Phosphorus Forum 2018

February 27, 2018 | Tempe, AZ

TODAY'S AGENDA

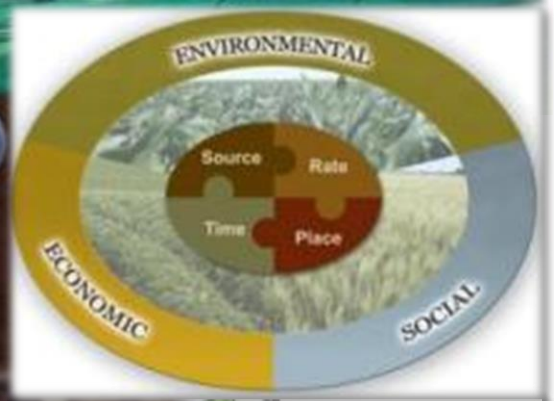
- 8:30: **Dr Jim Elser** (ASU) Welcome and our job today.
- 8:45: Keynote: **Dr Sally Rockey** (FFAR)
- **9:30: Dr David Vaccari** (Stevens Inst of Technology) "A Substance Flow Model for Global Phosphorus"
- 10:00: Coffee & networking
- 10:30: **Dr. Luis Herrera** (CINVESTAV), GMO technology for phosphite fertilizer use
- 11:00: **Dr Kevin Dooley** (ASU) & Allison Thomson (Field to Market): Market drivers of nutrient sustainability
- **12:00 – 1:30: Lunch & networking**
- 12:30 – 1:00: Lunch keynote: **Dr Paul Fixen** (IPNI, retired)
- 1:30: **Ned Beecher** (Northeast Biosolids & Residuals Association), regulatory challenges with recycling organic residuals
- 2:00: **Noel Lyons** (McGill Compost) and **Dr Amir Varshovi** (GreenTechnologies), commercialization of compost and recycled fertilizer products
- 2:45: **Dr Jim Elser** (ASU) Final discussion & closing comments.
- 3:30 – 5:30: Networking time (Postino's on College Ave)

Sustainable Phosphorus Alliance

Dr Paul Fixen, Senior Vice President (Retired) International Plant Nutrition Institute (IPNI)

Agronomy superstar!

- Coordinated IPNI programs in the Americas and Oceania and directed IPNI research.
- Fellow of the American Society of Agronomy, the Soil Science Society of America (SSSA), the American Association for the Advancement of Science, and the Fluid Fertilizer Foundation
- Authored 300+ articles and book chapters on nutrient management
- 2016 President of ASA
- Past Associate Editor of the Soil Science Society of America Journal

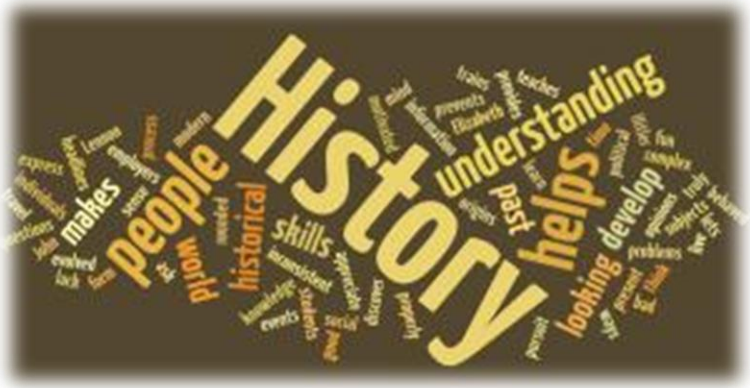


35 Years of Progress in Nutrient Management and Agronomy

Paul Fixen
Sr. Vice President (Retired)
International Plant Nutrition Inst.

35 years in 25 minutes

- Agronomic changes … for context



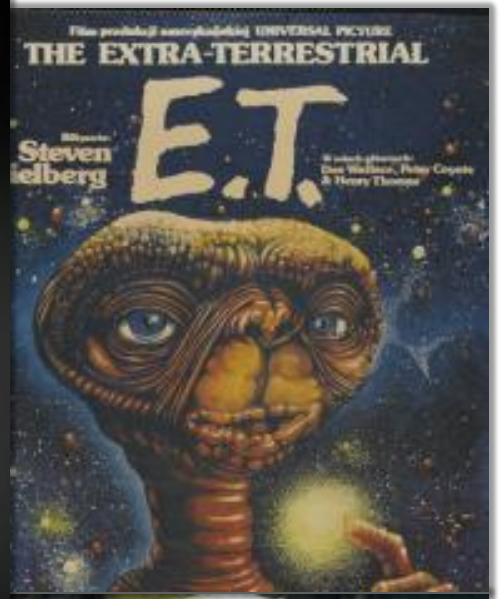
- Nutrient management changes … our history

- Where from here? … our future

Life in 1982

27

Commercial cell phone



What was the state of agronomy?

- Agronomic changes … for context

- Nutrient management changes … our history

- Where from here? … our future

Why Maximum Yield Research?

Dr. R. E. Wagner, President
Potash & Phosphate Institute and
Foundation for Agronomic Research

April 1982

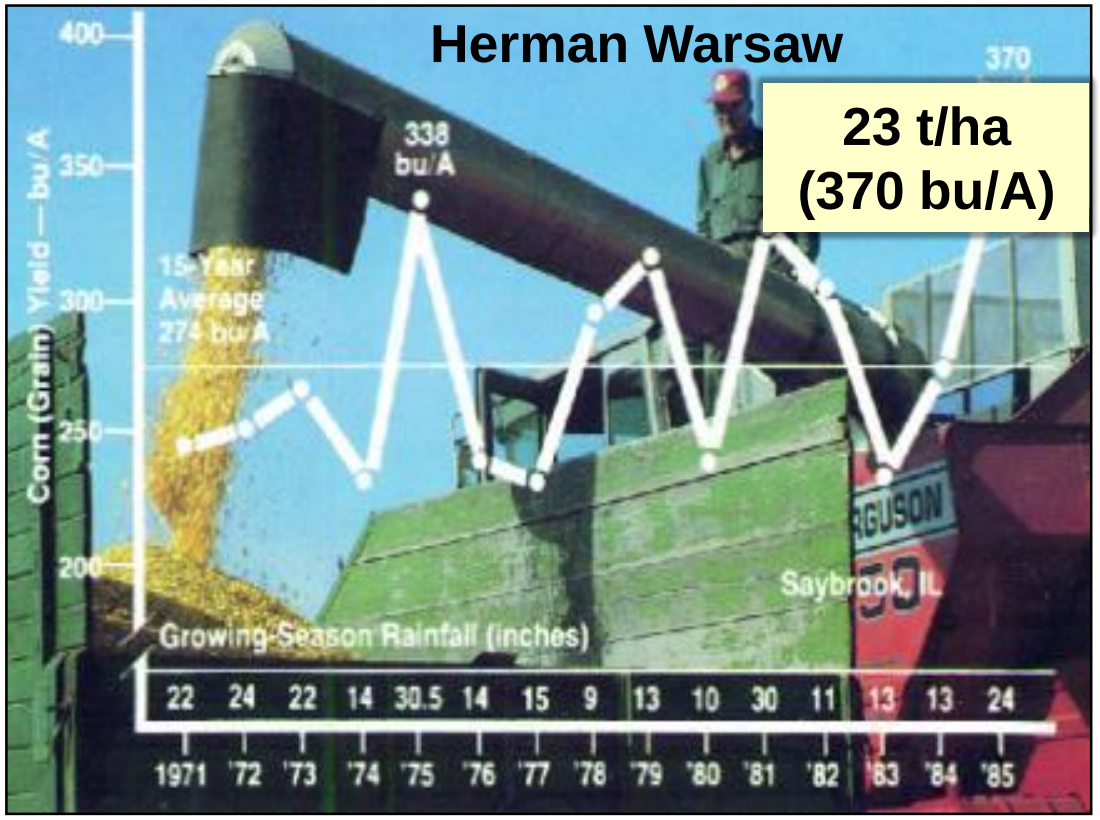
1980s: MYR Theme

Top corn yields from researchers (1982)

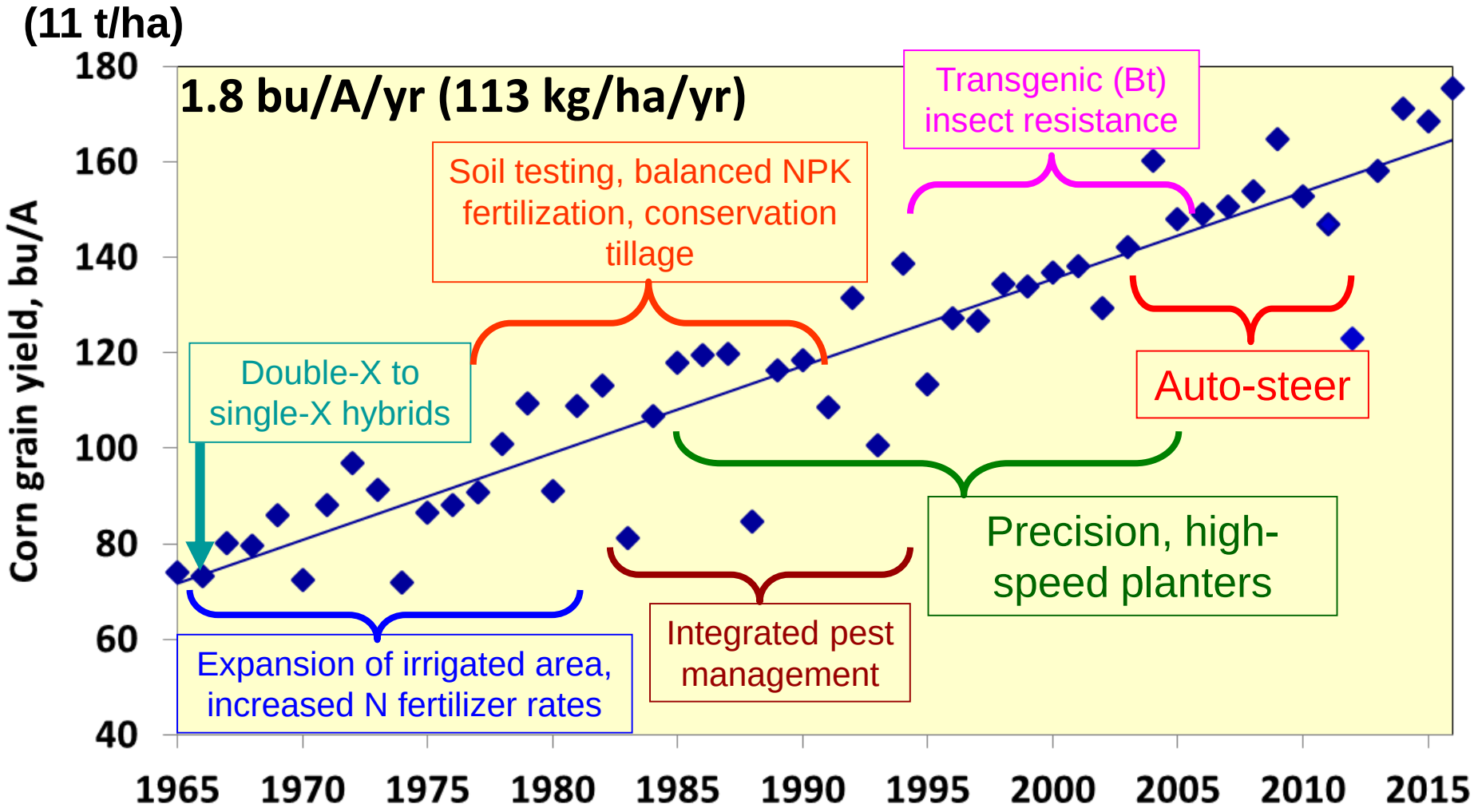
Dr. Roy Flannery
New Jersey

Dr. Sterling Olsen
Colorado

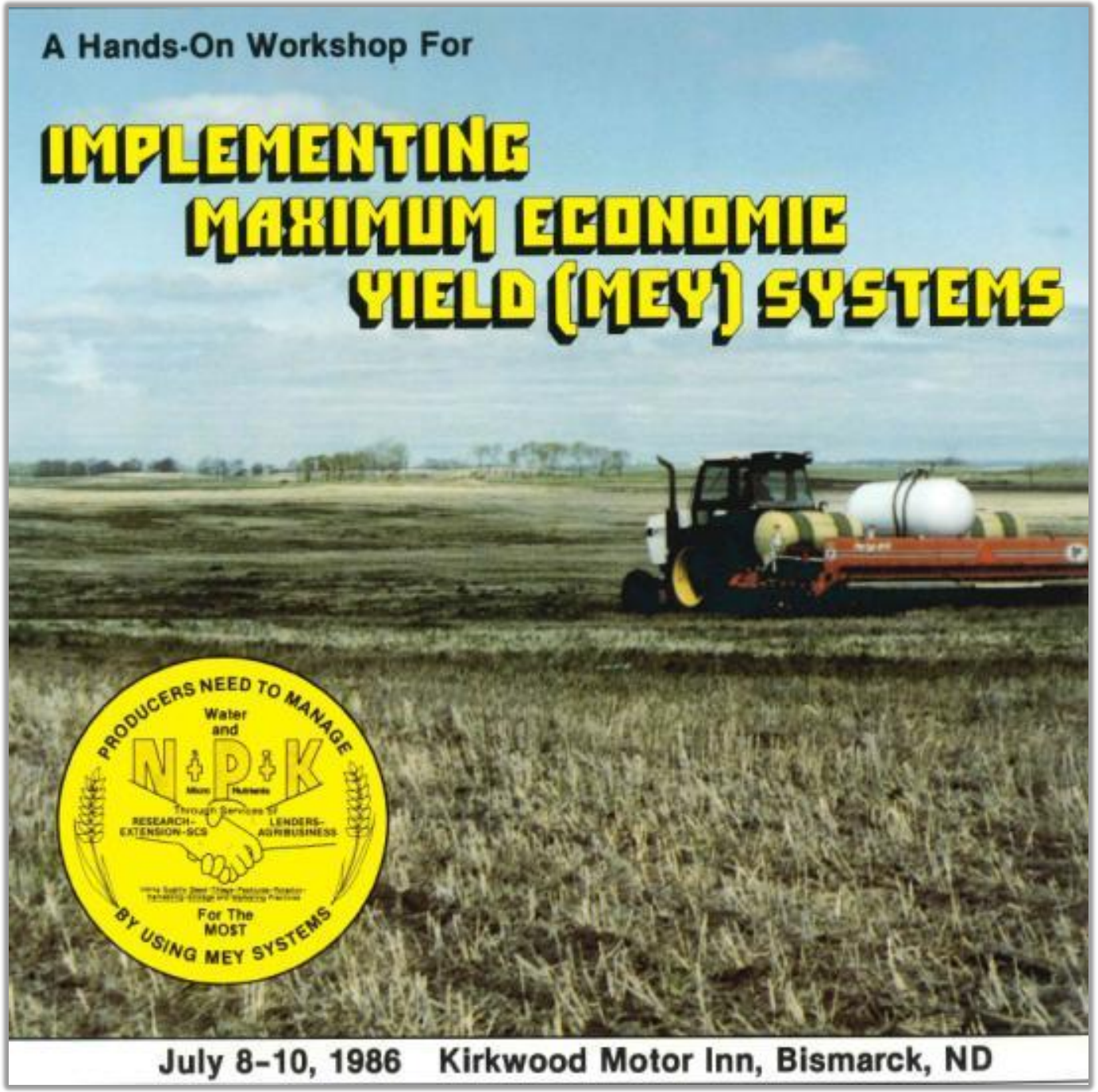
21 t/ha (334 bu/A)



US Average Corn Yields



Updated w/ permission: Cassman et al., 2006

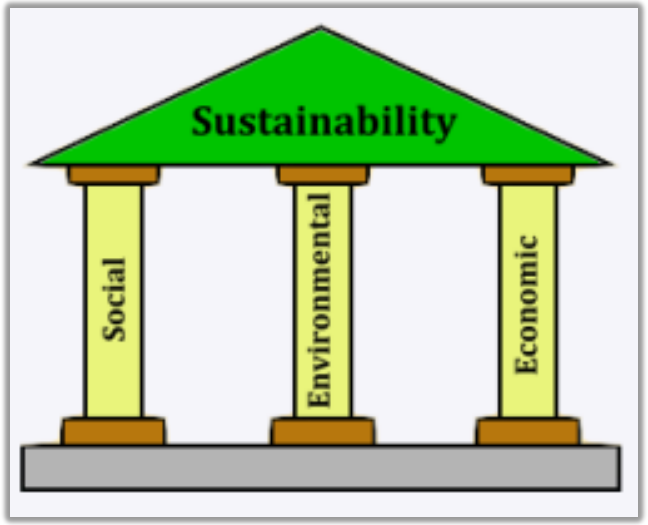


MYR

MEY

Theme

Conferences, workshops, farmer clubs, publications, cutting edge software



Late 1980s: BMP Theme

For productivity AND Environmental Advantage

BEST MANAGEMENT PRACTICES (BMPs) for CORN (GRAIN) PRODUCTION IN NORTHCENTRAL IOWA

BEST MANAGEMENT PRACTICES (BMPs) for SOYBEAN PRODUCTION IN SOUTHEAST INDIANA

BEST MANAGEMENT PRACTICES (BMPs) for HARD RED SPRING WHEAT in the NORTHERN GREAT PLAINS (MONTANA, NORTH DAKOTA, SOUTH DAKOTA)

BEST MANAGEMENT PRACTICES (BMPs) for HARD RED WINTER WHEAT IN KANSAS

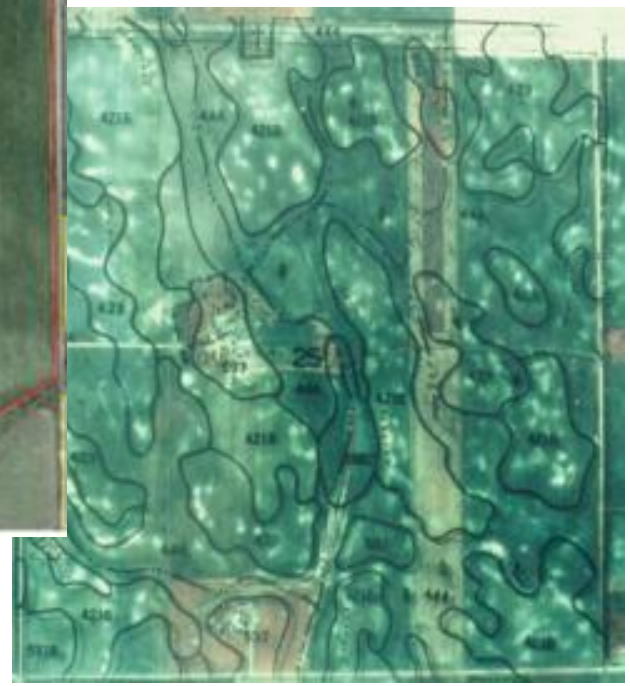
Nutrient and general agronomic practices

Selected Agronomic BMPs:

Factor	Current Practice	Recommended BMP	Environmental Advantages

Early 1990s: Site-specific Management Theme

BMP selection is based on universal principles, but resulting practices are dependent on properties & circumstances of the specific site.



