Waste-biogas is at least ten times more effective than crop-biogas at reducing greenhouse gas emissions

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In a paper just released in the leading bioenergy journal *Global Change Biology Bioenergy*, researchers from Bangor University and the Thünen Institute in Germany conclude that crop-biogas and liquid biofuels are at best inefficient options for greenhouse gas (GHG) mitigation, per hectare of land used and per £ public subsidy required. At worst these options could actually lead to higher global GHG emissions owing to indirect land use change caused by displacement of food production. In comparison, waste-biogas and Miscanthus (woody grass) heating pellets achieve at least ten times more GHG mitigation per tonne of dry matter biomass and per hectare of land used, respectively, leading to cost-effective GHG mitigation.

Bio-electricity feed-in-tariffs (FiTs) are encouraging the use of crops to produce biogas in large scale anaerobic digestion plants, whilst mandatory biofuel blend targets are driving the production of liquid biofuels from food crops. There is concern that these policy measures do not target the most sustainable bioenergy options to reduce dependence on polluting fossil fuels, and to reduce GHG emissions that contribute to climate change.

Scientists from Bangor University's School of Environment, Natural Resources & Geography and the Thünen Institute in Germany evaluated the environmental balance of various bioenergy options introduced into a typical arable farm rotation. They applied farm models and

consequential life cycle assessment to compare the environmental performance of: (i) electricity and heat production from on-farm biogas plants fed by either maize, grass, pig manure or food waste; (ii) bioethanol and biodiesel production from wheat and oil seed rape, respectively; (iii) heat production from Miscanthus pellets.

Whilst GHG emissions from indirect land use change can outweigh the GHG mitigation achieved by fossil energy replacement for crop-biogas and liquid biofuel options, anaerobic digestion of manures and food wastes avoids emissions arising from manure storage and composting of food waste, even before the GHG mitigation of fossil energy replacement by the biogas produced is accounted for. However, care is required to minimize ammonia emissions during storage and land application of the digestate "bio-fertiliser" produced alongside biogas in anaerobic digestion plants.

Dr David Styles, who led the research, commented: "Whilst subsidies are necessary to correct for market failure and develop vital renewable energy sources, it would seem sensible to link such subsidies with environmental sustainability criteria to ensure that they efficiently contribute to overall net public good. Our results highlight the importance of applying life cycle assessment to comprehensively evaluate the environmental sustainability of bioenergy options, capturing hotspots such as indirect land use change associated with food crop displacement, the climate effect of bio-methane leakage, and ammonia emissions arising from digestate storage and spreading."

More information: Styles, D., Gibbons, J., Williams, A.P., Dauber, J., Stichnothe, H., Urban, B., Chadwick, D., Jones, D.L., 2015. "Consequential life cycle assessment of biogas, biofuel and biomass energy options within an arable crop rotation." *Global Change Biology Bioenergy*: DOI: 10.1111/gcbb.12246

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