DAIRY MANURE TREATMENT & NUTRIENT RECOVERY

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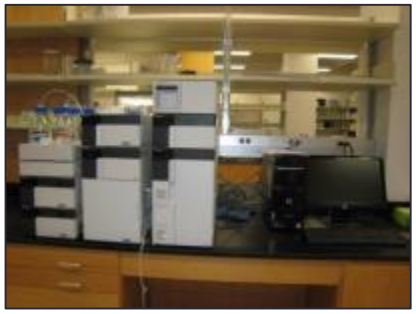
Anaerobic Digestion Research and Education Center (ADREC)

OBJECTIVES

- Research and develop novel waste-to-resource technologies capable to convert organic wastes into value-added fuel and chemical products
- Fulfill commercialization and technology transfer of new waste-to-resource concepts
- Educate the next generation of engineers, scientists and policymakers on waste utilization design and practice



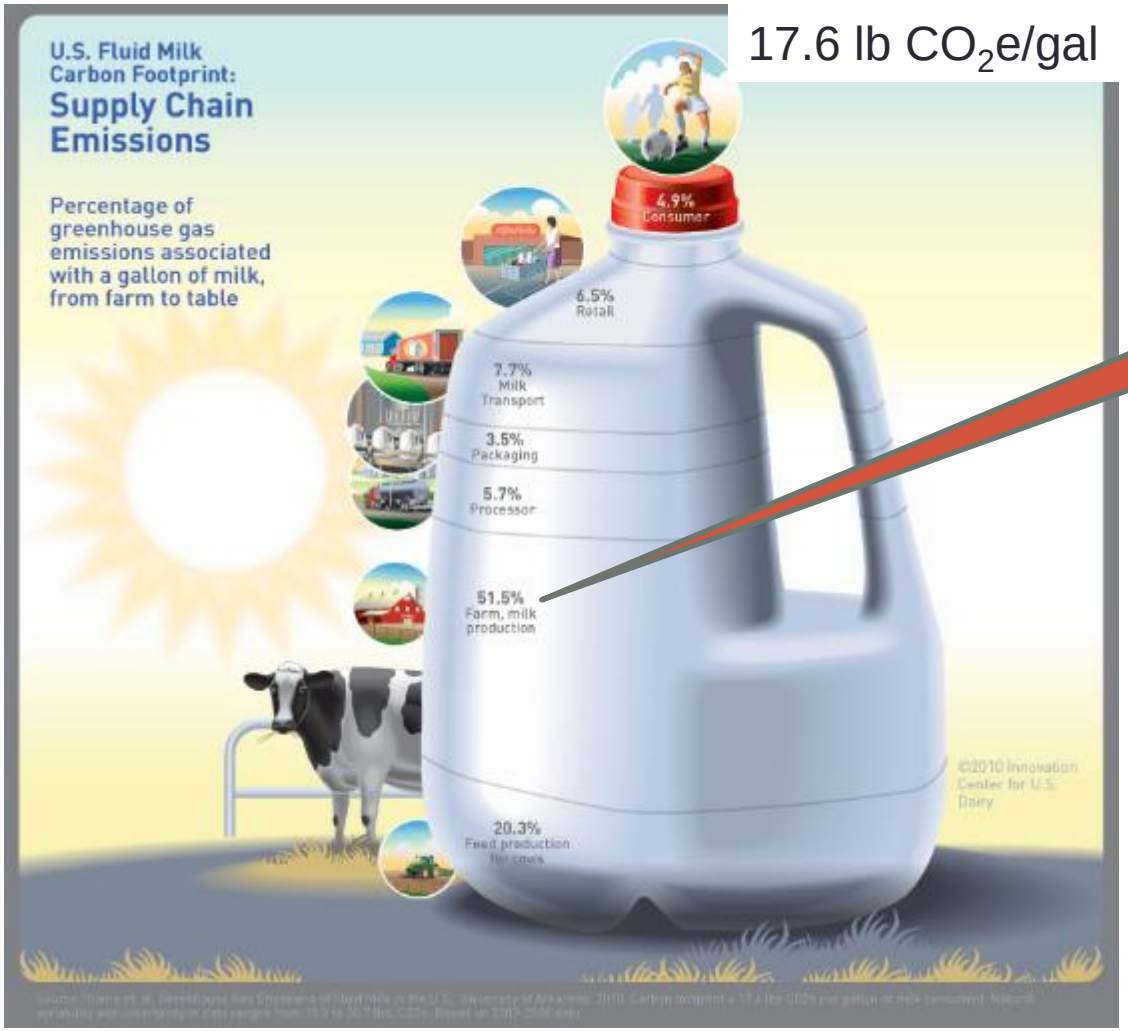
Manure Management Challenges & Opportunities

Recent Headlines

- Yakima, WA
  - 5 dairies
  - Lawsuit over groundwater contamination
  - Finding that manure is considered a solid waste when not beneficially
- Lake Erie
  - Blue-green algae blooms
    - Phosphorus is the trigger
    - Nitrogen impacts toxicity
  - City of Toledo water supply contaminated

Carbon Footprint of Milk

17.6 lb CO_2e/gal



51.5% at the farm

INNOVATION CENTER FOR U.S. DAIRY
HEALTHY PEOPLE • HEALTHY PRODUCTS • HEALTHY PLANET

Nutrient Value of Manure (per cow)

Nutrient	Production (lb/cow/yr)	Potential Value
Nitrogen (N)	223-260	$174
Phosphorus (P_2O_5)	40-69	$32
Potassium (K_2O)	88-146	$88
Total		**$294**

