Best practice nutrient management: beyond the rhetoric

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KEY MESSAGES

- While the term best practice nutrient management is widely used, it is questionable if growers and advisers know how to translate this to in-paddock actions.
- The contrast between soil phosphorus and soil pH status in WA soils is a key indicator that nutrient and soil management can be improved to deliver greater benefits for WA growers.
- Approaches to improve nutrient management need to be (i) easier to understand and implement, (ii) consider non-nutritional factors like soil constraints, (iii) provide an indication of likely financial benefits and risks, and (iv) assess and review effectiveness.

There is, and probably always will be, a need to "improve" nutrient management (NM) in WA and other food production regions. A whole discussion could be made around what we mean by "improve" but here we mean getting more output relative to the nutrients used. The drive towards improved NM has seen the Better Fertilizer Decisions for Crops database developed (e.g. Speirs *et al* 2013) but this is only one of many dimensions, leaving plenty of scope for improvement.

In many ways, nutrients are used the same way now as they have been for the past 40 years. NM decisions are based on past experiences, recent soil tests and/or rules of thumb and often, without a lot of assessment of likely returns and risks or reviews of nutrient effectiveness. NM practices in WA have not evolved at the same rate as our understanding of soil fertility or the capacity to capture data that could be used to improve NM.

The concept of best management practices (BMP's) for agriculture is not new. BMP's define practices that are scientifically proven and grower tested, improve or optimise production, maximise input efficiency and minimise adverse environmental impacts (Griffith and Murphy 1991). BMP's help agriculture earn a social licence to operate by meeting community and market expectations. Documentation of BMP's and adherence to them, often as part of broader stewardship programs, is generally considered evidence of satisfactory self regulation.

Despite the term best practice nutrient management (BPNM) being in Australian agriculture parlance for about 15 years, it is still a nebulous expression, particularly for growers and their advisers. Poor definition of what management practices are the best makes it hard to gauge if the industry is actually moving towards BPNM.

In this opinion paper, we highlight examples of how current BPNM approaches fail to deliver maximum benefit, provide an explanation of why we think this is the case and then provide some thoughts for an improved system that integrates constraints outside of the current mainstream approach. This paper is motivated by our view that there are significant profit gains to be made for WA growers by improving NM.

Discussion

NM needs to and can improve

Evidence that current NM needs to improve can be found in the contrast between the soil P and soil pH status of WA soils. Recent extensive surveys found 87% of soils had a Colwell-P level above that required for 90% of relative yield while 70% (Weaver and Wong 2011) to 72% (Gazey and Andrew 2013) were below recommended levels for soil pH. If there is

conjecture over what these critical levels should be, perhaps consensus should be our first priority.

The contrast between current soil P and soil pH status is a good example of how NM needs to improve because P fertiliser decisions are often made without considering soil pH, yet soil pH can affect the profit made from P fertiliser. Where soil pH is below recommended levels yield potential is reduced as is the availability of soil P; both of these factors are major drivers of the profit achieved from P fertiliser. When yield was constrained by soil pH, treatments where 20 to 30 kg P/ha were applied did not achieve the same grain yield as treatments with soil pH at or above recommended levels with no or low P fertiliser applied (Scanlan *et al* 2013, Scanlan *et al* 2013b). In this scenario, it seems logical to adjust fertiliser inputs to realistic yield potentials and shift investment to lime.

Water repellence is another soil constraint that affects the response to fertiliser but typically is not included in the fertiliser decision-making process. Water repellence reduces the availability of soil nutrients (Scanlan *et al* 2013b) and reduces yield potential (Davies *et al* 2011). The presence of this constraint requires a choice about mitigation (living with it) or amelioration (fixing it) and the choice of fertiliser strategy depends upon this. This scenario also occurs for other soil constraints; soil compaction, root disease and subsurface chemical constraints.

What is BPNM and does it matter?

While many have heard of the term BPNM, there seems little evidence of its effect on how nutrients are managed on farms. Interpretation of what BPNM means varies widely between growers and even from one season to the next for a given grower. There is negligible understanding and considerable confusion around the strategies, tactics or actions that may comprise BPNM. Many growers think that adopting BPNM is something they should do (but do not); while for others it is a collection of rules of thumb for fertiliser use (Pluske 2013).

