

# Decisions used by NSW grains industry advisers to determine nitrogen fertiliser management recommendations

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## Key findings

- Making nitrogen (N) management decisions requires an understanding of soil and plant science, and soil test interpretation.
- Training new agronomists is a priority.
- Senior NSW agronomists identified crop yield expectation as guided by soil moisture at sowing (or at the time of N decision making) as the most important determinant of N fertiliser requirement.
- Further research will increase the understanding of how management practices affect potentially large gaseous N losses.
- Changing from legume pasture-crop sequences to continuous cropping in many central and southern areas of New South Wales is posing new questions for managing N supply. Less frequent pasture legume phases with their N-fixation benefits to the soil is seen as a substantial loss of N-buffering capacity.
- Despite most advisers choosing soil testing as a key approach for determining N fertiliser required, many of their clients had a lower confidence in soil testing, citing 'high perceived variability in soil nitrate results in the lead up to sowing'.

## Introduction

There is concern that grower and adviser decisions related to nitrogen (N) management in field crops are often inaccurate, despite the range of decision tools available to inform and assist. Factors that potentially contribute to sub-optimal decisions on N management include variable rainfall patterns, climate change, declining soil organic matter, using no-tillage, and a declining frequency of legumes in farming systems. A survey was conducted to improve our understanding of how advisers make decisions relating to field crop N nutrition in order to better target assistance to Australian grain growers and their advisers to reduce the uncertainty and financial risk associated with N management.

The survey was conducted across Australian grains regions to better understand the knowledge, perceptions, current practices, and the assumptions underpinning the practices of grain industry advisers when providing advice on N management. This information, combined with a literature review of Australian research into N processes in cropping soils, will help identify knowledge gaps and develop new research programs for grain growing areas.

This paper presents the findings from the NSW component, which included an on-line survey of grains industry advisers and subsequent detailed interviews with a state-wide selection of selected senior respondents to further examine their responses.

## Survey details

A multiple choice survey, based on common questions developed by the national project team, was used to gauge the practices of grains consultants. Hardcopy surveys and email requests were sent out to advisers throughout New South Wales from September to November 2015 using the online portal, Survey Monkey. In total, 132 advisers responded from across the NSW grains area. Of these, 105 provided their postcode, which enabled the geographical spread of respondents to be mapped (Figure 1). Forty-seven percent of respondents were from the northern region, 20% from central and 33% from southern NSW. Given that each adviser represents a client base, the survey results encapsulate advice given to a large cross-section of the NSW grains farming sector.

In addition to the survey, more detailed phone interviews were conducted for 45–70 minutes with 11 senior advisers, grouped by three regions within the state: northern, central and southern NSW. During the phone interviews, the original survey questions were revisited, with the responses explored further using additional open questions and pre-determined prompts.