Nutrient and Fertilizer Value of Dairy Manure
https://www.uaex.edu/publications/PDF/FSA-4017.pdf

The U.S. Dairy Industry is at a Critical Juncture

Current State

- Increasing regulatory and societal pressure about manure management
- Litigation
- Surface and ground water issues related to nitrogen and phosphorus in the wrong places
- Erosion in consumer trust

Desired State

- Dairy farms help resolve societal issues related to water pollution and GHG emissions
- Producers realize economic benefits from voluntary actions
- Dairy industry improves social license to operate and increases consumer trust

Source: Innovation Center for U.S. Dairy & Newtrient, LLC

Nutrient Recovery

Dissolved
Air Flotation

Belt Press

Thermal
Conversion

Clarification

Nutrient Recovery System

Q_R

Coarse Solid – Liquid Separation

Fine Solid –Liquid Separation

Nitrogen Recovery

Salt Recovery

Water

Coarse Fiber

Fine Solids & Phosphorus

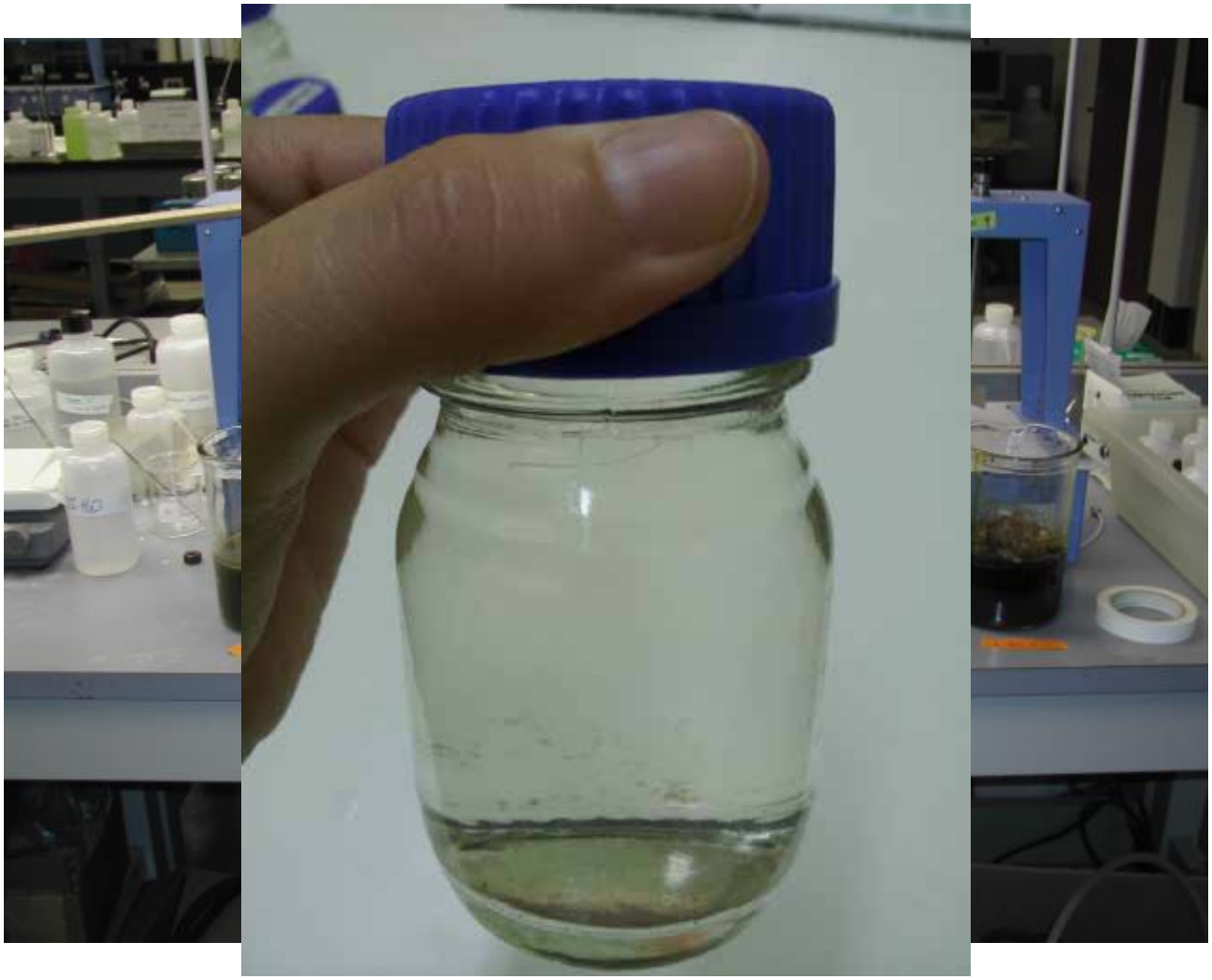
N Concentrate

Salt Concentrate

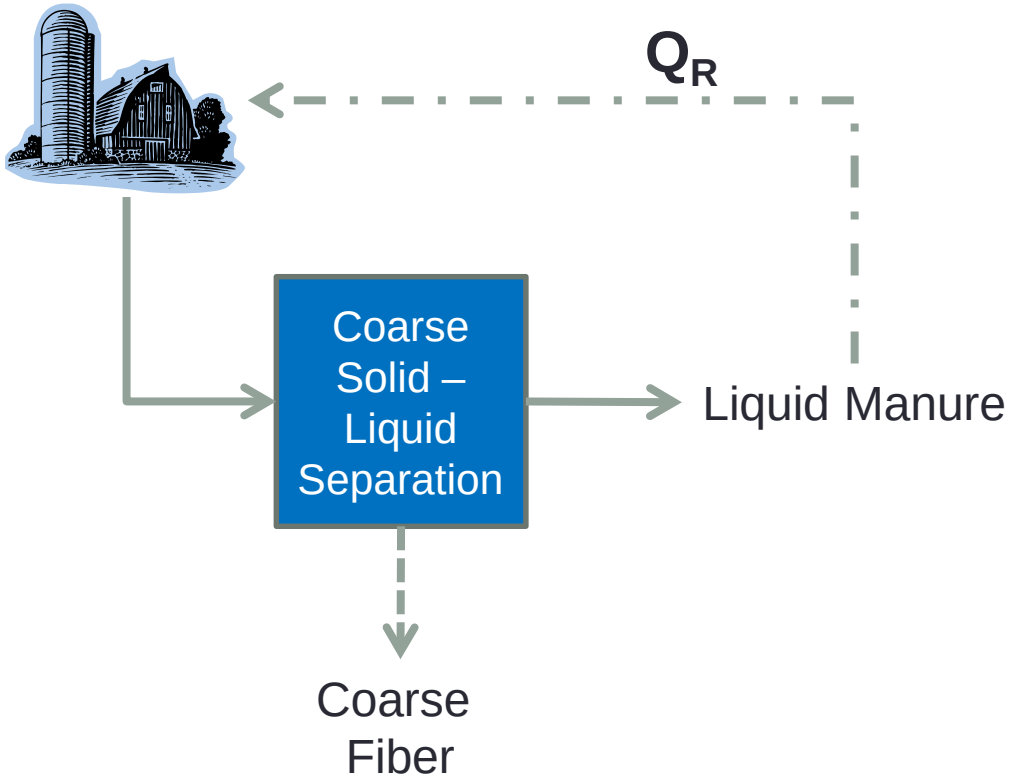
Legend

- Manure
- Concentrate
- Filtrate
- Recycle (Q_R)

Significant Research & Development



Nutrient Recovery System

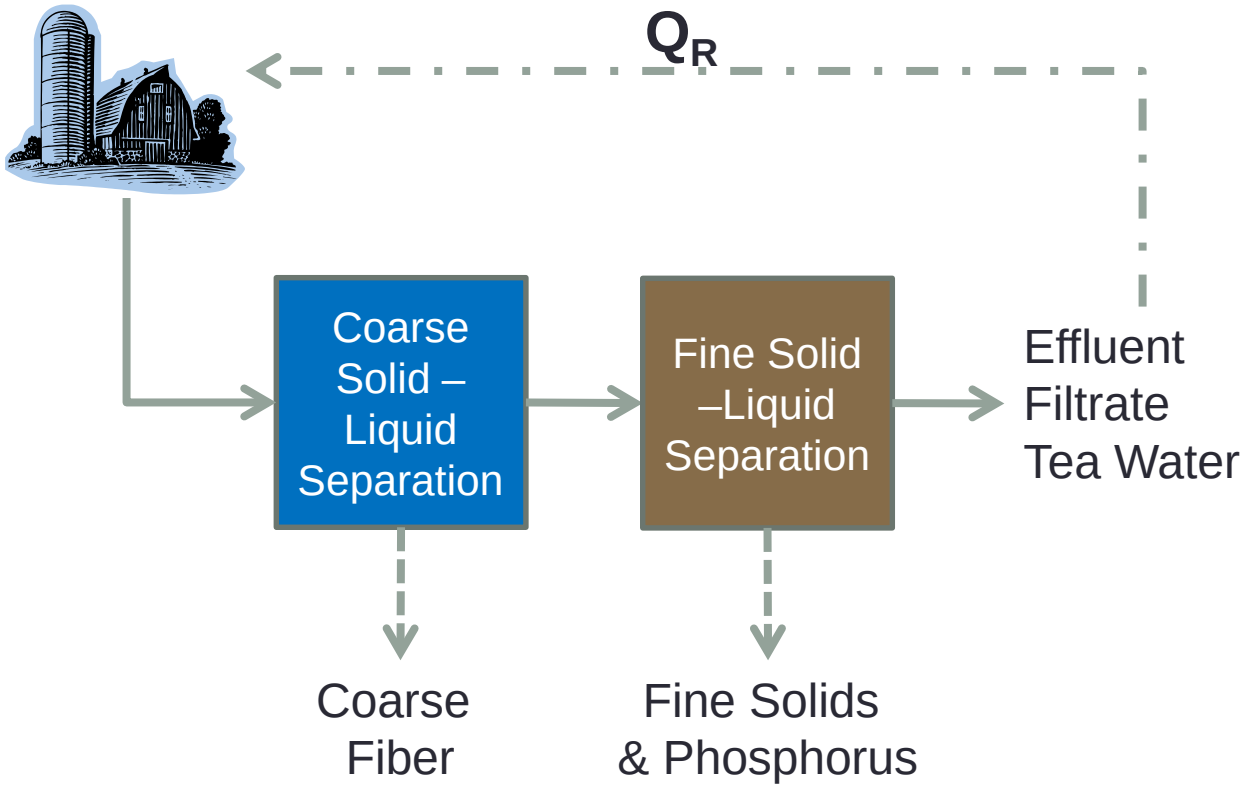


Coarse Solid-Liquid Separation Approaches in the U.S. ($/cow)