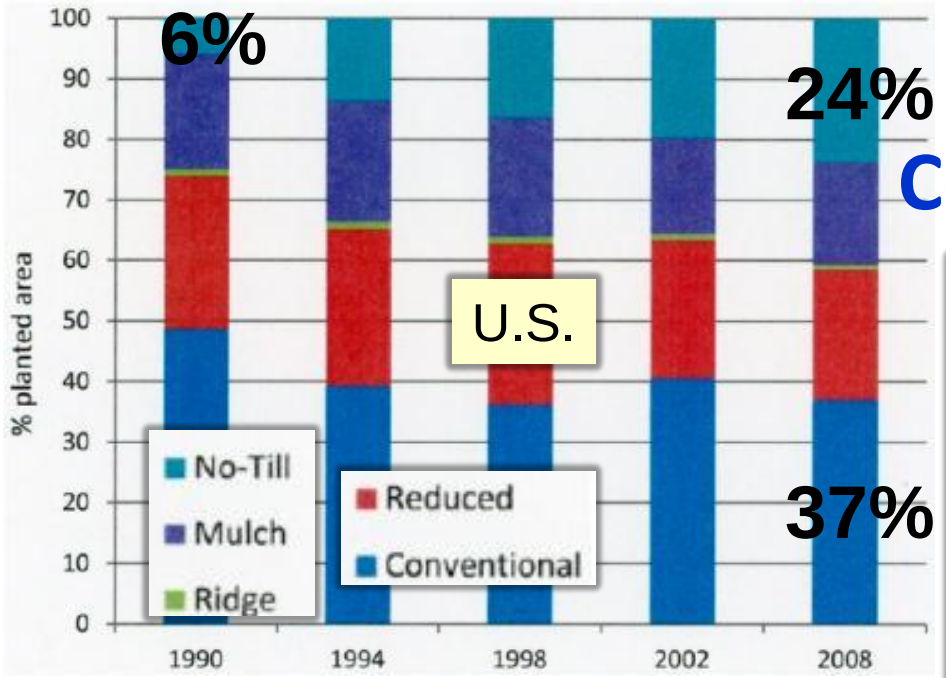
American Society of Agronomy

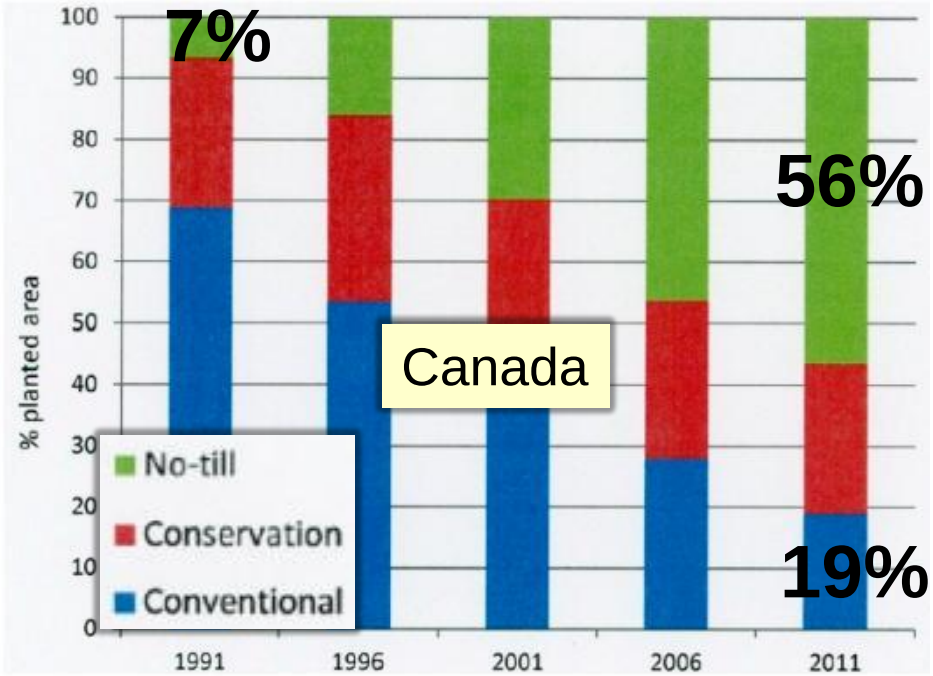
1992

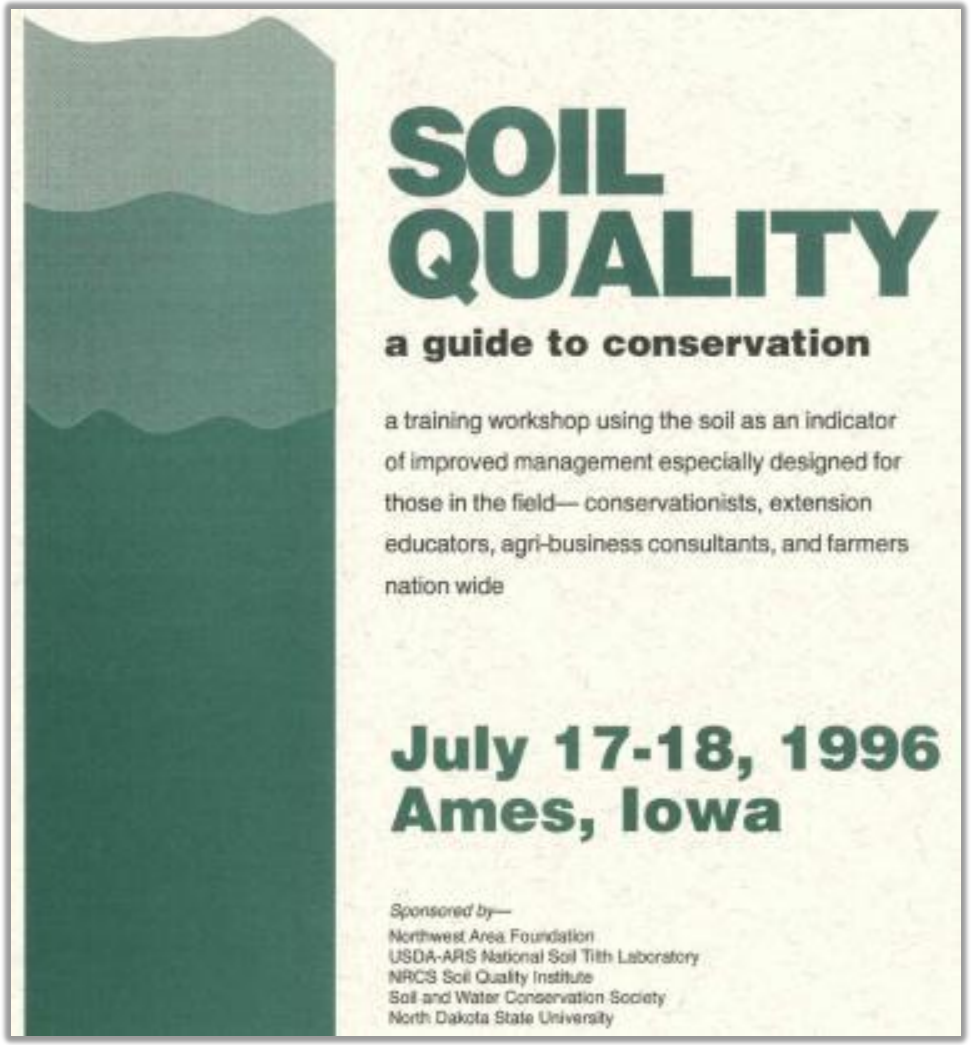
CERTIFIED CROP ADVISER

Mid 1990s: Precision ag … SSM meets Technology

1990s: Soil Quality & Conservation Tillage Theme

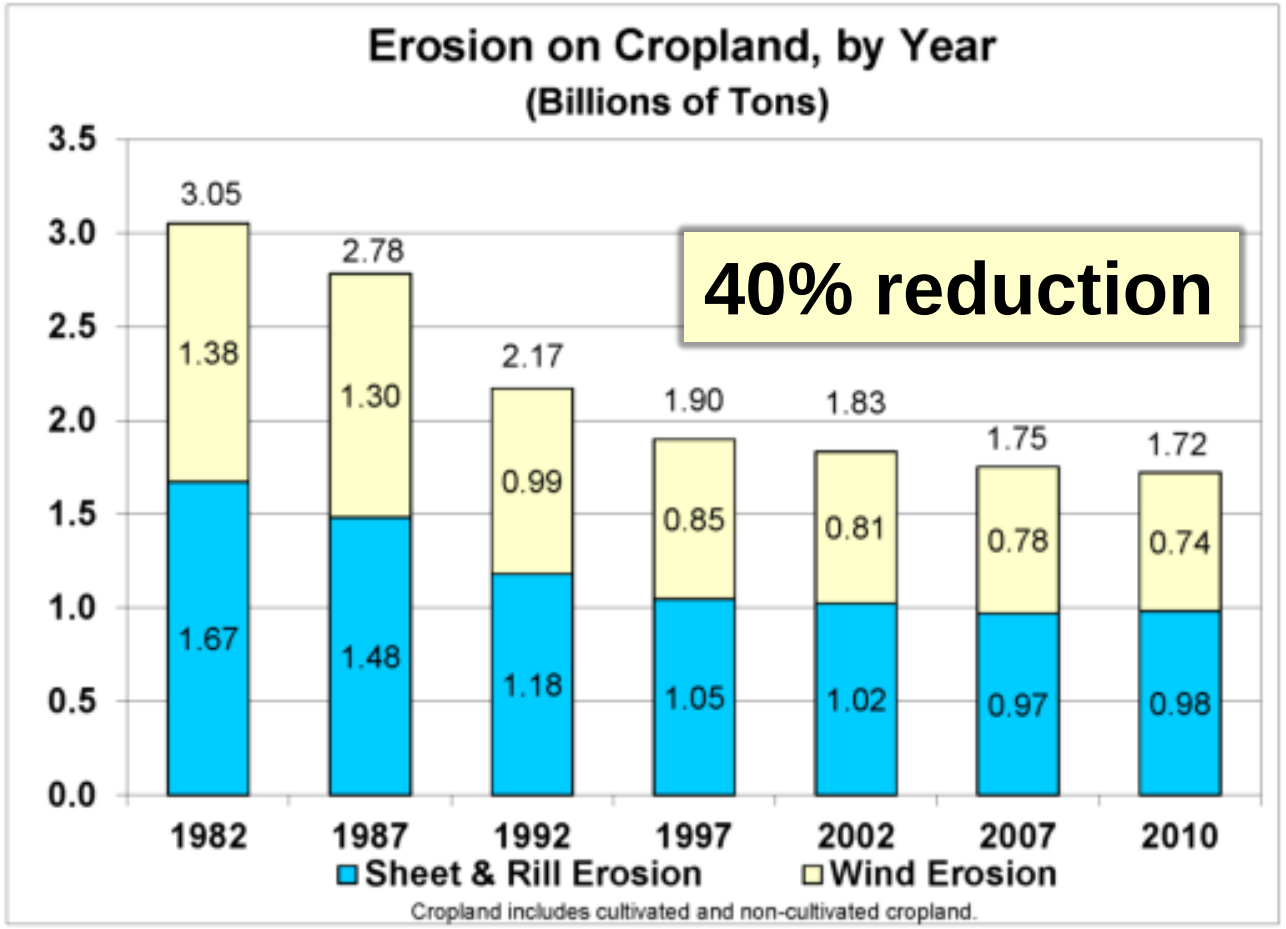






Graphs from Baumhardt et al., 2015.

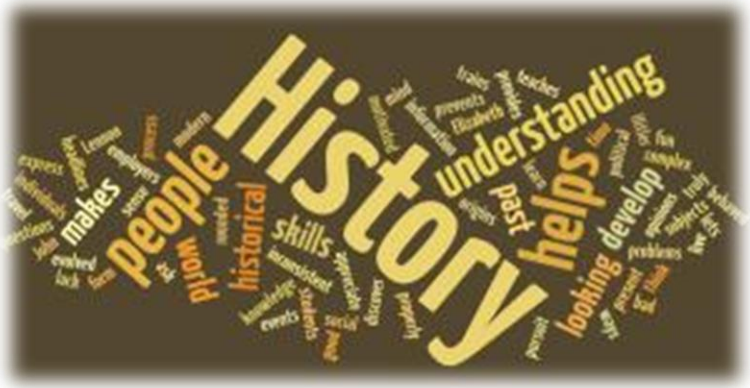
Progress in erosion reduction in the U.S.



Baumhardt et al., 2015.

35 years in 30 minutes

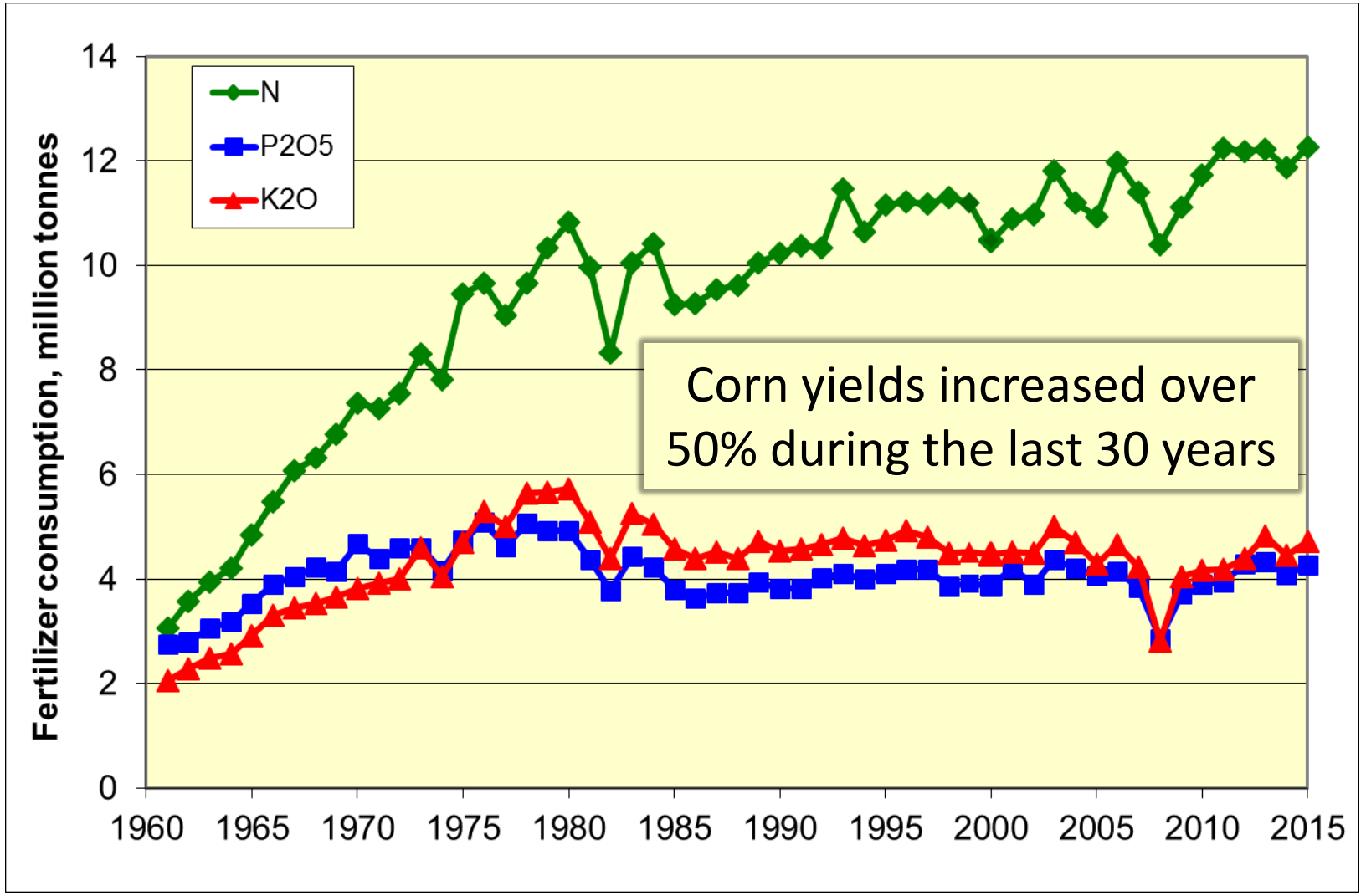
- Agronomic changes … for context



- Nutrient management changes … our history

- Where from here? … our future

Fertilizer consumption in the U.S., 1960-2015



Data Source: IFA, 2018.

