The Metropolitan

Water Reclamation District

of Greater Chicago

WELCOME
TO THE JANUARY EDITION
OF THE 2016
M&R SEMINAR SERIES

BEFORE WE BEGIN

- SAFETY PRECAUTIONS
  - PLEASE FOLLOW EXIT SIGN IN CASE OF EMERGENCY EVALUATION
  - AUTOMATED EXTERNAL DEFIBRILLATOR (AED) LOCATED OUTSIDE
- PLEASE SILENCE CELL PHONES OR SMART PHONES
- QUESTION AND ANSWER SESSION WILL FOLLOW PRESENTATION
- PLEASE FILL EVALUATION FORM
- SEMINAR SLIDES WILL BE POSTED ON MWRD WEBSITE (www.MWRD.org: Home Page ⇒ Reports ⇒ M&R Data and Reports ⇒ M&R Seminar Series ⇒ 2016 Seminar Series)
- STREAM VIDEO WILL BE AVAILABLE ON MWRD WEBSITE (www.MWRD.org: Home Page ⇒ MWRDGC RSS Feeds)

Mr. Steve John

Executive Director, Agricultural Watershed Institute, Decatur, Illinois

Experience: - Steve John is the co-founder and executive director of the Agricultural Watershed Institute, a nonprofit conservation and research organization based in Decatur, Illinois, incorporated in 2003. AWI's Local Bioenergy Initiative is addressing the environmental benefits of perennial energy grasses.
- Prior to AWI's formation, Mr. John was an environmental planning consultant.
- From 1987 to 1995, he served on the Decatur City Council and was active in watershed management to protect Lake Decatur.
- He serves on the steering committees of the Green Land Blue Waters Consortium and the Illinois Biomass Working Group.

Education: BA in Sociology from the University of Notre Dame, Indiana

Point source/nonpoint source collaboration on nutrient loss reduction with the concept of an Environmental Utility

Steve John
Agricultural Watershed Institute

sfjohn@agwatershed.org
(217) 877-5640

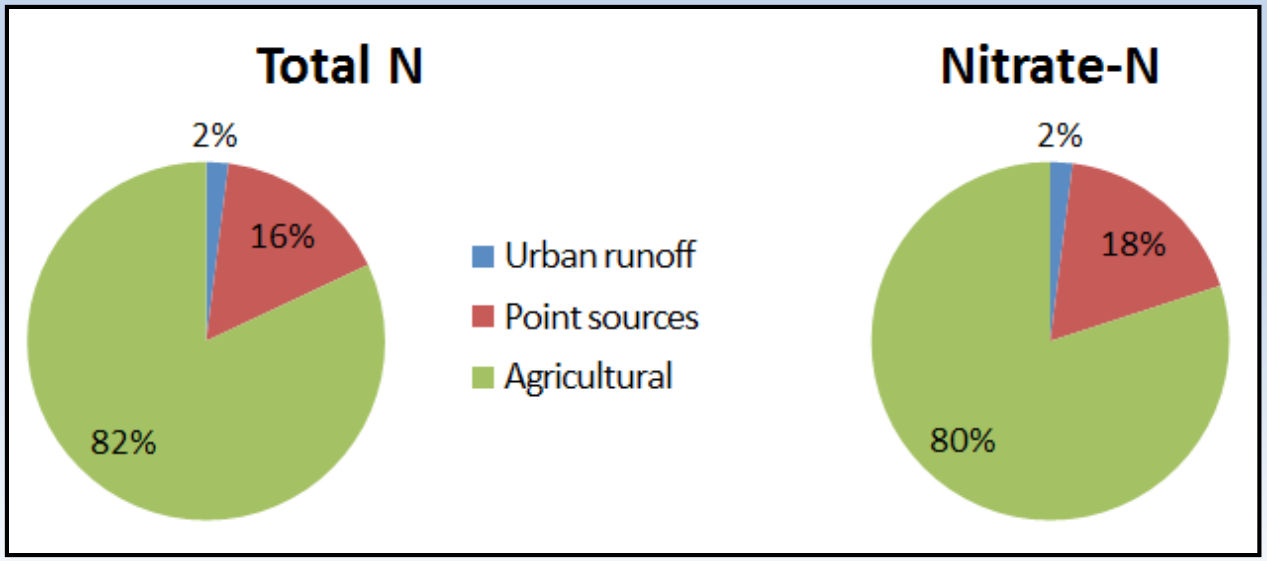
MWRDGC M&R Department Seminar
January 22, 2016

THE AGRICULTURAL WATERSHED INSTITUTE

Overview

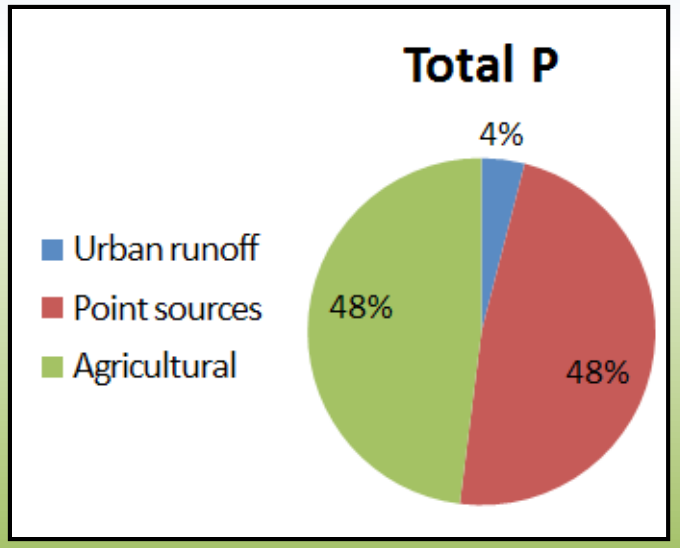
- Background on ag nutrient loss & the EU concept
- End-of-tile and Edge-of-field BMPs
- A digression about Paradigm Change
- Perennial Biomass Crops and nutrient loss reduction: Going beyond BMPs – Engagement with POTWs
- Thoughts on PS/NPS collaboration for nutrient loss reduction & utilization with an EU
- Questions—Comments—Discussion

Proportion of Illinois nutrient loss to Mississippi River

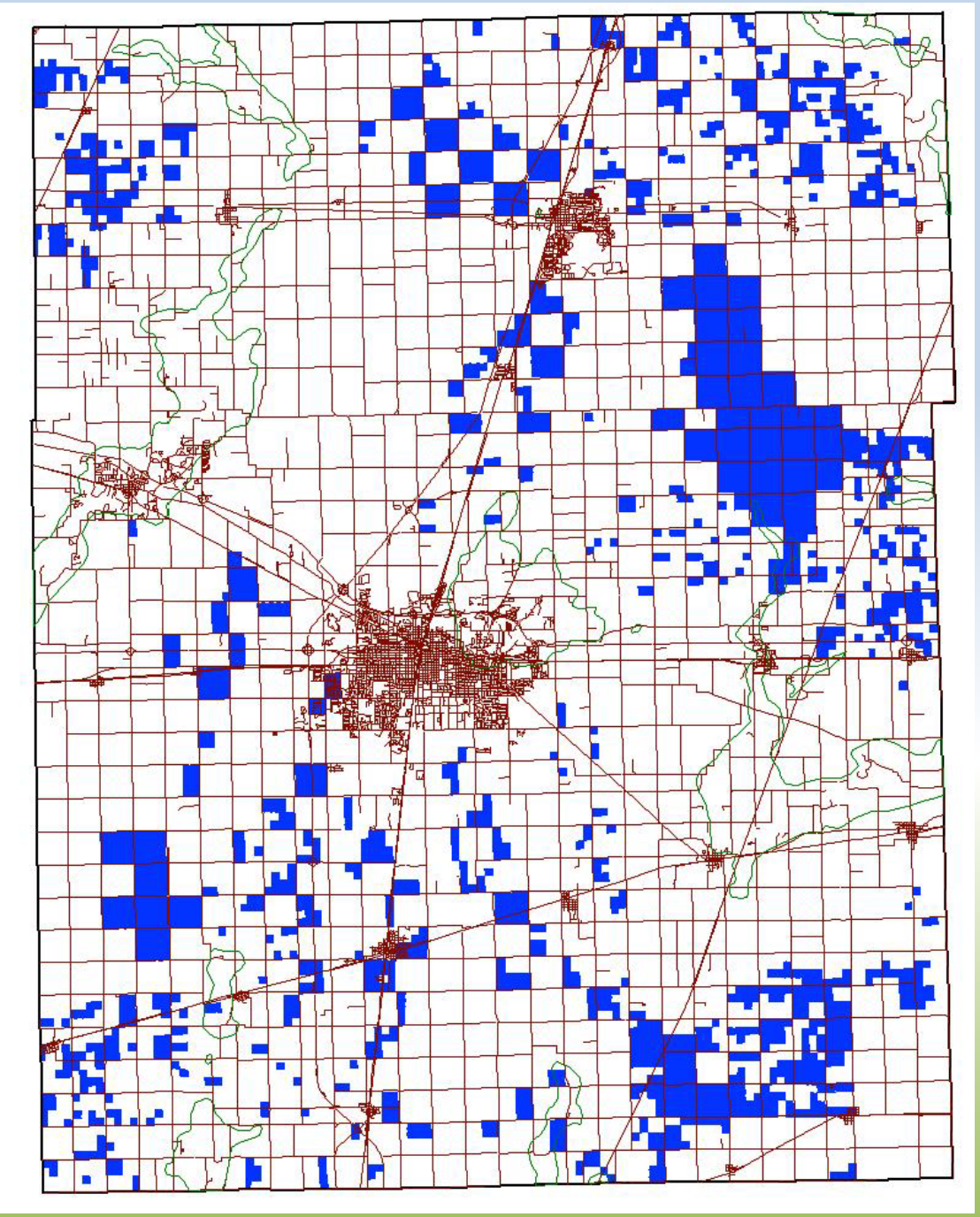


Total N & NO3 mainly from agriculture. NO3 from ag mainly in tile flow.