Technology	Performance		OPEX	CAPEX	Scale
	TN	TP			
Primary & Secondary Mechanical Screens	15 – 30%	15 – 25%	$5 – 6	$32 – 36	Commercial

Frear, C. 2013. Review of Nutrient Recovery Technologies

Nutrient Recovery System



Fine Solid-Liquid Separation

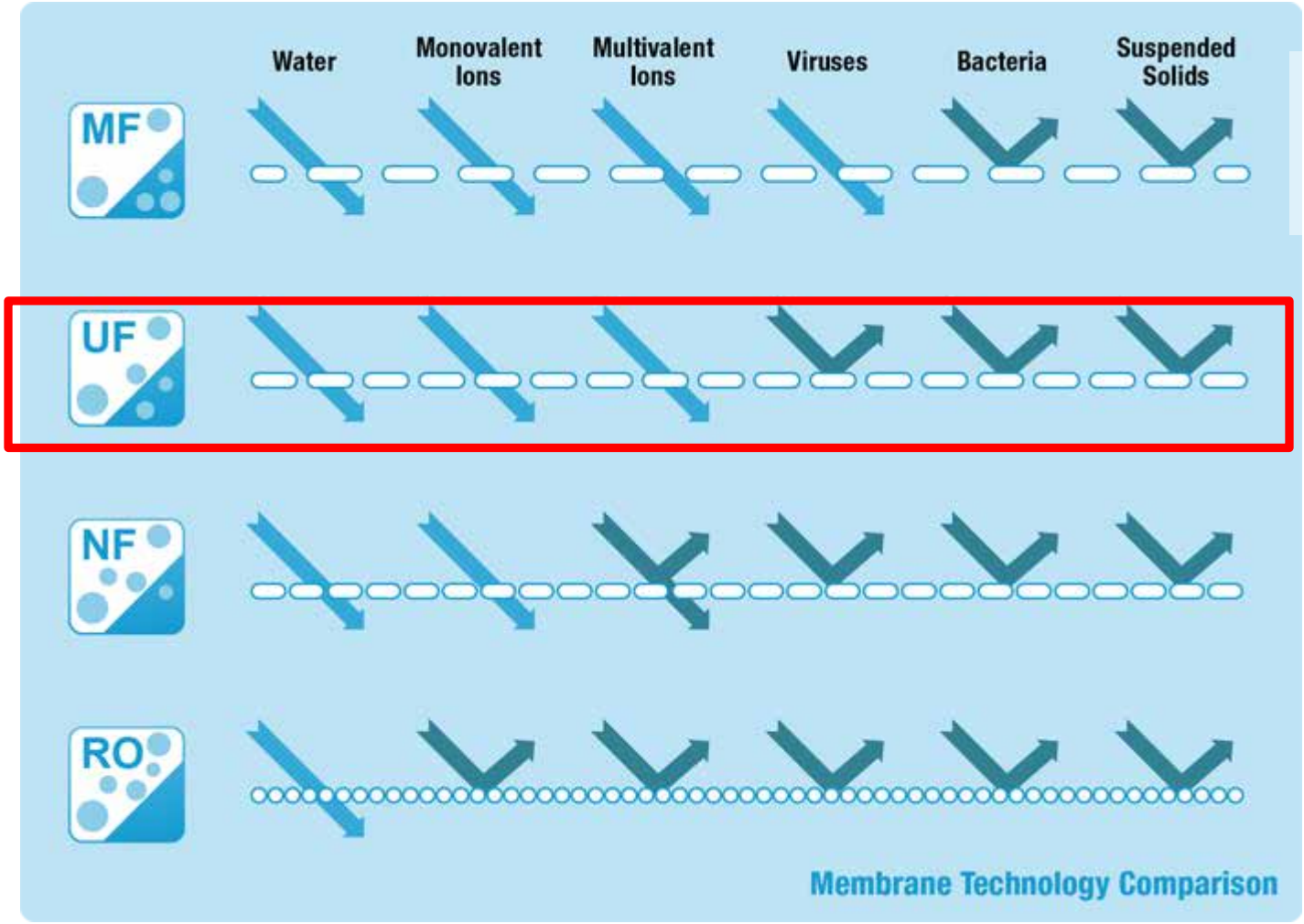
- Why
  - Phosphorus limited
  - Reduced truck traffic or cost
  - Field distance
  - Desire to irrigate
  - Nutrient market opportunity
- Solids use
  - Soil amendment & fertilizer
  - Compost

Fine Solid-Liquid Separation

- Phosphorus, organic nitrogen & colloidal solids are target
  - Phosphorus separation >70%
- Particle sizes less than 250 micron
  - As fine as 0.01 micron
- Technologies:
  - Sequential separators
  - Chemical additions
    - Belt filter presses
    - Dissolved air floatation
  - Clarifiers
  - Ultrafiltration


