A farm platform approach to optimizing temperate grazing-livestock systems: metrics for trade-off assessments and future innovations

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Global agriculture is at a critical juncture when competing requirements for maximal production and minimal pollution have led to the concept of sustainable intensification. Livestock production, especially ruminant livestock is central to this debate. Ruminants make an important contribution to global food security by converting feed that is unsuitable for human consumption to high value protein, demand for which is currently increasing at an unprecedented rate. Sustainable intensification of ruminant livestock production may be applied to pastoral grazing, mixed-cropping, feedlot and housed production systems. All these systems have associated environmental risks such as water and air pollution, greenhouse gas emissions and soil degradation, as well as issues affecting production efficiency, product quality and consumer acceptability, such as reduced animal fertility, health and welfare, reflected in the development of agricultural sustainability policies. Further, in many societies livestock represent a resource far greater than just food, e.g. fibre, draught, fertiliser, fuel, bank and social. These challenges necessitate multidisciplinary solutions that can only be properly researched, implemented and tested in real-world production systems which are suited to their geographical and climatic production practice, e.g. temperate grassland.

The North Wyke Farm Platform (http://www.rothamsted.ac.uk/farmplatform) was established during 2010 as a UK national capability for collaborative research, training and knowledge exchange in agro-environmental sciences. Its remit is to research agricultural productivity and ecosystem responses to different management practices for beef and sheep production in lowland temperate grasslands. Following construction, a typical beef and sheep system based on permanent pasture receiving chemical fertilisers on first grade pasture (>60% perennial ryegrass) was implemented across the 67.2 ha farm platform in order to obtain baseline data on hydrology, emissions, nutrient cycling, biodiversity, productivity and livestock welfare/health for 2 years (April 2011 to March 2013). Since April 2013, the platform has been progressively modified across three distinct ca. 22 ha farmlets with the underlying principle being to improve the sustainability (economic, social and environmental) by comparing contrasting pasture-based systems (permanent pasture, grass and clover swards, and reseeding of high quality germplasm on a regular cycle). This modification or transitional period ended in July 2015, when the platform assumed full post-baseline status.

In this paper, we summarise the sustainability trade-off metrics developed to compare the three systems, together with the farm platform data collections used to create them; collections that can be viewed as 'big data' when considered in their entirety. We concentrate on the baseline and transitional periods and discuss the potential innovations to optimise grazing livestock systems utilising an experimental farm platform approach.