | Not Important | Not sure | Important | Very Important |
|---|---|---|---|---|---|
| Certification with Australasian Soil and Plant Analysis Council Inc. (ASPAC) | ❑ | ❑ | ❑ | ❑ | ❑ |
| Accreditation with National Association of Testing Authorities (NATA) | ❑ | ❑ | ❑ | ❑ | ❑ |
| The recommendation of my private consultant | ❑ | ❑ | ❑ | ❑ | ❑ |
| The recommendation of another farmer | ❑ | ❑ | ❑ | ❑ | ❑ |
| The recommendation of a family member | ❑ | ❑ | ❑ | ❑ | ❑ |
| The recommendation of the rural merchandise store | ❑ | ❑ | ❑ | ❑ | ❑ |
| The recommendation of the fertiliser agent | ❑ | ❑ | ❑ | ❑ | ❑ |
| The convenience of the service | ❑ | ❑ | ❑ | ❑ | ❑ |
| The cost of the soil test package | ❑ | ❑ | ❑ | ❑ | ❑ |

31. Who explains your soil test results to you? *(You may select more than one response)*

a) I am able to interpret the results myself
b) My consultant
c) A state government department advisor
d) My rural merchandise store / sales agronomist
e) A family member or another member of the business
f) Other farmers
g) A soil testing company
h) My fertiliser agent
i) Other (please specify) _____

32. Does anyone provide you with fertiliser or nutrient management recommendations based on the results of your soil test? *(You may select more than one response)*

a) Yes
b) I am able to make fertiliser and nutrient management decisions myself, based on the soil test results *(Please go to question 36)*
c) No *(Please go to question 36)*

33. *Who provides you with fertiliser recommendations? *(You may select more than one response)*

a) My consultant
b) A state government department advisor
c) My rural merchandise store / sales agronomist
d) A family member or another member of the business
e) Other farmers

f) A soil testing company
g) My fertiliser agent
h) I am able to work out fertiliser requirements myself *(Please go to question 36)*
i) No one, I do not ask for advice on fertiliser *(Please go to question 36)*
j) Other (please specify) _____

34. When you receive a fertiliser or nutrient management recommendation, what do you usually do as a result of that recommendation?

| | Never | Sometimes | Most of the time | Always | Not Relevant |
|---|---|---|---|---|---|
| The fertiliser I apply to my pastures is the type that has been recommended to me | ❑ | ❑ | ❑ | ❑ | ❑ |
| The fertiliser I apply to my pastures is at the rate that has been recommended to me | ❑ | ❑ | ❑ | ❑ | ❑ |
| I apply what I can afford to | ❑ | ❑ | ❑ | ❑ | ❑ |

35. If none of the above match your situation, please explain how you respond to recommendations in the box below. Please skip this question if it is not relevant to you.

36. Even if you do not use fertiliser on pastures, please respond to the following statements about the use of fertilisers on pastures. By fertiliser we mean both conventional forms such as superphosphate, as well as non-conventional products such as manures, composts and microbial agents.

| | Strongly Disagree | Disagree | Not Sure | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Fertiliser is a major cost in my pasture management program | ❑ | ❑ | ❑ | ❑ | ❑ |
| The high cost of fertiliser means that I no longer apply fertiliser to pasture | ❑ | ❑ | ❑ | ❑ | ❑ |
| The high cost of fertiliser means that I prioritise the paddocks that are fertilised | ❑ | ❑ | ❑ | ❑ | ❑ |
| There is no evidence of an economic return from fertilising pastures in my district | ❑ | ❑ | ❑ | ❑ | ❑ |
| My soils are naturally high in nutrients and I don't need to apply fertiliser | ❑ | ❑ | ❑ | ❑ | ❑ |
| Production from some paddocks is enough to support my livestock system so I do not apply fertiliser to these at present | ❑ | ❑ | ❑ | ❑ | ❑ |
| Conventional fertilisers contain impurities that I do not want to add to the soil | ❑ | ❑ | ❑ | ❑ | ❑ |
| I apply specific nutrients, such as phosphorus, and I apply a product that matches the needs of my soils | ❑ | ❑ | ❑ | ❑ | ❑ |
| I do not have to add fertiliser and instead use natural methods to make the nutrients in the soil available to the pasture | ❑ | ❑ | ❑ | ❑ | ❑ |

37. *Do you apply fertilisers (either conventional or non-traditional products) to pastures?

a) Yes
b) Not at present, but expect to in the future - my current pasture production exceeds stock needs and I am running down soil nutrient levels
c) No, the nutrients I apply during the cropping phase are sufficient to carry over to the pasture phase *(Please go to question 40)*
d) No, never *(Please go to question 47)*

38. Which fertilisers, soil additives or non-traditional products do you apply to your pastures? *(You may select more than one response)*

a) Single superphosphate
b) Double super
c) Triple super
d) MAP
e) Nitrogen
f) Potash
g) Molybdenum
h) Copper
i) Zinc
j) Cobalt
k) Dolomite
l) Lime
m) Gypsum
n) Rock phosphate
o) Humic product
p) Animal manure (e.g. poultry litter)
q) By-products (e.g. compost)
r) Crushed rock minerals
s) Others (please specify)

39. *The following statements relate to how you decide which paddocks to fertilise. Do you agree or disagree with the following statements?

| | Strongly Disagree | Disagree | Not Sure | Agree | Strongly Agree |
|---|---|---|---|---|---|
| I have no set strategy | ❑ | ❑ | ❑ | ❑ | ❑ |
| I am guided by soil test results | ❑ | ❑ | ❑ | ❑ | ❑ |
| I fertilise if the pasture looks as though it needs it | ❑ | ❑ | ❑ | ❑ | ❑ |
| I am guided by the recommendations of my advisor | ❑ | ❑ | ❑ | ❑ | ❑ |
| I am guided by the stocking rate of each paddock | ❑ | ❑ | ❑ | ❑ | ❑ |
| All pastures are fertilised to balance inputs with nutrient removal | ❑ | ❑ | ❑ | ❑ | ❑ |
| I have an annual fertiliser budget and fertiliser costs dictate my fertiliser program | ❑ | ❑ | ❑ | ❑ | ❑ |
| I purchase fertiliser when I need a tax off-set | ❑ | ❑ | ❑ | ❑ | ❑ |
| I fertilise when I can afford to | ❑ | ❑ | ❑ | ❑ | ❑ |

40. Is managing soil phosphorus a priority in your fertiliser program?
a) Yes
b) No *(Please go to question 42)*

41. * Which of the following statements best describes your phosphorus management program? *(You may select more than one response)*
a) I don't have a set phosphorus management program
b) I aim to lift phosphorus level to a critical target value across all pasture paddocks
c) I am currently running down high soil phosphorus levels
d) I use the rule of thumb 'one kilogram of phosphorus per dry sheep equivalent'
e) According to an old rule of thumb, I apply single superphosphate to pasture paddocks at a rate of about 125kg/ha (one hundred weight to the acre)
f) Phosphorus application rates are the same across all pasture paddocks every year
g) Phosphorus application rates are adjusted according to soil test information
h) The livestock enterprise must show a return on investment from phosphorus, this dictates my phosphorus program
i) Other (please specify) _____

42. Have you changed your pasture fertiliser program during the past 5 years?
a) No, I apply a similar amount of fertiliser to a similar plan *(Go to question 44)*
b) I have reduced my fertiliser application
c) I have increased my fertiliser application
d) I apply a similar total amount of fertiliser, but I am more strategic in my fertiliser application

43. When you changed your pasture fertiliser program, how important were the following factors in your decision to change?

| | Not Important At All | Not Important | Not Sure | Important | Very Important | Not Relevant |
|---|---|---|---|---|---|---|
| Increased understanding of the benefit of fertiliser to pasture production | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ |
| Surplus feed due to understocking and / or good seasons | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ |
| Reduced pasture area due to increased cropping area | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ |
| High fertiliser prices - buying less | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ |
| Soil test results | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ |
| Increased understanding of nutrient requirements of the different soil types on my farm | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ |
| Increased understanding of varying nutrient requirements of the different pastures on my farm | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ |
| Money needed to be spent in other parts of the farm operation | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ |
| Money allocated to other priorities | ❑ | ❑ | ❑ | ❑ | ❑ | ❑ |

44. When applying fertiliser, do you take into account the following considerations:

| | Never | Sometimes | Most of the time | Always | Not relevant |
|---|---|---|---|---|---|
| Apply fertiliser where plant material (green and dead) covers more than 70 per cent of the soil surface | ❑ | ❑ | ❑ | ❑ | ❑ |
| Maintain a buffer zone between fertilised areas and waterways and drainage lines | ❑ | ❑ | ❑ | ❑ | ❑ |
| Split fertiliser applications e.g. half in autumn and half in spring | ❑ | ❑ | ❑ | ❑ | ❑ |
| If phosphorus levels are close to the upper soil test figure, I aim to manage application rates so that the level does not increase to above this | ❑ | ❑ | ❑ | ❑ | ❑ |
| Delay fertiliser applications if impending rain is likely to cause run-off | ❑ | ❑ | ❑ | ❑ | ❑ |
| Delay fertiliser applications if waterlogging is likely to be an issue | ❑ | ❑ | ❑ | ❑ | ❑ |

45. Are you aware of the FertCare training and accreditation programme for advisors?

a) Yes
b) No *(Please go to question 47)*
c) Not Sure *(Please go to question 47)*

46. Is the person providing you with fertiliser recommendations FertCare accredited?

a) Yes
b) No
c) Not Sure
d) I don't have an advisor

47. In recent years there has been growing interest in non-traditional products as a means of improving soil conditions. These non-traditional products include manures, by-products and composts. We would like to know your views on non-traditional products. Do you agree or disagree with the following statements:

| | Strongly Disagree | Disagree | Not Sure | Agree | Strongly Agree |
|---|---|---|---|---|---|
| Non-traditional products used in conjunction with conventional fertilisers provide balance to improve soil condition / health | ❑ | ❑ | ❑ | ❑ | ❑ |
| Non-traditional products improve soil condition / health | ❑ | ❑ | ❑ | ❑ | ❑ |
| Non-traditional products are a more natural way to improve soil condition | ❑ | ❑ | ❑ | ❑ | ❑ |
| Some non-traditional products contain microbes that will benefit the soil | ❑ | ❑ | ❑ | ❑ | ❑ |
| Non-traditional products are a suitable substitute for conventional fertilisers | ❑ | ❑ | ❑ | ❑ | ❑ |
| Non-traditional products can substitute for conventional fertiliser if they are cost-effective to apply | ❑ | ❑ | ❑ | ❑ | ❑ |
| Before trying non-traditional products, I find out the nutrients present in the product and | ❑ | ❑ | ❑ | ❑ | ❑ |

| | | | | | |
|---|---|---|---|---|---|
| the concentration of those nutrients | | | | | |

48. During the next 5 years, do you plan to change the amount of non-traditional products you apply?

a) I don't use non-traditional products
b) Yes, I plan to use more non-traditional products during the next 5 years
c) Yes, I plan to use less non-traditional products during the next 5 years
d) No, I plan to use about the same amount of non-traditional products during the next 5 years
e) I'm not sure

49. Are there any other comments you would like to make regarding non-traditional products?

a) Yes
b) No *(Please go to question 51)*

50. Please enter your comments regarding non-traditional products in the space below.

51. The amount of information being delivered to producers is extensive. How would you like to receive information on nutrient management in pastures? *(You may select more than one response)*

a) I rely on my advisor to keep up to date with information
b) Factsheets - hard copies
c) Factsheets - electronic copies
d) Half-day workshops
e) Comprehensive workshop spread over a number of days
f) Field days
g) On-line training programs that you can work through at your own speed
h) Computer Decision Support Systems
i) Other (please specify) _____

52. What is your age?

a) Less than 25 years
b) 25-35 years
c) 36-50 years
d) 51-60 years
e) 61-70 years
f) More than 70 years

The main part of the questionnaire is now complete. Your contribution to MLA's Phosphorus Use Efficiency Program is very much appreciated. The information will assist in developing future strategies to improve nutrient management in the grazing systems of southern Australia.

53. Do you agree to being contacted in the next 6 months for a follow-up to gather more information on your nutrient management program for pastures?

a) Yes, I am prepared to give my contact details
b) No, I would not like to be contacted *(Please go to question 55)*

54. Phone Number:

Email:

55. Would you like to enter the draw to win one of two $500 Gift Vouchers?

a) Yes please - I have already given my contact details *(survey complete - thank you for completing this survey)*
b) Yes please - but I need to give my contact details *(Please go to question 56)*
c) No thanks *(survey complete - thank you for completing this survey)*

56. Phone number:

Email:

*Thank you very much for completing this survey.*

## 7.4 Appendix 4 - Advisor consultation process

Fifty-two (52) advisors, including independent consultants, retail agronomists aligned to rural suppliers or fertiliser companies and public sector advisory officers were interviewed. Jim Shovelton conducted interviews with 13 advisors operating in VIC, with the balance interviewed by Helen Burns. Advisors interviewed were selected to ensure geographical spread, range of affiliations and years of experience in an advisory role. To ensure consistency across all interviews, a semi-structured interview technique was used, and the same core questions were asked of all advisors. The same background information relating to the project and purpose of the interview was provided to all interviewees and the same core questions were asked:

- Provide some background information on the agricultural production systems in the area serviced – including description of pasture types.
- What are the current nutrient management practices of producers you service – including soil testing programs (also seek comment on practices of wider population in that area)?
- What is your opinion of the level of understanding of nutrient management of pastures among your clients (and the wider population)? Interviewees were asked to identify the gaps.
- What information sources do you rely upon to build your knowledge and understanding of nutrient management of pastures? What resources would assist be of value to you?

Additional questions were asked depending on responses to these core questions and these were individualised depending on the nature and detail of responses. This allowed the line of questioning to identify those issues that were considered to be important to the interviewee.

The line of questioning relating to the broad themes is set out below:

**What is your view on current fertiliser practices – what is actually happening on the ground?**

- What are the main livestock enterprises across region?
- Main pasture types – approximate percentage?
- What is the length of growing season (Tablelands - Slopes)
- What do you see as the major nutrient limitations of pasture in your region?
- What fertiliser is applied and to what pastures? Do producers use fertiliser as a blanket treatment or are they strategic in their decisions? Has this changed over time?
- How frequently, at what rate
  - How does practice (ie fertiliser applications) compare with what you consider is the relative importance of various nutrients – are some essential nutrients being ignored – if so, why?
- What is the basis for the fertiliser decisions?
- Where does nutrient management (esp P) sit on your clients' hierarchy of priorities when aiming to optimise profitability of the livestock enterprises?