Phosphorus Cake

Membrane Separation Technologies



MF – mirco
UF – ultra
NF – nano
RO – reverse osmosis

http://www.kochmembrane.com/Learning-Center/Technologies.aspx

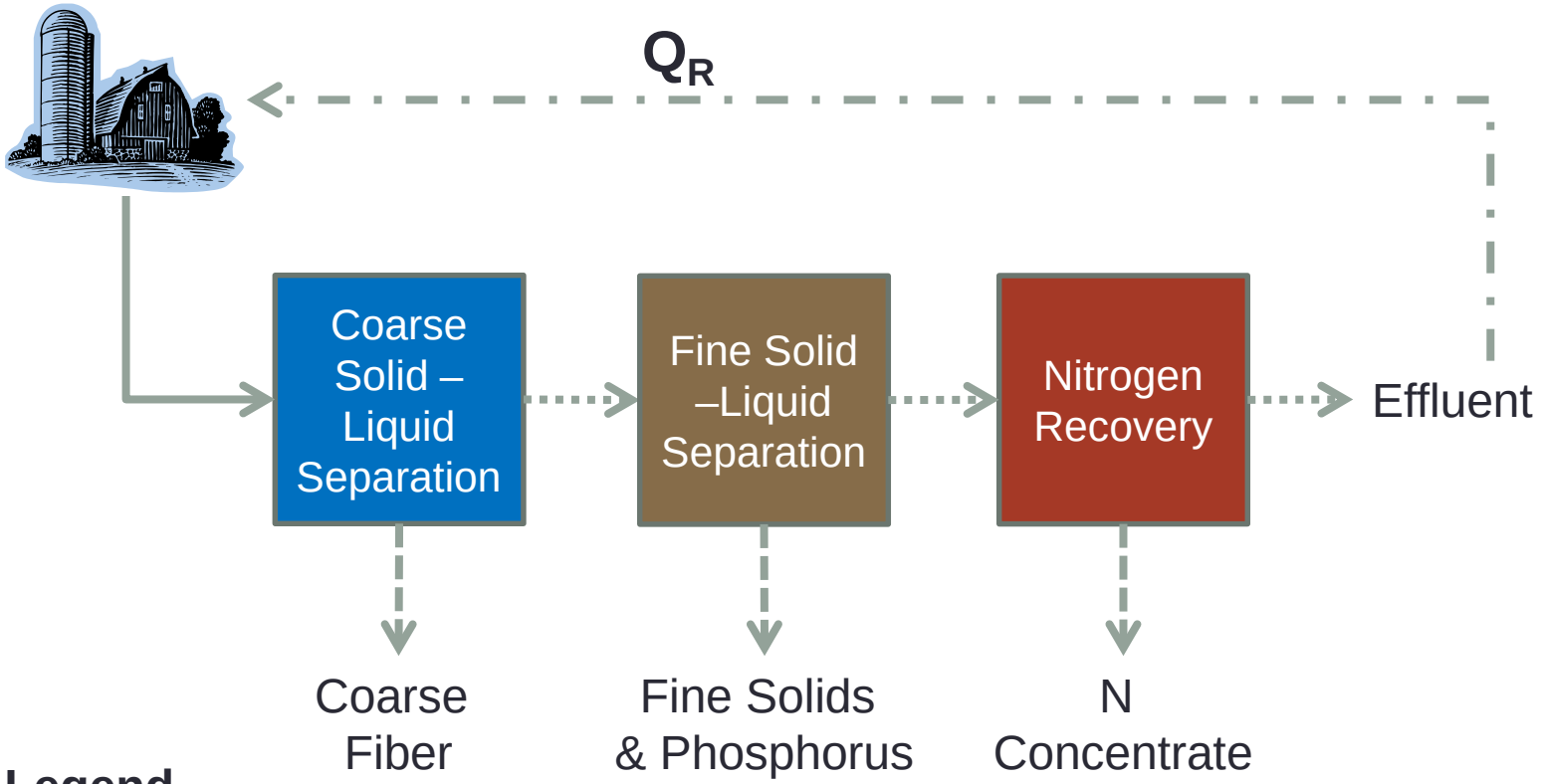
Fine Solids Products

Fine Solid-Liquid Separation Approaches in the U.S. ($/cow)

Technology	Performance		OPEX	CAPEX	Scale
	TN	TP			
Sequential Screening + Advance Non-Chemical	24 – 30%	50-65%	$25 – 50	$57 – 136	Commercial
Sequential Screening + Advance Chemical	45 – 55%	75 – 90%	$25 – 75	$130 – 150	Commercial
Struvite Crystallization	30%	75%	$90 – 110	$100 – 150	Commercial

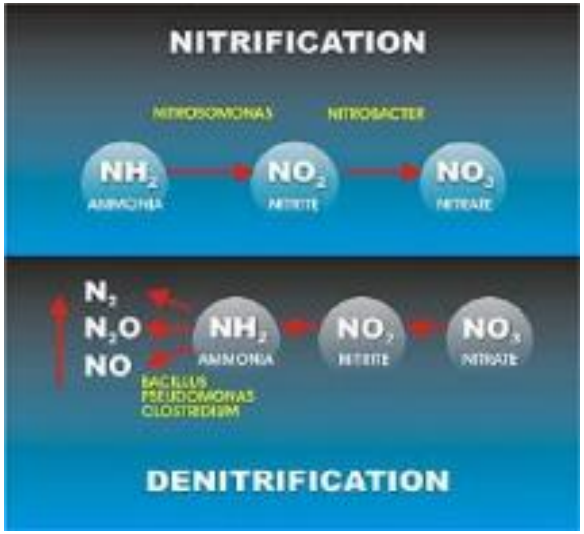
Frear, C. 2013. Review of Nutrient Recovery Technologies

