# Bioenergy Production from Sheep and Goat Manure

*Claudia Sanchez[1] and Ann C. Wilkie[2]*

[1] Department of Animal Sciences, College of Agricultural and Life Sciences

[2] Faculty Mentor, Soil and Water Sciences Department, University of Florida-IFAS, Gainesville, Florida

## Abstract

Sheep and goats require less land and feed than larger livestock, making them less expensive to maintain. Their manure is in a pellet form that can easily be collected and utilized for bioenergy and biofertilizer. Methanogenic bacteria from the animals' ruminant digestive system are present in the manure. Thus, sheep and goat manure are ideally suited feedstocks for anaerobic digestion to recover renewable energy (*i.e.* methane). Sheep and goat manure are also rich in macronutrients including nitrogen and phosphorus, as well as micronutrients including iron, zinc and copper. Following digestion, these nutrients remain in the effluent and can be used for soil amendment. The objectives of this study were to characterize each manure type and determine their ultimate methane yields. Fresh sheep and goat manure were collected locally and characterized for pH, conductivity, alkalinity, dry matter (DM), organic matter (OM), and chemical oxygen demand (COD). The sheep manure had a pH slightly above neutral (8.10 ± 0.07) and thus would be beneficial for improving soil pH. Methane index potential batch assays were conducted at 35°C for 40 days, in triplicate. Goat manure had higher DM and OM contents, resulting in a higher methane yield from goat (7.1 L $CH_4$/lb) versus sheep (5.1 L $CH_4$/lb) manure on a fresh weight basis. However, both types of manure were determined to be viable for methane production. Nutrient characterization in the post-digestion effluent is recommended to evaluate its potential biofertilizer value.

## Introduction

Anaerobic digestion (AD) is a process whereby microbes convert organic matter into biogas when oxygen is absent. Manure can be used as a feedstock for AD to produce renewable energy in the form of biogas, which is mostly methane. This energy can be used on small farms for heating, cooking and running machinery.

By capturing and using methane as an alternative to fossil fuels, greenhouse gas emissions can be reduced.

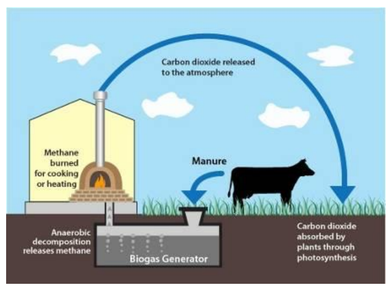



***Figure 1. Carbon-Neutral Cycle: Manure to Methane***

### Why use Goat and Sheep Manure as AD Feedstock?

- Goats and sheep are ruminants with diverse microorganisms for digestion.
- Goat and sheep manure is readily available on small farms and in developing countries.
- High dry matter of manure allows for easier handling and placement into a digester.
- Liquid effluent from a digester contains nutrients for fertilizing plants.

***Local Goat Farm, Gainesville***

***Sheep at UF Animal Sciences***

## Objective

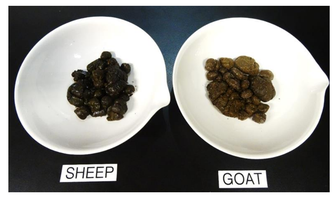
Determine the potential of goat and sheep manure for bioenergy production

***Digesters fed sheep manure at UF-IFAS Bioenergy and Sustainable Technology Laboratory***

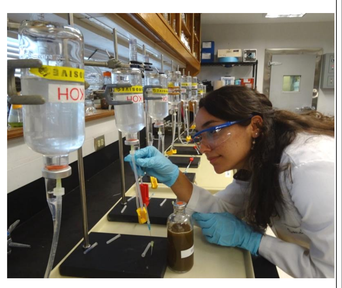
***Sheep manure digestate applied to organic garden at UF-IFAS Bioenergy and Sustainable Technology Laboratory***

## Methods

- **Manure characterization:**
  dry matter (DM), organic matter (OM), pH, conductivity, alkalinity, and total COD according to standard methods[1].
  - DM (drying at 105°C for 24 hrs)
  - OM (ashed at 550°C for 2 hrs)
- **Methane Index Potential (MIP) Assays[2]:**
  - Conducted at 35°C over 40 days
  - Triplicate assays for each feedstock
  - Manure in wet slurry form (diluted 1 part manure to 3 parts water)
  - Methane gas measured using volumetric displacement method




