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# The afforestation of upland slopes in the United Kingdom a food security threat or environmental opportunity

James Reilly

*School of Biology, University of Aberdeen*

**Abstract**

*The UK is not self-sufficient in food, the population being too great and the land being insufficient. Arable production is the most efficient type of food production in terms of energy use and conversion. It has the least impact on climate in terms of Green House Gas (GHG) production. The UK has a high proportion of agriculture land and little forest. The expansion of forest onto land which is only suitable for livestock farming has a benefit of reducing GHG production. The afforestation of upland slopes which are used in livestock farming will not have a significant effect on UK food security, because agricultural production is low, and the UK relies on imports. Additional benefits will be realised where afforested land is managed under continuous cover systems.*

**[Keywords]:** Forestry, Climate change, Food security

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## INTRODUCTION

The United Kingdom (UK) has considerably more land in agriculture and less in forest than either the world or European Union (EU) averages. Around 71% of the UK land is in farmed agriculture (Defra, 2019). For comparison, for countries across the world, the average proportion of agricultural land is just over 37% while in EU countries, this proportion is higher at around 42%. Forests account for only 12% the land area of the UK (Forest Research, 2019), while for countries in the rest of the world the average forest cover is about 30%, and in the EU, 38% (World Bank, 2019). The land use structure that exists in the UK is a result of thousands of years of competing requirements: the advancement of new and abandonment of old technologies (Ang, et al., 2010), growing populations, empire (Cain, 1980), agricultural lobbying (Monbiot, 2014) and food security (Defra, 2010).

In 2017, around 50% of food consumed in the UK was grown in the UK; the remainder was imported. Of the 49% imported, around 30% came from the EU with another 2% coming from the rest of Europe. A further 16% came from Africa, Asia, North and South America and 1% from Australasia (Defra, 2018). The four largest imported commodities by value (at 2017 prices) were fruit, vegetables, meat and beverages (Defra, 2018). In a wider sense the reliance on imports can be a food security issue. During World War One, both British and German naval strategies centred on the blockade and destruction of enemy shipping, whilst maintaining their own shipping supplies (Dunn, 2016; Massie, 2007). The threat and destruction of shipping in both World Wars One and Two led to the expansion of agriculture and rationing of food in the UK. This vulnerability has led to some considering food self-sufficiency.

## Discussion

Despite the large proportion of land in agriculture, the UK is not food self-sufficient. The UK relies on both home-grown and imported food products to be food secure (de Ruiter, et al., 2016; de Ruiter, et al., 2017). The UK's human population is too large to be supported by its own agricultural means because there is insufficient land of the required quality. In addition, modern cropping relies on imported energy and fertiliser (Defra, 2008). 'Food security' does not necessarily equate to self-sufficiency, nor to having a strong home-grown farming sector, although in certain circumstances, being able to grow your own food is an advantage. The FAO defines four main dimensions of food security; these are availability, access, utilization and stability (of supply). According to the FAO, to achieve food security all four dimensions need to be fulfilled simultaneously. A great many variables influence these dimensions, as they act and interact on each other.

Agriculture (farming, horticulture *and* forestry) are all limited physically by climate, soils, land and labour (Forbord & Jostein, 2017). Countries and areas within countries are limited in both the range of crops they can grow and the yields they can produce. The UK, for example, could not be self-sufficient in rice or olives and these foods are imported. If such foods were not imported, the UK would have to rely on a smaller range of home-grown crops, which would be problematic (Defra, 2010). Where diets rely heavily on a limited range of crops, disease and crop failure become issues (Khoury, et al., 2014). Having enough farmland is a prerequisite for self-sufficiency of production. If a country has too little land and too many people, it cannot be self-sufficient in purely home-grown terms. Although arguments for maximizing self-reliance can be made (NFU, 2017), the efficiency of farming decreases at the margins with more effort being used to achieve less output. This has a negative effect on the environment and might cause (for example), soil erosion, flooding, pollution, loss of wildlife, forest and wilderness (Robinson & Sutherland, 2002).

Most of the uplands of the UK have limited agricultural capabilities and are grazed by sheep. While arable crop production on lowlands can often be measured in several tonnes or more per hectare, the productivity of upland sheep farms can be measured only in kilogrammes per hectare (SAC, 2011). Upland slopes of the UK are often not suitable for arable production and are predominantly an artificial environment created by the grazing of animals. Livestock production is not as efficient as arable production, since converting arable or grass crops to livestock, via feeds or grazing and then consuming the livestock is less efficient than consuming the arable crop directly (Schader, et al., 2015). The production of relatively low volumes of food from upland farms, it can be argued, does not add significantly to UK food security. Additionally, it has been estimated that in UK conditions, the production of 1 kg of beef is associated with the equivalent release of approximately 16 kg of carbon-dioxide equivalents ($CO_2e$). For sheep, this figure is slightly higher at 17 kg $CO_2e$;

while the production of 1 kg of wheat releases approximately 0.8 kg $CO_2e$ (Williams, et al., 2006; Garnett, 2009).

