AUTUMN NITROGEN FERTILISER: A RELIABLE MANAGEMENT TOOL

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ABSTRACT

This paper develops the concept of autumn N fertiliser as an integral component of farm management systems. A range of examples are given which demonstrate reliable enhancement of late winter/early spring forage availability, despite sometimes slow development of the initial response.

Pasture response to autumn N is broken down into two components, an initial climate dependent response, where climate sets the application window and the rate at which the initial response develops, and a longer term response. This longer term response is consequent on improved pasture management, made possible by the initial N response, and is the basis of real annual production gains, more than simply a seasonal production shift.

Greater management flexibility is also possible, particularly with respect to shifting the production season forward, allowing achievement of objectives such as heavier lambs by critical dates and/or avoidance of drought.

Additional Keywords: *Nitrogen, management pasture.*

INTRODUCTION

Within New Zealand animal grazing systems, N has traditionally been seen as a means of producing an additional bulk of forage to overcome feed with the then prevailing approach to N research which emphasised the magnitude of the initial pasture response, often over as little as 6 weeks. Comparatively few studies investigated subsequent regrowth beyond the first cut. Such an approach led to an emphasis on spring N application because of consistently high (15-25 kg DM/kgN) initial pasture responses at that time of year. Growth expression by existing tillers is the reproductive development emphasising shoot growth relative to root growth, all favouring high short term responsiveness to N.

What was often overlooked in economic terms was the fact that, outside of dairy farms, this was commonly a period of feed surplus with only low economic value for additional feed production. Of the few studies that followed the longer term implications of spring N applications, many demonstrated subsequent slumps in production relative to control pastures. This also detracted from the economic value. These production slumps were probably the result of thinning of the grass tiller population and/or severe reduction of clover stolon populations. Both these effects could be attributed to reduced light intensity near the ground as a result of increased growth when growth rates were already high. We had a situation where, again outside of dairy farms, it was difficult to justify N use apart from boosting yields on hay or silage paddocks.

A refinement of this situation developed with the realisation that, at least in the North Island, earlier applications of N could be used to boost pre-lambing/calving greenfeed supplies. This filled a real economic need as adequate greenfeed supplies were particularly critical to twin bearing ewes in the three weeks leading up to lambing with respect to 'sleepy sickness'. Feeding levels during early lactation were also known to influence subsequent lactation in dairy cows. Lower initial pasture responses to N were acceptable because of the high economic value of additional feed supplies at these times. Recommendations were made to apply N during winter, six weeks prior to these critical times for feed supplies. However there recommendations reflected the dominance of North Island research in this field at that time and were inappropriate for much of the South Island where soil temperatures were too low for reliable

N uptake by pasture grasses during winter (Hoglund, 1980).

About this time the practice of 'all grass wintering' was gathering momentum and spreading from its southern origins. This proved to be an alternative way of providing for pre-lambing greenfeed as well as catering for winter feed supplies. In its early implementations some hay was normally fed and the main emphasis was a shift from winter root crops to greater reliance on grass and the resulting cost savings. Some hay was required because of the difficulty in accumulating a sufficient bulk of feed to get onto the 100+ day winter rotation. These problems were exacerbated on the drier eastern part of the South Island where unreliable autumn rains are a normal climatic feature, often resulting in only a short period of time in which to accumulate feed to get onto the winter rotation. Increasing emphasis on high fecundity ewes was also increasing demands for pre lambing greenfeed. Matua prairie grass as a special purpose greenfeed was promoted as one solution, but there was still a feed shortfall for early lambing flocks. Autumn N had been tried but damned in the past, because of variability in the short term responses. However, interest was rekindled with the realisation of the high economic value of additional pasture at this time of year, particularly when considered in the context of 'all grass wintering' systems and low winter soil temperatures.

RECENT PERSPECTIVES

Mr Peter Brooker, who farms 242 ha at Maruia has made the transition from winter swedes pre 1980 to his current management of all grass wintering in conjunction with autumn N (Brooker, pers.com.). Benefits include improved wintering of his 3200 stock units, apparent frost tolerance of the pasture, greater management flexibility and a lower labour requirement to manage his system than previously. He also specifically notes the reliability of this system, despite some variability in the rate at which the initial N response develops. At 135% lambing, reliability of pre-lambing greenfeed is a necessity.

In 1982 a grazing system trial was set up at DSIR Lincoln to look at the longer term implications of regular autumn N application in a lamb production system involving high fecundity ewes grazing ryegrass/white clover using 'all grass wintering' principles under dryland conditions. The most striking result obtained from 4 years data collection was the enhancement to 12 month per hectare animal production; 50 kgN applied in autumn allowed an extra 2.2 ewes to be carried with 2.8 extra lambs and 9.0 kg extra wool (Hoglund & Pennell, 1989). An important contrast between this experiment and most of its predecessors was the fact it was a closed system. This meant that despite the increased stocking rate on N treated pasture, not all of the increased growth was eaten and this was in turn reflected in increased post grazing residual yields (Fig.1).

