

The North Wyke Farm Platform: A new UK national capability for research into sustainability of agricultural temperate grassland management

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Abstract. The North Wyke Farm Platform is a new UK National Capability that will enable studies that can be closely monitored and controlled under different land-use options at the farm-scale. As a Biotechnology and Biological Sciences Research Council -funded National Capability, the Farm Platform provides centralised scientific facilities including core data (field and water chemistry, water flow rates, greenhouse gas emissions from soils, livestock and agronomic data, and farm management records). Access to the Farm Platform for experimental work or to data will be available to other research users and collaborators. This shared approach will enhance the depth and breadth of information gained for the benefit of the wider community.

Keywords: Livestock production; water quality; environment.

Introduction

The concept of being able to increase significantly output from the same area of land and at the same time reducing any possible environmental impact is outlined in the Foresight (2011) report 'The future of food and farming: Challenges and choices for global sustainability'. Modern farming practices have a major impact on the landscape and farmers can influence the wider environment in pursuit of higher agricultural production. Strategic research to achieve sustainable food production requires controlled experiments operating at the farm scale. The information that is required cannot be obtained from commercial farms as the intensity of monitoring involved and the sophistication of modern instrumentation employed needs a permanent presence of trained technical staff.

UK grasslands occupy 67% of the utilisable agricultural area and support a total of 10 million cows and calves and 32 million sheep and lambs with a net worth to the UK economy of around £8 billion per annum. They also provide a number of other key ecosystem services including supporting (*e.g.* water and nutrient cycling), regulating (*e.g.* climate regulation), cultural (*e.g.* recreational), and biocontrol (*e.g.* source of predatory organisms) services. Despite the importance of these services much agricultural research is focussed at a fundamental level. The pressing need is to integrate such fundamental studies into a systems based framework at the farm scale and allowing us to meet the challenge of optimising the production of grasslands whilst at the same time minimising any impact on the environment. In order to achieve this there is an urgent need to develop long-term experimental monitoring platforms that will allow us to develop such systems that are

both fit-for-purpose and practical for the farmer. The UK Biotechnology and Biological Sciences Research Council have funded the establishment of such a facility – the North Wyke Farm Platform (NWFP). This platform facilitates studies on the sustainability of grassland management systems. The NWFP uses recent advances in technology to capture the data necessary to develop a better understanding of the dynamic processes and underlying mechanisms that can be used to model how agricultural grassland systems will respond to management inputs. Data monitoring, mathematical modelling and experiments are being brought together within a well-resourced, collaborative and integrated research environment. The NWFP was commissioned in April 2011 (Orr *et al.* 2011) as a large farm scale experiment, established as a UK national capability for training and knowledge exchange in agro-environmental sciences (Hatch *et al.* 2011).

Methods and Materials

The North Wyke Farm Platform is a large, farm-scale experiment which was established during 2010 as a UK national capability for collaborative research, training and knowledge exchange in agro-environmental sciences which addresses agricultural productivity and ecosystem responses to different management practices. Since the Farm Platform was commissioned in April 2011 a standard beef and sheep system has been implemented across the site in order to obtain baseline data in hydrology, nutrient cycling and productivity.

The underlying principle is to manage each of three farmlets of approximately 22 ha (Griffith *et al.* 2013) in different ways: improvement through use of mineral fertilisers; improvement through use of legumes; improve-

ment through innovation. The connectivity between the timing and intensity of different management operations and the transport of nutrients and potential pollutants from the farm is being evaluated using the latest sensor technology coupled with more traditional field study methods. Detailed farm management records allow us to better understand processes and underlying mechanisms that will be used to model how agro-ecosystems will respond to changes in management and help us to respond to the challenges of sustainable grassland farming.

Site description

The NWFP is located at North Wyke in the south west of England (50.46°N, 30.54°W), on land with soil suited to grassland agriculture which historically has been used for grazing by sheep and cattle. The 10 year mean annual rainfall at the North Wyke site is 990 mm with a mean air temperature ranging from 6.6-13.4°C. North Wyke has relatively high and consistent summer rainfall which is characteristic of major grassland areas in the UK. The soil is a slightly stony clay loam topsoil (approx. 36% clay) overlying a subsoil of mottled stony clay (approx. 60 % clay) with an interface at approximately 30 cm depth. The topsoil is permeable, and the subsoil is highly impermeable. This feature, along with the topography, allows us to channel all the water leaving each field through a flume (15 in total) via perforated plastic pipe drains which are back-filled to the surface with stones. Each of the 15 flumes is fully instrumented to enable flow rates to be measured and water samples to be automatically collected and analysed.

