

Food, Fuel and the Environment: implications for land use in Europe and beyond
Ben Allen and Hannah Lee
November 2010

1 SUMMARY

With finite resources Europe faces significant challenges in delivering sustainable food production, meeting rising bioenergy demands, and ensuring the protection of the environment, both within its borders and beyond. How much of these commodities do we need in the future; how will they be produced; and where will they come from; are all key questions in the debate over future land use in Europe.

2 LAND AND LAND USE

Land is a finite resource; it can be changed, developed, or eroded, but only in exceptional circumstances created. Although this may seem an overly generalised view of land availability it provides a useful context in which to view the spatial constraints as they relate to land and the way it is used.

In absolute terms land is finite based on the limit of its physical presence (*the total area of land*), and its suitability for any particular purpose (*the accessible area of land¹*). Land use is rarely strategic and current patterns represent historical developments rather than optimal placement. The different approaches that countries take to land use reflect many national variables, including planning systems, institutional structures, socio-cultural characteristics, population pressures and environmental priorities (Keenlyside *et al*, 2009).

Within a fixed area of land, changing the way land is used can cause disproportionate effects on the availability of land for other purposes. These changes can be seen between different types of land for example the expansion of urban areas has significant implications for the rural environment and often on high quality agricultural land (e.g. Royal Society, 2009; Montgomery 2007; Nizeyimana *et al*, 2001; EEA, 2006b; IAASTD, 2009; Verzandvoort *et al*, 2009). Or the changes can be observed within a particular land use for example the change in crop type on arable land. These changes can be direct, occurring where one land use is substituted for another, or indirect land where the substituted land use is displaced to a less valuable use. Indirect land use change effects have become synonymous with the on going debate over biofuels but it is important to recognise that this is a consequence of any driver of land use change (Kretschmer, 2010).

Economic value therefore plays a significant and complex role in these changes driven largely by productivity (e.g. EEA, 2010b; Plantinga *et al*, 2002) or its potential for development (EEB 2006b), and changes in the way land is used can also be

¹ In production terms this is often referred to as the Utilised Agricultural Area (UAA), i.e. the area of land that is suitable for the production of agricultural goods including associated woodland and scrub.

reversed where land or certain commodities become less profitable leading to abandonment, change in crop type, or change in use. This economic factor involved with change has wide ranging consequences especially for the natural environment, which despite recent efforts to apportion value based on the services provided by biodiversity (e.g. The Economics of Ecosystems and Biodiversity (TEEB, 2010)), remains largely unvalued by commodity markets. These can include habitat loss, isolation of species populations, over use of natural resources such as water

In response to the predicted increases in demand for energy and food, idle² or marginal³ lands have been considered areas into which to expand production. Though these areas appear unproductive they are nevertheless working, and therefore being used, delivering 'services' such as biodiversity protection, water filtration, and recreational space⁴ (Foresight Land Use Futures Project, 2010). Across Europe for example many nature reserves owe their existence to their inaccessibility to agricultural production. Bringing marginal land into production can involve considerable investment and lower average yields, while possibly incurring social and environmental costs (OECD & FAO, 2009).

In Europe policy interventions are used to counteract some of the negative consequences of land use change, e.g. the protection of designated areas to avoid conversion to (intensive) agriculture or the compensation of farmers in less favoured areas to avoid land abandonment and depopulation (Verburg *et al*, 2010; Koomen *et al*, 2008; Oñate *et al*, 2007). However, despite these interventions the increasing demands for land based products and services in Europe are causing land use patterns to change causing concern over abilities to deliver environmental targets as well as those of sustainable production (EEA, 2010b). This pattern of land use change driven by increased demand can be seen around the globe and due to the increasingly integrated nature of commodity markets the consequences of demands in the developed world, particularly the EU, are felt on a global scale.

3 DRIVERS OF CHANGE

3.1 Food

Estimates of population increases vary, but the emerging consensus is that the world will have approximately 9 billion people by 2050 (UN, 2008). Predictions of future food demands to meet these population increases also differ, some suggesting up to a 70% increase by 2050 (FAO, 2006), but even the most optimistic scenarios require increases in food production of at least 50% (Royal Society, 2009). The fact that remains inescapable is that the global population is increasing and will need a secure and healthy supply of food.

² Idle land is land that was cultivated but is now in a state of disuse (OECD, 2010) with the potential to be re-cultivated. Idle refers to its state as productive land and may include abandoned land or fallow land.

³ Marginal land is land of poor quality with regard to agricultural use, and unsuitable for housing and other uses. (OECD, 2010). Another interesting definition with regards to 'real estate' 'Land with little immediate usefulness because of problems with access, water control, topography, environmental restrictions, or other such factors' (Evans & Evans, 2007).

