ARE DISTRICT NITROGEN RECIPES OBSOLETE?

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Summary. District fertiliser recipes have not provided an adequate process to address the impact of soil fertility decline on the profitability of cereal grain production in Queensland. As a major component of the Operation Quality Wheat (OQW) project, a new process of nitrogen (N) management was developed based on established critical grain protein levels for wheat, barley and sorghum. Recording grain yield and protein levels for each crop, combined with strategic paddock soil testing in years when crop yield and protein levels cannot be used, provides many farmers with enough information to greatly improve N management. This process allows farmers to both monitor and understand N management on a paddock by paddock basis regardless of N management options being used. Ninety one percent of participants in the OQW Most Efficient Yield (MEY) project indicated this process represented a significant improvement in N management on their properties. Since 1990, this process has been incorporated extensively in extension publications and extension activities developed to improve whole farm N management

INTRODUCTION

Clearing and development of the major cropping soils in Queensland progressed rapidly from the early 1950's to the mid 1980's with the area of cultivation increasing from 750,000 hectares to 3.3 million hectares. Farming systems used in these regions led to the rapid decline in soil fertility to a point where now many soils can no longer supply the N requirements of cereal and grazing crops (7, 8). Over the same period, rapid advances in crop agronomy (e.g. higher yielding varieties) and conservation farming techniques have increased crop N requirements.

By the late 1980's there had been a rapid increase in the percentage of cereal grain deliveries downgraded due to low grain protein. In 1990, up to 65% of prime hard varieties delivered in some regions in Queensland were downgraded to ASW due to low grain protein (2). Over the period 1984 to 1990 Queensland Barley Board figures indicated the average protein levels for malt barley had been below 10% for 5 out of the 7 years. In 1990, 60% of all malt deliveries in Queensland were below 9% protein which is now established as the minimum desirable protein level for the malting industry. Also, by 1991 depot protein testing for sorghum was introduced in central Queensland to ensure a minimum protein of 9% which had been established as the minimum for export contracts.

This rapid increase in downgradings comes at a time when both domestic and international markets are increasing penalties for low protein grain and increasing the premiums for higher protein quality grain. For example, since 1990 premiums for PH (13% protein) classification of wheat have been up to $98/tonne higher than ASW (10% protein). Malt barley is now only accepted between 8.5% and 12% grain protein. Many export sorghum and feed contracts now set a 9% minimum grain protein content standard.

It was increasingly obvious that district N recipes common in many extension publications (1) up to 1990, were not helpful to many farmers as they offered farmers little or no understanding of the process necessary for improving N management in a strategic or tactical sense.

For the extensive awareness activities conducted by Operation Quality Wheat (Qld)(OQW) and the OQW MEY group activities (3) a new paradigm in N fertility management was developed to address individual paddock N requirements necessary to achieve optimum yield and grain protein levels. N management strategies developed for the OQW project gave farmers a process to both monitor the effectiveness of their N management practices and to refine the management of individual paddock soil fertility.

METHOD

By 1990 it was obvious current information on N management and fertiliser use was not addressing grower needs. Simple recipe fertiliser recommendations were not working as they neither solved the immediate problem of producing quality grain or gave farmers any understanding of the process of N management necessary to achieve optimum yields and protein levels for each specific grain market, particularly when both the production and marketing environments were subject to rapid changes.

As part of an extensive campaign to improve N management, the OQW group developed an integrated series of activities to address this key constraint to cereal production in the northern region. These activities included an extensive number of grower meetings held regularly throughout the region and the OQW MEY project (3). While early activities were designed to increase grower awareness, the majority of the OQW group's activities were designed to initiate the adoption of improved N management strategies which not only provided season by season crop N requirements but also developed a process which assisted farmers to understand the N management decision they had made. To be effective, this process needed to recognise that:

• Each farmer's paddock may be at a different point on the fertility decline curve due to age of cultivation or management practices;

• Each region or soil type may require specific management practices;

• Soil tests were not used extensively and farmers lack confidence in their results when used.

• The immediate paddock history leading up to the planting may vary considerably. For example, long or short fallow, grain legume, oil seed crops, cotton or pasture;

• Farmers needed to see how each N management option can be adapted for each paddock on their own properties.

The strategy used for the OQW project was based on the development of indicators that were either familiar to each farmer or could be easily demonstrated to be essential indicators for improved N management. Key indicators used in the OQW process were:

(a) Recording of crop yield and grain protein percentage

Established critical grain protein levels for wheat (10), barley (6) and sorghum (9) were used as the basis for developing this N management strategy. These critical grain protein indicators can be used to monitor the effectiveness of each management option(fertilisers, pastures, grain legumes or fallowing) adopted, for a particular paddock, in providing the N requirements for specific yield or protein outcomes for each crop. For example, actual paddock yield and protein outcomes can be compared with critical grain protein levels given in Table 1 to decide whether current N management strategies have been effective in achieving optimum yields and desired protein levels for quality grain markets.

