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Manure Processing in Wisconsin

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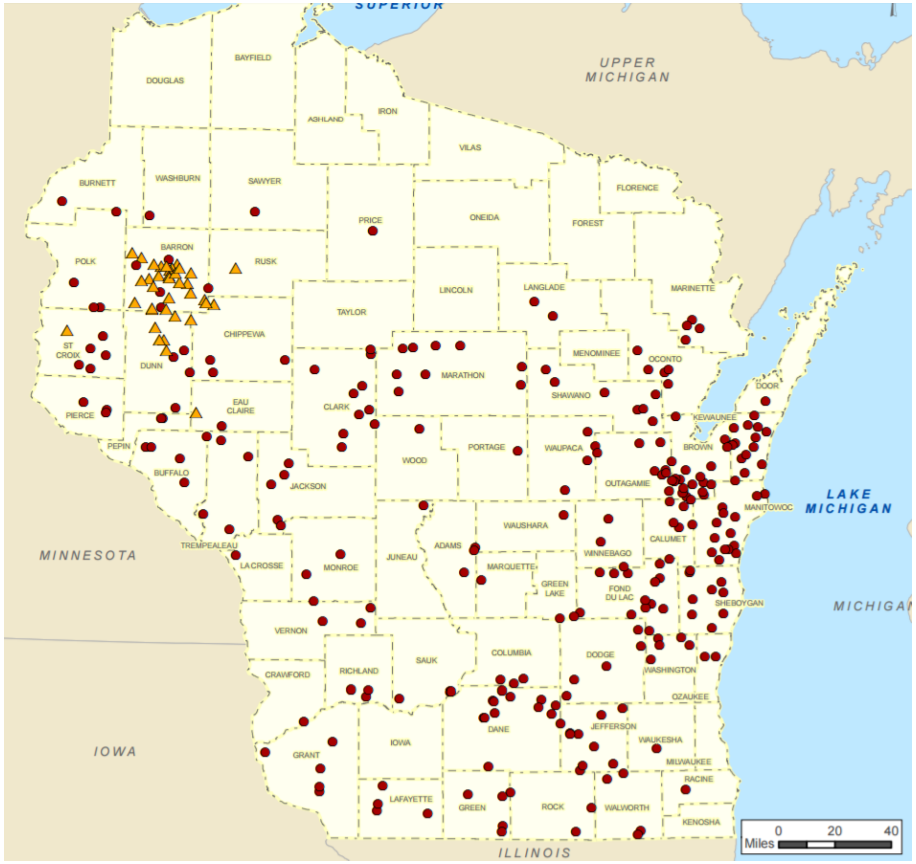
Topics

- Dairy Manure Issues
- Manure Separation Technologies & Rationale
- Research Work
  - Separation technologies
  - Nutrient separation
  - Pathogen reduction

Dairy in Wisconsin

- NASS for dairy cows – 1.3 million cows
- 9990 farms
- 284 CAFO permits
- $43.4 Billion Economic Impact



http://www.wmmb.com/assets/images/pdf/WisconsinDairyData.pdf
http://dnr.wi.gov/topic/AgBusiness/CAFO/StatsMap.html

Cow “back-end output”

Manure Produced by a 1,400 lb Cow/Day

Manure (lbs)	112
Manure (gal)	13.5
Total Solids (dry lbs)	14
Volatile Solids (dry lbs)	11.9
COD (lbs)	12.5
TK Nitrogen (lbs)	0.63
Total Phosphorus (lbs)	0.098
Total Potassium (lbs)	0.36

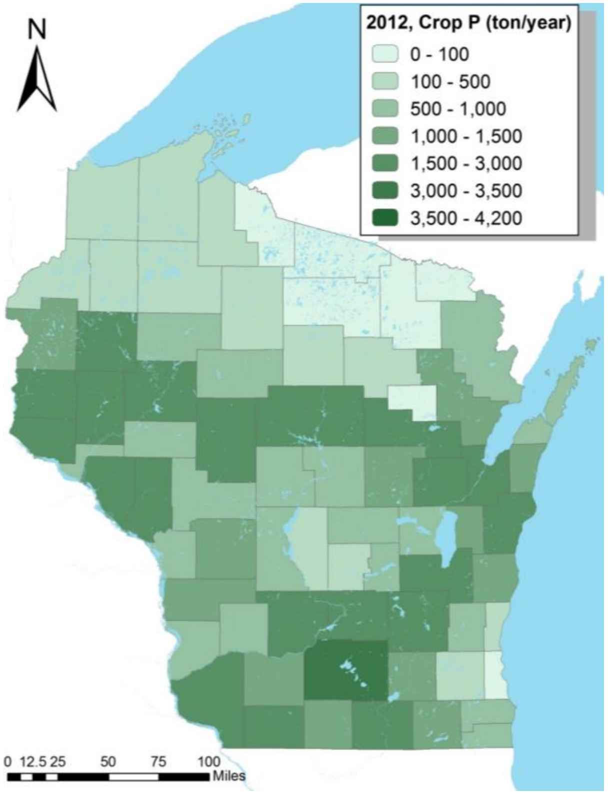
1.3 million cows = 26.5 million tons/year
= 28 Trillion Btu from AD generated CH_4
= generate ~4% of our electricity

