Maximizing the Value of Digester Fiber

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Digestate Characteristics

- Contains mineralized nutrients.
- Nitrogen
  - 25 percent more accessible NH_4-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.

Sources: 1. Monnet , 2003 2. Heslop , 2004

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]

Sources: 1. Frame et al., 2001 2. Martin 2003

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

Screen separator

Source: Katers, John. 2008. Value-added Opportunities for Separated Manure Solids presentation.

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

Source: Katers, John. 2008. Value-added Opportunities for Separated Manure Solids presentation.

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

Source: Katers, John. 2008. Value-added Opportunities for Separated Manure Solids presentation.

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

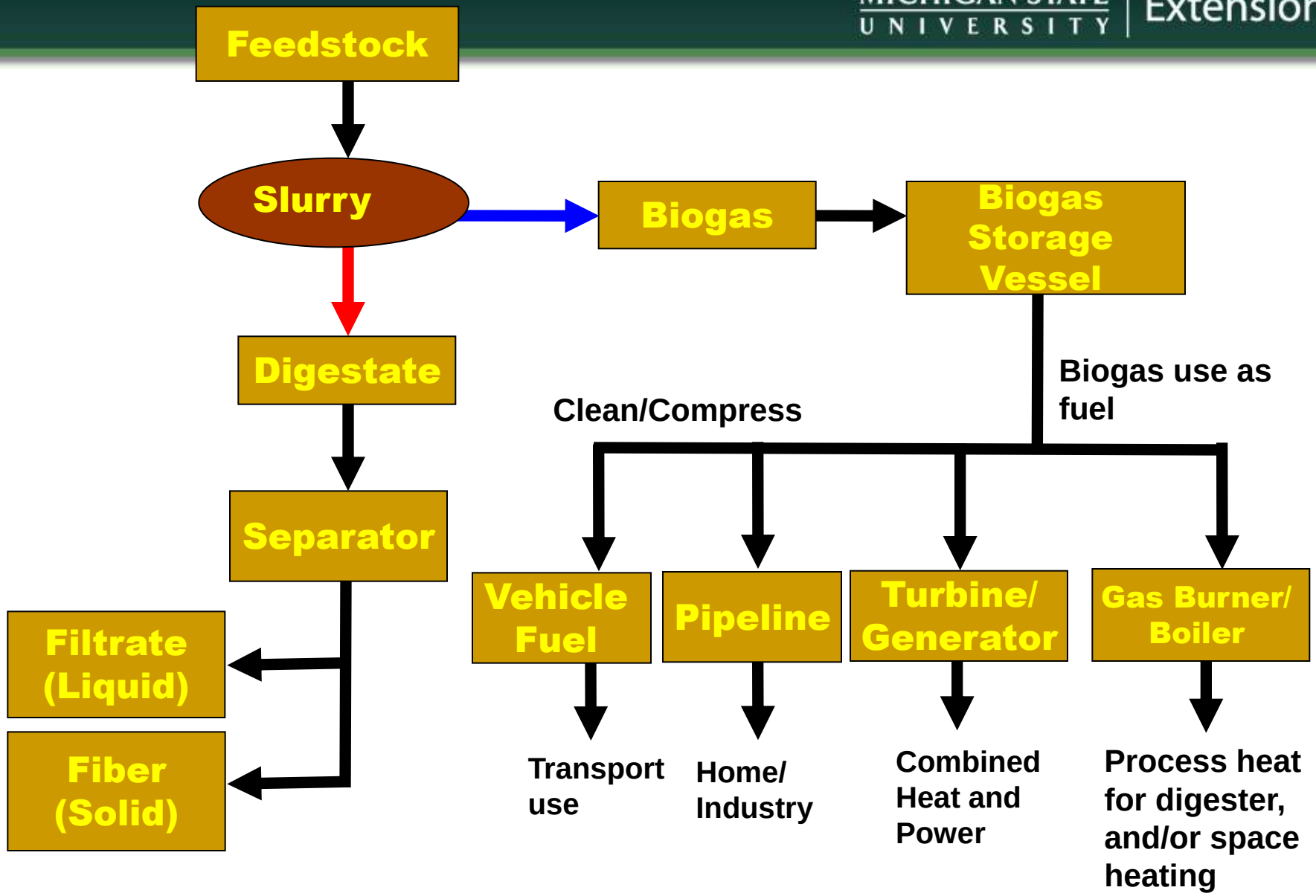
- Cost can be a factor
  - The most expensive separator may not be best to meet the objectives
  - The least expensive separator may not be best to meet the objectives

