Low-Cost Waste Management Solutions for Small-to-Medium Scale Pig Farms in China

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Low-cost waste management solution for a medium-size pig farm in China

Sustainability Without Borders - China
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About Me

- Ph.D. candidate, Mechanical Engineering and SEAS
- SWB-China: 2017-present
- Research interests:
  
  life cycle management and design optimization problems in renewable energy systems and building energy efficiency
Project background

Pig farming in China
- China - world’s largest pork producer
- Important source of income to rural population

New waste discharge regulation
- Zone type: allowed, restricted, prohibitive
- Restricted household production
- Government subsidies available for large farms

Problem
- Little assistance for small-medium farms
Project Goal

- Provide **low-cost, regulation-compliant** waste management solutions for Mr. Zhu’s farm **by the end of 2018**
- Provide strategies for community-building and wastewater runoff and odor prevention
Project Timeline

- 2017: Project proposed
- 2018: DOW award
- Assessment trip
- 2019: Library mini grant
- Solution proposal
- Survey white paper
- 2020: ?
Assessment trip (Summer 2018)

• Conducted site assessment of Mr. Zhu’s farm
• Sent manure samples for lab-testing
• Collected 60 community surveys on broader perceptions of pig farming practices and new regulations
• Conducted interviews with 4 former pig farmers whose farms have been shut down
• Consulted with local EPA and village officials
• Toured a biodigester plant in Jiangxi
Mr. Zhu’s Farm
- Farrow-to-feed
- ~ 2,000 piglets
- Restricted zone
Insights from surveys

N_Anhui = 30, N_Jiangxi = 30, error bars represent standard errors of mean (SEM)
Waste management proposal

- Library search engine to find relevant literature
- Online retailers to find product specs and quotes
- Completed Dec. 2018
Nov. 2018 - Mr. Zhu’s farm infected with African Swine Fever (ASF)

- ASF in China first reported in Aug. 2018, spreaded through animal feeds
- Exterminated all pigs on farm
- At least 9-month ban on operation

Mar. 2019 - experiment with goose farming
Next step

Report on survey results and interviews by end of mid-April
  • Library search engine for literature review

Further work depends on Mr. Zhu’s future plan
  • Waste management proposal may still be useful for geese production
Acknowledgement

Library Mini Grant 2018-2019
DOW Sustainability Project Award 2017-2018
SWB - officers and advisory board
Past and current members of SWB-China
Community partner - Mr. Zhu & family

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Extra slides
Biodigester - SolarCities
with gas capture

Biowastes

Biogas Generator
Biogas Car
Biogas Stove

Organic Liquid Fertilizer
Gas capture and processing

Compressed Steel Wool to remove hydrogen sulfide

Floating Drum Storage

Biogas

Outlet Pipe Drains Fluid from the middle of the tank

31inch Inlet Pipe deposits new feed at the Bottom

Bubbling the gas through Water reduces the CO2

Water

To Biogas Burner

Fire Trap Water
Covered lagoon

- Area: 309 square meters (pond 1)
- Area: 185 square meters (pond 2)

- Extra capacity: 0.3 meters deep
- Human waste storage: 0.8 meters deep
- Anaerobic digestion range: 1.8 meters deep
- Sludge storage: 4.3 meters deep

Diagram showing the flow from Digester Influent to Biogas Storage, with a cover and biogas pipe leading to Digester Effluent.
**Biosand filter**

1. **Inlet Reservoir Zone** - Where water is poured into the filter.

2. **Standing Water Zone** – This water keeps the sand wet while letting oxygen pass to the biolayer.

3. **Biological Zone** – Develops at the top 5-10 cm (2-4”) of the sand surface. The filtration sand removes pathogens, suspended particles and other contaminants.

   As in slow sand filters, a biological layer of microorganisms (also known as the biolayer or schmutzdecke) develops at the top 1-2 cm (0.4-0.8”) of the sand surface.

4. **Non-Biological Zone** – Contains virtually no living microorganisms due to the lack of nutrients and oxygen.

5. **Gravel Zone** – Holds the sand in place and protects the outlet tube from clogging.

**Layers of the Biosand Filter**

- **Filtration sand** < 0.7mm
- **Concrete sand** 1mm
- **Separating gravel** 6mm
- **Drainage gravel** 12mm