Nutrient Recovery System



Nitrogen Recovery

- Why
  - Application restrictions
  - Desire to irrigate
  - Nutrient market opportunity
- Technology
  - Air stripping
    - Temp, pH & ammonia concentration sensitive
  - Biological conversion
- Product use
  - Nitrogen gas or fertilizer
  - Low nutrient water



http://nsspo.com/p1/Nitrification.htm

Nitrogen Recovery Approach in the U.S. ($/cow)

Technology	Performance		OPEX	CAPEX	Scale
	TN	TP			
Ammonia Stripping	65 – 85%	85 – 90%	$100 – 190	$450 – 650	Commercial

Frear, C. 2013. Review of Nutrient Recovery Technologies

Nutrient Recovery System

Q_R

Coarse Solid – Liquid Separation

Fine Solid –Liquid Separation

Nitrogen Recovery

Salt Recovery

Water

Coarse Fiber

Fine Solids & Phosphorus

N Concentrate

Salt Concentrate

Legend

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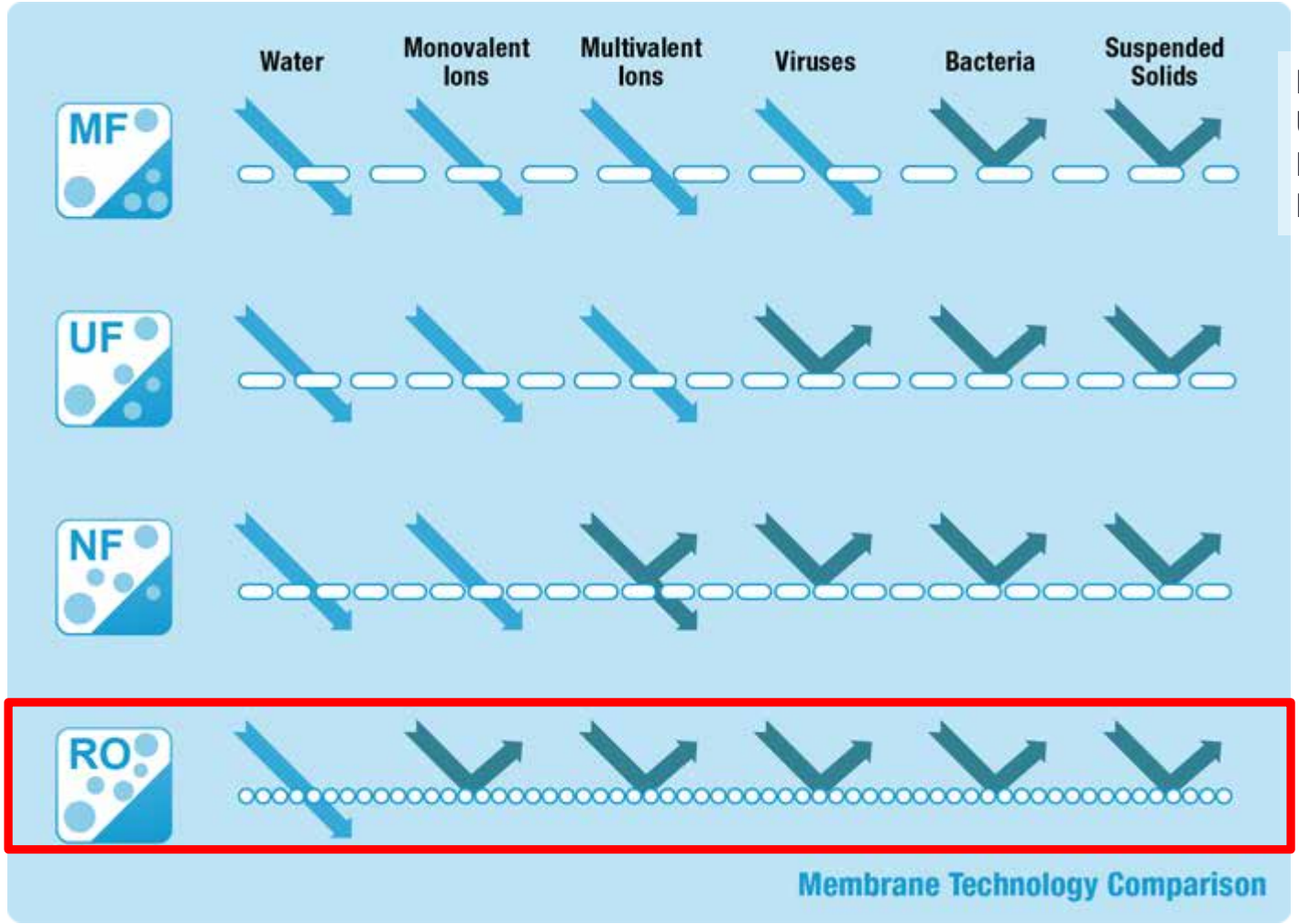
Salt (Water) Recovery Technology



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Clean Water Approach in the U.S. ($/cow)

Technology	Performance		OPEX	CAPEX	Scale
	TN	TP			
Salt Recovery	85 – 95%	85 – 95%	$500–1,000	$1,500–1,800	Commercial