Total P evenly split between point sources and agriculture. P from ag mainly in soil-attached surface runoff.



Charts from Illinois Nutrient Loss Reduction Strategy



Farming the Illinois prairie

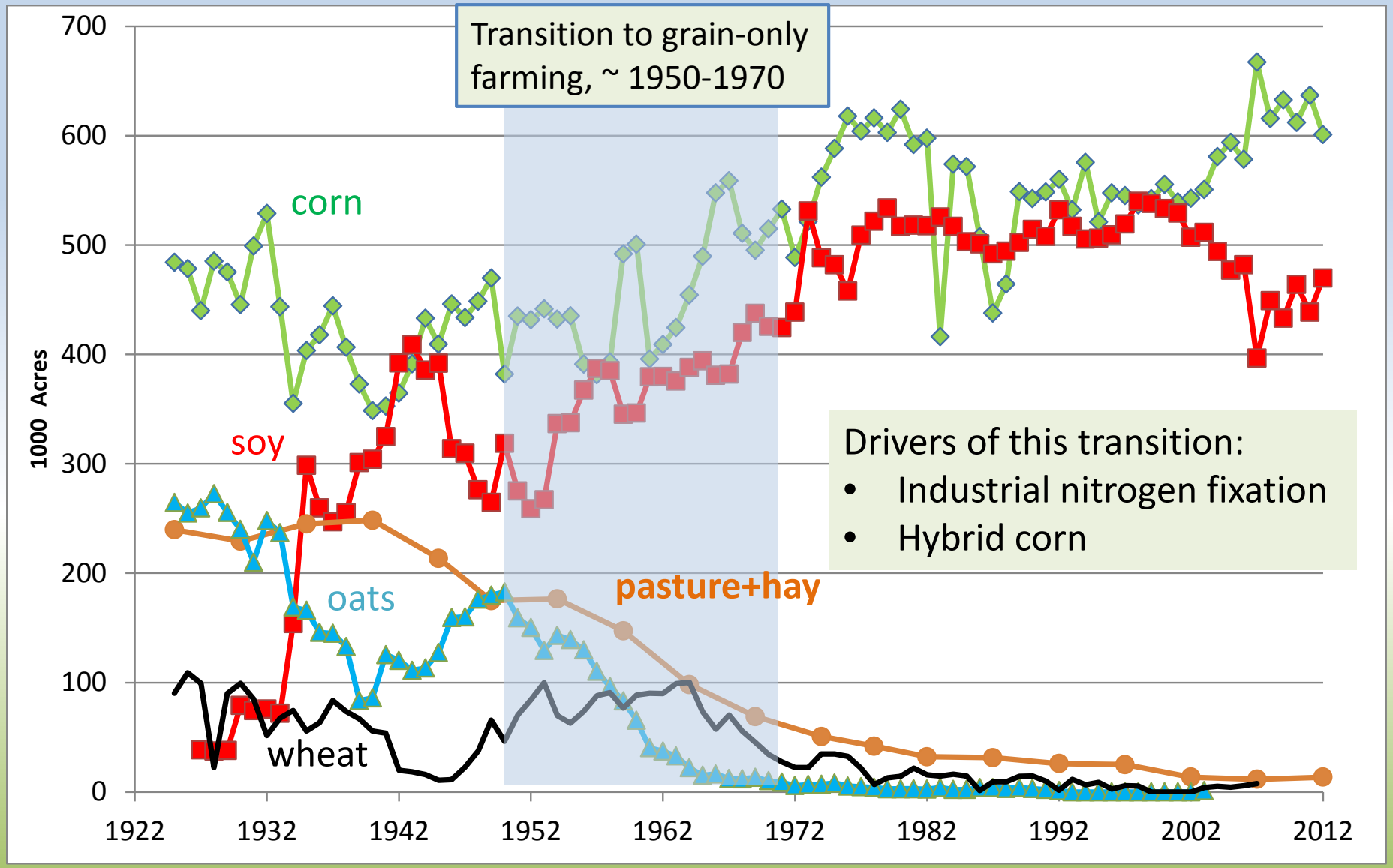
These Champaign County "swampland" tracts were rejected as too wet to farm by early settlers, 1830-1850

- Ditches & tiles enable row crop production in wet areas
- **Saturation-tolerant perennial crops make it feasible to "naturalize" agricultural drainage**
- Let's consider why & how to achieve low-impact agriculture

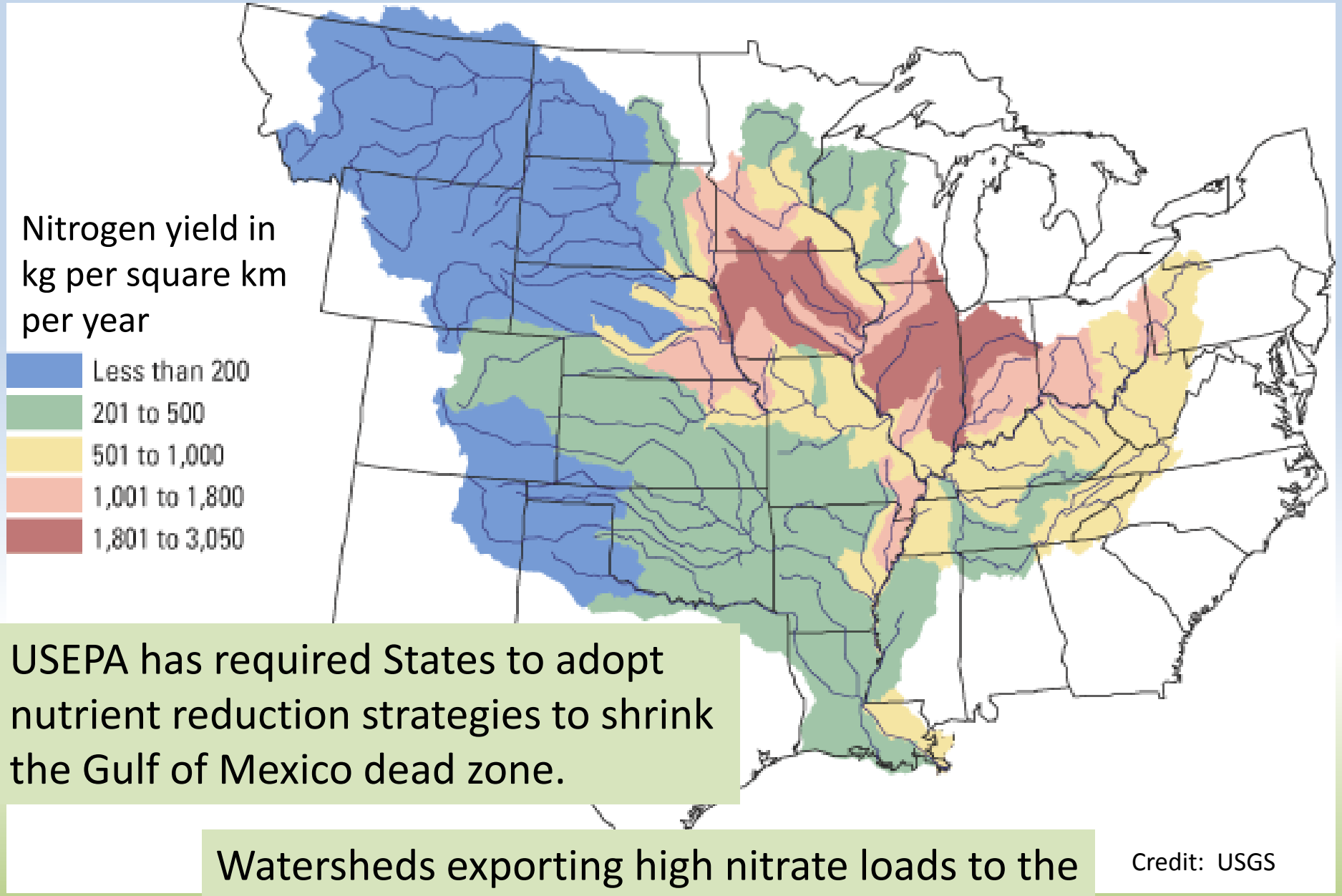
Map credit: Bruce Hannon, based on County land records