Our view is that BPNM is an approach to making the decisions about using nutrients. It is based on good evidence that could be taken from the literature or common practice, but must be verifiable. It is not a set of best practices but describes a path to the decision about NM.

Given BPNM is generally used for direction, we assume it refers to proven decisions and actions that improve the efficiency with which plants use nutrients from soils and fertilisers. This should have flow on benefits to society (starting with profits for growers) and the environment. BPNM is commonly espoused by the industry as evidence of voluntary responsible NM. This is crucial given there is currently no over-arching nutrient use regulation but there is considerable public concern about unintended impacts of using nutrients like food quality, eutrophication of water resources, groundwater nitrate contamination and nitrous oxide emissions. While these are important issues, their consideration within NM as BPNM should consider economic as well as environmental outcomes.

While the intention of the BPNM concept is unquestionable, a lack of a tangible link to “my farm” or “my bank account” means any real changes to NM need to come from those who know more about practical NM, typically growers and their advisers. Experiences from overseas and in parts of Australia suggest stewardship programs are inevitable so it makes sense if we are to make them work they need to deliver real NM benefits, not just lip service.

Current approaches to BPNM

“Cracking the Nutrient Code” (Fertilizer Industry Federation of Australia 2001) is a comprehensive set of guidelines to help individual industries and regions develop their own NM codes of practice. While its target audience is not growers, its NM “toolbox” includes practical items like soil and plant testing, nutrient budgeting, record keeping and the C.R.A.F.T. fertiliser deployment factors of choice, rate, application, frequency and timing.

Many of the code’s principles flow through to Fertilizer Australia (FA) and the Australian Fertilizer Services Associations’ Fertcare® accreditation program, especially regarding the provision of advice to users of fertilisers.

Cracking the Nutrient Code and Fertcare® have successfully collated broad information for awareness and education purposes. It is reasonable to expect knowledge gained in the accreditation program improves fertiliser advice, albeit accreditation of those who are advising on fertiliser use assumes participants already have most of the knowledge they require before they commence their Fertcare® training. Because accredited advisers receive little new information in the program, it seems unlikely new information will filter to fertiliser users after advisers are accredited.

Support of the Fertcare® program has successfully lessened regulatory interference for fertiliser use. However it is questionable whether it has led to wide scale improvements to on-farm advice or fertiliser use. Fertcare® content is often generic so advisers still need to source specific information from elsewhere. Processes, frameworks and templates in programs like Fertcare® tend to be too time consuming for busy broadacre advisers who are after maximum benefit for minimum effort.

It could be argued that Fertcare® is more focused on being seen to be avoiding environmental damage than providing professional development for advisers, their clients or their company. The current value of Fertcare® as a standalone program could be questioned with only three independent advisers from WA listed on the FA website. This is in stark contrast to the AgSafe chemical industry stewardship program which has completed 20 years of industry training. The success of the AgSafe program could be related to the ACCC authorising trading sanctions on businesses not meeting accreditation responsibilities. Maybe the fertiliser industry should consider following this lead.

A common feature in many professional accreditation programs that have initial training or recognition of prior learning is that they require ongoing and documented professional development to maintain accreditation. Examples from Australia include the Certified Professional Soil Scientist, Australian Association of Agricultural Consultants and Certified Practicing Agriculturalist programs. In North America, the Certified Crop Advisor (CCA) program follows this model and has deep penetration in the agronomic community in the US and Canada, and is now being adopted in countries like India and Brazil.

4R Nutrient Stewardship

In recent times, parts of various codes, guidelines and frameworks have been distilled down into the Global “4R” Nutrient Stewardship Concept (Roberts 2007). “Right source, right rate, right time, right place” is a simple slogan that is easily sold. The four fertiliser rights are simple and cover all the practical aspects of NM. They sit within a farming system and aim to deliver efficient, profitable and environmentally friendly fertiliser use. However, even though the foundation and guiding principles of 4R are backed by science, it is largely left to advisers to decide what is right.

4R, like most NM concepts, has a program logic that can be worked through and draws on generic and specific information. Development of such frameworks recognises that every situation is different, but if frameworks are not used they cannot alter NM in any situation.

