Brown Gold: The Smell of $$$

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Accelerated Renewable Energy Consortium

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Mining Manure: An Economic Case for Nutrient Management
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INTRO (Conclusions!!!)

Extant and emerging separation technologies provide opportunities to "*fractionate*" this cellulosic feedstock into multiple value added products:

- **Energy: methane gas, ethanol**
- **Intermediate chemical products: bio-butanol**
- **Mulch: peat moss substitute**
- **Organic fertilizers:**
  - **Concentrate and/or pelletized: high P and OM**
  - **Liquid ("tea water"): high N & K, Low P|OM, for fertigation**
- **AND: a variety of amino acids (proteins): "industrial" *plastics feedstocks*.**

Dairy Farms = Cellulosic Feedstock Bio-Refineries!!!

Manure Separation ➔ Bio-Refineries!!!

OUTLINE

I. Key Cellulosic Feedstock Challenges
II. Manure Separation is KEY!!!
    - Key Functional Perspectives
    - Example: Polymer Based
        - Facilitates Value Added Bio-Feedstock Extraction
III. Precision AG Manure Nutrient Management Planning (NMP)
IV. Cellulosic based, bio-energy and bio-feedstocks
V. Wrap Up

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Key Cellulosic Feedstock Challenges

Aggregate, Concentrate, and Homogenize

- True of most “industrial process” feedstocks.

Food versus Fuel:

- LCA (Life Cycle Analysis)
- Carbon Footprint
- Displaced “rain forests”

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Key Cellulosic Feedstock Challenges

Dairy Manure = Triple (*bio-chemical*) "Pre-Processed".

1) **Ensile**
2) **Ruminate**
3) **Anaerobic Digestion**

These "simple" biochemical/fermentation processes use less energy than many alternative refinery/separation processes….

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Separation is KEY to Unlock Manure $$$

Key Functional Perspectives

1) Liquids versus Solids Fractions
   - Handling logistics/costs
2) Nutrient Fractions (NPK|OM)
   - Ideally separate N from P.
   - Soluble N|K fractions: “tea waters”
   - OM|P fractions: concentrates
3) Fiber Fractions (new)
   - SoilNet & BRDI Project
   - Large versus Small Fibers

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Variability of Agitated Pit Manure

200 samples of Agitated Pit Manure (**CIG** Project):

- taken every 4 hours during application
- over 4 years
- On average N:P ratio is 2:1.
- Variability (coefficient of variation, CV) is 2.5X higher for P than N.

SUMMARY: 1st and 2ND YEAR MANURE NUTRIENT COMPOSITION AS APPLIED (Pounds/1,000 Gallons)					
AVERAGE	DM	N	P	K	S
2006	3.5	8.1	4.4	13.4	1.4
2007	3.3	6.9	3.4	13.9	0.8
2008	2.7	7.0	3.5	11.6	0.7
2009	2.2	7.0	3.1	14.2	0.5
2006-2009 AVG	2.9	7.2	3.6	13.3	0.9
Coefficient of Variation	DM	N	P	K	S
2006	36%	16%	44%	17%	25%
2007	43%	21%	56%	22%	36%
2008	35%	21%	51%	35%	37%
2009	22%	14%	40%	19%	21%
2006-2009 AVG	34%	18%	48%	23%	30%

Blue – Above Average Red – Below Average

Manure Processing (Separation) Can Reduce Environmental Risk

- **Partition manure into high and low P fractions**
  - Apply low P fraction (permeate) on high soil test P fields
  - High P fraction (concentrate) for low-P or distant fields
- **Better control of environmental impacts:**
  - More nutrient consistency for better nutrient management, particularly N
  - Distributing nutrients over full growing season, in ***small doses*** via "fertigation" with high N/low P liquid fraction

