

Dairy Manure Nutrients: Variable but Valuable

Bill Jokela¹ and John Peters²

¹USDA-Agricultural Research Service,
Dairy Forage Research Center, Marshfield/Madison, WI

²Soil Science Dept., Univ. of Wisc, Marshfield/Madison, WI²



Agricultural Research Service



U.S. Dairy Forage
Research Center



COLLEGE OF
AGRICULTURAL
& LIFE SCIENCES
UNIVERSITY OF WISCONSIN-MADISON

Manure Management and Nutrient Management Planning

- Maximize utilization of manure nutrients for crop production
- Manage nutrients to prevent adverse impacts on water and air quality
 - Avoid excessive application rates
 - Improve management methods (timing, application techniques, etc.)
- Need to know the nutrient content of manure to be applied

Questions for Today

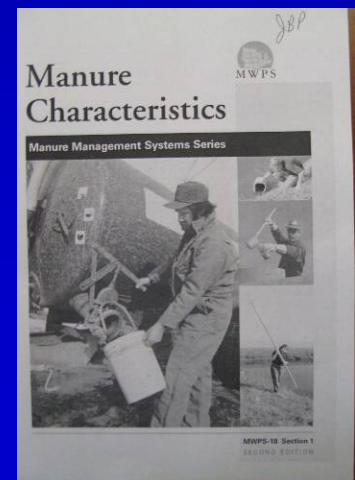
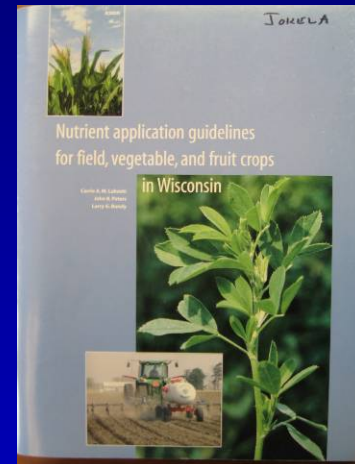
- What is the nutrient content of dairy manure? How reliable are book values?
- Have there been changes in average nutrient content over the past 10-15 years because of shifts in feeding or other management practices?
- What is the economic value of manure nutrients, especially with recent high fertilizer prices?
- How variable is manure nutrient content? (among farms/within a farm?)
- How important is regular manure sampling and analysis on individual farms?

Recent Long-term Summaries of Dairy Manure Lab Analyses

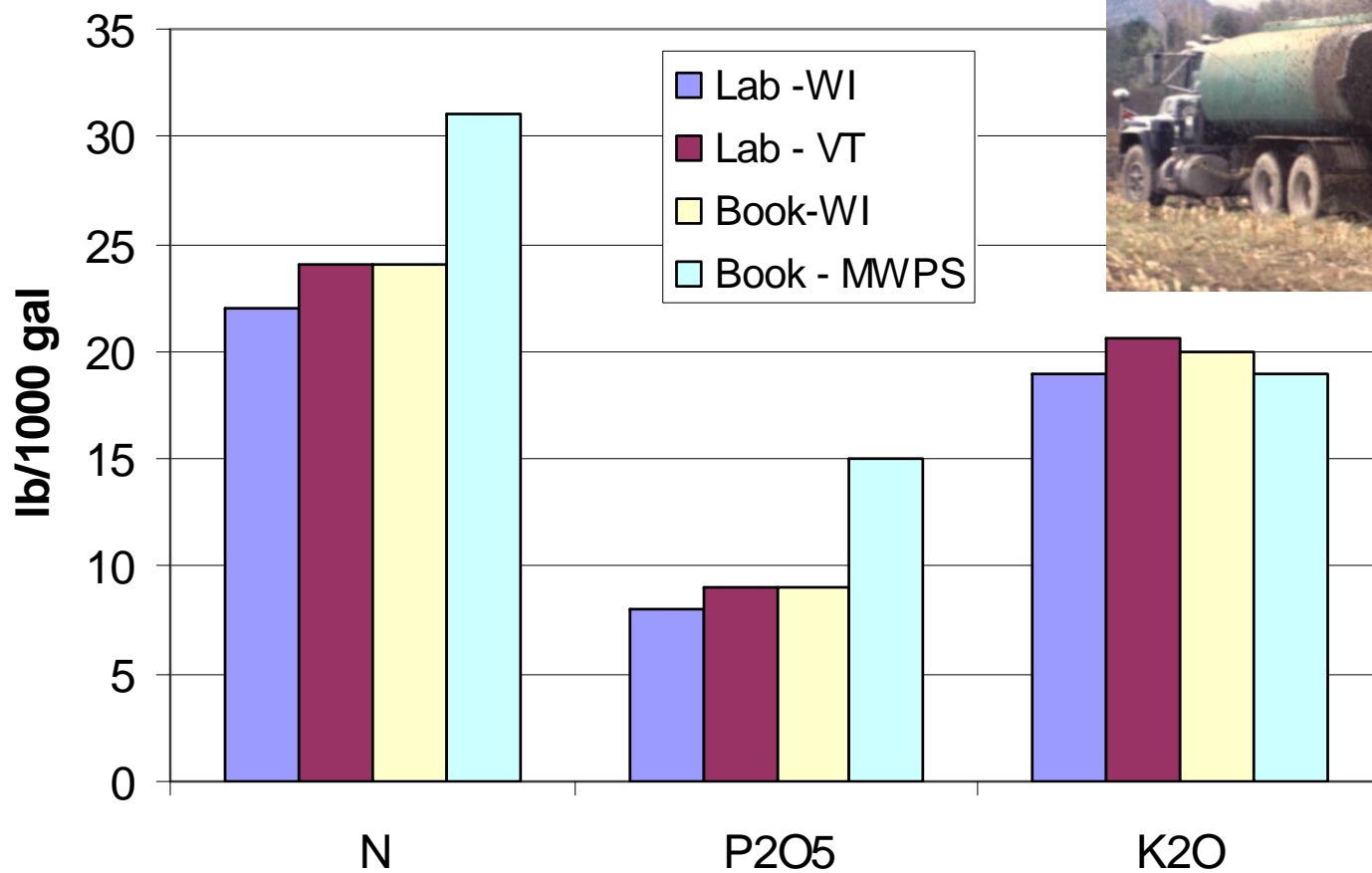
- Vermont (Jokela et al., 2005)
 - Time period: 1992-2006
 - 2366 dairy manure samples
 - University of VT Agricultural and Environmental Testing Lab
- Wisconsin (Peters, 2008)
 - Time period: 1998-2008
 - 14,835 dairy manure samples
 - Four WI labs (AgSource, Dairyland, Rock River, and UW Soil and Forage Lab)