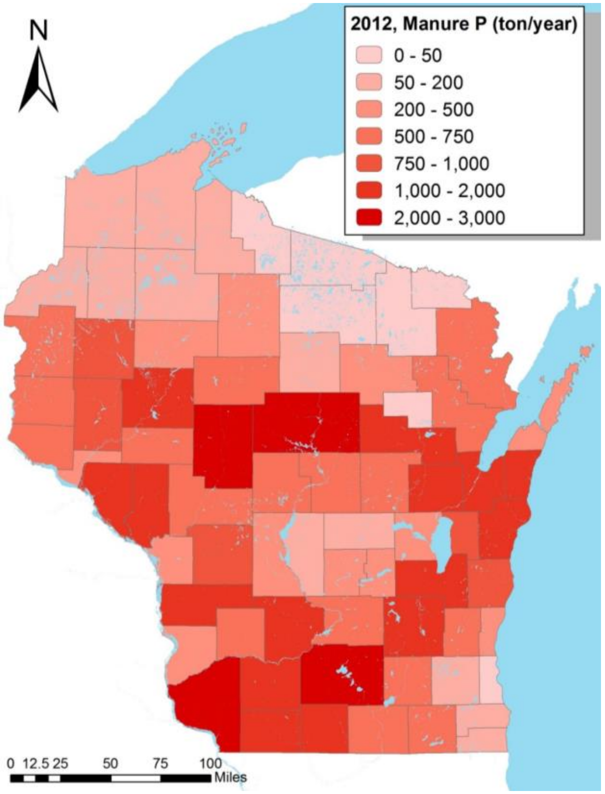
Manure management in WI

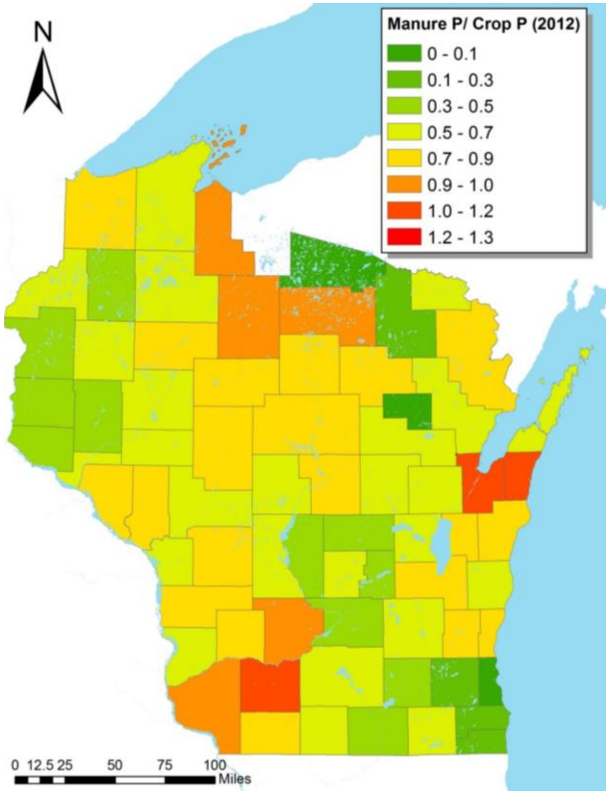
- Rough rule of thumb - Dairy farming
  - 1 acre of tillable land per cow for feed
  - 1 acre of tillable land per cow for manure spreading
- Have enough land
  - ~1 million cows
  - ~10 million tillable acre
- Issue has become one of cow density