**Current use of soil testing by your clients**

- Soil tests - who uses?
- Sample density and frequency per client? Has this changed in the last 5 years What paddocks are selected to be tested?
- What do they do with the soil analysis – what does it inform?
- What agencies do clients use for soil testing – is there a trend?
- Do you know if recommendations are followed – if so how closely are the recommendations followed – if not closely followed, why?

**Knowledge of producers and their information sources**

- What do you consider is the range in producers' level of understanding of nutrient management?
- What are the gaps?
- Have you an opinion on the level at which the information provided by the public and private sector is pitched – (is it recipe focus or is the aim to build understanding)? Is there an assumption of a certain level of comprehension in the information available? Is it pitched at the right level?
- What resources, back-up or supporting information or resources do you need to support your advice and to improve nutrient use efficiency in livestock production systems?
- Would you suggest some lead producers who I should contact?

**Where do you get information about nutrient management?**

- What information resources do you consider most valuable in building knowledge/understanding of staff? – recommend to your staff?
- What are the information gaps and/or tools that would assist you in facilitating practice change to improve nutrient use efficiency?

## 7.5 Appendix 5 - Segmentation of livestock producers

Segmentation of the broad livestock producer population is required to appreciate the many factors affecting attitude to nutrient management of pastures and production targets. It is also important to consider when developing extension programs that focus on the 'hooks' and 'triggers' needed to prompt practice change among each segment.

The focus groups and interview processes indicated that different market segments exist for the red meat industry's perspective on nutrient management based on (i) enterprise focus and (ii) attitude to information. This study and historical reports (Trompf et al, 1998, Scott and Cacho, 2000, Karunaratne and Barr, 2001, Schroder, 2001, Shrapnel and Davie, 2001, Maguire and Cartwright, 2008 and Wilkinson, Barr and Hollier, 2011) identified differences between the segments of the producer population in their attitude to information and learning, and inclination, capacity and opportunity to access and translate key principles into knowledge.

**The enterprise perspective**

For each livestock production enterprise there is a lag between a particular nutrient management decision and action (e.g. milk or crop yield, weight gains, lambing or calving percentage or wool yield) and the financial consequence. Assuming soil fertility levels are marginal, the timeframe for economic feedback on sound or poor nutrient management decisions is likely to be most rapid for dairying, followed by cropping, red meat production (vealer and prime lamb production provide more rapid feedback than weaner production), with wool production the least sensitive.

In reality, the ability to read market signals depends on the experience of the producer and/or ability to measure or recognise precursors such as daily weight gain or condition score and to detect factors that will impact on market signals such as pasture growth rates and pasture quality. Those producers able to recognise indicators or detect signals are likely to have a better understanding of soil fertility, pasture and livestock interactions and have the confidence and capacity to make timely and informed tactical decisions when conditions change. This is significant given the uncertain climatic and financial environment caused by a combination of drought, volatile livestock prices, the upward trend in fertiliser prices and poor cash flow.

The majority of producers respond to a poor cash flow situation by cutting fertiliser inputs (Scott and Cacho, 2000), as discussed in Section 3.3.2 (page 21). The study indicates that this is a real farm business viability risk for producers who do not appreciate the economic ramifications of soil fertility on key livestock production indicators. Where fertiliser inputs have been cut in response to a poor cash flow situation and P reserves are being 'run down', these operations may fall into the cycle of *'creeping decline in soil fertility'* or *'downward spiral of production'* referred to by advisors interviewed for this study, in which production targets are readjusted down as P levels and pasture production potential fall.

Those red meat producers with a significant cropping enterprise are more attuned to soil fertility levels than their grazier counterparts (R Smith, 2012 and N Phillips pers. comm.) and are more likely to have a good understanding of the dynamics of soil P levels and the impact of product removal on soil fertility status.

When developing extension packages it is important to recognise the differing levels of understanding that producers have of key principles essential to achieve efficient nutrient use. Similarly, training packages for advisors must account for differing levels

of experience and understanding. Experienced producers and advisors confident in their knowledge of nutrient management emphasised the importance of systematic measuring, recording and monitoring in building capacity to recognise and detect market signals, with 'hands-on' field experience ideal for developing confidence in strategic planning and tactical decision making.

**Producer attitude to information**

A characteristic of producers that became obvious during the consultation process was their attitude to information and the importance that they placed on learning and building their knowledge stocks. Segmentation on this basis is important as the study clearly indicates that a proportion of producers have an expectation that simple guidelines and recipes are sufficient to guide practices that ensure long-term sustainability of their operation. However, it is clear that learning and understanding of dynamics and complexity of the extensive grazing systems is required to achieve production efficiency that ensures business viability. This study highlighted the differences in segments of the producer population in their attitude to learning, clearly identifying a significant proportion who rely on reinforcement of key principles as a surrogate to learning and who, according to Schroder (2001), 'require continued involvement' to promote adoption of new technologies.

The study identified four broad producer groups: 'Intensive', 'Extensive', 'Static' and 'Non-receptive' which have similarities to the segmentations proposed by Trompf et al (1998), Schroder (2001), Shrapnel and Davie (2001), Karunaratne and Barr (2001) and Wilkinson et al (2011). The groups are not well defined and producers are likely to move from one to another, depending on inclination and opportunities. The breakdown is also likely to vary depending on the basis used for segmentation, for example producers specifically interested in animal genetics may be aligned to the Intensive group when the focus is genetics, but may fall into the Extensive or Static group for this study if pasture nutrition is not seen as an important driver of the business.

The study indicates that there is limited interaction at a technical level between the various peer groups as described by Schroder (2001) and so the 'trickle-down effect' is unlikely to result in significant transfer of information (explicit knowledge) or experience (tacit knowledge) between the groups. Most producers have not participated in technical extension programs relating to nutrient management, do not understand the key principles and are not familiar with technical terms (and jargon) used by their more informed peers. Given that nutrient management is just one component of the very complex extensive grazing system, those producers who lack understanding of the key principles will not adopt new strategies unless they are presented in the context of the production system and in a language with which they are familiar.

The importance of peer groups and the preferred learning environments of each group are important to consider. Shrapnel and Davie (2001) proposed that most producers do not respond well to a group learning environment. While Schroder (2001) discounted the 'trickle-down effect' for the facilitation of practice change in complex systems, he stressed the need to recognise the influence of peers. This study suggests that the peer group affect should be factored into extension or learning activities. Feedback from producers engaged in the current study indicates that a combination of respected peers and technical expertise is very effective in creating awareness and building the foundations for practice change. The tiered extension approach presented in Section 5.2 is based on these findings.

It is beyond the scope of this study to investigate the proportion of red meat producers in each group, although experienced advisors were asked to provide an assessment of the breakdown of livestock producers they deal with. Characteristics of the proposed groups and approximate breakdown are presented below and summarised in Table A.10.

**The Intensive group** may comprise between 10-30% of producers, depending on the location, internet access, exposure to technical experts and opportunity to develop networks. They focus on efficiency of their production system, plan to expand (scale or production level) and have financial capacity to invest in the business. Fertiliser is viewed as a non-discretionary cost because they are able to quantify the impact of soil fertility on pasture response and hence their livestock production system, they measure business performance on a $/ha basis and have a relatively high level of pasture utilisation.

Producers in this group actively seek information and have the inclination, capacity and opportunity to achieve a high level of understanding of technical detail. They demonstrate an enthusiasm and willingness to develop information networks and invest in intellectual capital with an enthusiasm that is markedly different to producers in the other groups. Investment may be in time to build up their own intellectual capital or investment in the intellectual capital of an expert (i.e. employ a consultant), which they see is essential to achieve productivity efficiencies.

They are innovative, but are not necessarily early adopters, with many having the attitude of the of Growth Farms Australia CEO David Sackett (Graham Centre, 2012), preferring to adopt technologies once they have been proven and 'the risks taken out'. Most prefer to research new information themselves in areas of specific interest, often going to the primary source of data to draw their own conclusions, rather than relying on the interpretation of others. Consultants are employed to cover areas of less interest or in which they lack expertise. Even when using consultants, producers in this group aim to be sufficiently informed to know what questions to ask and maximise the contribution of their consultant.

They value interaction with their network of similarly focused peers in the Intensive group; they learn by their own research and adopt technology based on evidence. They value on-farm data and are motivated to monitor key production indicators, which results in a high level of confidence and good 'systems understanding'. They aim to be flexible and have the ability and confidence to make timely tactical decisions based on key performance indicators and drivers of their production system. This is essential if they are to achieve optimum return on investment, which may be considered to be an indication that producers in this group are 'risk takers'. However, most would not consider their management style risky as they are confident in their understanding of the system and their objective approach to management means that they pro-actively minimise risk, recognise and respond early to triggers and so avoid 'system collapse'.

Shrapnel and Davie (2001) associate attitude to risk with personality type, whereas this study suggests that knowledge stocks (tacit and explicit) should be considered in discussion of risk, particularly with respect to management of complex systems.

Karunaratne and Barr (2001) suggest that 'intensive graziers have a good understanding of their farming system and the driving forces for their system's profitability'. Producers interviewed suggested confidence in nutrient management decisions is the product of good understanding of the economic benefits of nutrient management, monitoring, anticipating challenges and knowing what to expect

through the use of predictive information sources (e.g. climate and commodity prices) and how to respond when the reality deviates from expectation. Producers refer to extension programs that were the 'building blocks' of their knowledge (Triple P Program, Prograze®) suggesting that these programs are prerequisite learning components for producers aiming to optimise nutrient management of pastures. Not only did these courses provide an understanding of the foundation principles (e.g. the link between soil fertility and stocking rate) but also the hands-on experience (including measuring, monitoring and data collection) and the capacity to read signals that trigger a response and confidence in the repeatability and their ability to predict outcomes of various tactics.

**The Extensive group** represent 20 to 30% of producers. This is a very diverse group, which includes producers from the Intensive group who have adopted more conservative production targets as they move toward retirement. Some next generation producers are also in this group: they are likely to be information seekers, but lack understanding and experience in extensive grazing systems, so are on a steep learning curve. They intend to expand their business and appreciate the value of knowledge to optimise their business operation and may move into the Intensive group as they build their knowledge stocks through greater understanding of principles (explicit knowledge) and experience gained over time (tacit knowledge).

Also in this group are those producers who operate in what has been a historically safe climate and/or have a sound financial buffer. Such producers have not been vulnerable to uncertainty and have not needed a high level of management that requires understanding of triggers and indicators. However, the seasonal uncertainty and continuing decline in terms of trade has prompted some of these to look to change their approach to management and with that comes the need to improve understanding of their production system. They have potential to move into the Intensive group as they build their knowledge stocks.

Producers in this group actively seek advice from public sector or retail agronomists, but few pay for advice. They value interaction with their peers and although they attend field days and meetings, are often passive participants in a mixed audience, are often lost in the jargon and detail that is covered at technical events or are intimidated by more knowledgeable participants from the Intensive group. They are less likely to seek out research outputs and prefer summaries and evidence from regional R&D sites, as they lack depth of experience or confidence in their ability to interpret and adapt information to their own situation. Schroder (2000) suggests that they will learn by trying rather than researching themselves. They respond well to participatory learning that allows them to experience the impact of technology in their own environment, which serves to build tacit knowledge and provides data they have not had the skills (or perhaps the inclination) to collect.

Many producers in the Extensive group rely on trusted advisors or reputable technical experts to validate their decisions. They are confused by the volume of misleading information that they are exposed to and find it difficult to identify credible sources. While many are susceptible to confusion from multiple and varied information sources, they respond to scientific evidence when it is presented in a language they understand. Because they often lack experience or understanding of 'the system' they are likely to require more convincing and specific information than those in the Intensive group, to be convinced of the benefits of change (Johnson and Slovic, 1995). For example, a proportion of producers at the focus meetings indicated that change in nutrient management practices would only occur if they had access to economic data relevant to their own production system and local trial data.

The level of understanding and/or experience of pasture nutrient management among producers in this group means that they lack the confidence to make tactical decisions, often because they lack the on-farm data to recognise and respond to triggers. Therefore, many in this group tend to be reactive and, as reported by Schroder (2001), decisions are 'made in response to specific problem, so if no problem exists, the trend (is) to maintain the status quo'.

Individuals in this group have the potential to improve their profitability and viability, but this requires a higher level of understanding and management, and requires a conscious effort to invest in intellectual capital, either to build their own or to utilise that of others (i.e. employ a consultant). While some producers in this group may have participated in extension programs that provided some key principles (e.g. Triple P Program, Prograze®) these may have been forgotten or never applied (learnt). Many producers in this group do not understand foundation principles (e.g. link between soil fertility and stocking rate), and find the technical language alienating.

This group may be considered more risk averse than the Intensive group, but this may equate to lack of confidence and understanding of their system. The easy option is to set inputs and production targets in a conservative comfort zone that means they do not have to respond rapidly to changing circumstances: 'It is easy to be a complacent grazier' (P Schroder, 2001). The downside of this means they lack flexibility and are unlikely to be in a position to capitalise on opportunities.

**The Static group** may represent 20 to 30% of producers, who are similar to the Extensive group in many ways, but are more sceptical of science and high input systems and susceptible to pseudo-science messages. They are less likely to attend public field days, etc and prefer a one-on-one learning environment (Shrapnel and Davie, 2001) or in small groups of peers. They avoid events (social and educational) that are dominated by those in the Intensive group. They look for recipes and rules of thumb and do not respond if it is 'too academic'. They are likely to have opted for a conservative production system of low inputs and low production targets that allows them to maintain a status quo and traditional practices. As proposed by advisors consulted for this study, this group lack confidence, are unable to recognise triggers, so tend to be reactive to changing circumstances (e.g. climate, markets). They lack the knowledge to make tactical decisions and navigate through system challenges: the likely response is inaction, with many suffering from 'decision paralysis'.

Some producers in this group may be open to practice change, but need to see the benefits for themselves in their own district. They use $/DSE as a measure of performance, and see fertiliser as a cost, which is only applied when there is surplus cash. This has ramifications if this group is to be engaged. Fertiliser comes with connotations of cost without understanding of enterprise benefits. Therefore nutrient use efficiency needs to be sold as a solution to their poor cash flow situation.

**The Non-receptive group** may represent 20 to 30% of producers who are either very traditional or tend to reject science and favour the pseudo-science approach. Their information network is restricted to their 'community of interest' group.

