Circular Economy Organics R&D Fund

Impact Summaries

Gaia Envirotech explore options to increase the value of recycled organics

Sustainability Victoria

VICTORIA State Government

Authorised and published by
Sustainability Victoria
Level 12, 321 Exhibition Street
Melbourne Victoria 3000 Australia

Circular Economy Organics R&D Fund Impact Summaries – Gaia Envirotech explore options to increase the value of recycled organics

February 2025

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Sustainability Victoria acknowledges Aboriginal and Torres Strait Islander people as the Traditional Custodians of the land and acknowledges and pays respect to their Elders, past and present.

Background

Sustainability Victoria (SV) delivered funding to enhance the market for recycled organics under the Circular Economy Markets Acceleration Program. Impact Summaries are a brief outline the great work that recipients of this funding have achieved. SV expects that the information in these summaries will generate discussion, stimulate ideas, inspire action and ultimately contribute to a more profitable and sustainable organics sector.

Based in Ballarat, Gaia Envirotech manufacture modular composting and anerobic digestor (AD) units. Housed within a shipping container these units are small enough for low tonnage organics facilities yet scalable by simply adding additional modules when feedstock supply increases. The units are an organics recycling option, particularly for regional areas or clients with lower feedstock supplies.

Gaia Envirotech know that strong markets for products produced by their equipment improves client revenue and helps stabilise the organics sector. One way to strengthen markets is by increasing value of the end product. Accordingly, they theorised that manipulating Food and Garden Organic Waste (FOGO) feedstocks, could produce better compost and higher AD biogas yields. With a grant from the SV Circular Economy R&D Fund, Gaia Envirotech undertook the project 'Commercialising FOGO and other organic waste using anerobic digestion' and explored novel ideas to increase the economic value of recycled organics.

Gaia Envirotech theorised that increased value could be achieved by adding food waste to their animal manure AD module to produce more biogas. They also theorised that the readily degradable component of FOGO would be high value AD feedstock that would produce more biogas. There is commercially available equipment to separate this component, however it is large, expensive and not suited to modular waste processing, so Gaia Envirotech decided to build a more suitable unit.

To complete the process, the residue from the anaerobic digestion process (digestate) would be dried and composted with the FOGO. The compost was then tested to determine if it is a high-value soil amendment.

Figure 1: The modular design of Gaia Envirotech composters makes them suitable for small scale facilities.

Research questions

1. Can food waste be digested in the Gaia Envirotech anerobic digestor?
2. Can small scale equipment to separate readily degradable material as a liquid from FOGO, be manufactured by Gaia Envirotech?
3. Is it commercially feasible to extract the readily degradable component of FOGO?
4. Is the readily degradable component of FOGO a high-value feedstock for anerobic digestion?
5. It is commercially feasible to dry digestate?
6. Is dried digestate a high-value, additional feedstock for composting FOGO?

Methodology

To answer the research questions the Gaia Envirotech team refurbished a dairy waste anerobic digestor to enable it to process food waste and accurately measure biogas output. These works included the addition of a digestate-biogas separation tank, a new mixing system, improved insulation and larger biogas piping. Food waste was then digested with cattle manure in the refurbished digestor.

Next the team had to construct equipment to separate the liquid component from FOGO. The *FOGO Preprocessing Module* (Figure 2) consisted of a receival bay with a perforated floor, a pump, a macerating press screw and a storage tank. Liquid and small particles were forced through the perforated floor and pumped to the macerating press screw which separated the liquid and deposited it in a storage tank. The contents of the storage tank were recirculated through the system to accumulate more organic matter. The biogas generation potential of the liquid was determined in the laboratory.

