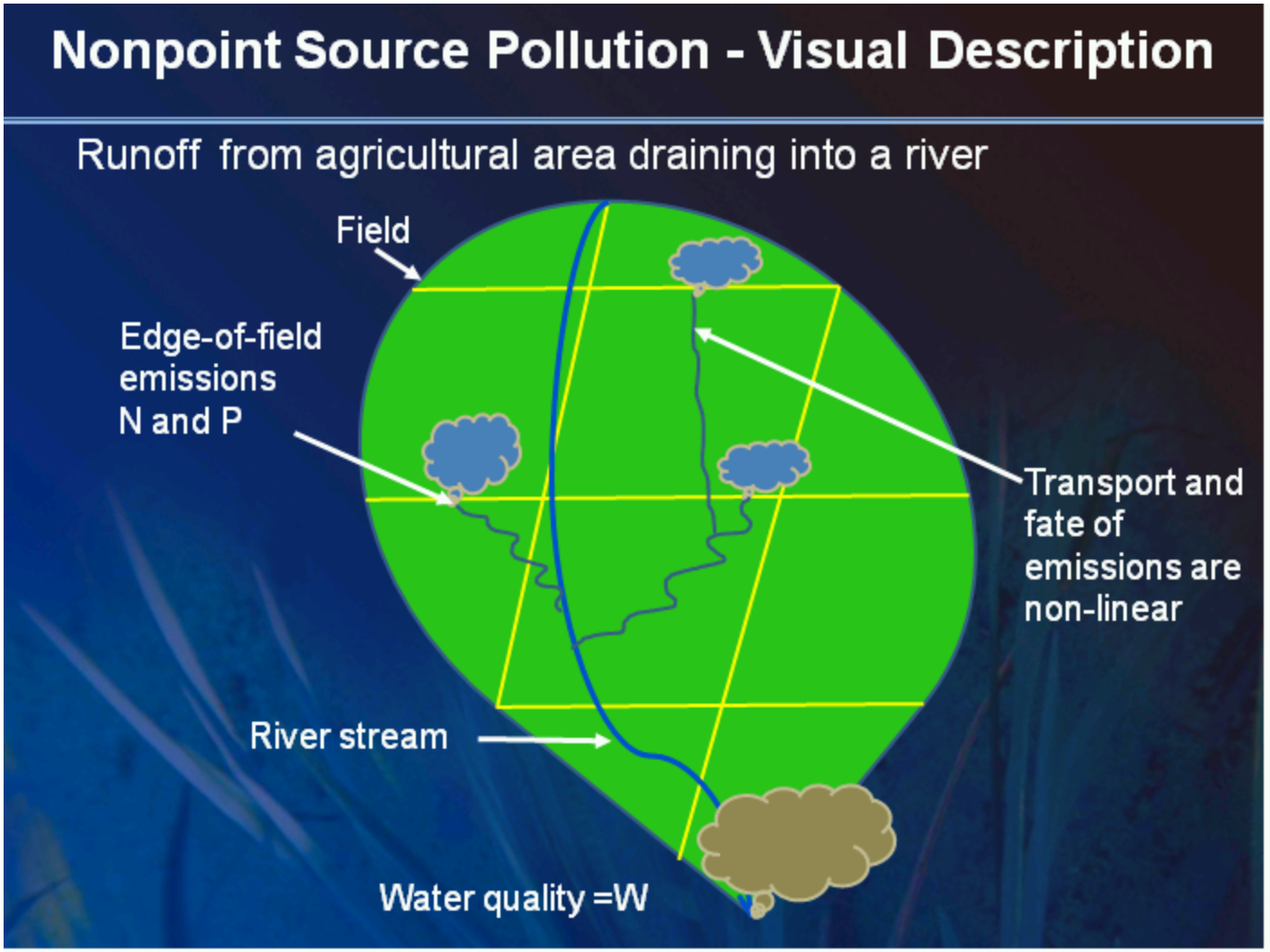
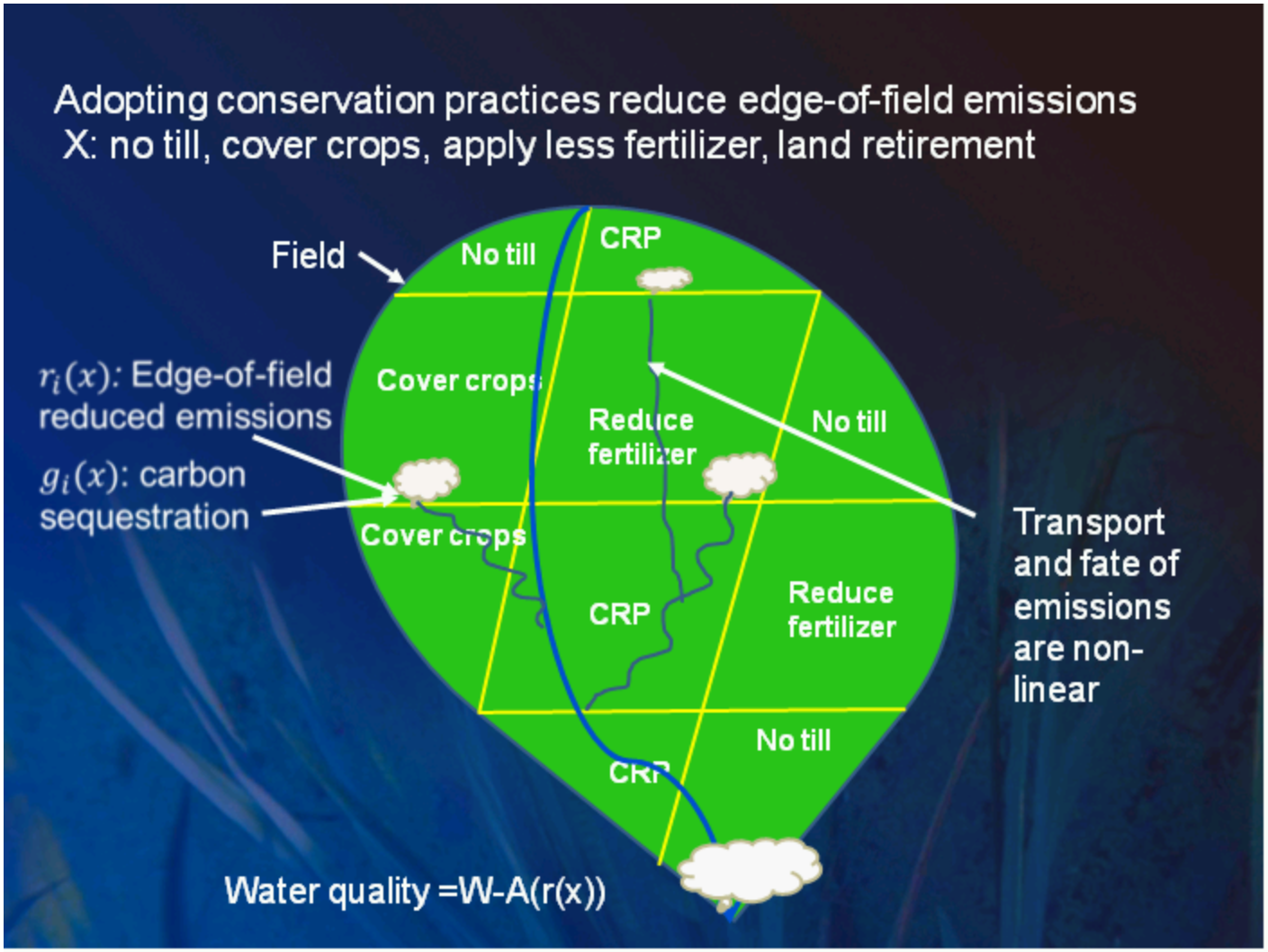
CREDIT STACKING IN AGRI-ENVIRONMENTAL PROGRAMS:WATER QUALITY AND CARBON MARKETS



