A European approach to facing the challenges of climate change in ruminant agriculture

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Researchers at the Institute of Biological, Environmental and Rural Sciences (IBERS), Aberystwyth University have recently led a European collaborative review summarising present research in mathematical modelling of European ruminant production under climate change. The review highlights future developments and challenges to be faced.

The scientific principles of climate change relating to agricultural practice are reviewed in a recent Farming Connect Technical article. Amongst many challenges for the farming sector in the future, changing practices to cope with the effects of climate change and working to reduce greenhouse gas (GHG) emissions, are two of the most important.

European scientific modelling is working to establish how climate change is going to affect agricultural practices in Europe over the coming years. The modelling process is highly complex and in the future will also need to incorporate on-farm management practices which are developed in response to climate change.

The effects of climate change on agricultural production will be both direct, through effects on factors such as yields or health, and indirect, through changes in the spread and abundance of pathogens and pests. It is therefore essential to inform the agricultural industry of the issues likely to be faced in the coming years.

Animal Health and Welfare

Some effects of climate change on livestock pathogens and diseases have already been observed. However, we can expect to see further changes, with changes in the spread of pathogens and alterations in seasonal disease risk, infection patterns and intensity. Many pathogens and vectors are sensitive to changes in temperature and rainfall amongst other environmental factors. Mathematical modelling can be used alongside pathogen related experimental research to predict the spread of pathogens and vectors, based on ecological and climatic data. This predictive work is essential for vector borne diseases such as blue tongue virus, for which the government predicts a high risk of spread to the UK by the end of summer 2016.

A further worry in terms of animal health and welfare is the effect of heat stress in cattle. With the frequency and intensity of heat waves increasing in southern Europe, both animal production and welfare are likely to be detrimentally affected, especially in the dairy sector. Management and housing strategies will need to be modified to help combat these issues. Both regional and global modelling can be utilised to identify hotspots where management practices or farming policy may need to be altered.

Grassland Productivity and Biodiversity

There are expected to be wide differences in the effects of climate change on grassland productivity across Europe. The north of Europe is likely to see extended growing seasons with warmer weather and higher rainfall, whereas southern European regions are likely to experience extended bouts of drought. For both areas both the yield and nutritive value of the grassland need to be predicted. Modelling productivity and nutritional value is particularly challenging for permanent grasslands, with the need to incorporate multiple species, as well as improving the characterisation of soil and water processes. Beyond the growing season, models also need to take into account the effect of changes in winter conditions, such as changes in snow-fall and the effects of frost. Improved modelling of potential increases in phosphorous run-off (due to increased and heavy rainfall) has also been identified as a priority by researchers, as part of a wider concern to better model extreme weather events, which are expected to increase under climate change.

Over the coming years, grassland management will need to change in order to adapt to novel environmental conditions. These changes alongside the effects of climate change are likely to affect grassland biodiversity in Europe. Bio-economic optimisation models are essential in this instance to understand how wider management changes will affect the biodiversity, and to find the most economically efficient way to meet biodiversity goals. This type of modelling provides vital support to policy makers, ensuring that the agricultural industry is able to get the most out of the land whilst limiting damage to local ecosystems. It can also highlight 'win-win' management options, where improving environmental conditions can help to sustain production in the long term. Further knowledge about the co-existence of plants, invertebrates, birds and animals within ecosystems and food-webs is necessary to improve modelling.

Environmental Impact of Farms – Greenhouse gas emissions

The main sources of methane from agriculture are rumination and manure (from housing, slurry pits or spreading). There are opportunities to mitigate the release of methane from farm systems through alterations in management. Because methane represents energy lost from the production system, changing management to reduce emissions means efficiency savings for farmers. The representation of such changes is an important area for model development, alongside the need to incorporate climate change based variations in animal disease and welfare. Beyond the farm, life cycle analyses, which incorporate GHG emissions from transportation and feed production are important in enabling policy makers to consider the whole picture when making choices about support for mitigation strategies.

In terms of climate change mitigation, European grassland has great potential through carbon sequestration in the soil. Modelling shows how grassland management can be successfully balanced to allow for effective mitigation, whilst also being utilised as productive land for ruminant production.

What does the future hold?

Scientific modelling to predict the effects of climate change on agriculture is an ongoing process. The models must be relevant for the real world and so need to be informed both by scientific knowledge and by information from farmers and farm advisors. Furthermore, the socio-economic factors relating to policy choices need consideration, requiring cross-disciplinary work to link economic and environmental modelling. Educated policies are required for the future to minimise manmade emissions and maximise production efficiency, creating as sustainable a ruminant production industry as possible.

Over the coming years, ruminant production systems throughout Europe are going to need to adapt to environmental change. Farms will not only need to cope with management changes to maintain current production, but also improve their environmental footprint, through mitigation and improvement of factors such as grassland carbon sequestration. This will be a big challenge for the ruminant farming industry, but the further development and use of mathematical models will enable policy makers and farmers to explore the options and consequences of their choices in a climate change world. In order for such developments to take place, cross discipline communication and knowledge transfer between farmers, scientist and modellers, needs to be advanced.