A century of agricultural landscape transformation

Macon, Piatt, Champaign Counties



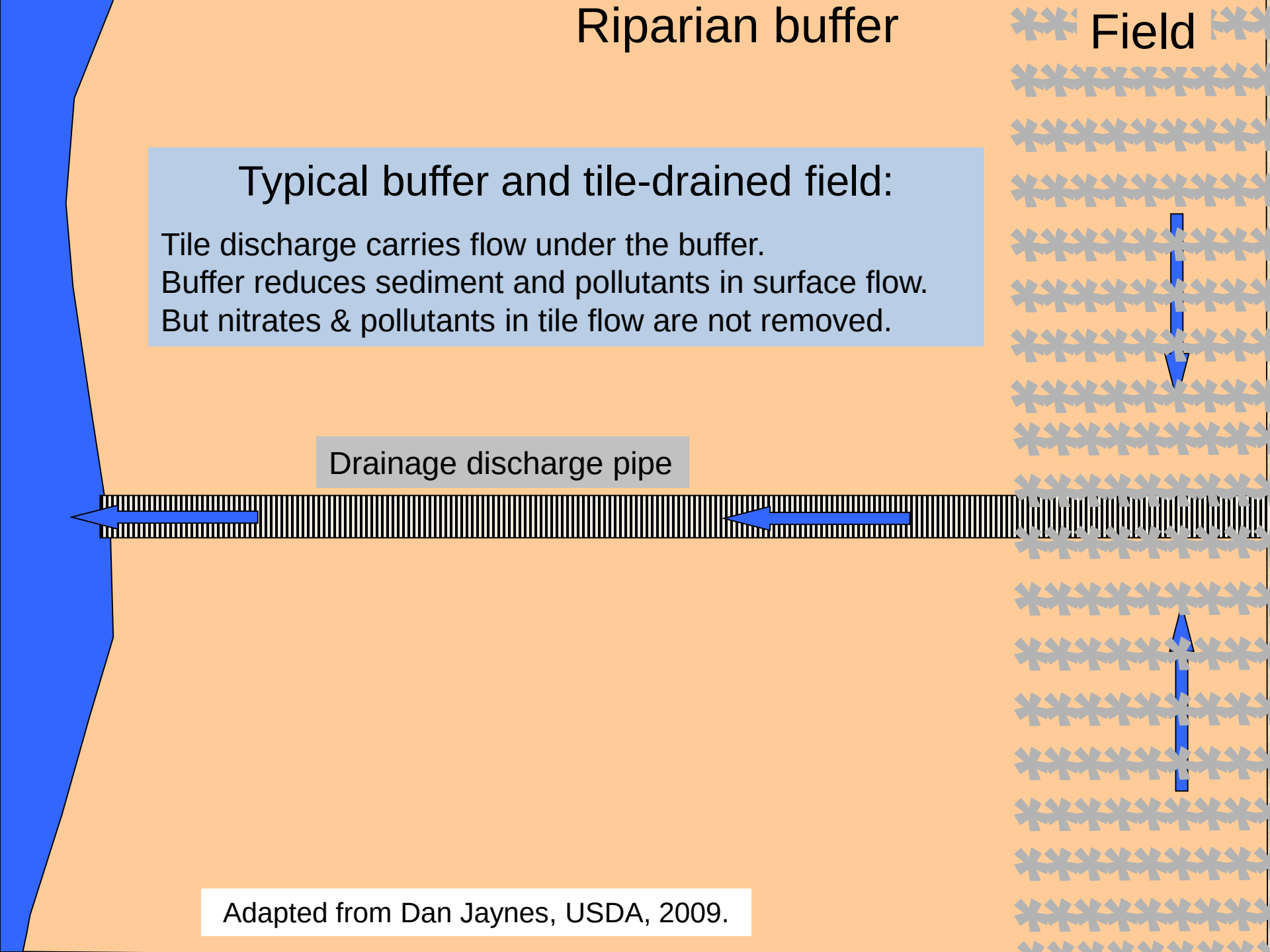
Credit: Greg McIsaac, from NASS data



USEPA has required States to adopt nutrient reduction strategies to shrink the Gulf of Mexico dead zone.

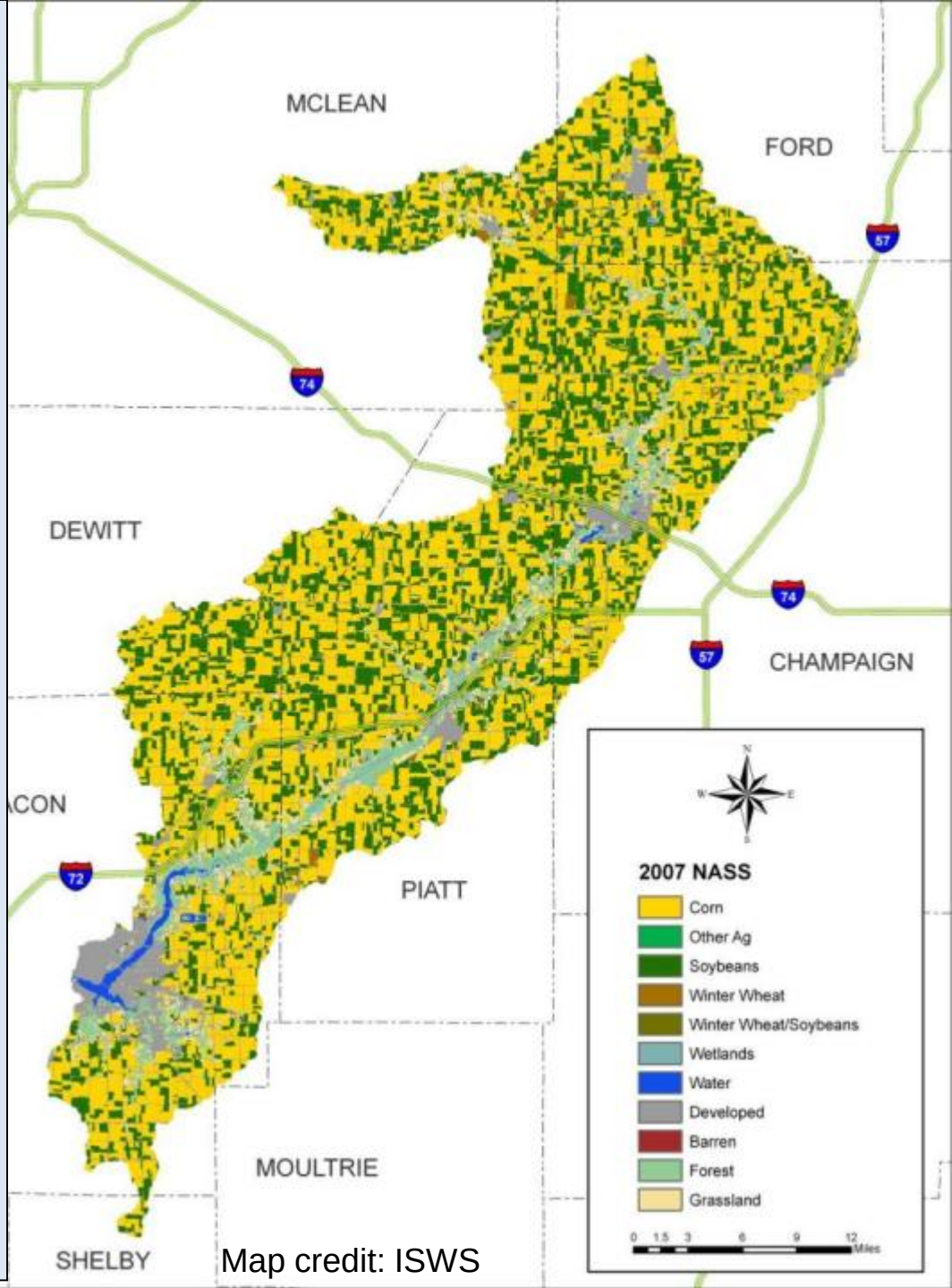
Watersheds exporting high nitrate loads to the Gulf are mainly the tile-drained croplands of Illinois, Iowa, and Indiana.

Credit: USGS


Riparian buffer
Field
Typical buffer and tile-drained field:
Tile discharge carries flow under the buffer.
Buffer reduces sediment and pollutants in surface flow.
But nitrates & pollutants in tile flow are not removed.
Drainage discharge pipe
Adapted from Dan Jaynes, USDA, 2009.