It can be argued that in supporting upland farms we are diverting resources away from more efficient food production systems elsewhere, while damaging the environment and climate on which agriculture and food production depend. Thomson et al (2018) examine how mitigation measures could reduce GHG emissions from UK agriculture by 2050, while still maintaining current levels of per capita food production. The report identifies that agriculture and land use sectors need to make considerable progress on GHG emissions reduction, if the UK is to meet its future statutory emissions reduction targets. The models used in the report assume different levels of uptake of various technologies and behaviours. Several emission mitigation measures were considered, among them land-sparing strategies which included arable crop yield improvements, dietary change and consumer waste reduction. The report states that although "the UK's land area is finite", "increasing yields per hectare" can free up land for other GHG mitigation measures. The report found that scenarios with dietary change and arable crop yield improvement spared the most land for alternative uses such as forestry which according to Law, et al., (2018) have strong GHG mitigation potential.

Afforestation has been identified as a GHG Mitigation measure (Rounsevell & Reay, 2009). Growing forests sequestrate $CO_2$, while mature forests store $CO_2$. The rate of forest $CO_2$ sequestration depends on a range of conditions, soils, tree species, climate and silviculture (Willey & Chameides, 2007). Woodland with widely spaced trees may contain 20 to 40 tonnes of carbon per hectare (tC $ha^{-1}$) (Smith, et al., 2007) while forests managed for timber might contain 50 to 100 tC $ha^{-1}$ (Birdsey, 1996). Undisturbed temperate and tropical forests might hold between 100 to 200 tC $ha^{-1}$ (Houghton, 1999). In addition, forests provide a range of environmental economic and social services (Campbell & Luckert, 2002) and commonly make up those described elsewhere as ecosystem services (Chaplin-Kramer & Green, 2016; Boyd & Banzhaf, 2007). Forests protect watersheds, conserve soils, provide habitat for wildlife, timber foods and shelter (Sands, 2005). Some land uses may decrease (in the case of afforestation) or increase (in the case of upland livestock and intensive farming) the risk of flooding (Wheater & Evans, 2009).

Increasing the area of forest in the UK has climate change benefits, with the least impact on UK food security when the land afforested consists of upland slope pasture. Additional environmental, economic, landscape and social benefits can also be realised by the type of forest planted and through its silviculture (the method of management). Commonly, for reasons of finance and rapidity of growth, single species coniferous plantations managed on a clear-fell system have been chosen. Clear-fell systems are intensive and ecologically poor. Mixtures of trees are difficult to manage because of differential rates of growth and monocultures are favoured. Ecological solutions are bolted-on and ecological management is not integral to the system. Forests end up being compartmentalised, with areas of production separated, from areas of conservation.

Optimisation is important to clear-fell systems, because upfront costs have a disproportionate effect on economics. Maximising production, speed of growth and rapidity of harvesting are products of the system. Optimised systems are vulnerable systems. Optimal systems lack reserve and redundancy, their economics have simply created an environment where little or no spare capacity exists. Alternative continuous cover silvicultural systems which use a mix of tree species can address comprehensively the weaknesses, outlined above. Secondary environmental service activities, soil and watershed protection and landscape etc. are integral to many continuous cover systems, unlike clear-fell they are not 'bolted on'. Compared to clear-fell, continuous cover silviculture has a superior carbon sequestration profile, better resistance to wind, pests and disease. Continuous cover silviculture is practical on semi-improved and rough pasture which consist the majority upland slope grazing. In addition, smaller woodland units become economically viable, because we concentrate on low-volume, high quality high price products (Matthews, 1992; O'Hara, 2014; Puettmann, et al., 2008).

## Conclusion

In conclusion food security is about access to the 'right-food'. It can be delivered in the UK through a mix of domestic and foreign production. A large population, limited land, limited cropping, threats from diseases, the reliance on imported inputs and environmental costs mean self-sufficiency is not possible, desirable or appropriate. Concentrating on intensive arable farming and facilitating trade would maintain the UK's food security. Upland farming, particularly grazing, has low productivity, but relatively high GHG emissions per unit of production. UK food security is not dependant on upland farming. The conversion of some upland farming to continuous cover forest has a range of benefits which will improve the environment and sequestrate $CO_2$ with little or no food security penalty.

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