Nonpoint Source Pollution - Visual Description


Adopting conservation practices reduce edge-of-field emissions
X: no till, cover crops, apply less fertilizer, land retirement
Field
No till
CRP
$r_i(x)$: Edge-of-field reduced emissions
$g_i(x)$: carbon sequestration
Cover crops
Reduce fertilizer
No till
Cover crops
CRP
Reduce fertilizer
Transport and fate of emissions are non-linear
No till
CRP
Water quality =W-A(r(x))

Slide 3


Abatement Actions: Reduced (no) Tillage
No till and corn
No till and soybean
http://www.pickawayswcd.org/pictures/No%20Till%20&%20Strip%20Till/corn_no_till.jpg
http://library.farmprogress.com/WAL0812P73-web-images/08121746A_fmt.jpeg

Slide 4


Abatement Actions: Cover Crops
Cover crops: winter rye
RYE
http://www.sustainablecorn.org/n_Field_Management/img/rye2.JPG
Cover crops: winter rye, no till
http://iowalearningfarms.files.wordpress.com/2012/08/cover_crop_corn_residue.jpg

Slide 5


Land Retirement
Gamma grass-big blue stem planting
http://www.fsa.usda.gov/Internet/FSA_Image/ia_767_15.jpg

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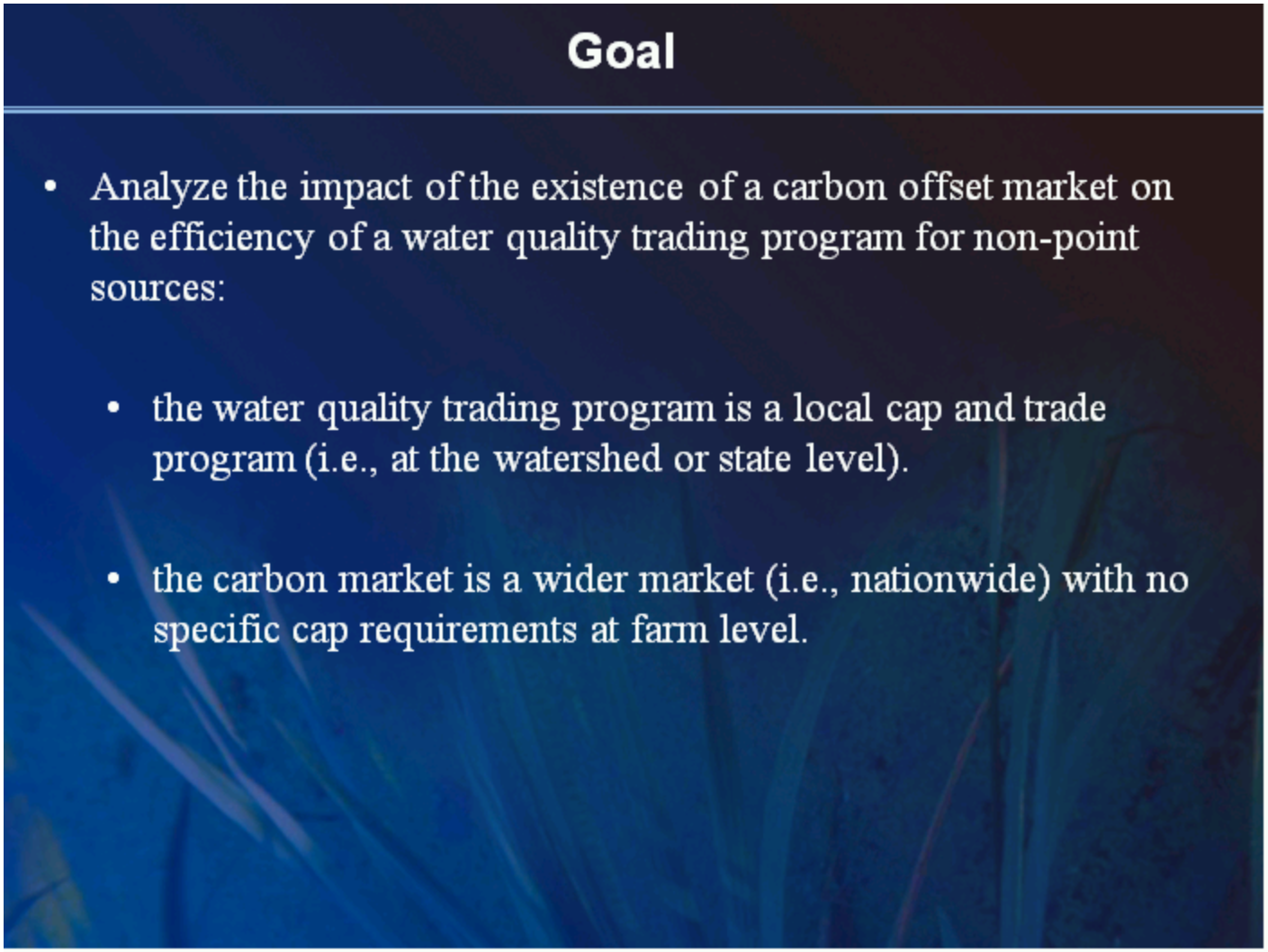
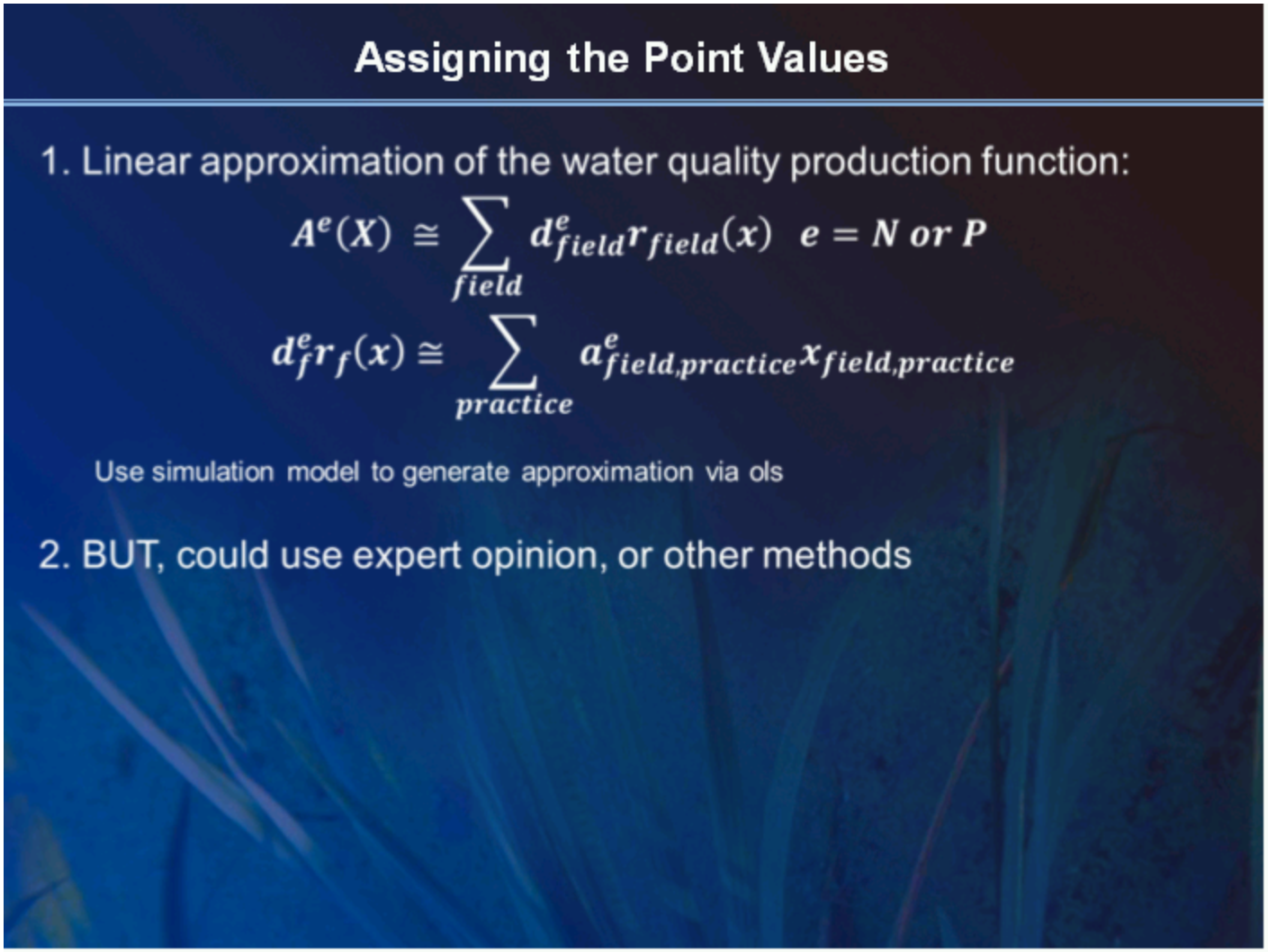
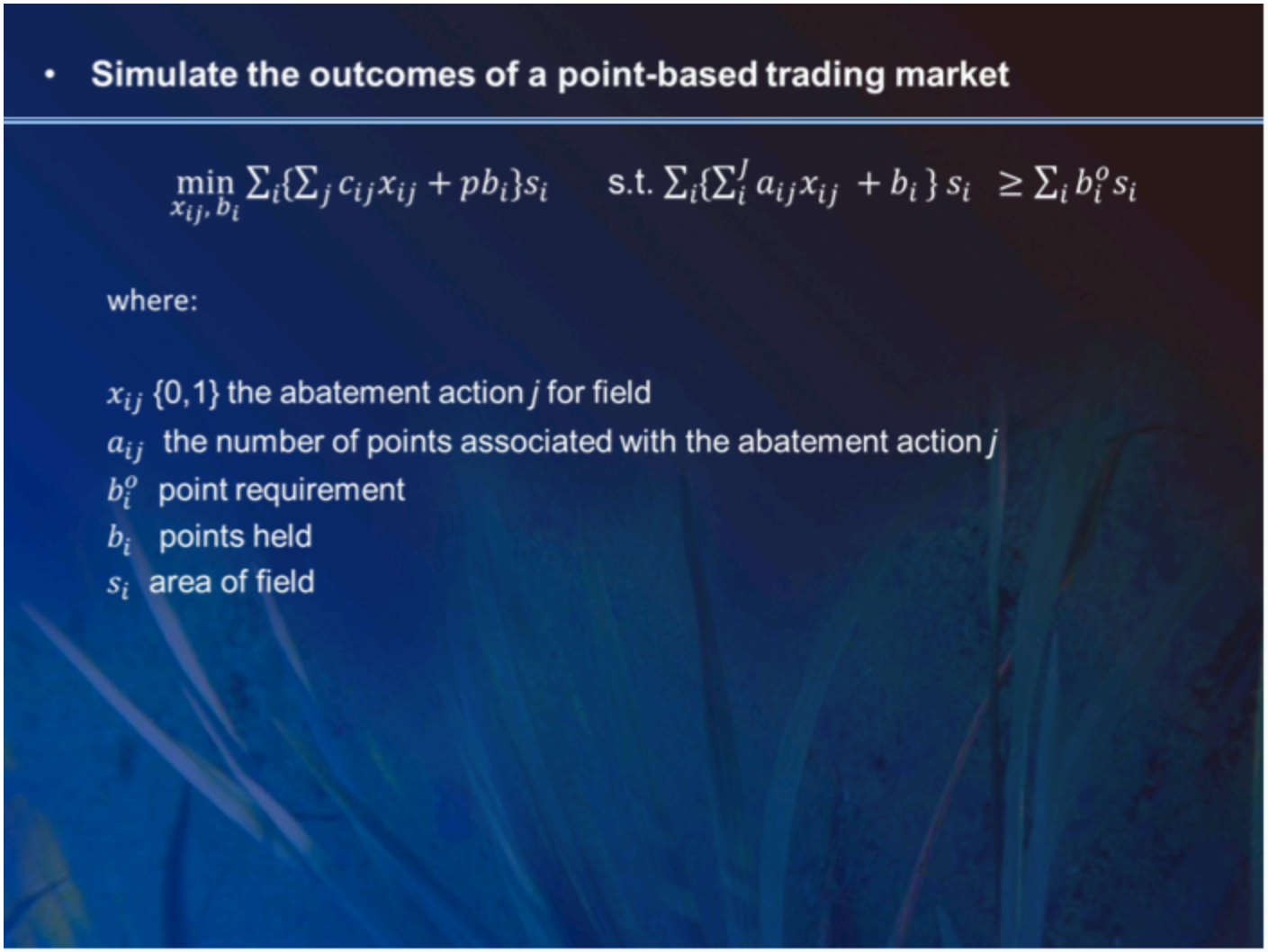