BPNM needs to result in better returns

Most approaches to BPNM deal just with NM or, even narrower, just with fertiliser management, which is not surprising given a lot of NM approaches come from fertiliser organisations. Even if fertiliser-focussed approaches like 4R are used, they can fail to adequately consider other soil, management and environment factors that can have far greater impact on NM than NM *per se*. NM may be easier elsewhere, but in WA, best practice soil management that considers factors like acidity, toxicities, compaction and non-wetting could deliver better outcomes for NM than BPNM on its own. Examples of this include inefficient use of subsoil moisture and nutrients in dry springs because of subsurface acidity, nutrient stratification, water repellence reducing availability of soil and fertiliser nutrients and major alteration to nutrient profiles by soil renovations like delving and mouldboard ploughing.

There are no widely-used measures to review nutrient use or to check for improved NM. As crude as it is, French and Schultz’s (1984) 20kg grain/mm rainfall has been a widely adopted

yardstick against which water use efficiency has been measured. Similar measures of nutrient efficiency could be used to gauge and benefit NM. Examples include partial factor productivity (kg grain/kg nutrient applied) and partial nutrient balances or nutrient recoveries (ratio of nutrient removed to nutrient applied).

Some broad indicators of recent changes in NM in WA are shown in Figure 1. The major change has been increased use of lime which, given acidity is usually peripheral to BPNM concepts, reinforces that best practice needs to be about more than just nutrients. Another major change that is not so obvious in the figure has been more splitting of nitrogen (to play the season), an improved practice largely driven by a new commercial product in Flexi-N®.

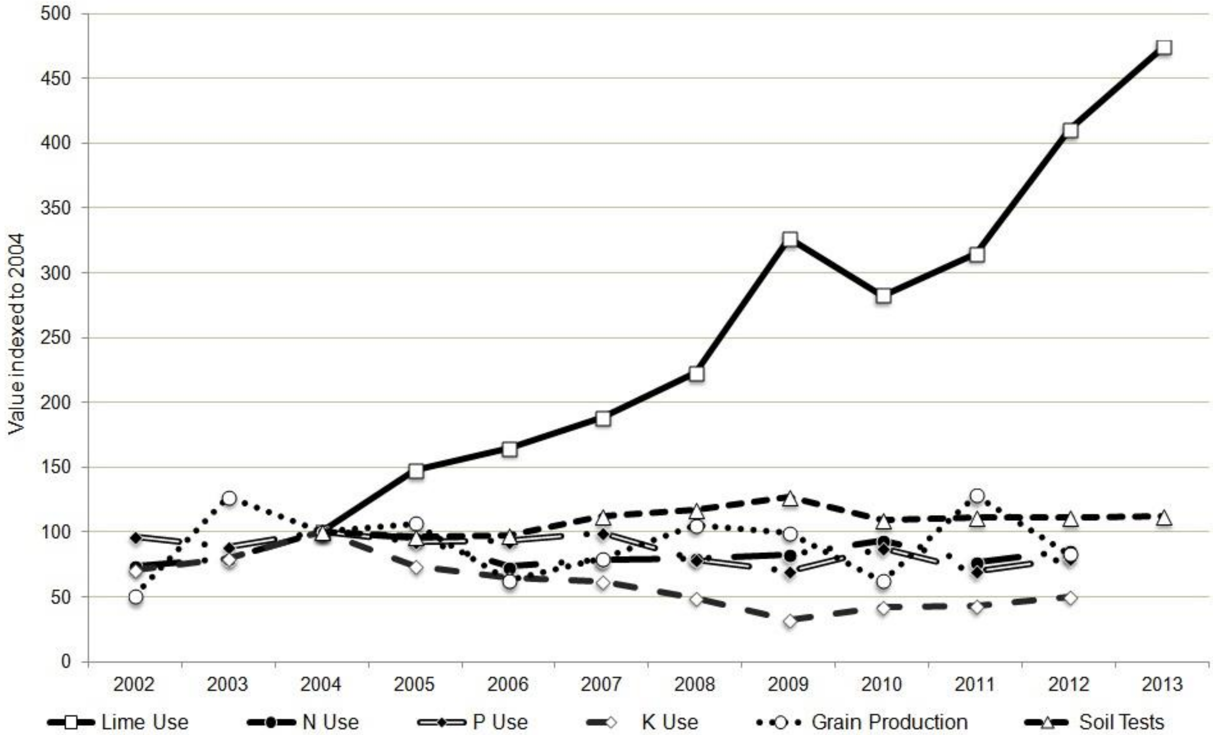

Figure 1 Indicators of nutrient management in WA from 2002 to 2013. Sources of data: Lime use – 2004-12 Gazey *et al* 2013, 2013 Gazey pers comm., N, P and K use – Fertilizer Australia, Grain production – Australian Crop Report, Dec 2013, Soil tests – CSBP.