    versus

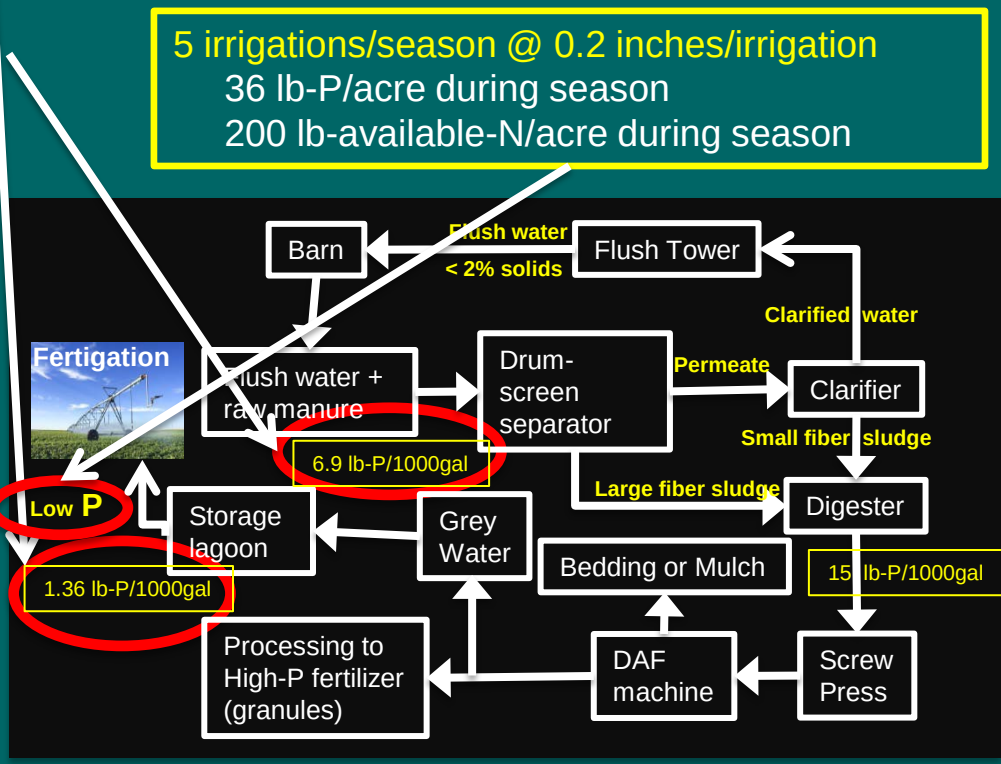
    large single quantities at potentially risky Spring and Fall periods
  - Less over-the-road manure hauling
  - Fewer lagoons needed

Manure Separation

Manure Separation:
Polymer-Based

Manure Processing (Separation) Can Reduce This Environmental Risk

- P Concentration Flow Diagram (lab results)
  - After clarifier: 1.36 lb-P/1000 gal
  - Raw manure: 6.9 lb-P/1000 gal
- One irrigation of 0.2 inches will wet a soil to a depth of 1 to 1.5 inches in a silty clay loam soil.
- At average evapotranspiration rate of 0.12 inches/day, *this water will be evaporated or transpired in about 2 days.*
- No runoff if 1/5" applied over 10 minutes or more



Manure Separation: Polymer-Based

Cellulosic Based, Bioenergy and Bio-Feedstocks

- **Bioenergy:**
  - bio-ethanol, methane (electricity *and* heat)
  - BRDI Project (oilseeds): bio-diesel/SVO
- **Intermediate Chemicals:**
  - bio-butanol, proteins/amino acids (plastics)
- **Bio-Fertilizers:**
  - mulches & pelletS

