Science for Environment Policy

New system to convert food waste into fertiliser for greenhouse use gives potential 95% reduction in CO_2 emissions

15 December 2016
Issue 479
Subscribe to free weekly News Alert

Source: Stoknes, K., Scholwin, F., Krzesiński, W., Wojciechowska, E. & Jasińska, A. (2016). Efficiency of a novel "Food to waste to food" system including anaerobic digestion of food waste and cultivation of vegetables on digestate in a bubble-insulated greenhouse. *Waste Management*, 56: 466–476. DOI: 10.1016/j.wasman.2016.06.027.

Contact:
ketil.stoknes@lindum.no

Read more about:
Climate change and energy, Soil, Sustainable business, Sustainable consumption and production, Waste

To cite this article/service: "Science for Environment Policy": European Commission DG Environment News Alert Service, edited by SCU, The University of the West of England, Bristol.

A new method of processing food waste into fertiliser has been outlined in a recent study. The process uses a digester system with microorganisms to break down organic waste into fertiliser. The resultant fertiliser was used in a low-energy greenhouse to produce a range of food crops. The method is a potential way to utilise food waste and reduce the energy consumption of food production as part of a circular economy.

Globally, food waste accounts for 6–10% of human greenhouse gas emissions. In the EU, an estimated 88 million tonnes of food is wasted annually, which is around 20% of food produced, or 95–115 kilograms of food per person each year. The EU is attempting to reduce the environmental impact of waste through the Circular Economy Strategy, which aims to maintain the value of materials in the economy for as long as possible and to reduce waste by promoting the reuse and recycling of materials; this programme includes food waste as a priority sector.

Anaerobic digestion — the breakdown of organic material using microorganisms in the absence of oxygen — is a good way of allowing resources in food waste to be used rather than disposed of at landfill. This method also reduces carbon dioxide (CO_2) emissions from composting or landfills. The biogas — gaseous fuel, such as methane – produced from the process can also be used as a substitute for fossil fuels. However, the treatment and handling of digestate — the material remaining after anaerobic digestion — is still a cause of CO_2 emissions, or equivalent emissions from methane or nitrous oxide, even when sustainably used as a substitute for mineral fertiliser. Utilising digestate directly in a closed greenhouse system can, therefore, improve the sustainability of this process. However, digestate is toxic to plants and needs to be treated if it is to be used directly on plants as a fertiliser. Greenhouses can also produce high CO_2 emissions due to artificial heating, transportation of produce grown for commercial sale and the cooled storage of vegetable crops grown.

The eco-innovation project Food to Waste to Food (F2W2F) aimed to develop an integrated system to recycle food and garden waste and reduce the energy costs of producing food in greenhouses for local use. This study outlines the way F2W2F used digestate as part of greenhouse horticulture in a prototype system. The system uses a biogas plant which includes a digester — a container where substances are exposed to heat and microorganisms in order to aid anaerobic digestion — to process both food and garden waste into digestate. The resulting digestate is then further treated with earthworms and mixed with compost so that it is not toxic to plants. The researchers also used a new bubble-insulated greenhouse technology, which uses soap bubbles between double foil for thermal insulation of the walls and roof, and a climate-control system to reduce energy use. The soap bubbles are circulated in tanks, which form the greenhouse walls, and water pumped through these tanks can be heated or cooled to control the greenhouse temperature.

Continued on next page.

Science for Environment Policy

New system to convert food waste into fertiliser for greenhouse use gives potential 95% reduction in CO_2 emissions

(continued)

15 December 2016
Issue 479
Subscribe to free weekly News Alert

Source: Stoknes, K., Scholwin, F., Krzesiński, W., Wojciechowska, E. & Jasińska, A. (2016). Efficiency of a novel "Food to waste to food" system including anaerobic digestion of food waste and cultivation of vegetables on digestate in a bubble-insulated greenhouse. *Waste Management*, 56: 466–476. DOI: 10.1016/j.wasman.2016.06.027.

Contact:
ketil.stoknes@lindum.no

Read more about:
Climate change and energy, Soil, Sustainable business, Sustainable consumption and production, Waste

The researchers experimented with a range of different treatments of digestate in fertiliser and compost to identify the best conditions for growing different crops, including tomatoes, mushrooms, herbs and cucumbers. Treatments comprised different concentrations of liquid and solid waste digestate, compost, peat and composting earthworms. For all of the different experimental treatments, controls were also included, using mineral fertilisers instead of digestate, in a commercial substrate. Climatic conditions (temperature, CO_2 level, humidity, etc.) as well as watering and fertilisation schedules were all controlled by the climate-control system of the greenhouse.

The researchers managed to produce good yields for the different crops grown in the study, indicating that commercial growth of vegetables is possible using organic waste (digestate) as a substitute substrate and fertiliser, without the need for additional mineral fertiliser or soil. Although the researchers only provide an overview of the cultivation results in this study, they say that in some cases, higher yields were produced compared to yields produced on commercial substrates and fertilisers (for example, cucumber yields increased by more than 100% in one experiment). Although only at the pilot level, this study assumed a 98% reduction in methane emissions from organic waste compared to using landfills and a potential 95% reduction in CO_2 emissions. The digester system developed also resulted in a reduction in mineral fertiliser use, waste and water use (by up to 80%, as the bubble greenhouse requires less ventilation, leading to less evaporation).

The success of their technique was the combination of pre-treatment methods for organic waste, including composting, vermicomposting (using composting worms) and solid–liquid separation of the digestate. These treatments avoided the potential toxic conditions of using digestate as fertiliser and enabled optimal conditions for plant growth. The use of garden-waste compost also meant (fossil) peat was not required as a substrate, which the researchers describe as a significant advantage over conventional growing systems. The energy use of the prototype bubble greenhouse used in the study was 10–20% of that of traditional greenhouses. The level of CO_2 was also higher within the enclosed bubble greenhouse, which promoted increased plant growth and compensated for reduced light from the double foil and bubbles used for shading. CO_2 from the biogas also substituted fossil CO_2 normally used in greenhouses.

A commercial-scale bubble greenhouse is now operating in Poznan, Poland. The researchers say further research is needed to confirm the optimal growing conditions for different crops, as well as upscaling of the system to make it commercially viable to produce food crops for local sale and consumption. This is currently happening in Norway, where public innovation funds have financed a large commercial-scale pilot to be completed by the summer of 2017, in cooperation with commercial greenhouse growers.