Goal
Analyze the impact of the existence of a carbon offset market on the efficiency of a water quality trading program for non-point sources:
the water quality trading program is a local cap and trade program (i.e., at the watershed or state level).
the carbon market is a wider market (i.e., nationwide) with no specific cap requirements at farm level.

Goal

A point-based trading program for non-point sources



Assigning the Point Values


• Simulate the outcomes of a point-based trading market
$\min_{x_{ij},\, b_i} \sum_i \{\sum_j c_{ij} x_{ij} + p b_i\} s_i$ s.t. $\sum_i \{\sum_i^J a_{ij} x_{ij} + b_i\}\, s_i \geq \sum_i b_i^o s_i$
where:
x_{ij} {0,1} the abatement action j for field
a_{ij} the number of points associated with the abatement action j
b_i^o point requirement
b_i points held
s_i area of field

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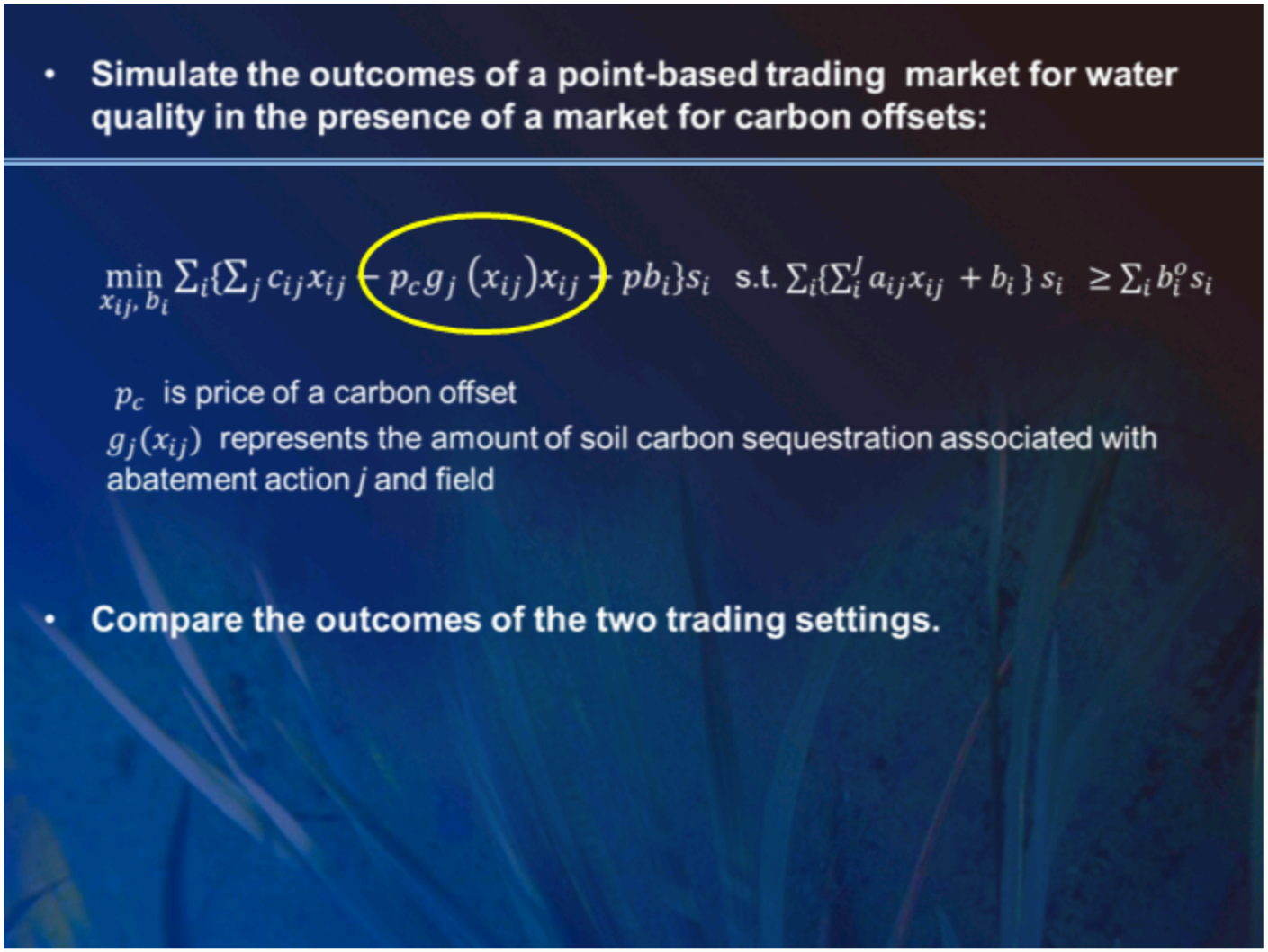
• Simulate the outcomes of a point-based trading market for water quality in the presence of a market for carbon offsets:
$\min_{x_{ij},\, b_i} \sum_i \{\sum_j c_{ij} x_{ij} - p_c g_j(x_{ij}) x_{ij} + p b_i\} s_i$ s.t. $\sum_i \{\sum_i^J a_{ij} x_{ij} + b_i\} s_i \geq \sum_i b_i^o s_i$
p_c is price of a carbon offset
$g_j(x_{ij})$ represents the amount of soil carbon sequestration associated with abatement action j and field
• Compare the outcomes of the two trading settings.