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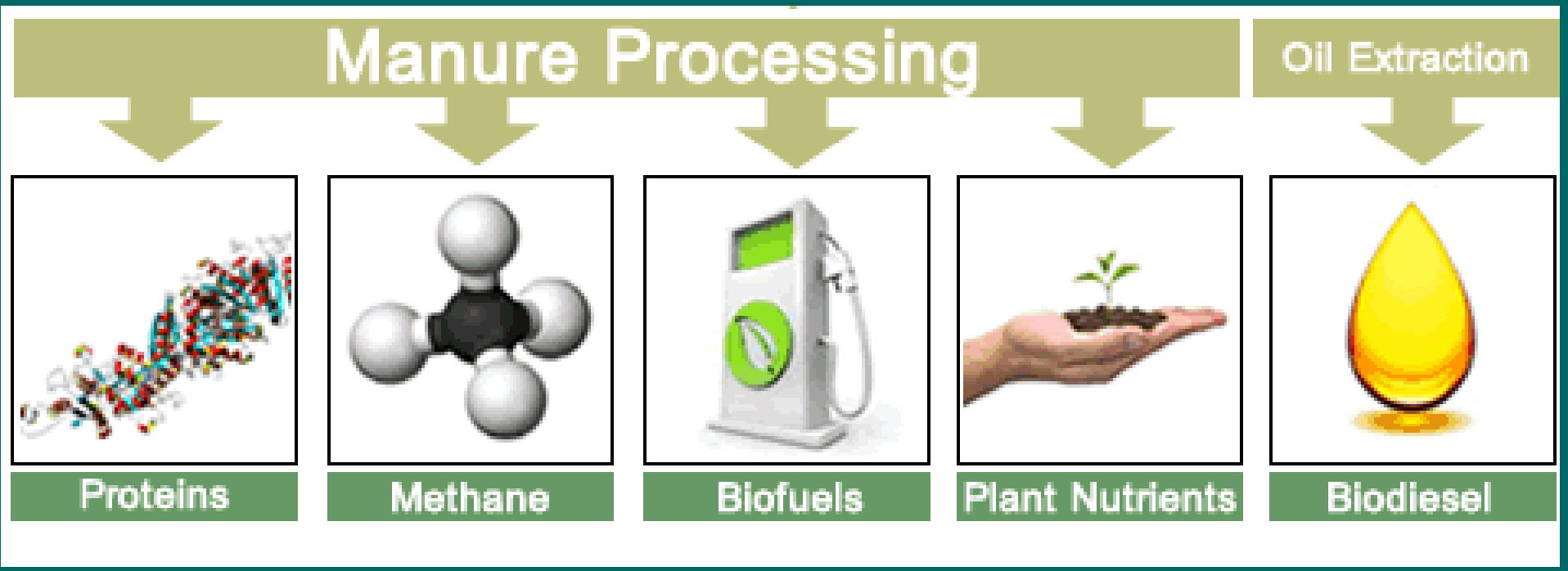
Cellulosic Based, Bioenergy and Bio-Feedstocks