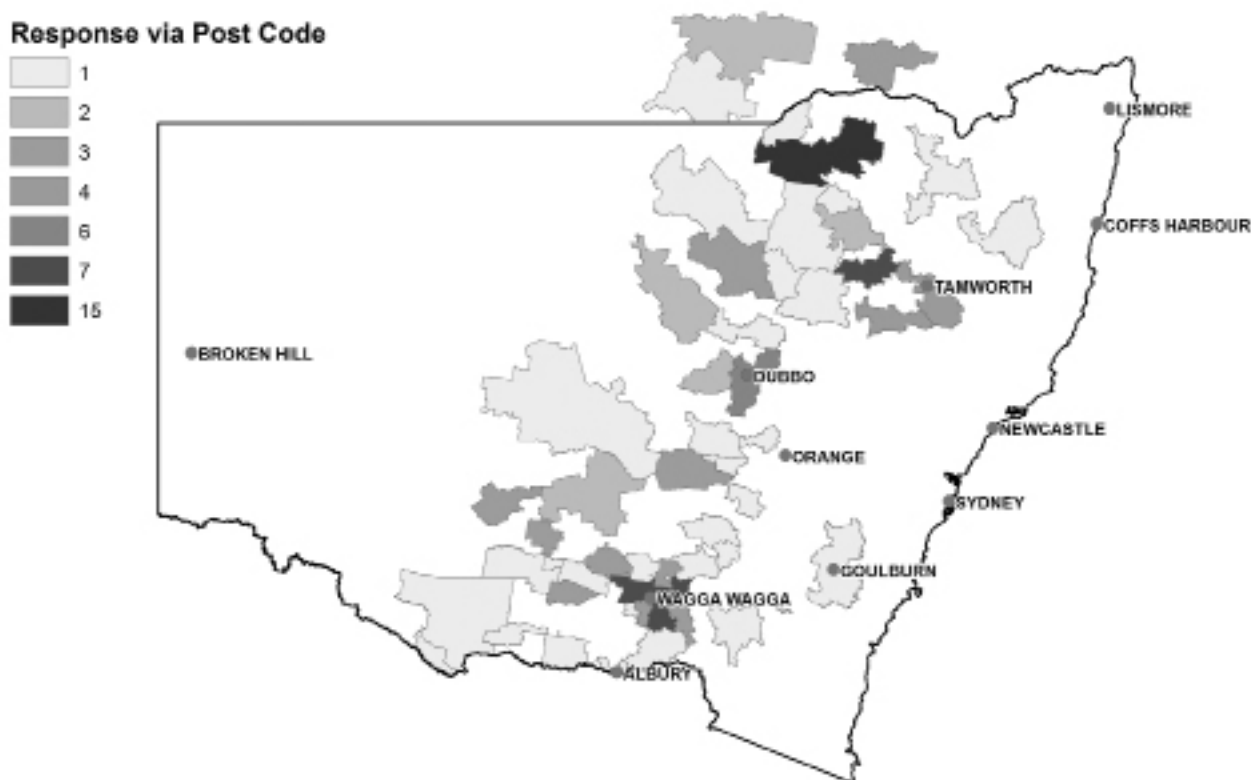


Figure 1. The geographical frequency and distribution of survey respondents by region.

## Results

- Soil moisture at sowing (or at the time of N application decision-making) was identified as the most important determinant of N fertiliser requirement by nine of the 11 senior agronomists interviewed. Other factors considered important included: seasonal conditions, crop rotation, soil testing, financial risk, in-season crop assessment and previous paddock history.
- Respondents used decision support systems (DSS) for some of their decision making. Several of the interviewed advisers said they used DSS tools to help them understand issues and to challenge their thinking under certain circumstances. The learning gained from the DSS is then applied in future decision making. Examples of DSS used in northern NSW included SoilMate™ (Back Paddock Company) and N Balance (Herridge 2011). The John Angus N model/spreadsheet was similarly well respected and used by senior advisers in southern NSW. Yield Prophet was used by several senior advisers (mainly in southern NSW), primarily for helping to develop more accurate yield estimates based on soil water present at the time of decision making. Accurate soil characterisation was considered core to this system's accuracy.
- Senior advisers gained their knowledge from leading experts by attending GRDC Updates, formal training events and personal contact, as well as experience with their own clients. There is an ongoing need for adviser access to expert advice, plus the availability of detailed and well-delivered training targeted to advisers' needs.
- Senior advisers reported that a client's attitude to risk influences their N recommendation, with more conservative growers aiming for a lower input/lower risk system. In some instances, the amount of N applied is limited by available funds rather than a cost/benefit estimate. However, in the higher yielding, more reliable cropping zones of the state, advisers recommend applying higher rates of N fertiliser to maximise long-term profit, and growers generally follow this advice.
- N contribution from legumes is considerable in southern NSW where long pasture phases, dominated by lucerne, are often an integral part of the farming system. However, in central west NSW, farmers are moving away from pasture ley mixed farming to continuous

cropping. Advisers in the centre and north of the state highlighted the low contribution of N from crop and pasture legumes in these areas as a major constraint to production.