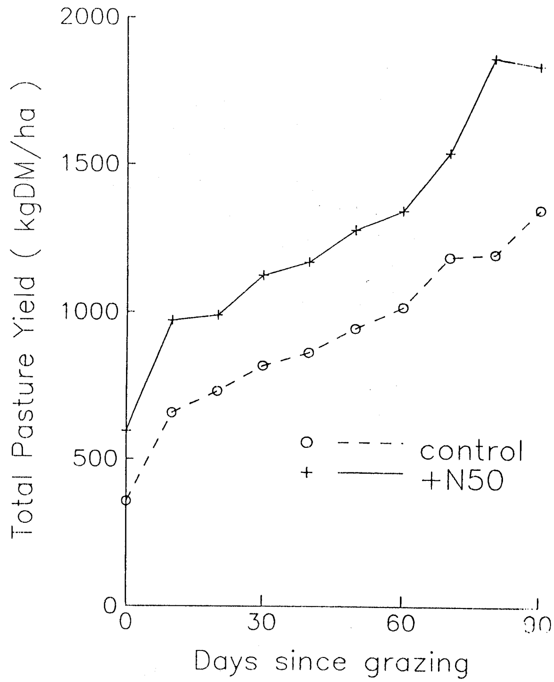

Figure 1. **Typical late July feed profile.**

Increased post grazing residual yields in the above heavily stocked trial equated to improved pasture management, the ongoing effect of which was to cause an apparent persistence of the N response until drought arrested growth in late spring/summer (Fig. 2). Despite the normal range of of climatic variability over the four years which caused variation in the rate at which the pasture response to N developed, autumn N reliably increased availability of pre-lambing greenfeed and the condition of the ewes at lambing.

Reduced grazing intensity had also previously been shown to be associated with increased N

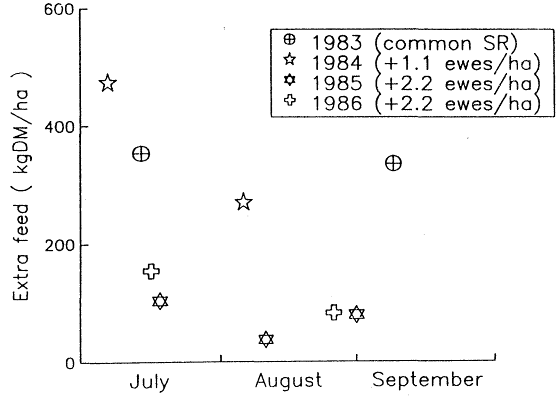

Figure 2. Pre-lambing feed budget boost by 50 kg autumn nitrogen.

retention in sheep grazed pastures (Fig. 3: Hoglund, 1985). The postulated mechanism was through allowing greater carbon input to the soil organic matter which in turn provided a substrate to stabilize soil N which might otherwise be leached. Confirmation of this effect was possible in the above autumn N fertiliser trial which showed the N fertilised treatment to have accumulated an additional 590 kg C/ha and 70 kg more N/ha over the trial period (Table 1). Because of reduced N-fixation on the N fertilised treatment, net N input was only 6 kg/ha/annum greater than for control pasture, or only about a third of the observed increase in soil accumulation (Table 2). This increased N retention was obtained despite the higher stocking rate on the N fertilised treatment. Higher stocking rates are more commonly associated with increased N losses (Steele, 1982).

Another estimate of efficiency in the system can be made by determining the apparent N recovery in the pasture. A conservative estimate of increased pasture production required to sustain the additional 2.2 ewes, plus associated lambs, for 12 months is 1,600 kg DM. this is equivalent to a N response of 32 kg DM/kg N, or at 3.5% N in the herbage, equating to 112% recovery of the applied N fertiliser. These figures also suggest reduced N losses in the N fertilised pastures leading to greater recycling efficiency.

From our perspective, undue weight has been placed on short term N responses when in fact the major economic benefits may be associated with increased management flexibility. For example, in a sheep grazing system the major benefit flowing from autumn N use may be associated with the opportunity to adopt an earlier lambing date. This could in turn allow target lamb weights to be achieved earlier in the season, earlier drafting and less stress on the ewes over summer. similar principles have been demonstrated for winter N applications on a Taranaki research dairy farm (Roberts & Tomson, 1989), where N in combination with earlier calving produced greater economic benefits than either option in isolation. Not only was milk production in the current season higher, but cow condition was improved indicating probable desirable carry over effects to the following season.