http://en.wikipedia.org/wiki/Concentrated_Animal_Feeding_Operation

2012 Manure and Crop P







Watershed-level Manure and Crop P

<u>**Dane County**</u>

Area: 1,238 square miles

Crop area: 46% of county area

Avg. P assimilative capacity: 3,082 ton P/year

Avg. Manure P rate: 2,044 ton P/year

P manure/P crop = 0.66

<u>**Six Mile Pheasant Branch Creeks**</u>

Subwatershed area: 119 square miles

Crop area: 54% of subwatershed area

Avg. P assimilative capacity: 401 ton P/year

Avg. Manure P rate: 625 ton P/year

P manure/P crop = 1.56

Potential Manure Issues

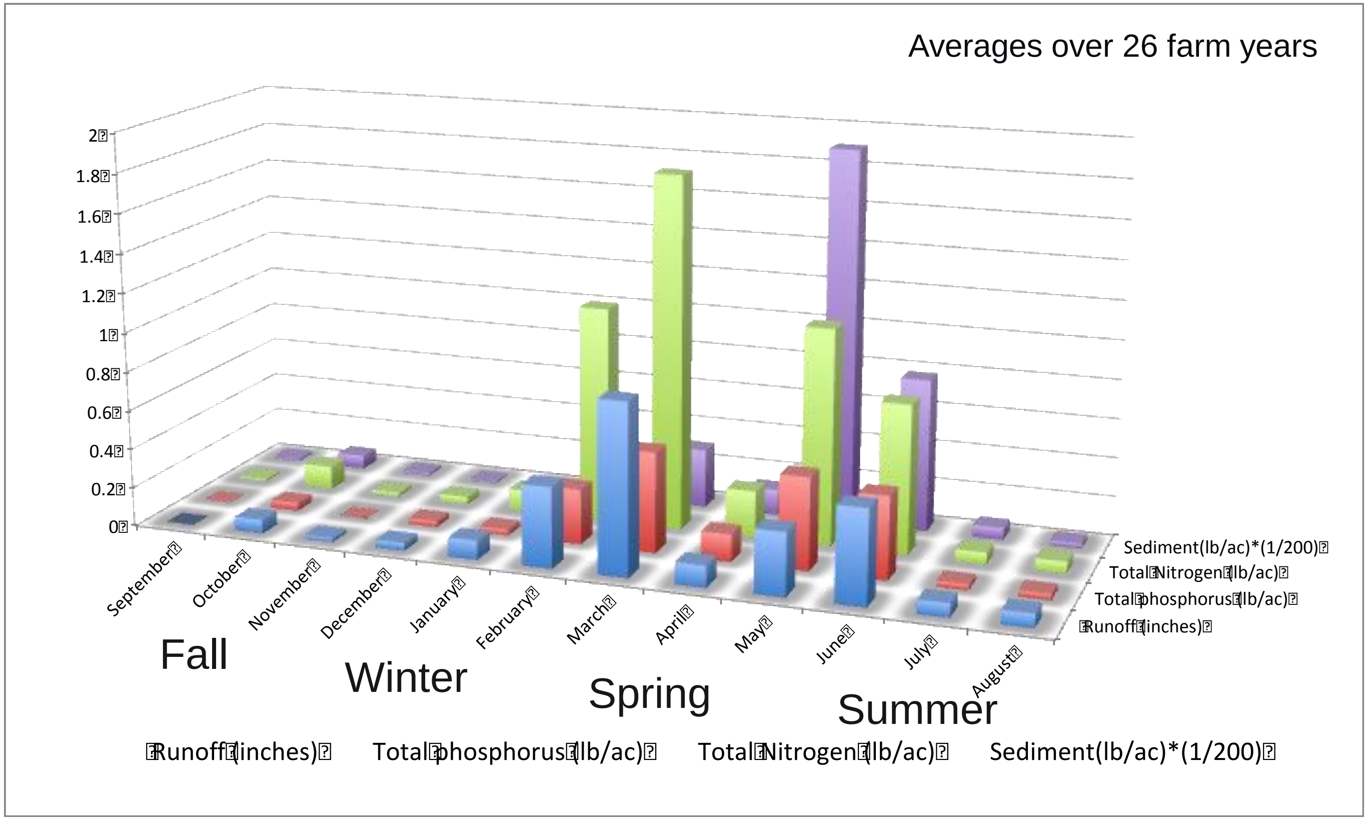
Large Dairies = Large amount of manure

Large amount manure: Environmental & health risks

Water Quality concerns: Leaching and runoff

Farms and public concerns on pathogen from application and recycling

Mean Monthly Runoff, P-, N-. & Sediment Loss from Discovery Farms and Pioneer Farm 2003-08

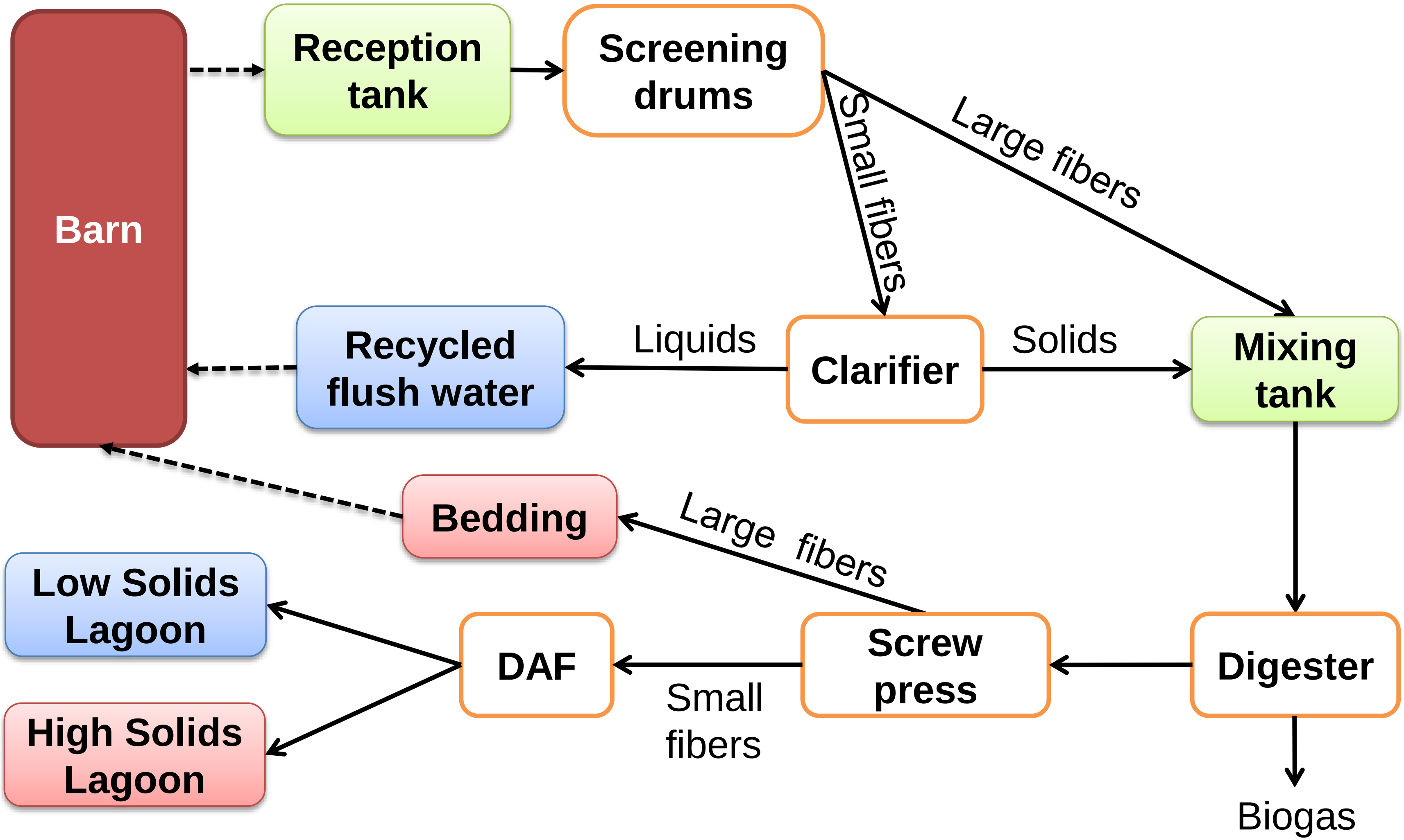


Late Winter and Spring are the times of maximum runoff, P-loss, N-loss and Sediment loss in Wisconsin