Nutrient balance on US cropland

NUE Expression	1987	2012
N removal/use	0.74	0.75
N balance, lb/cropland A	19	27
P_2O_5 removal/use	0.78	0.92
P_2O_5 balance, lb/cropland A	5.2	2.2

Considers, legume fixation, recoverable manure nutrients, and fertilizer; IPNI, NuGIS (1/5/2017).

State median soil test levels and P balance in a region where use and removal are similar

	Removal /use*	Median Bray P, ppm**			
State	Average	2001	2005	2010	2015
MT	1.12	12	14	14	15
ND	1.03	10	11	11	11
SD	0.95	11	14	13	15
MN	0.95	16	18	18	21

** NuGIS: average of three periods (2001-2003, 2004-2006, and 2010-2011); fertilizer P applied plus recoverable manure P.*

*** IPNI Soil Test Summary (*http://soiltest.ipni.net*).*

Replacing P removed in harvested portions of crops maintained soil P as indicated by soil tests

Significant challenges remain

Watershed (2012)	Lower Rock (IL)	Black (NC)
	lb P_2O_5/cropland acre	
Fertilizer	27	26
Recoverable manure	3	209
Crop removal	46	36
Net balance	**-16**	**199**

Decoupling of livestock & crops

manure tech

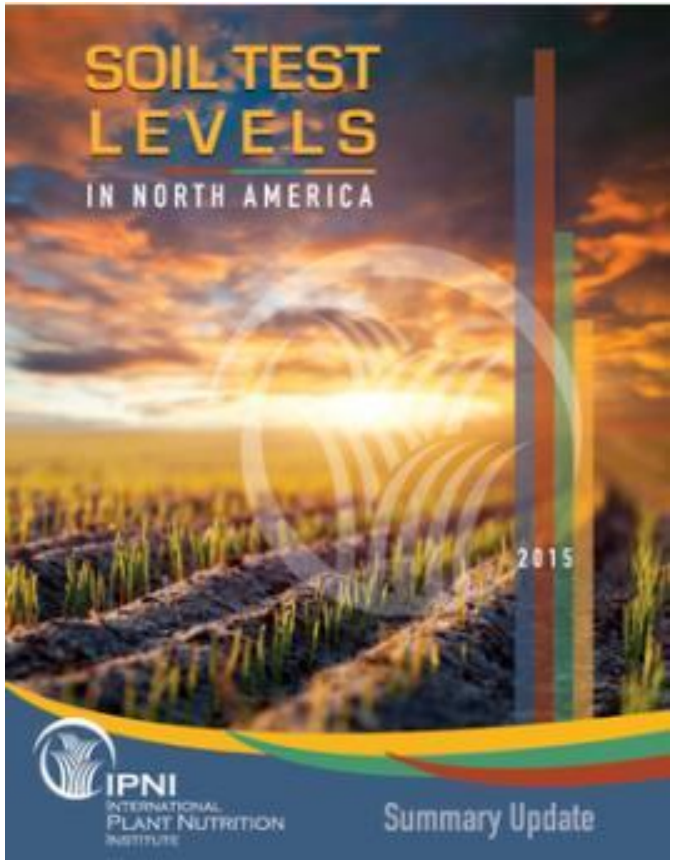
Emphasis on knowing nutrient balances and soil test levels … & how they're changing

IPNI

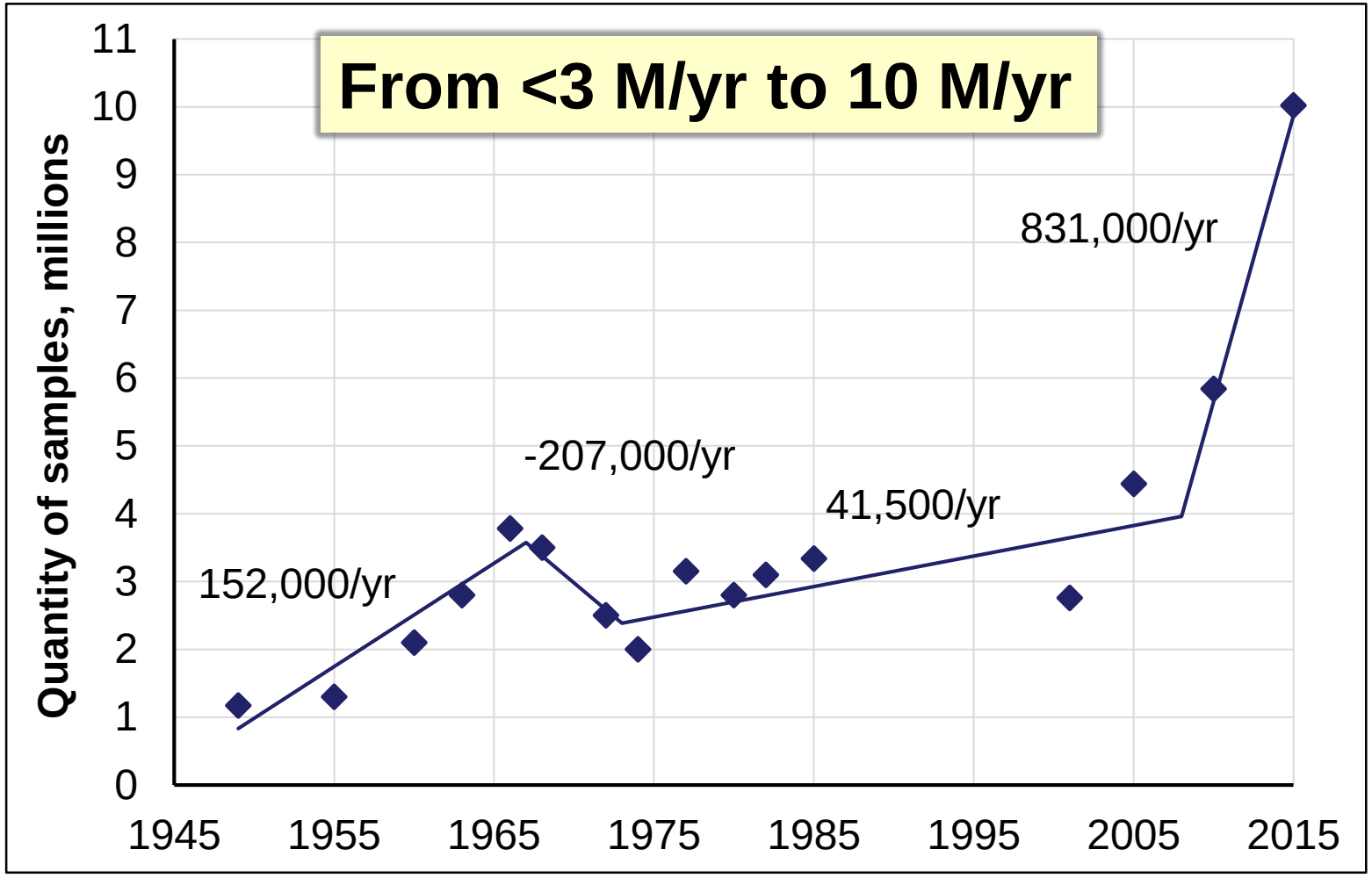
NuGIS
Nutrient Use Geographic Information System

Home | Methods | Discussion | Applications | References | Interactive Map

Visit the Interactive Map



Progress in soil testing in the U.S. 1949-2015



Nutrient use has never been as measurement-guided as it is today

webinar@ipni.net

1 CEU
Nutrient Management
Approved!

IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

WEBINAR SERIES

Join us for a FREE

WEBINAR

DATE: **Wednesday, January 10, 2018**
10AM Central Standard Time (U.S.)

SPEAKER: **Dr. Heidi Peterson**
Director, Phosphorus Program

TOPIC: **Meeting Water Quality Nutrient Reduction Goals with Watershed and Farm-scale P Balances**

Today **4R Nutrient Stewardship**

2000s **Balanced nutrition & NUE**

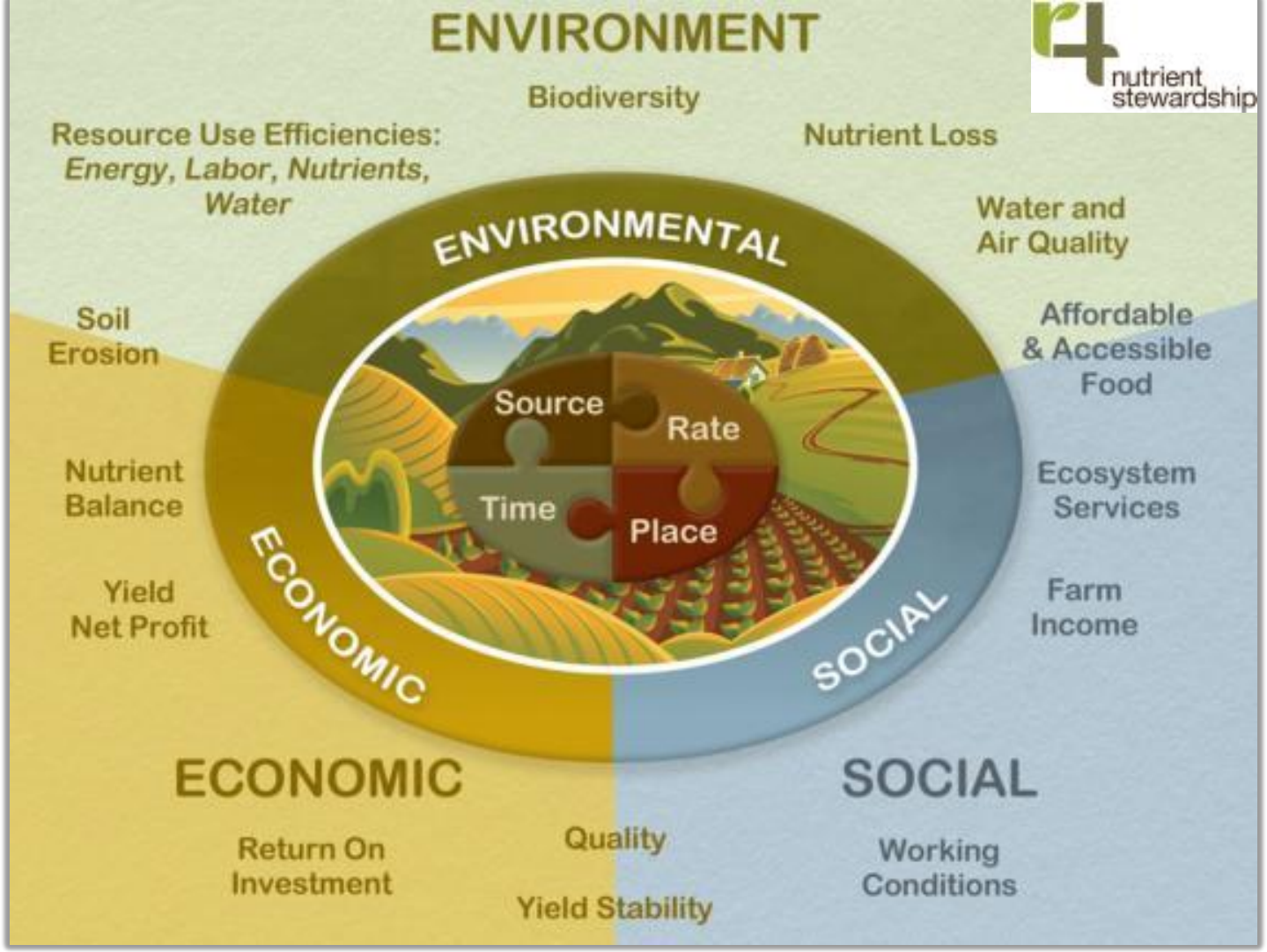
Mid 1990s **Soil quality & conserve. til.**

Mid 1990s **Precision ag**

Early 1990s **Site-specific management**

Late 1980s **Sustainability & BMPs**

1980s **MYR MEY**



- Global framework for nutrient BMPs within well managed systems
- Applying the right nutrient **source** at right **rate, time,** and **place**
- Where right is determined by impact on sustainability performance

Future holds promise … advances in technology

… require calibration data or data synthesis for appropriate use & to inform stake holders

35 years in 30 minutes

- Agronomic changes … for context

- Nutrient management changes … our history

Alan Kay

(computer scientist)

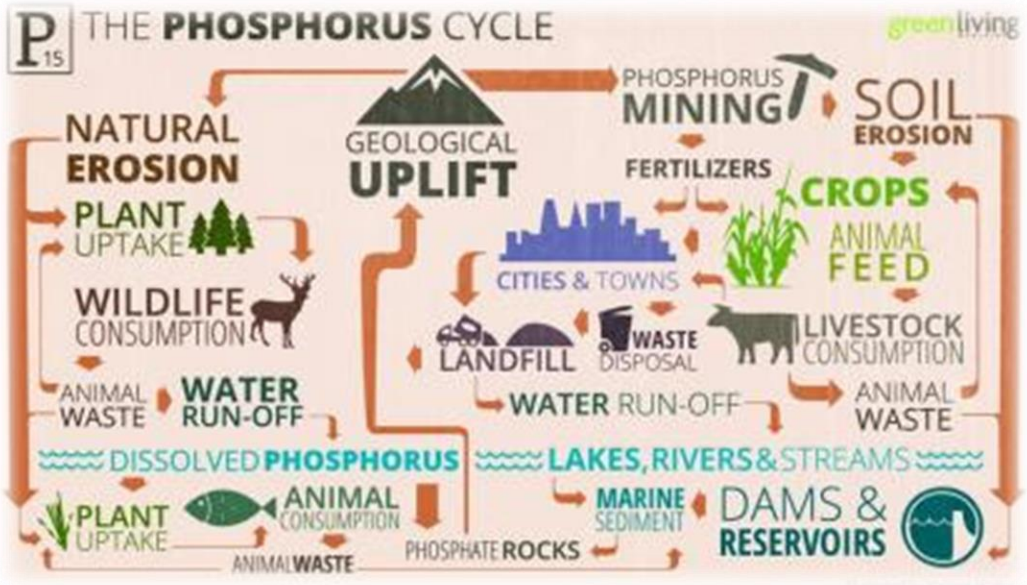
- Where from here? … our future

Sustainable Phosphorus Alliance

A diverse group that is engaged & collaborative

Mission: to be North America's central forum and advocate for the sustainable use, recovery, and recycling of phosphorus in the food system.

My remarks: just one aspect of that mission … what happens within the confines of farm fields.



Leads us to: **"Evidence-based science"**

- Viewing **data** as a primary product of science that **GROWS in value** with accessibility & with time
- Seeing each new research contribution as a **CONTINUATION of the discovery process**, not just as an independent event
- Involves data set publishing, data repositories, systematic reviews, meta-analysis, etc.

Measurement of Gravitational Waves

- Distortions in “spacetime” resulting from huge shifts in mass somewhere in the universe.
- Predicted by Einstein in 1916.

2017 Nobel Prize in Physics

NASA/CXC/GSFC/T. Strohmayer

- On 9/14/2015 the impact on space-time was **MEASURED** on Earth … Einstein in 1916 was right!

