

# Harvard Forest Grazing Seminar

- Thanks to David for the unique opportunity
- Thanks for including me
- My background is Forest Ecosystems
- Recent USDA SARE grant
- Humbled by expertise in the room!
- UNH Organic Dairy Research Farm-  
a unique facility
- Will offer a few observations  
and results – some on water!



# Organic Dairy Research Farm

- First in the Nation (only? – why?)
- Support: four largest US organic dairy processors
  - Stonyfield
  - Aurora
  - Horizon
  - Organic Valley
- Inspiration
  - Chuck Schwab
  - Rick Kersbergen
  - Tom Kelly
  - John Carroll



# Lead Donor



“This could not come at a better time, as the organic dairy market in general and New England in particular is in need of more organic farmers. We believe organic dairy farming has the promise of saving New Hampshire and New England family farmers,”

~*Gary Hirshberg,*

- *President and CEO, Stonyfield Farm*

- *Co-founder, New Alchemy Institute (1970s)*





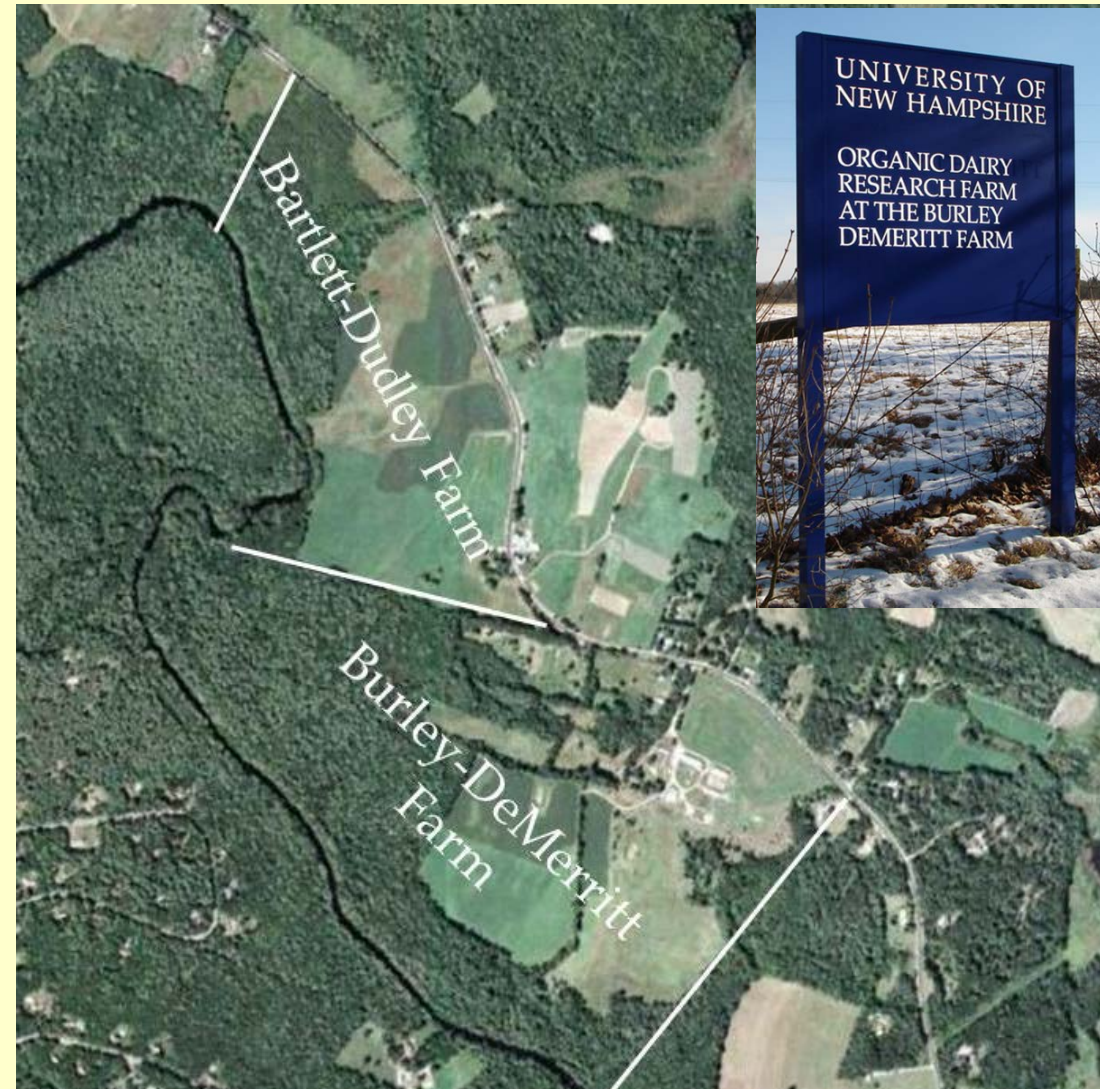
# The Farm and Forest Resource

~100 acres certified organic pasture

- 40-50 milkers, 100 total
- ~100 animals total

~160 acres (~64 ha) of typical old-field New England woodland

Research on nutrition, pasture productivity, silvopasture, Water quality, Nitrogen balance, GHG emissions...



# We Got to Ask the Question:

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## What are the Biggest Challenges to Organic Milk Providers In New England?

- Financial Viability
    - Imported Commodities
      - Bedding
      - Energy
      - Grains
    - Most Successful Farms Have Diversified Income and/or Value Added Processing
  - Environmental Impact
    - GHG emissions
    - Runoff and Water Quality
    - Manure Management
      - Composting
      - Spreading
- Role of Land-grant Institutions**



# Research - Increasing the Resilience of New England Agriculture - An Example

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## A Closed-System, Energy Independent Organic Dairy Farm for the Northeastern U.S.