Manure Lab Summaries vs. "Book" Values

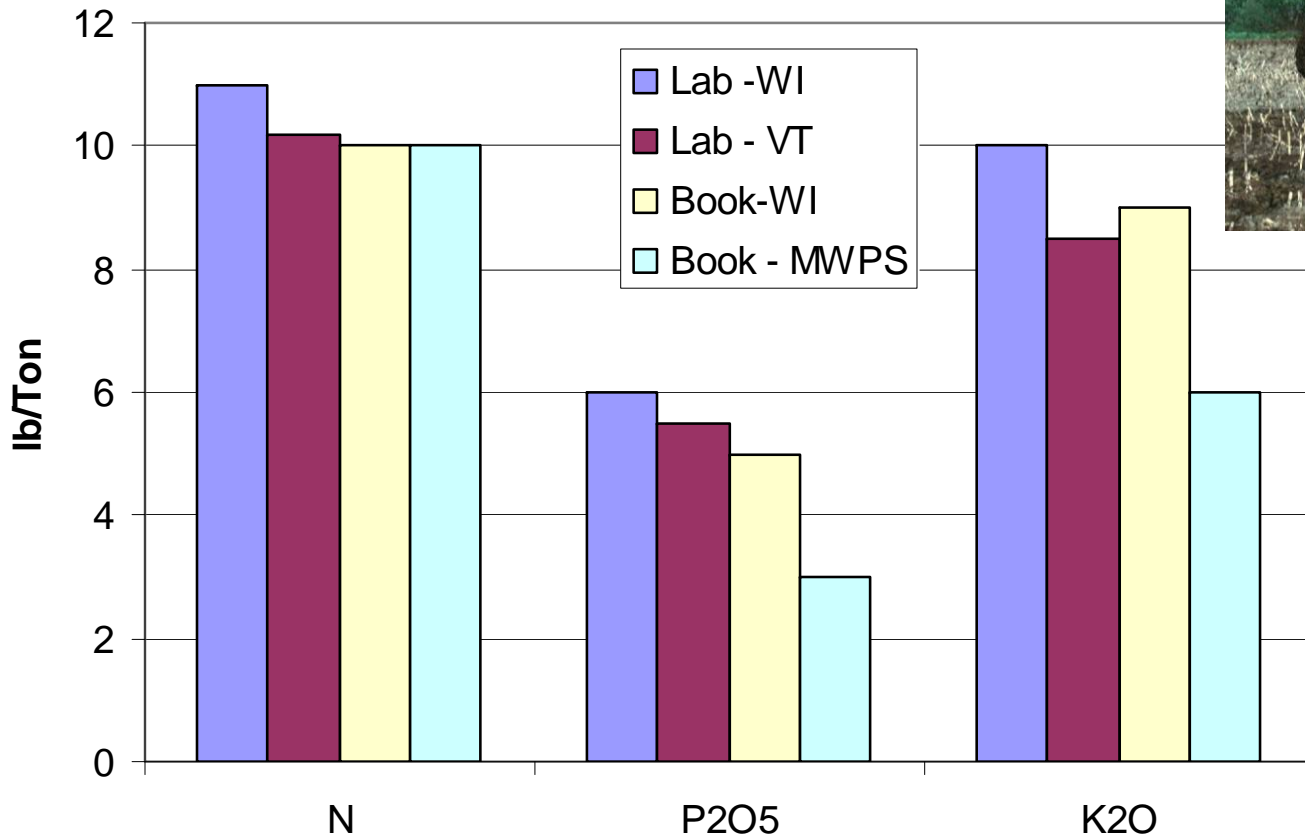
- Book values: Estimates published in Extension bulletins, etc for use in nutrient management planning
 - WI: Nutrient application guidelines ... UW-Extension Publ. A2809 (Laboski et al., 2006)
 - MidWest Plan Service (MWPS). 2007. Manure characteristics, 2nd edition.
 - Extension pubs from other states.



Liquid Dairy Manure Nutrients: Lab Summary vs Book Value



Solid Dairy Manure Nutrients: Lab Summary vs Book Value

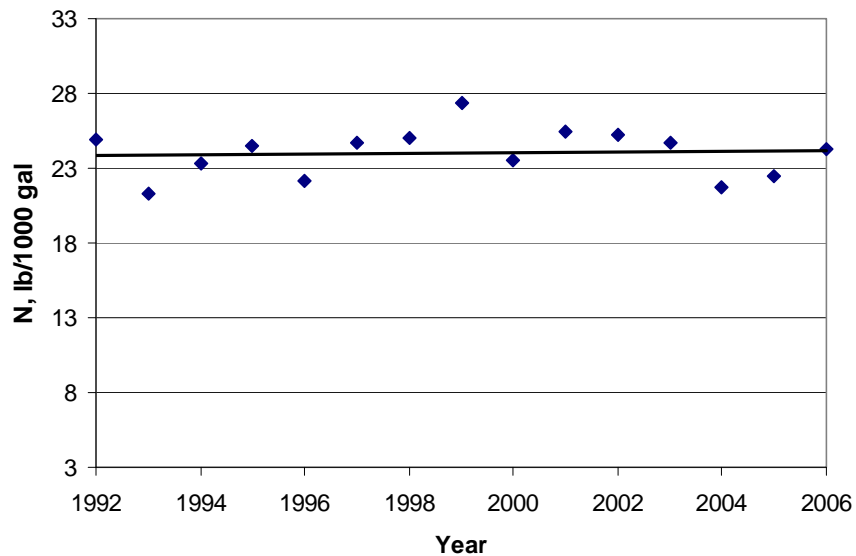


Lab Summary vs Book Values

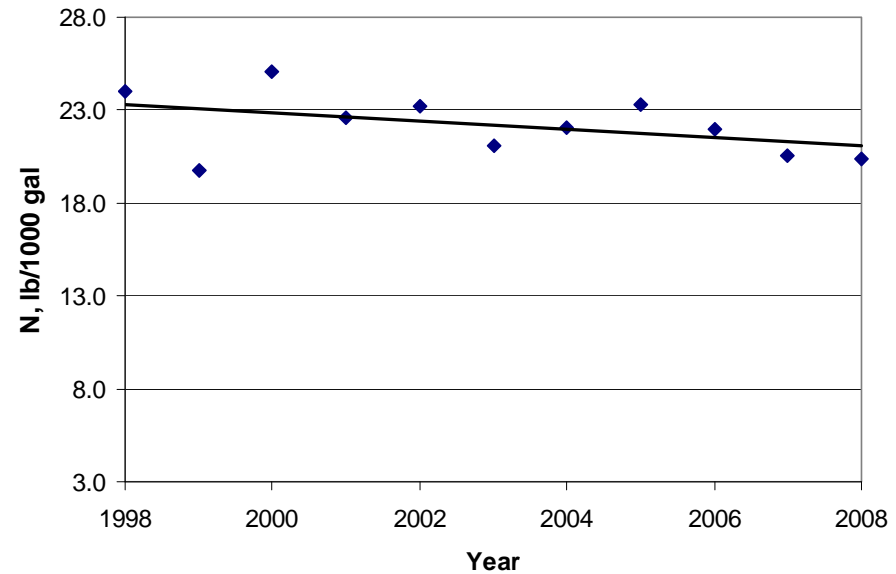
- WI book values (A2809) agree quite well with average lab values for WI and VT
- MWPS book values agree in some cases but are high or low in others
- These are long-term averages... but have there been changes over time?

