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Life Cycle Assessment of Bioenergy from Lignocellulosic Crops Cultivated on Marginal Land in Europe

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Population growth and changing diets due to economic development lead to an additional demand for land for food and feed production. Slowly but surely turning into a mass market, also the cultivation of non-food biomass crops for fibre (bio-based products) and fuel (biofuels and bioenergy) is increasingly contributing to the pressure on global agricultural land. As a consequence, the already prevailing competition for land might even intensify over the next decades. Against this background, the possibilities of shifting the cultivation of non-food biomass crops to so-called 'marginal lands' are investigated. The EC-funded project 'Sustainable exploitation of biomass for bioenergy from marginal lands in Europe' (SEEMLA) aims at the establishment of suitable innovative land-use strategies for a sustainable production of bioenergy from lignocellulosic crops on marginal lands while improving general ecosystem services.

For a complete understanding of the environmental benefits and drawbacks of the envisioned cultivation of bioenergy crops on marginal land, life cycle assessments (LCA) have proven to be a suitable and valuable tool. Thus, embedded into a comprehensive sustainability assessment, a screening LCA is carried out for the entire life cycles of the bioenergy carriers researched in SEEMLA. Investigated systems, on the one hand, include the specific field trials carried out by the SEEMLA partners in Ukraine, Greece and Germany. On the other hand, generic scenarios are investigated in order to derive reliable general statements on the environmental impacts of bioenergy from marginal lands in Europe. Investigated crops include woody and herbaceous species such as black locust, poplar, pine, willow and Miscanthus. Conversion technologies cover the use in a domestic or a district heating plant, power plant, CHP as well as the production of Fischer-Tropsch diesel (FT diesel) and lignocellulosic ethanol. Environmental impacts are compared to conventional reference systems such as heat and/or power as well as transport fuels from fossil energy carriers. Results are obtained for various environmental impact categories including climate change, non-renewable energy use, acidification and eutrophication.

Preliminary results show that all investigated bioenergy carriers are associated with environmental advantages and disadvantages compared to the conventional reference systems. Nevertheless, bioenergy carriers showing most environmental benefits could be identified. However, it also became clear that LCA is less suited to address local environmental impacts (e.g. on biodiversity and water). Therefore, the classical LCA approach is supplemented with a separate life cycle environmental impact assessment (LC-EIA).

Final results will indicate the best performing crops and conversion technologies, the process steps and parameters that strongly determine the results and the optimisation potentials. From these results, recommendations will be made to various stakeholders including policy makers and farmers, e.g. regarding the criteria that should be met in order to advocate bioenergy production from biomass cultivated on marginal land in Europe.