Principal Investigator:

John Aber

Co-Principals:

Bill McDowell, Matt Davis, Matt Smith, Allison Leach



United States Department of Agriculture



Sustainable Agriculture  
Research & Education



UNIVERSITY of NEW HAMPSHIRE

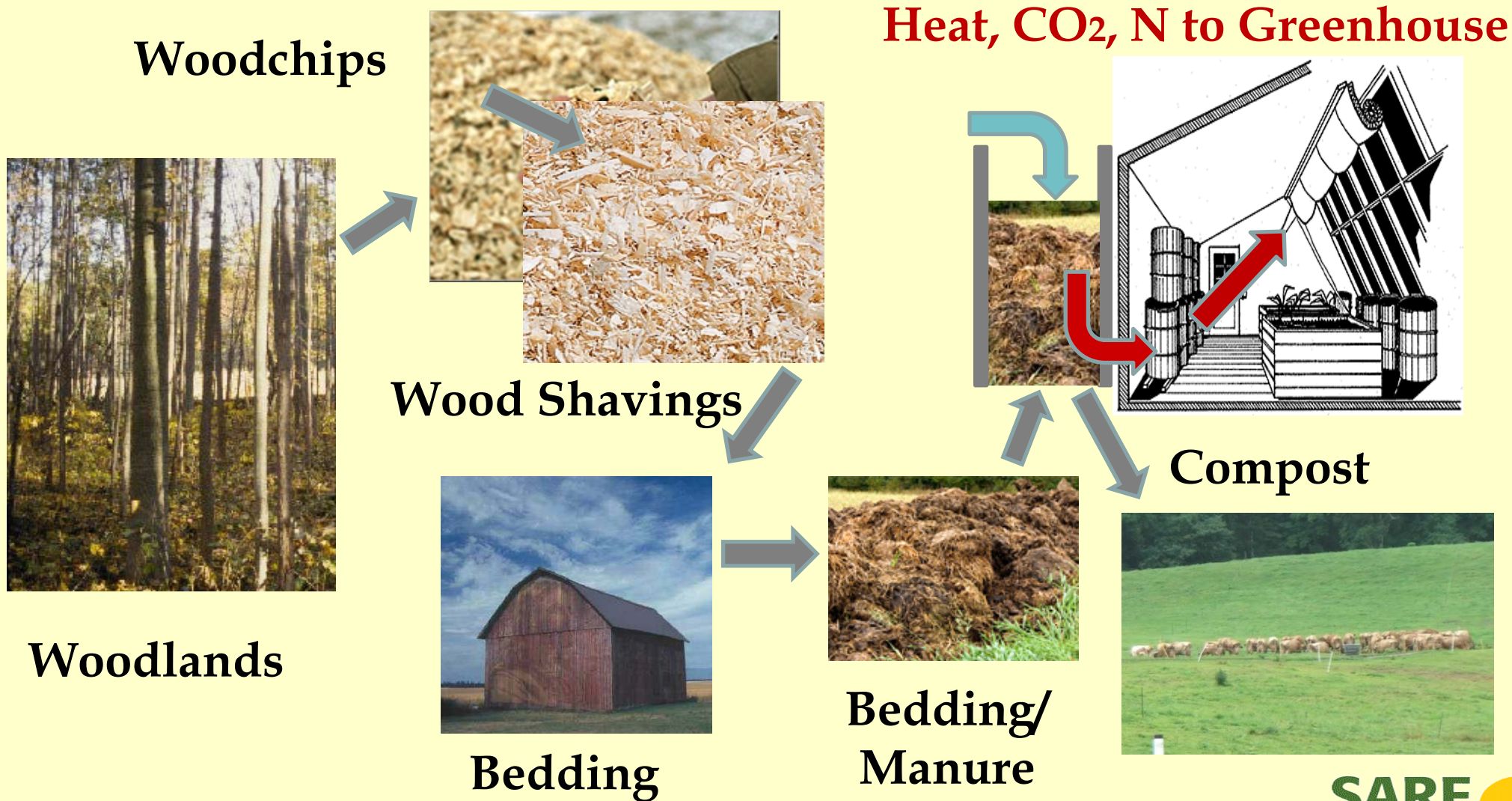
College of Life Sciences and Agriculture

Department of Natural Resources and Environment

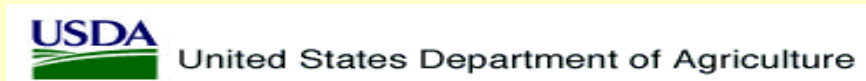
NH Agricultural Experiment Station



# An Integrated System to Provide Bedding, Manure Composting and Energy and CO<sub>2</sub> for a Greenhouse Operation



[http://attra.ncat.org/images/solar-gh/solar-gh/solar\\_greenhouse.g](http://attra.ncat.org/images/solar-gh/solar-gh/solar_greenhouse.g)



# But First – Kudos to Matt Smith, Ph.D. Student The Brains and Brawn Behind the Project!





# First Step: Sustainable Harvesting of Low Quality Softwoods



## Measured Productivity and Biomass

- About 40 hectares of manageable, low-quality old field woods
- Need to harvest .4 hectare/year or  $1/6^{\text{th}}$  of total annual wood production





# Second Step: Producing Bedding from Harvested Wood

Data show yield of 3 “cords” of shavings for 1 “cord” of wood  
(1 cord =  $\sim 4 \text{ m}^3$ )