Table 1. Using grain protein to refine N management of individual paddocks (4).

Wheat grain protein (11.0% mc)	Barley grain protein (0% mc)	Sorghum grain protein (13.5% mc)	Indicated N supply
Less than 11.5%	Less than 11%	Less than 9%	Acute N Deficiency This Season Grain yield would almost certainly increase with increased N supply (eg. N fertiliser) Protein % will also increase if N supply is

			adequate for optimum yield.
11.5 to 12.5%	11 to 12%	9 to 10%	Marginal N Deficiency This Season Grain yield may increase and protein will increase with increasing N supply.
Greater than 12.5%	Greater than 12%	Greater than 10%	N Not Limiting Yield This Season Higher N supply may increase grain protein. Producing higher protein is only economical if high protein premiums exist.

(b) Strategic Use of Soil Tests

There are a number of situations where cereal yield and protein figures do not provide an adequate record for effective N management. These include:

• long fallow periods which may result in much higher available N supply.

• In rotations after crops such as cotton, oil seeds, grain legumes and pastures.

• cereal crop failure, where high protein levels indicate yield was limited by moisture deficit and significant N residues may be carried over to the next crop.

The latter point is the reason that record numbers of preplant N soil tests were taken in 1995 due to the continued drought. The key to the acceptance of strategic soil testing has been the ability of this approach to link soil test results to crop yield and protein levels over a period of time particularly where responses to N fertiliser or other N management options have been recorded.

For example, in Table 2, the low protein levels obtained with continuous wheat in the zero N treatment would indicate this soil can no longer provide the N requirements of wheat crops. In this situation there is little need to soil test, even after a long fallow (1987, 1992), with low protein levels indicating a consistently low N supply which is also reflected in the preplant nitrate figures.

Table 2. Wheat yield (t/ha) and grain protein% (12% m.c.) and preplant nitrate (kg N/ha, 0-120 cm) for the Warra Fertility Restoration Trial.

Treatment	Year	87[(a)]	88	89	90	92[(a)]	93	94	95
0N CT	Yield	3.6	3.1	2.1	2.2	3.5	1.9	1.10	NA
	Protein	12.6	8.3	8.0	8.3	10.7	9.6	8.6	NA
75N CT	Yield	3.6	4.6	2.3	3.4	3.7	1.9	1.5	NA
	Protein	13.0	12.9	14.5	11.8	13.4	15.1	13.2	NA

CP/W	Yield	4.6	2.9	3.6	4.2	2.2	1.6	NA
	Protein	8.4	10.1	9.4	12.4	11.8	10.0	NA
Preplant (May) nitrate nitrogen levels (kg N/ha, 0 to 1.2 m)								
0N CT		149	54	35	38	89	35	47	63
75N CT		136	97	51	63	179	140	143	168
CP/W		127	107	64	74	139	62	78	86

[(a)] Long fallows due to drought, CT : conventional tillage, CP/W : Wheat after Chickpea

In the 75N CT treatment protein levels tell only part of the story, particularly in the very dry years since 1992. Low yields and high grain protein levels (>12.5%) since 1992 indicate that N residuals would be expected as moisture deficits have restricted crop yield. It is in these years that preplant soil testing would assist N management. As with the zero N CT treatment, low protein wheat grown after chickpea indicates that chickpea does not provide adequate N for following wheat crops in this particular paddock. This is also reflected in the low preplant nitrates after chickpea. Other trials incorporating sorghum and barley have been used to demonstrate these principles. Importantly it is the process of monitoring yield, protein and preplant nitrate that is the key to improved N management for individual paddocks. Previously, district recipes would extend one absolute response figure to a whole region, for example the Darling Downs.

This process has been used extensively with farmers, particularly those participitants of the MEY group process where these principles, used in conjunction with paddock records, were developed and monitored over a sequence of crops.

RESULTS AND DISCUSSION

This process of improving N management is now well developed and widely adopted in extension publications such as the Darling Downs Crop Management Notes, the Central Queensland Crop Management Notes and OQW publications (4, 5). This process is incorporated into extension activities such as the Warra Field Days and incorporated in decision aids such as WHEATMAN plus BARLEYPLAN. The development, extension and adoption of this strategy has been a key concept developed in OQW farmer discussion groups established throughout Queensland. A recent survey of OQW MEY groups indicated that 60% of group participants gave this process a high importance for improving their individual N management while a further 31% indicated it was of moderate importance. Only 9% of respondents felt that this approach was not useful to them. This approach encourages the development of a self help process which a farmer can use to both establish paddock N requirements for each cropping season as well as develop a better understanding of the process required to improve individual paddock N management. As part of the OQW MEY group process this strategy has been developed within an adult education, action learning framework which 70% of the participants acknowledged was a successful methodology which allowed *them* to develop improved N management practices on their own properties. This process will also allow farmers to modify N management strategies as technology and the economics of crop production change.

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