Liquid Dairy Manure N Content Trend over Time

Vermont, 1992-2006

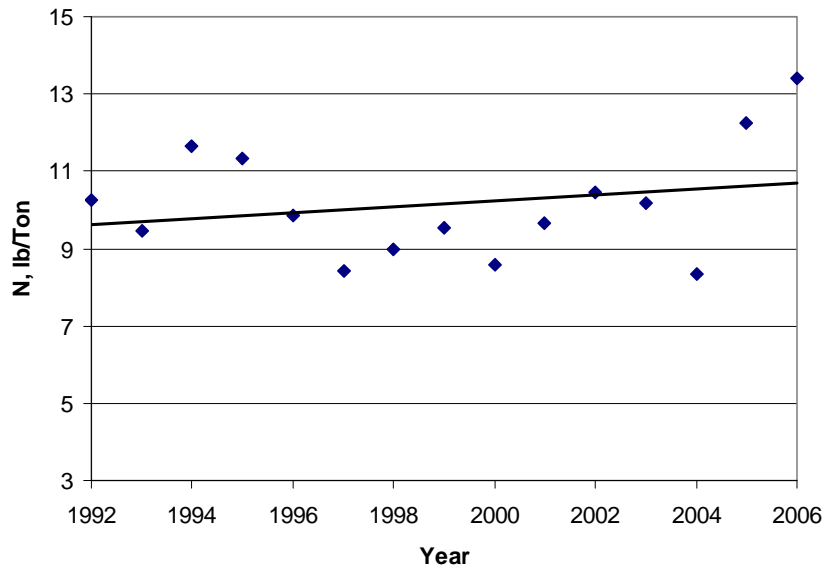


Wisconsin, 1998-2008

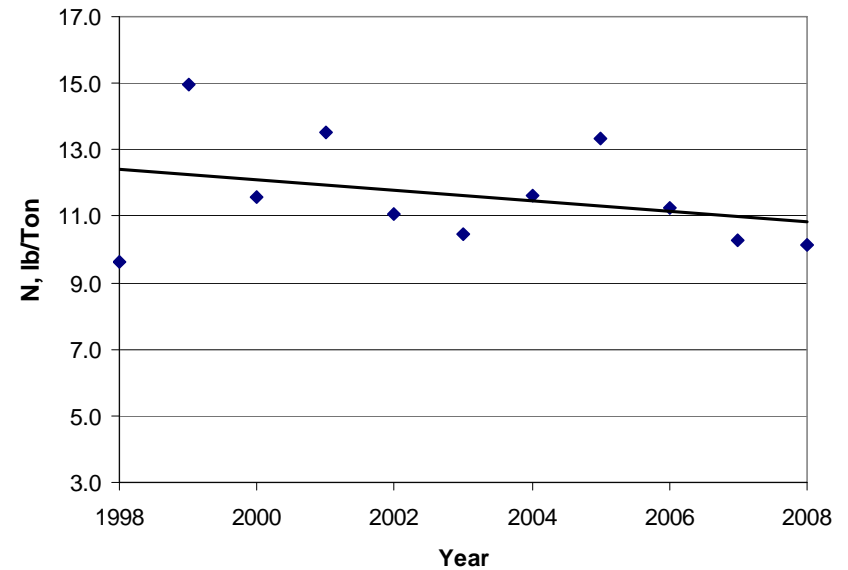


Solid Dairy Manure N Content Trend over Time