**Table A.10.** Characteristics of the red meat producer population, based on a segmentation of their production focus and attitude to information regarding nutrient management of pastures

| **Producer segment** |
|---|
| **Intensive group (which represents approximately 10-30% of red meat producers)**<br>The key characteristics of this group include:<br>• Having a production focus is to optimise return on investments: benchmark performance of livestock enterprise on $/ha basis and maximisation of productivity*<br>• Using on-farm data to cost P on basis of kg of beef /ha – understand link between soil fertility and livestock production<br>• A systematic approach to soil testing, receptive to role of soil testing as a key decision support tool to monitor fertility status, matched to livestock production targets<br>• Considering that fertiliser is a non-discretionary cost – soil fertility is a driver of 'the system'†<br>• Having a high level of pasture utilisation* they recognise stocking rate is the driver of profitability<br>• Having plans to expand their business ‡<br>• A willingness to invest in intellectual capital as they actively seek learning opportunities and research in their areas of interest/expertise to build own knowledge **OR**<br>- pay a consultant for detail in areas of weakness<br>• Seeking advice from multiple sources – confidence in ability to ask pertinent questions<br>• Established linkages to a large technical network<br>• Involvement in research activities* and/or actively seeking primary sources of information (do not rely on others for interpretation of data) – only adopt technologies that are proven<br>• Having the confidence to apply remote evidence-based technologies (i.e. not reliant on regional RD&E)<br>• Valuing interaction with peers*<br>• Familiarity with technical terms relating to livestock, pasture production and soils<br>• Having a flexible and proactive* approach – they have the confidence in their knowledge to make difficult, timely tactical decisions<br>• Having on-farm data collected through a systematic measuring and monitoring program, which gives them the confidence in repeatability and predictability of outcomes from tactical responses<br>• Having confidence in their financial situation (either as a result of having a strong financial situation, or an awareness of return on investment of alternative options) ‡<br><br>**Extensive (which represents approximately 20-30% of producers)**<br>The key characteristics of this group include:<br>• Having a production focus which is benchmarked on the basis of $/DSE, with a ocus on animal health and condition*<br>• Lacking on-farm data to calculate return on investment from P<br>• Using soil testing sporadically – as a general rule, soil testing is usually used to diagnose problem paddocks<br>• Consider phosphorus fertiliser as a discretionary cost and they are likely to be one of the first inputs cut in response to poor cash flow†<br>• Having an understanding of the role of nutrients in pasture production, but they lack an appreciation of the level of response and consequently, they are unable to quantify the impact of fertiliser on livestock production<br>• Lacking the confidence to target high production systems<br>• Having a conservative approach to their stocking rate – their pasture utilisation is less than that of the Intensive group*<br>• Having a plan to their expand business‡<br>• Favouring the free service which is provided by retail agronomists and the public sector BUT if they are mixed farmers, they are more likely to pay for advice on the cropping component of their business<br>• Lacking the confidence to filtering scientifically sound information, and become confused by mixed messages so instead, thety tend to focus on trusted sources (if these are accessible) otherwise they are likely to revert to traditional practice<br>• Lacking the confidence in their knowledge to apply technology from outside the region; favour regional RD&E or seek support from their trusted network§<br>• Lacking on-farm data and the knowledge and experience to recognise triggers for management, |

leading to lower confidence so they tend to be reactive to a change in circumstances (such as climate variation, commodity prices)
- Being unlikely to attend large technical events[§]; their lack of understanding of technical detail and technical language is off-putting to them and this limits their learning outcomes,
- Favouring small discussion groups with peers which are pitched at a familiar level*; favouring a learning environment that is conducive to asking questions of clarification without feeling ignorant[§]
- Being keen participants in participatory research and action learning opportunities, but they are intimidated by groups dominated by producers from Intensive group;

**Static group (which represent approximately 20-30% of red meat producers)**
The key characteristics of this group include:
- Having a production focus which is benchmarked on the basis of $/DSE; animal health and condition are the priority for their business
- Consider that phosphorus fertiliser is a discretionary cost and thus it is likely to be one of the first inputs cut in response to poor cash flow[†]
- Not understanding the implication of phosphorus deficiency on their livestock production potential
- Being unlikely to use soil tests unless prompted by an advisor and these are usually used to diagnose problem paddocks
- Favouring soil testing services that provide comprehensive tests
- Favouring a one-on-one learning environment[§]; they are unlikely to attend public events which have a significant technical component
- Being confused by multiple information providers and mixed messages, thus, they are likely to revert to traditional practices
- Being susceptible to 'silver bullets' and simple pseudo-science messages, and are alienated by technical language
- Being sceptical of high input systems
- Lacking an understanding of the 'system' and key drivers of profitability[II]
- Having conservative production targets which allows them to maintain their traditional practices
- Attribute external factors (e.g. drought, commodity prices) for their difficulties[§]

**The non-receptive group (which represents approximately 20-30% of red meat producers)**
The key characteristics of this group include:
- Having a production focus which s benchmarked on the basis of $/DSE; animal health and condition are the priority
- Being sceptical of science
- Having a production focus which is predominantly based on low input systems
- Engaging in traditional practices
- Having a network which is confined to peers and communities of interest[*, #]

Adapted from: [*] Schroder (2001), [†] Scott and Cacho (2000), [‡] Wilkinson, Barr and Hollier (2011), [§] Shrapnel and Davie (2001), [II] Karunaratne and Barr (2001), [#] Maguire and Cartwright (2008)

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## 7.6 Appendix 6 - The uptake and use of decision support systems and best management practice guidelines

MLA invests in decision support systems (DSSs) as a means of providing options to producers to customise decision making using their own information. According to MLA's 2012-2015 Business Plan Summary for Producer Engagement, DSSs provide producers with a tool to access significant volumes of data in a form that can be used 'to make sound business decisions, manage challenges and capture opportunities to boost productivity and profitability'.

Understanding the factors that motivate producers to adopt DSSs as a recognised business management tool is part of the process for increasing their uptake and ensuring ongoing use. Through consultation with producers, researchers, advisors and industry representatives this study identifies strategies and features of DSSs that will improve adoption and use of these tools.

The study also aims to identify current best management practice guidelines (BMPs) for nutrient management of pastures and the underlying scientific principles that form their basis. Agreement among researchers, technical specialists and advisors on the interpretation of scientific data and the development of uniform and technically sound messages is part of facilitating the uptake of extension material and the adoption of practices that will improve nutrient use efficiency of pastures. This study aims to identify common ground, areas of contention and issues affecting uptake and adoption of 'best management practice' guidelines.

Key points:

- This study indicates that less than 10% of producers who were part of the survey use DSSs and the majority of producers (and advisors) involved in this study do not support investment in DSSs for nutrient management of pastures
- Most DSSs used by producers are simple calculator tools that inform a particular component of feedbase management decisions; very few producers who were part of this study use complex DSSs to inform nutrient management decisions.
- Having confidence in the accuracy of the inputs producers are required provide for the DSSs and Decision Support Tools (DSTs) is a major deterrent raised by many people at the focus meetings.
- Producers most likely to use DSSs are those more likely to have good internet access and speed and/or a support network of peers and/or technical expertise"
- Retail agronomists, particularly recent graduates, are the advisors most likely to use DSSs that inform nutrient management decisions. The DSSs are most likely to be of value when 'learning the trade'.
- DSSs developed by private industry and incorporating industry accepted soil test analyses-pasture response calibrations (Nutrient Advantage Advice®, SoilMate®, NUlogic®) are those most commonly used by advisors to inform nutrient management decisions.
- Most DSSs nominated by advisors do not integrate soil fertility, pasture production and livestock components. There is an expectation that advisors (and producers) have sufficient understanding of the factors that optimise nutrient use efficiency in extensive grazing systems to apply the DSS outputs and provide implications of management options.
- The Five Easy Steps DSS integrates the grazing system components, although its uptake is likely to be greater among advisors than producers.
- Industry self-regulation to ensure industry standards are embedded in all DSSs, BMPs and training programs targeting producers and advisors could be facilitated through an active National Networking Group of stakeholders. Effective functioning of such a group requires national coordination

- The critical soil test values presented by Gourley et al (2007) and the International Plant Nutrition Institute 4R Framework (Norton and Roberts, 2012) are embedded in the pasture nutrient management BMPs identified in this study that have been developed since 2007.
- BMPs are not widely used by advisors, although they do form the framework of nutrient management workshops and extension programs delivered by consultants and public sector extension officers.
- The complexity of extensive grazing systems makes it difficult to develop generic BMPs for nutrient management of pastures. Effective BMPs (i.e. those that influence practice) focus on specific agro-ecological zones and guide practices for which there is scientific evidence of optimisation of economic, social and environmental outcomes. There are very few targeted BMPs that provide this level of detail.
- The majority of recently developed BMPs and workshops that will inform nutrient management of pastures, and to which a small proportion of producers have access, are those either developed and/or delivered by qualified and experienced advisors in joint ventures with NRM organisations.

### (i) Decision Support Systems

Results and discussion

The online survey asked producers to select the form in which they *'..like(d) to receive information on nutrient management in pastures'*. As shown in Table A.11, 22.6% of the 362 producers who responded to this question and 13.3% of the 105 producers who responded in the focus meeting survey selected Computer Decision Support Systems (DSSs).

**Table A.11.** Methods of delivery of nutrient management information favoured by producers responding to the online survey and focus meeting survey (FMS). More than one method could be selected.

| **Preferred method*** | **Online survey responses** | | **Focus meeting responses** | |
|---|---|---|---|---|
| | **Number of response** | **Frequency (%)** | **Number of response** | **Frequency (%)** |
| Half-day workshops | 181 | 49.2 | 60 | 61.2 |
| Field days | 211 | 57.3 | 57 | 58.2 |
| Factsheets: hard copy | 132 | 35.9 | 39 | 39.8 |
| Factsheets: e-copy | 203 | 55.2 | 38 | 38.8 |
| Advisor | 118 | 32.1 | 38 | 38.8 |
| Online training programs | 122 | 33.2 | 15 | 15.3 |
| Comprehensive workshops | 53 | 14.4 | 19 | 19.4 |
| Computer decision support systems (DSS) | 83 | 22.6 | 13 | 13.3 |

*Respondents had the option to select more than one option

### What is a decision support system?

For the purpose of this study it is important to differentiate between (i) Decision Support Systems - complex programs that take into account multiple factors impacting on the livestock production

system; and (ii) Decision Support Tools (DSTs) and Calculators - tools that focus on a single component of the 'system'.

During the focus meetings it became clear that a proportion of producers consider accessing information from the internet qualifies as use of DSSs. Google searches and the MLA email *Friday Feedback* were listed as well as complex computer models and simple excel spreadsheet calculators. Although this study focuses on the DSSs that inform fertiliser decisions all responses from the 170 producers at the meetings and interviews are presented in Table A.12. The National Livestock Reporting System (NLRS) was the most frequently nominated 'DST'.

**Table A.12.** The computer decision support systems and tools nominated by producers participating in producer focus meetings and interviews. Producers could nominate multiple items.

| **Decision Support System or Tools used by producers** | **Times nominated** |
|---|---|
| **Decision support systems** | |
| Phosphorus Tool – Five Easy Steps (NSW DPI/CSIRO) - MLA | 6 |
| Grassgro™ – CSIRO | 2 |
| GrazFeed® – CSIRO | 5 |
| **Decision support tools** | **Times nominated** |
| Beef-N-omics | 1 |
| Beefspecs Calculator | 1 |
| Cost of Production Calculators - MLA | 2 |
| Feed Demand Calculator | 3 |
| Grazclock™ – NSW DPI | 3 |
| Gross Margins - NSW DPI | 1 |
| National Livestock Reporting System - MLA | 35 |
| Pastures from Space™ - CSIRO | 1 |
| Pasture picker - MLA | 2 |
| Cumulative rainfall and stocking rate spreadsheet - RCS | 1 |
| Rainfall data - Meteorological | 5 |
| Stocking Rate Calculator | 3 |
| **Other** | |
| Fairport Farm Software | 2 |
| *Friday Feedback* - MLA | 2 |
| EverGraze website | 2 |
| Google search engine | 1 |

### DSSs being used by producers

During both the producer focus meetings and interviews participants were asked:

*'What Decision Support Tools do you use (to inform livestock enterprise decisions)?'*

The open-ended question provided a gauge of the acceptance of computer programs and support systems per se. Defining DSSs and DSTs would have created confusion and influenced responses. Similarly producers who completed either the online or focus meeting surveys were not provided with a definition before filling out the survey.

The Five Easy Steps DSS was introduced to 120 producers in southern NSW as part of a pilot program for the Five Easy Steps workshops. Holbrook Landcare Network hosted one of the workshops and conducted a phone survey of participating producers two years after the pilot was held. When asked whether they had subsequently used either the Five Easy Steps worksheet or the P Tool, 40% indicated that they had but 20% considered that while they had learnt a lot of valuable principles from the workshops, they felt overwhelmed by the tools and were not confident to use them (M Ritchie, pers. comm.). All producers attending the Cooma Five Easy Steps workshops, hosted by Monaro Farming Systems, chose to take up the offer of a CD of the Five Easy Steps DSS, but only a small proportion (<20%) of participants at the Cooma workshop are likely to use it independently (N Spoljaric, pers. comm.).

**Market demographics for DSSs**

Discussion at the producer focus meetings and consultation with advisors indicates that very few producers use DSSs. John Francis, of Holmes and Sackett Pty Ltd, suggests there is a particular 'type' of producer who is likely to adopt DSSs, which represent no more than 7% of his clients.

When asked what proportion of their clients used DSSs all advisors indicated that less than 10% of producers use DSSs of any type, with *'none'* and *'very few'* being the common response to this question. A project officer interviewed suggested that less than 20% of 'the top producers' use the more complex DSSs and that they need to be used on a regular basis to maintain competency.

The number of usable responses to the online survey produced insufficient data for segregation on the basis of multiple variables, such as age, location and enterprise. However, two-way cross-tabulations on the basis of information source by age, and information source by business intentions provides some indicators of the demographic of DSS users.

The results from the online survey indicate no statistical difference responses when segregated on the basis of age. Survey respondents were also asked to choose from a number of options relating to future business intentions: (i) currently expanding or intending to expand, (ii) planning to retire, sell or lease, (iii) no plans to change in the medium term (0 to 5 years) or (iv) no plans to change in the longer term (5 to 10 years). A cross-tabulation analysis that tested association between selection of DSSs and business intention suggests that business intention is a more reliable indicator of use of DSSs by producers than age, with those intending to expand most likely to use DSSs (Table A.13).