Lake Decatur Watershed

- 925 square mile impoundment of the Sangamon River
- 87% of area in row crops
- Extensive tile drainage
- TMDL Implementation Plans to reduce NO_3 & P prepared for two subwatersheds in 2014.
- Plans include BMPs plus perennial crop scenarios.



Map credit: ISWS

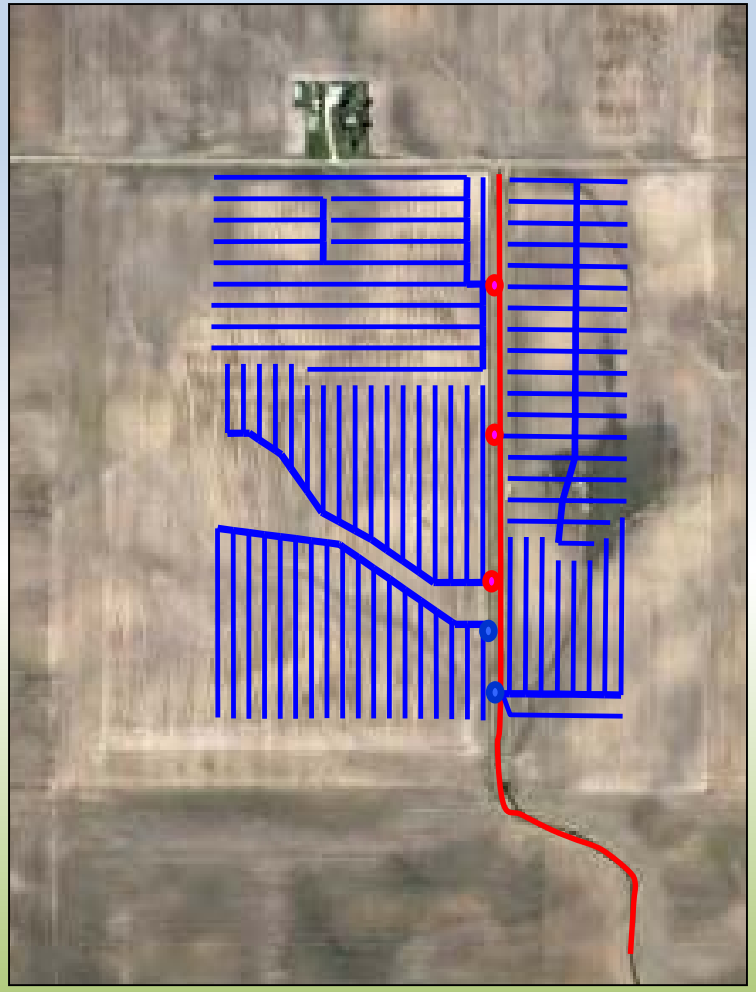
The Environmental Utility Concept

- Recommendation of the MS River Nutrient Dialogues http://uswateralliance.org/sites/uswateralliance.org/files/publications/MRND-FINAL-REPORT.pdf (Note: Called "Watershed Protection Utility" in report.)
- "… raise funds and invest in the lowest cost opportunities to address nutrient loading & other issues … "
- "no entity currently fully owns the challenge of excess nutrients specifically or watershed protection broadly"
- Integrate solution strategies : 1) Watershed-based leadership & decision-making; 2) Market mechanisms; 3) Data, monitoring & modeling
- Change watershed protection from economic liability to opportunity – Incentivize/invest in innovative technology

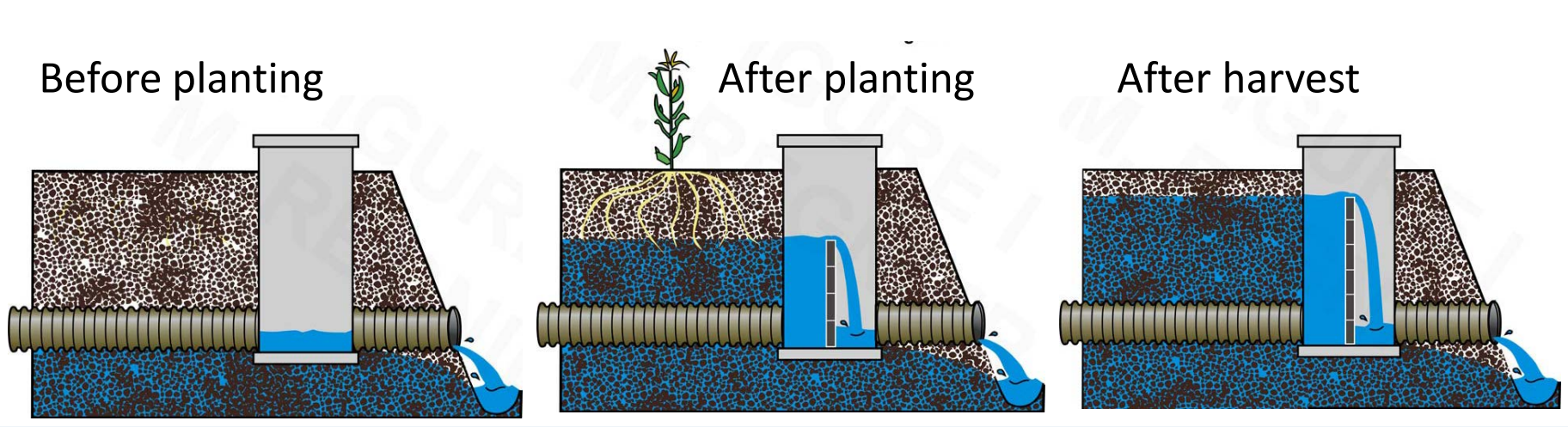
End-of-tile and Edge-of-field BMPs

Candidate technologies for WQ trading or an Environmental Utility:

- Drainage water management
- Bioreactors
- Saturated buffers
- Wetlands



DWM – How it works



Only drain what you need, when you need it

Image courtesy Purdue University

Slide courtesy Ecosystem Services Exchange

Research bioreactor

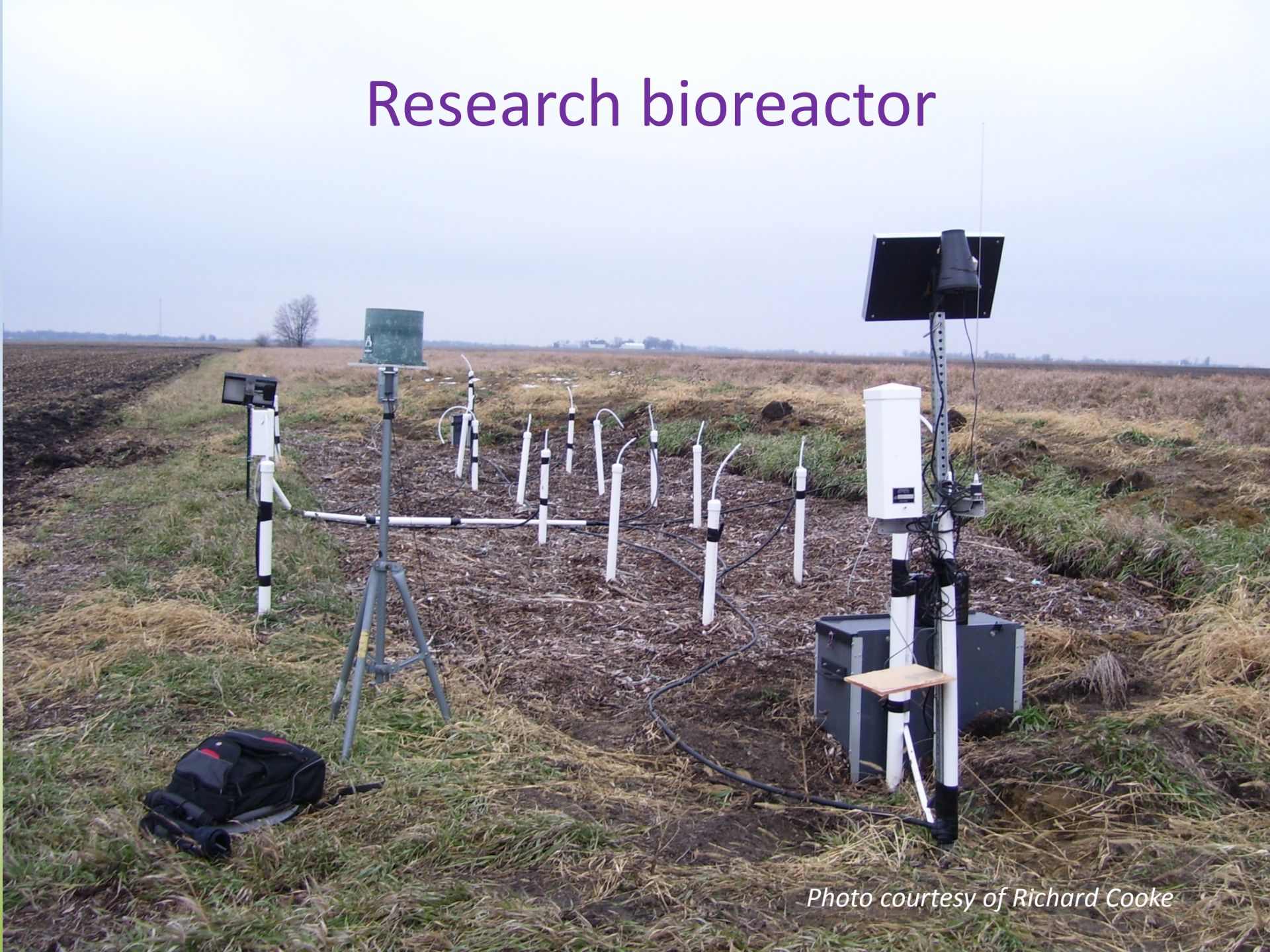
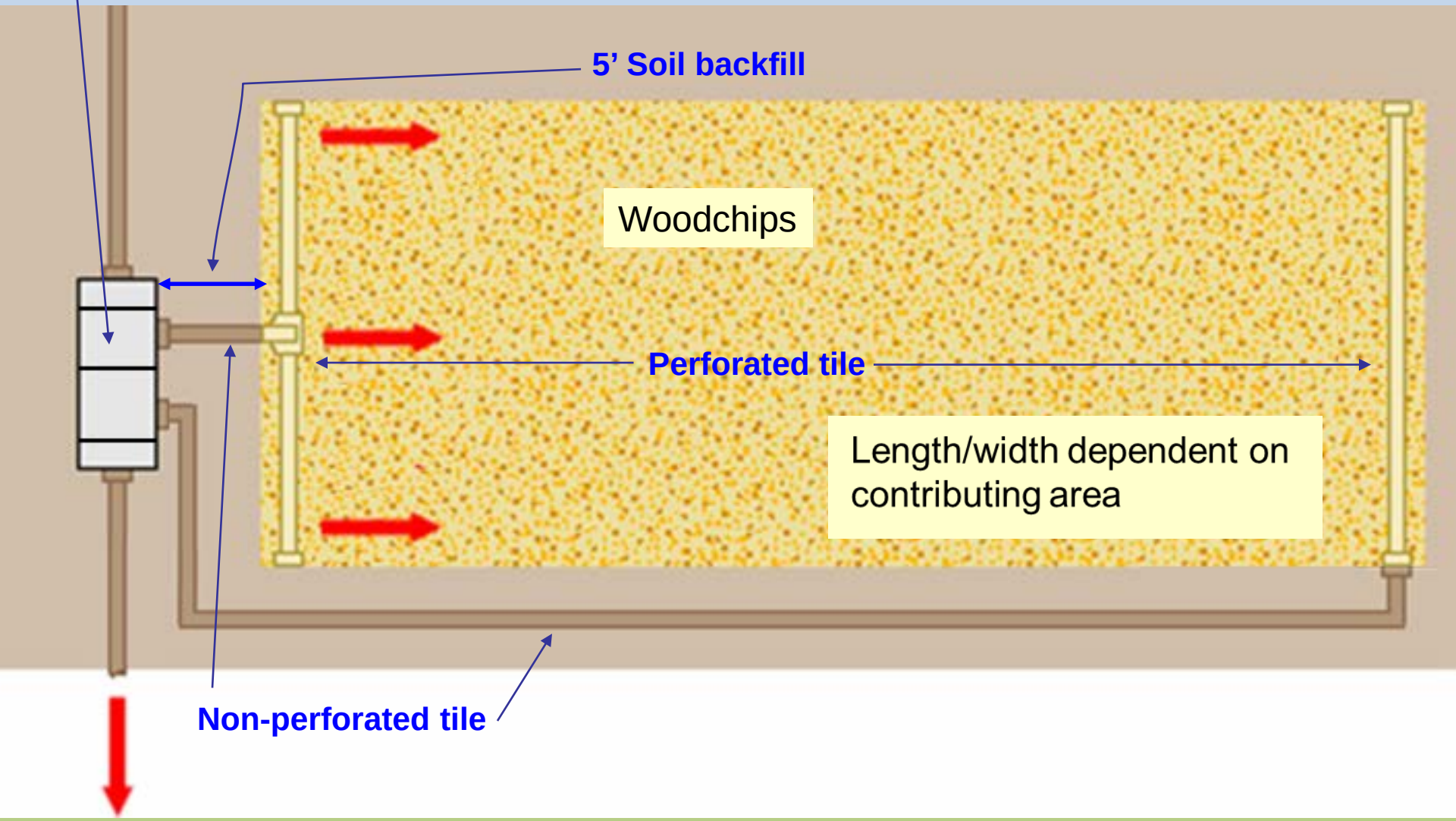
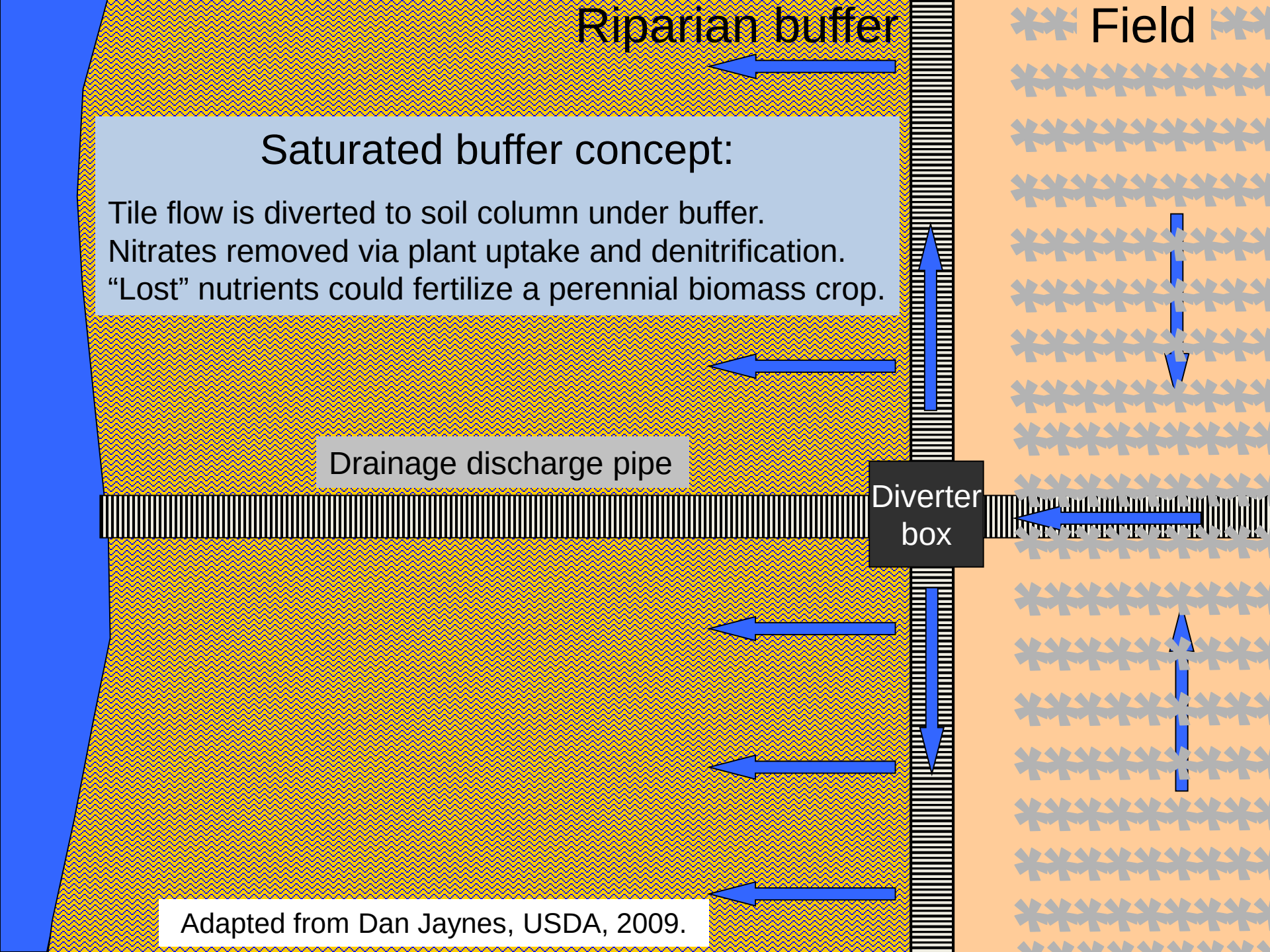