***Fresh Manure***



***MIP Assays***

## Results

***Table 1. Manure Characterization***

| | Goat Manure | Sheep Manure |
|---|---|---|
| pH | 6.95 ± 0.05 | 8.10 ± 0.07 |
| Conductivity (mS/cm) | 1.71 ± 0.14 | 1.85 ± 0.16 |
| Alkalinity (mg $CaCO_3$/L) | 7500 ± 132 | 8033 ± 76 |
| Dry Matter (%) | 39.4 ± 0.9 | 25.3 ± 0.5 |
| Organic Matter (% DM) | 87.9 ± 0.3 | 84.4 ± 0.4 |
| Total COD (mg/g DM) | 1208 ± 64 | 1071 ± 59 |

- Sheep manure had a higher pH and alkalinity than goat manure.
- Goat manure had higher DM than the sheep manure and these values are consistent with those previously reported by Cu et al. (2015) for goat (35.3%) and sheep (25.4%) manure[3].

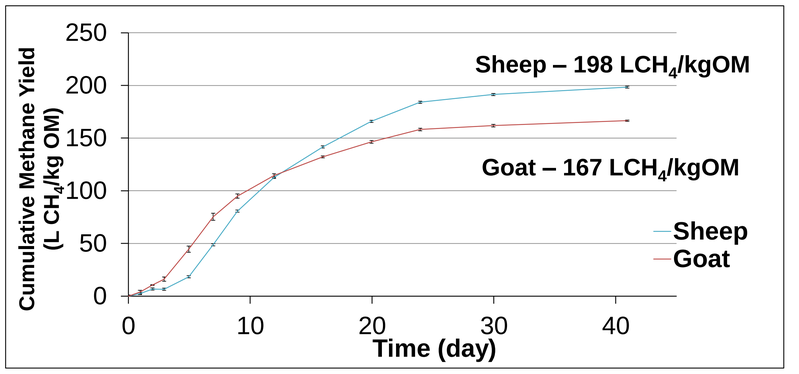



***Figure 3. Cumulative Methane Yields for Sheep and Goat Manure***

***Table 2. Methane Yields of Manure***

| Methane yield | Goat Manure | Sheep Manure |
|---|---|---|
| L $CH_4$/lb fresh manure | 7.1 | 5.1 |

Approximately 94% of the methane production occurred within the first 24 days of the experiment. Methane yields are consistent with the literature for goats (170 L $CH_4$/kg OM) but much higher than those reported for sheep (151 L $CH_4$/kg OM)[3].

## Conclusions

- Goat manure had a higher organic matter content than sheep manure, thus more methane was produced on a fresh matter basis.
- Sheep manure had a higher pH than goat manure and would be beneficial for soils with a low pH.
- Both goat and sheep manure are viable feedstocks for anaerobic digestion and could provide a renewable, sustainable energy source for small farms.

## Future Work

Measure nutrient concentrations in the liquid effluent to determine its post-digestion biofertilizer value.

## References

1. APHA. (2012). *Standard Methods for the Examination of Water and Wastewater*. 22nd ed. Washington DC: American Public Health Association/American Water Works Association/Water Environment Federation.
2. Wilkie, A.C., Smith, P.H. and Bordeaux, F.M. (2004). An economical bioreactor for evaluating biogas potential of particulate biomass. *Bioresource Technology* **92**(1), 103-109. doi:10.1016/j.biortech.2003.08.007
3. Cu, T., Nguyen, T., Triolo, J.M., Pedersen, L., Le, V., Le, P., and Sommer, S.G. (2015). Biogas production from Vietnamese animal manure, plant residues and organic waste: Influence of biomass composition on methane yield. *Asian-Australasian Journal of Animal Sciences* **28**(2), 280-289. doi:10.5713/ajas.14.0312

## Acknowledgements

This research was conducted as part of the *2015-2016 CALS University Scholars Program* and SWS 4911 – Supervised Research in Soil and Water Sciences.