# Third Step: Bedding use in the Barn





## Fourth Step: Composting the Bedding/Manure Mixture: A High-End Research Facility



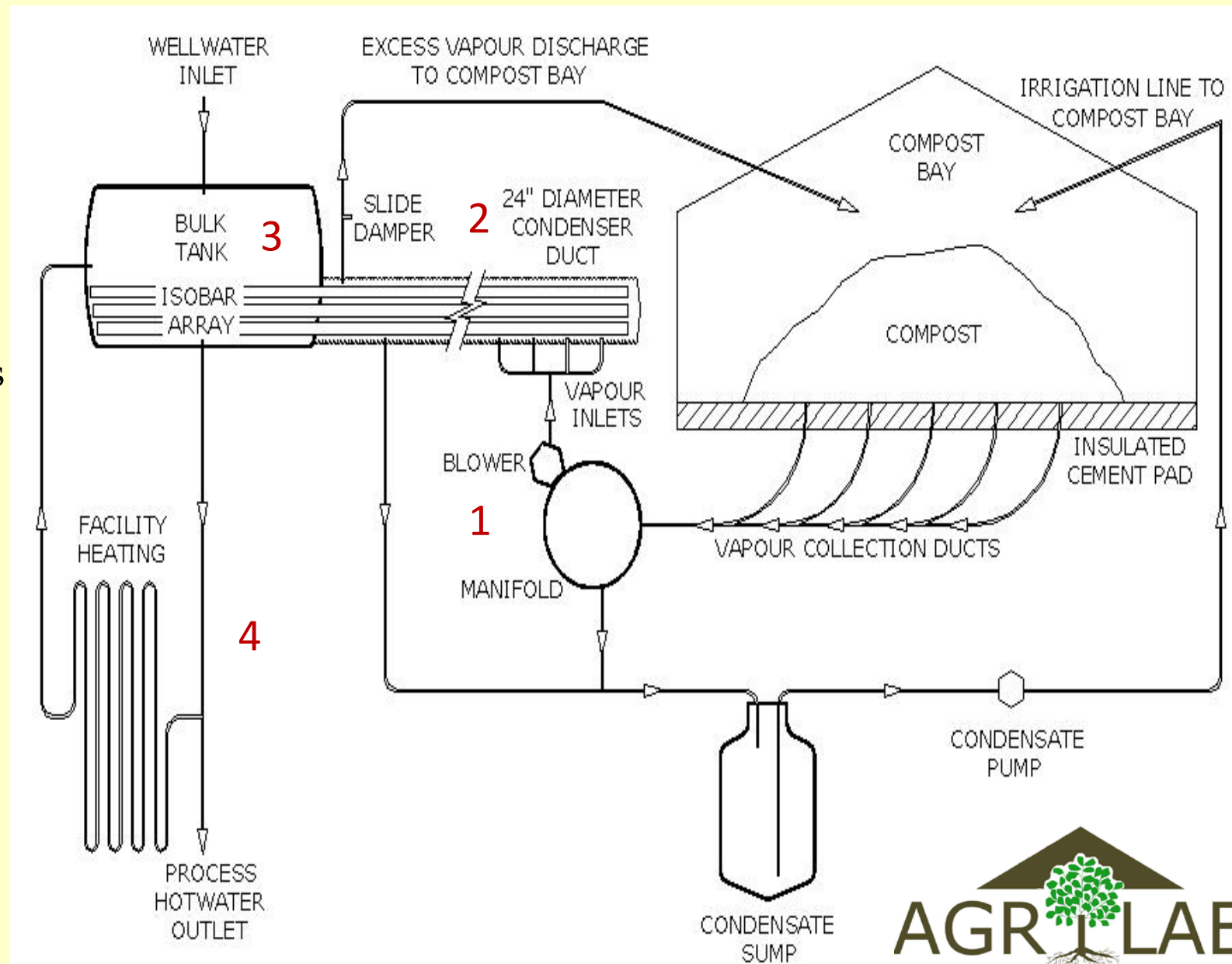
# Another Alternative: Static Pile Aerobic Composting (SPAC)





# Schematic Diagram of the Operation of an Aerobic Composting System for Energy Capture

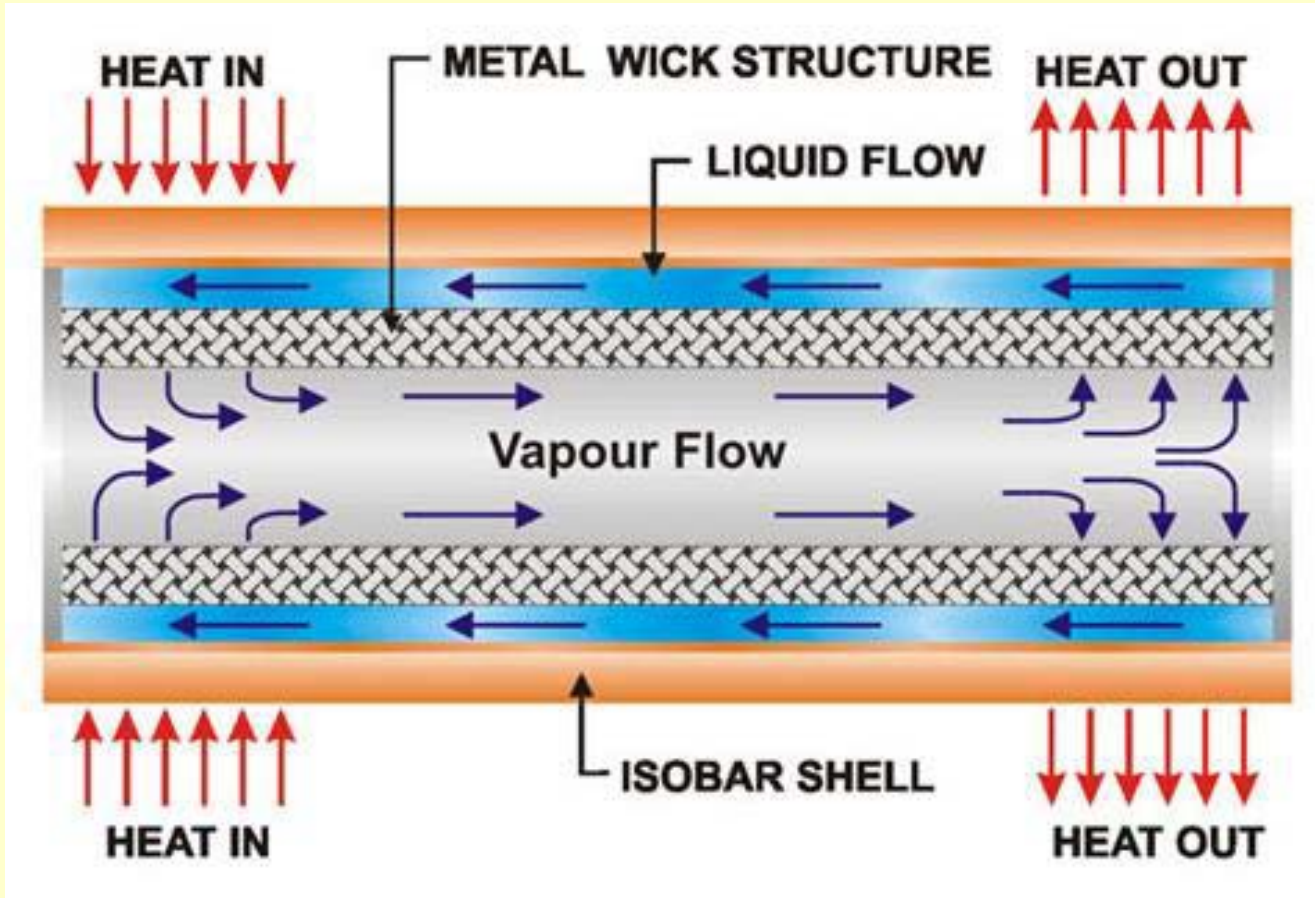
1. Blower pulls air through compost
2. Hot, moist air passes over isobars; heat captured in phase change to gas in isobars
3. Heat transferred to bulk water tank as phase change back to liquid in isobars
4. Hot water used for heating, washing, etc.