Therefore, from the survey results, producers planning to expand their business appear to be most likely to use DSSs than those choosing to maintain current production level. For the purpose of this study the producers with intention to expand their business are likely to be in the 'Intensive' group, which is discussed in Appendix 5. Producers most likely to use DSSs and respond when presented with outputs of DSSs are in the Intensive group.

**Table A.13.** Producers who selected Computer Decision Support Systems as a preferred information delivery method and their business intentions.

| | **Business intention** | | | | | |
|---|---|---|---|---|---|---|
| | **Expand** | **Retire, sell out or lease** | **No change in med. term** | **No change in long term** | **Other** | **Total** |
| Number who selected DSS | 43 | 7 | 24 | 6 | 3 | 83 |
| Per cent of respondents who selected DSS (83) | 51.2% | 8.5% | 29.3% | 7.3% | 3.7% | |
| Per cent of each business category that selected DSS | 25.6% | 15.2% | 22.2% | 16.2% | 27.3% | |
| Per cent of survey respondents selected DSS (449) | 11.5% | 1.9% | 6.6% | 1.6% | 0.8% | 22.4% |
| Responses to question on business intent | 164 | 46 | 108 | 37 | 11 | 366 |

Producers in several locations (VIC and NSW Tablelands) noted slow internet speed (and access) as a major deterrent to internet use, consequently it is assumed that location will impact on uptake and sustained adoption of DSSs. Additionally, location is likely to have a bearing on opportunities for training in DSSs and interaction and support from technical experts, which the study indicates will impact on uptake of DSSs. Support from peers and technical expert was raised at many meetings and by advisors interviewed as providing important motivation for ongoing use of complex DSSs.

**DSSs being used by advisors**

DSSs most commonly used by advisors for nutrient management decisions are those made available through nutrient management training courses: Nutrient Advantage Advice® (Incitec Pivot Limited), SoilMate® (Back Paddock) and NUlogic® (CSBP). Many of the experienced advisors interviewed said that these tools are an excellent starting point, from which they develop their own DST, based on their experience with local soil types and producer goals.

Most retail agronomists with the major agribusiness companies, including Elders, Landmark, Pursehouse Rural, CRT, Ag'n'Vet and Delta Agribusiness, participate in one of the three nutrient management training courses listed above, which are discussed in more detail in Section 3.3.4. Agronomists and advisors gain access to the relevant DSS on completion of the training and accreditation process. There is no cost to staff and the company satisfies auditing and duty of care obligations through their involvement.

On the other hand, many consultants and public sector agronomists do not invest in this formal training and rely on their networks, knowledge and experience to inform their recommendations, so do not have access to the DSSs.

There is limited use of DSSs among experienced advisors, many of whom interrogate DSSs when they are first released as a means of staying in touch with developments and to validate their interpretations.

Early career agronomists commented on the value of DSSs as a means of broadening their experience and building confidence.

One early career advisor indicated that the Five Easy Steps DSS, to which he was introduced via the pilot program for producers in southern NSW, allowed him to link soil fertility and livestock production and he was using this as an advisory tool to provide producers with the implications of fertiliser input options. This was not possible with the Nutrient Advantage Advice® software.

The DSSs and DSTs and Calculators nominated by advisors are presented in Table a.14, Appendix 7. This is not a complete register of DSSs, Tools and Calculators used by advisors as many develop their own tools, either for their own use or for distribution in-house or within their networks. Several of those listed are no longer available, but are considered valuable by the advisor and represent significant research data and investment.

**Producer uptake of DSS**

The producer surveys indicate that approximately 20% of livestock producers use DSSs or DSTs. These figures are likely to be an overestimation as the producer group surveyed and consulted is a subsample of all livestock producers and represents those more likely to seek information and with a demonstrated interest in nutrient management of pastures (i.e. in the Intensive and Extensive groups described in Appendix 5).

As can be seen from Table A.12, most of the 'DSSs' nominated by producers are in fact simple decision tools, most relating to feed base management. Therefore the uptake of DSSs that inform fertiliser decisions is likely to be considerably less than the 22% and 13% recorded in the online or focus meeting surveys. The segment of producers using DSS is less than 10%, and likely to be represented by producers in the Intensive group.

The majority of advisors indicated that while a proportion of producers were *"comfortable with simple linear models"* (DSTs), a very small proportion was sufficiently confident in the accuracy of the data they enter to use complex models without guidance from a respected and trusted advisor. Producers in the Intensive group who were interviewed suggested that they needed to be convinced that time dedicated to becoming familiar with a complex DSS would benefit them and while it may be valuable to validate thinking:

> *"If you know the information that needs to go in, then you probably know the outputs and don't need the model…."*

Producers at the Bathurst focus meeting responded negatively to the DSSs, and raised concerns that many DSSs are simplistic, inflexible and narrow in focus and fail to account for the impact of management decisions on the broader production system. Knowledge of assumptions behind the model and confidence in the accuracy of inputs were absolutely essential for these producers to consider using DSSs. This point was raised at the majority of focus meetings. A support network of peers and/or access to a technical expert/DSS champion was considered essential for adoption and continued engagement of less confident producers.

The features that producers consider important for uptake and ongoing use of DSSs include:

- The DSS must be easy to learn and operate – use is often sporadic (i.e. once or twice per year), therefore it is essential that the system is simple enough to return to without need for re-training. The need for training and regular use to remain competent and confident is a major deterrent for producers. Advisors suggest that if producers are not engaged and confident in the DSS within 10 minutes they will exit and not return.
- The DSS is endorsed by a reputable organisation and will have credibility if it is promoted by technical expert(s) familiar with the DSS and the production system it informs.

- Introduction or promotion that spells out the assumptions and research data behind the system will reinforce the relevance and credibility of the outputs.
- The data inputs must be clearly defined before logging on to the system. Producers indicated that for most DSS there was an assumed level of understanding. If they commence a run and come to a point that requires information they either do not have access to or are unsure of, they will exit and will be unlikely to return to the DSS.
- Producers emphasised that confidence in the inputs is essential:

*"if you aren't confident with the inputs, then there is a big chance the outputs will be rubbish."*

- Outputs must be of obvious benefit to the business – i.e. time and intellectual capital taken to learn the system is a good investment.
- A valuable DSS should be promoted. Producers consider the DSS market is overloaded; they do not 'trawl' the internet to seek out DSSs.
- Producers are more likely to use a DSS for which there is a reputable contact person. Access to reputable technical specialists/advisors for consultation to validate inputs and discuss interpretation of outputs is essential. This is particularly the case where the default figures on the DSS vary greatly from the individual's inputs.

The above points are reinforced by comments from organisers and producers who attended the Five Easy Steps pilot workshops. Producers most likely to use the associated DSS beyond the workshop experience are those who: (i) are confident in the accuracy of the assumptions and calculations behind the model, (ii) are in the habit of monitoring and measuring production indicators, (iii) are able to recall details of their livestock business, such as annualised stocking rate (iv) are therefore confident in the accuracy of the data they enter, and (v) are familiar with the terminology used.

A producer who had used the Five Easy Steps DSS reported a feature of the process was the linking of soil P levels to production targets and the confidence this gave to set priorities for strategic P applications. This is in contrast to another group of producers who attended a pilot and have no intention of delving into the detail of the program; they had difficulty in keeping pace because they were not confident in calculating such basic inputs as DSE units for livestock classes. This suggests that there are distinct markets for a Five Easy Steps training program, with only a proportion of producers sufficiently confident and/or motivated to use the DSS independently. This will be discussed further in this Section 4.4.1.

Another point raised by an observer at one of the workshops was the variation in the ability of participants to incorporate the outputs of the DSS into the decisions that will achieve optimum outcomes for the livestock production system. There is a risk that producers overawed by the detail, focus on a single component (i.e. phosphorus) and cannot:

*"work through the process, use the tools to make nutrient management decisions and* [so] *have an impact on production* [efficiency]*."*

This was along the lines of concerns raised by experienced NSW DPI pasture agronomist, N Griffiths:

*"DSSs…aim to be accurate and precise in identifying 'the' rate of fertiliser to apply at a given time (based on soil testing and/ or nutrient budgeting) ..... In a permanent grazing system I'm not sure that 'the rate' matters as much as the trend."*

A DSS is more likely to be used if:
- there is a perceived need for the information
- the DSS is the most time-efficient way to source credible information
- the user is confident to provide accurate inputs
- outputs are relevant to user's situation
- the assumptions and default values are transparent and applicable
- the outputs are reliable
- DSS is easy to use and does not require time to re-familiarise
- there is an opportunity for the user to discuss and validate anomalies and concerns with an expert familiar with the DSS and the livestock system

Discussion at several producer focus meetings highlighted the importance that producers placed on support by trusted advisors to validate inputs and discuss interpretation of outputs. Availability of technical competent advisors familiar the DSS and the production system being interrogated is likely to impact on uptake and ongoing use of DSSs by producers.

**Advisor uptake of DSS**

The DSSs developed by private industry (Nutrient Advantage Advice®, NULogic® and SoilMate®) are the DSSs most frequently nominated by advisors as those used to guide fertiliser decisions. These are well supported by agribusiness and promoted as being based on industry agreed standard soil test analyses-pasture response calibrations. They incorporate critical nutrient values, which advisors may adapt to local conditions, particularly for soils with PBI values at extreme ends of the published scale (see Section 4.3.2). For example the Incitec Pivot Limited Nutrient Advantage publicity[3] 'recognises the value of local knowledge in fine-tuning the charts and keys… (and) In making any recommendation, consideration must be always given to the objectives and resources of the farmer, and to the local environment and conditions'.

These systems need to be regularly upgraded, with capacity for the addition of data as it becomes available. This is necessary for wide acceptance of DSSs and to build advisor confidence in the DSS outputs and their ability to provide defensible recommendations.

There is a reliance on industry self-regulation and a presumption that the DSSs are based on the most recent and best available science. The Fertcare® supported auditing mechanism is in place to ensure this and it is essential that whole of industry supports and promotes the value of this process and ensures that it is adequately resourced to maintain a high level of quality control of the DSSs available to accredited advisors. Strong leadership and co-ordination from industry is necessary to encourage continued collaboration and information sharing between industry and the private sector. This will help ensure that DSSs developed by private companies are based on the most recent, accurate data and there is industry agreement on the validity of the outputs.

Although environmental stewardship is a key component of Fertcare® and the accreditation process (i.e. Farm Nutrient Loss Index), environmental outcomes are not a focus in the DSSs aimed at nutrient management at the farm level, which tend to focus on pasture outcomes. There is an expectation that advisors have the capacity to adjust recommendations to meet environmental needs at the local level.

The DSSs link soil fertility to pasture production targets; however, the capacity to incorporate a producer's individual livestock production goals is reliant on the advisors skills. This study indicates that a proportion of advisors (experienced and early career) do not link soil fertility, plant nutrition and livestock production. This appears to be a major limitation in the knowledge

[3]http://www.incitecpivot.com.au/nutrient_advantage.cfm (accessed 12.10.2012)

base of the industry, which could be addressed by rolling out a revised training version of the Five Easy Steps to advisors.

Although Five Easy Steps Workshops and the DSS have been piloted with producers in southern NSW through NSW DPI, it has not been extended to advisors. The Back Paddock Company intends to further develop their Better Soil Management training for pasture advisors to incorporate aspects of Five Easy Steps (C Dowling, pers. comm.).

An early career retail agronomist observed that working through Five Easy Steps with clients was the step beyond Nutrient Advantage Advice®:

> *"It* [Five Easy Steps] *is an excellent extension tool for me and the farmers…… It builds their knowledge* [and mine] *… shows the dynamics of the system* [soil, plant and animal components] *and how fertiliser effects … livestock production."*

There is limited uptake and ongoing use of DSSs by experienced advisors. While the use of DSSs for cropping systems, with easily defined and measurable parameters, are supported, several advisors questioned the role for DSSs in complex extensive grazing systems. A private sector specialist/mentor identified a risk if the DSSs are viewed as a substitute for knowledge and understanding; and if advisors accept DSS outputs without question and did not develop knowledge and the capacity to evaluate and adjust outputs. Interpretation and interrogation of DSS outputs:

> *"…require(s) a significant amount of systems understanding and knowledge…."*

Most producers consider that complex DSSs should be aimed at consultants and advisors. Those favoured by producers are simple tools that inform on components of the decision process. However, when following this up with consultants most said that in general producers, their clients, are reluctant to pay consultancy fees for data entry and there is an expectation that the DSS outputs are already known by the consultant. A number of consultants reported that a small proportion of clients present them with outputs of DSTs or DSSs for validation of their interpretation.

So who is using DSSs? The study indicates that retail agronomists (particularly early career advisors) are most likely to use DSSs (nutrient recommendation software) to inform fertiliser recommendations. The important points raised by producers, advisors and researchers during the consultation phase were:

- DSSs are a tool to validate thinking
- DSSs cannot be relied upon to detect inaccurate data entry
- they should not be viewed as an information source
- in isolation DSSs will not bring about practice change

Comments from producers included:

> "*They are a decision support tool, not a decision tool*."

and

> *"Very few producers will use DSS tools – a more valuable option would be (for industry) to employ someone to write regular reports on DSS outputs"*

Advisors were critical of the significant number of DSSs 'lost' as a result of inadequate funding for ongoing servicing and upgrading. An example of this is the Lime and Nutrient Balance Calculator released by NSW DPI and CSIRO, through GRDC in 2002. Researchers and advisors involved in the development of the Five Easy Steps DSS are concerned it will not achieve its

potential uptake if it is not sufficiently resourced for on-going upgrading with new information to ensure relevance and accuracy of outputs.

**(ii) Best management practice guidelines**

Results and discussion

**Producer use of BMPs**

Most producers attending focus meetings and interviewed were sceptical of the role of BMPs beyond providing an introduction to a new technology or concept.

Producers at the focus meetings required prompting when asked to nominate BMPs they used to inform their nutrient management decisions. The majority of producers had only been exposed to guidelines presented as part of the Prograze®, Landscan™ workshops or the Triple P Program, and were not forthcoming with specific BMPs, but referred to 'rules of thumb', such as 'kilograms of P per dse', or benchmarks such as the critical P values.