From prediction to reality: a history of the search for gravitational waves

1915 - Albert Einstein publishes general theory of relativity, explains gravity as the warping of spacetime by mass or energy

1916 - Einstein predicts massive objects whirling in certain ways will cause spacetime ripples—gravitational waves

1936 - Einstein has second thoughts and argues in a manuscript that the waves don't exis

196 opti

wav

196 aluminum cylinders—replication efforts

1972 - Rainer Weiss of the Massachuset independently proposes optical method

1974 - Astronomers discover pulsar orb down due to gravitational radiation—wo

1979 - National Science Foundation (NS Pasadena and MIT to develop design for

- Science progresses incrementally – each contribution needs to connect to the past & the future
- Each viewed as part of the whole

1996 - Construction starts on VIRGO gravitational wave detector in Italy taking data in 2007

2002–2010 - Runs of initial LIGO—no detection of gravitational waves

2007 - LIGO and VIRGO teams agree to share data, forming a single glo gravitational wave detectors

2010–2015 - $205 million upgrade of LIGO detectors

2015 - Advanced LIGO begins initial detection runs in September

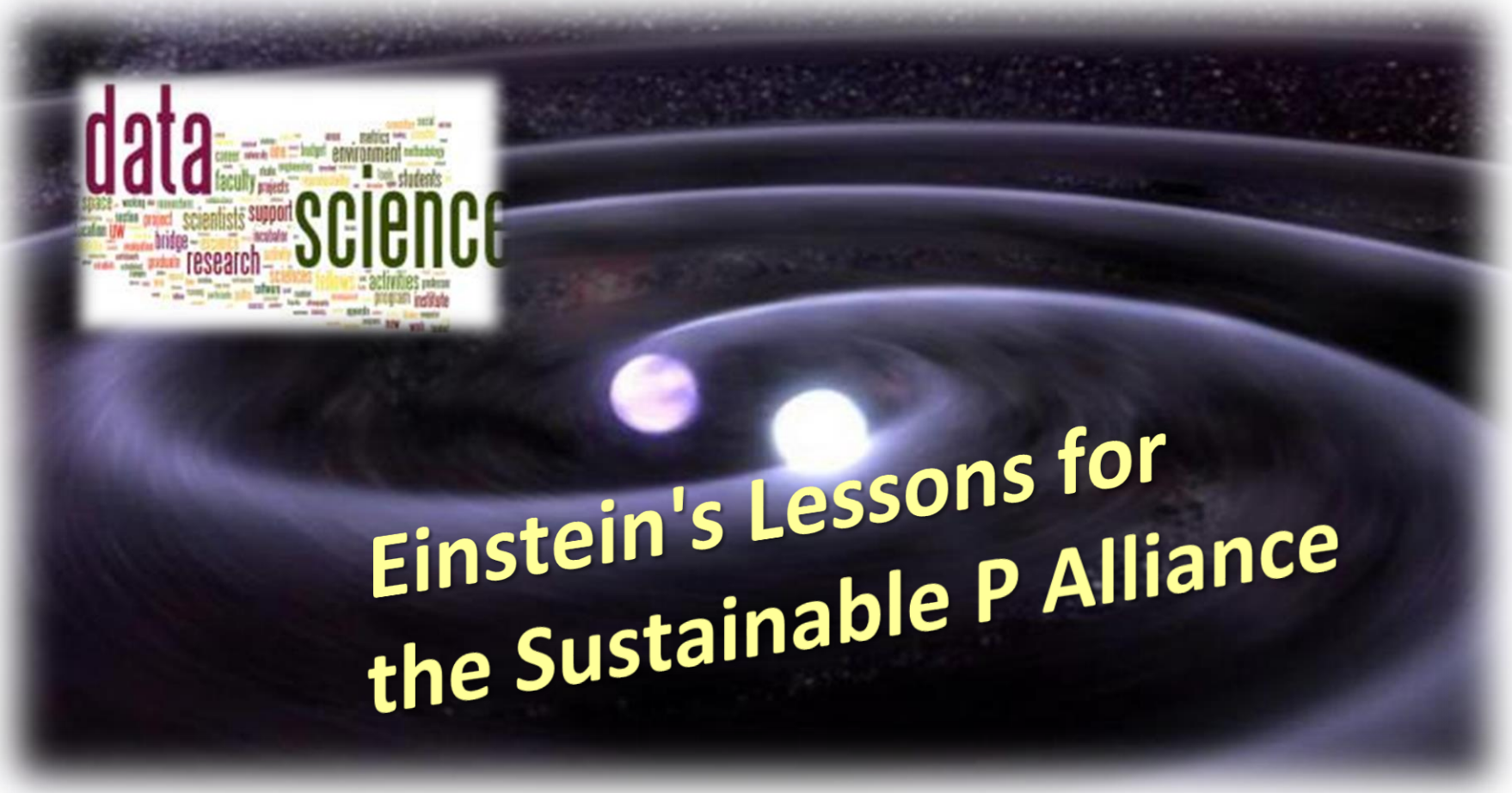
2016 - On 11 February, NSF and LIGO team announce successful detecti waves

Source: Science Magazine

PRL 116, 061102 (2016) Selected for a Viewpoint in *Physics* PHYSICAL REVIEW LETTERS week ending 12 FEBRUARY 2016

Observation of Gravitational Waves from a Binary Black Hole Merger

B. P. Abbott *et al.**



- **Lesson 1:** Science advances incrementally – studies need to connect.
- **Lesson 2:** Collaboration and data sharing are powerful.

Retirement: When an institutional mission gets replaced by a personal mission

Data stewardship and evidence-based science have become part of my own personal mission

Sustainable Phosphorus Alliance

Mission: to be North America's central forum and advocate for the sustainable use, recovery, and recycling of phosphorus in the food system.

My advice … that you view:

- **Shared accessible data** as primary output of your efforts and an avenue for increased collaboration
- **Evidence-based management** of the P cycle as your target

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Sustainable Phosphorus Alliance

Phosphorus Forum 2018

Regulatory Challenges for Recycling Phosphorus in Organic Residuals

Ned Beecher

Executive Director

North East Biosolids and Residuals Association (NEBRA)

nebra
North East Biosolids & Residuals Association

Topics to Be Covered

- Why biosolids are recycled
- Biosolids & P regulations: federal & state
- P dynamics & where state regulations present challenges
- How to impove state regulations
- Supplementary materials (see online PDF of these slides)

Why biosolids are recycled

Options for Organic Waste Management

Organic Waste

Garbage Disposal

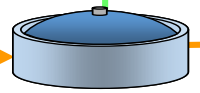
Wastewater Treatment

Onsite Composting

Solids Separation

Biogas

Biosolids



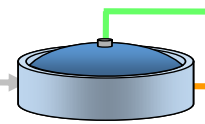
Anaerobic Digestion

Materials Recycling Facility

Solids Separation

Biogas

Biosolids



Amendment

Composting Facility

Compost

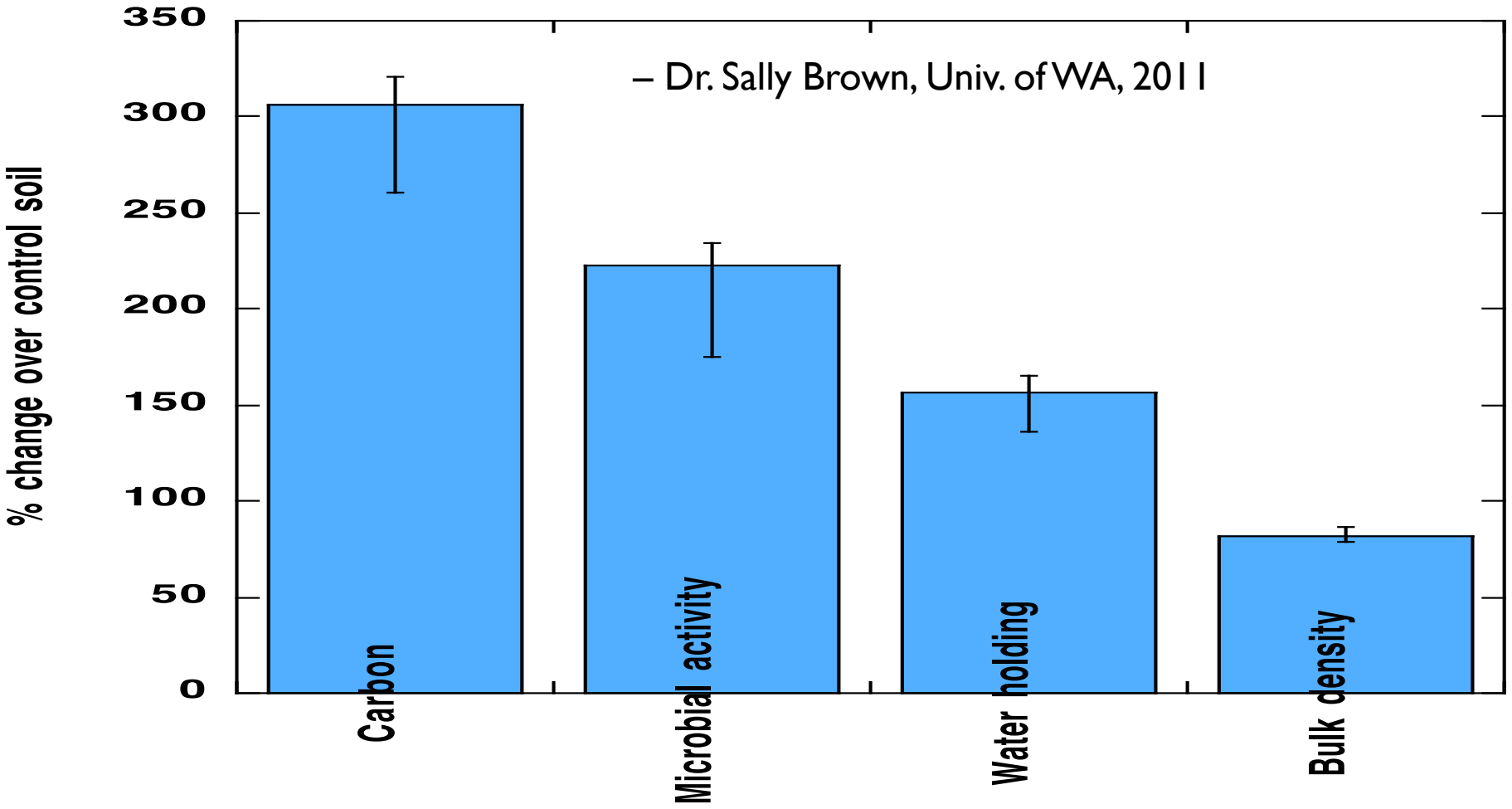
Waste to Energy

Electricity

Landfill

Biogas

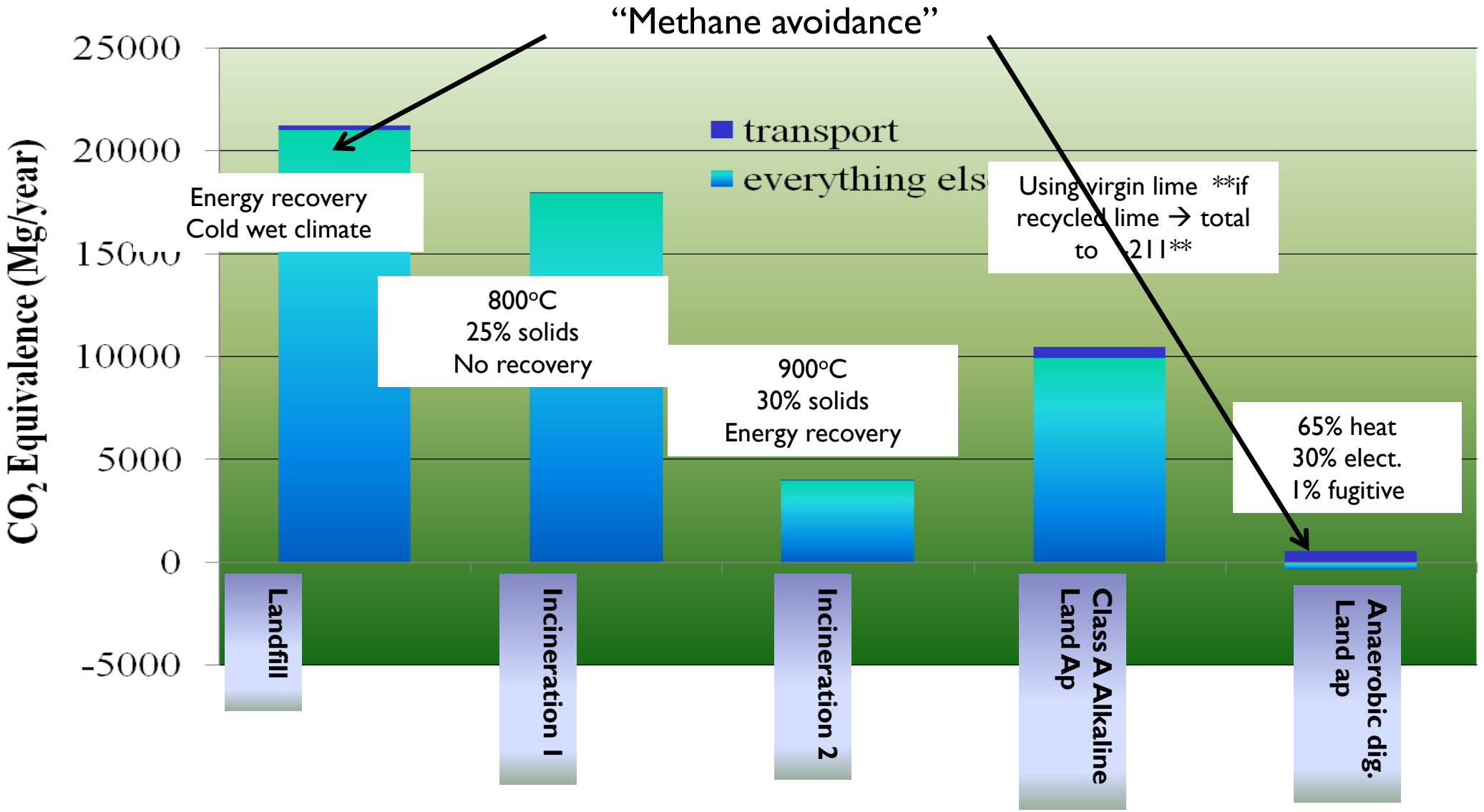
…demonstrated & researched benefits of using biosolids:



Numerous studies demonstrate the benefits derived from adding organic matter, such as biosolids, to soils: higher carbon content (carbon sequestration), increased microbial activity, increased water-holding capacity, and lower bulk density (which means easer tillage & handling).

Evaluating GHG emissions from different use / disposal of biosolids:

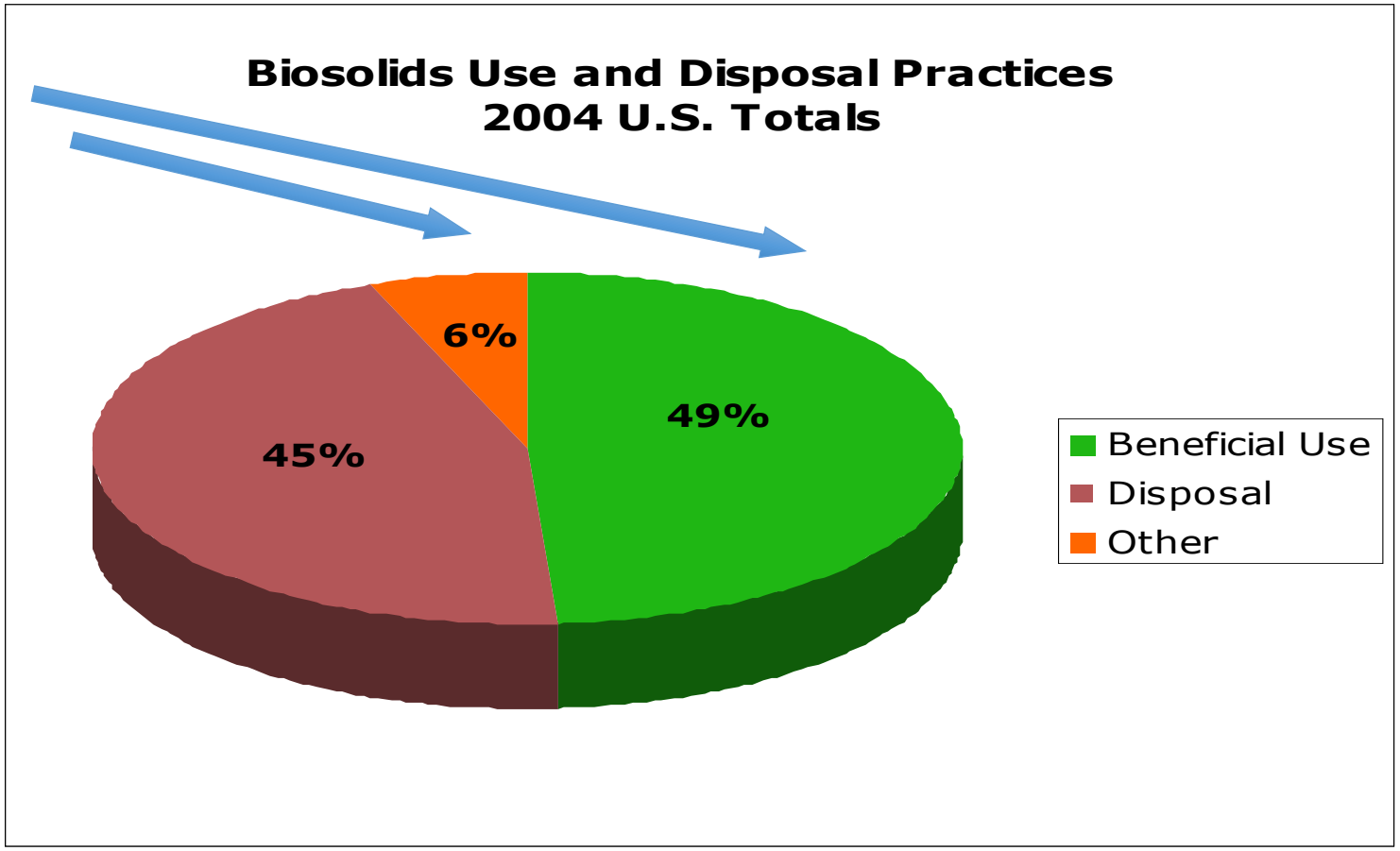
Lowest GHG emissions are from anaerobic digestion followed by use on soils.