Photo courtesy of Richard Cooke

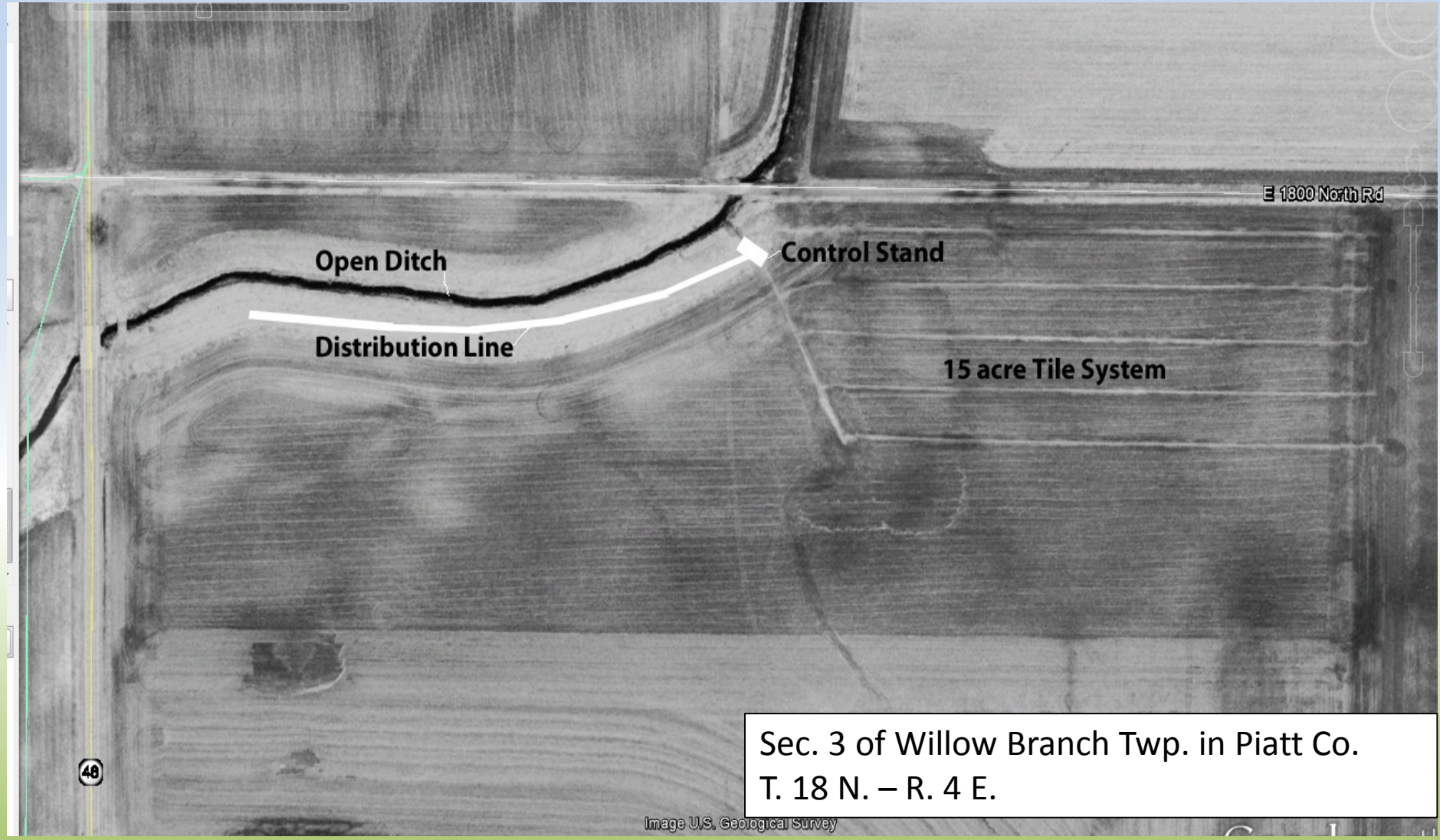
Denitrifying Bioreactor (plan view)



Slide courtesy of Richard Cooke


Riparian buffer
Field
Saturated buffer concept:
Tile flow is diverted to soil column under buffer.
Nitrates removed via plant uptake and denitrification.
“Lost” nutrients could fertilize a perennial biomass crop.
Drainage discharge pipe
Diverter box
Adapted from Dan Jaynes, USDA, 2009.

Saturated Buffer – Piatt Co. Demo Site



Sec. 3 of Willow Branch Twp. in Piatt Co.
T. 18 N. – R. 4 E.

Some issues for edge-of-field and end-of-tile nitrate reduction BMPs

- General:
  - Producer/landowner willingness to adopt BMPs that provide little or no benefit to farm operation – Rules or mandates?
  - Cost-effectiveness as an NRCS or EU practice?
  - O&M needs & who performs these tasks – Role for POTW/EU?
- How much of the landscape is suited to DWM & SB?
  - Limited by topography
- DWM: Need more research on real-world performance
- Saturated buffers: Not yet an NRCS standard practice
- Wetlands: Land taken out of crop production

Potential POTW and/or EU role for edge-of-field BMPS:

With enabling legislation, POTWs could:

- Perform O&M tasks
- Monitor performance

With rules & funding mechanisms, EU could:

- Finance installation and O&M
- On-farm R&D for innovative practices
- Conduct education and outreach w/USDA & Extension
- Track installation and performance as part of statewide database

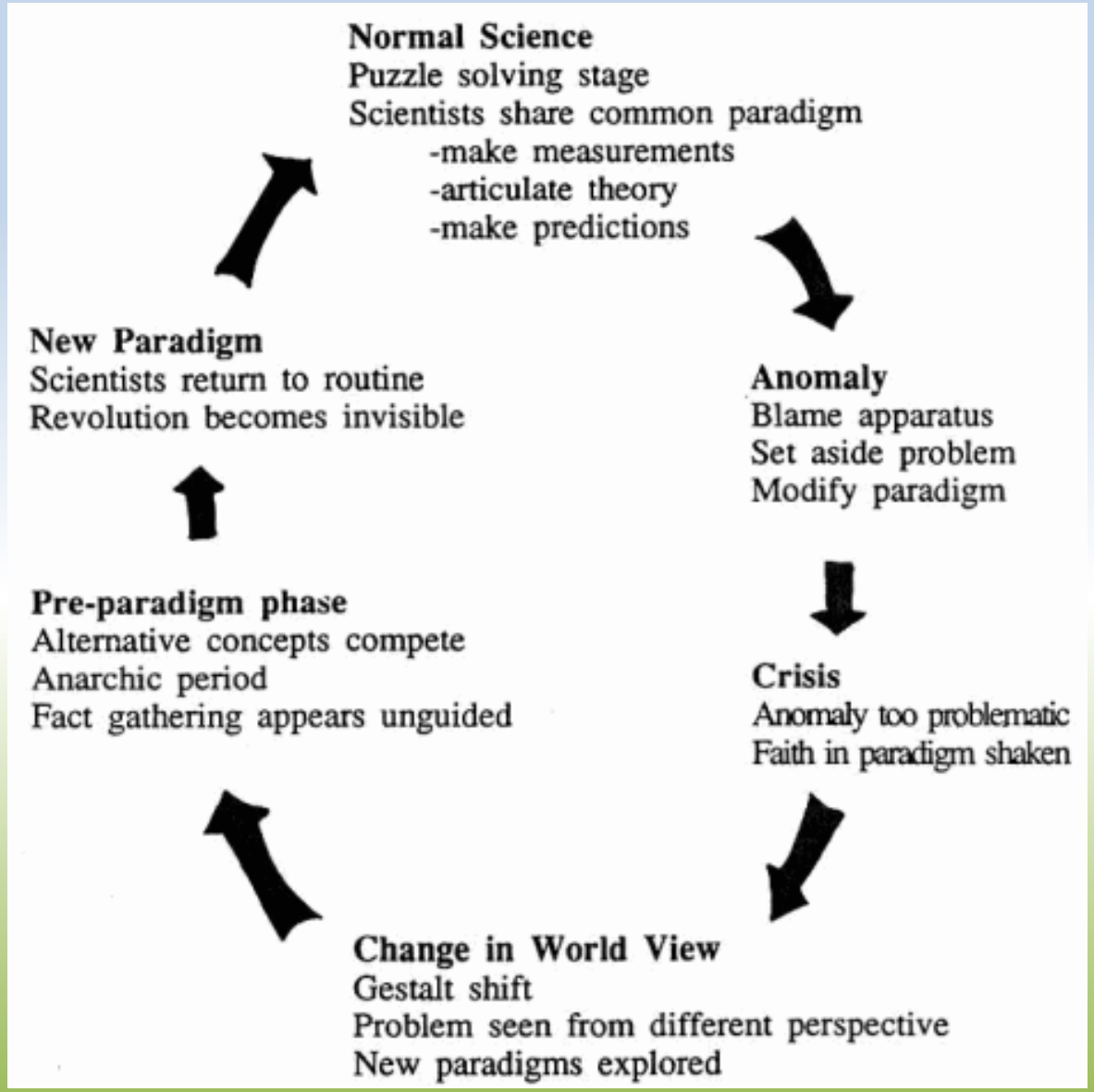
Paradigm change and nutrient loss reduction:

