by Rory Shaw, PhD student, University of Bangor

Using nitrate soil sensors to increase sustainability

Optimising the use of nitrogen (N) is one of the major goals of sustainable livestock farming from both an economic and environmental standpoint.

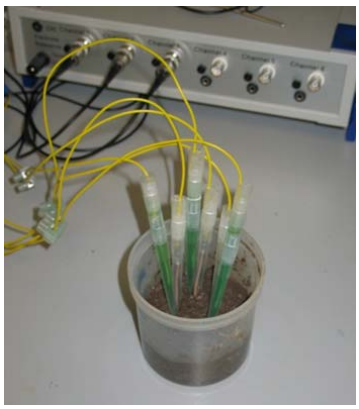
While there have been thousands of studies investigating different management strategies for optimising N use, translating this research into practical management advice and subsequent adoption by farmers has been patchy. There is still a long way to go before N is used efficiently within the UK livestock sector.

Sensor technologies

For my PhD I am aiming to demonstrate how applying new sensor technologies can enable practical management of N on livestock farms.

Knowing the level of nutrients in the soil helps achieve optimal yields because inputs can be applied precisely. However, for soil N, ensuring supply meets but does not exceed demand is extremely tricky.

N application levels in excess of crop requirements are costly to the farmer and in some situations can result in harmful effects on the environment. But under-fertilisation risks a reduction in yield which can incur extra costs of buying-in expensive supplementary feed.



Due to the dynamics of the N cycle, soil N concentrations can vary and change quickly in response to inputs, weather changes and crop uptake. Currently testing soil nitrate concentration is costly and time consuming. There is also a delay between sampling and application which can make results difficult to interpret.

I am currently working on developing new sensors to continuously monitor the presence of nitrate in a soil solution.

The sensors consist of ion-selective electrodes which detect and convert the activity of a specific ion dissolved in solution into an electrical potential. This is then measured by a voltmeter and converted into a reading of the amount of nitrate in the soil solution.

These sensors could be coupled with a wireless device to allow farmers or agronomists to remotely monitor soil nutrients.

Testing in the fields

So far most of my work has been in the lab, building and testing the sensors. This spring, I will begin testing them in the field.

The trials will be taking place at Bangor University and comparing grass/clover swards receiving no N fertiliser, to pure ryegrass leys receiving inorganic N fertiliser.

The study will examine the effect of clover inclusion on grass yields and greenhouse gas emissions. It will also aim to determine equivalent rates of N fertilisation at different clover densities. The nitrate sensors will be used within this study to better understand N dynamics in the soil of grass/clover swards.

Real-time monitoring

In future, sensors may be constructed as sensor networks within fields, to allow real-time monitoring throughout the growing season. More detailed monitoring around times of fertiliser application will help farmers understand how to maximise resource use efficiency.

The applications for this type of technology are endless. As well as being extremely useful in research programmes, it could also be the starting point for targeted fertiliser applications based on real-time data, meaning farmers can apply N fertiliser exactly when and where it is needed.

Further reading

This project is co-funded by EBLEX, DairyCo, HCC and QMS. More information can be found on our website or watch DairyCo's video.

For more information on fertiliser application download the EBLEX BRP manual Managing Nutrients for Better Returns or download DairyCo Grass+ Chapter 11: Optimising Fertiliser Practice.

EBLEX studentships

EBLEX is currently funding 20 PhD and 2 MSc studentships – find out more on our website.

Another three of them are looking at grass and forage questions:

- **Intensive pastoral production systems for beef – impact and value**
  University of Bristol and North Wyke Farm Platform

  Understanding the environmental impact of intensive grass based beef production systems is an important factor in establishing and improving their sustainability and efficiency. Potentially, pastoral systems can provide a high level of production of higher value product, in terms of fatty acid and vitamin composition. However, they have also often been criticised as inefficient and polluting. Well-managed grassland systems have the potential to store more carbon in the soil, but we have a poor understanding of the carbon losses from the system.

- **Use of stable isotopes to quantify carbon sequestration in managed grasslands**
  The James Hutton Institute and University of Aberdeen

  This project aims to develop a more detailed understanding of how grassland management techniques can be employed to optimise retention of carbon, thereby improving grassland productivity and helping to address the global issue of elevated atmospheric carbon dioxide (CO_2). The project will apply novel stable carbon isotope measurement techniques, developed at the James Hutton Institute, on an established grazing experiment in Scotland. Comparisons of these data will be made between areas subject to differing grazing regimes, aiming to deliver practical and useful data on carbon cycling in grassland soils.

- **Understanding the genetic basis for slow plant-mediated proteolysis in festulolium hybrids**
  Aberystwyth University (IBERS)

  Forage from current ryegrass cultivars consumed by ruminant animals is broken- down too quickly in the rumen causing an excess of nitrogen which is excreted as harmful environmental waste. Freshly eaten forage is broken down by rumen microbes but recent studies have shown that this process is highly inefficient due to plant-mediated "shock" responses to hostile rumen conditions such as high temperatures (39°C), no oxygen, and total darkness. The consequence is an imbalance between protein availability and energy required by rumen microbes that leads to a poor protein capture by the ruminant.