NITROGEN FERTILISER MANAGEMENT WITH ZONE CHARACTERISATION IN GRAZED PASTURE SYSTEMS

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Introduction

Spatial information is frequently used for managing the inputs (nutrients, water, energy labour etc.) of arable crops. The idea of developing management zones is often to enable accurate supply of such inputs for local crop needs and a historical focus is on nitrogen supply. This helps avoid excessive introduction of nutrients into the environment, and also to reduce fertiliser costs. Despite the success of this concept in arable farming, it is a poorly adopted practice for the management of grazed pastures.

Grazed pasture systems have an additional level of complexity compared to the mono-species canopy of most annual crops. Pastures are typically perennial in nature with short intervals between harvests (by a grazing animal) and therefore, require frequent fertiliser applications to maintain biomass production. Additionally, pastures often consist of two or more desirable plant species and the distribution of waste from livestock results in many small patches of very high nutrient content.

We propose a concept to create management zones of grazed dairy pastures, using attributes of pasture paddocks that are substantially linked with the nitrogen turnover for the biomass. The basic assumption is that in a well-managed pasture the farmer needs to ensure provision of only the amount of nitrogen that the forage biomass will take up. That demand can, to some extent, be met through the plant available N in the soil (including legume assimilated N) and other sources (N from atmospheric deposition, effluent or slurry application etc.). Thus any information on probable nitrogen availability across a paddock supports decision making for variable rate application of N-fertiliser.

The target of the concept discussed here will be to identify zones of most likely high nitrogen availability and use this information to estimate the required local fertiliser target. The spatial information required for this approach may include:soil variation

- irrigation
- animal density
- slope
- farm infrastructure (i.e. troughs and shelter)
- previous pasture fertilisation
- N-export by animals
- previous pasture growth

Using readily available geographical information systems, spatial attributes of features relevant to plant available nitrogen can be utilised to create map layers. These layers can then be spatially related through estimations, balance calculations or simple rule-based models (e.g. if-then logics). Subsequently, zones for the application of varying amounts of fertiliser can be delineated at the sub-paddock scale. We are in the process of deriving response curves for N-ramps on selected paddocks in NZ and Australia which have sufficient spatial variability of the mentioned site characteristics.

Deriving criteria for N-availability

Nitrogen is influenced by several factors across a landscape, and the availability of this information will vary for different farms. Key data which could contribute to creating an assessment of N-availability include:

Nitrogen availability information	Data source (farm level)	Effect on nitrogen availability
Paddock infrastructure and the link to cattle distribution	Paddock maps (i.e. fences, water troughs, gates, shelter belts)	Can be used to derive areas of high use by livestock (i.e. increased time spent at gates and troughs). Relates to non-fertiliser N application and soil compaction.
Spatial livestock distribution across pasture (non-fertiliser N-input sources)	Livestock tracking or producer experience of high and low visited areas	Increased N availability in these areas over time due to non-fertiliser inputs.
Topography	Survey maps (elevation and slope)	Informs potential N use efficiency of plants which is influenced by aspect and soil moisture.
Soil compaction	Combination of soil type, paddock infrastructure and cattle distribution	Compacted soil may limit N use efficiency of plants.
Soil moisture	Electrical Conductivity (ECa) mapping	Different soils have different nutrient/water holding capacity. This will influence denitrification, leaching and mineralisation rates of N.

In order to make use of these data layers they first need to be individually assessed for influence on N-availability. Once the relationships are established, the spatial information layers can be compiled and used to create zones of expected plant available nitrogen with simple agronomic understanding of the local nitrogen cycles.

Deriving fertiliser application rates

Depending on the available spatial information for a farm, there are several potential approaches for data integration to determine N availability zones:

Last rotation based

This approach requires biomass yield maps from the previous rotations. An example of how this can be achieved is by using technology such as the Pasturemeter®, which can link measured biomass to location with a GPS. Additionally, with a correlation of biomass amount to nitrogen-uptake a prescription map to replace estimated previous N-uptake can be derived. This information can contribute to understanding of previous nitrogen availability across a farm.

Using GIS-based farm information management systems

Any nitrogen related spatial data can be included in this analysis. These layers of information can be compared spatially and allow for manually adjusted N-fertilisation recommendations.

Model based management
Building on the previous method, layers of data can be weighted based on the contribution to N-availability. The resulting map can be used to further define N-availability zones.

On-farm validation
Several statistical methods are available to analyse spatial layers to create zones across an area. Validation of zones for New Zealand grazing production systems is essential for several reasons. Firstly, the management zoning methods available have predominantly been applied to arable farming situations which are not influenced by the presence of animals and short growth cycles. Secondly, inaccurate zoning may result in significant under- application or utilisation of applied nitrogen fertiliser.

In order to monitor the accuracy of N-availability zones created we propose the following methodology:

      1. Create N-availability maps based on spatial data layers

      2. Establish N-response trials with 'N-ramps'

      3. Monitor biomass dry matter production and nitrogen content over time

      4. Evaluate sensitivity of nitrogen fertilisation from N-availability maps.