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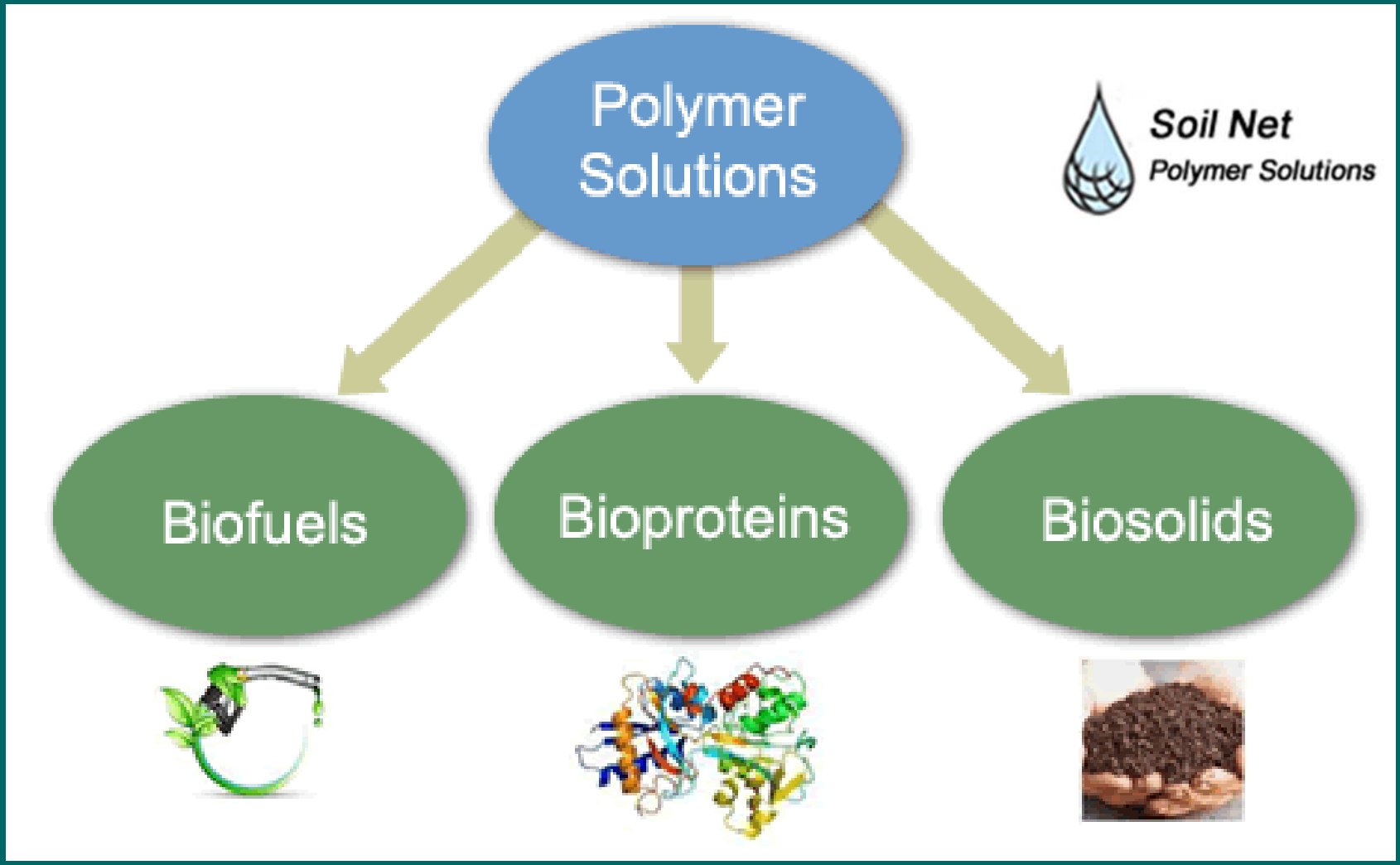