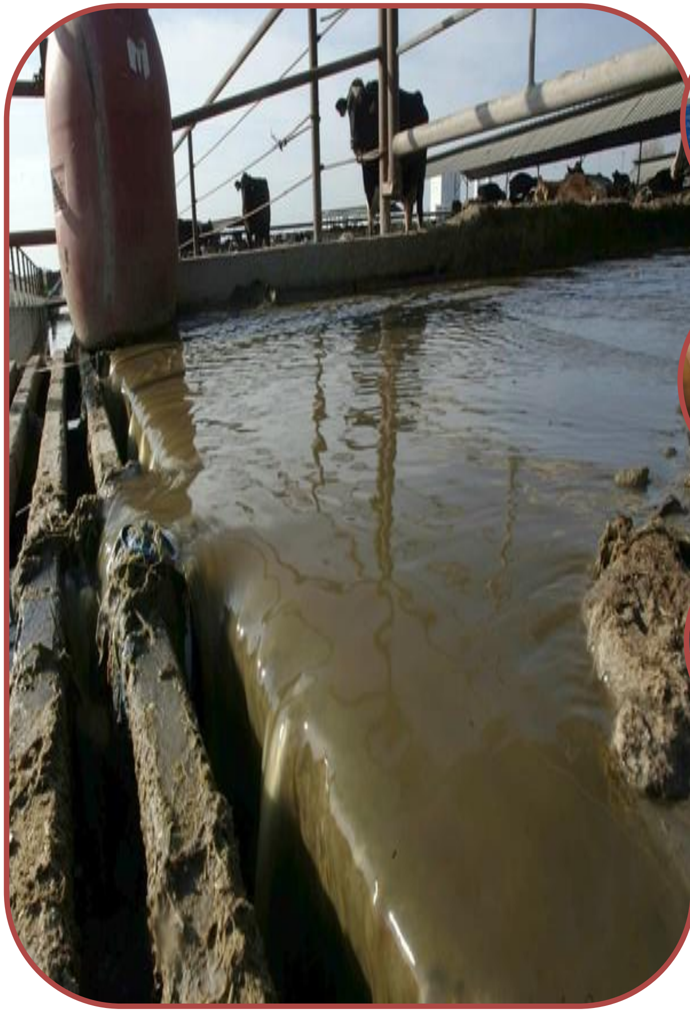
Manure Process Tour

Maple Leaf Dairy
Manure treatment plant

Maple Leaf Dairy Processing - Simplified



Manure Processing Rationale



Solid/liquid separation

Nutrient fractionation

Pathogen reduction

Energy production

Separation Technologies

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

- Gravity settling (passive)
  - Clarifiers
  - Settling Ponds

- Chemical addition to assist flocculation

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

Separation Rationale

- Produce sellable material – Organic fertilizer
- Improved land application logistics
- Recycling
  - Process Water
  - Bedding
- Enable nutrient fractionation

Recycling Water and Bedding

Maple Leaf Dairy

- Flush system – remove and transport manure
- Recycle fibers for bedding

Saves

- 25 million gallons of water
- 1.1 million tons of bedding

Enable Nutrient Fractionation

- Create low solids stream with low P (high N) for use on farm fertilizer.
- Create high solids stream with high P (low N) for transport to low P land.

Ratio	N	P_2O_5	K_2O
Manure	3	1	2
Liquid	4	1	3
Solid	2	2	1

Removal of P out of Watershed

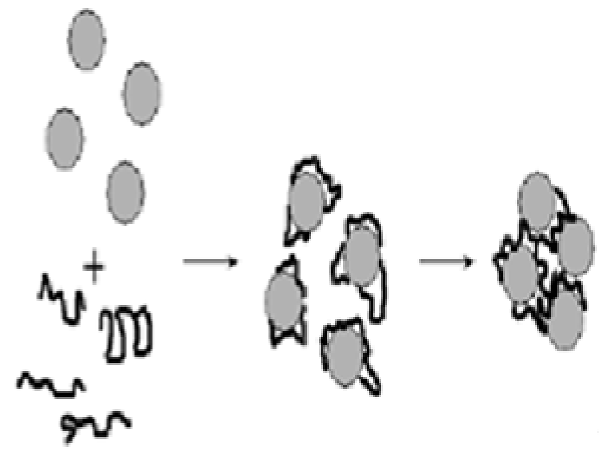
- Separation can creates high solids/high P fertilizer
- Can be dried and granulated
- Can be exported to:
  - Low P land in watershed
  - Outside watershed
  - As organic fertilizer
- AD gas is envisioned as nice source of drying heat
- Envision Depot model for processing numerous smaller farms