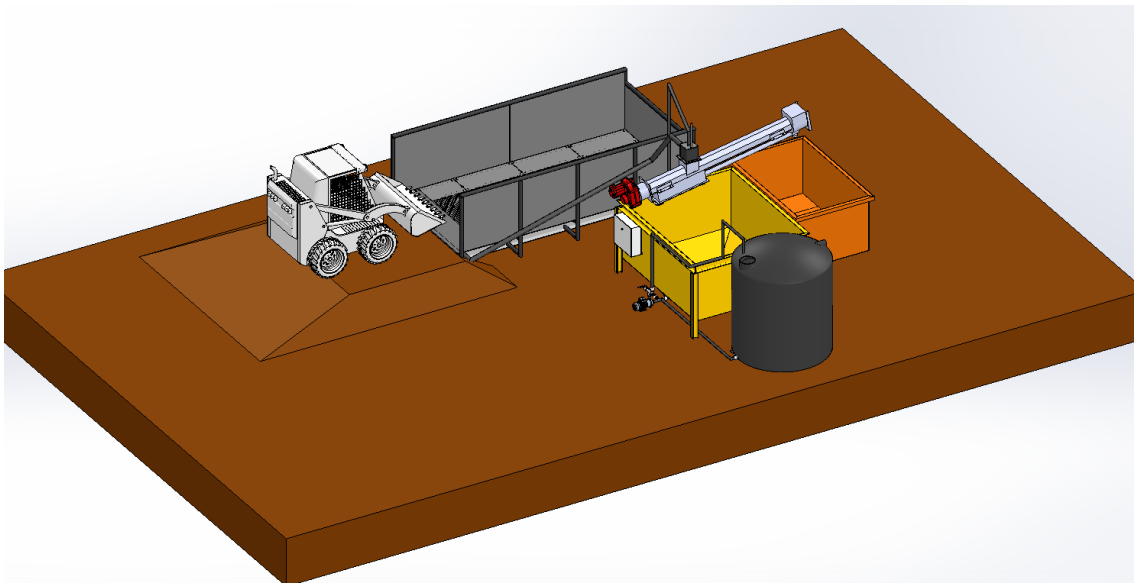

Figure 2: Design of the FOGO Preprocessing Module

To de-water digestate a Benenv MDS-101 multi disc separator was purchased. A polyacrylamide powder was added to flocculate the digestate and aid the de-watering process. The end product known as digestate ‘filter cake’ was then analysed for total solids and moisture content.

One sample of the filter cake was stored a 4.0^{0}C and two samples of the filter cake were prepared for composting, one of the stored samples was mixed at a 1:1 ratio with FOGO before composting and both samples were compared with a standard FOGO sample. The three samples were wrapped in a cotton cloth, composted to pasteurisation in the Gaia Envirotech in-vessel composter (Figure 3) and matured in a laboratory over four weeks. The three finished compost batches, and the stored 'raw' sample were analysed in a laboratory and sent to RMIT university for assessment as a plant growth medium.

Figure 3: Filter cake, FOGO and a 1:1 filter cake & FOGO mix being composted in the Gaia Envirotech in-vessel composter.

Results

The refurbished digestor was located at a dairy, so municipal food waste could not be used because of animal biosecurity concerns. However, animal pathogen free distillery waste and crude glycerine liquid derived from vegetable oils were sourced and digested with cattle manure. Higher biogas and methane yields were achieved when this waste was mixed with cattle manure, compared to cattle manure alone (Table 1).

Table 1: Biogas and methane yields with different feedstocks

	Cattle manure	Cattle manure + distillery waste	Cattle manure + glycerine waste
Biogas output (m^3/day)	202	215	567
Methane output (m^3/day)	123	139	374

These results align with other international research that shows the addition of food waste to animal manures significantly enhances biogas and methane yields.

The FOGO Preprocessing Module succeeded in separating liquid from FOGO waste streams. However, laboratory results showed that the biogas potential of the liquid component was not high enough to cover the cost of transporting it to the facility.

To enhance the feasibility of this concept the FOGO Preprocessing Module requires modifications and a feedstock with a higher proportion of food organics is required.

The de-watering system worked well with the addition of polyacrylamide powder, digestate with just 4.1% total solids was de-watered to form a 'filter cake' with 23.5% total solids.

Figure 4: De-watered digestate

The filter cake was composted to pasteurisation regardless of whether it was mixed with FOGO or not. Compost that included filter cake as a feedstock had a relatively higher concentration of nitrogen (N), phosphorus (P) and potassium (K). Nutrients such N, P and K have a value aligned with the cost of mineral fertiliser; therefore, the addition of filter cake has increased the value of FOGO derived compost.

Table 2: Chemical properties of composted filter cake, FOGO and raw digestate.

	Composted FOGO	Composted filter cake	Composted FOGO & filter cake	Raw digestate
Moisture content (%)	51	64	52	77
pH	8.59	7.81	8.12	8.06
Electrical conductivity (dS/m)	4.99	9.66	6.23	7.71
Total nitrogen (%)	1.65	3.58	2.45	4.37
Total phosphorus (%)	0.29	2.78	1.27	2.76
Total potassium (%)	1.35	1.08	1.41	0.85

The RMIT plant growth experiments found that composted filter cake had no characteristics that would preclude it as a component of garden soil mixes or as a soil conditioner in agricultural systems.

Opportunities

More revenue for intensive livestock businesses

These results represent an opportunity for intensive livestock producers to receive additional revenue from accepting food waste, for a fee, and subsequently increasing biogas and methane outputs from the anerobic digestion of manures, to reduce energy costs.

The challenge is managing biosecurity, feedstocks that contain animal products could be infected with pathogens. However, controls that Livestock producers could implement to manage this risk are available and used internationally with success, or source food waste that is free of animal products.

Higher value compost

The addition of de-watered digestate (filter cake) to FOGO increases value by increasing the nutrient concentration of recycled organics compost. This would reduce the amount of mineral fertiliser required for a farming system and return a market premium for the composter.

Manipulating nitrogen levels in compost

Intensively managed agricultural markets, such as high value vineyards demand inputs with consistent characteristics. Nitrogen inputs in particular are applied in exact amounts. By mixing filter cake with FOGO at ratios based on their N concentrations, a compost producer could create compost with a pre-determined and consistent N concentration.

Further information

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