Although global food security⁵ is not just about producing enough food but also ensuring people have access to it (Ericksen, 2008), and that supply chains are efficient, there will likely need to be an increase in production to meet growing demands. This is partly driven by changing and converging diets in particular consuming more meat⁶, fats and refined cereals, and fewer traditional cereals, vegetables and fruit (Royal Society 2009). Increasing the accessibility and distribution of current global food resources will play a major role in meeting growing food needs and is a key factor in determining if there is enough food being produced from the land available.

3.2 Bioenergy

In response to the need to combat climate change, and become less reliant on finite resources for energy, many governments are proposing to expand the use of liquid biofuels, and solid biomass to power parts of their transport sectors and provide heating and power. Global trends in the production of agricultural feedstocks, for biofuels in particular, have recently been on the rise due to an increase in demand generated by renewable targets in the EU, and elsewhere around the globe (i.e. in the US and Brazil).

In 2009 Directive 2009/28/EC on the use of energy from renewable sources, known as the Renewable Energy Directive (RED), was adopted by the EU replacing two previous directives (2001/77/EC, and 2003/30/EC). This new and wider directive (now including the provision of heat from renewable sources) set out the binding target for 20% of final energy be produced from renewable sources by 2020, (differentiated across the Member States), as well as another binding target (this one fixed across Member States) to provide 10% of transport fuels from renewable sources. As the 23 recently released National Renewable Energy Plans (NREAPs) outlining projected biofuel use indicate, by 2020 a total of 26 Mtoe (million tonnes of oil equivalent) of biofuels will be used by Member States (Atanasiu, 2010). This represents an increased use of biofuels of 16.6 Mtoe.

The European Commission estimates that reaching the target of a 20% renewable energy share could multiply total biomass demand from agriculture and forests by a factor of 2 to 3 (European Commission, 2006). This however, assumes a substantial increase in efficiency of biomass production and use. It is anticipated that conventional biofuels produced from agricultural crops such as soybeans, rapeseed and maize will contribute up to 92% to the total predicted biofuel use required to meet increased bio-energy needs (Bowyer, 2010). In contrast to conventional biofuels, advanced biofuels and solid biomass that are used for heating and power can be produced from waste sources or forestry. Therefore the use of these fuels will

⁵ As defined by the 1996 world food summit “Food Security, at the individual, household, national, regional and global levels [is achieved] when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life” (FAO, 2006).

⁶ Already more than one-third of the world’s grain is fed to domesticated livestock (rising to nearly 70% in some industrialised countries) (Royal Society, 2009).

have different land use impacts as they are not in direct competition for arable land in the way feedstock biofuel crops are.

4 THE LAND USE CONSEQUENCES OF EXPANDING EU DEMAND FOR ENERGETIC BIOMASS

Over the short to medium term (to 2020) the expanding EU demand for biomass (for energy and food) is unlikely to be met through technological advances with intensification and precision agriculture offering more realistic opportunities to increase crop production, certainly within the EU, although it is unclear just how this potential will be mitigated by the cost of inputs, machinery, resource fluctuations, and environmental policy limits. Expansion of agricultural areas seems increasingly likely as a response. This however raises questions about how much additional production can be accommodated within the farmed area of Europe without eliminating a substantial area of more extensive production, much of which is important from the perspective of biodiversity, landscape and other environmental public goods (Baldock *et al*, 2010).

With the driver for the promotion of the use of more renewable energy sources being the reduction of green house gas emissions the consequences for land use and other land based services appears to be largely overlooked. Sustainable use of resources be it for energy or food production requires a wider scope of consideration. With land use changes and the intensification of existing agricultural areas the sustainability of increased food production to meet predicted demands, and the use of biofuels to meet Europe wide targets is questionable.

Efficiency in current systems, both for energy and food, poses one potential solution. By reducing waste and becoming more efficient, increasing the nutritional and energy content of existing crops, reducing energy use, and adopting new technologies, the need for intensification and expansion could be reduced.

Over the medium to longer term (2020 onwards) the development of new technologies and crop varieties may begin to contribute to increased yields. However these are likely to still be reliant on (artificial and natural) inputs to the system and given even the optimistic yield increases required it is unlikely that modified crops would be able to contribute without some need for expansion especially if this increased production is to be sustainable. It is difficult to forecast the extent to which the new markets for bioenergy and food will be met from European rather than imported sources. This depends on a wide range of factors (see Baldock *et al*, 2010).

What seems certain is that there will be (continuing) changes in land use patterns in response to bioenergy and food production drivers. These may be direct changes through specific growth of biofuel feed stocks or the indirect changes caused by displacement of other less economically productive land (uses) (Kretschmer, 2010; Bowyer, 2010).