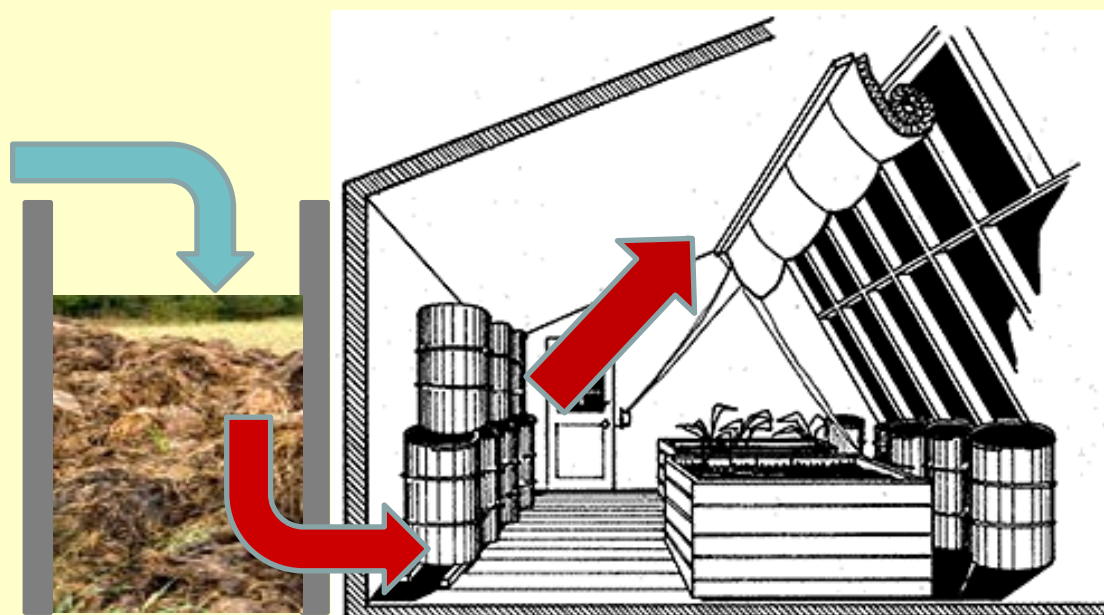


# Schematic Diagram Energy Capture and Transfer using AGRILAB Isobar system





# The Future: Energy, CO<sub>2</sub> and ammonia for a High-Tunnel Greenhouse Operation



**Compost**

**Number of composting operations  
Growing rapidly in New England**

<http://www.farmtek.com/wcsstore/EngineeringServices/allbizunits/prodimages/zoom/1x/103083d.jpg>





# Water Quality Work

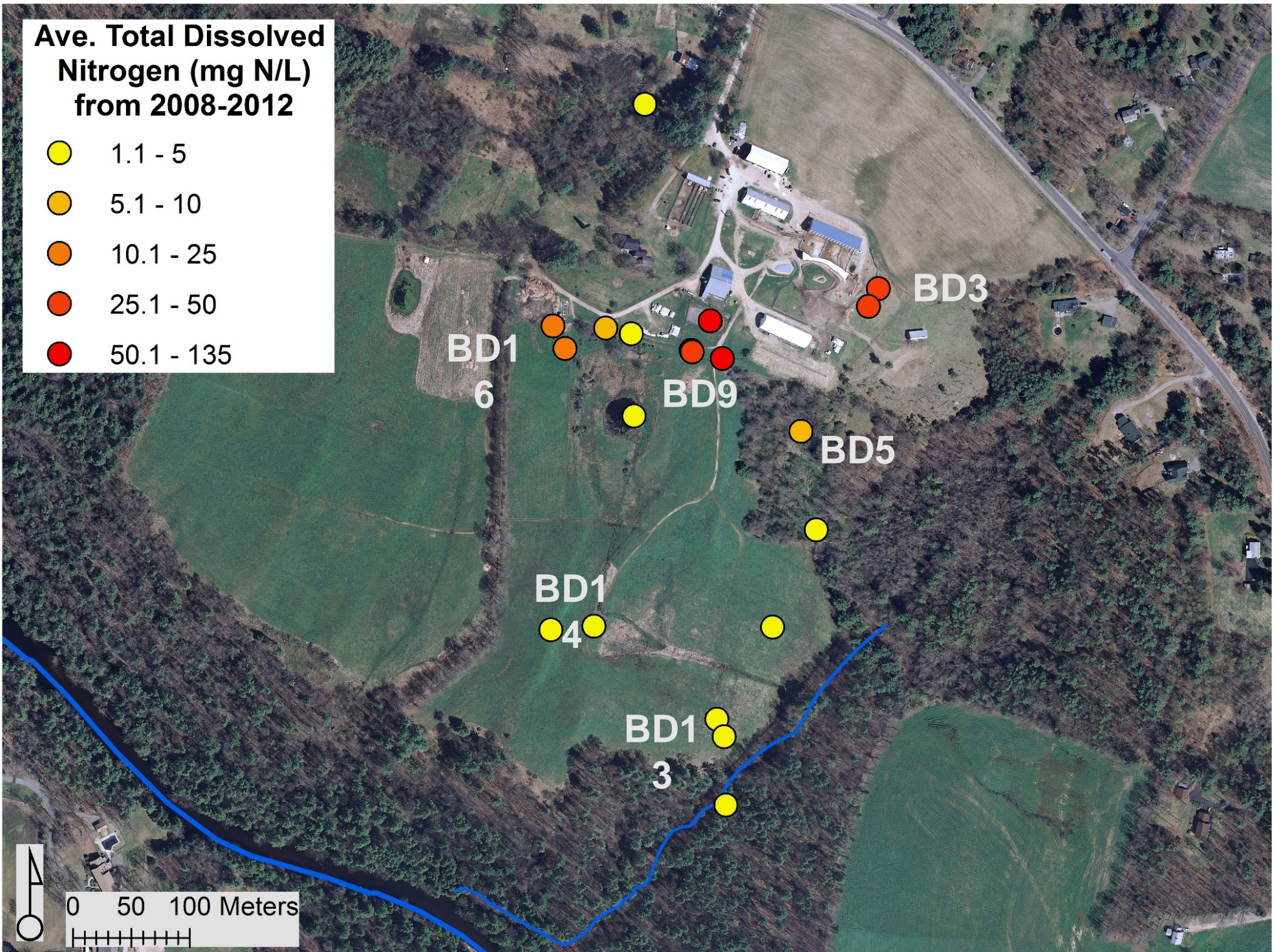
Before: Bedding/manure stockpiled for months-years