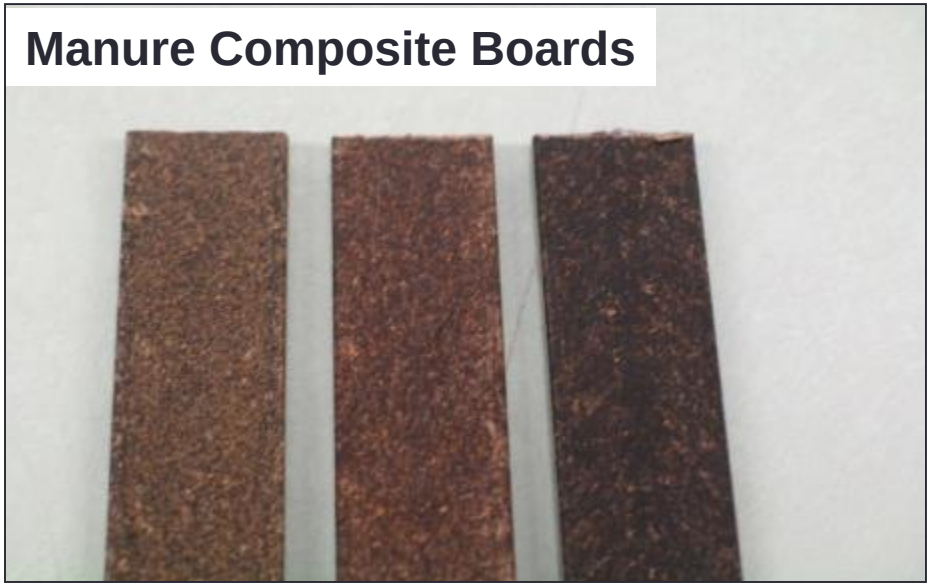
Frear, C. 2013. Review of Nutrient Recovery Technologies

Products & Markets

Manure Solids Bedding

Compost

Manure Composite Boards



Products & Markets

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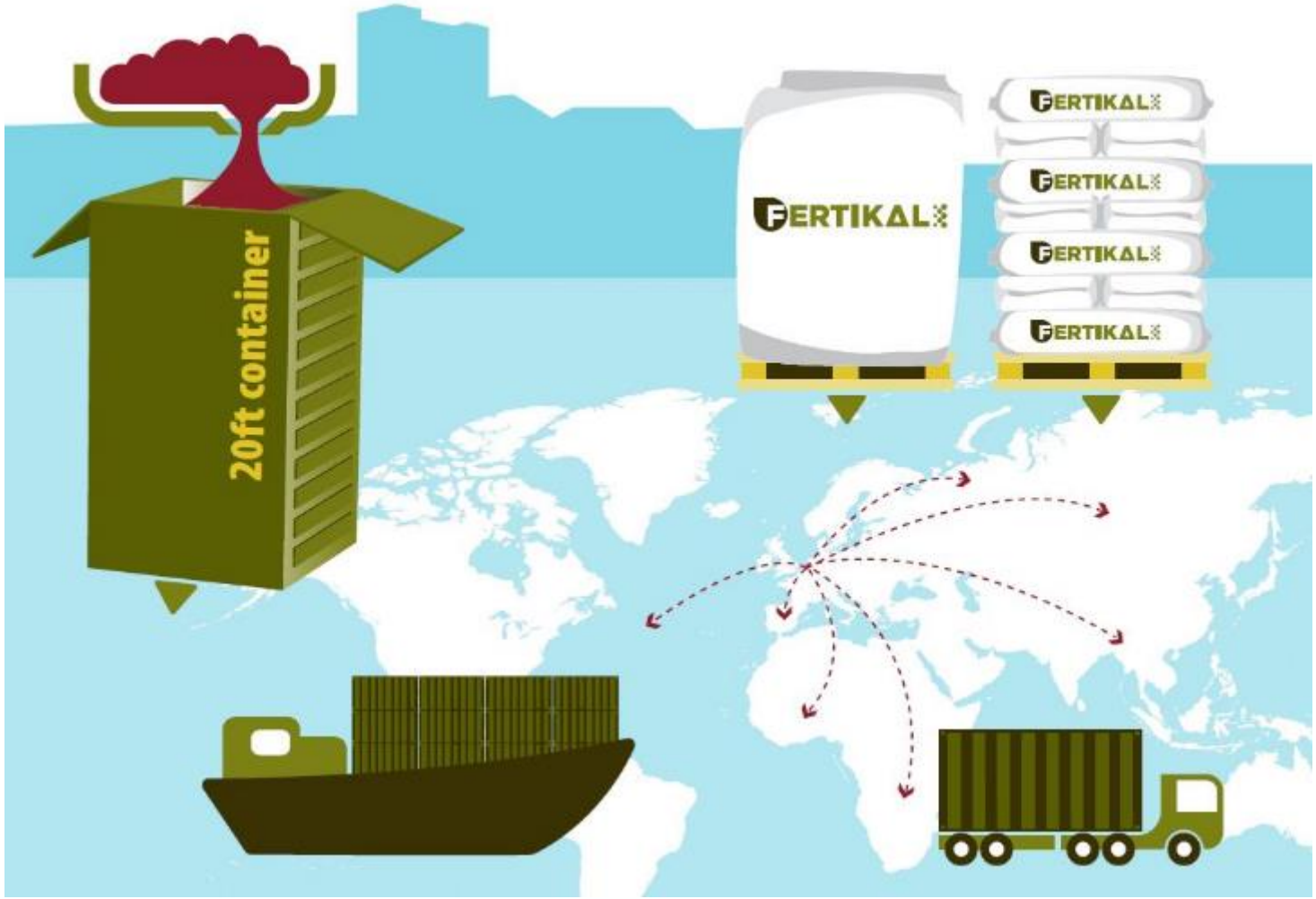

http://www.fertikal.be/en/process-distribution

Nutrient Recovery System

Q_R

Anaerobic Digestion

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Fine Solid –Liquid Separation