TP Removal Comparison

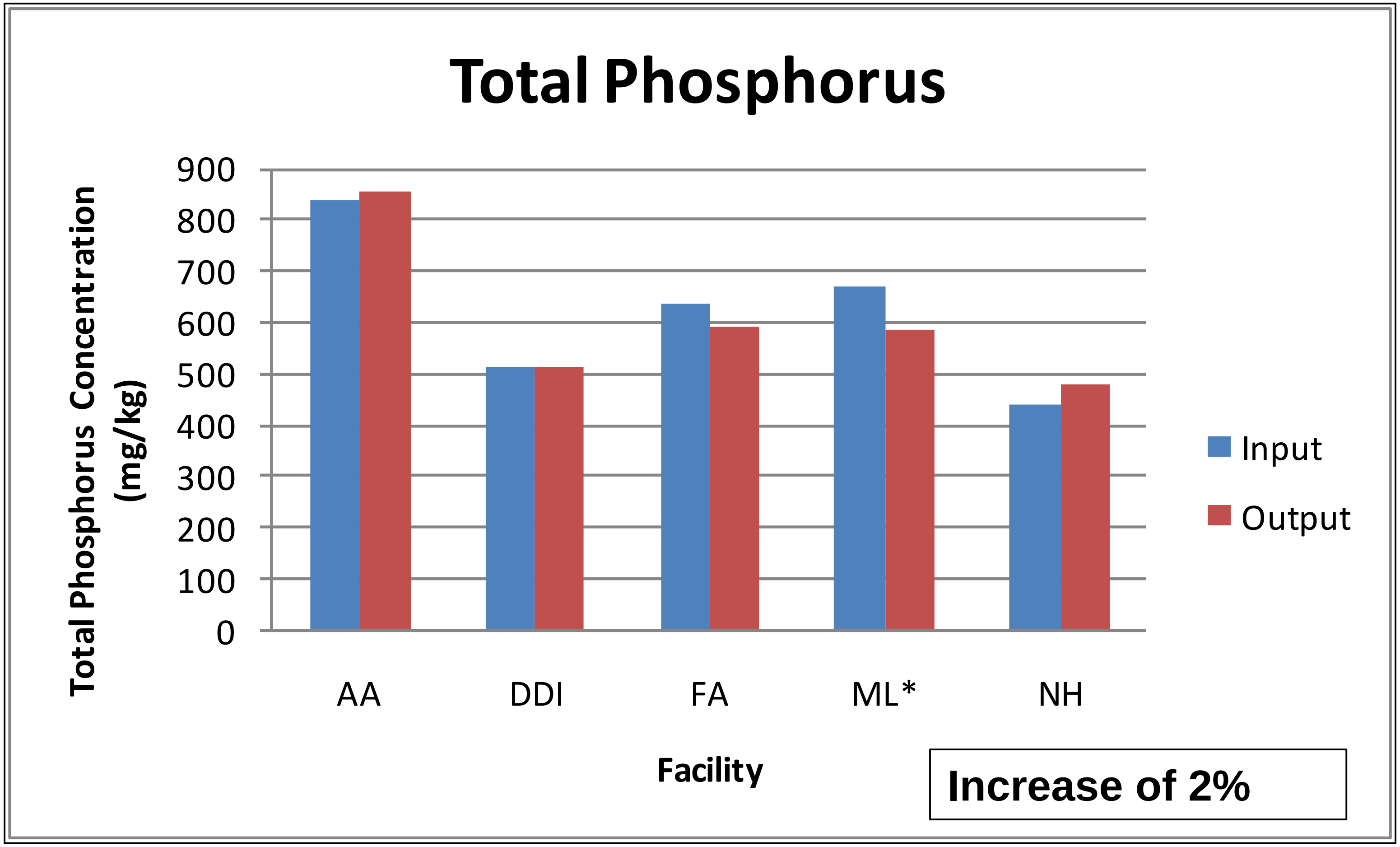
Technology	Initial TS (%)	TP Removal (%)
Settling Basin	~4	28
Screw Press	variable	15-24
Centrifuge	variable	60
Dewatering using Geotextiles	0.71	46
Inclined Plane	variable	53
Screens	0.4-3.2	<17
Screens with Polymers	0.4-3.2	34-65
Chemical Precipitation	0.87-1.5	80-90

Polymer P separation

- Significant additions of chemical and polymer
- 80-90% TP removal
- Chemical additions can be high