**Ave. Total Dissolved Nitrogen (mg N/L) from 2008-2012**

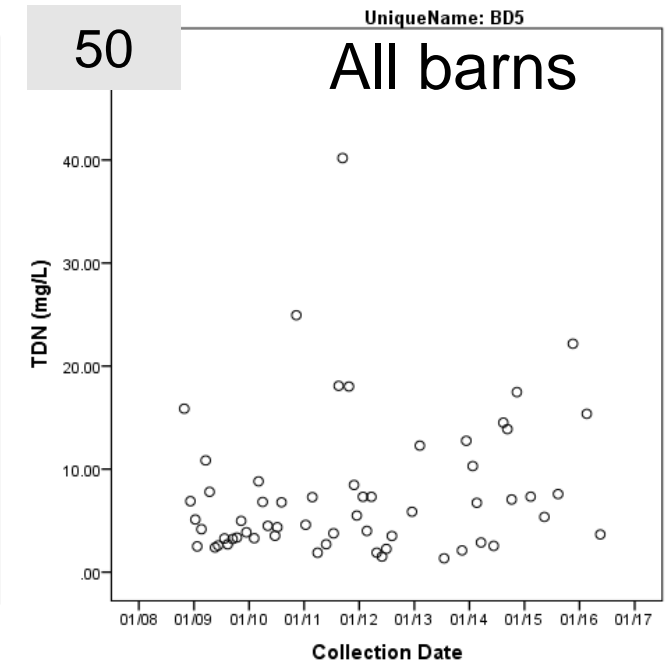
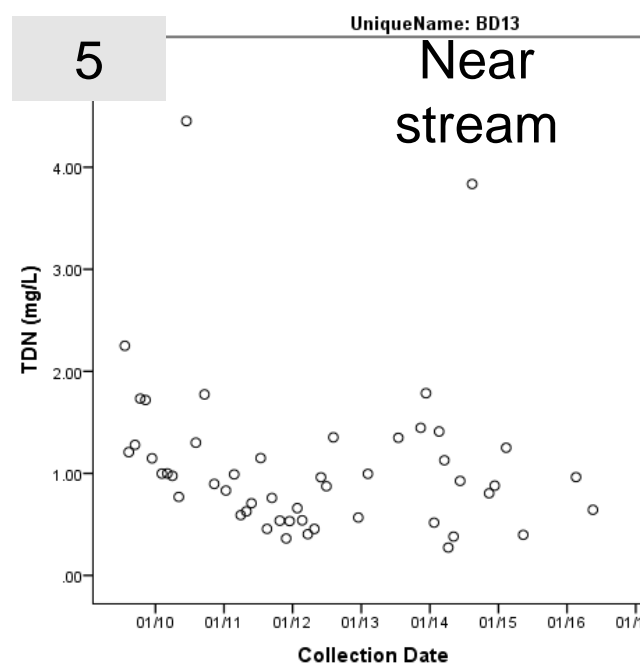
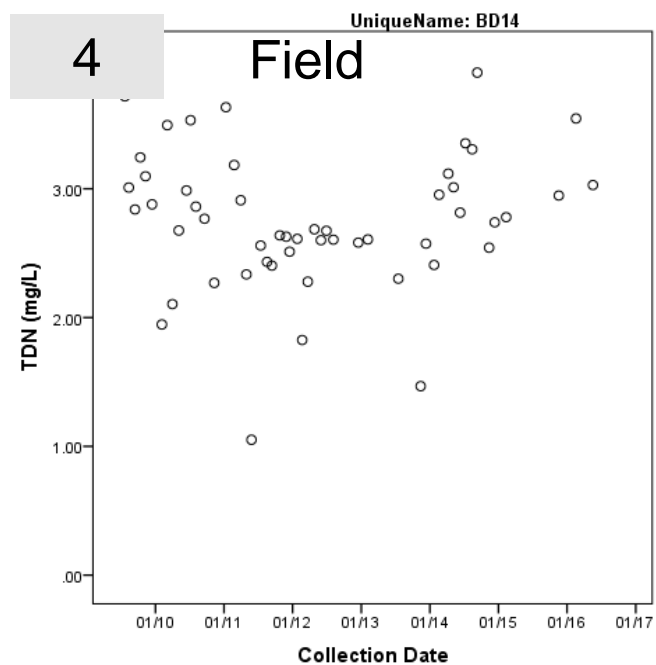