Corn—Soy paradigm adopted between 1950 & 1970

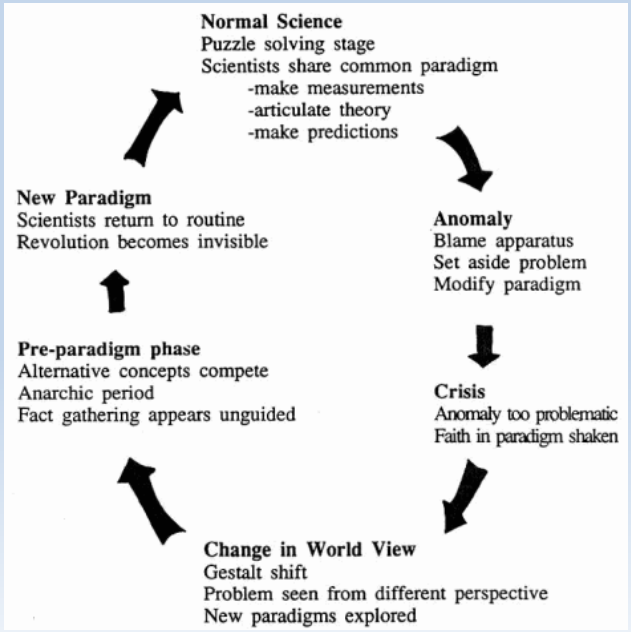
- **Post-WW II:** Wartime munitions plants convert to peace economy – Haber-Bosch process for inorganic N fertilizer
- **Hybrid corn** varieties dramatically increase yields – Need increased N application to achieve yield potential
- **Feedlot system** develops – Grain largely replaces perennial forage crops in livestock rations
- In much of **IL, IA, IN, & MN,** farmers become grain specialists – Livestock & pasture/hay acres drop sharply
- Environmental impacts associated with this paradigm include **WQ problems, habitat loss, & GHG emissions**

Kuhn's Structure of Scientific Revolutions:

Anomalies lead to Crisis → Crisis leads to Paradigm Change



Kuhn cycle



Socio-Economic Paradigm Change:

Dysfunctions can play the role of Anomalies in the Kuhn structure.

Dysfunction → Crisis

It is time for an Agricultural Paradigm Change.

Dysfunction → Crisis

Agricultural Paradigm Change

Dysfunction → Crisis → New Paradigm

Dysfunctionalities of Corn—Soy—Feedlot paradigm:

- Soil erosion and depletion
- Loss of habitat and biodiversity
- Water quality impairment, e.g. Gulf of Mexico hypoxia
- Food system issues, e.g. antibiotic resistance
- Fossil fuel dependence & greenhouse gas emissions
- Others???

These have been addressed as “normal” problems.
But now may have risen to the “crisis” level.
Corn—Soy & MPCS paradigms can co-exist.

Basis for a new agricultural paradigm:

Climate change, the shift to renewable energy, and Gulf hypoxia may drive a paradigm change comparable to the introduction of inorganic fertilizer after WW II.

Biomass crops are the only source of renewable energy that can provide landscape-scale ecological benefits → clean water, wildlife habitat, GHG reduction, soil health …

Multifunctional Perennial Cropping Systems (MPCs) can meet society's need for feed, bioenergy, & bio-based products, and can increase climate resilience.

INLRS notes that perennial crops reduce nutrient loss. Need **markets & eco-payments** for large scale economic viability.

Perennial Biomass Crops

- Switchgrass
- Miscanthus
- Other grasses
- Prairie polycultures
- Willows & other SRC trees

Today → *heat, electricity, forage*

Tomorrow → *cellulosic biofuels, animal feed*

THE AGRICULTURAL WATERSHED INSTITUTE

Reducing nitrate, phosphorus, & soil loss by converting land from annual crops to perennial crops

- Converting from annual crops to perennials reduces nutrient loss by 90% +/-. Also reduces runoff & sediment.
- Strategically located perennials + drainage modifications can increase WQ benefits by treating water that drains across the area converted to perennials:

  - Contour strips & toe-of-slope buffers
  - Harvested saturated buffers or slopes
  - Harvested seasonal wetlands

STRIPS: Science-based Trials of Row-crops Integrated with Prairies

Neal Smith National Wildlife Refuge, Prairie City, IA

12 experimental watersheds, 1 to 8 acres each, 4 to 8% slope

Large reductions in sediment loss were accompanied by large reductions in N and P losses.

Slide courtesy of Matt Helmers, Iowa State

Four treatments:

100% crop (no-till)

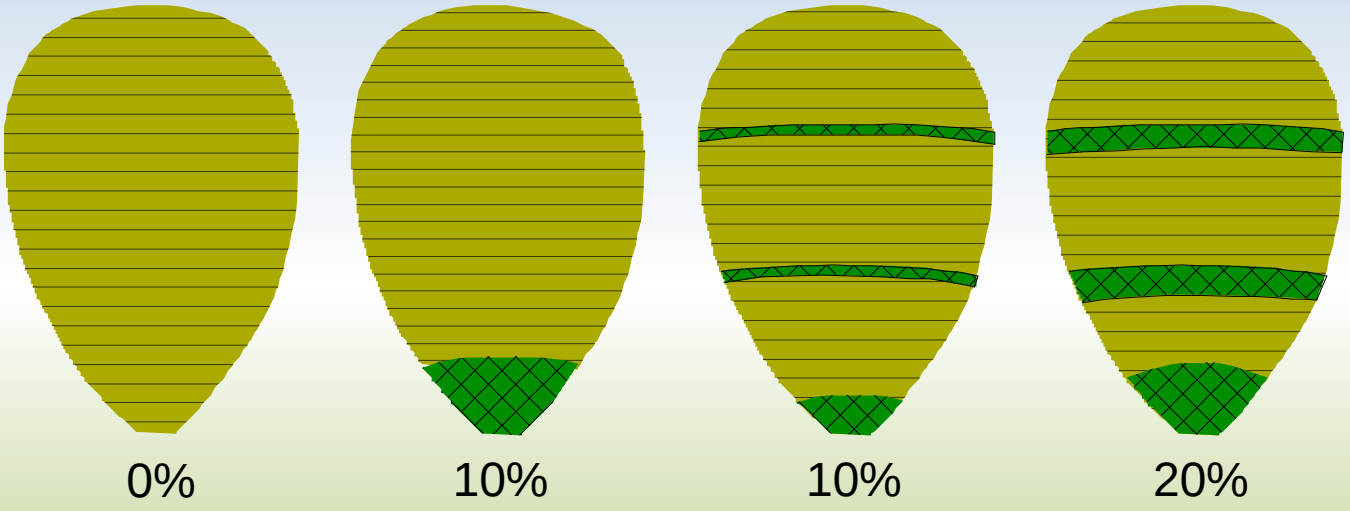
10% buffer, at toe slope

10% buffer, in contour strips

20% buffer, in contour strips

Experimental Watershed Treatments

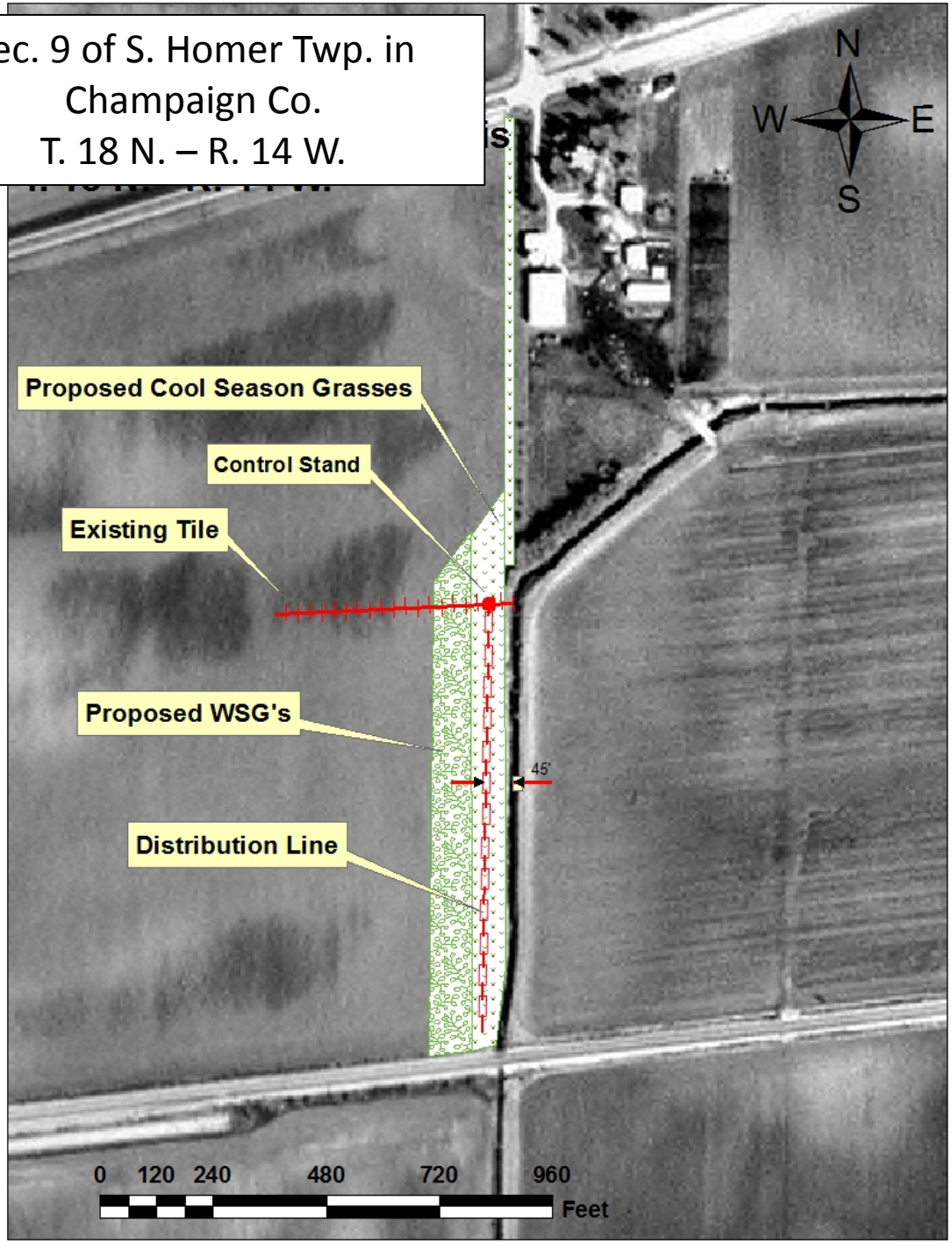
12 watersheds:
Balanced Incomplete Block Design:
3 reps X 4 treatments X 3 blocks