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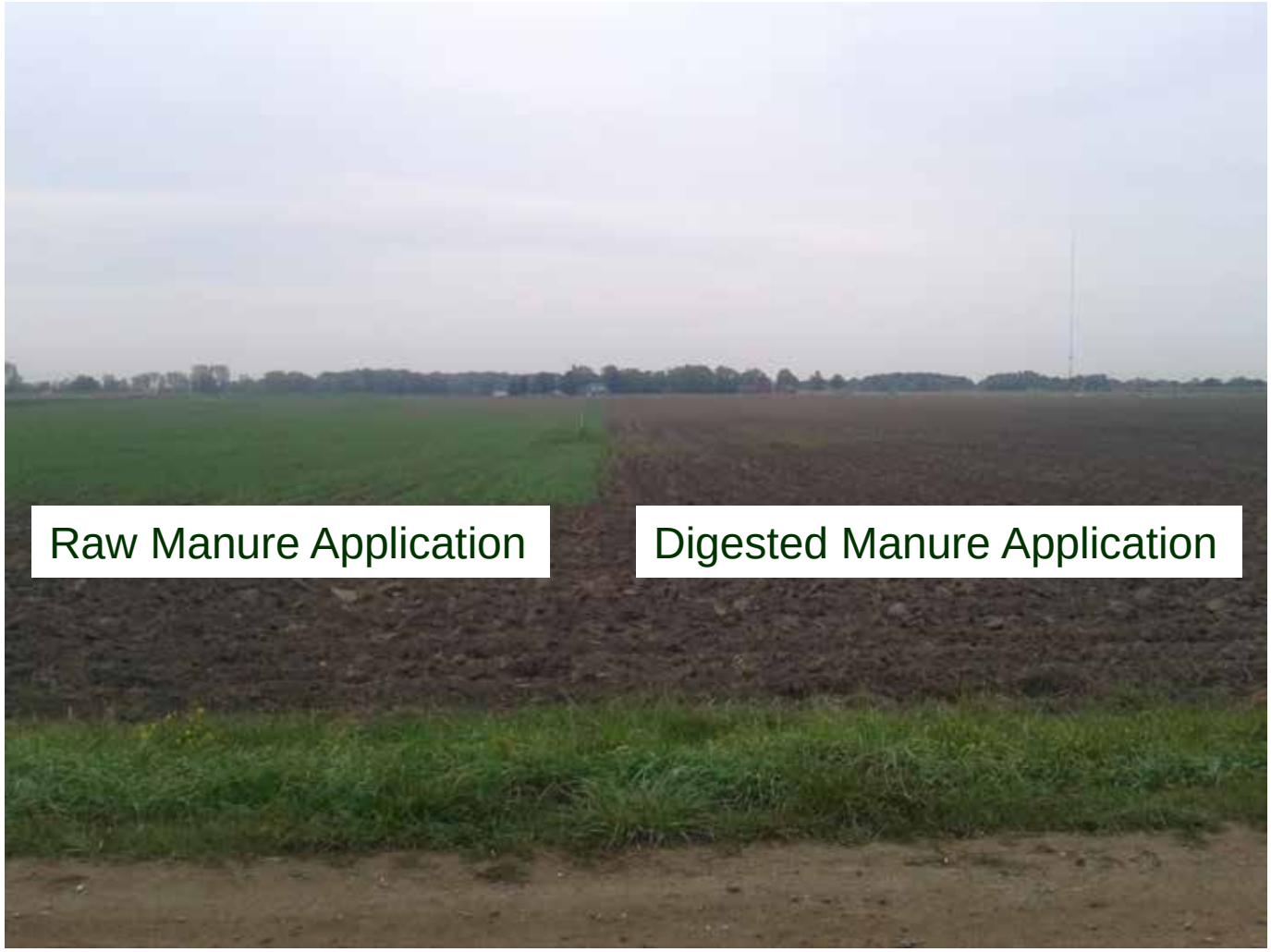
Raw vs. Digested Dairy Manure



Nutrient Recovery Advancing Quickly

Where do we stand today

- Manure application costs inexpensive
- Social pressure extremely high
- Manure handling & storage practices consistent
- Nutrient recovery technologies
  - Commercially viable technologies available
  - Capital and operational costs are high
  - Nutrients do not go away, still require management
  - Systems can be developed to address site specific needs
  - Markets for products not yet developed

“Newtrient is excited to be a driver of positive change in the emerging industry of dairy manure use and management. By serving as a catalyst advancing new technologies, practices, products and markets, we help generate profits for farmers, while at the same time preserving and enhancing the environment.”

NEWTRIENT™
INNOVATIVE SOLUTIONS IN RESOURCE RECOVERY

http://www.newtrient.com/#/Home/

Technology Advancement Process Steps

Newtrient Recognized **Technology to Watch**

Recommend

6. Informed decisions
A 9-Point Criteria helps Newtrient make informed decisions

5. Compile & assess and synthesize

Information will be compiled, assessed and synthesized into catalogs

4. On-site visits

TAT member(s) visits "showcase" installation(s) to conduct due diligence (e.g., Throughput, mass balance, economics)

3. Technology information request

Phone interviews to gain deeper insights into specific technologies

2. Business information request

Tech Providers share information and insights with Newtrient regarding their company and technologies

1. **Catalog**

Catalog of existing technologies

NEWTRIENT

Questions?

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