PROFIT FROM POOP?

- Two dairies located 4 miles apart
- 8,000 head Holstein cows
- 80 employees
- >75 vendors, >35 farmers
- 11,500 acres of cropland (not owned)
- 3,200 Calves on site – remainder at custom growers
Digester 1&2
16’x32’x290’ ea.

Separated Solids

MANURE SYSTEM

PLUG FLOW, MODIFIED PLUG FLOW, AND TOTAL MIX

• Variables
  – Time manure is in digester
  – Temperature of digester
  – Amount of stirring

• Implication
  – Nutrient levels
  – Type & number of bacteria

Top View

End View

• Modified Plug Flow Design
  – Consistent digestion time
  – Consistent heating
  – Minimal Stratification
GAS COLLECTION

DIGESTER REVENUE STREAMS

- Electrical Production
- Bedding
- Carbon Credits
- Tipping Fees
- Heating
- Reduced Manure application costs

CAPITAL INVESTMENTS

- Digester Structure $1,100,000
- Genset and Separator Building $275,000
- Methane Powered Generator Engines $330,000
- Separators (3) and equip plus Installation $150,000
- Backup Boiler $50,000
- Plumbing, Electrical, Installation and Misc. $300,000

Total Investment $2,200,000

Note: 2006 costs.

BIOGAS ENGINES
ELECTRICAL PRODUCTION

- 2 x 600 kW Glauscor Biogas Engines
- Engines run at fixed RPM of 1200
- All electricity generated is sold to grid
- Maintenance contract with Martin Machinery
- Contract pays based on kW's produced and runtime.
- Preventative maintenance is critical
- Run times of 90%+ are achievable

ELECTRICAL SALES

BEDDING SOLIDS
BEDDING VALUE AND SALES

Bedding Cost (Midwest average) $0.10/cow/day
Annual value for our dairy (4500*365*.10) $235,000
Solid Sales to other dairies $40,000
Total $ value $275,000
Separator Repair and Maintenance $21,000
Net $254,000

PROS OF DIGESTED SOLIDS AS A BEDDING SOURCE

• Readily available.
• Reasonable cow comfort and traction
• Manure system friendly
• Not adding additional material to manure stream
• Potential revenue stream for the dairy
• Milk quality can be excellent!

CONS OF DIGESTED SOLIDS AS A BEDDING SOURCE

• Stigma of using Manure as bedding
• Material is moist when going into stalls
• Solids will blow around in strong winds
• Stall bedding levels are less forgiving
• Need storage and must manage inventories
IMPACT OF DIGESTED SOLIDS ON SCC

![Graph showing impact of digested solids on SCC](image)

CARBON CREDITS

- Requires Monitoring of Methane destruction
- Yearly calibration of meters and quarterly analysis of gas concentration
- Use an outside broker, certifier and verifier
- Requires upfront capital to certify credits.
- Multiple exchanges – can’t move credits to different exchange once certified
- Sold 2011 and 2012 to BP to offset Olympians’ travel to London Olympics
- Revenue after expenses $104,000
TIPPING-SUBSTRATE

• All substrates need approval by DNR
• Foreign material huge concern
• Logistically how to add material to digester
• Impact of adding substrates to bedding solids from digester?

TIPPING - SUBSTRATES

• Food process wash down water
• Food/Grocery store waste
• Rumen Paunch
• Paper Sludge
• Revenue average $75,000

HEATING BENEFITS

Use excess heat from gensets to heat:
• Digester
• Separator Room
• Parlor building
• Holding area
• Treatment and Veterinary area
• Shop and machinery room
• Calf nursery
**MANURE MANAGEMENT BENEFITS**

- Digester: Reduces soluble phosphorus levels by 50%
- Liquid can be applied to growing crops
- >60% typically applied to hay ground
  - High in Potash for growing hay
  - Applied right after hay is harvested (gives water to the plants at critical stress time)
  - Increases hay yield approx. 1.5 T/acre DM/year
  - Increase longevity of hay stand
- Apply higher solids manure to corn/wheat ground to match nutrient needs

**MANURE ANALYSIS (2012)**

<table>
<thead>
<tr>
<th>First Year Available (Per 1000 Gal.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% DM</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>First Pond</td>
</tr>
<tr>
<td>Second Pond</td>
</tr>
<tr>
<td>Third Pond</td>
</tr>
<tr>
<td>Ave. Manure</td>
</tr>
</tbody>
</table>

**THE $ VALUE OF DIGESTER PER YEAR**

### INCOME
- Electrical $420,000
- Bedding $275,000
- Fertilizer $440,000
- Heating $30,000
- Carbon C $125,000
- Tipping $75,000
- Tax Credit $40,000
**Total $1,384,000**

### EXPENSES
- Maintenance $250,000
- Manure Application $400,000
- Reduced Manure App. $(30,000)
- Depreciation $115,000
- Carbon Credit fees $21,000
- Total $756,000

Return on Investment: $628,000/$2,200,000 = 28.5%

**MAJOR MISTAKES**

- Choose reliable genset / vendor
- Place electrical switchgear and controls in clean air room
- Cement block building and larger engine room.
- Purchase methane/fuel oil boiler
- Separators require lots of maintenance
- Place radiators away from solid separation
- Don’t inject oxygen into digester
KEYS TO IMPROVE SUCCESS

- Dedicated Management - “Buy-in”
- Engine Maintenance - +90% run times
- Able to capture value of bedding
- Willing to invest in infrastructure to benefit from carbon credits
- Land base and storage to accommodate substrates
- Willing to make mistakes and learn from them (some expensive ones)

CHALLENGES

- Managing digester takes time from dairy
- Planning enough capacity for future inputs
- Controlling Hydrogen Sulfide in gas emissions (shortens engine and oil life)
- Parameters to measure digestion quality and resulting bedding quality
  - Oxygen demand/availability
  - Bacteria counts
  - Sugars/starches (digestible nutrients?)

PLAN FOR THE UNEXPECTED

- Installing a grit pit
  - Prevent more debris from reaching digester
  - Allow flow to digester halves to be more even
  - Chamber to pre-warm manure before entering

- Evaluating bedding dryer system to improve mastitis management
  - Long term shift has been to more Klebsiella and gram-negative mastitis

- Monitoring internal solids buildup – suspect need to clean every 5 to 10 years

- Economics of nutrient recovery looks very promising

FUTURE PLANS AND OPTIONS
Thank You

Tool of choice for emptying a digester
Heating pipe rack in acid chamber
WHAT DID WE FIND?

- Sand buildup on floor and at entrance to digester
- Solids buildup varied from 4’ to 10’ deep
- An amazing amount of empty cotton seed hulls
- Rocks, metal gate hooks, plastic, rubber gloves
- Leaking and deteriorated steel water pipes
- Heating racks plugged with fiber solids

LESSONS FROM OUR EXPERIENCE

- Digesters are not a simple cement box, but rather an interesting and complex feat of engineering.
- Build a settling pit for the manure ahead of the digester.
- Be aware of what material is going into your digester.
- Plan for needing to maintain the inside of your digester.
- A drop pit at the exit to facilitate emptying digester.
- Protective gear inside the digester is important (especially Swim Goggles!).
- Digesters can be and are very profitable.

Thank You