IOWA STATE UNIVERSITY
Agricultural and Biosystems Engineering

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Influence of Farm Size on The Profitability of Impermeable Covers for Methane Utilization

Project Rationale and Goals

- Livestock produce 14.5% of greenhouse gas emissions generated by human activity
- U.S. manure-based anaerobic digesters (AD) reduce 6.09 million metric tons of CO_{2e} annually, equivalent to removing 1,323,000 cars off the road
- Meat producers such as Smithfield Foods, Tyson, and JBS have committed to significant greenhouse gas reduction by 2030
- If more farms discovered that AD is profitable, more significant implementation would occur

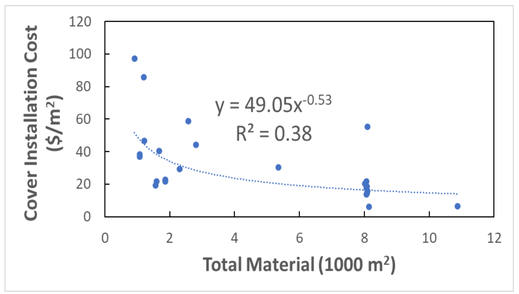
Methods

Sources of Revenue

- Natural gas sales: \$0.227/m^3 methane
- Renewable Identification Number (RIN) credits: \$1.44/m^3 methane
- Low Carbon Fuel Standard (LCFS) credits: \$155/metric ton CO_{2e} abated

Sources of Cost

- Impermeable cover cost: modeled using 24 different costs from Roos et al. (1999)



- Biogas upgrader cost: modeled using 24 different capital cost estimates from 6 different companies
- Brokerage fees- range from 20% to 10% of credit value depending on farm size. Does not exceed \$200,000 per year
- Deep pits require additional manure storage estimated at \$0.066/L storage plus \$18,000 per 1200 head
- Natural gas injection site has an estimated capital cost of \$1,000,000

Assuming a **5-year life**, **8% interest**, and that the biogas will be produced **in Iowa** and **upgraded** to renewable compressed natural gas (RCNG) and **injected** into the **natural gas grid**…

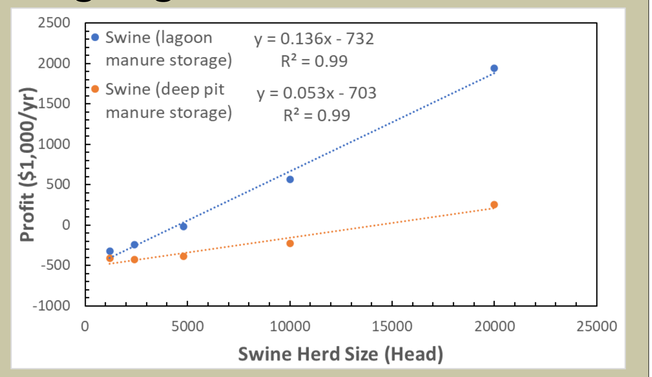
A **swine farm** using **lagoon** manure management requires **6,000 head** to **break even**

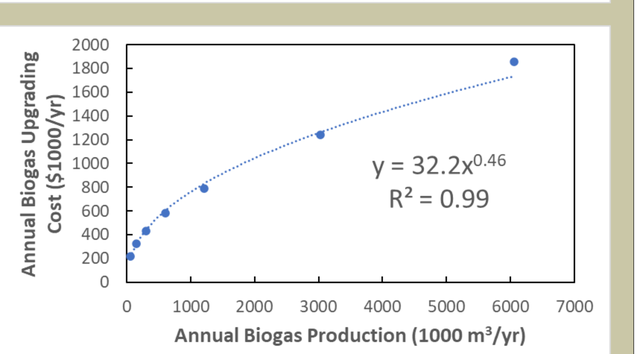
A **swine farm** using **deep pit** manure management requires **17,000 head** to **break even**

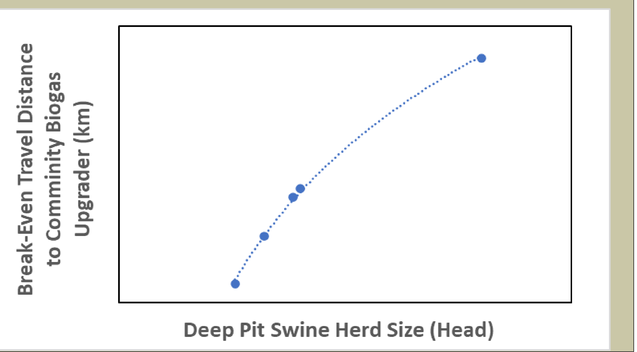
A **dairy farm** requires **600 head** to **break even**

The **annual biogas upgrading cost curve** features economies of scale with a **0.46 scaling factor**

Deep pit swine farms could potentially **profit** by **shipping biogas** to large **community biogas upgrader**







Results

Methane Production

- 382 m^3 methane produced per dairy cow per year
- 38 m^3 methane produced per swine per year

Carbon Intensity (CI) Score

- Dairy and swine (lagoon) have CI Score of 382 g CO_{2e}/MJ
- Swine (deep pit) have CI Score of -138 g CO_{2e}/MJ
- In 2027, an additional 84 g CO_{2e}/MJ can be claimed as credit by selling RCNG

Deep Pit Downfalls

- Construction costs needed for new manure storage and deep pit to drain pit conversion
- Less baseline emissions in the deep pit scenario results in a lesser CI score and less LCFS credits

Application to Iowa Farms

- 103 dairy farms with over 600 head in Iowa
- 350 swine farms with over 6000 head in Iowa
- 22 swine farm with over 14,000 head in Iowa
- **Over 120 farms in Iowa could profit**

Conclusion

- Swine farms with lagoon manure management are more profitable RCNG producers than swine farms with deep pit manure management
- Most farms in Iowa that could profit from RCNG production are dairy farms
- More research on community biogas upgraders and hauling biogas is necessary to analyze profitability for smaller farms

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