Source: Katers, John. 2008. Value-added Opportunities for Separated Manure Solids presentation.

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

Eco-Composites LLC

perfectcycle

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

Chemistry

Major Components In Lignocellulosic Biomass

Lignin: Dairy Manure 17%, Hog Manure 7%

- Complex network of aromatic compounds

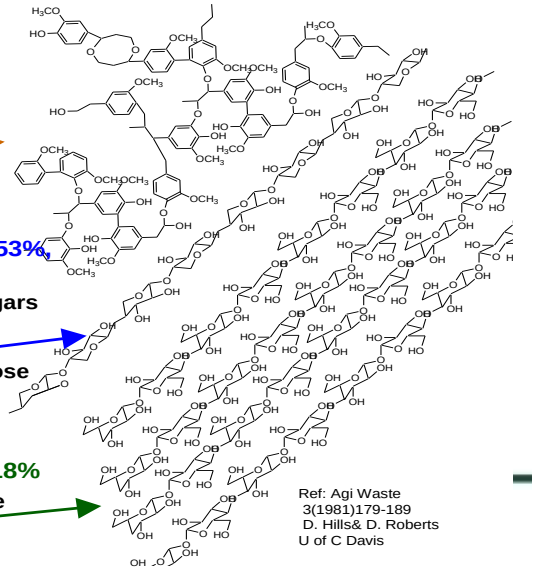
Hemicellulose: Dairy Manure 53%, Hog Manure 49%

- A collection of 5- and 6-carbon sugars linked together in long, substituted chains- branched
- Xylose, arabinose, glucose, mannose and galactose

Cellulose:

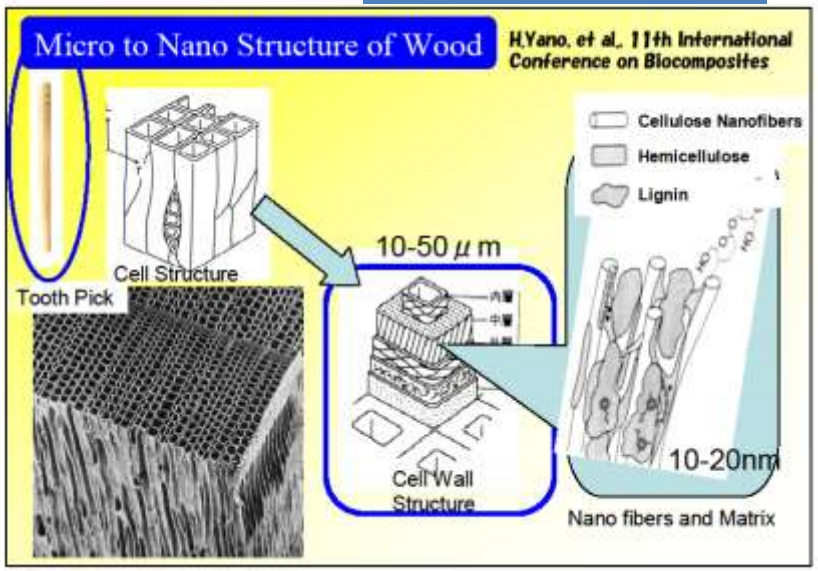
Dairy Manure 25%, Hog Manure 18%

- Long chains of beta-linked glucose
- Semicrystalline structure



Ref: Agi Waste 3(1981)179-189
D. Hills& D. Roberts
U of C Davis

Cell Wall Structure



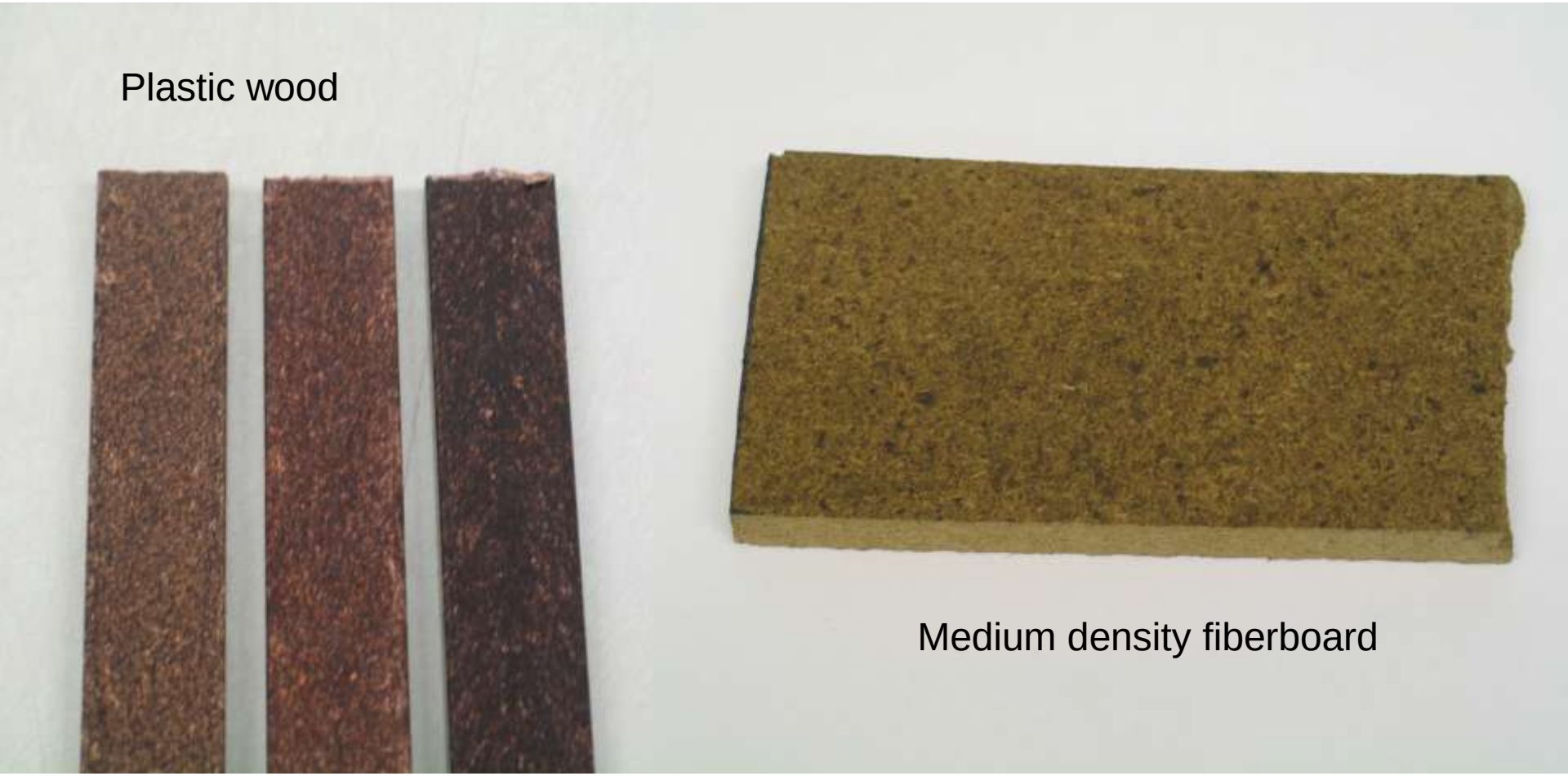
Bio-mass drying and process development of digester fibers

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



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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