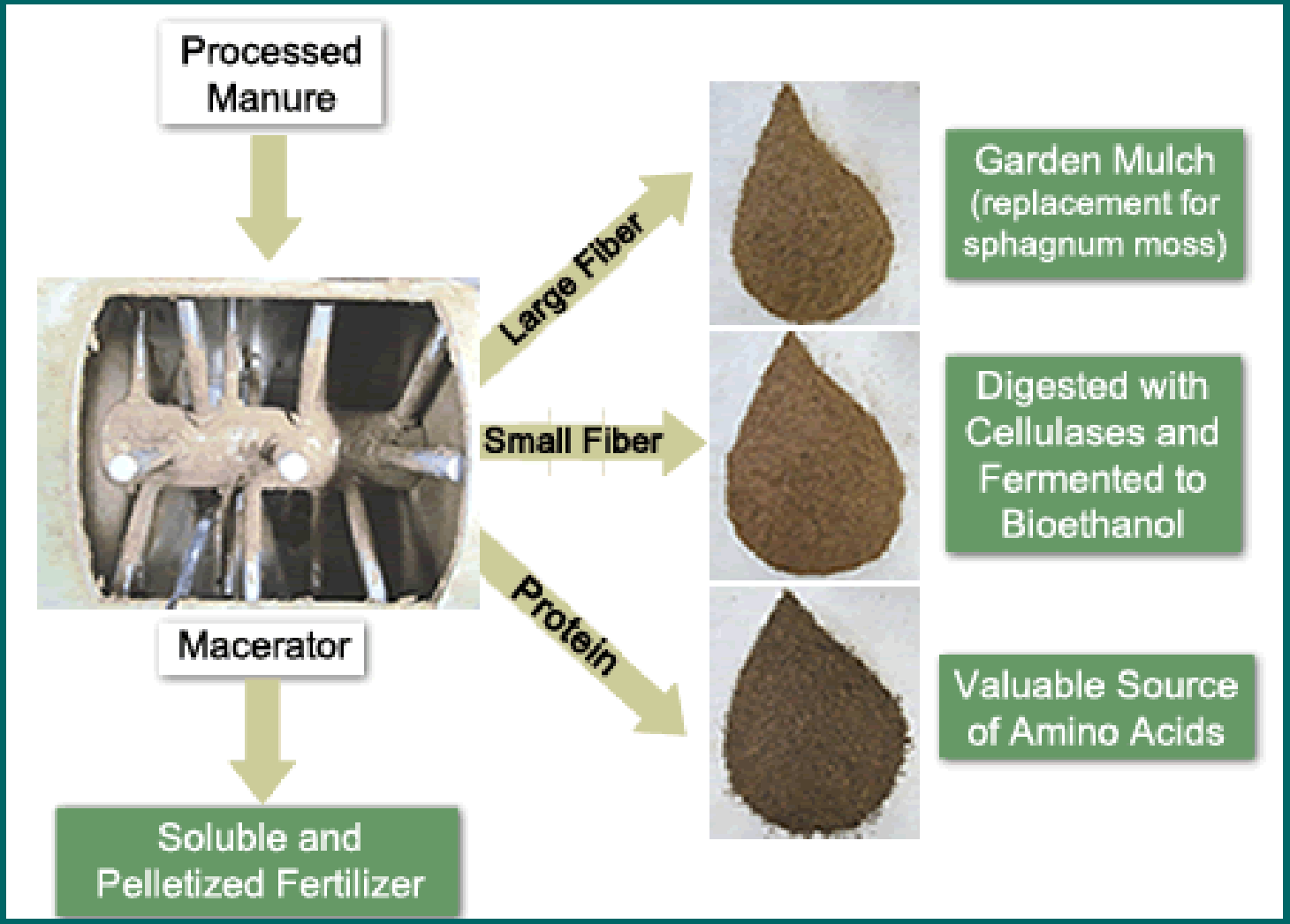
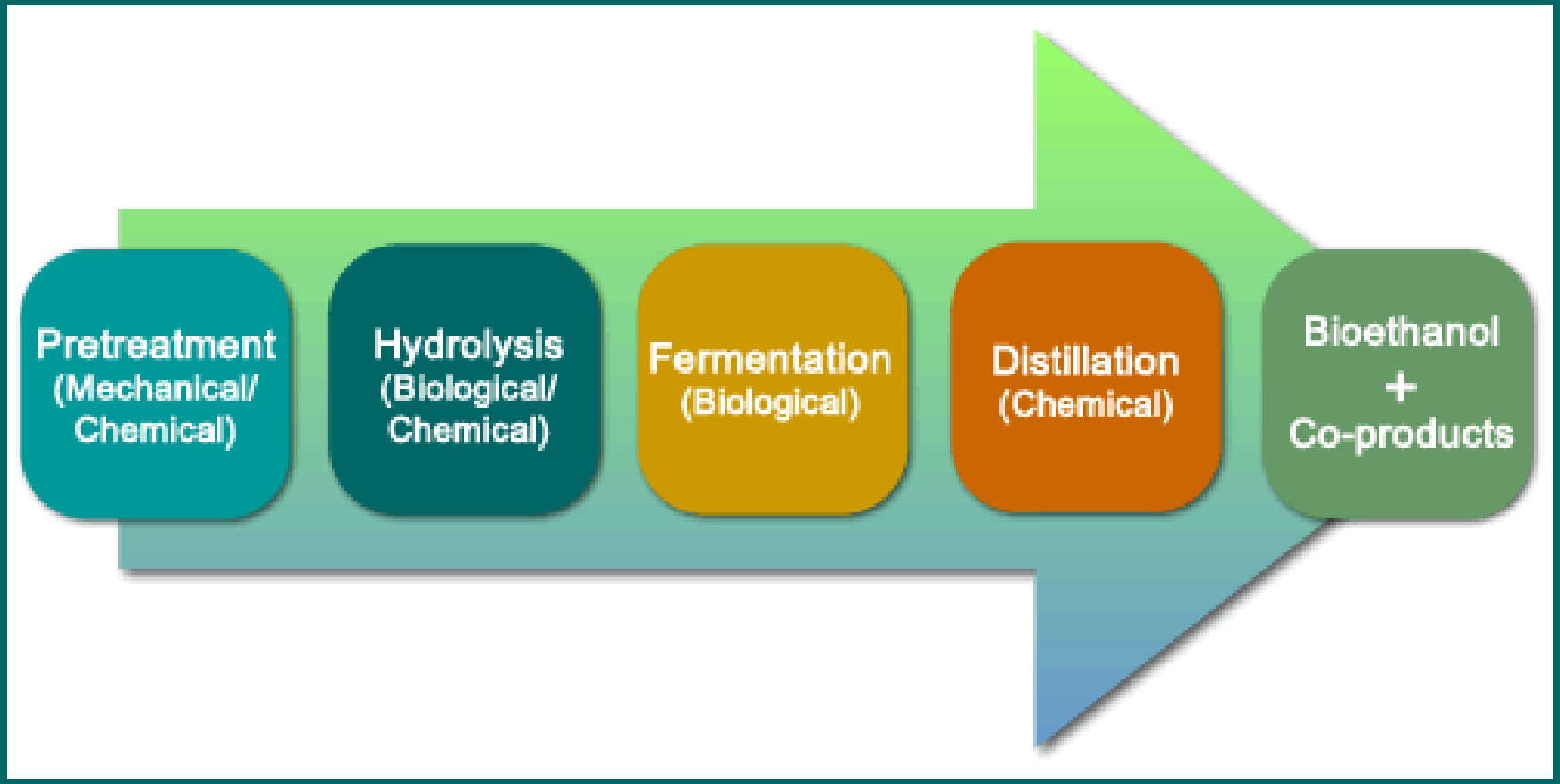
AREC USES SOIL NET'S POLYMER TECHNOLOGY