Anaerobic Digestion Does NOT Remove P

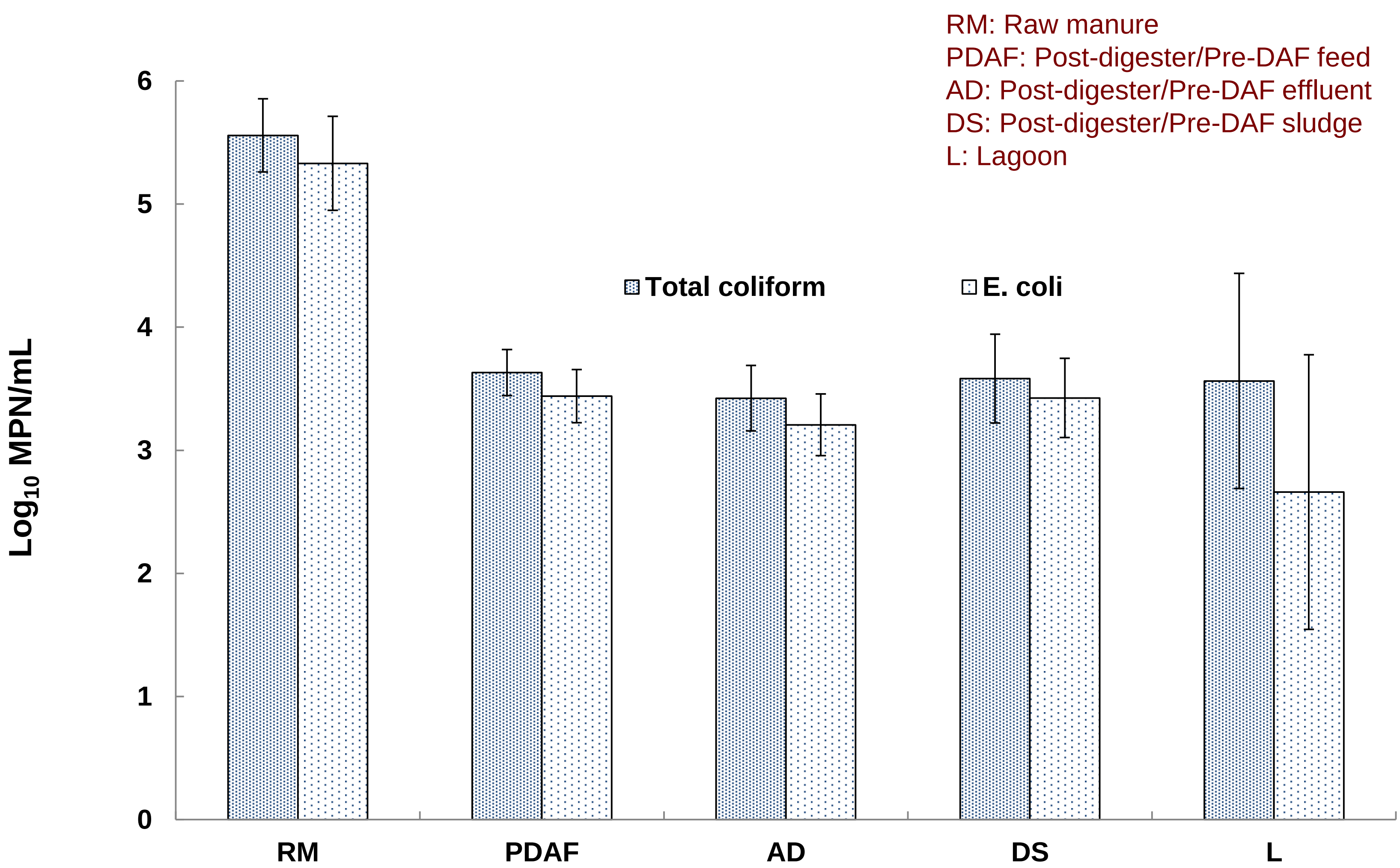


Wright, et al. 2004. Preliminary Comparison of Five Anaerobic Digestion Systems on Dairy Farms in New York State

Pathogen Management

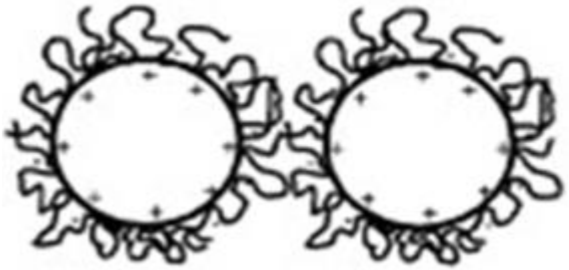
- Manure Pathogen Reduction
  - Worker safety
  - Herd health
    - Recycling water
    - Bedding
- Land application
  - Worker safety
  - Irrigation/Fertigation