Instrumentation and measurement

The uniqueness of the facility lies in the level of instrumentation and in the range of parameters that are being measured. These are discussed in detail in Griffith *et al.* (2013), for water quality the instruments sit in flow-cells at each flume and report back to the data servers via a radio-telemetry system. These sensors record every 15 min during periods of sufficient water flow (≥ 0.02 L/s). Likewise the rain gauges and soil temperature probes also report at 15 min intervals. Herbage yield and quality is determined on each field and live weight gain of all the animals is recorded. The core data collected from across the Platform (Table 1) will be available to all research users and collaborators in accordance with the Rothamsted's and BBSRC's commitment to ensuring that the Farm Platform is a truly National Capability.

Baseline data, which reflects the way in which the

North Wyke farm is currently being managed (Beef and Sheep), was gathered between April 2011 and March 2013 before the new treatments were imposed. However, one of the treatments will be an extension of the baseline management system, therefore continuing as a control. The underlying principle is to manage each of these Farmlets optimally, but using different strategies and record the impact on water, air and soil in addition to data relating to the farm operations.

Management scenarios

The management scenarios in place in the initial phase of the work all address different ways of sustainably managing beef and sheep production:

Sustainable intensification of permanent grassland (Sward improvement through increased fertilisation).

In this system we will increase the use of industrially produced fertilisers which will increase the carrying capacity of animals.

Increased use of legumes (Sward improvement through introduction of legumes).

Clover based systems can replace up to 150 kgN/ha of industrially produced nitrogen, contribute to high protein and high digestibility forage; have high animal intake and performance; and are suitable for both grazing and conservation. With current international costs of oil and gas rising, the cost of fertilisers is also increasing and potentially farmers might have to become there could be more reliance on nitrogen biologically fixed by clovers. In this system we will enhance the current [low] levels of clover in the existing permanent pastures by direct reseeding or over-sowing the existing sward. We will not rely on clover alone to supply the nitrogen, but we will supplement with manures and low levels of bagged fertiliser. Here we would anticipate that animals would finish faster and there would be a lower carrying capacity, but there may be both a quality and economic advantage.

Planned reseeding (Sward improvement through reseeding).

There are 1.2 million ha of temporary grassland, *i.e.* pasture that is < 5 years old. Approximately 1/3 is reseeded each year in the UK, so reseeding is therefore an important management system. Reseeding pastures with newer varieties should increase animal production in the first

Table 1. Parameters measured in the North Wyke Farm Platform

Water chemistry (at 15 flumes)	Soil parameters (at each farmlet)	Atmosphere	Farm management
Nitrate	Soil Moisture	Rainfall	Liveweight gain
Ammonium	Soil Temperature	Temperature	Field inputs
Dissolved Organic Carbon	pH	CO ₂ and N ₂ O	Field outputs
Turbidity	Bulk Density		Farm activities
Water Flow	Soil N, P & C Status		Labour hours
Temperature	Soil Biology (PLFA)		Machine hours
Conductivity	Decomposition		
pH			
Dissolved Oxygen	Plant Diversity		
Phosphate (at 3 Flumes)			

years. With a planned reseeded it is possible to include new pasture varieties and traits into the farm. New varieties (high sugar grasses, deep rooting grasses) can be easily incorporated as can other species such as chicory.

Conclusions

The NWFP has three tenets: (1) Research and Collaboration; (2) Knowledge Exchange; and (3) Commercialisation and Training. The NWFP complements other grassland systems research. It provides a 'Research Hotel' to attract researchers from different communities and disciplines to promote new ideas or tackle old problems in new ways. It is globally unique in that it can provide the research community access to a range of in situ state-of-the-art instrumentation in hydrologically isolated fields and farmlets with a very high degree of control over management inputs to better address key issues in sustainable agriculture. The NWFP will provide enhanced capacity through a national facility for research, translation and training. It will contribute to international networks of models, experimental and monitoring platforms. The NWFP provides training for graduate students, post-doctoral scientists and other researchers who spend time at North Wyke.

In short, the NWFP provides a holistic approach to understanding grassland management at the systems level. It is a platform from which production can be intensified,

but the environmental costs will be known. It will provide evidence of the sustainability that each management system can achieve. It will become a showcase for sustainable intensification and information integration and it will provide the link between people who write policy, people who influence policy and the general public.

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