Slide courtesy of Matt Helmers, Iowa State

Harvested Saturated Buffer

Champaign Co. R&D Site (Proposed)



Innovations in agricultural drainage technology can facilitate saturated hillsides and related concepts

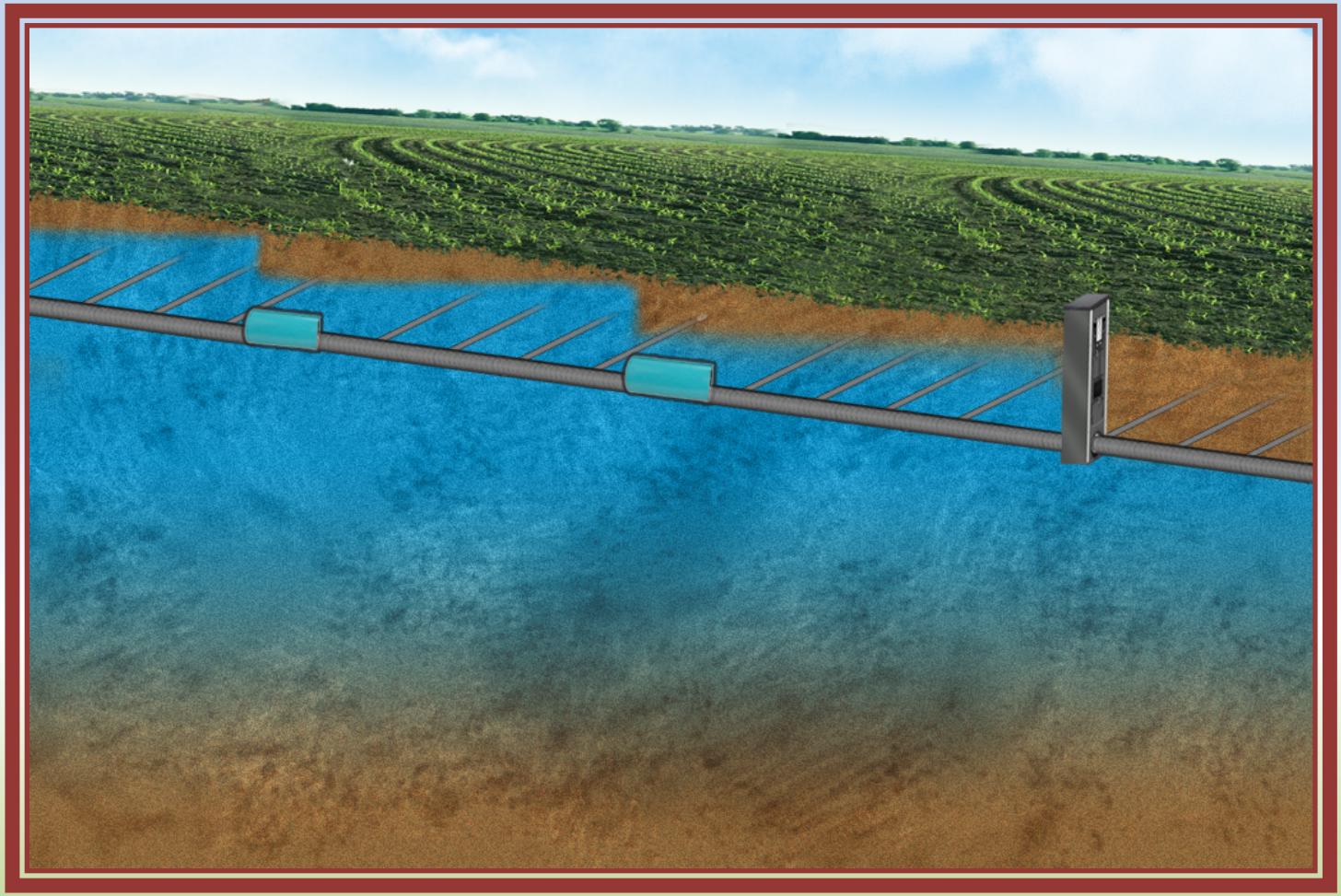


Image courtesy Agri Drain Corp.

Agri Drain's Water Gate float-activated head pressure valves can be used to manage the water table on a sloping field from a single control structure.

Cropland subject to ponding could be converted to harvested seasonal wetlands producing perennial crops that can tolerate periods of saturation

U of I agronomist D. K. Lee developed ‘Savoy’ cordgrass cultivar as a bioenergy crop

Prairie cordgrass *(Spartina pectinata):*

- High yielding warm season native
- Starts growing in early spring
- Thrives in wet conditions
- Could be grown in harvested seasonal wetlands
- Promising candidate for nitrate removal / utilization

Some issues for Perennial Biomass Crops as a nutrient reduction strategy

- **The Big Issue:** Need markets for the biomass & green payments for economic viability
- Need interdisciplinary applied R&D program including:
  - Crop improvement for feedstock plus eco-services
  - Landscape design – Synergies & Trade-offs for multiple goals
  - Engineering design – Develop Low Impact Agriculture concepts
  - Economic analyses from farm & environmental perspective
  - Policy development to achieve wide adoption & optimization
- Need "grass farmers" to produce biomass + eco-benefits
- Apply lessons from past landscape transformations

Linking POTWs and agriculture –

- ✓ Use nutrients in wastewater effluent for crop production
- ✓ Use biomass at POTWs for heat and power

- Nutrients in wastewater effluent are a recyclable resource
- An EU could evaluate opportunities and assess cost-effectiveness of land treatment systems that use wastewater to fertigate crops
  - ➢ As markets develop, fertigation with wastewater could support MPCSs
  - ➢ In soils with low available water holding capacity, studies have already shown supplemental irrigation with wastewater to be a sound investment
- This appears to be a promising area for collaboration among POTWs, consulting engineers, and agricultural specialists

Potential POTW and/or EU role for Perennial Biomass Crops:

POTWs could:

- Use secondary effluent for biomass production – Energy farms on POTW land or private farmland
- Use biomass for renewable energy – Anaerobic digesters or Combined Heat/Power systems

EU could:

- Fund on-farm R&D for innovative MPCSs
- Fund R&D for biomass use by POTWs or PWSs
- Provide “stackable” ecosystem service payments to establish & manage PBCs for clean water objectives
- Finance land treatment & biomass energy systems

Closing thoughts …

- WQ plans generally assume Illinois will grow the same crops in the same proportions in the future.
- Agriculture experienced transformational change in the 20th Century and may again in the 21st.
- Perennial Biomass Crops combined with drainage modifications can capture & use “lost” nutrients.
- An Environmental Utility could be the mechanism to finance and prioritize WQ protection efforts.
- POTWs & engineering firms can identify and test PS/NPS synergies for nutrient reduction / reuse.

THE AGRICULTURAL WATERSHED INSTITUTE

AWI's Mission:

To conduct research and educational programs on practices and policies that:

- improve water quality
- maintain or restore ecosystem health
- conserve and manage land and water resources

in agricultural watersheds.

Funding for the Local Bioenergy Initiative comes mainly from the City of Decatur and the Walton Family Foundation.

Questions

Comments

Discussion

THE AGRICULTURAL WATERSHED INSTITUTE