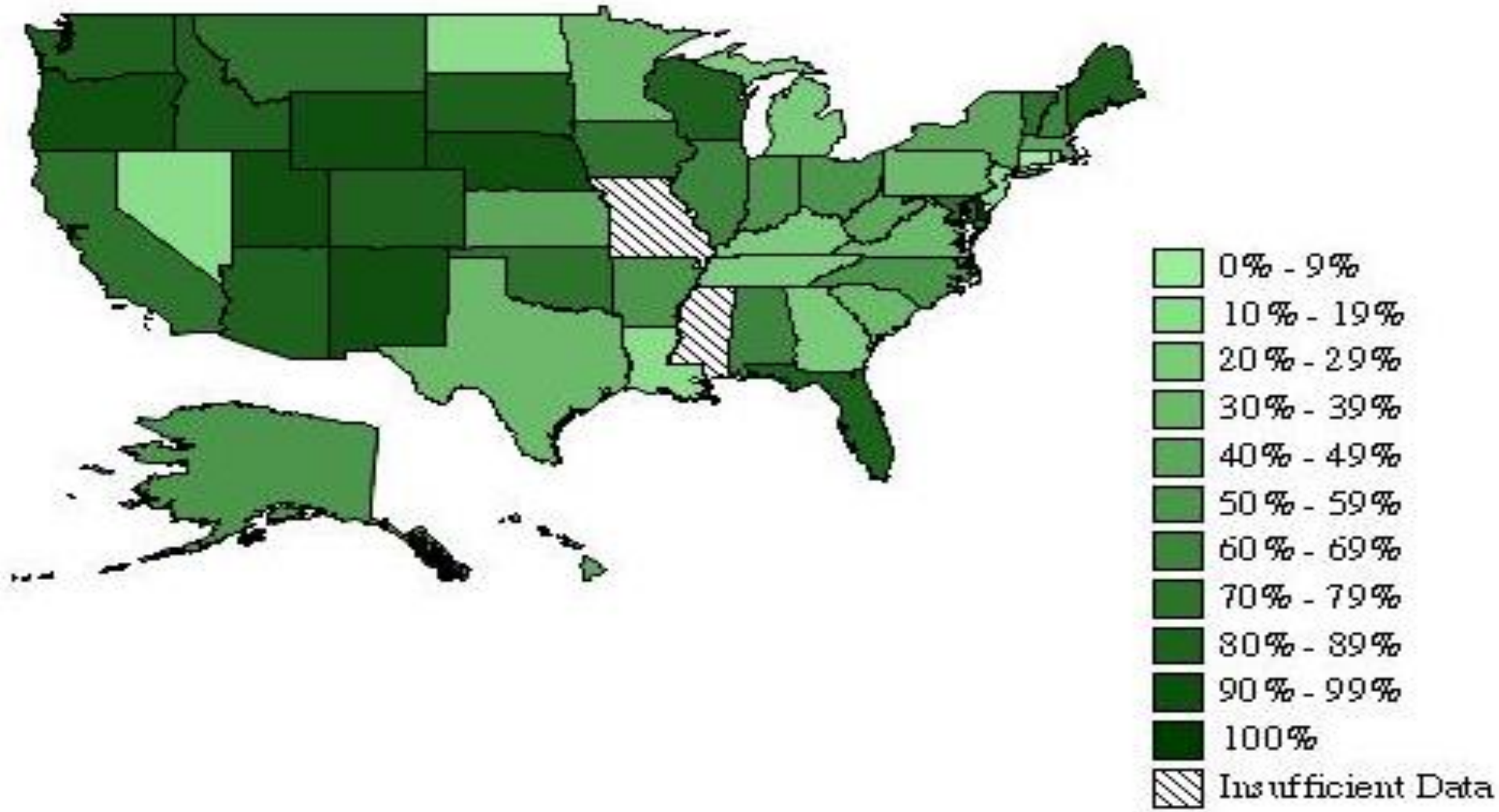
USA total wastewater solids:

7,180,000 dry U. S. tons/year (~35.9 million wet tons)

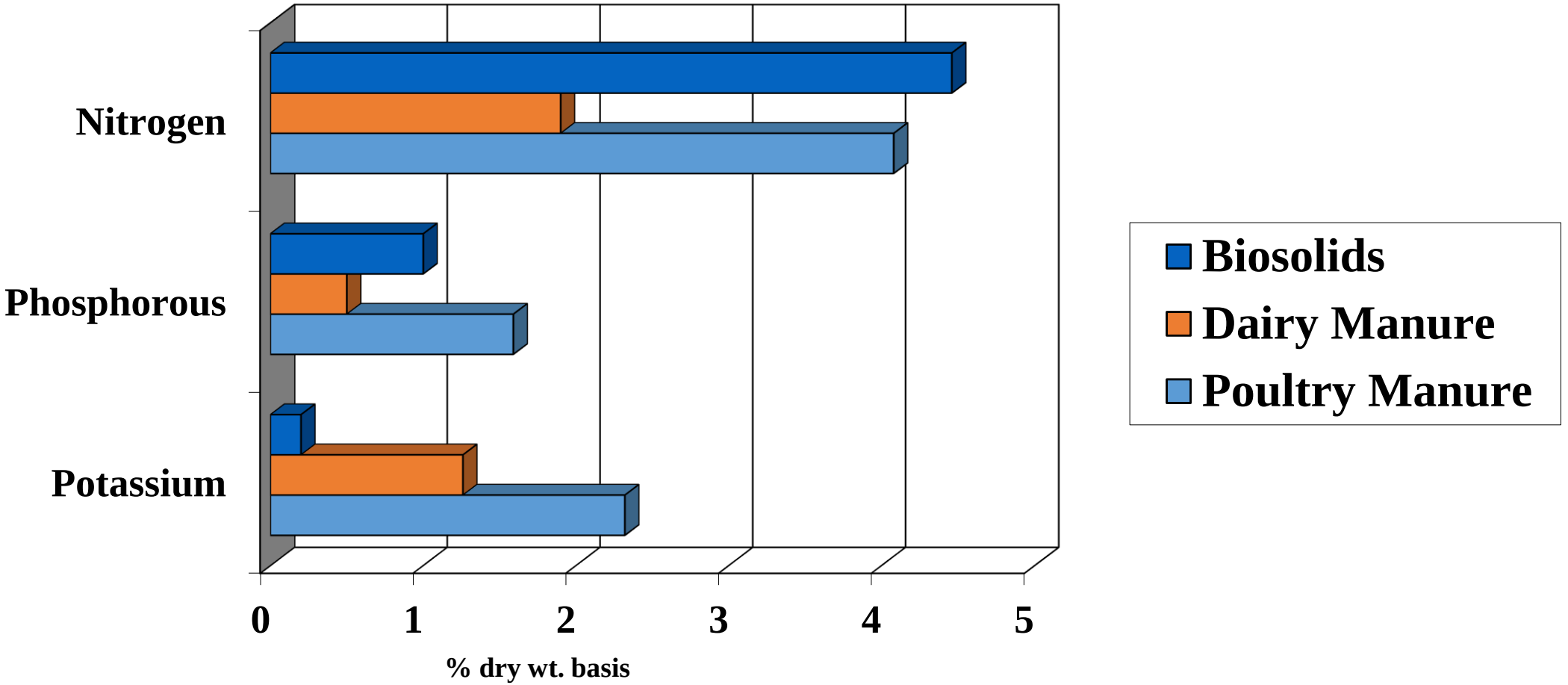
55% is used on soils



Percent Biosolids Beneficially Used by State, 2004



Nutrient Content of Manure and Biosolids



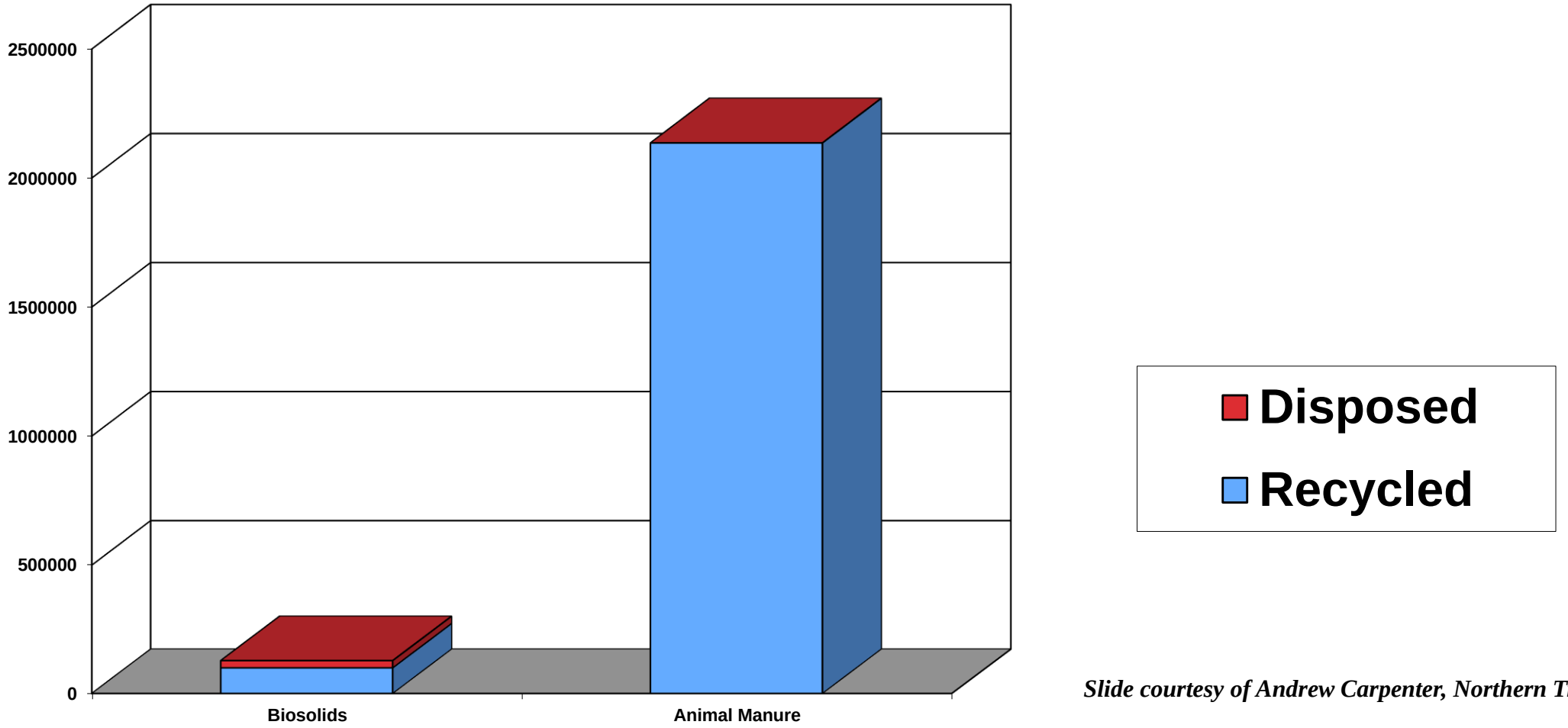
Biosolids values from The Use of Biosolids in Maine: A Review (report by the Mitchell Center)

Manure Values calculated using median values from the 2010 University of Maine Analytical Lab manure analysis summary report

Biosolids vs. Manure Volumes (Maine data; similar throughout U. S.)

And remember, there are other residuals with similar trace contaminants & pathogens…

Wet tons generated annually



Slide courtesy of Andrew Carpenter, Northern Tilth

Types of recycled residuals & their relation to P

- Biosolids - excess P in organic and mineral forms
- Manures - excess P in organic and mineral forms
- Composts – moderate P in organic and mineral forms
- Digestates - moderate P in organic and mineral forms

Increasing volumes as organic wastes are banned from landfills.

- Wastewater solids incinerator ash:
  - research on P value
  - minimal use (except in Germany)

Residuals used to reduce P availability / bind P *in situ*, in soil:

- Hydrosolids – water treatment residuals (WTR)
- Other residuals (e.g. gypsum)

Biosolids & P regulations: federal & state

Federal regulations: U. S. EPA 40 CFR Part 503

Standards for the Use and Disposal of Sewage Sludge

- Became effective in February 1993
- Minimum requirements for three management options: Land application, Incineration, Surface disposal
- Self-implementing rule - Federally enforceable without a permit
- Essentially all states have adopted Part 503 or something more restrictive
- Choice of use or disposal practice is a local decision.
- Requirements focus on the generator/preparer, user, & disposer and "are designed to work together to protect human health and the environment"
  - General requirements
  - Numerical limits for certain pollutants (e.g. "heavy metals")
  - Management practices
  - Operational standards
  - Monitoring
  - Recordkeeping
  - Reporting
- **Addresses P tangentially through requirement to apply Class B / bulk biosolids at agronomic rate (commonly based on N, not P)**

Federal regulation: Food Safety Modernization Act

Produce Safety (2016 – 2017)

- Applies to manures, biosolids – concerns with pathogens
- Reclaimed water & biosolids must be applied in accordance with EPA Part 503 and similar standards.
- Manures must be managed with similar safeguards as biosolids.
- Reasonable.
- Protective.
- Challenging for farms.

FDA Food Safety Modernization Act (FSMA)

SHARE TWEET LINKEDIN PIN IT EMAIL PRINT

Sign-Up for FSMA Email Updates

About 48 million people in the U.S. (1 in 6) get sick, 128,000 are hospitalized, and 3,000 die each year from foodborne diseases, according to recent data from the Centers for Disease Control and Prevention. This is a significant public health burden that is largely preventable.

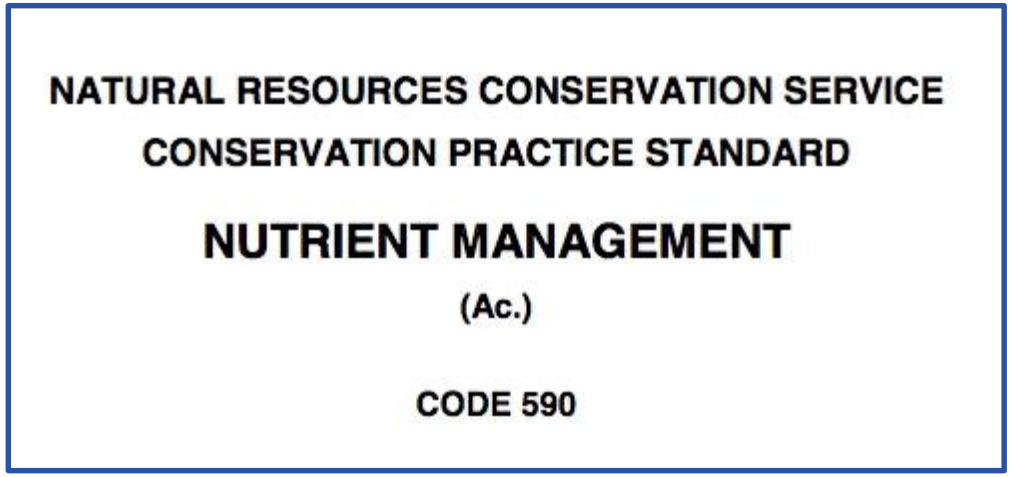
The FDA Food Safety Modernization Act (FSMA) is transforming the nation's food safety system by shifting the focus from responding to foodborne illness to preventing it. Congress enacted FSMA in response to dramatic changes in the global food system and in our understanding of foodborne illness and its consequences, including the realization that

Spotlight

Federal guidance: USDA NRCS Code 590

Nutrient Management (January 2012)

- Applies to all nutrients – fertilizers, manures, biosolids, etc.
- Driving farm nutrient management planning
- Not regulatory, but required for many farm support programs & grants (EQIP, etc.)
- Adopted & tailored by most states


NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT

(Ac.)

CODE 590

Decades of efforts on nutrient management
→ mostly guidance until recently

- Agricultural nutrient management planning
  - Early focus on N (leaching / groundwater), then focus on P (runoff / surface water)
  - NRCS Code 590 – last updated in January 2012, incorporated biosolids in 2011
  - Recent state examples: MD & VT efforts to reduce P to Chesapeake & Lake Champlain
- State turf & lawn fertilizer regulations – past ~10 years
  - Focused mostly on P
  - Key provision: soil test must show need before P is applied
  - ~16 states in Mid-west & Northeast, also WA
  - Some exempt biosolids, some exempt agriculture
  - New England Interstate Water Pollution Control Commission (NEIWPCC)→ model state regulation

NEIWPCC
New England Interstate Water Pollution Control Commission

State regulations restricting P

- States generally have jurisdiction for fertilizer regulation and AAPFCO* tries to establish consistency
- These regulations prohibit application to
  - impervious surfaces
  - frozen or snow-covered ground
  - during specified winter months (seasonal restrictions)
  - and unless soil test shows need
- Some restrict retail sales of P-containing fertilizers
- Signage and/or labeling requirements

*American Association of Plant Food Control Officials, http://www.aapfco.org/

Healthy Lawns – Healthy Water

Use Zero-Phosphorus Lawn Fertilizer!

It's the Law!

Phosphorus runoff poses a threat to water quality. Therefore, under Massachusetts Law, phosphorus-containing fertilizer may only be applied to lawn or non-agricultural turf when:

- a soil test indicates that additional phosphorus is needed for the growth of that lawn or non-agricultural turf; or
- is used for newly established lawn or non-agricultural turf during the first growing season.

Most lawns in Massachusetts do not need additional phosphorus for healthy growth.

Look for the "Zero" to Protect Our Waters

Check the fertilizer bag for a set of three numbers representing the percentage of nitrogen (N), phosphorus (P) and potassium (K).

Buy the bag with a "0" in the middle: Zero Phosphorus!

Visit www.mass.gov/agr for more information and resources on plant nutrient management.

MDAR
MASSACHUSETTS DEPARTMENT OF AGRICULTURAL RESOURCES

Wisconsin… early, typical state regulation

- 2009 law…
  - generally prohibits the application of fertilizer that contains P to lawns, golf courses, and other mowed grassy areas (turf).
  - does not apply to land used for agricultural production
  - does not apply to the use of manure that is mechanically dried, ground, or pelletized, or to a finished sewage sludge product (biosolids)
  - allows use of fertilizer that contains P to establish grass during the first growing season
  - allows the application of fertilizer containing phosphorus to an area if a soil test shows need

DON'T "P" IN THE LAKE!