Comments regarding the value producers placed on BMPs included:

*"A good starting point but lack level of detail"*

*"…not sufficient detail if aiming for high level production"*

*"'Everybody is different so can't use one set of rules."*

**Advisor use of BMPs**

Most advisors consulted were not aware of specific BMPs targeting nutrient management of pastures, although some referred to broader checklists/benchmarks they had developed to guide client pasture management decisions.

The BMPs presented in Table A.14 include published nutrient management documents, environmental objectives and BMP guidelines nominated by advisors and extension officers. The 'BMP' most commonly nominated by advisors was the critical soil test values for nutrients presented in the BFD (Gourley et al, (2007).

Much of the published material referring to BMPs and which relate to pasture management are fully or partially funded by NRM organisations and/or industry bodies, often developed in collaboration with agricultural agencies. There appear to be three types of BMP relating to nutrient management of pastures:

1. The imperative is agricultural production efficiency with environmental consideration, but the focus is on agricultural practices aimed at optimising production. The Five Easy Steps guidelines are in this category. Although developed by agricultural scientists, an outcome, but not the main focus, is reduced P discharge into waterways. The pilot program has been possible with funding from the Sydney Catchment Authority, delivered by NSW DPI.
2. Pressure of regulation creates an industry imperative for self-regulation. The dairy industry is at greatest risk of regulation and has responded, working closely with state and federal agencies and the fertiliser industry. An example of this is the 'whole of industry' approach initiated by the WA State Government and coordinated through the Fertiliser Partnership 2012-2016 (which supersedes the Fertiliser Action Plan – 2007), to mitigate fertiliser runoff/seepage from urban and rural areas of south-west WA. The partnership recognises the need to balance production and environmental requirements.
3. BMPs with an environmental imperative may be very broad, such as 'establishment of perennial pastures', included in catchment management plans in Victoria as a strategy 'to reduce the rise of groundwater tables…' (Department of Environment and Plant Industries, VIC, undated), or focused BMPs developed around a single objective to

improve condition of a regional asset. For example, the 13 BMPs presented in the Peel Harvey Estuary Water Quality Action Plan (Anon, 2008) aim to achieve P reduction targets in waterways. Six of the BMP 'themes' specifically target agricultural lands and include recommended actions and technical material to guide implementation.

Rather than looking to BMPs to inform their recommendations relating to nutrient management of pastures, advisors cited experience and principles presented in extension programs such as the Triple P Program (funded by AWI and delivered in NSW, VIC, SA and TAS), Prograze®; significant documents such as *Phosphorus for sheep and beef pastures* (Cayley and Quigley, 2005) and *Five Easy Steps* (Simpson et al, 2009); industry standards such the International Plant Nutrition Institute (IPNI) 4R Framework (Bruulsema, 2009); and critical values proposed by Gourley et al (2007).

Although included in Table A.14, the IPNI 4R principles are not BMPs, and instead provide an industry accepted operating procedure, while the Gourley et al (2007) critical values provide guidelines. They have been adapted and are referenced in numerous training programs and publications (public and private sector) in NSW, SA, TAS and WA.

**Table A.14.** Best management practice guidelines and examples of documents and publications relevant to nutrient management of pastures nominated by advisors during the consultation phase of the project.

| Document or Program Title | Description | Process or recommended actions | Reference and funding source |
|---|---|---|---|
| **The agricultural imperative** | | | |
| 1. Fertiliser: A key to Profitable livestock Production and Sustainable Pastures – NSW Agriculture | • Based on 15 years of pasture nutrition research in the Upper Hunter, Central and Northern Slopes and Near Plains of NSW and linked to a major extension program.<br>• Strategies to increase livestock productivity and profitability by improving pasture production and sustainability – with a focus on pasture nutrition and grazing management. | • Adjust grazing management to groundcover targets<br>• Use soil testing to guide fertiliser selection and program<br>• Determine priority paddocks and determine those of highest potential,<br>• Use fertiliser with the adequate P and S to match soil fertility<br>• Ensure good legume content in the pasture for best fertiliser response<br>• Maintain a fertiliser program<br>• Use extra quality and quantity feed to improve returns per animal and in most cases extra animals/ha<br>• If cash is tight prioritise paddocks for fertiliser application<br>• Use grazing techniques to enhance plant persistence and production. | Watson et al (2000)<br>*Funded by NSW Agriculture* |
| 2. Phosphorus for beef and sheep pastures | This is a comprehensive document designed to assist producers to:<br>• decide how much phosphorus to apply to particular paddocks<br>• decide what type of phosphorus fertiliser to use<br>• plan a soil phosphorus monitoring program<br>• prioritise paddocks for fertiliser application | More detail than BMPs<br>Uses long-term data from Hamilton Long-term P Topdressing trial: to match fertiliser rates to stocking rate (referenced in Five Easy Steps | Cayley and Quigley (2005)<br>DPI VIC<br>*Supported by AWI* |
| **3.** Making better fertiliser | The booklet presents soil test – pasture | The critical soil test values proposed in this booklet are widely accepted by industry; | Gourley et al (2007) |

| Document or Program Title | Description | Process or recommended actions | Reference and funding source |
|---|---|---|---|
| decisions for grazed pastures in Australia | response relationships and interpretations soil tests based on the major elements, P, K and S | they provide benchmarks for the interpretation of soil test results and fertiliser recommendations | *DPI VIC, funded by Dairy Australia, MLA and Land & Water Australia* |
| 4. Five Easy Steps | • Developed for temperate legume-based pastures that are grazed by sheep and beef cattle on acid soils in southern Australia<br>• Provides BMP guidelines for the use of soil test information to plan fertiliser and livestock investments. | 1. Undertake a soil testing program<br>2. Check that the stocking rate is appropriate for the current or projected soil fertility level<br>3. Determine how much P to apply relative to the projected stocking rate and soil P status<br>4. Check the economic implications of the proposed investment in P fertiliser<br>5. Consider other factors that may modify your decision to apply P<br>THEN<br>Apply P and /or adjust stocking rate. | Simpson et al (2009)<br>*CSIRO and NSW DPI joint venture funded by Pastures Australia* |
| **The industry imperative** | | | |
| 5. IPNI 4R Stewardship Framework | • Developed by the fertiliser industry to link management of plant nutrition to sustainability<br>• Considers economic, social and environmental outcomes.<br>• Provides BMP guidelines for responsible fertiliser use | • Right source (product)<br>• Right rate<br>• Right timing<br>• Right placement | Bruulsema T (2009)<br>*International Plant Nutrition Institute* |
| 6. Best Management Practice checklist for nutrient management | Fert$mart is a Dairy Australia initiative to improve the efficiency and profitability of fertiliser use.<br>This is an abridged version of the BMP/checklist compiled at Fert$mart workshops attended by producers, public and private sector agronomists, NRM coordinators, CMA staff, dairy industry and finance representatives | Checklist<br>• Have a nutrient management plan<br>• Use advisors with Fertcare® Advisor Accreditation<br>• Classify and understand your soil types<br>• Understand nutrient losses from runoff, leaching and volatilisation<br>• Use soil and tissue testing<br>• Use correct soil sampling methods<br>• Use NATA accredited testing laboratories, check for ASPAC certification<br>• Know critical values for soil and tissue tests<br>• Follow 4R framework<br>• Adopt variable rate fertiliser<br>• Use calibrated spreaders<br>• Match fertiliser application to nutrient removal<br>• Apply fertiliser in appropriate weather conditions<br>• Accurate record keeping, including details on timing and placement<br>• Monitor soil fertility trends over time<br>• Maintain buffer zones for fertiliser | Kowitz (2012)<br>Fert$mart<br>*Dairy Australia with funding through DAFF (CfOC)* |

| Document or Program Title | Description | Process or recommended actions | Reference and funding source |
|---|---|---|---|
| | | application. | |
| **The environmental imperative** | | | |
| 7. Best Management Practices for Temperate Pastures in New South Wales | • The BMP guidelines presented provide a basis for sustainable grazing management in the for the Sydney metropolitan water supply catchment<br>• The document has a strong environmental focus<br>• 9 BMPs are included – from soil fertility to grazing management | Each BMP outlines:<br>• issue being addressed<br>• the objectives<br>• practices to achieve objectives | Anon (2006)<br>*Funded by National Heritage Trust Collaboration between NSW DPI and the Hawkesbury-Nepean CMA* |
| 8. Environmental Best Practice Guidelines – fertiliser management | Uses IPNI 4R Framework<br>• Targeting intensive grazing areas of south west WA<br>• Aim to reduce fertiliser costs and minimise off-farm environmental effects | • Record keeping<br>• Regular soil and tissue tests<br>• Apply nutrients based on soil test results<br>• Time applications to match plant needs<br>• Choose the right fertiliser and placement<br>• Time applications<br>• Calibrate fertiliser spreader<br>• Use fertiliser buffer zones near waterways<br>• Use slow-release fertiliser on sandy soils<br>• Use nutrient budgets to help fertiliser decisions | Rouda R (2006)<br>*Department of Agriculture and Food Western Australia Geographe Catchment Council coordinated the project in partnership with Western Dairy and the Department of Agriculture and Food Western Australia (DAFWA).* |
| 9. Water Quality Improvement Plan for the Rivers and Estuaries of the Peel Harvey System – Phosphorus Management | This Plan identifies:<br>• the current status of phosphorus loads;<br>• the environmental values (EVs) of water bodies<br>• the water quality objectives (WQOs) that will protect the EVs, and<br>• a set of management measures and control actions to achieve and maintain those EVs and WQOs.<br>The overall objective is to reduce P discharges into the Peel Harvey Estuary System | **13 BMPs** are identified as being necessary to achieve P reduction targets<br>6 of the BMPs relate to agricultural land management including **Rural fertiliser management** BMP recommended actions:<br>• Use low water soluble fertiliser<br>• Use regular soil tests and dose to required needs<br>• Time fertiliser applications appropriately<br>• Maintain buffer zone between fertilised areas and waterways<br>• Calibrate fertilser spreaders<br>• Use nutrient budgeting to assist fertiliser decisions<br>• Use slow release P fertiliser on sandy soils | Anon (2008)<br>*Prepared in partnership with Federal and WA agencies including the Departments of; Environment and Conservation, Water, Agriculture and Food, the Peel Harvey Catchment Council, and was co-funded by the Coastal Catchments Initiative* |

| Document or Program Title | Description | Process or recommended actions | Reference and funding source |
|---|---|---|---|
| 10. Sustainable land management practices for graziers – Best management practices for grazing in the Tablelands and Southern Highlands, NSW | • Detailed document with a strong environmental focus – protection of natural resources and water quality<br>• Managing soil fertility is just one component of sustainable management | Provides key actions for managing soil fertility which include:<br>• Regular soil testing<br>• Matching fertiliser applications to pasture needs & enterprise type<br>• Encouraging healthy ecosystems to improve nutrient cycling | (2009) *prepared by NSW Industry and Investment with funding support from Sydney Catchment Authority* |
| 11. Soil test and phosphorus rate for high rainfall clover pastures | • fertiliser management practices for strategic fertiliser use on sandy, low PBI soils of WA where leaching is a major factor – strong environmental focus | Provides a checklist of practices to optimise pasture production, minimise environmental impact which include:<br>• Tissue testing<br>• Timing of application<br>• Determine production target<br>• Estimate P requirement<br>• Choose appropriate form of fertiliser | Summers and Weaver (2011)<br>*Department of Agriculture and Food WA* |
| 12. SPANA (Soil Productivity and Nutrient Assistant)) | Simple BMP tool to helps compare soil test data to critical values to assist in P decision making on pastures in the > 600mm rainfall zone.<br>Critical P values adapted from Gourley et al (2007) | Key recommendations include:<br>• Use soil testing to determine P level<br>• Compare soil test results to determine the need for fertiliser<br>• Refer to a Fertcare® accredited advisor for advice to optimise P inputs | Anon (undated)<br>*Jointly funded by Dept of Agriculture and Food WA, South West Catchment Council, Dairy Australia, Western Dairy* |

Most advisors consulted consider that the scope of most BMPs is too broad to be of use in extending nutrient management information or making recommendations to clients. Although advisors working with cropping clients saw the value of BMPs for cropping systems, the greater complexity of extensive grazing systems means BMPs have to be very broad and so tend to be ineffective. They may provide basic guidelines, but:

> *"BMPs are of no value to farmers who need to make a decision. They are not about the practice – they flag the boxes that have to be ticked."*

and

> *"…there is a risk if the BMP guidelines are followed to the letter… BMPs do not encourage flexibility or provide enough detail to make strategic decisions when conditions change."*

During the interview process most advisors were forthcoming with concerns and/or frustration regarding the apparent pre-occupation of government and industry bodies with BMPs and over-use of the term. Several asked for more detail regarding the purpose of BMPs and the need to be clear on why they were developed and the target audience:

> "*By <u>whose</u> definition are they the <u>best</u> management practices?"*

and

> *"BMPs have to be written to ensure relevance of target audience and avoid alienation through lack of relevance"*

and

*"Generic BMPs must…. capture variability across agro-ecological zones, topography, soils.* [This] *can be difficult …. where variability is significant, at farm and paddock scale."*

Best management practice is a loosely and over-used term. There is also confusion over the definition. Two definitions apply to the BMPs presented in Table A.14:

1. The definition proposed by 'fertiliser industry scientists' applies to agricultural production BMPs, where the practice is the focus: 'research proven practices that have been tested through farmer implementation to optimize production potential, input efficiency, and environmental protection'[4].
2. For BMPs developed for industry and environmental outcomes the business definition is most applicable: 'methods or techniques found to be the most effective and practical means in achieving an objective (such as preventing or minimising pollution) while making maximum use of ….resources.'[5] For this definition the objective is the focus.

