PRIME HARD WHEAT AND MALTING BARLEY - HOW DOES PROFILE NITROGEN INFLUENCE THE FARMER'S CHOICE?

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Summary. Top quality in barley (moderate protein) and wheat (high protein) attracts a valuable price premium, but the associated soil fertility requirement differs markedly between these crops. The farmer, accustomed to soil and climate variability, may not feel confident that a specific quality target is attainable. Short fallow and application of fertiliser at planting ensure that the early needs of a cereal crop for nitrogen will be met. As the season progresses and the potential rate of N uptake increases, it will be taken up from that part of the soil profile where roots are active. Frequently in southern and central Queensland late in the season, the surface 30 cm of the soil is too dry to allow root activity to continue in that layer, necessitating N uptake from deep in the profile. An adequate reserve of deep nitrate thus provides insurance against loss of access of roots to shallow nutrients. In the presence of deep nitrogen the probability of Prime Hard wheat is increased, but that of Malt barley is reduced. Without detailed knowledge of the amount and distribution of soil nitrogen, and of the performance of the root system, the farmer would be hard pressed to optimise gross margins using these two crops.

INTRODUCTION

The nutrients available in many clay soils in the north-eastern subtropics of Australia have declined to a stage where the addition of nitrogen is essential to achieve the potential crop yield in a majority of years (2). Many farmers have adopted a simple fixed rate strategy for nitrogen fertilisation in order to reduce the risk of yield loss due to insufficient nitrogen. During the recent run of dry years in Queensland, a large amount of nitrate nitrogen (N) has accumulated below 60 cm depth in many paddocks, due to low yield or complete failure of crops. This has surprised many farmers who suspected that added N might be lost when a crop failed. Some paddocks remain low in nitrogen because none has been applied and the rundown of soil fertility is considerable.

There is a need to consider the range of possible outcomes when grain crops are grown in soil with different amounts and distribution of N. Farmer experience and research show that when the yield potential set by water supply in any given season is achieved, which depends on a non-limiting supply of nutrients including nitrogen, the protein concentration in the grain will be around 12.5% for wheat (11% moisture basis)(4), and 12% for barley (0% moisture) (1). (These different moisture bases will be used throughout this paper*)*.

Prior to 1990 there was little price incentive for the wheat grower to target higher protein. Variation in protein was often due more to fluctuations of soil water and fertility than to management. The incentive to manage nitrogen in order to increase the frequency of high protein in wheat was increased in 1990 and remains fairly high (Table 1).

The base price for wheat is for ASW (10% protein) with premiums quoted for AH (12.5%) and PH (13%). Malt barley classifications have varied considerably in recent years. Up to 1991, the protein range accepted as *Malt 1* was from 0% to 12% and *Malt 2,* 0% to 13%. In 1994 and 1995, barley was accepted into two location-dependent *Malt* aggregations with grain protein levels of 8.5% to 10.5% and 10.5% to 12%. *Feed* barley, which sets the base price, has protein levels both above and below these ranges.

Table 1. Summary of the evolution of premium prices ($/t) in wheat (above the price for ASW) and barley (above the price for *Feed*) in Queensland.

Crop and grade	Years ‘87-90	Years ‘92-94	Current (‘95)
Wheat PH	$9 to 32	$39-98	$55
Wheat AH	$0 to 7	$7 to 19	$20
Barley Malt 1	$36	$35	$40 to 60
Barley Malt 2	$26	$20 to 35	$40

Further inducement to pursue quality in wheat is provided by the use of the *Prime Hard Varieties* classification, which attracts a premium in the 12.5% to 13.0% protein range. The post-1990 premiums in wheat provide the incentive to manage soil nitrogen towards raising the protein level. In barley on the other hand the premiums have been modest until 1995 and the scope for manipulation is more complex as there is a price loss for exceeding 12% protein, which is the level indicative of optimum nutrition for yield. Farmers, who are fully aware of the quirks of crop performance under variable soil and seasonal conditions, realise that the quest for malting grade barley increases the risk of sacrificing yield. They are content to produce *Feed* barley while the price remains high.

The purpose of this paper is to report on the response of a small sample of farmers to detailed information about soil nitrogen when they are making a choice to plant a winter crop, and to analyse the implications of their responses.

MATERIALS AND METHODS

A limited survey was conducted in which 16 farmers were asked if the presence of deep nitrogen in the profile would influence their choice of planting wheat, barley or chickpea (Table 2). The farmers were drawn from two areas, the western Darling Downs around Chinchilla and from central Queensland around Biloela.

Table 2. Description of mineral nitrogen (**N** in kg/ha) by layers and water (plant available - PAW) presented to farmers from Biloela and Chinchilla in the crop decision study.