Our pristine lakes are at risk of algae blooms and poor water quality from recent overuse of unnecessary fertilizers

Why is Phosphorus bad for our lakes?

MD's Lawn Fertilizer Law

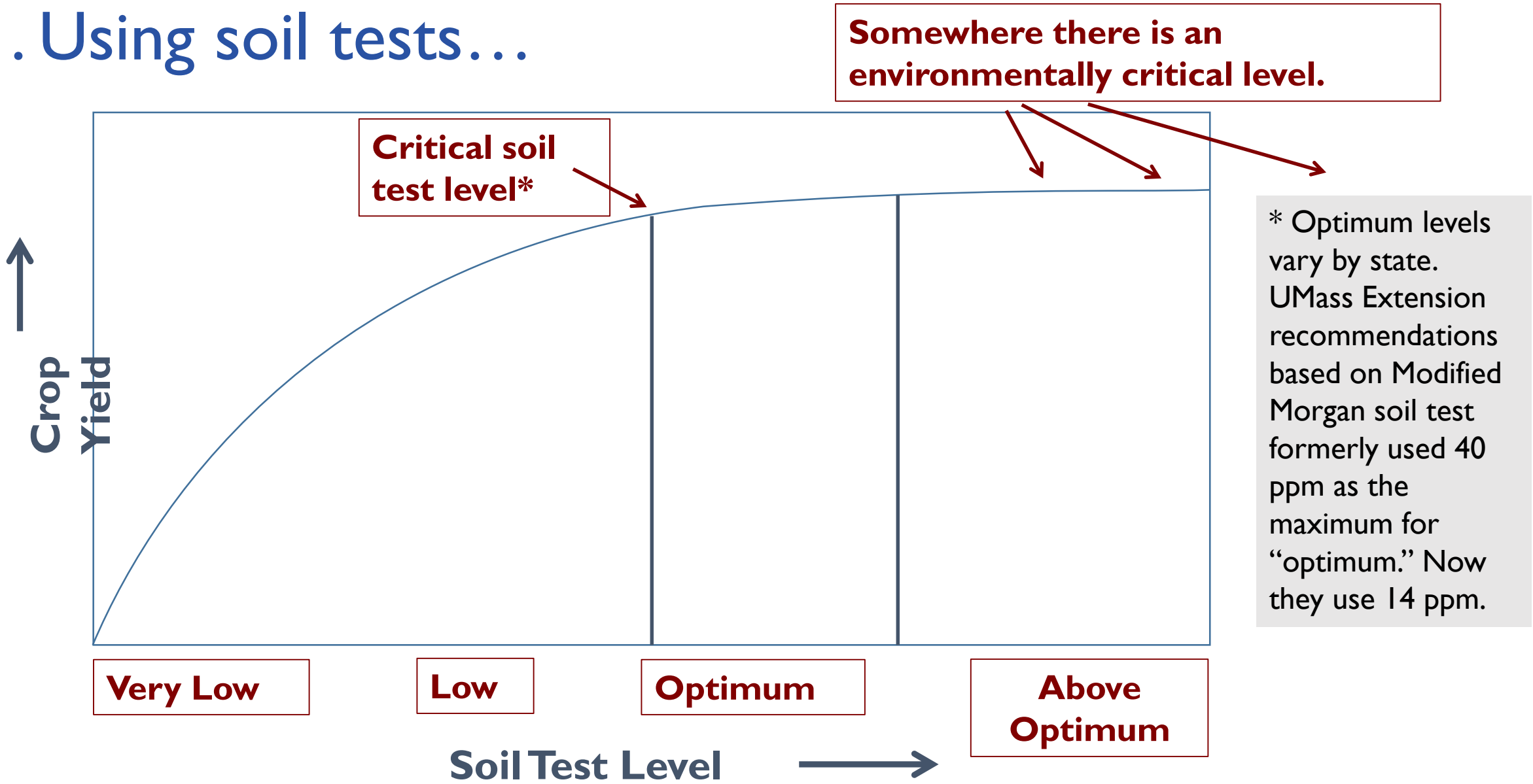
Are there regulatory barriers to recycling P in biosolids, etc.?

- U. S. EPA Part 503 – generally workable, effective for 20+ years
  - Addresses metal contaminants & pathogens
  - Does not fully address odors, nuisance factors, & best management
  - EPA interpretation: struvite recovered from biosolids is still subject to Part 503 (understandable, but a significant obstacle to P recovery & recycling)
- FDA FSMA – reasonable, no additional regulation for biosolids
- USDA NRCS Code 590 – guidance, reasonable
  - results in some reductions in biosolids & residuals applications in some cases
- State regulations: <u>Can significantly impede recovery & recycling of P</u>
  - Inconsistencies & policy conflicts from state-to-state
  - Many states focus on turf grass, which are Class A biosolids (compost, pellets) uses
  - Biosolids, composts, & other residuals are an afterthought; some exempt them

P dynamics & where state regulations present challenges

1. Using agronomic tests to assess environmental impacts
2. P source solubility / environmental relevance
3. Imbalanced P flows
4. Imbalanced nutrients in biosolids & residuals

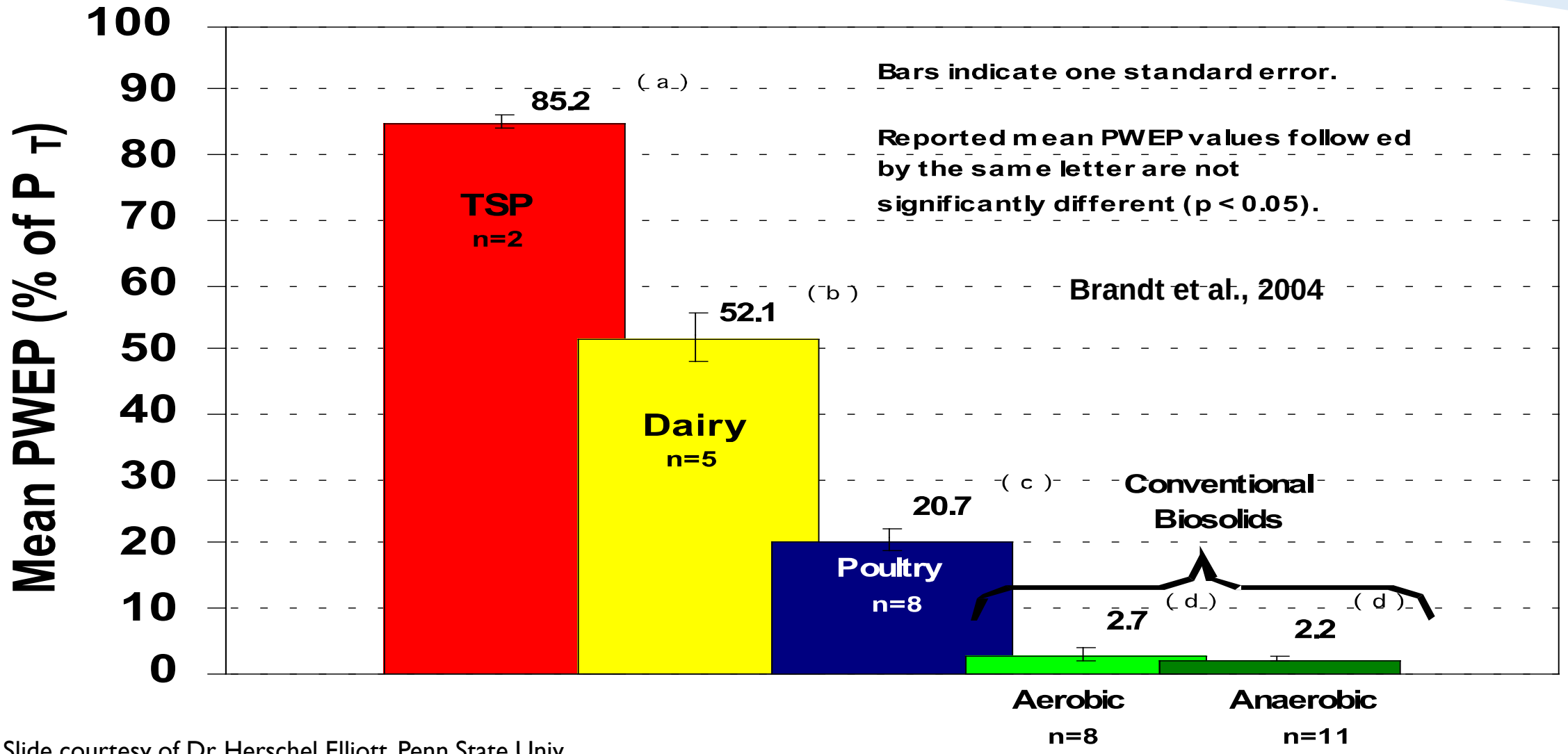
1. Using soil tests…



* Optimum levels vary by state. UMass Extension recommendations based on Modified Morgan soil test formerly used 40 ppm as the maximum for "optimum." Now they use 14 ppm.

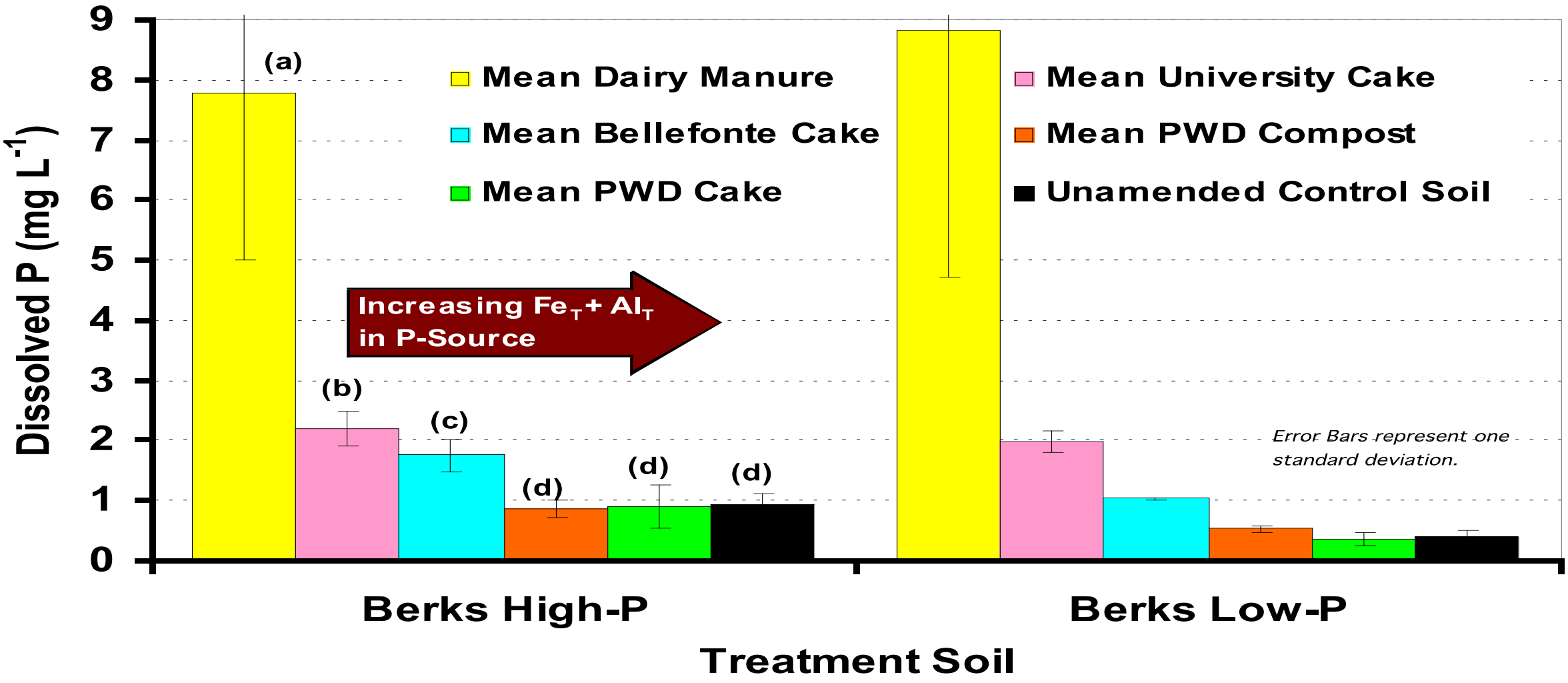
2. Source P Solubility

But bio-P behaves more liken TSP! (less Fe and/or Al)



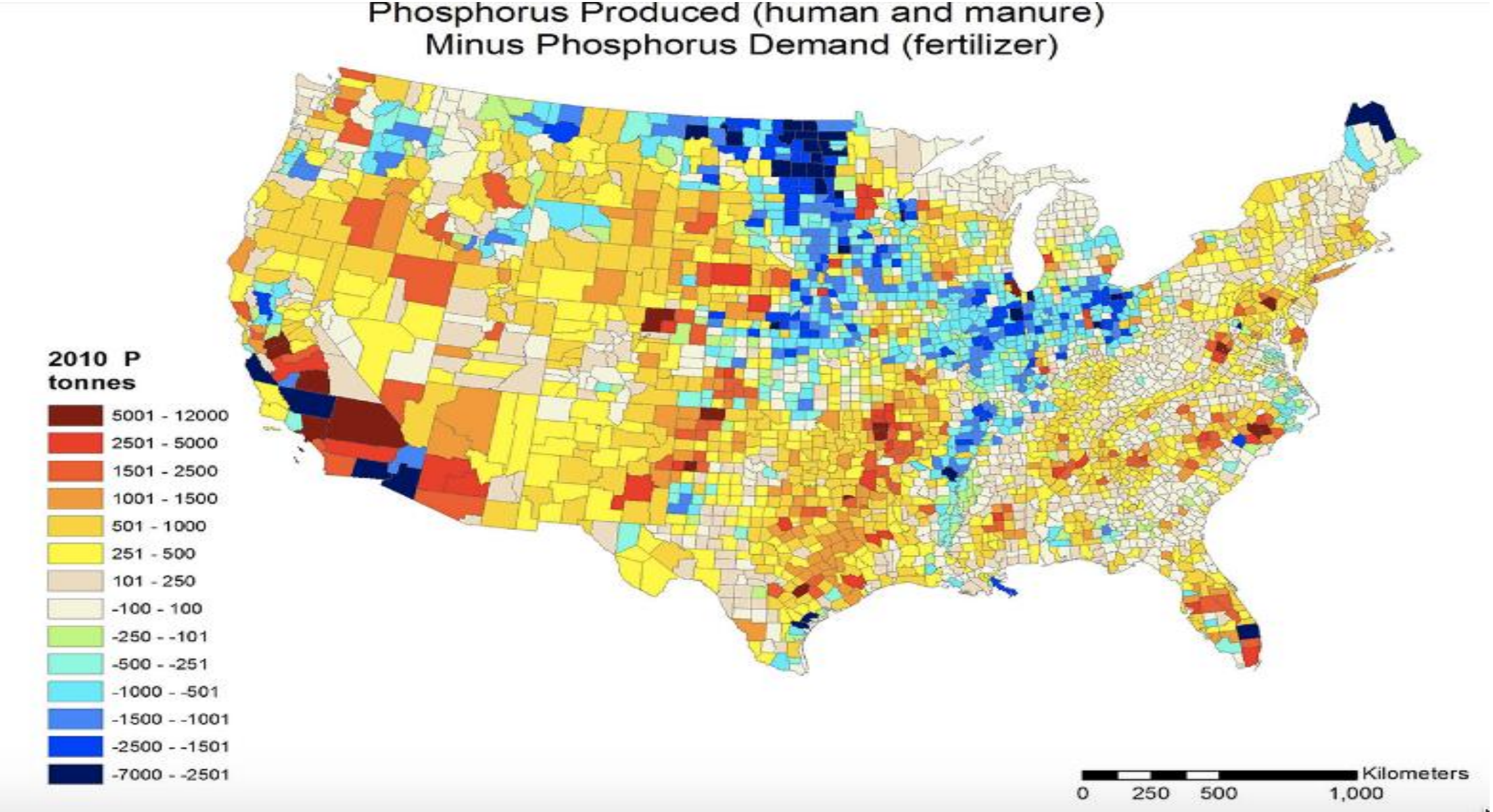
Slide courtesy of Dr. Herschel Elliott, Penn State Univ.