The majority of recently developed BMPs that will inform nutrient management of pastures, and to which producers have access, are those either developed and/or delivered in joint ventures with NRM organisations. As one senior advisor noted the pathways to achieving the BMP objective are not always clear:

*"There is a risk to present the BMPs as objectives or benchmarks and ignore the multiple ways to get there…."*

Given the broad scope of most BMPs, effective uptake and voluntary implementation of key practices will only occur if extension programs ensure the BMP is tailored to the target audience. This has been the case for several recent extension programs listed in Table A.14, including: the *Five Easy Steps* pilot in NSW, *Phosphorus management in the Peel Harvey Estuary Plan* in WA, and *Best management practices for grazing, Tablelands and Southern Highlands of NSW.*

Feedback from the producer focus meetings and through the interview process indicates that although resources (publications and workshops) developed by NRM agencies in isolation attract a proportion of producers; they do not attract production-focused producers seeking detail and scientific evidence. Lack of context, detail and relevance were criticisms by advisors of most pasture management related BMPs:

*"BMPs do not reflect the need for flexibility and ability to respond to changing conditions. Generalisation tends to oversimplify … implies the system is static."*

With very little investment in pasture nutrient management development and extension by industry or state departments of agriculture in the last decade, most extension programs have been in response to environmental priorities. As highlighted in the review of nutrient management actions of Catchment Management Authorities (CMAs) in Appendix 2 investment in programs targeting nutrient management is concentrated in catchments where nutrient discharge is impacting on priority water systems. Hence we have the situation that funding to enable fine-tuning of BMPs to ensure relevance and detail (that advisors insist is essential for uptake and adoption) is only happening in locations where fertiliser use poses a risk to an environmental asset or metropolitan water supply. Therefore, most of BMPs presented in Table A.14 will not be delivered to or adopted by the vast majority of red meat producers, who operate outside these catchments.

[4] Griffith and Murphy (cited in Norton and Roberts, 2012)
[5] Business Dictionary.com <http://www.businessdictionary.com>

The value of BMPs as a checklist was raised, particularly when part of a program which is introducing new technology to producers or in training new advisors. However, an experienced industry representative involved in training and mentoring early career advisors raised concerns about the move towards mobile applications (APPS), BMPs and 'rules of thumb' suggesting they provided an answer that does not require understanding or critical thinking. This was *"not compatible with good agronomic advice and interpretation."* This passive approach to learning and reluctance of some to access information and build capacity is a concern.

It is apparent that BMPs are developed for a range of purposes:

- as a checklist to stimulate action to reinforce process and key messages
- to signpost technical information and encourage self-directed learning
- to guide funding priorities
- as a management tool to monitor practice change and measure effectiveness of extension programs
- as a framework for extension and training packages
- to identify knowledge and information gaps.

Many of these relate to establishing a policy framework for monitoring and evaluation of investment. If the development of BMPs does not take into account the needs of the producer identified in this study - relevance, currency, benefit and context – uptake and implementation of BMPs will not achieve their full capabilities.

If the objective of developing and promoting BMPs or workshops is to motivate practice change it is important to consider the findings of Lavell et al (2004): 'some of these practices require a chain of events (treatment train) to reach their full capability'. Therefore to ensure practice change it is important to be aware of the 'treatment train' for each BMP scenario.

Also noted in this detailed audit of uptake of BMPs for nutrient management in the Peel-Harvey catchment: 'there was considerable confusion as to what are the best practices (to achieve the targeted outcome) ….which was supported by a strong desire for training and demonstration.'

Keipert et al (2008) suggest that if criteria such as the cost benefits of BMPs or the effectiveness of BMPs in achieving objectives are included, producers may be in a position to make informed decisions and select practices 'that will provide the largest (impact), and concurrent economic returns'. Of the BMPs presented in Table A.14 those developed to reduce P in the Peel-Harvey Estuary were the only ones that included benefit cost analysis.

Furthermore, it is important to be aware that uptake of BMPs is unlikely to occur if they are not accompanied by an incentive, and/or industry support and extension as suggested by Gourley and Weaver (2012). This message also came through clearly from advisors and producers consulted in this study. This has been the case with the pilot delivery of the Five Easy Steps program. A major incentive for participation in this program has been the provision of free soil tests and on-going technical support from the public sector, but further investment is required to ensure adoption.

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## 7.7 Appendix 7 - Future extension and delivery pathways

The project objectives stipulated that this study would:

- '*identify potential participatory research sites and collaborations based on contextualised soil fertility data and the relevance of regional issues'*
- '*provide guidance on their design and methodologies'*

The protocols for the proposed participatory research sites (now called producer research sites) were under development at the time this study was undertaken. To gain an insight into the potential for producer research sites and to gauge opinion from producer experience, the following discussion is based on producer experience with the model. Therefore the following recommendations are based on producer experience with a model they are familiar with (i.e. producer demonstration sites - PDSs), but not identical to the proposed producer research site model that has since been enacted.

This section of the report presents the study findings on the role of producer demonstration sites and the basis for recommendations relating to future extension and delivery mechanisms aimed at improving nutrient management of pastures.

### Producer demonstration sites (PDS)

The role and opportunities for PDS across the study area was raised at the producer focus meeting. The discussion was directed to provide information relating to:

- regional issues affecting productivity – initial broad discussion narrowing down to issues that could be addressed under the MLA PDS model
- the role for producer demonstrations including experience within the groups regarding demonstration sites

Representatives of landcare groups, farmer groups and advisors and/or consultants were also consulted. The line of questioning depended on the interviewees' role and experience with demonstration sites. Areas covered were:

- issues relating to nutrient management of pastures raised by producer members/clients that could be addressed by the PDS model
- the effectiveness of the current PDS model in meeting expectations of regional producers and/or group members
- the resources required to achieve PDS objectives: producer contribution, administration, communication, technical input (e.g. project design, measuring/monitoring, analysis, interpretation and presentation of results)
- the opportunity to use MLA base PDS funding as a leverage to attract funding from alternative sources

Farmer groups and NRM organisations contacted in addition to those represented at the producer focus meetings were: Farmlink Research, Monaro Farming Systems, Holbrook Landcare Network, Southern Farming Systems, MacKillop Farm Management Group, Evergreen Farming Group, Glenelg Hopkins CMA.

Key points:

- The current PDS model is effective for simple issues that are easily demonstrated in a three year timeframe BUT is of limited value in demonstrating longer term impact of pasture nutrition treatments on the livestock system – producers and managers propose that there is potential for extending the term.
- Several CEOs and project managers queried the effectiveness of three year programs in facilitating practice change, suggesting that while the impact of practices may be observable after three years, reinforcement of key messages leading to adoption required a longer timeframe.

- In-kind contribution is essential to ensure that the cost of PDS (to industry) is kept low, but competing commitments for producers and limited access to in-kind technical input from the public or private sector is not guaranteed. This means that the in-kind component is likely to decline.
- Dissemination of results beyond the project group is an expectation of levy payers; publicity of results beyond the project report requires funding to ensure the quality of outputs. Difficulty in accessing project reports was raised at the producer focus meetings.
- Confirmation of funding well in advance of the start date may enable groups to leverage additional funds, which producer groups suggest is relatively easy to attract if base funding is guaranteed
- Collaboration between groups and across agro-ecological zones on similar issues would increase the benefits and outcomes of the investment; this would increase the credibility and relevance of findings and creates opportunities to engage a wide audience
- Collaboration between groups was also raised as an opportunity to increase the learning outcomes from the projects, to stimulate thinking and identify diverse management strategies by engaging with groups outside usual networks
- Participation of a well-respected technical expert with a good reputation and experience will increase the potential for adoption; the right expert is often able to introduce principles beyond the focus of a simple demonstration and maximise the impact of the investment in the demonstration
- The Focus Farms model (discussed later in this section) was raised at a number of producer meetings as a preferred model that would allow the impact of nutrient management actions to be demonstrated on whole farm business and also provide an excellent learning environment for producers and service providers.

The PDS model was supported in principle at half of the producer focus meetings as an opportunity to see and experience first-hand new practices or technologies, with the PDS serving as a surrogate for producers who do not independently monitor and measure performance indicators on their own farm.

Producers and advisors also considered that a three year term limited the options for nutrient management projects, particularly as the questions most producers have relates to impact of fertiliser treatments on livestock production on a whole farm basis. If groups were assured, for example a three year initial phase with an option to extend, this is likely to encourage more ‘adventurous’ project design.

A number of producers who questioned the value of PDS in facilitating practice change suggested that their real value is as a ‘participatory learning’ site that fosters peer support and interaction between producers and technical specialists. The consensus from most of the producer focus meetings was that while the PDS is unlikely to create anything more than awareness, the discussion and group learning approach had the potential to stimulate practice change, potentially beyond the focus issues of the site.

<u>Clarifying the purpose of PDS</u>

There was considerable discussion by producers, NRM officers and CEOs of farmer groups regarding the purpose of the PDS, with a general view that sites that are very well designed and managed, and focus on a ‘couple of simple issues’ may produce valuable results and have a localised impact. However, there was also a view that there is a risk that a complex demonstration will create more questions than answers and the value of these was debatable.

The majority of producers consulted stressed the significant commitment required for a successful PDS experience and stipulated that any contribution they made to the PDS process must be justified by creating benefit to the wider community (local, region, industry) with a clear

outcome that justifies the investment (of funds and time). Producers considered that the most valuable sites were those covering issues of wide geographical relevance, particularly if these were to attract producers (and advisors) with diverse experience. Interaction between producers from other locations was seen as a way of optimising learning outcomes.

The administrative demands and logistics involved in PDS

The NRM and farmer group managers and project officers were forthcoming with concerns regarding administration issues and the need for clarification of expectations of MLA and producer members before committing to PDS:

- labour is a major component of the PDS budget with reduced in-kind contribution from the public sector
- *from a project officer*: it is not realistic to rely on in-kind contribution from producers for timely sampling, monitoring and measuring when they have many competing priorities; the capacity to take on projects is limited by the enthusiasm of the producers and their time availability
- project managers and CEOs requested standard guidelines and protocols for sampling, measuring and monitoring of sites
- there is a variable capacity of the groups to administer, measure, analyse, communicate/publicise and report and meet expectations of all stakeholders; these require multiple skill sets, which are not always readily available or accessible within the project budget
- secure funding for sites is essential to guarantee commitment of key personnel (in particular technical and administrative support) for the term of a PDS
- the budget allocation must take into account cost of reporting and the extension of results
- confirmation of funding well in advance of the start date would allow groups to leverage additional funds
- outcomes from the PDS create opportunities to link with the MLA Communications group, with the *Feedback* magazine seen as a promotional opportunity.

PDS opportunities relating to nutrient management of pastures

While some grower groups and NRM Boards and CMAs have delivered nutrient management programs with an environmental focus, most groups have had limited funding opportunities to explore nutrient management programs that focus on animal production. Those consulted suggested that as a result topics and knowledge gaps raised by producers at needs analysis days tend to be very broad. Only Holbrook Landcare Network, Monaro Farming Systems and TAS's NRM North (with TIAR) have conducted programs with a specific pasture nutrient management focus. One group interviewed for this study expressed concerns about sharing ideas with organisations that they see as competitors for funding.

When asked to nominate issues that may be investigated through the PDS program, executives of grower groups and NRM managers provided very broad subject areas, such as the need for perennial grass species for the low to medium rainfall zone, and the need for education programs to build understanding of key nutrients. All groups contacted expressed a willingness to participate in the PDS program and are particularly supportive of linking with other groups to develop projects that address common issues. However, it appears that most groups needed involvement from a technical specialist to fine-tune potential subject areas. Examples of this is the involvement of technical specialists in narrowing very broad issues to develop an extension opportunity for the Holbrook Landcare Network (N Phillips, NSW, DPI), the Monaro Farming Systems (R Simpson, CSIRO and P Graham, NSW DPI) and NRM North (R Smith, TIAR)

While most producer focus meetings conducted for this study provided a list of issues, others had difficulty narrowing the focus and indicated that they would rather discuss and tease out the underlying issues with a technical specialist familiar with their system.

*"We don't know what we don't know…."*

One group reconvened a fortnight after this study's focus meeting, reporting that some of the meeting comments did not reflect the true issues that were raised once they were back on their farms. It is important to keep this in mind when considering the issues below which were identified when producers at the focus meetings were asked to nominate topics they would like to see investigated under the PDS program. The key issues mentioned by attendees were:

- clover persistence: is this related to nutrition, poor variety selection, grazing management, disease?
- nutrient is management across variable landscapes:
    - there is a need to improve our understanding of soil variability and the impact of aspect and topography on nutrient levels;
    - varying fertiliser inputs to match land capability and stocking rate. This was raised by the Tooma group which has some exposure to the Five Easy Steps program and felt they needed further guidance in matching soil fertility to target stocking rate and fertiliser decisions.
    - 'prioritising fertiliser expenditure' was raised by several groups. *This should not be confused with variable rate technology. The study indicates that most producers do not easily grasp the concept of varying rate to match stocking rate and do not have with the skills and confidence to adjust rates across the landscape. Understanding the opportunities in varying rate without impacting on livestock production potential needs to be instilled before producers are introduced to variable rate technology.*
- the role for trace elements on pastures: (i) pasture growth limitation and (ii) link to animal health
- alternative fertiliser was raised by many groups:
    - comparisons of products, including composites of alternatives and traditional fertilisers (with a number of groups expressing frustration that evidence on the role of these is not accessible)
- the process for and benefit:cost analysis of lifting low production paddocks. this is relevant to several groups who debated the value of prioritising fertiliser applications on high versus low production paddocks
- production (economic) consequences of cutting P rates – e.g. how does $P_{50}$ compare to $P_{80}$ – identify the 'sweet spot in the production curve'
- economic analysis of P build-up and maintenance over short versus longer period
- economic impact of running down P
- update economic data – benefit:cost of fertiliser in current environment for a range of production systems; the point was raised that most of the economic data is for wool production systems.

What makes a successful PDS experience?

Producers, managers and advisors experienced in the management, operation and/or delivery on demonstration sites provided comment on the factors essential for success of PDS:

- the demonstration addresses issue(s) that are relevant to a wide group of producers, who should be represented in the development phase to ensure broad ownership of the PDS findings, and therefore increase support of the activities, awareness and likelihood of adoption
- the project must be rigorously designed and adequately resourced
- consultation between producers and technical expert(s) is needed during the proposal stage to ensure the concept is novel (i.e. not wasting time rehashing old work), to tease out the critical questions and ensure that the observations and measurements taken are the indicators or triggers in which a wide group of producers are interested
- scientific input is essential to provide confidence in measurements, analysis and interpretation and to ensure evidence-based discussion

- it is essential the issue(s) being tested is observable, the impact can be measured and the issue can be resolved within the project timeframe
- to maximise the learning experience the project must be adequately resourced to allow engagement of technical experts
- effective and timely of data collection is essential
- there is clear demarcation of roles and responsibility for measuring/monitoring, analysis, interpretation and presentation and communication of results; employment of individuals with necessary skills set as required
- administrative support is adequate to ensure timeliness in meeting project milestones
- outcomes will be strengthened if the project cultivates a stimulating learning environment that includes a mix of technical experts and producers who ask the hard questions and are prepared to try new technologies
- the project should have outputs in addition to the final report and includes an effective communication strategy to ensure producers (the key target) are updated and remain engaged – potentially through a combination of activities and publications
- engagement of service providers (i.e. accountants, bank managers) at the sites provides a link to professionals involved in the farm management decision process; it is an ideal learning environment for these and early career agricultural advisors.