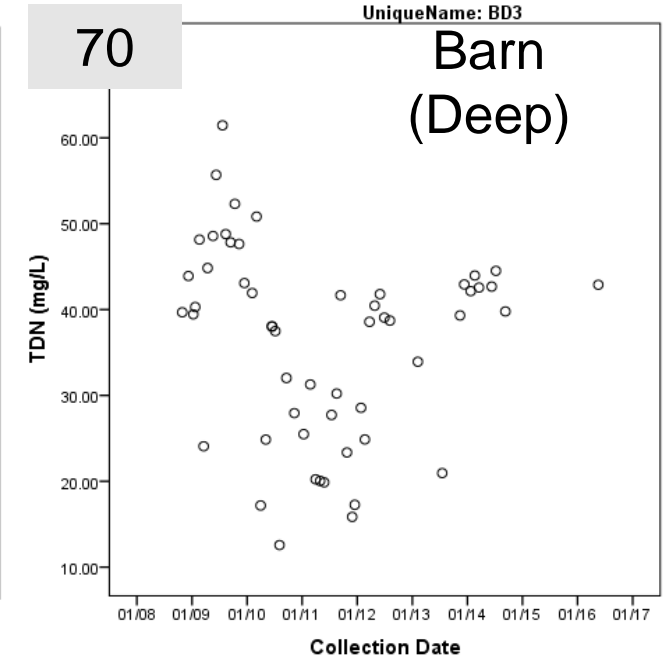
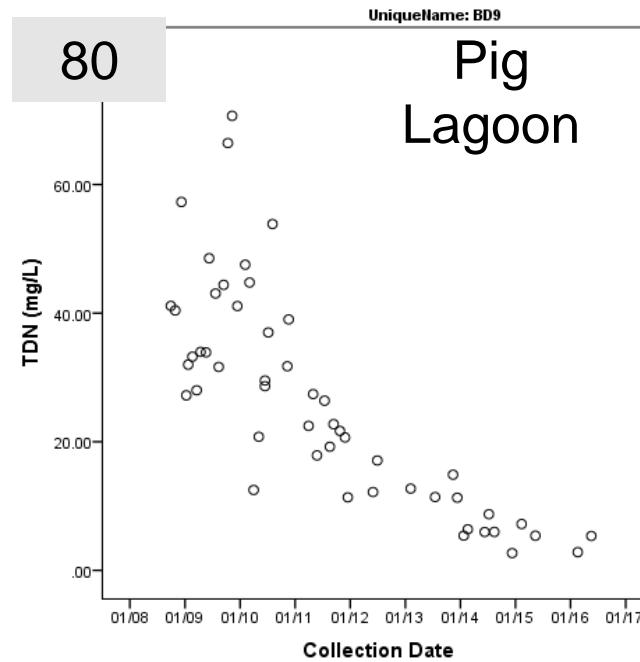
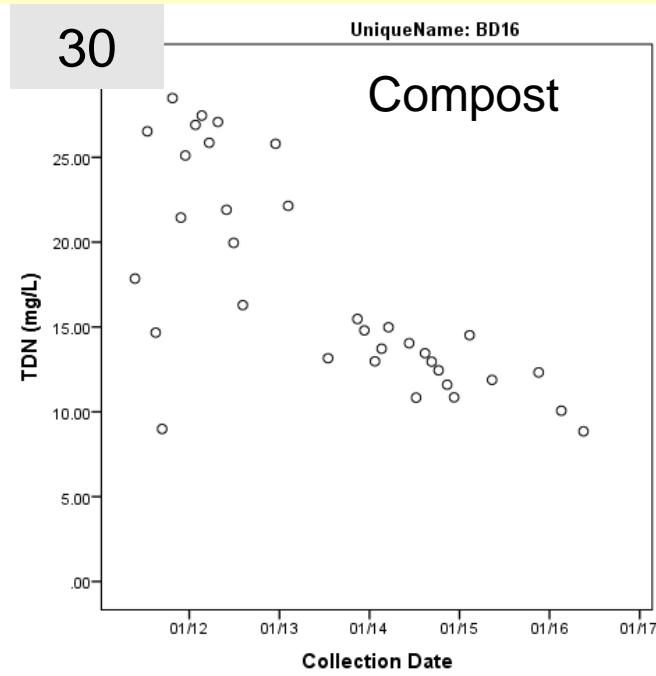
- 1.1 - 5
- 5.1 - 10
- 10.1 - 25
- 25.1 - 50
- 50.1 - 135



