Current State of Greenhouse Waste Biomass Disposal Methods

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Project Description

Context
- Pressures are increasing for the greenhouse sector to become more sustainable and use more circular practices
- Different disposal methods require different pre-treatments
- Project is focused on plant and fruit waste
- Essex County is used as a case study area due to volume of biowaste generated
- Biosecurity issues such as viruses are a priority from growers to mitigate
- Growers are looking from improved efficiency in use of space, transportation, energy and labour

Objectives
- Aim to investigate feasibility of various biowaste disposal methods
- Determine strategies or methodologies that may be implemented on a scalable level to reduce the environmental impact associated with greenhouse biowaste in Essex County

Characterization and Quantification

Characterization of Biowaste
- In-season waste consists mainly of non-sellable fruits and cuttings such as stems and leaves
- End-of-season waste consists mainly of non-sellable fruits, plant material such as stems and leaves, and roots
- Plastic contamination of strings and clips is a barrier preventing most valorisation options, particularly from end-of-season waste
- Moisture content is typically 80-90% of total mass
- 6-20% of dry weight of tomato leaves are macronutrients
- Chemical properties of vines are typically the most challenging type of waste for technologies to handle

Quantification

Table 1: Essex County greenhouse biowaste volume estimates

Estimation	Year	Quantity (tonnes)	Reference
Tomato vines (including plastic contamination and rockwool)	2022	27,200	1
Cucumber vines (including plastic contamination)	2022	19,000	1
Whole tomato grade-outs	2022	6,800	1
Whole cucumber grade-outs	2022	4,900	1
In-season waste	2024	40,000	2
End-of-season waste	2024	50,000	2
Total waste	2024	150,000	3
Calculation of in-season waste based on waste per yield	2022 - 2024	83,300	4, 5

Industry Practices

Landfill
- A current industry practice for in-season and end-of-season waste
- Decomposition of organic matter in the landfill generates significant methane emissions
- Large volumes of waste are causing the landfill to fill up at an alarming rate
- Farms of different sizes will face different challenges associated with reduced landfill access
- Easiest way to eliminate biosecurity risks because there is no reuse, recycling of material

Land Application
- A current industry practice mostly used for cucumber crops
- Certain crops (ex. Tomatoes) have greater concerns about pests and disease control
- Has reduced environmental impacts compared to landfilling
- More feasible for smaller scale farmers dealing with smaller volumes of waste

Table 2: 2023 survey results of greenhouse practices, covering 37% of Ontario acreage [6]

Practice	Percent of Surveyed Growers Practicing
Landfilling of green waste (leaf, vine)	69%
Spreading organic waste on field of outdoor farm	47%
Landfilling crop grade-outs	42%
Managed composting system (incl. turning for aeration, blending with other organic material)	21%
Rockwool repurposing	16%
Conversion of organic waste into value added products (e.g. vinegar, growing media)	11%
Unmanaged organic decomposition (material is left to decompose outside, no active management)	11%
Biodigester	5%

Anaerobic Digestion

A microbial process used to break down organic matter, including greenhouse waste, resulting in several usable products.

Inputs and Outputs
- Any organic waste can be put in, but some have more favourable properties or may need to be combined with other waste materials to improve the properties
- It is unlikely that the waste from one greenhouse could supply enough energy to heat that greenhouse
- End products could be renewable natural gas, electricity, and/or heat and digestate
- Vines pose challenges in large quantities because of their fibrous make-up
- Plastic contamination is an issue

Current Research Areas
- Optimization using different combinations of feedstocks
- Scale of digestion
- Logistical issues with timing of waste and storage

Figure 1: Anaerobic digestors [7]

Char

The use of heat and pressure to convert organic waste into a carbon-enriched materials. Initial research has tested this on greenhouse waste.
- Challenging to scale production in both cases, but harder for hydrochar

Hydrochar
- May be used as an energy production replacement, wastewater adsorbent, soil amendment
- Produced using hydrothermal carbonization, which is more ideal for wet feedstocks
- No emissions produced during production

Biochar
- Produced using pyrolysis
- May be used as an energy production replacement, wastewater adsorbent, soil amendment, or for carbon storage

Figure 4: Char [10]

Insect Digestion

The use of black soldier flies, crickets, and/or mealworms to digest organic waste, particularly leaf mash or discarded fruit.
- Insect frass can be used as an organic fertilizer
- Insects may be used as an alternative protein source

Current Research Areas
- Optimization of insect farming processes
- Scale-up of insect digestion specific to greenhouse biowaste

Figure 2: Mealworms grown for insect digestion [8]

Composting / Fertilizer

Using bacterial processes during decomposition, in an aerobic or anaerobic environment, to produce a mulch or soil amendment. This is currently practiced at some organic greenhouses.
- Plastic strings and clips are a major contamination issue. Biodegradable strings and clips are available but not widely used.

Composting and Fertilizer
- Plant reuse may fully substitute as an organic fertilizer, impacting plant and soil health
- Has reduced environmental impacts compared to landfilling and land application
- Some small amount of plastic may be acceptable to produce composts

Figure 3: Composting windrow [9]

Other Valorization Options

- Organic waste from greenhouses may be upcycled to produce growing media. This would also reduce the amount of waste associated with current growing media practices
- Researchers are attempting to process organic waste to be used for heating in biomass boilers. Increased success occurs when the material is processed into bio-briquettes first
- Whole fruits may be freeze dried or dehydrated to increase shelf life and used in products like soup mixes

Next Steps

In the next stage of this project, a detailed research plan and feasibility study considering the options above will be completed to determine the most suitable solution for Essex County. Experimentation, modelling, data collection, and literature may be used.

Comments or Questions? Contact Us:

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Acknowledgements: This project is one of several working towards improving greenhouse sector sustainability and is supported by Ontario Ministry of Food and Agri-Business (OMAFA)