Promoting wide adoption of nutrient management best practice – Focus Farms

Producers at several meetings proposed a revision of the PDS model with support for fewer, well-resourced sites at strategic locations, run over a longer term to investigate the impact of a range of nutrient management scenarios on the livestock production system, including feedbase management. Their views align well with the objective of the Lead Farm and Focus Paddock model proposed by Shovelton et al (2011). As was the case in the 2011 study, producers consulted during this study also 'want to see the consequence of technology adopted in a whole-farm context in their locality and supported by good financial data'.

There is concern amongst advisors consulted for this study that the term 'Lead' Farm would not engage the bulk of the producer population who do not relate to 'lead' producers, as discussed in Appendix 5. Focus Farm is the preferred term widely used by industry, which may help overcome the peer group effect.

The Focus Farm model has advantages over the PDS model in its potential to provide a grazing systems context that can then be used to demonstrate the relative advantage, compatibility and complexity of nutrient management decisions, with potential to engage producers (advisors and other key service providers) in a participatory learning environment to develop skills and knowledge through the trialling and monitoring (observability) process. The ability to 'witness a response ….results in greater confidence to adopt the system further' (de Fegely, 2000).

As proposed by Shovelton et al (2011), the Focus Farm would 'demonstrate productivity, profitability and sustainability relevant to the target market' of producers and 'would provide a focus for on-farm demonstrations/trials and would provide regional foci for the collection of agronomic and other data'. The use of real data to evaluate the impact of new technologies on the whole farm business matches the need for economic analyses of the impact of nutrient management on farm business sought by producers and advisors consulted during this study. This model also provides an opportunity to engage a range of stakeholders and will provide participatory learning opportunities, relating to environmental, social and economic issues faced by red meat producers.

If the aim is increased adoption of best practice, the Focus Farm model meets the Rogers'(2003) characteristics of innovations (*relative advantage, trialability, compatibility, complexity and observability*) and would provide opportunity to reinforce the 'relative advantage' and 'trialability' of new nutrient management practices, the two characteristics of a new technology or practice considered by Pannell et al (2006) most important in driving adoption or non-adoption.

This project has identified the lack of opportunity for next generation advisors and producers to develop an understanding of system integration and to gain on-ground experience and confidence. The Focus Farm model presents significant opportunity to introduce 'whole of system' principles that provide a landscape perspective.

**Future extension and delivery pathways for producers and advisors**

It is timely to be presenting producers and advisors with a fresh approach to nutrient management that highlights productivity gains that may be achieved by matching nutrient inputs to production targets. Particularly as a consequence of the drought, the study indicates that most producers and advisors are receptive to nutrient management programs linked to productivity as a means to manage uncertainty of seasonal conditions, unpredictable commodity prices and declining terms of trade.

However, the study also indicates that the majority of livestock producers have not participated in nutrient management extension programs and do not pay for advice on nutrient management programs, and so remain isolated from advances in scientific understanding. This is in part a result of the protraction of public sector extension services and failure of many producers to actively seek information and invest in intellectual capital. While producers in the Intensive and Extensive groups (Appendix 5) are likely to participate in nutrient management extension programs, the study indicates that the level of understanding that is perceived necessary to make optimum fertiliser decisions varies considerably between producers. From an industry and environmental perspective, it is important that extension programs target all livestock producers to achieve, as a minimum, awareness of CVs and the role of soil testing to match nutrient inputs to production targets and so reduce the incidence of under- and over-fertilisation.

Advisors raised concerns that any program highlighting P use efficiency alone will fail to engage a significant proportion of the producers who consider P as a discretionary cost and who are unable to quantify or justify the economic benefits of targeted nutrient use. For many of these producers cutting fertiliser use has provided a positive outcome for their cash flow situation. In fact several producers at the focus meetings noted that they had not seen pasture response to fertiliser post drought, so have elected to stop fertilising and appear to have lost confidence in the economic benefit of fertiliser application.

Therefore, it is not surprising that experienced producers and advisors emphasised that in order to attract a wide producer audience, extension programs must present compelling economic data that promotes the role of soil fertility and targeted fertiliser use in the profitability of the grazing system. Furthermore a whole of landscape approach that promotes the multiple benefits of nutrient management best practice (e.g. soil acidity mitigation, grazing management and ground cover, carbon sequestration and weed management), will address priority issues for a wide producer audience compared to a campaign that focuses on nutrient use efficiency alone.

The current funding model has created a situation where NRM organisations have become the 'gatekeepers' for delivery of soil-related extension programs and in some locations opportunities to engage a cross-section of producers is lost because NRM organisations are working separately and attracting different audiences to those delivering production focused programs. There are opportunities to identify common ground and develop complementary and collaborative programs to reinforce key management principles. This is the approach used by DAFWA, through the Fertiliser Partnership, NSW DPI and the Sydney Catchment Authority, and Dairy Australia through the Fert$mart program.

The Fert$mart program has engaged multiple stakeholders and aligns the economic, environmental or social considerations of nutrient management with the principles of the International Plant Nutrition Institute's (IPNI) 4R Nutrient Stewardship program and the IPNI 4 R

framework[6]. These present bipartisan and internationally supported objectives that have relevance to all land managers.

Producers and advisors seek greater access to evidence-based information

The huge amount of conflicting information to which producers (and advisors) are exposed has created a demand for evidence-based, technically sound information, which is seen as essential to rebuild knowledge stocks and improve confidence in the decision process. Development of a (i) a central repository, and (ii) hosting of industry symposia were proposed by producers and advisors with a view to increase dissemination of information and to assist in the development of professional networks for researchers, advisors and key industry leaders.

(i) Central repository

Producers and advisors support improved access to credible information and resources (including research outputs) through a central repository, hosted by an independent coordinating organisation, with the capacity to link to generic resources that are relevant to other industries (red meat, grains, dairy, wool). Production of generic resources should be achievable as many of the researchers and technical experts are already linked to a number of industries (e.g. grains, red meat, wool and dairy) and collaboration would enable efficient use of limited technical resources.

Much of the material from R&D that targets producers has been edited, rebadged, is often over simplified, and rarely includes reference to primary source to enable checking of context and interpretation. While factsheets and summaries may satisfy many producers and some advisors, there is a risk that accuracy is lost in the interpretation and editing of primary sources. There is a need to improve access to peer reviewed technical information and reports. This is required by advisors seeking technical detail and producers who want to be able to apply research findings to their own systems rather than relying on the interpretation of others, as noted by one producer at a recent mixed farming workshop:

> *"I want access to the research…I do not want the recommendations and interpretations of the research presented in a package"*

While producers in the Intensive group actively seek information, as discussed in Appendix 5, the majority of producers and advisors have difficulty accessing credible information (or cannot justify the time) and tend to be passive recipients of information. The majority of producers at the focus meetings indicated they do not spend time trawling the internet and felt that if information and resources are worthwhile, they should be promoted. It follows that if information is not promoted it will not disseminate beyond a limited group of producers and/or advisors.

(ii) Industry symposia

The GRDC annual industry updates (for advisors and producers) was cited by advisors and producers interviewed for this study as a model that would increase exposure to recent pasture and feedbase R&D findings and provide advisors, producers and researchers with an opportunity to expand their professional networks.

Increased publicity and exposure of advisors and producers to R&D outputs is absolutely essential in the current environment where extension of research appears to be limited to 'communities of interest' groups. This is highlighted by poor uptake of the BFD CVs and also the

[6] IPNI 4 R framework - apply the right source (form) of nutrient, at the right rate, at the right time, and in the right place.

poor dissemination of outputs from state-based projects and research projects within common IBRA zones being stifled by state boundaries and a narrow industry focus.

Participants at the project's National Networking Workshop also discussed the benefits of regional (annual or biennial) symposia open to researchers, advisors and producers. Such a scientific forum, with peer-reviewed content is an opportunity to:

- integrate soil, pasture and livestock components of the red meat production system
- maintain or build knowledge stocks of all participants
- create an opportunity for sharing of experiences and for open debate and discussion, with potential to establish an agreed scientific position
- encourage cross-fertilisation of ideas and linkages and capture scientific thinking in a readily accessible form
- develop partnerships that meet the needs of all players
- identify R,D&E gaps and opportunities
- facilitate development of active networks
- satisfy key performance indicators for researchers through delivery of peer-reviewed papers in a scientific environment.

Exposure to current research and evidence-based, peer-reviewed information and open discussion was considered important in building capacity of next generation researchers, advisors and producers and therefore in rebuilding industry knowledge stocks. The challenge to the success of such events is open sharing of information in an environment where intellectual property is increasingly a marketable commodity.

Promotion and support for ASPAC and Fertcare®

Building producer confidence in the reliability of soil testing (Section 3.3.1) and the fertiliser recommendations made by advisors aligned to fertiliser outlets (Section 3.3.2) is required to ensure improved nutrient use efficiency.

Although the ASPAC certification that is held by some analytical laboratories should provide producers with a level of confidence in soil test results, the study indicates that most producers are not aware of the ASPAC status of the service they use. Many advisors are also unaware of the guarantees provided by the ASPAC certification status. Industry promotion is required to increase the awareness of ASPAC certification as a means of building confidence in reliability of the testing service and the soil test results.

The Fertcare® accreditation process is gaining momentum among industry and has the potential to become a quality assurance mechanism for producers. However, feedback from independent advisors indicates that they are unlikely to pursue accreditation unless Fertcare® accreditation status provides a commercial advantage whereby producers favour accredited advisors. Industry must promote Fertcare® accreditation and, particularly the biennial auditing that is part of the accreditation requirement, to promote advisor accreditation as a highly valued component of the advisor's portfolio that reflects an advisor's level of expertise in nutrient management. This is needed to encourage adoption among independent advisors, who currently represent just 7% of accredited advisors (N Drew, pers. comm.).

At present the Fertcare® accreditation program is the only formal mechanism to introduce advisors to industry agreed CVs. The Fertcare® accreditation process relies on the robustness of the nutrient recommendation software. Effectiveness and confidence in the process depends on monitoring of these DSSs to ensure that the industry-agreed standard values and up-to-data scientific data are integrated into the models. The reliability of the DSSs and the rigour of the advisor auditing process is the only assurance for industry that advisors making farm-level recommendations are using CVs where appropriate and applying sound science in recommendations that fall outside the PBI confidence range.

Extension pathways for producers

Although the scientific community and many producers are in general agreement that attention to fertility status of pastures provides economic and environmental benefits, the majority of producers will not alter their predominantly traditional nutrient management practices unless there is a compelling argument that clearly identifies the benefits of change. Many producers appear to have lost sight of the role of soil fertility in their livestock system.

The study identified that many producers favour interactive learning environments, such as field days, workshops and focus groups facilitated by technical experts as a means of information delivery. A significant feature of extension programs nominated at the producer focus meetings (Paired Paddock Program, Prograze®, Landscan™ and Five Easy Steps) is the use of action learning and adult learning principles.

A review of the Five Easy Steps pilot nutrient management extension program indicated that sustained adoption of new technology requires a learning experience that straddles several seasons. This allows the introduction and reinforcement of basic principles and enables producers to apply guidelines to their own situation. For example a longer time horizon allows them to observe trends in P levels and pasture response and quantify the relative advantage of management change to their overall business. This action learning approach is required to ensure the key principles become ingrained in the nutrient and feedbase management decision process. This is the ideal, but in reality only a proportion of producers aim for this level of understanding. Therefore it is essential that advisors are up-skilled and have the capacity and confidence to develop nutrient management programs with their clients. The Five Easy Steps P tool is a valuable extension tool that serves this very purpose (A Rolfe, pers. comm.).

The need for programs that provide producers (and advisors) with hands-on experience of outcomes of practice change was also stressed by producers who considered that monitoring and measuring impact of changing fertiliser management on both pasture and livestock production was key to building their knowledge, confidence and capacity to recognise signals and to make hard (timely and tactical) decisions.

> The explicit knowledge gained through the introduction to scientific principles combined with the tacit knowledge gained from witnessing, monitoring and discussing on-farm experiences with peers and technical specialists provides a level of understanding and confidence that cannot be replicated in passive learning environments. This is essential for behavioural change and sustained adoption.

The action learning and adult learning principles employed for the Grasslands Productivity Program (GPP) and the Paired Paddock Program (Triple P) allowed producers to experience the impact of practice change (Trompf et al, 1998). Similarly Freebairn et al (1996) undertook a 10 year pasture soil nutrition program in northern and central NSW that promoted the role of fertiliser in profitable and sustainable livestock production. In this case sharing of local experiences, reinforcement of key principles and consistency of message ensured ‘successful adoption of a technology ….. (via) a well researched and promoted program…’ that addresses ‘generations of beliefs (of producers agribusiness and professional agriculturalists) that require changing’.

Although the GPP and Triple P program ran between 1992 and 2004 and the NSW pasture soil nutrition program ran from 1983 to the mid 1990s, these programs carry a legacy and were credited by some producers and advisors engaged for this study as providing the key learning components that are the basis of their current understanding and provide the skills and confidence in their current nutrient management decisions.

Common features of the programs producers’ credit with providing the ‘building blocks’ of their understanding of grazing systems include:

- participants are attracted because the programs are delivered by a reputable technical expert who has an understanding of local production systems;
- the content is based on scientific data;
- content is tailored to address local issues; and
- the program timeframe is sufficient to ensure outcomes of practices are witnessed and key messages are reinforced and validated.

Feedback and preliminary revision of the WFNM and Five Easy Steps programs suggest that these provide a solid basis from which to develop future nutrient management extension programs for producers (and advisors). While the Five Easy Steps program was developed specifically to improve P use efficiency of extensive grazing systems of the higher rainfall zones of south-eastern Australia, it should be reviewed and adjusted to broaden the area of application. However, the extension principles apply to all regions.

Previous experience with nutrient management programs suggests the extension program should extend over a number of seasons to allow for the reinforcement and validation that is required to affect behavioural change. Feedback from the Holbrook Landcare Network (HLN) Five Easy Step pilot program suggests that while producers may attain a level of awareness after one season, they needed reinforcement of their understanding and validation of their fertiliser decisions in the second season, Many would not have had the confidence to make changes without follow-up in the second season (N Phillips, pers. comm.). Freebairn et al (1996) reported on the success of the 10 year pasture nutrition program (Sustainable Stock from Stable Pastures) claiming '…the need to continually promote the message over a long period…….. cannot be underestimated…. farmers need to be convinced …(fertiliser investment) works in good years…..also …dry times.'