- Most advisers believe they have a very good understanding of the mechanisms behind their approach to N recommendations and factors such as mineralisation rates, yield, N and protein budgeting. As a result, most respondents felt their recommendations were generally reliable with the occasional failure when seasonal conditions were contrary to predictions, as occurred in the 2015 season.
- Most advisers felt that their N fertiliser recommendation needed to be within 10–15% of yield potential, and that their prediction of yield potential needed to be within 10–25% of the actual yield. Greater accuracy is not possible due to the many variables affecting yield and the inherent variability in parameters measured or estimated through rules of thumb.
- Soil tests were considered moderately to very important, with testing often used as a tool to help determine recommendations. Senior advisers said it was uneconomic to test as rigorously as was required to achieve a high level of accuracy, and moreover a significant number of growers had confidence issues with soil testing, with perceived high variability in soil nitrate results often reported in the period before sowing. Northern region advisers stratified soil tests by depth increments and were likely to carry out soil testing earlier in the fallow period than their southern counterparts, as N fertiliser is more likely to be applied pre-sowing in this region. In southern NSW, testing is conducted nearer to sowing as N is mostly applied post-sowing.
- Eighty percent of advisers indicated that they account for pre-sowing mineralisation in their recommendations, with 70% also accounting for in-crop mineralisation. Estimates of N mineralisation were usually based on rules of thumb derived from years of research and practical on-farm experience.
- When making recommendations, 86% of advisers accounted for how efficiently plants absorb N, with interviewed advisers commonly using a factor of 50% conversion efficiency of N fertiliser to grain N.
- N losses (leaching or gaseous) were accounted for by 40% of advisers. The understanding of gaseous N losses was better in northern NSW, where research over the past few years had been well publicised, than in southern NSW where no recent field work had been conducted.
- In the online survey, denitrification as di-nitrogen gas ( $N_2$ ) was considered the major source of N loss by 40% of advisers, with a further 31% of respondents stating leaching and 23% stating ammonia volatilisation as the cause for losses from the system. Greater emphasis was placed on denitrification as the key loss pathway in interviews with senior advisers. However, as denitrification losses were generally associated with significant waterlogging events that were difficult to predict and sporadic in most regions, losses due to these pathways were generally seen as outlier events and not considered in N budgeting.

## Conclusions and recommendations

- Senior advisers highlighted the importance of rigorous training in N decision-making, understanding the background soil and plant science involved, and soil test interpretation for the next generation of agronomists. They supported the availability of training courses that included representation from highly experienced local agronomists.
- The understanding of gaseous N losses requires further research, development and extension to the grains industry. Recent field research in the north was limited in scope and produced challenging outcomes that are already leading to large practice changes for when and how N fertiliser is applied. Further research and development work is warranted to answer more of the practical questions growers and advisers are asking in regards to losses associated with certain alternative practices.
- The northern NSW results on N loss pathways are less relevant to advisers in the central and southern NSW regions where N application timing, soil type and climate are quite different from the north. N loss research is recommended for the lighter-textured soils, more typical of central and southern NSW, in regards to the potential for N volatilisation losses from surface N application. Economic outcomes from the various strategies being practiced are

also needed. Nitrogen loss research should focus less on expensive slow-release products and more on optimising results from urea, the cheapest N source.

- Research into better soil water measurement was highlighted as a priority area, especially given the importance all advisers place on this when making N-fertiliser decisions for the cropping season. Zonal management within paddocks is not possible with single site characterisations, so atypical areas of paddocks are over- or under-fertilised.
- Applying N fertiliser early, ahead of a winter cropping season, is a well-established practice in the northern grains region. However, what is not known is how well the pre-applied N might be protected from denitrification resulting from later flooding events. Greater knowledge on specific N use within the profile during the cropping season would assist with decisions related to the accessibility of late-applied N for plant uptake.
- State-wide, agronomists highlighted N mineralisation as an area for greater understanding with regards to the differences caused by climatic conditions, especially rainfall. Better understanding of the N produced from both native organic matter and recent legume pasture residues was also requested.
- There are several useful decision-support tools currently available, with the suggestion to combine the best points of each into one package, preferably available as an app with grower-friendly reports.
- Some advisers noted that farmers don't always have confidence in the accuracy of pre-sowing soil nitrate testing results. This might be related to a range of factors including poor sampling methods, incorrect sample handling, insufficient sample numbers, inadequate service from laboratory analysts, or inaccurate interpretation of the results. Soil testing is often regarded as an expensive option, with some advisers looking for quicker, more cost-effective methods for estimating soil mineral N.
- Some senior advisers see variety-specific N management packages as key areas for continued research funding, as results from some new varieties have been quite different in terms of N uptake and protein outcomes.

## Reference

Herridge DF (2011). *Managing legume and fertiliser N for northern grains cropping*. (Grains Research and Development Corporation: Kingston, ACT, Australia).

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