Global challenges: land use for food and energy – 2020 and beyond

P J Gregory
SCRI, Dundee, United Kingdom
Email: peter.gregory@scri.ac.uk

Until recently, there has been a widespread working assumption in many rich countries that problems of food production have been solved, and that food security is largely a matter of distribution and access to be achieved principally by open markets. The events of 2008 challenged these assumptions. Today, for the first time in almost a quarter of a century, food is back on the political agenda. There are many reasons for this including:

- the increased demand for food, especially meat, in the rapidly growing economies of Asia;
- the demand for land to grow biofuels;
- drought and severe flooding in diverse countries, and awareness that water for crop and pasture production is limited;
- diseases associated with the food consumed in rich countries; and
- the increasing awareness that changing climate may profoundly affect the zones of major food production globally.

The imperative to achieve food, energy and water security for an increasing global population with an increasing demand for meat is further complicated by environmental changes such as altered land use, modified biogeochemical cycles and changed and/or more variable climate. The growth in the human population from about 3.0 billion in 1960 to 6.6 billion in 2008, coupled with increased income and changes in diet, has been accompanied by substantial increases in crop and animal production (2.67-fold for cereals, 1.64-fold for roots and tubers and 4.02-fold for meat). This increase will need to be maintained if the projected population of 9 billion by about 2040 is to be sustained. Past increases in crop production have occurred as a result of both extensification (altering natural ecosystems to produce products) and intensification (producing more of the desired products per unit area of land already used for agriculture or forestry). Of the world's 13 billion hectare land surface, only about 3 billion ha is suitable for crop production and about one half of this is already cultivated (1.4 billion ha in 2008). The remaining potentially cultivatable land is currently beneath tropical forests but it would be undesirable to convert this to arable land because of the effects on biodiversity conservation, greenhouse gas emissions, regional climate and hydrological changes, and because of the high costs of providing the requisite infrastructure. While extensification may contribute significantly to crop production in sub-Saharan Africa and South America, elsewhere intensification will be the dominant means of increasing production.

It is widely recognised, then, that only a small proportion of future increases in crop production will come from the cultivation of new land, but forest may continue to be cleared for ranching and grazing of animals. The main means of intensifying crop production will be through increased yields per unit area together with a smaller contribution from an increased number of crops grown in a seasonal cycle. As cereal production (wheat, maize and rice) has increased from 877 million t in 1961 to 2,342 million t in 2007, the world average cereal yield has increased from 1.35 t ha^{-1} in 1961 to 3.35 t ha^{-1} in 2007, and is projected to be about 4.8 t ha^{-1} in 2040. Simultaneously, per capita arable land area has decreased from 0.415 ha in 1961 to 0.214 ha in 2007. Put another way, had the increases in yield of the last 60-70 years not been achieved, almost three times more land would have been required to produce crops to sustain the present population; land that, as indicated above, does not exist except by using some that is unsuitable for cropping. Continued intensification of crop and animal production systems is anticipated.

Climate change will bring opportunities for agriculture in some regions but enhance existing problems of food and water security elsewhere, particularly in communities that are poor and with limited capacity to cope with, or adapt to, environmental shocks. Food security is underpinned by effective food systems, which are a set of dynamic interactions between and within biogeophysical and human environments (Gregory *et al*. 2005; Ericksen, 2008). A substantial challenge now and beyond 2020 will be to achieve the levels of food, energy and fibre production required in ways that contribute to fair access and utilisation by all human communities sustainably.

References

Ericksen, P.J. 2008. Global Environmental Change. 18, 234-245.
Gregory, P. J., Ingram, J. S. I. and Brklacich, M. 2005. Philosophical Transactions of The Royal Society B, London. 360, 2139-2148.

https://doi.org/10.1017/S2040470010005054 Published online by Cambridge University Press