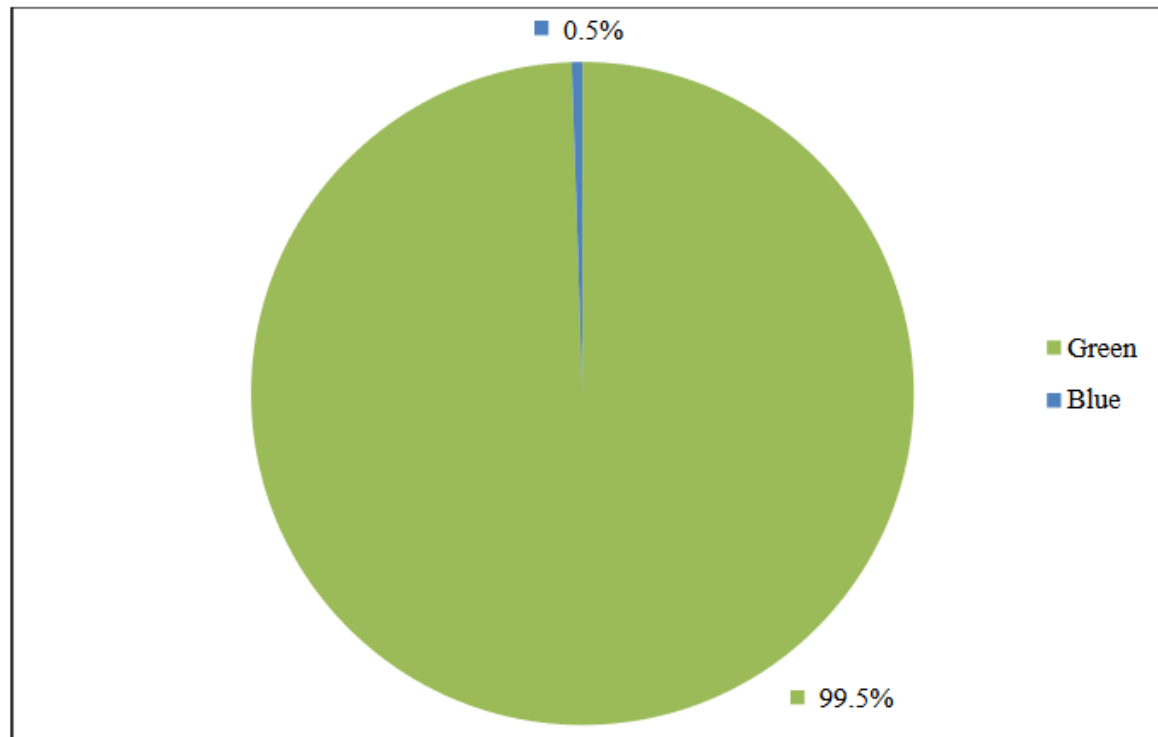


# Total Dissolved Nitrogen (TDN) Over Time in Groundwater

McDowell and Shattuck, et al.



# J. Matthew Davis. Water Footprint of the Organic Dairy Research Farm, University of New Hampshire [Report](#) 2014



	<b>Green Water Footprint</b>	<b>Blue Water Footprint</b>	<b>Grey Water Footprint</b>	<b>Impacted Water (blue + grey)</b>
<b>UNH ODRF</b>	1230	7	0	7
<b>USA Grazing System</b>	1256	78	101	179
<b>USA Mixed System</b>	661	67	100	167
<b>USA Industrial System</b>	504	69	114	183

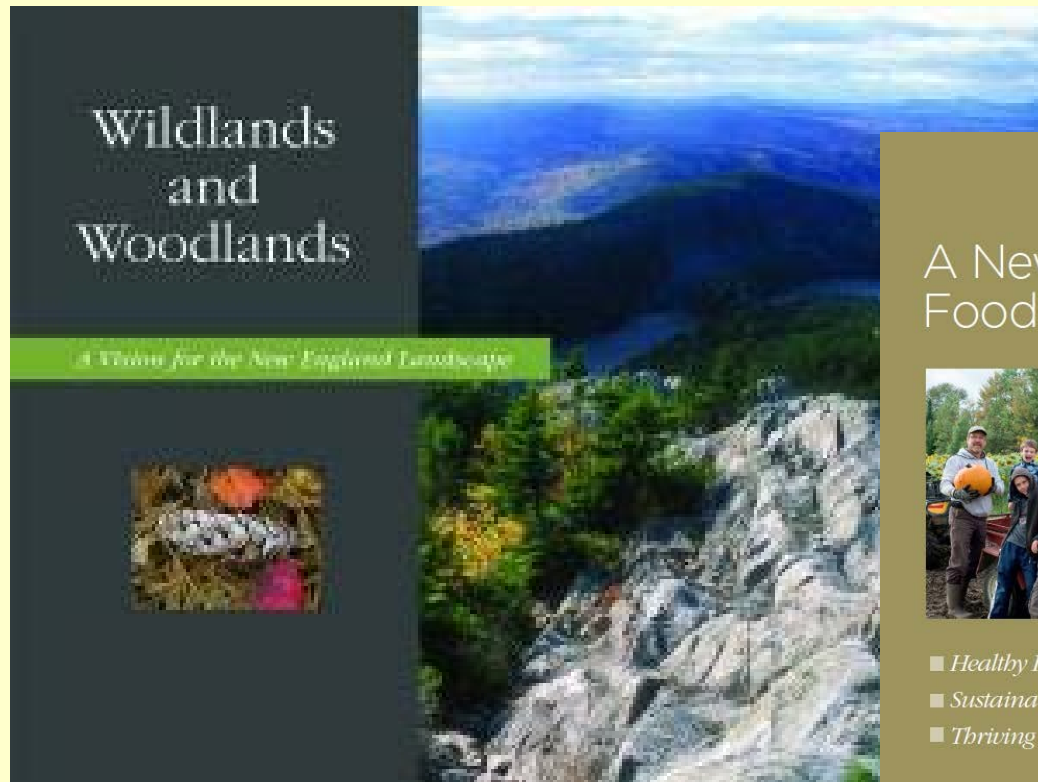
Liters of water per Liter of milk





# The Land Use Challenge for New England Agriculture

## Alternate Visions of the Future?



### A New England Food Vision



- *Healthy Food for All*
- *Sustainable Farming and Fishing*
- *Thriving Communities*

