Meeting the challenges of prioritizing land use – the role of agricultural science

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Concerns about the global security of supplies of food, water and energy have gone beyond lectures and articles and are now being taken forward in a raft of reports and initiatives. Agricultural science is centre stage in a way that would have seemed unthinkable to many of us even five years ago. It is appropriate that much of this research will address issues of productivity of the individual organism, through breeding and protection against pests and disease, seeking to ensure that production is achieved in a resource-efficient way, and is resilient to the increasing variability of weather and changing climates. Such research helps address how to get more agricultural production out of the land. However, it does not address the question of which land to use for agricultural production, nor does it address the question of how optimum patterns of land use (should they exist) be brought into being.

Optimisation and prioritisation of land use address the fact that that there are different outputs from the land, with different values, that vary across space and time. These outputs include agricultural production of course, but also include other ecosystem services, such as climate regulation, flood management, cultural heritage and so on. They also include potential value for land transformation into and (more usually) out of agriculture into, for example, urban development, forestry and coastal set-back. A key question for agricultural science is, therefore, which ecosystem services we expect from agricultural land, and the extent to which their joint production is possible, as opposed to requiring segregation of land into different functions. It turns out that, for grassland systems at least, increasing levels of agricultural production tend to be associated with *decreasing* levels of many other ecosystem services. This gives three ways forward; either segregate land, go for less intensive production methods, or seek new methods of agriculture that avoid these conflicts. Such questions require a more holistic ecosystem science, in which agricultural research is but one component - as is being taken forward by the UK National Ecosystem Assessment.

Suppose we explore how to segregate land into different functions. In principle, it is easy to optimise land use by function according to environmental character. But this assumes that we know the value of each function. Such methods of valuation are being developed for ecosystem services, but it's worth recalling how transient some of these values are. Environmental quality is increasingly characterised in terms of carbon, very different to the emphasis on biodiversity in the 1990s. Also, different people place different values on different functions and different areas of land, making consensus difficult to achieve.

But even if such consensus could be achieved, would our national land prove capable of providing our needs anyway, no matter how well it is parcelled up? Current UK agri-food systems are extremely expensive in energy and water by the time they reach the consumer. So we need to start looking at agri-food systems that deliver human needs (perhaps needs as opposed to desires) within manageable global environmental footprints. For example, perhaps it is inappropriate to divert soya that could provide protein for people into animal feed. Our prioritisation of land use may involve prioritisation of human expectations.

If forecasts of population, social, economic and climate change are anything like robust, it will prove hard for us to adapt our land management to meet human needs in the coming decades. The evidence base will require the integration of agricultural science with the other developing sciences that address global change; this is a wonderful opportunity for a new kind of systems agricultural science, drawing on new farm-scale experimental facilities like the one being developed at North Wyke Research as well on latest developments of genomics.

But the science we need does not all have to be so grandiose. A great deal can be learned by combining information from many much smaller experiments, whether undertaken by scientists or by farmers as they adapt to changing conditions. Is there scope for evidence-based agriculture, as is already happening in medicine? If so, how should it be organised ?

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