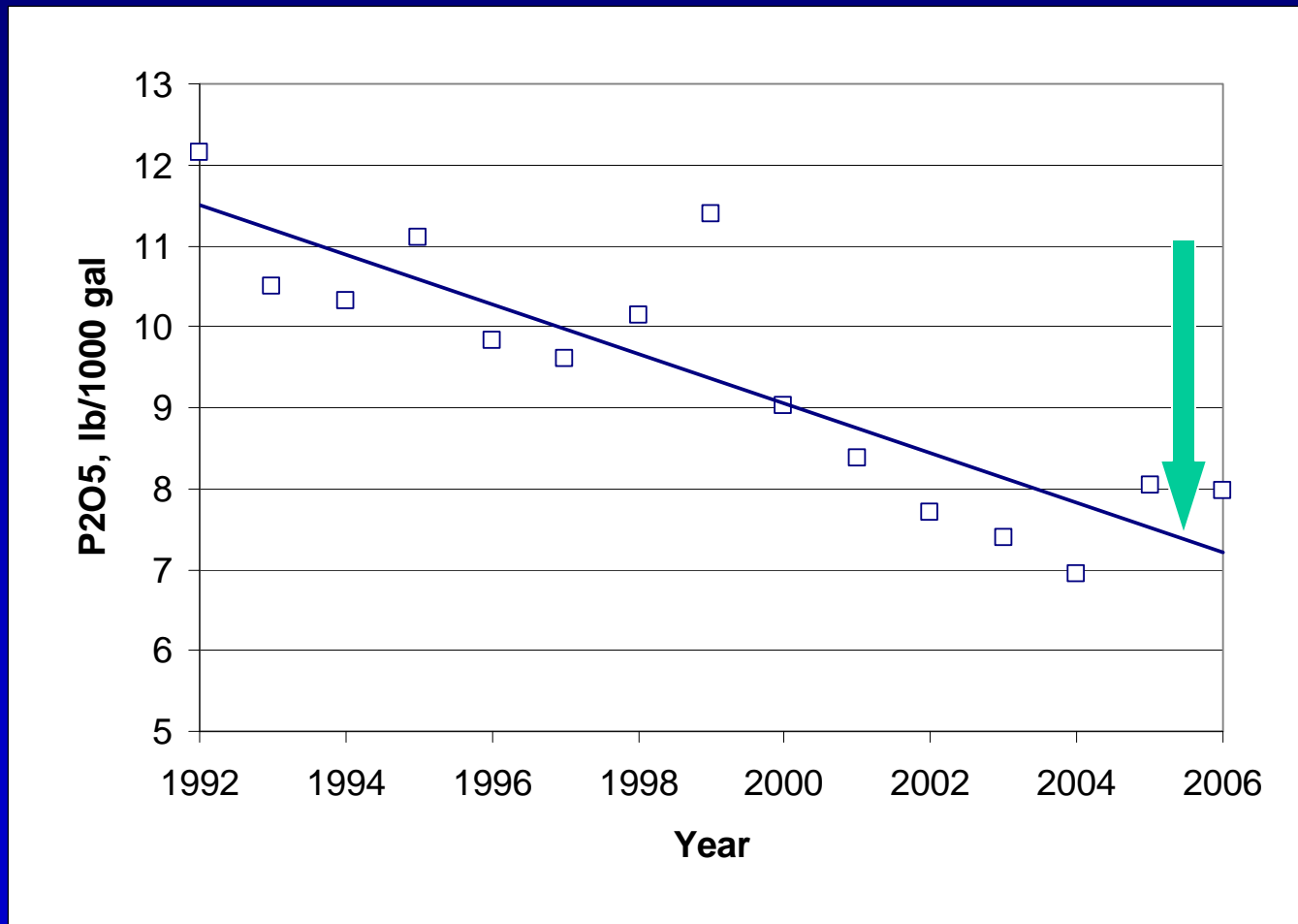
Vermont, 1992-2006



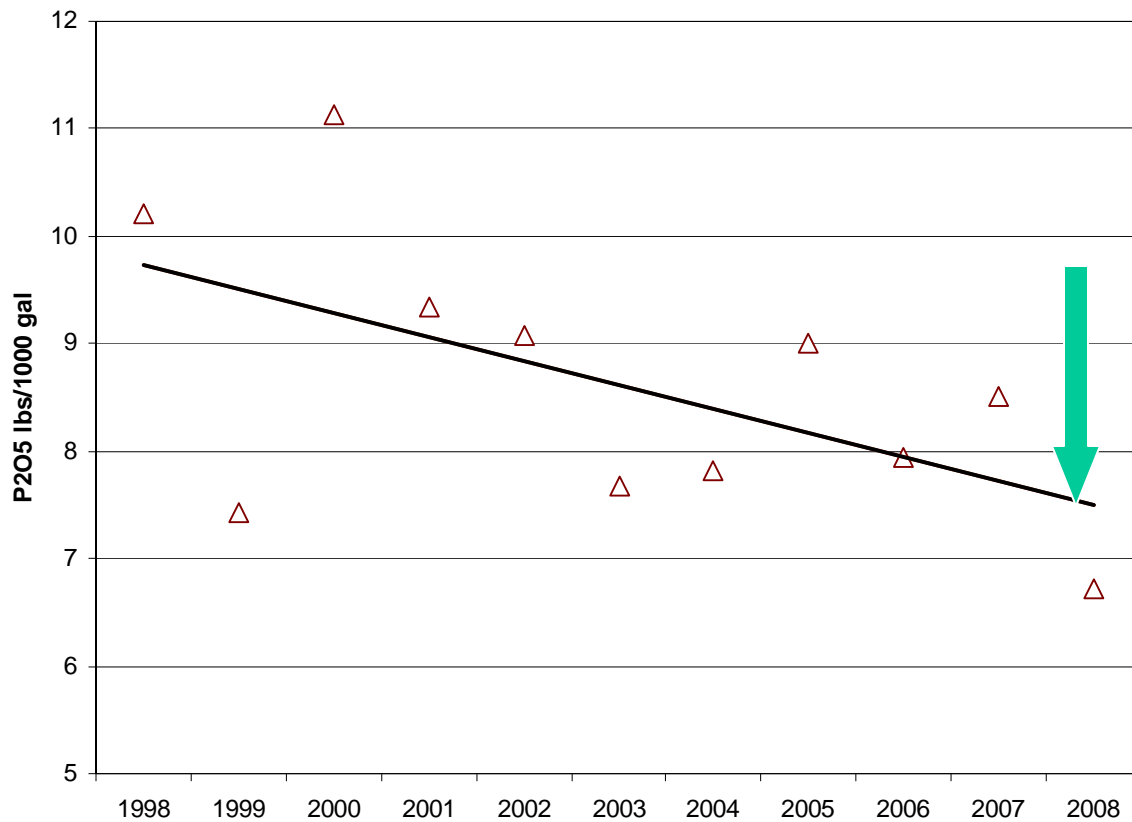
Wisconsin, 1998-2008



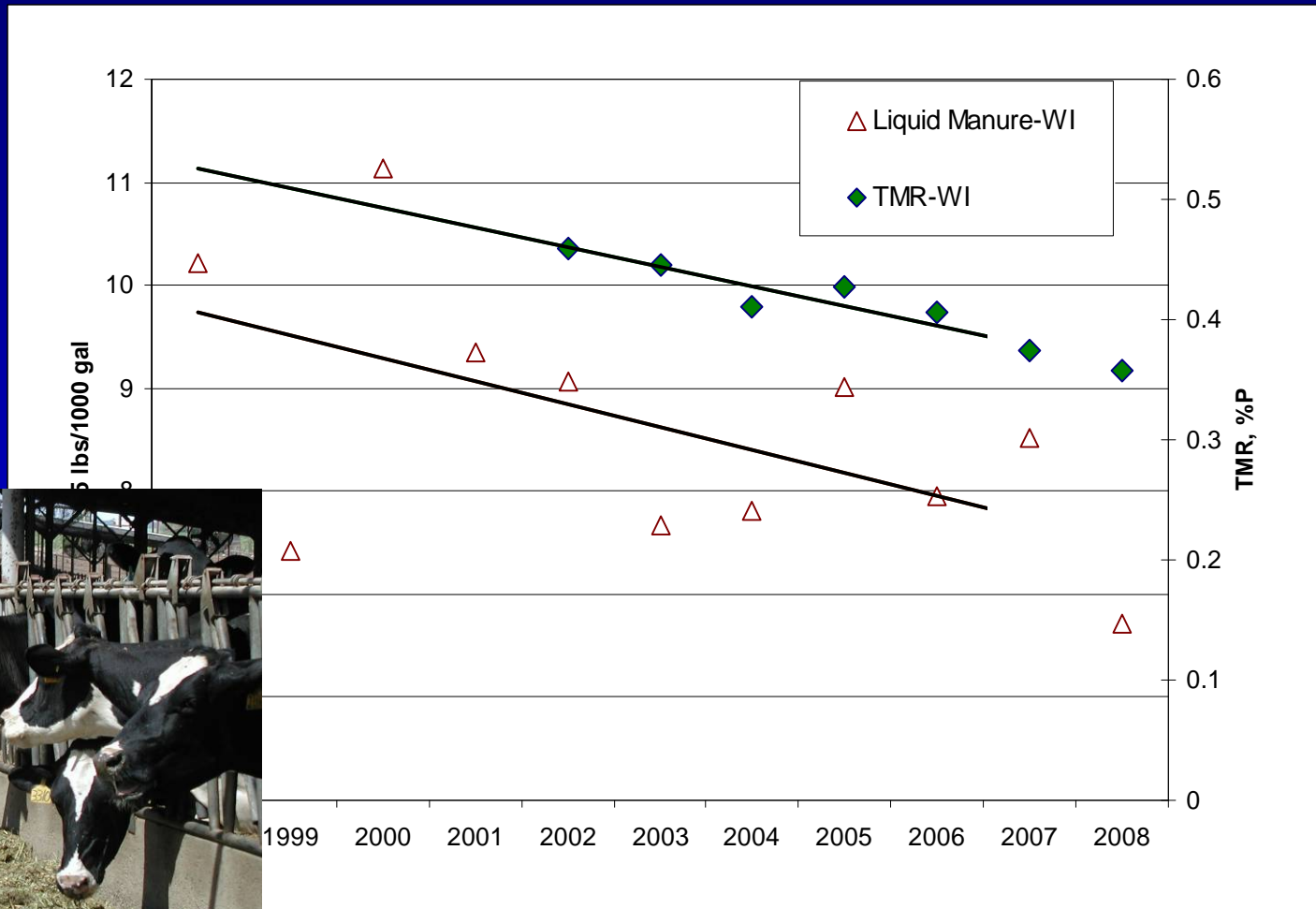
Liquid Dairy Manure P Content Trend over Time, 1992-2006, VT