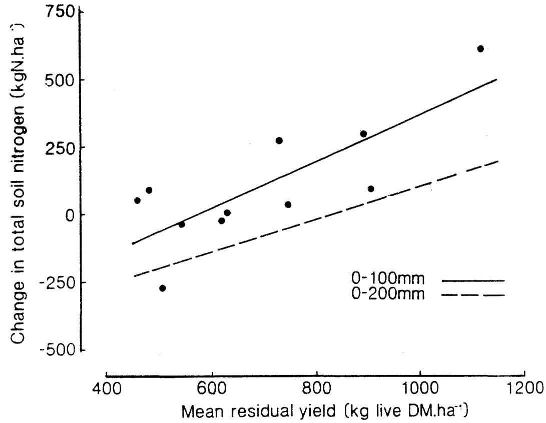

Figure 3. Influence of grazing intensity on 3 year change in soil nitrogen (from Hoglund, 1985)

It may also be wrong to simply look at the pasture N response only on that part of the farm receiving N applications. The major benefit may accrue to the balance of the farm through, for example, being spelled for a longer period than would otherwise be possible as a result of animals spending a higher proportion of their time on the area receiving N.

To anyone contemplating use of N the twin questions of what rate over what area must be addressed. Traditional studies have determined response curves for varying situations. Commonly, linear responses to increasing rates apply at the lower rates with diminishing returns at higher rates. Examination of this type of data led to the conclusion that the best responses are obtained from pastures with a high proportion of improved grasses, such as ryegrass, and where appreciable pasture cover was present at time of N application (Ball & Field, 1982). While this recommendation may produce the best short term responses, a number of additional factors should be considered to optimise long term benefits and management flexibility.

Table 1; Five year accumualtion of soil nitrogen and carbon (kg/ha 100 mm)

	Nitrogen	Carbon
Control	425	3,970
Autumn N50	495	4,560
Significance	*	*

Table 2: Soil nitrogen balance (kg N/ha per annum).

	Control	Autumn N50
N fertilizer	0	50
N fixation	169	125
Total N input	169	175
Soil N accumulation	85	99
Estimated N losses	84	76
N retention (%)	50	57

Perhaps the biggest danger from simply following the above recommendation is the tendency to use too much N on the most responsive areas. Particularly during winter, when light levels are low, there is a high probability of reducing tiller numbers through shading caused by excessive herbage accumulation. In order to avoid loss of tillers, and herbage quality, it may be necessary to graze the area earlier than desired, resulting in a reduction in management flexibility. By way of a contrast, if the additional growth was spread over a larger are then there would be less risk of detrimental effects and an increase in management flexibility. A common observation following N application to 'average' pasture is that there is a subsequent improvement in the pasture composition, leading to longer term benefits. Autumn N has also been shown to enhance the recovery of pastures ravaged by pasture pests, such as grass grub and Argentine stem weevil, through boosting tiller growth and stimulating the formation of new tillers. Because of lower herbage levels in these damaged pastures, extra tillers are likely to be retained over winter, a contrast to trends in denser, light stressed swards.

These considerations lead us to the conclusion that long term benefits and management flexibility are both likely to be enhanced by spreading the budgeted N over as high a proportion of the farm as possible at comparatively moderate rates. Lowest practical rates for uniform urea application are in the region of 25 kg N per ha. Maximum rates to avoid shading and loss of tillers are probably in the region of 50 kg N per ha., even if short term response curves indicate linear responses to higher levels.

A further consideration is when to apply N. To optimise management flexibility and economic gain, it is important to achieve just the right amount of additional feed at the required time. There is no point in applying N too early in autumn if the requirement for additional feed is in late winter. The risk is excessive shading and loss of longer term production. Applications should be delayed until a better appreciation of feed supplies is possible, although applications should be made before 10 cm soil temperatures fall below about 10 degrees.

Finally on the question of reliability of autumn N responses, it is essential that all forms of N are applied during, or immediately prior to, conditions conductive to achieving plant N uptake. These conditions are not always in line with those considered desirable for field work by those investigating N responses. Failure to adhere to these guidelines may have contributed to less favourable assessments of the reliability of autumn N in the past. The application window with the right combination of soil moisture and temperature may be quite short and optimum responses may require applications during rain over a weekend. During the course of the DSIR trial mentioned previously, a fair cross section of Canterbury autumns were experienced, including late autumn rains followed shortly after by frosty conditions. In those years the pasture did little more than green up in the first instance but always resulted in greater growth by the time the additional feed was required in late winter. Similar experiences are reported by Peter Brooker and other farmers.

In conclusion, we believe that autumn applied N is a potent management tool because of its potential to enhance management flexibility and be a reliable growth generator, not simply a growth accelerator as has often been the case for N applied at other times of the year. Many of these features are associated with opportunities created for improved pasture management and associated improvements in the efficiency of recycling of N within the pasture/soil ecosystem.

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