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Improved biodiversity from food to energy: Meta-analysis of land-use change to dedicated bioenergy crops

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Whilst dedicated bioenergy crops with non-food uses are currently sparsely deployed across the world, most future energy pathways necessitate a sizeable scale-up of 100-500 million ha of land converted to these crops to provide both energy substitutes for fossil fuels and negative emissions through bioenergy with carbon capture and storage (BECCS). In the face of expected bioenergy expansion, understanding the environmental and societal impact of this land-use change is important in determining where and how bioenergy crops should be deployed, and the trade-offs and co-benefits to the environment and society. Here we review the existing literature on two difficult to measure impacts which could prove critical to the future wide-scale acceptability of global bioenergy cropping in the temperate environment: biodiversity and amenity value. We focus on agricultural landscapes, since this is where large-scale bioenergy planting may be required. A meta-analysis of 42 studies on the biodiversity impacts of land-use change from either arable and grassland to bioenergy crops found strong benefits for bird abundance (+ 109 % ± 24 %), bird species richness (+ 100 % ± 31 %), arthropod abundance (+ 299 % ± 76 %), microbial biomass (+ 77 % ± 24 %), and plant species richness (+ 25 % ± 22 %) and a non-significant upward trend in earthworm abundance. Land-use change from arable land led to particularly strong benefits, providing an insight into how future land-use change to bioenergy crops could support biodiversity. Evidence concerning the impact of bioenergy crops on landscape amenity value highlighted the importance of landscape context, planting strategies, and landowner motivations in determining amenity values, with few generalizable conclusions. In this first meta-analysis to quantify the impacts of land-use change to bioenergy on biodiversity and amenity, we have demonstrated improved farm-scale biodiversity on agricultural land but also demonstrated the lack of knowledge concerning public response to bioenergy crops which could prove crucial to the political feasibility of bioenergy policies such as BECCS.