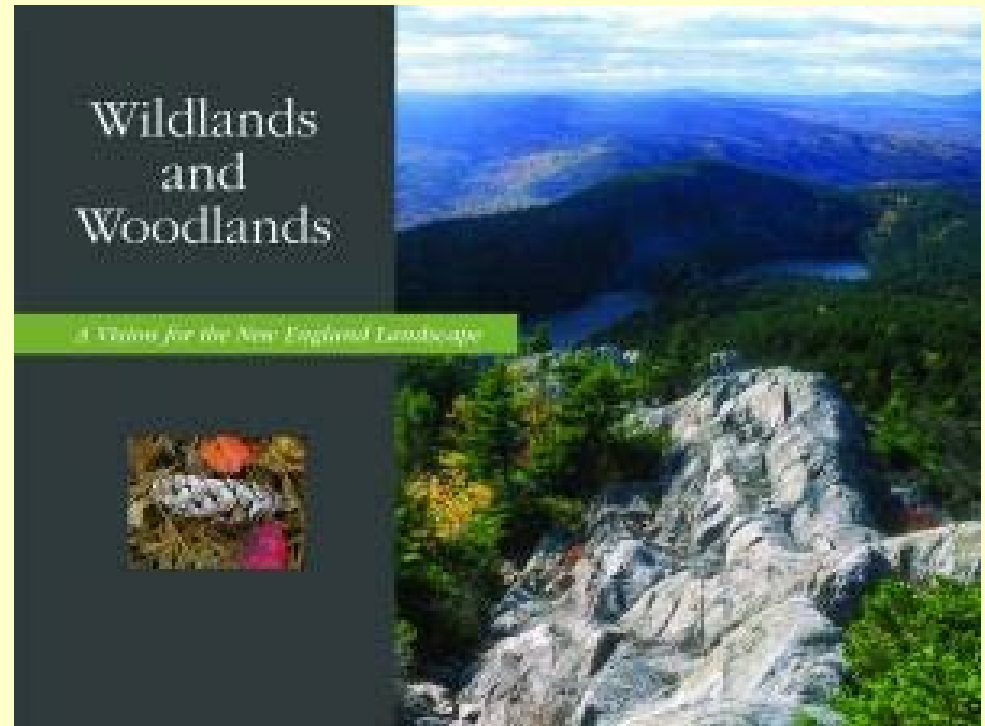




# The Land Use Challenge for New England Agriculture

## Wildlands and Woodlands

- 70% woods (7% Wildlands)
- 5% water and wetlands
- 25% developed and agriculture



<http://www.wildlandsandwoodlands.org/>



# The Land Use Challenge for New England Agriculture

Food Solutions New England  
What fraction of calories can be grown in the region?

- Current diet –
  - 40%, need 6M acres
- Omnivore's Delight diet –
  - 50%, need 6M acres
- Self Reliance diet –
  - 70%, need 7M acres
- Total acres in New England: ~46M (current ag ~2M acres)
- **Can we Intensify Agricultural Production?**

<http://www.foodsolutionsne.org/new-england-food-vision>





# Can We Intensify and “Harden” New England Agriculture?

## UNH Research

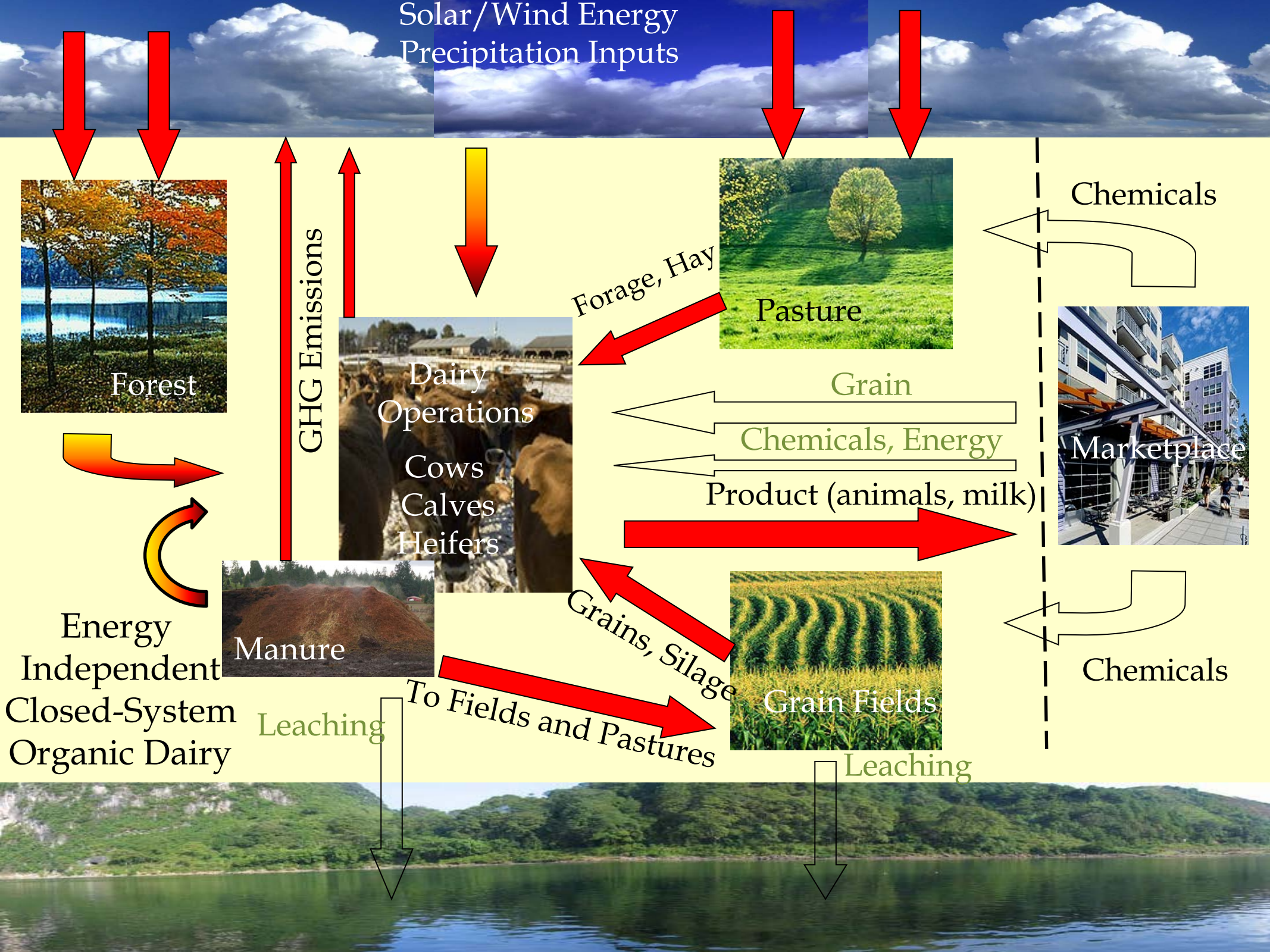
- High tunnels (Sideman, Ogden...)
  - Grow produce for dining services
  - Species trials
  - Energy efficiency enhanced with heat pumps
  - Heating with Compost (more later)
- Extending grazing season and increasing pasture productivity with novel species mixtures (Smith)
- Organic dairy nutrition (Brito)

## Another opportunity?

- Espalier fruit









# Unbundling the Process - Multiple Sources of Revenue



[http://attra.ncat.org/images/solar-gh/solar\\_greenhouse.gif](http://attra.ncat.org/images/solar-gh/solar_greenhouse.gif)