Colour coded farm nutrient maps may be a tool that would add value to the Five Easy Steps program, to provide producers with a visual representation that helps clarify the concept of fertility variability across the landscape. They have been well-received in the WFNM workshops, by Dairy Australia, and in the TIAR/NE NRM project in TAS. Feedback from advisors and producers suggests that the maps, in conjunction with awareness of CVs, provide producers with confidence to prioritise paddocks.

<u>Tiered delivery to satisfy objectives of a diverse producer audience</u>

While training programs such as Prograze® have provided a common language for livestock production, only the livestock producers with significant cropping experience appear to be confident with terms and interpretations relating to soils, soil test analyses and nutrient budgeting. It was apparent from the focus meetings that many livestock producers with limited exposure to pasture management principles are deterred by the unfamiliar technical language and concepts used in discussion of nutrient management. A three-tiered extension program that caters for the experience and learning objectives of the different segments of producer population is proposed to improve nutrient use efficiency at the landscape scale.

Delivery of the Tier 1 phase of the program will create awareness of CVs and a level of understanding of nutrient management principles that will reduce incidences of over and under-utilisation of P fertiliser. However, greater investment is required to facilitate practice change that will result in widespread improvement in nutrient use efficiency. The tiered approach is outlined below, incorporating components of previous extension programs, including the Five Easy Steps program. The proposed delivery process is covered in detail in Sections 5.2 and 5.3.

> **Tier 1** draws on existing mechanisms and resources. It would be relatively easily achieved and provides an opportunity for significant impact in the short-term. Promotion of ASPAC certification and the Fertcare® accreditation process taps into existing industry programs; the extension resources for producers and advisors are currently under review and will require a level of updating in line with the findings of this study.

Workshops that may be delivered as part of the Tier 1 extension program should include components from Five Easy Steps and other training programs, such as Landscan™ and Prograze®, to introduce basic soil, pasture and livestock production principles and terms. They are likely to suit the learning objectives of next generation producers, those new to livestock production or those who do not want detail and who rely heavily on their advisor to fine-tune their fertiliser programs

The minimum learning outcomes for Tier 1 workshops are:

- awareness of the BFD CVs to reconcile where their system fits on the $P_{95}$ continuum, and below[7]
- understanding the role of CVs and soil test results as a tool to guide fertiliser decisions
- understanding the role of accurate soil testing as a means to monitor soil fertility levels over time, and
- providing the confidence to ask their advisors questions to ensure nutrient recommendations are based on industry agreed CVs.

Although these workshops cover basic scientific principles, it is essential that these are delivered by a recognised expert(s), with thorough knowledge of local soils, production systems and factors limiting the adoption of nutrient management best practice for two reasons. Firstly, the reputation of the presenter is known to increase participation levels, as reported for the HLN pilot program. Secondly, the presenter will be required to tailor the program to suit producers with varying levels of understanding of quite complex principles. It is absolutely essential that the principles, many of which are likely to be new to many participants, are presented in a manner that is clear and relevant to the local conditions. Feedback from producers indicates that many find the concepts new and difficult to comprehend, it is important that the presenter is competent in providing data and scientific basis for discussion.

It is probable that producers new to agriculture will progress to Tier 2 workshops once they are confident with foundation principles.

1. **Tier 2** workshops would target producers from the Intensive and Extensive groups. It is anticipated that most would have a level of understanding of key principles relating to soil types, soil testing and pasture management, although feedback indicates that producers who sign up for Tier 2 workshops may need reinforcement of pasture and livestock management principles. A sound understanding of the principles of grazing management and the implications of pasture composition on feed quality, quantity and livestock production are essential to maximise learning outcomes.

   The minimum learning outcomes from Tier 2 workshops include those from Tier 1 as well as:

   - understanding the impact of soil fertility on pasture response, and
   - understanding the relationship between soil x pasture production x livestock efficiency.

   Feedback also indicates that producers aiming to achieve this level of understanding are prepared to adjust their nutrient management practices. However this requires a significant change in attitude and even producers who participated in the Triple P program and Prograze® supported the need for the program to be run over at least two seasons. Nigel Phillips (NSW DPI pasture specialist) reported that the second year of the pilot Five Easy Steps program hosted by HLN's 'Understanding P' provided

[7] It is assumed that most livestock producers operating extensive grazing systems will not aim for soil P levels above 95% of maximum pasture production.

participants with an opportunity to reinforce their decisions: producers presented soil test results in the second year and asked questions to which they knew the answer, but sought validation. It is unlikely they would have had the confidence to make practice changes without this validation.

3. **Tier 3** workshops would target producers with a high level of understanding of their grazing system, who are prepared to invest significant intellectual capital to optimise both enterprise profitability and nutrient use efficiency. This requires a higher level of understanding, confidence and management. Producers participating in Tier 3 workshops may be or have potential to develop as industry champions.

The minimum learning outcomes from Tier 3 workshops include those from Tier 1 and Tier 2 as well as:

- adjusting fertiliser strategies to match seasonal variation in feed demand, variability of the landscape and stocking rate, and
- develop a high level of understanding to manage soil fertility trends, matching economic and environmental targets.

Experience from producers involved in the HLN pilot suggests that most producers have established their production levels and will not be responsive to opportunities for increased production, and so are unlikely to be interested in the detail presented in the refining components of the Five Easy Steps program. In addition, although the study indicates that producers want the economic data to justify practice change, most producers are not interested in developing the skills to quantify the return on investment of their nutrient management program, presented in Tier 3 workshops (i.e. most are not interested in Steps 4 and 5 of the extension program – N Phillips, pers. comm.).

The majority of producers do not wish to achieve the level of understanding provided through participation in Tier 3 workshops, instead relying on advisors for that level of fine-tuning. This highlights the importance of building the capacity of advisors.

Extension pathways for advisors

Experienced advisors consulted for this study were asked to nominate the strengths of their training and learning experiences that provided the basis of their confidence in understanding of extensive grazing systems, in particular the aspects relating to nutrient management of pastures. Most have a background as technical specialists or extension officers with private sector or state agencies and cited hands-on field experience in integrated soil fertility and livestock production system RD&E programs as invaluable in developing their understanding of grazing system integration that many next generation advisors appear to lack. Beside the skills gained from monitoring and measuring, advisors nominated a large network of research and technical experts as essential for ongoing validation and interpretation and for remaining up-to-date with R&D outputs.

Industry could play a role by increasing opportunities for the exposure of early career advisors to recent and current research and in the development of their professional network. Participation at the industry symposia discussed previously would provide opportunities for exposure to scientific information and so contribute to building the explicit knowledge of advisors. However, building the tacit knowledge of next generation advisors and producers is more difficult under the current environment of RD&E investment. MLA's producer demonstration site program offers opportunities for increased involvement of private sector advisors and linkages between researchers, producers and advisors. The Focus Farm model, discussed previously, presents a significant opportunity to introduce 'whole of system' principles and to develop advisors' skills in monitoring and measuring, and an appreciation of key drivers of their system.

The study indicates that there is poor awareness among advisors of the BFD CV guidelines by producers and advisors (Section 3.3.1). this is in contrast to the scientific community which considers that these are landmark guidelines that could significantly improve the productivity of managed pastures. This indicates a failure of the current information delivery mechanisms. Key nutrient management principles and guidelines are not disseminating beyond advisors who have participated in private sector accreditation programs (Nutrient Advantage Advice®, NULogic® and SoilMate®). This study suggests that even those advisors introduced to the guidelines do not have sufficient confidence and understanding of the interrelation between soil fertility and livestock production to apply the industry agreed CVs to pasture nutrient recommendations and pasture management in such a way as to optimise nutrient use efficiency.

Building the confidence and capacity of early career advisors is an imperative given the reliance of producers on advisors for soil test interpretation (87% of producers responding to the online survey) and nutrient recommendations (58% from the online survey). The challenge is to fast-track the capacity building of next generation advisors and address a demonstrated lack of understanding of 'the system', and understanding of the relationship between soil fertility, pasture production, composition, utilisation and livestock production.

This highlights the potential role for an advisor version of Five Easy Steps program. The Back Paddock Company currently offers a follow-up of the Better Soil Management training that is offered as a part of the Fertcare® Advisor Accreditation process that incorporates components of the Five Easy Steps program to introduce the relationship between soil fertility and livestock production.

As is the case with producer extension programs it is proposed that three versions of the advisor training program are offered. Many next generation advisors are on a steep learning curve and are inundated with competing demands. Therefore training opportunities should cater for different entry levels and recognise that not all advisors have the interest or capacity to be proficient in all components of an advisor version of the Five Easy Steps program.

It is proposed that the advisor workshops would have similar content to the producer versions, with the Tier 3 program serving as a train-the-trainer program. Upskilling of advisors is essential to meet the shortfall in experienced advisors. The lack of experienced individuals to deliver producer training programs to meet producer demand is an issue encountered in WA with delivery of the WFNM program. Five Easy Steps has been delivered in NSW by NSW DPI extension staff but recent organisation restructuring has reduced that capacity. Given that many early career advisors have limited exposure to RD&E programs; it is proposed that advisors participating in the Tier 2 and 3 programs would also be encouraged to actively participate in the proposed producer research sites or producer demonstration sites.

Key learning outcomes should include the principles of grazing management and the implications of pasture composition on feed quality, quantity and livestock production, some of which may need to be introduced or reinforced. Sustained adoption requires that advisors receive 'significant on-going encouragement, training and support' (Schroder, 2001) from the scientific community, particularly through linkage to R&D.

1. **Tier 1** would cater for those advisors primarily servicing mixed farming operations, who are likely to have very little experience in grazing systems, but an expectation to develop a working knowledge of the principles of CVs and linking these to livestock production targets. The minimum learning outcomes from Tier 1 workshops are:
    - appreciation of Fertcare® Advisor Accreditation program
    - understand the ASPAC certification and NATA accreditation schemes
    - understand the role of CVs and soil test results as a tool to guide fertiliser decisions
    - awareness of the BFD CVs, and relationship to pasture production targets

- understand the role of accurate, regular soil testing as a means to monitor soil fertility levels over time, and
- understand the impact of soil fertility on pasture response, and
- understand the relationship between soil x pasture production x livestock efficiency.

2. **Tier 2** advisor training workshops would cover the detail presented in the Tier 3 producer workshops and targets advisors servicing livestock producers.

The minimum learning outcomes are as for the Tier 3 producer workshops:

- appreciation of Fertcare® Advisor Accreditation program
- understand the ASPAC certification and NATA accreditation schemes
- awareness of the BFD CVs, appreciating where their system fits on the $P_{95}$ continuum, and below
- understand the role of CVs and soil test results as a tool to guide fertiliser decisions
- understand the role of accurate, regular soil testing as a means to monitor soil fertility levels over time
- confidence to ask their advisors questions to ensure nutrient recommendations are based on industry agreed CVs.
- the impact of soil fertility on pasture response
- understand the relationship soil x pasture production x livestock efficiency.
- adjust fertiliser strategies to match feedbase requirements, variability of the landscape and stocking rate, and
- acquire high level of understanding to manage soil fertility trend matching economic and environmental targets, and
- competency in Five Easy Steps P Tool (DSS)

3. **Tier 3:** These train-the-trainer workshops would target those advisors with a strong background in pasture and feedbase management and livestock systems. It would include all components of the Tier 2 workshops, but also cover the economic return on investment from various fertiliser strategies, including implications of maintenance, capital and run-down strategies for a range of soil P levels, for example $P_{95}$, $P_{85}$, $P_{75}$.

   Advisors 'graduating' from the Tier 3 workshops have an essential role in the on-going training of next generation advisors and as champions of industry agreed CVs and guidelines. Investment in these industry champions provides an informed group to help guide future RD&E. It is also an essential step in addressing the decline in knowledge stocks identified in this study.

<u>Economic evidence required to encourage producers to review nutrient management programs</u>

The study indicates that economic data that demonstrate the impact of strategic fertiliser management on the farm business is needed to engage and facilitate change to current nutrient management practices among a large proportion of the livestock producer population.

If practice change is the desired outcome it is worth noting the observations of Lindner et al (1979) who noted that '.. time to adoption (of an innovation) will be shorter, the more profitable is the innovation…Almost as interesting is the initial expectation about relative profitability of the innovation on the time to adoption….time to adoption ..is directly related to the (decision makers) degrees of <u>pessimism</u> … about relative profitability (of the innovation)… and also directly related to his degree of <u>conservatism</u>, or the … conviction with which he holds this initial expectation…'

These observations are very pertinent to the current levels of conservatism and pessimism of a proportion of producers involved in this study, heightened by the recent drought experience. If, as proposed by Lagerkvist (2005), attitudes are learnt and are the result of past experience the

Millennium Drought has left a legacy. The greater the required shift in attitude, the more compelling the information required (Johnson and Slovic, 1995). This was the case for the more conservative producers at the focus meetings, as supported by comment from the Euroa focus meeting, where producers indicated that they needed 'risk profiles' and 'risk mitigation strategies' of alternatives before they would consider a change to nutrient management strategies.

Advisors report that 'the average' producer lacks economic skills and confidence to invest in nutrient programs aimed at increasing stocking rate. Very few producers (and advisors) understand the complexities of nutrient cycling and quantify the link between soil P status and stocking rate, it is reasonable to assume that <20% of producers are able to make objective decisions based on the return to their livestock enterprise from investment in pasture nutrient management.

There is a need to shift the focus from short-term cash flow implications to long-term outcomes. This study indicates that, at present, most producers and advisors do not collect sufficient on-farm data to link nutrient management strategies to financial outcome, and so do not have the information or the skills to make sound economic decisions on nutrient allocation for pastures that involve long timeframes. There is a need for an economic framework to evaluate system-wide impacts and economic outcomes of action versus inaction for a range of scenarios. The model developed by Scott and Cacho (2000) provides such a framework for wool production systems of the NSW Northern Tablelands, but needs to be expanded to reflect implications for current livestock production systems across the study area.

The study has identified that most producers will not be receptive to the outputs of an economic model. Therefore advisors are likely to be the primary users of outputs. However, the use of the model in conjunction with case studies that present the economic analysis for across a range of production systems and IBRA7 regions would provide the basis for excellent extension resources.

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