	Paddock 1	Paddock 2	Paddock 3	Paddock 4
Soil depth (cm)	**N**	**N**	**N**	**N**
0 - 30	100	10	100	10
30 - 60	0	20	0	20
60 - 90	0	70	0	70
below 90	0	0	0	0

Total N in profile (kg/ha)	100	100	100	100
PAW (mm)	150 (200)[1]	150 (200)	50(100)	50 (100)

[1] Farmers at Biloela were asked to consider a higher amount of soil water, shown in brackets.

The questionnaire was designed to find out if variation in the distribution with depth of profile nitrogen influenced the farmers' decisions with regard to planting wheat, barley or chickpea. It was intended to test whether farmers distinguished between nitrogen at different levels in terms of its likely influence on grain quality. They were invited to report the reason for each choice.

RESULTS AND DISCUSSION

The decisions taken by the farmers are summarised in Table 3. Ten farmers responded at Chinchilla, most preferring barley, and six at Biloela, where there was a strong preference for wheat. Almost half the Chinchilla farmers took the same risky decision as all the Biloela farmers to plant wheat on the dryer profile where the soil nitrogen was mostly close to the surface. Only one Biloela farmer would plant barley and none opted for chickpea, although both these crops were significant in the choices at Chinchilla.

Table 3. Number of the 10 farmers from Chinchilla (C) and the 6 from Biloela (B) who made a crop choice for the paddock conditions shown in Table 2.

	Paddock 1	Paddock 2	Paddock 3	Paddock 4
Crop Chosen	C B	C B	C B	C B
Wheat	2 6	2 5	4 6	0 5
Barley	6 0	7 1	0 0	0 0
Chickpea	3 0	3 0	0 0	1 0
No crop	0 0	0 0	8 0	10 1

At Chinchilla, barley was the preferred crop on the higher level of soil water, perhaps because 150 mm of soil water was not regarded as really adequate for planting wheat, which the farmers felt was less drought hardy than barley. The different location of nitrogen in the profile did not influence the choice for barley. As these farmers were not offered the use of nitrogen fertiliser they would have regarded the production of a moderate level of grain protein as quite likely, especially in an *average* year with a modest amount of in-crop rainfall.

Shallow versus deep nitrogen

The farmers did not differentiate between shallow and deep nitrogen in making a crop choice at either location. Advisers have not hitherto measured nitrogen routinely in the 60 to 90 cm layer, so it is unlikely that most farmers have been prompted in the past to think about deep nitrogen and its potential effect on the level of grain protein. It would be important to provide a clear explanation of the possible effect of deep soil nitrogen if farmers are to do better at achieving a specified grain protein target.

Understanding root performance

It is also important that farmers are made aware of the performance of the root system in the deep clay soils of the sub-tropical cereal-growing region. Observations show that roots of both crops can reach a depth of 1 m within about 8 weeks of emergence, which implies that deep N can play a role around heading and during grain filling if the soil surface has become dry. It should then be clear that deep sampling or other information about the history of the paddock are needed in order to indicate the amount of deep N that is available.

Other nutrients

There appear to be some situations when the grain protein concentration is not increased by the presence of N deep in the profile even when deep water is being taken up. The absence of active roots near the surface reduces access by the crop not only to shallow nitrogen but also to such other nutrients as phosphorus (P) and zinc (Zn). Interactions of deep N, P and soil water could be tested on the Waco clay, for example, or a related soil with high P status to depth, but low availability of Zn may be a problem. In cases where the level of these nutrients in deep soil layers is low either one of them might impose a limitation on growth, thereby lowering the capacity of the crop to utilise N. The presence of specific nutrient limitations when only deep soil water is available would be quite difficult to identify, requiring a missing element fertiliser trial on the farm using placement deep enough to reach the active root zone in a season when the surface remained dry for an extended period. Soil analysis would also be useful.

Timing of fertiliser application

When better information bcomes available about the relative performance of crops under different distributions of soil N, the management of the supply of N to the crop could be improved. For example, it is logical to expect that if N fertiliser were applied at the time of harvesting a crop, some derived nitrate could be located near the depth of penetration of subsequent rainfall recharging the profile. On the other hand application of fertiliser into soil that is fully recharged with water is likely to result in the N remaining near the surface where it is more readily isolated from the active root zone during a dry period. Farmers who have tested the post-harvest application of fertiliser claim that it achieved a better response in the subsequent crop in some years than later application (C. Clark, pers. commun.).

Simulation modelling

When the response to P is well enough understood to be incorporated into a simulation model of crops such as wheat (3) and barley, it should be possible to explore further the issues raised in this paper. A combination of monitoring available soil N (and P where warranted), combined with simulation modelling, has the potential to help explain the response of grain protein in wheat and barley to a range of soil fertility and seasonal conditions. This should be a valuable aid to decision-making by the farmer.

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