Liquid Dairy Manure P Content Trend over Time, 1998-2008, WI

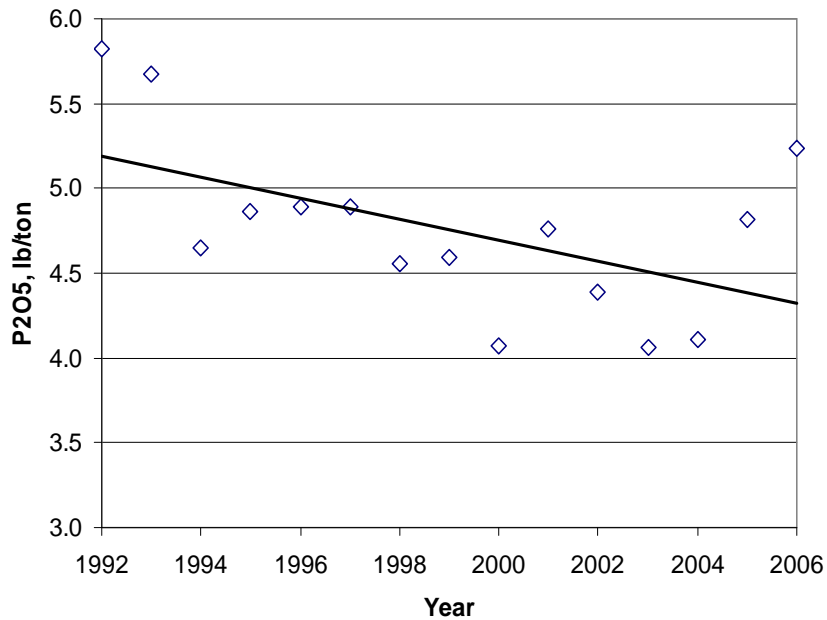


Liquid Dairy Manure and TMR P Content Trend over Time, 1998-2008, WI

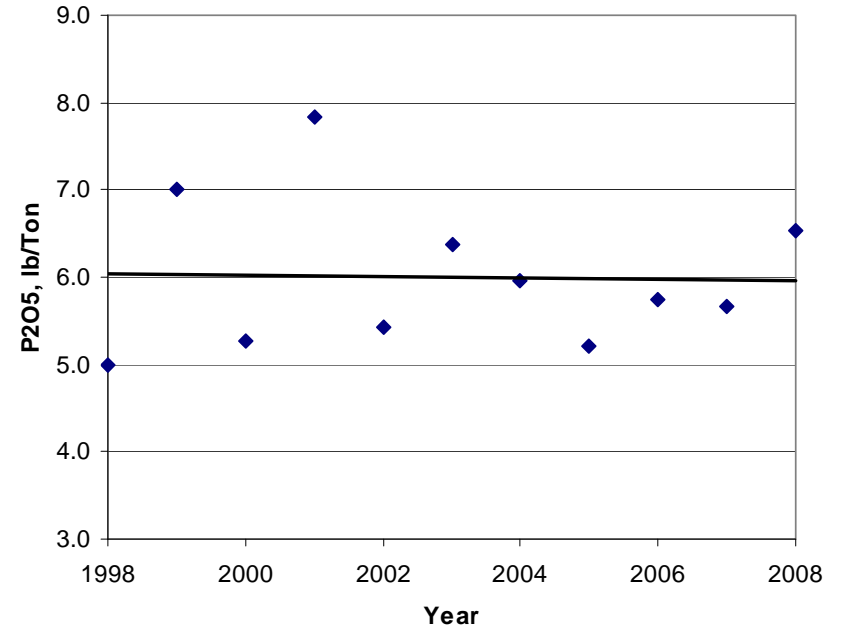


Solid Dairy Manure P Content Trend over Time

Vermont, 1992-2006



Wisconsin, 1998-2008



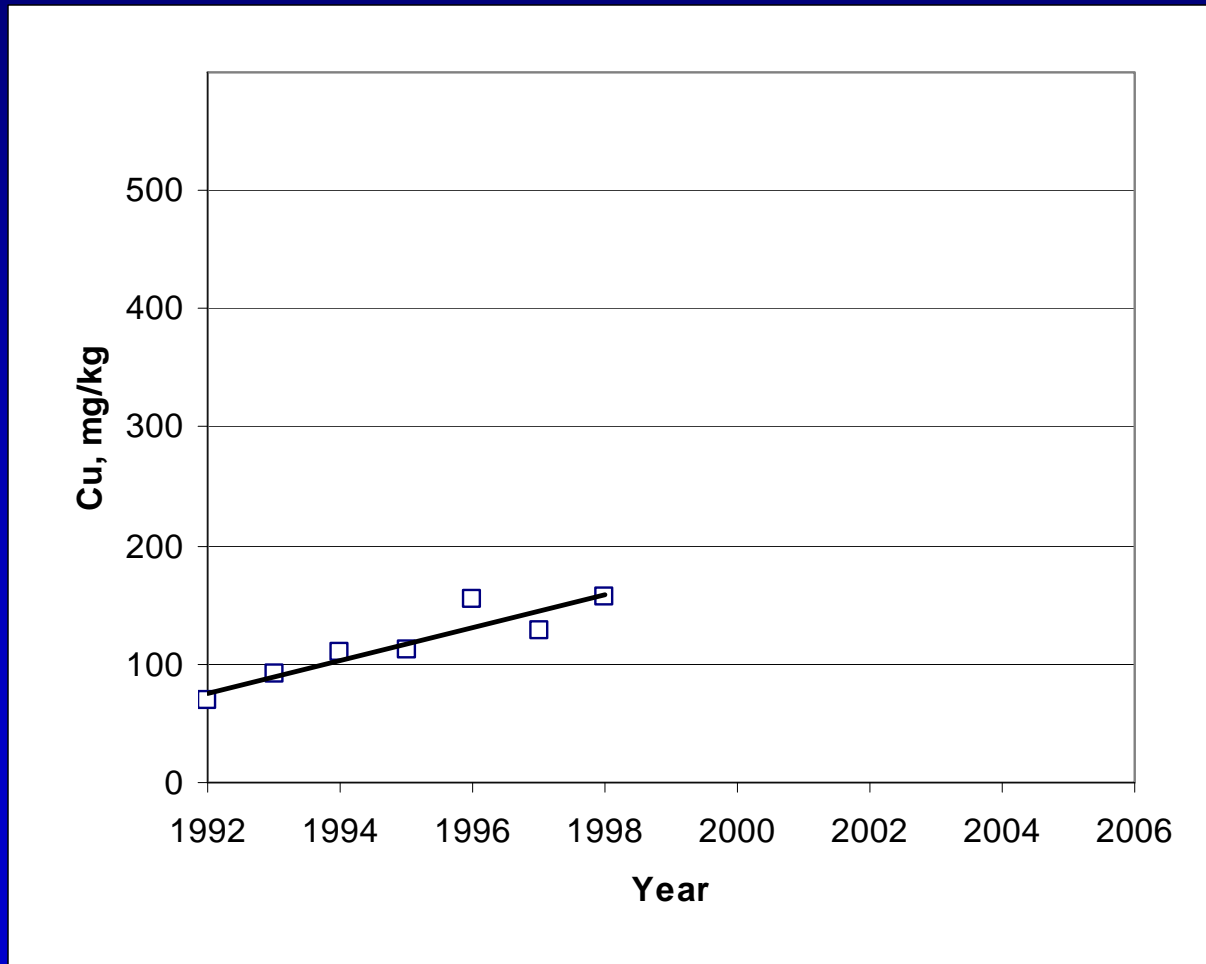
Change over Time: NPK

- Nitrogen
 - Little or no consistent change in N content over time (slight decrease in WI?)
 - High year-to-year variability
- Potassium (not shown)
 - Variable and no consistent trends
- Phosphorus
 - No (WI) or some (VT) decrease in solid manure
 - Significant decrease (25-30%) in liquid manure in VT and WI
 - Parallel decrease in P content of TMR in recent years in WI supports P diet change as cause

Micronutrients in Manure

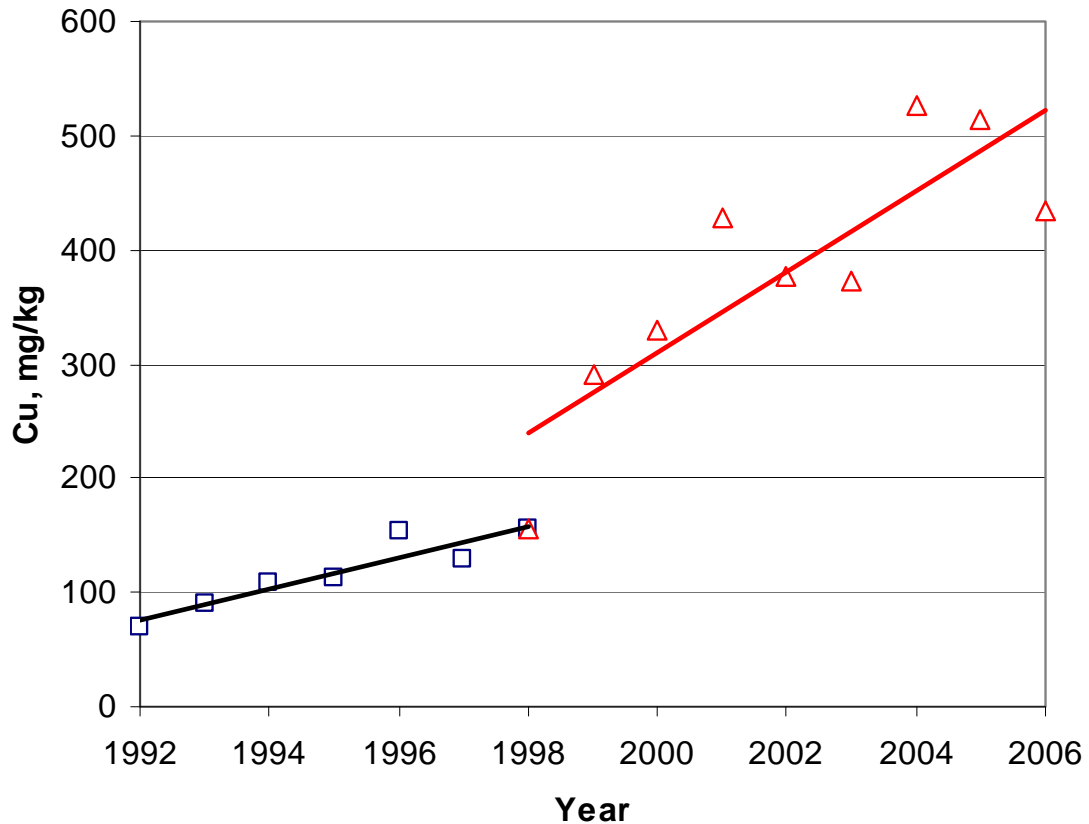
- Little or no consistent trends in VT samples over time for most micronutrients (Not routinely analyzed in WI labs)
- One noteworthy exception... Copper (Cu)