The EU is already the world's second largest importer of food and largest of biomass for energy, moreover, it is currently reliant on imports of fossil fuels. With land value and market drivers viewed at the global scale it is highly likely that the global supply chains for food and bioenergy will further expand agricultural production in the developing world creating international land use changes. This may be mitigated to some degree by the need to ensure security of supply and source an increasing amount of food and fuel domestically.

Irrespective of the drivers the changes in the way land is used have direct and indirect consequences. When considering the need to produce more biomass for fuel production, or the need to increase the amount of food grown on land, it may be more important to consider the land available as the resource for the production of all of these commodities and how this can be used sustainably rather than focussing on the individual commodities that it produces.

There is therefore a need to consider more holistically Europe's resource needs and the global consequences of an increasing international land use footprint. This will involve the move away from what is currently separate thinking on agricultural (and forestry) production of food and fuel. Within the EU agricultural sector the wider consideration of what different areas of land provides for society is already being considered, this thinking needs to be integrated across other land uses and drivers if we are to truly understand the impacts and solutions to managing and using land for the needs of an increasing global population.

5 REFERENCES

1. Atanasiu, B (2010) Analysing the importance of bioenergy to the delivery of the renewable energy Directive – reviewing Member States Commitments under the NREAPs.
2. Baldock, D., Gardner, S. and Keenleyside, C. (2010) Scoping the development of the environmentally sustainable production agenda. A paper prepared by IEEP for the Land Use Policy Group.
3. Bowyer, C. (2010) Anticipated indirect land use change associate with expanded use of biofuels and bioliquids in the EU - an analysis of the National Renewable Energy Action Plans.
4. European Commission (2006) An EU Strategy for Biofuels. Com(2006) 34
5. EEA (2006b) Urban Sprawl in Europe. The Ignored Challenge. EEA, København, EU.
6. EEA (2010b) Land in Europe: prices, taxes and use patterns. EEA Technical report 4/2010
7. Ericksen, P. J. (2008). Conceptualising food systems for global environmental change (GEC) research. *Global Environmental Change* 18, 1, 234–245.
8. Evans, D. L., and Evans, O. W. (2007) *The complete real estate encyclopedia*. The McGraw-Hill Companies, Inc.
9. FAO (2006), *World Agriculture: Towards 2030/2050 (interim report)*. An updated version, with extension of projections to 2050, of two of the key chapters (2 and

- 3) of the study Bruisnama, J (ed) (2003), World Agriculture: Towards 2015/30, Earthscan, London.
10. Foresight Land Use Futures Project (2010) Final Project Report. The Government Office for Science, London.
 11. IAASTD (2009) Agriculture at a Crossroads. Global Report
 12. Keenleyside, C., Baldock, D., Hjerp, P. & Swales, V. (2009) International perspectives on future land use. *Land Use Policy*. 26S (2009) S14–S29
 13. Kretschmer, B (2010) The land use implications of EU bioenergy policy – going beyond ILUC
 14. Montgomery D (2007). *Dirt: the Erosion of Civilizations*. University of California Press.
 15. Nizeyimana, E.L., Petersen, G. W., Imhoff, M. L., Sinclair, H. R., Waltman, S. W., Reed-Margetan, D. S., Levine, E. R., and Russo, J. M. (2001) Assessing the Impact of Land Conversion to Urban Use on Soils with Different Productivity Levels in the USA. *Soil Sci. Soc. Am. J.* 65:391–402.
 16. OECD (2010) OECD glossary of statistical terms. Accessed 14th November 2010. <http://stats.oecd.org/glossary/detail.asp?ID=1276>
 17. OECD & FAO (2009) *Agricultural Outlook 2009-2018*
 18. On˜ate JJ, Atance I, Bardajı I, Llusia D (2007) Modelling the effects of alternative CAP policies for the Spanish high- nature value cereal-steppe farming systems. *Agric Syst* 94:247–260.
 19. Plantinga, A. J.; Lubowski, R. N. and Stavins, R. N. (2002) 'The effects of potential land development on agricultural land prices', *Journal of Urban Economics*, 52: 561–581, available at; www.rff.org/documents/RFF-DP-02-11.pdf [accessed March 2010].
 20. Royal Society (2009) *Reaping the benefits - Science and the sustainable intensification of global agriculture*.
 21. TEEB (2010) *The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB*. <http://www.teebweb.org/>
 22. UN (2008) Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, *World Population Prospects: The 2008 Revision*, <http://esa.un.org/unpp>, Thursday, October 28, 2010; 12.04 GMT.
 23. Verburg, P. H., van Berkel, D. B., van Doorn, A. M., van Eupen, M., and van den Heiligenberg, H. A. R. M. (2010) Trajectories of land use change in Europe: a model-based exploration of rural futures. *Landscape Ecology*. 25: 217-232
 24. Verzandvoort, S., Rietra, R & Hack, M. (2009) *Pressures on prime agricultural land in Europe*. Alterra, Wageningen UR