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Three new systems for recycling of urban organic waste to agriculture

By **Jacob Møller**, **Sander Bruun** and **Jakob Magid**, The Royal Veterinary and Agricultural University (KVL), Dept. of Agricultural Sciences.

Carbon and nutrient cycling between urban and rural districts are studied and optimized in two on-going projects, Short-Circuit and CRUCIAL. An outline of the projects is presented in **Box 1**.

One of the main objectives of the Short-Circuit project is to develop three new full-scale source separation and composting systems designed to optimise recycling of organic urban waste to agriculture. This is done by establishing a close relation between the sources, households, and the end users.

The thee new systems are related to:

- On-farm composting of urban waste
- Collection and composting of vegetable waste from Aarstidernes costumers
- Centralised combined biogas production and composting of urban waste

Implementation of the systems is expected to generate high-quality compost based on technical improvements in connection with more qualified source separation, due to a higher responsibility and perceived ownership by the public.

On-farm composting of urban waste

The objective was to develop a cheap and efficient on-farm composting system allowing the farmer to produce high-quality compost that comply with Danish as well as EU-regulation, made from e.g., source separated household waste or toilet waste. Furthermore, the system should minimize the loss of N from the composting process. This has resulted in the container-composting system shown in Figure 1.

Figure 1.

The HI-LO on-farm composting system at KVL´s experimental farm. The container is filled using a manure spreader manoeuvred into the container by a tractor.

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The system, called the HI-LO composting system (short for high temperature, low cost, low emission), meet the following specifications: temperature should be high enough to allow hygienisation of the compost, and at the same time the system should be inexpensive and manageable using equipment commonly available on farms.

As shown in Figure 1 a tractor can load the compost container with a manure spreader in tow. The double-layered black plastic covering the roof and sides of the composting container function as a heat-exchanger and condenser of hot process-air. The condensate is collected and in this way, ammonia loss from the system is minimised. Up till now the system has been tested with source separated household waste and various agricultural residues as feedstock.

Collection and composting of vegetable waste from Aarstidernes costumers

The Internet-based box scheme business Aarstiderne is participating in the project with the objective to recycle the green waste from their costumers to the farm (Krogerup in North Zealand) that is supplying the organic vegetables to Aarstiderne. Recycling by collection of residues from a vegetable box scheme business and transporting it back to the farm where the vegetables were grown has, to our knowledge, not been implemented before. It is an obvious way to promote recycling of organic waste, especially since box schemes have been growing fast - in Denmark as well as in Europe in general.

The collection scheme is still in pilot-scale, i.e. only a limited number of costumers in the Østerbro area in Copenhagen were invited to participate. They received compostable plastic bags to collect the residues from their vegetable boxes together with written instructions on how to source separate correctly.

Figure 2 shows the solution made by Aarstiderne to transport the green residues back to Krogerup farm: A 120 l waste bin was placed on the outside of one of Aarstidernes delivery vans, and the delivery man placed the compostable plastic bags containing green waste in there (note that the delivery man is wearing disposable gloves for hygienic reasons). This simple solution meets the requirements from the health authorities to separate waste material from fresh grocery.

Figure 2.

A van from Aarstiderne Ltd. equipped with a 120 l waste bin for residue

collection.

The challenge in this part of the project is not so much to employ advanced technical solutions as a question of optimizing logistics and hygiene and to further develop communication with customers who participate in the waste collection scheme.

The collected waste was subsequently composted in windrows at Krogerup farm together with horse manure and straw material. It was demonstrated, that the biodegradable collection bags can be handled in a manure spreader, and that the biodegradable bags were degraded during the composting process. The windrow system is working satisfactory and compost piles reached high temperatures for an extended period of time, only with few turnings. Some of the material was not degraded during composting, but it is assumed, that this can be solved if the collection operation is scaled-up so the amount of waste will allow construction of bigger windrows.

Centralised combined biogas production and composting of urban waste

The third system is a new way to establish community involved composting using an innovative coupling of biogas production and subsequent composting of the residues. The AIKAN-plant (figure 3) consisting of 15 high-tech centralised combined biogas production- and composting units has been established near Holbæk by the composting firm Solum Ltd. in collaboration with a number of local municipalities. It should be noted, that the EU-funding covers only a minor part of the costs associated with establishing the plant.

The plant will eventually include a pre-treatment and a post treatment unit for screening for impurities. The system utilizes the source separated household waste initially for biogas production and subsequently produces compost with high process control and sanitation according to EU regulation. The end-product is stable compost better suited for soil application than biogas residues.

Figure 3.

Solum´s AIKAN-plant near Holbæk. Each 600 m3 compartment is used for biogas production followed by composting of the degassed material.

An important novel feature of the plant is that biogas production and subsequent composting of the waste material takes place in the same compartment. In this way, handling of the waste material is minimised and the environmental impact of the waste treatment is less than if the two processes were taking place in separate modules.

Simultaneously with the technical development of the plant there has been an effort by Solum Ltd. to improve source separation and increase the amount of waste collected in the municipalities who participate in the project.

Modelling the environmental impact

To assess and compare the environmental impacts of the different systems, we use the waste management model ORWARE (Dalemo et al., 1997). A database consisting of data on compost quality and environmental emissions necessary for modelling the three systems has been constructed. Three new ORWARE sub-models were created for the three different types of composting-systems that are implemented in the project. The model will be used to run scenarios representing the different composting facilities and the environmental impacts will subsequently be compared mutually and with other more traditional waste treatment solutions.

The ORWARE sub-model that estimates environmental impacts after land application of compost has further been modified to be in correspondence with Danish conditions and legislation. This is done by running a set of land application scenarios in the agro-ecosystem model DAISY, and estimate emission coefficients of different pollutants based on these scenarios (Bruun et al., submitted). The coefficients can then be combined to give average emission coefficients to be incorporated in the ORWARE model. The results of the simulations of compost applications using the DAISY-model will be published in a later edition of DARCOFenews.

Public promotion of recycling

The work so far has focused on implementing the three new systems. This phase of the project has now been completed, and at present the emphasis is on data collection and subsequent evaluation of environmental impact of the source separation and composting systems using the ORWARE and DAISY models.

We anticipate that the implementation of these new and innovative systems can be used to promote recycling of organic waste to agriculture by farmers and other stakeholders. At the same time the implementation of the systems may strengthen the public's idea of recycling by dissemination of the results, by providing a concrete platform for the public debate and by offering possibilities for the public to visit the field sites.

References

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