Manure of the Future

Mark Jenner, PhD
Manure Visionary

• Will require a greater knowledge of manure quality as a feedstock than ever before.
• Will utilize complementary, nested technologies and generate multiple outputs.
• Will require a more sophisticated infrastructure.
Current Manure Utilization
2002, USDA Census of Ag

What is the Quality of Your Manure?

If you want to sell your manure, you had better know the quality of it!
Manure Must Be Understood

- Feces and urine as voided.
- Feces, urine, other excrement, and bedding produced by livestock that has not been composted.
- Manure, bedding, compost and raw materials or other materials commingled with manure or set aside for disposal.
- Unused corn and soybeans.

Manure Today is Different Than Manure of 30 Years
Manure Today is Different Than Manure of 30 Years

Most manure tables were created on animals from the 1970s to 1980s.

Manure Quality Varies

- 0.7 dairy cows
- 1.3 beef cows
- 7.4 swine
- 16.7 sheep
- 1 horse
- 250 laying hens
- 500 broilers
- 66.7 turkeys
- 333.3 ducks

Pounds per 1000 lb of live weight:
- Ash
- Carbon
- Water
- Urine
Water Content Matters

400 lbs solids @ 80% moisture = 2,000 lbs
400 lbs solids @ 40% moisture = 667 lbs

1,333 lbs less water

Is Manure an Environmental Benefit or Liability?

- CERCLA air quality emissions limit is 100 lbs., NH3 per day. 365-days of that emission is 18 tons/year of NH3.
- A CAFO Rule success has been that it is easier to managing P in the feed.
- Carbon Credits have changed the way we look at CH4. Is CH4 an environmental evil or economic benefit?
Efficiency Is Increasing

- **Increased rate of gain** from better genetics and better feed formulations
- **Manure quality can be lower.** Smithfield methanol project did not work because real manure was less ‘potent’ than the tabled manure estimates.
- **Manure can have higher values.**
- **Before** capital investments are made, establish the quality of the manure.

High Quality Manure

<table>
<thead>
<tr>
<th></th>
<th>Lbs/ton</th>
<th>nitrogen</th>
<th>phosphorus</th>
<th>potassium</th>
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<tr>
<td>manure compost</td>
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<td>50</td>
<td>49</td>
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<td>fresh, dry manure</td>
<td>68</td>
<td>52</td>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>
High Quality Manure

- Nitrogen: 68 Lbs/ton
- Phosphorus: 52 Lbs/ton
- Potassium: 40 Lbs/ton

Manure compost:
- Nitrogen: 30 Lbs/ton
- Phosphorus: 50 Lbs/ton
- Potassium: 49 Lbs/ton

Fresh, dry manure:
- Nitrogen: 68 Lbs/ton
- Phosphorus: 52 Lbs/ton
- Potassium: 40 Lbs/ton

Capitalize on System Benefits

- Energy flows through the system. Capture that waste heat for other uses before it leaves.
- Recycle nutrients and water.
- Bring in outside materials to optimize the technology.
- Generate as many marketable products as possible.
The Production Ecosystem

Solar Energy

Primary Producers → Herbivorous Consumers

Soil ← Decomposers

Food
Fuel
Fiber

Gleissman, 1989

Intensive Grazing System

Solar Energy

Forage crops → Intensively grazed cows

Soil ← Manure deposition

Food
Fuel
Fiber

The original *cellulosic* bioenergy
E3 Biofuels (currently closed)

The Ecosystem w/ Markets
Consider Other Feedstocks

- Are there other materials that will aid in composting? Anaerobic digestion?
- Dairy wash water, mortalities, yard waste food processing wastes, restaurant leftovers, used oils, grease trap waste?
- What kind of regulatory/legal complications arise from mixing materials?
- Is there ‘tipping’ revenue available?

Do Not Rely On Single Market

- 2007, USDA NRCS report: digester costs from 7 to 29 cents/kWh installed.
- Revenue from power sales was reported between to be from 2 to 6 cents/kWh.
- Other revenue sources can be from cost offsets, sale of green power, digester solids, and carbon credits.

The Sum of Benefits >> Sum of Costs.
Target All Available Markets

- Fertilizer (N, P, K)
- Organic soil amendment (C)
- Compost
- Green power
- Carbon credits
- Building materials
- Other fiber markets
- Heat offsets
- Power offsets
- Local industrial demand
- Remediation Mkts
- Fish food
- Algae production
- Activated charcoal?

Infrastructure Development Adds Benefits/Costs

- Feedstock supply
- Technology maintenance
- Market development and service
- Market regulatory support
- Environmental regulatory compliance
- Infrastructure development takes time
The Early US Digester Industry

How Much Manure does it Take to Light a Light Bulb?
Serious Manure Power

- Benson, MN – 55 MW from turkey manure
- Stephenville, TX – Microgy producing natural gas from manure of 10,000 cows and 8 million gallons of digester capacity
- E3 Biofuels, Mead, NE – powering a 25 million gallon ethanol plant on manure from 28,000 cattle
- Panda Energy fueling a 115 million gallon ethanol plant on 1 billion pounds of manure

Infrastructure Development

- What energy form is most appropriate?
  - *Electricity* (challenges with transmission and interconnectivity)
  - *Sale of biogas direct to manufacturer*
- Regulatory costs must be smaller than the benefits of the energy.
  - *Feedstock must be an appropriate choice* (no serious risks)
  - *Cross-jurisdictional agencies must complement energy production and environmental goals.*
Address Specific Market

compost value market expects performance

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<tr>
<td>N-P-K</td>
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</table>

Are High Prices Good?

State Electricity Prices, 2005

States without digesters
States with digesters

MO 6.13 cents/kWh
Take Home Messages

• Know the *quality* of your manure.
• Look at how it can be nested with other technologies to produce *multiple outputs*.
• Work together to advance a new information, distribution, and market *infrastructure*.

Biomass Rules, LLC
Economics/Regulations/Infrastructure

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+ biomass inventory/utilization
+ streamlining regulations
+ land use / demographics

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