Maximizing the Value of Digester Fiber

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Digestate Characteristics

- Contains mineralized nutrients.
- Nitrogen
  - 25 percent more accessible NH₄-N and a higher pH than undigested manure.¹
  - 80 percent of the nitrogen available to plants.²
- Phosphorus
  - Phosphorus availability is influenced by numerous factors.
- Can be land applied or dewatered

- Dewatering digestate
  - Mechanical solids separation and/or flocculants into liquid and solid fractions.
  - Typically 18 to 30 percent dry matter.

Filtrate Characteristics

• Contains most of the soluble nutrients.
• Concentrations of total solids, total volatile solids, fixed solids and chemical oxygen demand differed significantly (P<0.01) between digestate, liquid digestate and solid digestate.¹

Source: Martin, 2003
Fiber Characteristics

- Moisture retention.
- Higher concentrations of N, P, K and trace elements than manure.¹
- Organic nitrogen and phosphorus concentration higher in the separated solids than in the liquid digestate.²

Solids Separation Technologies

• Gravity settling (passive)

• Mechanical separation (active)
  • Screens
    – Stationary inclined (static) screens
    – Vibrating screens
    – Rotating screens
  • Presses
    – Roller presses
    – Belt presses
    – Screw presses
  • Centrifuges

Solids Separation – System Performance

- Key issues
  - Separator efficiency
    - Solids capture rate rates range from less than 5% to higher than 70%
    - Can be increased significantly with the use of polymer

**WHY IS THIS IMPORTANT?** – Determines the amount of solids that will be recovered

- Solids content of recovered solids
  - Studies range from approximately 12% to 40% or higher

**WHY IS THIS IMPORTANT?** – Characteristics of solids are critical to value-added opportunities

Solids Separation – System Performance (cont.)

• Screens
  • Perform better with low solids manures
    – Avoids clogging of screens
    – Less moisture will be found in the solids
    – Balancing act between screen size and separator efficiency

• Presses
  • Higher separator efficiency and solids content
    – Little data available on performance
    – Often used following screens

What is the “Right” Separation System

• Depends on the objectives of the facility
  • Capture as many solids as possible – high separator efficiency
  • High solids content product – separation efficiency may be lower and more solids will end up in the lagoons

• Cost can be a factor
  • The most expensive separator may not be best to meet the objectives
  • The least expensive separator may not be best to meet the objectives

Value-added Products

- Liquids (filtrate)
  - Liquid fertilizer
- Solids (fiber)
  - Compost
  - Animal bedding
  - Pellet/Granule fertilizer
  - Fuel pellets
  - Fiber
    - medium density fiberboard
    - fiber/plastic composite products

- Biogas
  - Digester gas
  - Pipeline quality gas
  - Carbon dioxide
  - Ammonium-N
  - Hydrogen
- Fuel
  - Methanol
- Heat
- Steam

Plus spin off opportunities such as carbon credits, prawns, biodiesel, ethanol, specialty greenhouse crops...you are only limited by your imagination!
Dairy Biorefinery Concept
Adapted from: http://www.anaerobic-digestion.com/html/anaerobic_flow_diagram.html
What might a dairy biorefinery look like?

**Model 1**
- Liquid: Grow algae for biodiesel production.
- Fiber: Pelletize for animal bedding.
- Biogas: Clean and compress for vehicle fuel.

**Model 2**
- Liquid: Grow hydroponic crops in greenhouses.
- Fiber: Manufacture high quality compost.
- Biogas: Use for on-farm energy replacement.

**Model 3**
- Liquid: Grow hydroponic crops in greenhouses.
- Fiber: Make medium density fiberboard.
- Biogas: Burn in a boiler for heat.

KEY - closed loop systems.
Model 1: Pelletized fiber for animal bedding

- SBIR USDA Grant Activity 8.11 Animal Manure Management
  - Digester fiber as unique bio-fiber
  - Focus on bio-degradable/compostable product
  - Use existing commercial processing capacity
- Eco-Composites
  - Perfect cycle products from digester fiber
Focus on off farm products from a unique bio-fiber

What is it? “IT is Not Manure”

A plant based lignocellulose fiber processed by ruminant digestion and an anaerobic digester:

- Wet 60-75% moisture
- Light weight for transportation

Major Components In Lignocellulosic Biomass

**Lignin:** Dairy Manure 17%, Hog Manure 7%
- Complex network of aromatic compounds

**Hemicellulose:** Dairy Manure 53%, Hog Manure 49%
- A collection of 5- and 6-carbon sugars linked together in long, substituted chains- branched
- Xylose, arabinose, glucose, mannose and galactose

**Cellulose:**
- Dairy Manure 25%, Hog Manure 18%
- Long chains of beta-linked glucose
- Semicrystalline structure
Bio-mass drying and process development of digester fibers

First production trial run of pellet digester fibers 2010
Model 2: High quality compost

- Conduct a compost market assessment.
- High quality is the key.
- One Michigan farmer selling bagged compost is getting the equivalent of $525/cy (1200 lb/cy).
Model 3: Composite materials

Plastic wood

Medium density fiberboard
Additional Points to Consider...

- Published digester economic assessments tend to show that the most successful digesters are those that have:
  - Generated added value from separated manure fiber.
  - Charged tipping fees for accepting off-farm food processing wastes.
  - Had a nearby high-value use for the biogas or electricity.
- A very promising solution, if carbon emission reduction is the driving objective, is to employ manure separation and composting on smaller farms. Why?
  - A pathogen-free bedding material
  - Reduced solids loading in the lagoon
  - Carbon reductions on the order of 50% of what’s attainable with a digester, but at 1/10th the cost
- Dairy farmers who use the fiber from a digester as bedding value it as much as they do the energy.
In summary...

- Selecting the right solids separation equipment is critical to maximize fiber quantity and quality.
- Think in terms of a closed loop dairy biorefinery system to maximize the value of digester fiber.
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