Liquid Dairy Manure Copper Content Trend over Time, 1992-1998, VT



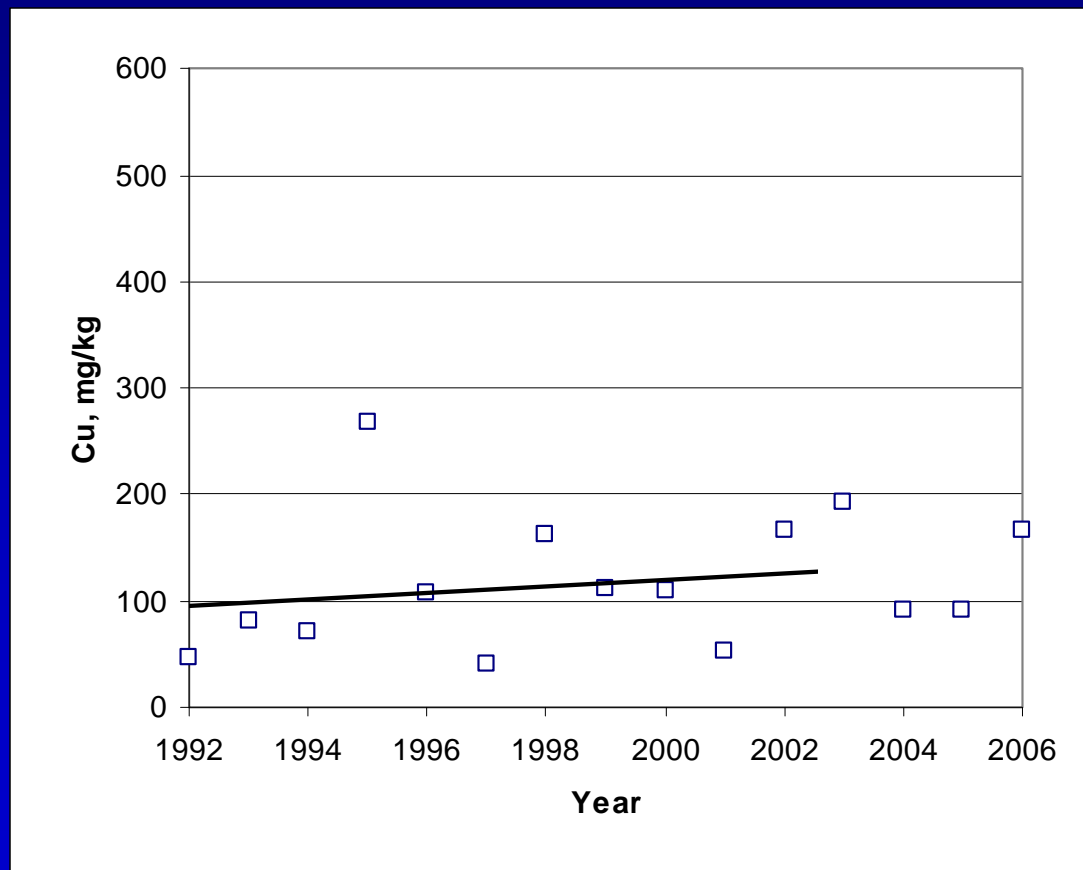
DM Basis

Liquid Dairy Manure Copper Content Trend over Time, 1992-2006, VT



DM Basis

Solid Dairy Manure Copper Content Trend over Time, 1992-2006, VT

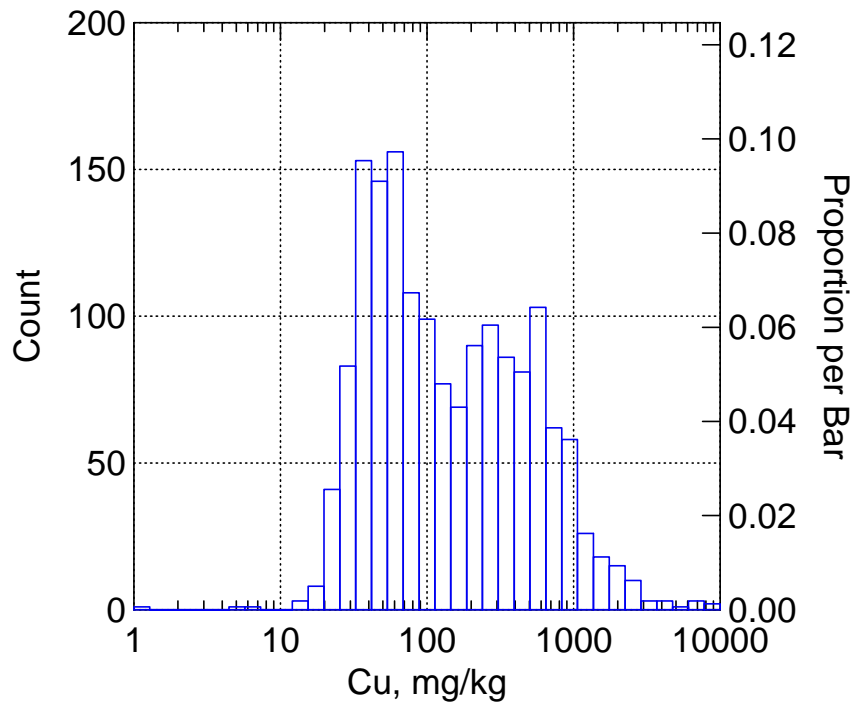


DM Basis

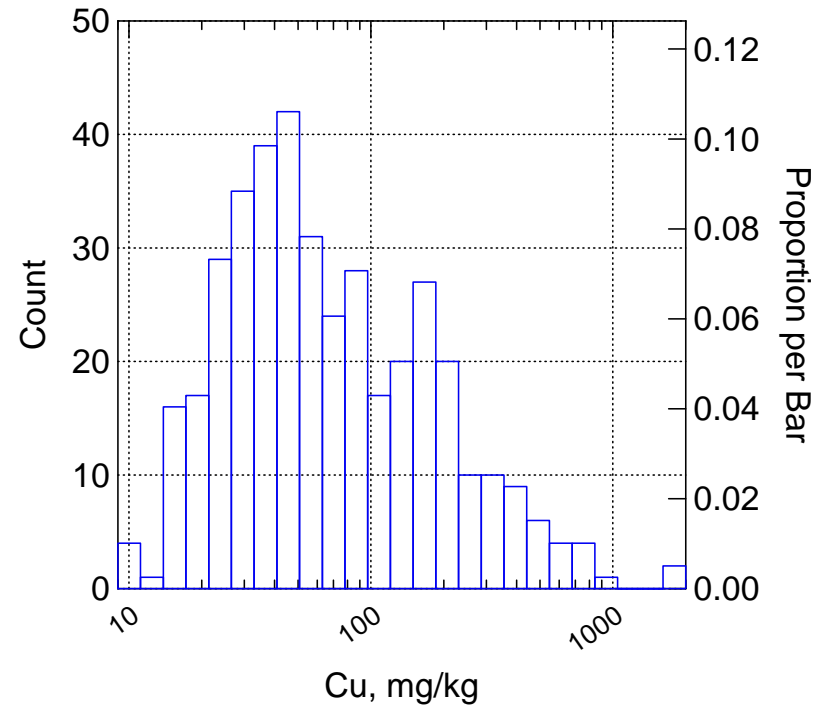
Variability in Dairy Manure Copper Content (DM basis)

1992-2006, VT

Liquid Manure



Solid Manure



Trends in Cu Content in Dairy Manure

- Dramatic increase in liquid manure in recent years (post-1998) in VT manure samples
 - Average of <100 to >500 mg/kg
 - Some testing in 1000s
- No consistent trend in solid manure
- Attributed to waste copper sulfate foot bath solution discarded into manure pits
- Possible concerns about excessive Cu loading of soil
 - Toxic levels in crop and feed? But Cu binding to soil OM limits plant uptake.
 - Environmental regulations: EPA and state loading limits
 - If high Cu rates applied, monitor manure, soil, and feed.
 - Consider management changes to lower Cu loading from manure.

What is the economic value of nutrients in dairy manure?

- Average nutrient content from 10-year WI lab summary
- Nutrient availability (fertilizer equivalent) estimates from UW Ext publication A2809
- Current fertilizer prices (11/08)

Nutrient Content and \$ Value of Liquid Dairy Manure in WI

Nutrient	Total	Available	\$ Value	
			lb/1000 gal	\$/1000 gal
				\$/10,000 gal
N	22	8.8	7.48	75
P ₂ O ₅	8	4.8	4.56	46
K ₂ O	19	15.2	11.10	111
Total			23.14	230

Nutrient content from WI lab summary and availability from UW Ext A2809 (40, 60, and 80% availability for N, P, and K).