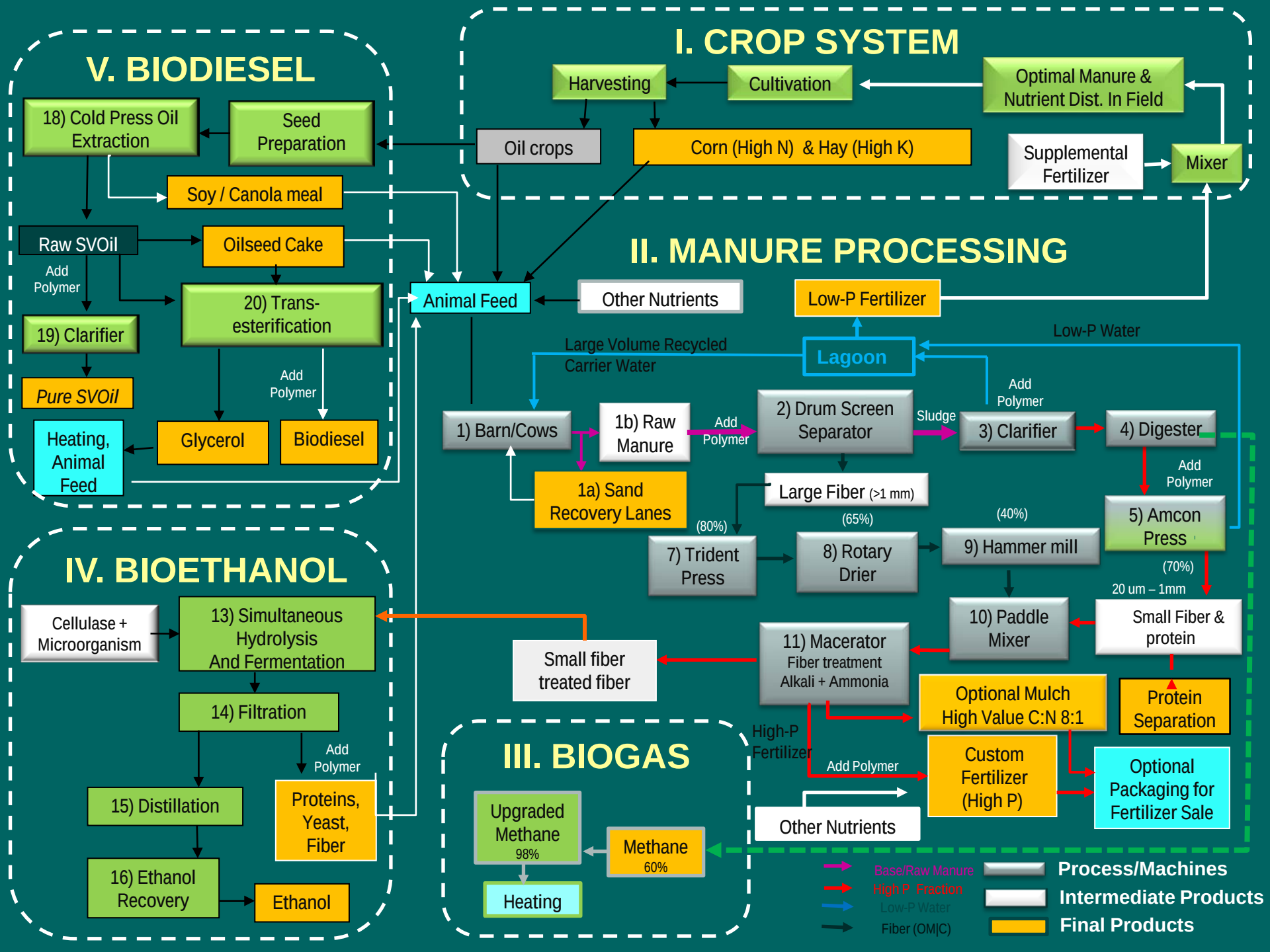


AREC TESTS WAYS OF CONVERTING MANURE TO VALUABLE COMMODITIES



BIOETHANOL PRODUCTION FROM SMALL MANURE FIBER




I. CROP SYSTEM
Harvesting
Cultivation
Optimal Manure & Nutrient Dist. In Field
Oil crops
Corn (High N) & Hay (High K)
Supplemental Fertilizer
Mixer
V. BIODIESEL
18) Cold Press Oil Extraction
Seed Preparation
Soy / Canola meal
Raw SVOil
Oilseed Cake
Add Polymer
19) Clarifier
20) Trans-esterification
Pure SVOil
Add Polymer
Heating, Animal Feed
Glycerol
Biodiesel
II. MANURE PROCESSING
Animal Feed
Other Nutrients
Low-P Fertilizer
Low-P Water
Large Volume Recycled Carrier Water
Lagoon
Add Polymer
1) Barn/Cows
1b) Raw Manure
Add Polymer
2) Drum Screen Separator
Sludge
3) Clarifier
4) Digester
Add Polymer
1a) Sand Recovery Lanes
Large Fiber (>1 mm)
(80%)
(65%)
(40%)
5) Amcon Press
7) Trident Press
8) Rotary Drier
9) Hammer mill
(70%)
20 um – 1mm
10) Paddle Mixer
Small Fiber & protein
IV. BIOETHANOL
Cellulase + Microorganism
13) Simultaneous Hydrolysis And Fermentation
Small fiber treated fiber
11) Macerator Fiber treatment Alkali + Ammonia
Optional Mulch High Value C:N 8:1
Protein Separation
14) Filtration
Add Polymer
High-P Fertilizer
Add Polymer
Custom Fertilizer (High P)
Optional Packaging for Fertilizer Sale
15) Distillation
Proteins, Yeast, Fiber
Other Nutrients
III. BIOGAS
Upgraded Methane 98%
Methane 60%
16) Ethanol Recovery
Ethanol
Heating
Base/Raw Manure
High P Fraction
Low-P Water
Fiber (OM|C)
Process/Machines
Intermediate Products
Final Products

Wrap Up

Biofeedstocks (dairy manure) from US crucial dairy sector provide multiple economic/environmental *challenges and opportunities* to "Grow the Green Economy".

