Anaerobic digestion potential of organic wastes from small farms

Ryan E. Graunke¹ and Ann C. Wilkie²

¹School of Natural Resources and Environment
²Advisor, Soil and Water Science Department

Abstract
Food waste and organic residues are generated in substantial quantities on small farms. These include weeds, row clearings, diseased plants, culled fruits and vegetables, animal manures, and processing and market wastes. Current disposal practices include composting, spreading on uncultivated land, or sending to landfills. Although small farms may gain some benefit from these current practices (i.e. use of compost on planting beds), the farms are losing a substantial opportunity to generate bioenergy from their organic wastes. By utilizing anaerobic digestion, small farms can generate methane-rich biogas for on-site use. These uses can include cooking, space or water heating, gas lighting, gas-powered refrigeration, or electricity production. Additionally, nutrients in the feedstocks are conserved in the effluent of the digester and converted into plant-available forms (i.e. ammoniacal nitrogen). Thus the effluent, known as biofertilizer, can be a valuable commodity to the small farm as an organic fertilizer. This project is a case study of a local, organic small farm called Crones’ Cradle Conserv located in Citra, Florida. A waste audit was conducted at the farm for three weeks during the summer season to determine the types and amounts of organic wastes produced on the farm. Samples from the audit were analyzed for moisture and organic content to estimate the methane potential if these wastes were anaerobically digested. Food waste from restaurants and schools in the surrounding community and glycerol and biodiesel production could also be brought onto the farm as additional feedstock for increased methane and biofertilizer production.

Introduction
Small farms are an ideal location to implement the anaerobic digestion of organic waste. These farms generate a variety of different organic wastes that are potential feedstocks for an anaerobic digester (Fig. 1 and 2). Biofertilizer reduces the nutrient to the farm, particularly for organic fertilizer. Anaerobic digesters are fully scalable; therefore, small farms of all sizes can utilize an anaerobic digester. The small farm studied in this project was Crones’ Cradle Conserv, an organic vegetable farm in Citra, Fl. The farm has 2.5 acres under cultivation and raises small animals.

Materials and Methods

Waste Audits
• A waste audit was performed for three weeks.
• All on-farm organic waste was collected each day and separated into appropriate categories (Table 1).
• Waste in each category was weighed using an electronic balance.

Waste Characterization
• Samples were chopped or ground to take a representative subsample during lab analysis.
• Total solids (TS) and volatile solids (VS) were measured on all samples using standard methods (APHA 2005).
• Methane production potential was estimated using total kg VS of each waste type and methane yield values from literature (Table 2).
• Daily values were summed for weekly waste generation and methane production.

Table 1: Organic waste categorization

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Waste Audits (%)</th>
<th>Waste Characterization (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Row clearing</td>
<td>Unproductive or dead crop plants</td>
<td>5.3</td>
<td>5.7</td>
</tr>
<tr>
<td>Weeds</td>
<td>Healthy crop with root (low soil content)</td>
<td>6.5</td>
<td>6.9</td>
</tr>
<tr>
<td>Greenhouse waste</td>
<td>Vegetative trimming, dead plants, and potting medium</td>
<td>6.0</td>
<td>6.4</td>
</tr>
<tr>
<td>Compost</td>
<td>Biodegradable waste for composting, particularly root</td>
<td>6.0</td>
<td>6.4</td>
</tr>
<tr>
<td>Culls</td>
<td>Damaged, spoiled, and unmarketable produce</td>
<td>5.1</td>
<td>5.6</td>
</tr>
<tr>
<td>Processing waste</td>
<td>Waste from kitchen processing for cooking, barking, etc.</td>
<td>5.5</td>
<td>5.7</td>
</tr>
<tr>
<td>Harvest waste</td>
<td>Unmarketable waste from harvesting activities</td>
<td>5.5</td>
<td>5.7</td>
</tr>
<tr>
<td>Pig manure</td>
<td>Seeped manure plus bedding from the farm’s pig</td>
<td>5.5</td>
<td>5.7</td>
</tr>
</tbody>
</table>

Results
• Each week showed great variability in types and amounts of waste produced (Fig. 3).
• The majority of organic waste was row clearings and weeds.
• The different types of waste showed very different TS and VS content (Fig. 4).
• Total organic waste (wet weight) and methane potential per week ranged from 379 to 545 kg and 8.98 to 10.12 m³, respectively (Fig. 5).

Discussion
• An estimated 9-10 m³ of methane could be generated per week which corresponds to 318,000-353,000 BTU per week.
• Greater mass (wet weight) did not correspond to greater methane; measuring moisture content and organic matter content is crucial.
• Determining the digestibility of each type of waste is critical for digester feedstock selection.
• Additional organic waste, such as food waste from local schools and restaurants or waste products from biodiesel production could be brought to the on-farm digester for additional bioenergy production.

Utilization of anaerobic digestion can create a closed-loop cycle of organic waste management with energy and nutrient recovery on small farms (Fig. 6).

References

Acknowledgements
• Jeri Baldwin, Lee Solomon, and the staff at Crones’ Cradle Conserv
• The 2011 BioEnergy Internship food waste team: Chelsea Brown, Isaphel Neel, and Tim Sink
• This work is funded by a grant from Southern SARE (Sustainable Agriculture Research and Education).