Solubility: P Runoff Comparison: Manure vs Biosolids



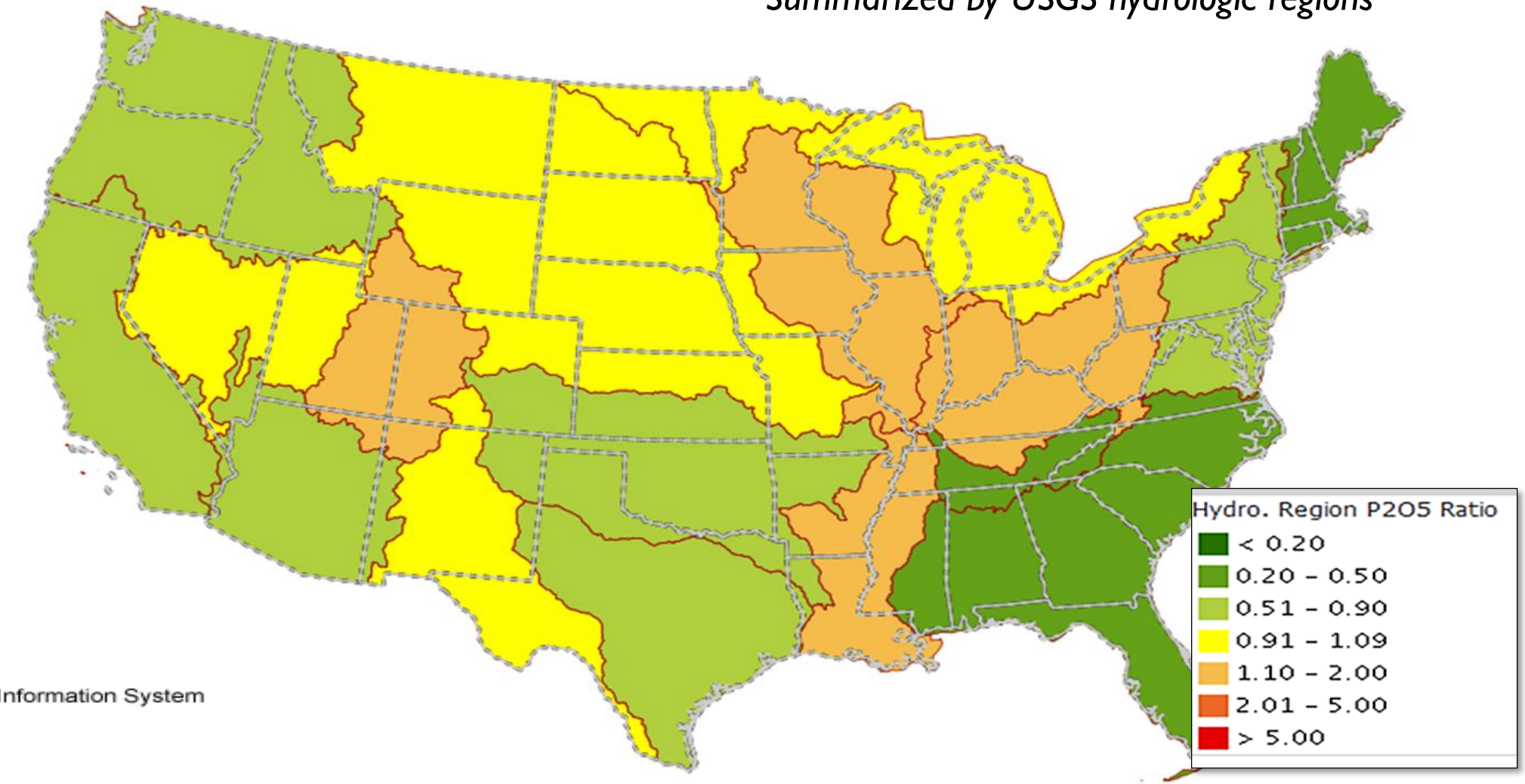
Slide courtesy of Dr. Herschel Elliott, Penn State Univ.

3. Imbalanced P flows



Ratio of phosphorus removed to phosphorus applied, 2007

Summarized by USGS hydrologic regions



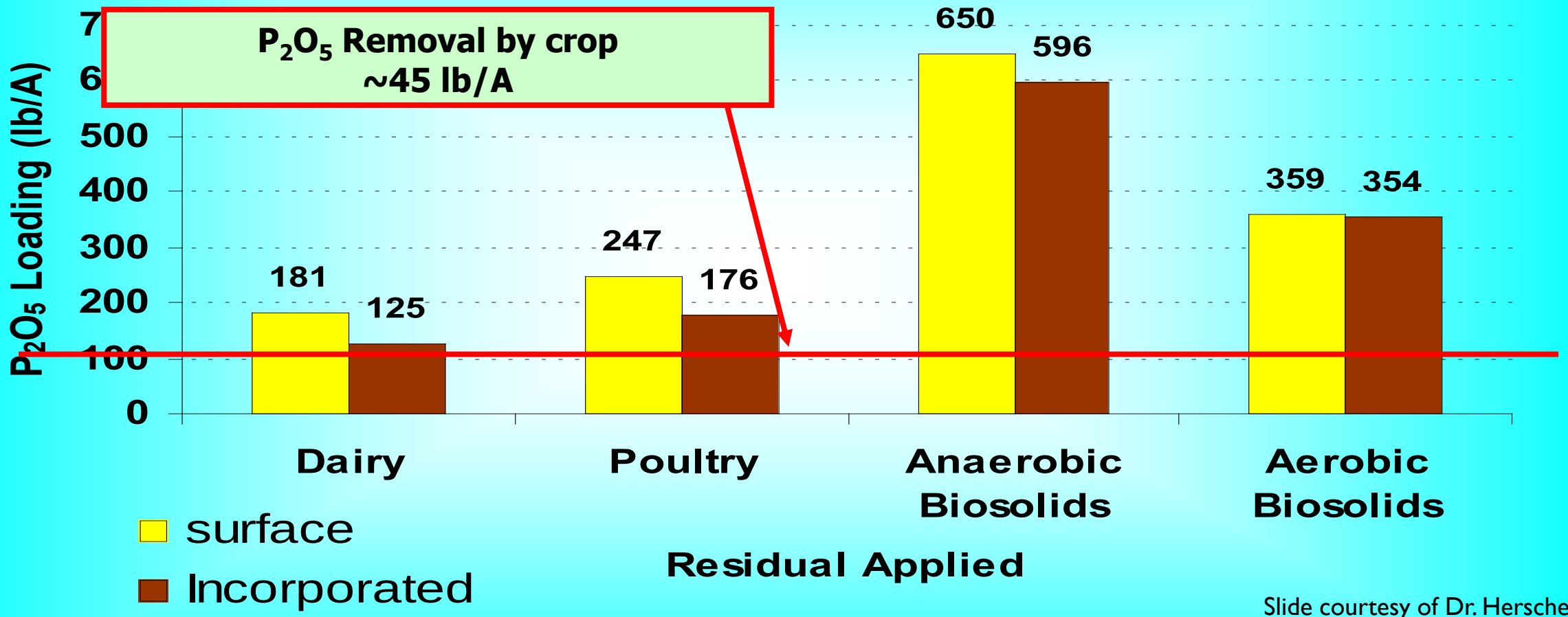
NuGIS
Nutrient Use Geographic Information System

IPNI

IPNI. 2012. A Nutrient Use Information System (NuGIS) for the U.S. Norcross, GA. January 12, 2012. Available on line >www.ipni.net/nugis<

4. Imbalanced nutrients in biosolids & residuals:

P_2O_5 Loadings When Materials Are Used to Satisfy Crop Nitrogen Needs



Crop = 125 bu/A corn for grain with net PAN need of 84 lbs./acre

Slide courtesy of Dr. Hersche
Elliott, Penn State Univ.

Example of challenge: NH Nutrient Law

University of New Hampshire
Cooperative Extension

Food & Agriculture

AGRICULTURE FACT SHEET
Spring 2014

New Hampshire's Turf Fertilzer Law What You Should Know

MARGARET HAGEN, Extension Field Specialist

Introduction

Nitrogen and phosphorus are nutrients essential for the growth of plants. However, an overabundance of these nutrients causes pollution in waterways. In New Hampshire, more than half of the nitrogen pollution to Great Bay can be traced back to urban and suburban nonpoint source pollution, including fertilizer runoff.* Nonpoint source (NPS) pollution, unlike pollution from industrial and sewage treatment plants, comes from many different sources. NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and transports natural and human-made

FERTILIZE RESPONSIBLY

- **Nitrogen Content Reduced**
  Lawn fertilizers sold at retail shall not exceed 0.9 pound of total nitrogen applied per 1,000 square feet per application when applied according to the label. At least 20% of the nitrogen must be in slow release form.
- **Phosphorus-Free**
  Most NH soils provide all the

Phosphorus-Free

Most NH soils provide all the phosphorus that a home lawn needs. Phosphorus sold at retail should be used only on newly established or repaired lawns, or on lawns testing deficient in phosphorus. Annual applications may not exceed a rate of 1 pound per 1,000 square feet of available phosphate.

What does "available" mean?

Example of challenge: Maryland

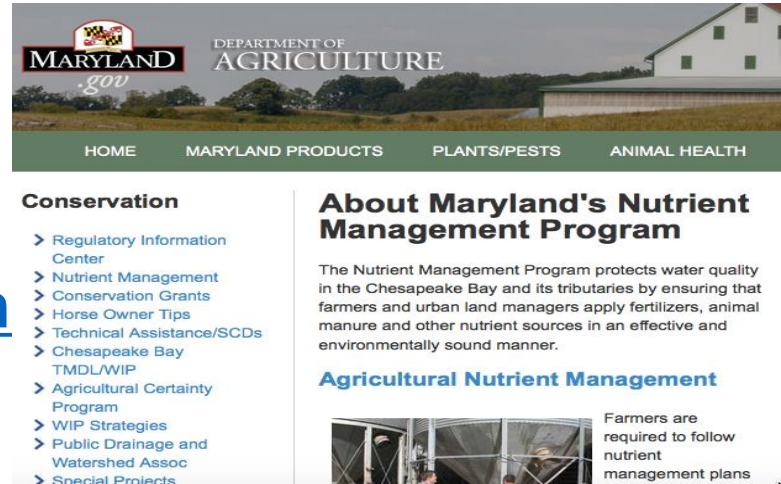
A very restrictive regulation… driven by Chesapeake Bay nutrient pollution issues.

Biosolids recycling falls under the revised University of Maryland Phosphorus Management Tool (UM-PMT) which, in June 2015, replaced the 2005 Maryland Phosphorus Site Index.

It was based on <u>total</u> P content of organic P sources (manures and biosolids). However, total P content is an unreliable measure of:

1. Environmentally relevant P
2. Phytoavailable P

http://mda.maryland.gov/resource_conservation/pages/nt_management.aspx



Massachusetts Plant Nutrient Management Regulations promulgated by Dept. of Agricultural Resources (MDAR)

- The regulation is poorly written; definitions are confusing
- Biosolids/residuals were not really considered in its crafting (typical of most states; some exempted residuals)
- UMass guidance is cited – but that guidance does not address residuals much

Meanwhile, MA is aggressively getting organics out of landfills!

(conflicting efforts)

To there credit, states are struggling with a challenging question:

"With respect to the recycling of organic residuals, the question is to what extent soils can be loaded with phosphorus (beyond agronomic needs) without environmental impacts." - Massachusetts DAR, 2/23/16:

They have not answered this question. It is hard to answer.

NEBRA's next steps

- Writing a professional guidance – best practices (which can be used in MA as long as UMass Extension guidance is missing).
  - We are seeking volunteers to help write & review.
  - Can this be a nationwide effort? Might it need to be tailored region by region?
- Also considering a research project to help inform UMass Extension and guidance.
- Promoting P recovery technologies & installations

P Recovery Technologies

- some examples
- there are more now

NuReSys®

Nutrient Recovery Systems

Pearl®

Ostara Nutrient Recovery Technologies Inc.

AirPrex™

CNP Technologies

PHOSPAQ™

Paques

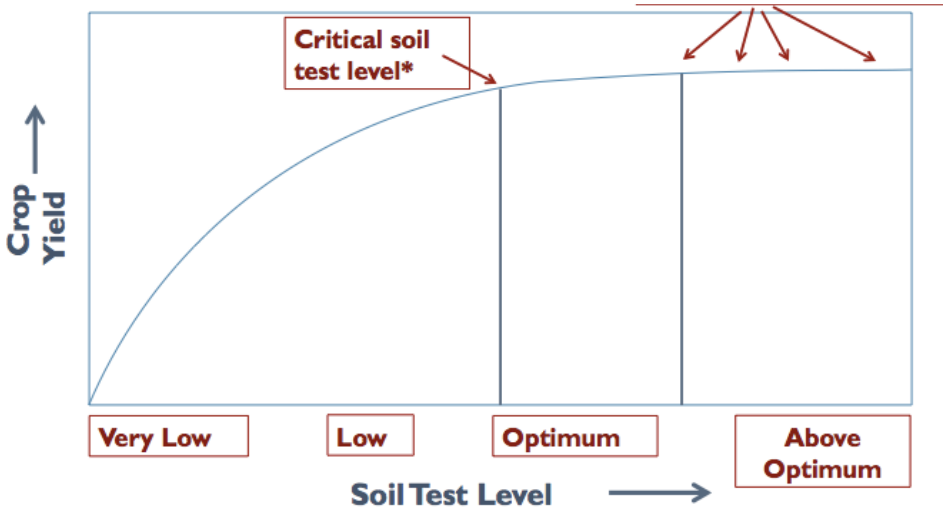
Multiform™

Multiform Harvest Inc.

Ideas for improving state regulations to support P & biosolids/residuals recycling

Ideas for improving state regulations (1):

1. Soil test interpretations:
   - Don't use agronomic tests to measure environmental impacts
2. P source solubility
   - Consider variability in P solubility based on source
   - Advance WEP, PSI, & other tests for environmental relevance
3. Imbalanced P flows:
   - Reduce mined P use (esp. in regions with net imports of P)
   - Prioritize & incentivize recycling of local P (in biosolids, manures, etc.)
4. Imbalanced nutrients in biosolids & residuals
   - Advance / incentivize P removal from manures, biosolids, digestates
   - Move concentrated P to areas that need it (prioritizing its use over mined P)
5. Update P Site Indices to include this nuanced science (e.g. source coefficients)



Different states/regions have different needs & goals!

Ideas for improving state regulations (2)

Remember:

- Overall policies need to balance conflicting realities:
  - Any excess P is a potential (long-term) risk; overapplication of any form of P should be avoided where possible

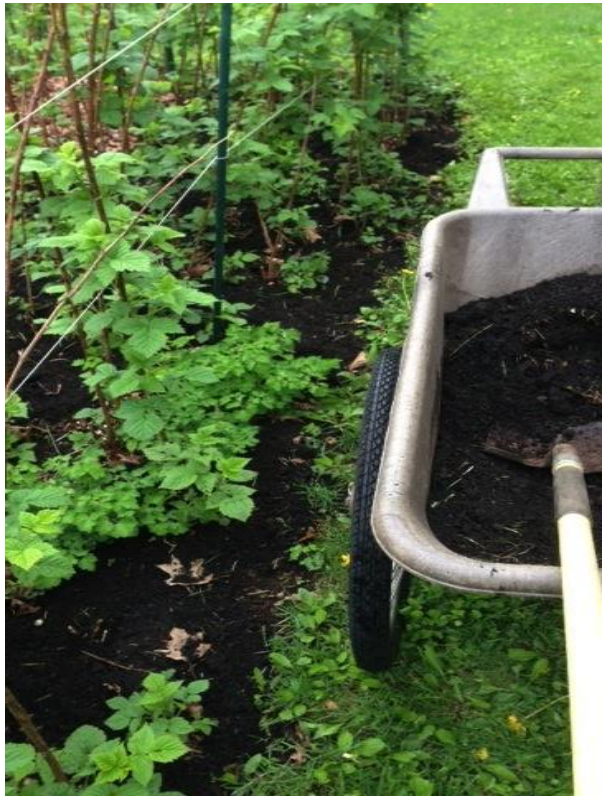
  vs.
  - Many environmental, economic, & social benefits of recycling residuals.
- Different states/regions have different needs & goals

Thus, top priorities = 3 & 4. These are hard to achieve. Need to focus on them.

- Imbalanced P flows:
  - Reduce mined P use (esp. in regions with net imports of P)
  - Prioritize & incentivize recycling of local P (in biosolids, manures, etc.)
- Imbalanced nutrients in biosolids & residuals
  - Advance / incentivize P removal from manures, biosolids, digestates
  - Move concentrated P to areas that need it (prioritizing its use over mined P)

Thank you.

Ned Beecher, Executive Director
NEBRA
Tamworth, NH
ned.beecher@nebiosolids.org
603-323-7654



Biosolids compost
for my raspberries.

Acknowledgements

Ron Alexander, Ron Alexander Associates

Herschel Elliott, Penn State University

Andrew Carpenter, Northern Tilth

George O'Connor, Univ. of FL

Rufus Chaney, USDA (retired)

Sally Brown, Univ. of Washington

David Parry, CH2M

John Uzupis, Synagro

NEBRA Members

Phosphorus Forum 2018

February 27, 2018 | Tempe, AZ

TODAY'S AGENDA

- 8:30 **Dr Jim Elser** (ASU) Welcome and our job today.
- 8:45 Keynote: **Dr Sally Rockey** (FFAR)
- **9:30 Dr David Vaccari** (Stevens Inst of Technology) "A Substance Flow Model for Global Phosphorus"
- 10:00 Coffee & networking
- 10:30 **Dr. Luis Herrera** (CINVESTAV), GMO technology for phosphite fertilizer use
- 11:00 **Dr Kevin Dooley** (ASU) & Allison Thomson (Field to Market): Market drivers of nutrient sustainability
- 12:00 – 1:30 Lunch & networking
- 12:30 – 1:00 Lunch keynote: **Dr Paul Fixen** (IPNI, retired)
- 1:30 **Ned Beecher** (Northeast Biosolids & Residuals Association), regulatory challenges with recycling organic residualss
- **2:00 Noel Lyons (McGill Compost) and Dr Amir Varshovi (GreenTechnologies), commercialization of compost and recycled fertilizer products**
- 2:45 **Dr Jim Elser** (ASU) Final discussion & closing comments.
- 3:30 – 5:30 Networking time (Postino's on College Ave)

Sustainable Phosphorus Alliance

GreenEdge®

GreenTechnologies, LLC

USDA CERTIFIED BIOBASED PRODUCT

Made in USA

Who We Are:

GreenEdge®
GreenTechnologies, LLC

- Manufacturer of innovative and sustainable Slow Release fertilizers since 1999.
- Offices & facilities: Jacksonville & Gainesville, Lakeland (2019), Florida.
- Innovative R&D, patented products, and diverse markets
- 2014 SBA Small Business of the Year for the State of Florida.