- **This biofeedstock shares fundamental (and relatively low cost) bio-chemical processing – *fermentation* – with several classical WI Ag products:**
  - ***beer, cheese and kraut.***
- **Triple fermentation:1) dairy feed rations (corn/alfalfa silage, haylage, etc.), 2) the cow's rumen, and 3) anaerobic digestion of manure.**

Provides an aggregated, concentrated and homogenized and (bio-chemically) "pre-processed" (low cost/under valued) *cellulosic feedstock*

- **One that largely avoids the *food/fuel issues* associated with many 1st and 2nd generation bio-feedstocks.**

Dairy Manure ➔ Brown Gold!!!

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CONCLUSIONS

These value added opportunities enhance sustainability

- **Economic: increase value-added product sales/revenues and decrease costs via on-farm substitution and increased nutrient use efficiency.**

and

- **Environmental: improved carbon footprint/GHG remediation, reduced nutrient variability, increased Precision Ag and reduced environmental (soil, nutrient, GHG) losses.**

"Triple Bottom Line"

CONCLUSIONS

This provides the fundamental sustainability foundations for:

Economic/Environmental Win-Win

and

Growing the Local Green Economy

- ***Local manufacturing of the separation technology and growth in associated bio-feedstock processing.***

“Triple Bottom Line”

ARE CONSORTIUM

Accelerated Renewable Energy Consortium

DOE/USDA Biomass R&D Initative Funding:

- **$7M Feds**
- **$1.7M Private "Matching"**

Private Collaborators:

Key Technology Partners:

SoilNet: Polymer and Maceration IP.
Braun Electric: Installation, Management.
FEECO: Machine/Process Manufacturing

Key Dairy Farm Partners:

Maple Leaf Dairy, Larson Acres, Cottonwood, others.