Prices: N, \$0.85/lb; P₂O₅ \$0.95/lb; K₂O. \$0.73/lb

Nutrient Content and \$ Value of Solid/Semi-solid Dairy Manure in WI

Nutrient	Total	Available	\$ Value	
			lb/ton	
			\$/ton	\$/20 ton
N	11	4.4	3.74	75
P ₂ O ₅	6	3.6	3.42	68
K ₂ O	10	8.0	5.84	117
Total			13.00	260

Nutrient content from WI lab summary and availability from UW Ext A2809.
 (40, 60, and 80% availability for N, P, and K).
 Prices: N, \$0.85/lb; P₂O₅ \$0.95/lb; K₂O. \$0.73/lb

Fertilizer \$ Value of Dairy Manure

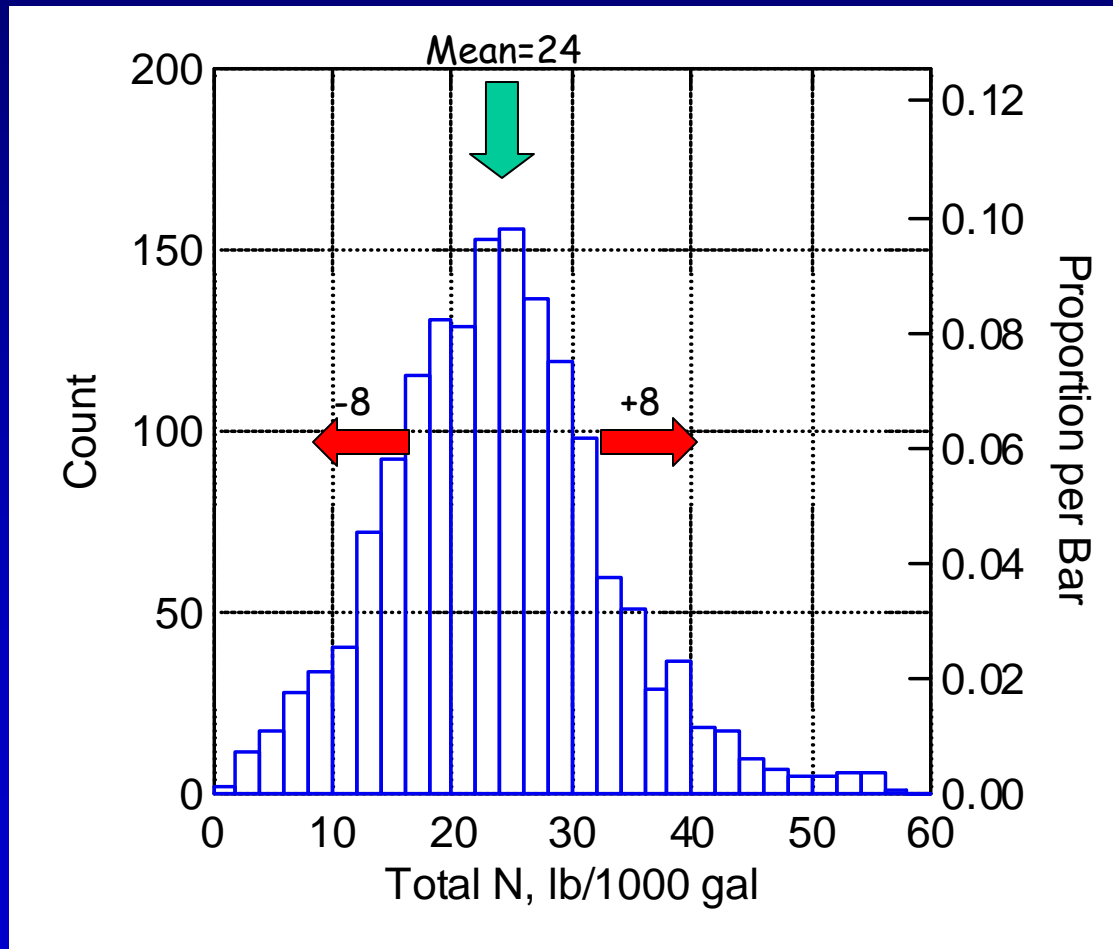
- N value
 - \$7.50/1000 gal liquid manure
 - 3.75/ton for solid manure
- N, P, and K (if all needed)
 - \$23/1000 gal or \$13/ton
- At typical application rates for corn
 - \$75 per acre for N
 - Over \$200/acre for N, P, and K
- Varies (esp. N) with manure management and availability estimates used.

- But how do book values or lab summary averages compare with actual measured analysis on individual farms?
- OR... How variable are nutrient content values across farms?