Pathogen Content: AD is the most effective in reducing

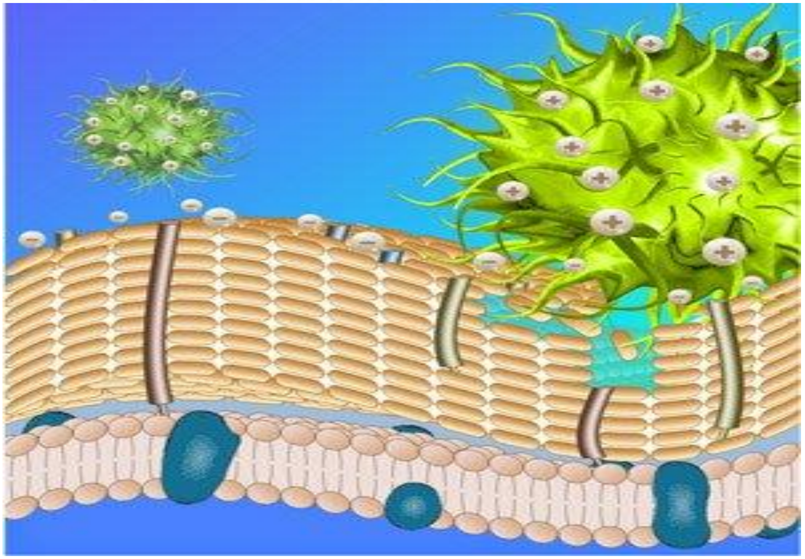


Investigations into Pathogen Reduction with Polymers

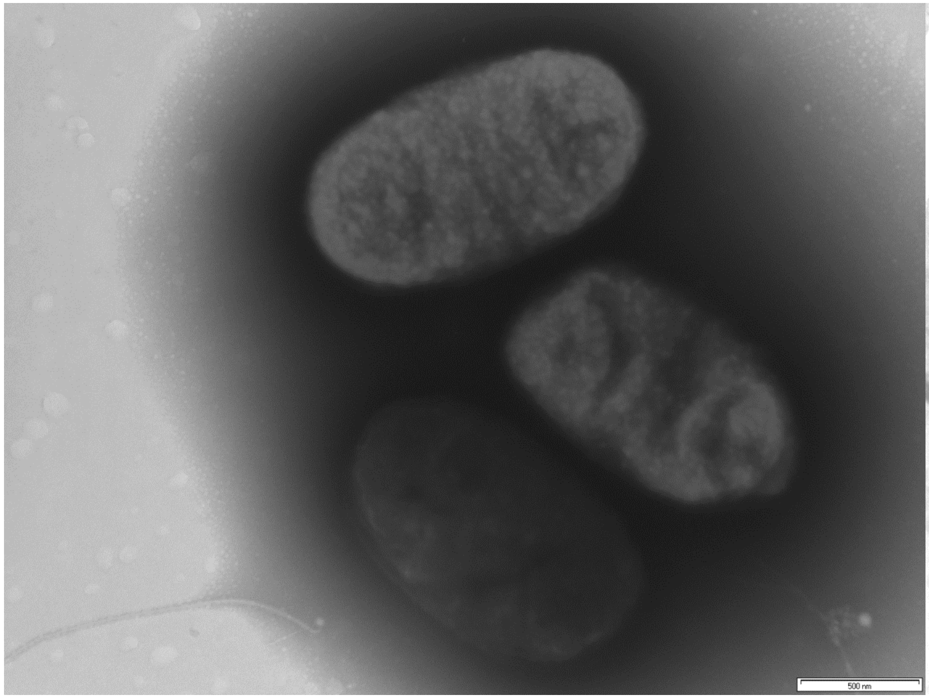
Polymer

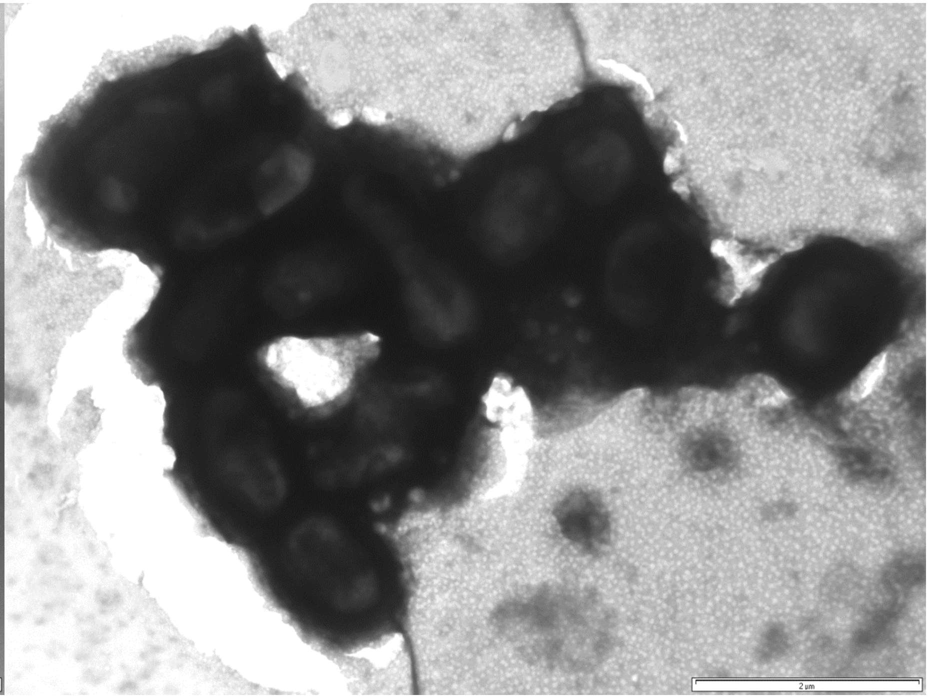


Bacteria

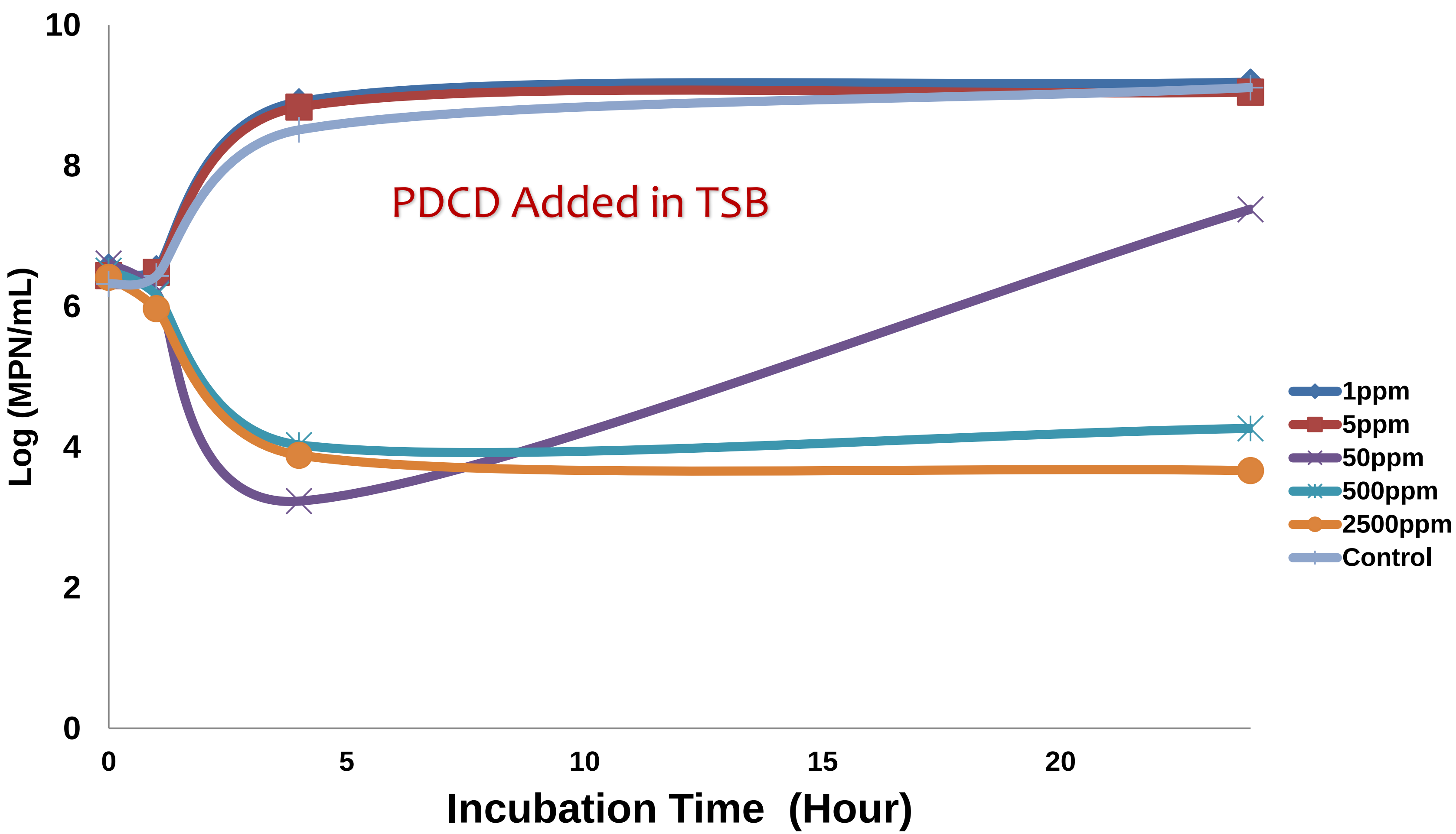


TEM--*E. Coli* cells after incubated with PDCD





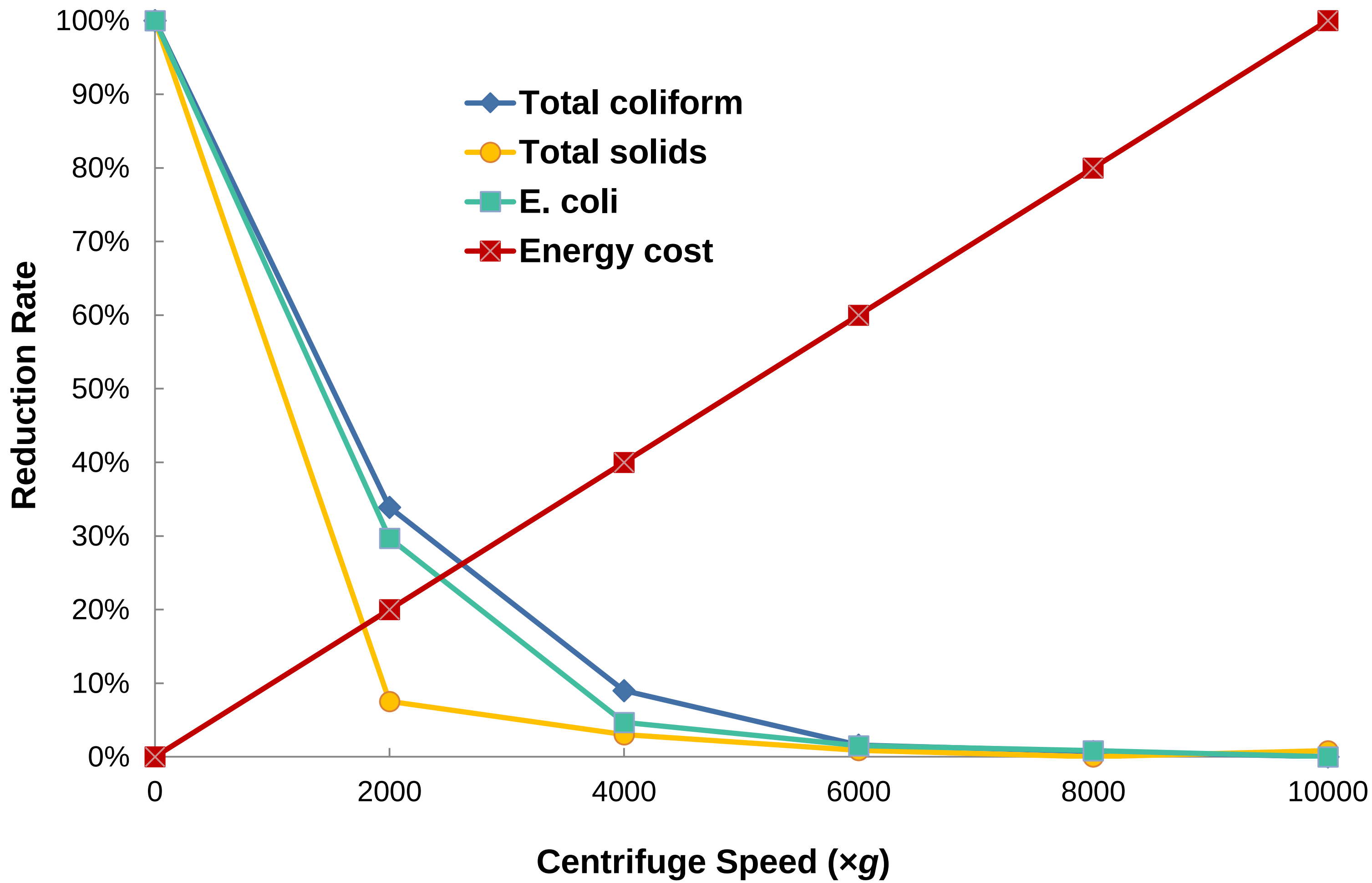
Polymer / Pathogen Experiment Results



Two-step separation (manure tests)

Treatment	TS %	Total Coliforms (MPN/mL)	E. coli (MPN/mL)
Digestate	4.08	7270	4880
PAM	1.15	261	186
PAM+PDCD	0.96	72	2

Also investigating Pathogen Reduction via Centrifugation



Manure Processing Conclusions

- Processing can effectively
  - Manage Solids / Liquids / Nutrients
  - Reduce Pathogens
  - Allow water recycling and manure fiber production
- Polymers can be effective for manure flocculation
  - Allows simpler systems (lagoons, screens, clarifiers) to be used
  - Can also reduce pathogen densities
- High speed centrifugation has a notable impact on solids reduction and pathogen reduction but higher cost

Future Perspective

- Manure Processing will become more predominant
  - Dairy Farms will get bigger
  - Value of fertilizer
  - Precision agriculture practices
- Will allow solids to be moved further
  - Move manure more cost effectively/safely to further fields
  - Sell as organic fertilizers
  - Export P nutrients out of “High P index” areas
- Need to have good techniques to use separated liquids
  - High N,K and low P
  - “Fertigation” is preferred method of land application by farmers

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WI Regulations on Manure Nutrient Management

Two laws are involved in manure nutrient management

- NR243 – Regulates manure management on CAFO's
- NR214 – Regulates permanent spray fields & excludes manure regulated under NR243
    - NR214 usually is applied to permanent spray fields that can receive effluent nutrients in excess of crop needs, such as from canneries, and require prohibitively expensive environmental monitoring
    - NR214 has been applied to non-permanent fertigation of raw manure to actual crop needs or less than crop needs

Updates to regulations need to occur to keep pace with new separation technologies.

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