From Biosolids to GreenEdge®

Commercialization:

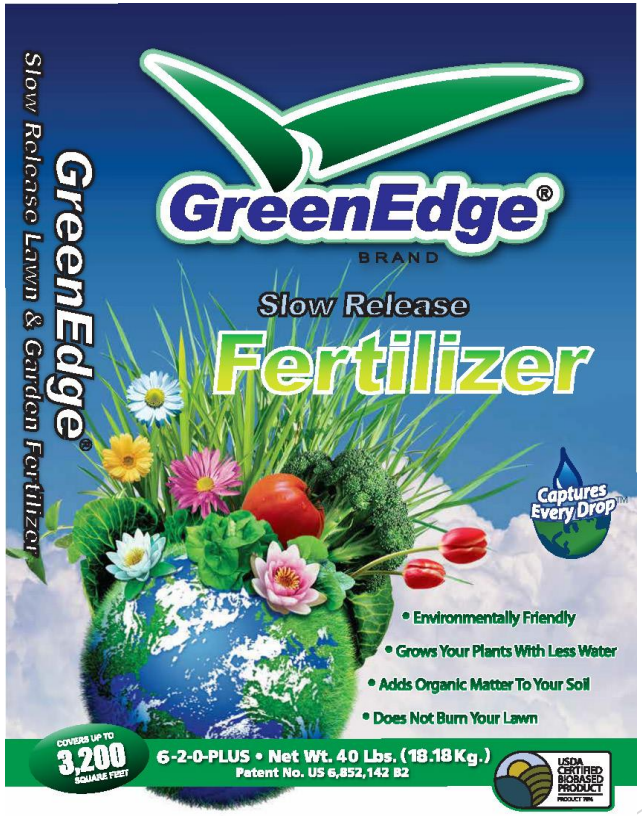
Challenges and Lessons Learned

GreenEdge®
GreenTechnologies, LLC

Classes of Biosolids and Alternative Treatment Technologies

- **Class B**
  - Digestion: Aerobic, Anaerobic
  - Lime Stabilization
- **Class A**
  - Thermal Drying, Thermal Hydrolysis
  - Composting

From Class B Biosolids to Commercialized ***GreenEdge®*** Products



Environmental Trends

Concerned about the Environment	Concerned about Water Pollution	Concerned about Air Pollution
90%	97%	93%

- The average American household uses 320 gallons of water per day, 30% of which is devoted to outdoor uses.
- ***GreenEdge***® products utilize nutrient-rich organic materials extracted during wastewater treatment.
- Nutrients recovered from the water treatment process can be recycled as fertilizer to improve and maintain productive soils and enhance plant growth.
- Recycling nutrients for fertilizer production completes the natural cycle of the environment.

Polling data provided by Gallup. Information provided Environmental Protection Agency

GreenEdge®
GreenTechnologies, LLC

Market Size & Trends

- The home lawn and garden industry generates an estimated 40 billion dollars in sales annually.
- Americans buy 70 million pounds of chemical fertilizer every year to keep lawns green.
- An estimated 72% of households in the U.S. (85 million) participate in lawn and garden activities annually.
- 48% of households did their own lawn care last year, 36% have a flower garden, and 22% have a vegetable garden.
- Americans spend an average of 73 hours per year maintaining their lawns and gardens.

GreenEdge®
GreenTechnologies, LLC

Process and Product Development

- Patented Slow Release NPK Fertilizer with Organic Nitrogen
- Multi nutrient release mechanisms
- Higher nutrient value

Slow Release Fertilizers

- ***GreenEdge***
  - Organic-base
  - Multi-release Mechanisms: Hydrolysis, Mineralization
  - Factors Affecting Nutrient Release
    - Moisture, Temperature,

GreenEdge®
GreenTechnologies, Inc.
Slow Release Fertilizer
Agronomically Superior Environmentally Sound
Technologically Advanced

USDA CERTIFIED BIOBASED PRODUCT

GreenEdge®: Homogenous Products

- 6-3-2Plus*
- 6-2-0Plus*
- 8-3-0Plus*
- 8-1-4Plus*
- 12-0-2Plus*

USDA CERTIFIED BIOBASED PRODUCT

- * Also Available in MicroPrill

(Greens Grade, SGN 90)

Production & Logistics

GreenEdge®
GreenTechnologies, LLC

Distribution Network

- **Regional Distribution Network**
  - Farm Supply Stores, Fertilizer Blenders and Distributors
  - Specialty Markets Distributors: Lawn and landscape, Golf, …
- **National Distribution Network**
  - Big Box Chains
  - E-Commerce

GreenEdge®
GreenTechnologies, LLC

Markets Selection and Development

Public Outreach and Partnerships

- **Community Events:**
  - Earth Day, Spring Festival,
- **Science Teachers Conferences**
- School Gardens and Athletic Fields
- **Environmental Organizations:**
  - Sierra Club
  - River Keepers

Earth Day Activities

GreenEdge®
GreenTechnologies, LLC

Customers Engagement

Conference and Trade Shows

State and Federal EPA

- Participation in Regulatory Programs and events
- Provide information about our activities, technology and products development
- Donating products to research and demonstration projects

Public Acceptance
Florida Biosolids Awards

EPA SBIR

- 2017 SBIR Phase II Award
- Development of filter media for phosphorus removal and recovery

GreenEdge®

GreenTechnologies, LLC

USDA CERTIFIED BIOBASED PRODUCT

Made in USA

Transforming waste… Rebuilding soils

Recycling Phosphorus through Composting

Noel Lyons, President
McGill Environmental Systems
Phosphorus Forum 2018 • Tempe, AZ
February 27, 2018

McGILL

transforming waste ... rebuilding soils®

LOCK the LOOP

What we do

- Build, own and operate composting facilities
- Market and sell compost products
- Design and manage for others

Where we are

Where we are

Ireland

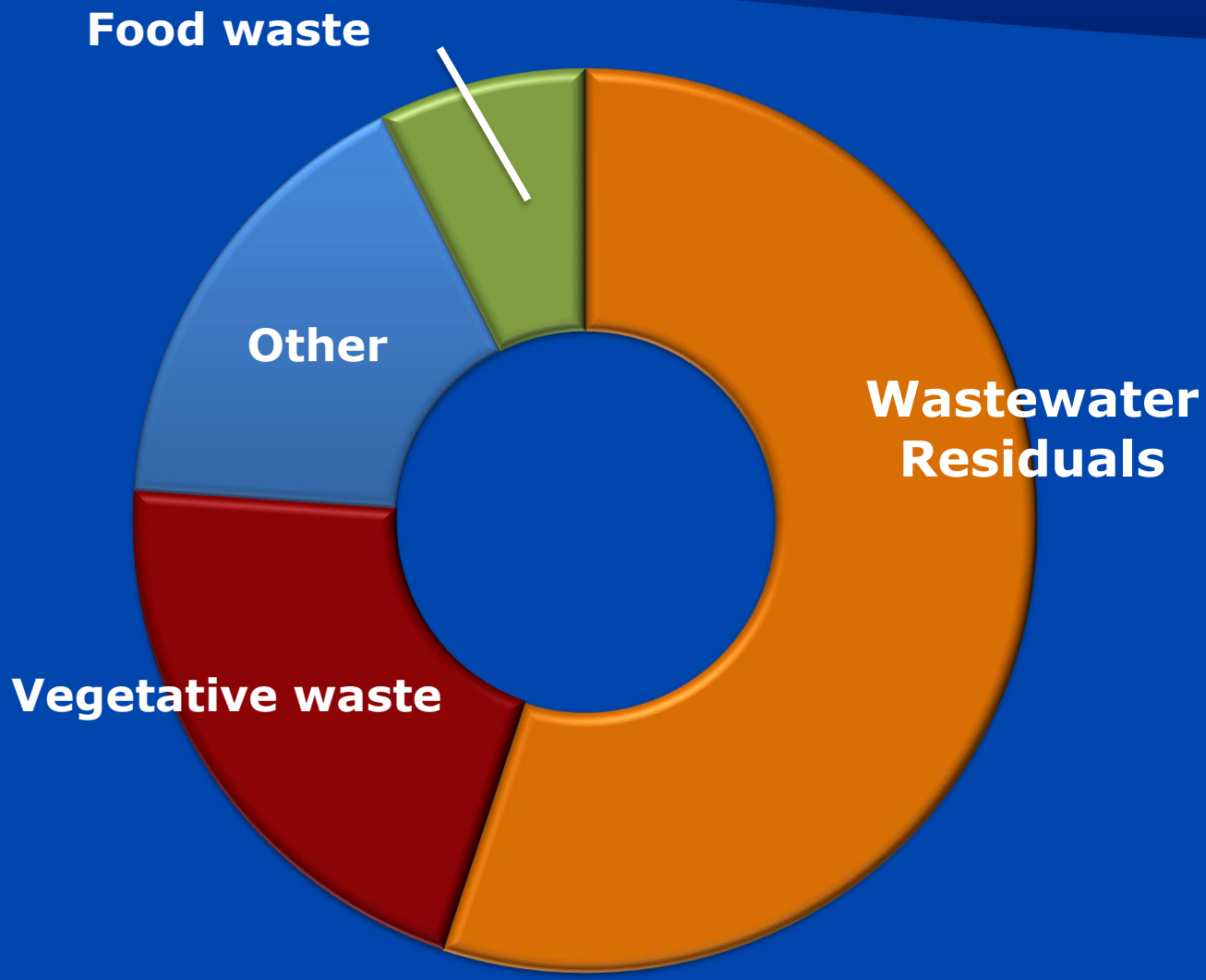
Our vision

To contribute to a more sustainable life on earth by providing the most effective solution for depleted soils.

Our mission

To use our composting technology to transform the widest range of biodegradable wastes into premium compost products.

What we compost



Our products

The McGill technology

Compost markets

McGill P_2O_5 Recycling 2017

	Delway	Merry Oaks	Waverly	Brighton	TOTAL
Tons of Compost	29,567	32,390	30,750	45,368	**138,075**
P_2O_5	2.2%	1.7%	3.7%	1.8%	
Tons	650	551	1,138	817	3,156

McGill P_2O_5 Recycling To Date

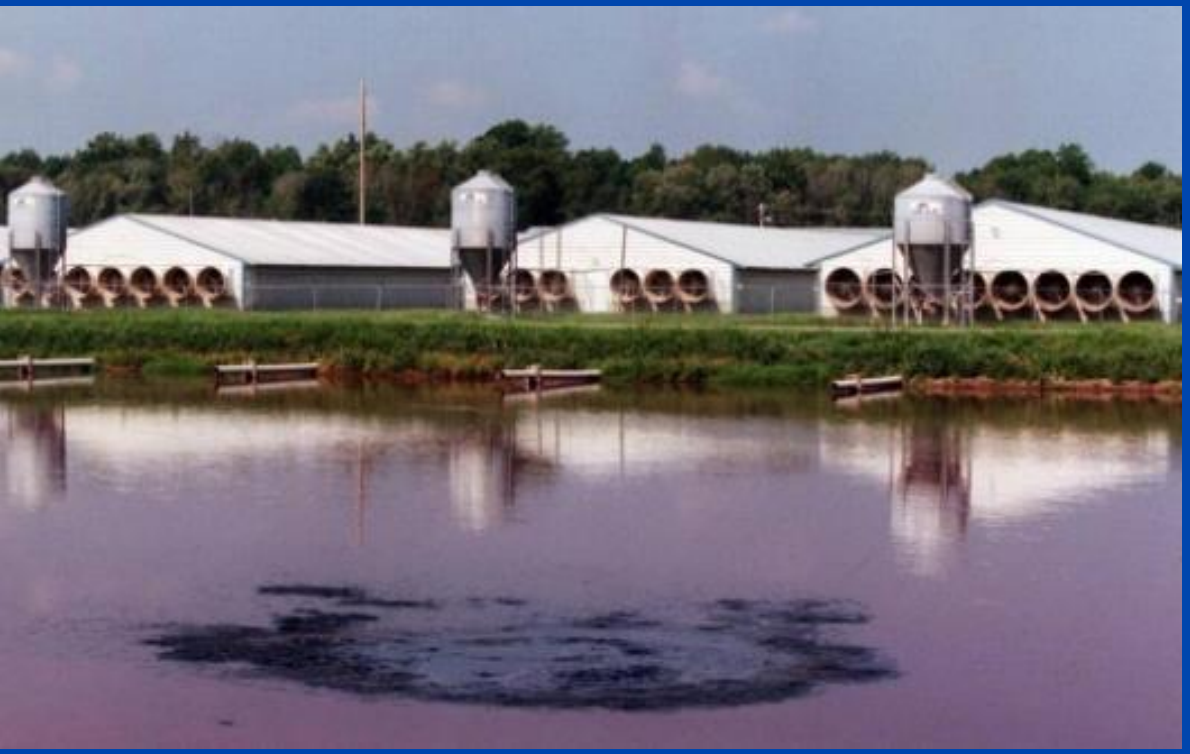
37,450 tons

U.S. Composting industry

- ~5,000 composting facilities
- ~25m tons composted

Recycling phosphorus through composting

Rural to urban



Stormwater/erosion control

Pollutant removal

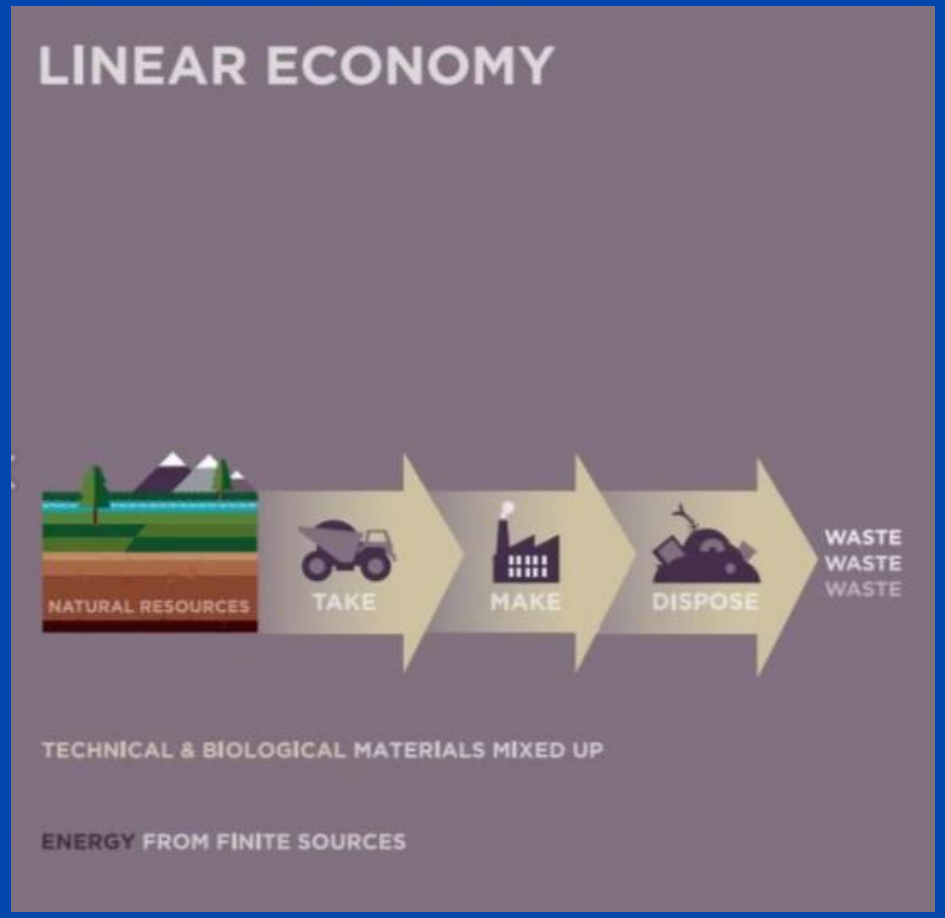
TSS	Total N	NH_4 –N	NO_3 -N	Total P	Sol. P	E. coli.	Oil	Diesel
80%	35%	35%	25%	**60%**	92%	98%	99%	99%

SOURCE: Faucette et al, 2009

"Storm Water Pollutant Removal Performance of Compost Filter Socks"

Journal of Environmental Quality

A look at the future



Unsustainable

Sustainable

www.mcgillcompost.com

Wrap up / final reflections

Are there questions or comments from the floor?

Wrap up / final reflections

- Survey is coming
- Recycle badges
- Postinos!
- Thanks are due

So what's your answer?

Are you a **wizard** or are you a **prophet**
or are you a ***wizard prophet***?

The Atlantic (March 2018)
Charles Mann (Illustrations by Ulises Fariñas)

Sustainable Phosphorus Alliance

And what about 2050?

Does the future belong to the *wizard prophets*?

Join us!

Our Mission

Our mission is to be North America's central forum and advocate for the sustainable use, recovery, and recycling of phosphorus in the food system.

Our Vision

We envision a food system that manages phosphorus more sustainably to provide abundant, nutritious food while protecting the health of rivers, lakes, and oceans.

Objectivity

Our decisions and actions are based in the best available science.

Stewardship

We support the implementation of technologies and practices that benefit ecosystems and not ones that facilitate their deterioration.

Inclusivity

We seek buy-in from diverse stakeholders about best policies and practices.

Sustainable Phosphorus Alliance

PhosphorusAlliance.org