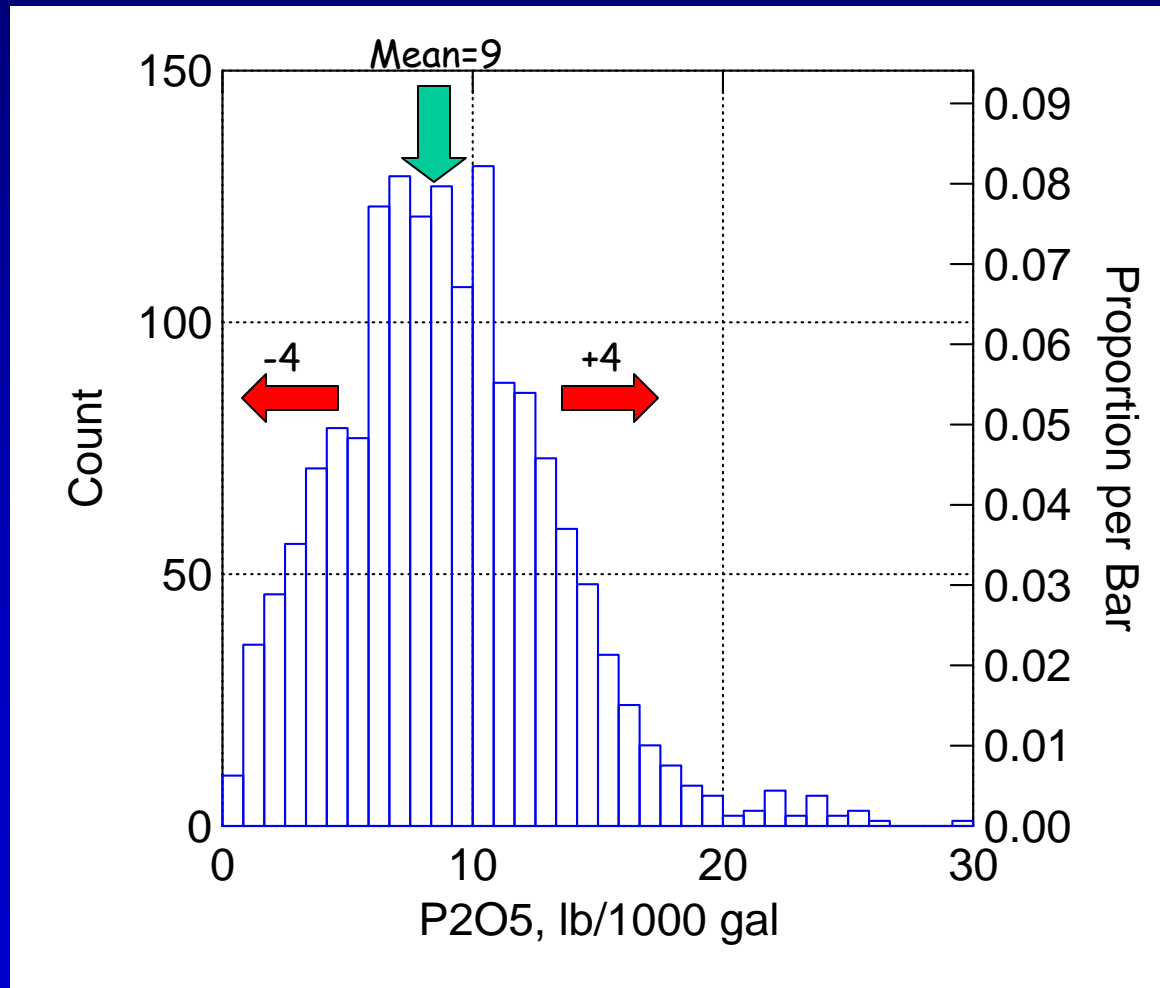
Variability of Liquid Manure N

VT Manure Summary, 1992-2006



Variability of Liquid Manure P

VT Manure Summary, 1992-2006



Variability of Liquid Manure Nutrients by Farm - Nitrogen

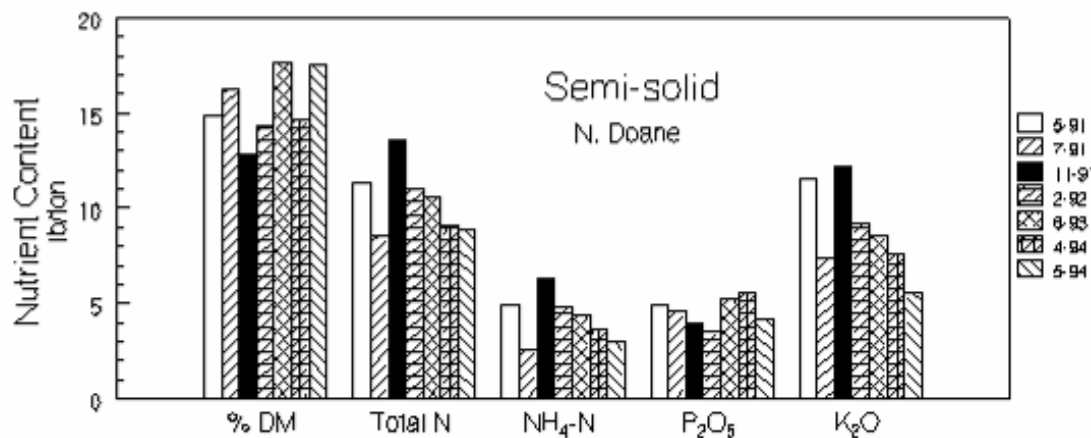
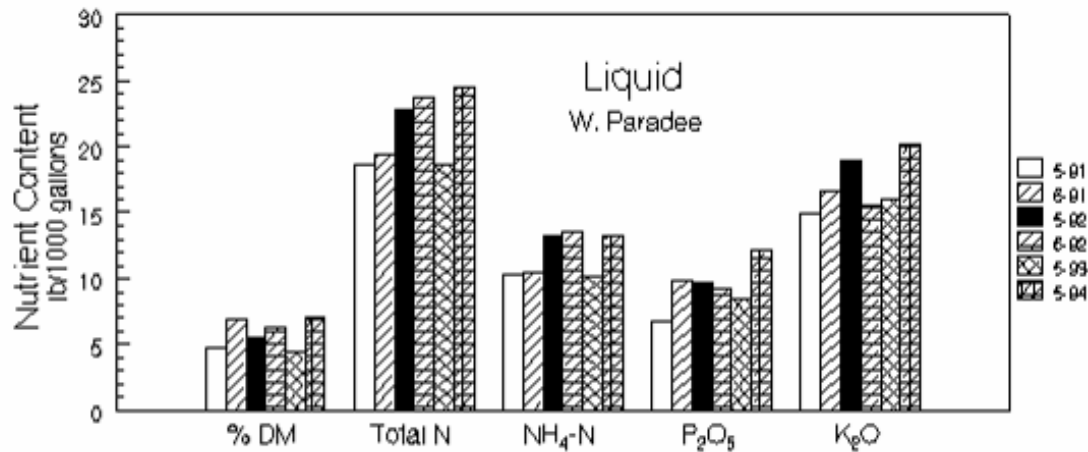
- About 2/3 of samples within 8 lb N (+/-) and 4 lb P₂O₅ of the mean value.
- But 1/3 were not...
- Assume manure applied at rate to meet 100 lb/acre N need (10, 400 gal /acre) based on average (VT) of 24 lb/1000 gal
 - If actual analysis = 16 (8 lb less), then fertilizer equiv. of 67 lb/acre → **N Deficient**
 - If actual analysis = 32 (+8 lb), then fertilizer equiv. of 133 lb/acre → **Increased leaching potential.**

Variability of Liquid Manure Nutrients by Farm - Phosphorus

- Same manure application rate would approximate the P need of 150 bu/A corn crop (55 lb/A) with optimum STP
 - If actual analysis +/- 4 lb /A , then available P would be excess or short 25 lb P_2O_5 /A.
 - If NM Plan requires P-based rate, then this could result in big difference in application rate (7,000-18,000 gal/acre) and, therefore, land area required.

Variation in Manure Nutrient Content over Time on Same Farm

Examples: 2 Farms in VT over 4 Years

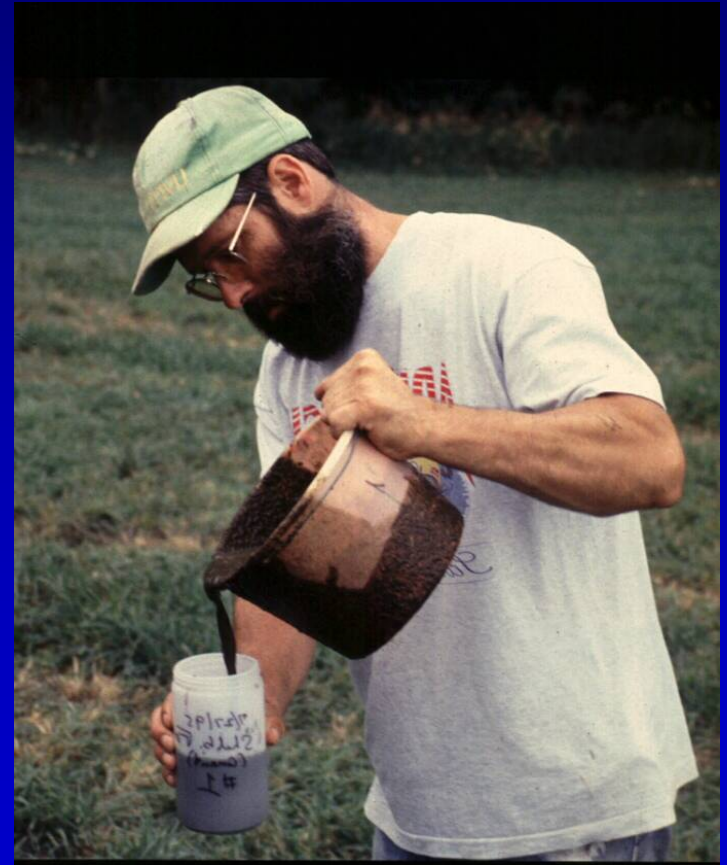


- Most analyses, esp. P, fairly similar over time
- But considerable variation at some sample times
- Need continued sampling and analysis

Jokela et al.,
1994.

Value of Manure Book Values and Lab Summaries?

- General guideline only
- Shows trends over time
- Important to sample and analyze manure for individual farm and manure source
 - Sample at time of spreading
 - Multiple years to establish baseline
 - More sampling if change in feed, bedding, storage conditions, etc.



Summary: Dairy Manure Nutrients

- Average nutrient values from WI and VT lab summaries agree well with WI book values, not so well with MWPS values.
- Long-term trends
 - Minimal consistent change for N, K, and most micronutrients
 - P decreased, especially in liquid manure
 - Cu increased in liquid manure

Summary (cont.)

- Manure is valuable as a crop nutrient source
 - At typical application rate, \$75/A for N, >\$200/A for NPK
- High variability among dairy farms, so regular sampling is essential to maximize nutrient \$ value and minimize environmental impact



Institute for Environmental Integrated
Dairy Management, Marshfield, WI