To be of genuine use, we believe BPNM needs to be flexible enough to suit every situation, easily understood and simple to implement. BPNM should not be time consuming if growers and their advisers are doing it and, while intuitively it makes sense that more complexity will deliver greater benefits, the overall outcome can be reduced when complexity compromises simplicity. For instance instead of using multiple layers of information to go to the nth degree to determine appropriate NM for one part of a paddock, it could be more time efficient and deliver better results to go to a lesser degree across a whole farm.

Thoughts around an improved approach

Given there are already established and pseudo-obligatory programs like Fertcare® in place, it makes sense to further develop them rather than to create new approaches. There is a good chance that FA members will see more commercial, as well as industry-wide, value in programs like Fertcare® if they improve on-farm advice.

We propose the best way to change NM is to focus on financial returns and risks. Increased profitability, especially from a major variable input like fertiliser, is a massive incentive for change. It is also a good indicator of nutrient efficiency and environmental care. Instead of starting with technical detail to (maybe) end up with cost:benefit assessments, it may be better to start with profit and drill down to technical detail where required. This could be

achieved by changing the way information is presented to growers which, in turn, would require some changes to the focus and processes used by advisers. A lot of technical information and fertiliser recommendations are currently provided by time-scarce advisers who, even if they have the desire to do so, may not have the tools to focus on fertiliser profitability and non-nutrient constraints.

Soil tests are a common starting point for NM. Soil testing has a great track record in WA, is a cornerstone for Fertcare® and is crucial to the 4R approach. Often maximum value from soil tests is not realised when advisers who are interpreting test results barely consider where samples were collected from and why. So, unlike the process defined by Speirs *et al* (2013) where site information (like soil type and target yield) is only considered when soil tests are being interpreted and any consideration of profitability is obscure, we believe site information must be considered before soil samples are even collected otherwise test results may be worthless and that the profitability of recommendations must be more explicit.

A starting point for an improved approach to NM is broadly explained below. It has many similarities to the 4R principles which are set within a farming system and have a relationship to other yield limitations like water, acidity and salinity. A key component is determining where to conduct a soil test and why because a targeted approach to site selection that identifies key drivers of productivity delivers greater value from soil testing.

1. Use spatial information to identify areas within and across paddocks that could be managed the same way. Spatial data could be anything from a drive across the paddock through to complex layers of maps, surveys and images.
2. Go to representative sites within the intended management areas to:
    a. Gauge water holding capacity and ground truth the spatial information. This could be based on correlations (e.g. with past yields), in absolute terms (e.g. soil type characterisation for the likes of Yield Prophet) or simply be the relativities of different areas.
    b. Dig and, where appropriate, sample to identify any non-nutritional surface and subsurface constraints like low water holding capacity, non-wetting, acidity, compaction, sodicity and toxicities. Shovels, penetrometers and back hoes are all useful tools.
    c. Confirm or alter the production zones identified in 1 above.
3. Determine if any identified constraints can be overcome cost effectively this season. If not, be prepared to manage inputs accordingly.
4. For each area, estimate likely yield because yield equates to nutrient demand. In the absence of any other data, the average yield for each area will be the most probable yield and will therefore be a reasonable estimate.
5. Soil test to determine cost effective nutrient rates and the most appropriate 4R's combination.
6. Post-season, review NM for each area using objective measures like yield and revenue per kilogram and dollar of applied nutrient, or even a productivity indicator like grain protein.

This approach obviously has several current knowledge gaps, the largest probably being cost effective remedies for constraints. However these gaps already exist with the current BPNM approaches, albeit they are not as noticeable because non-nutritional constraints are rarely an overt part of them.

The realisation of greater profit from improved NM will require a greater investment in time and services by advisers and/or growers. The approach we propose requires more in-paddock participation in the assessment of production zones and soil constraints. It requires advisers to develop additional skill sets, particularly in integrating spatial information into fertiliser recommendation systems. Perhaps current programs like Fertcare® (especially

accreditation of advisers) could put more emphasis on using spatial information and ground truthing in paddocks.

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