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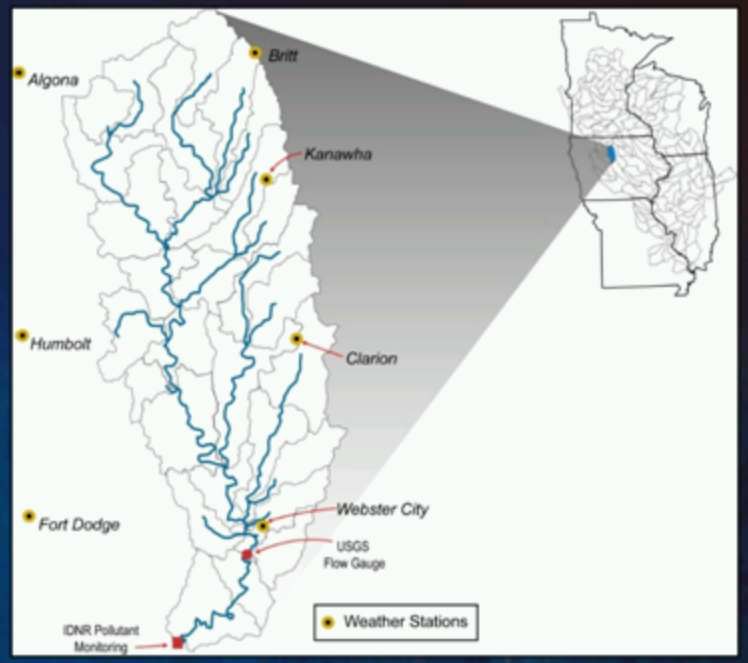
Data

- Boone River Watershed
- Soil Carbon sequestration simulated by EPIC
- Point-based trading markets for N and P
- Price of carbon $5, $15, $25 per eMtCO2



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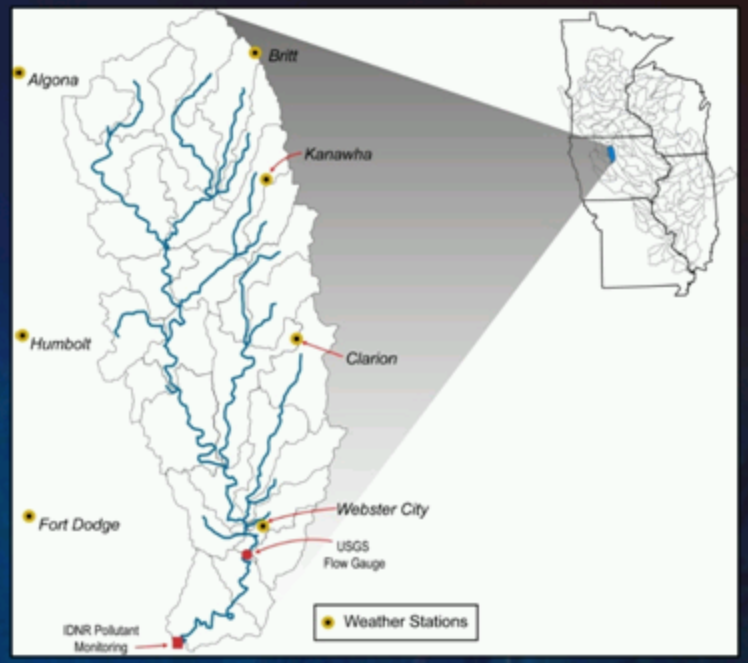
Boone River Watershed

- ~0.53 million acres
- tile drained, 90% corn and soybeans
- some of the highest nitrogen loads in Iowa
- 30 subbasins; 2,900 field units



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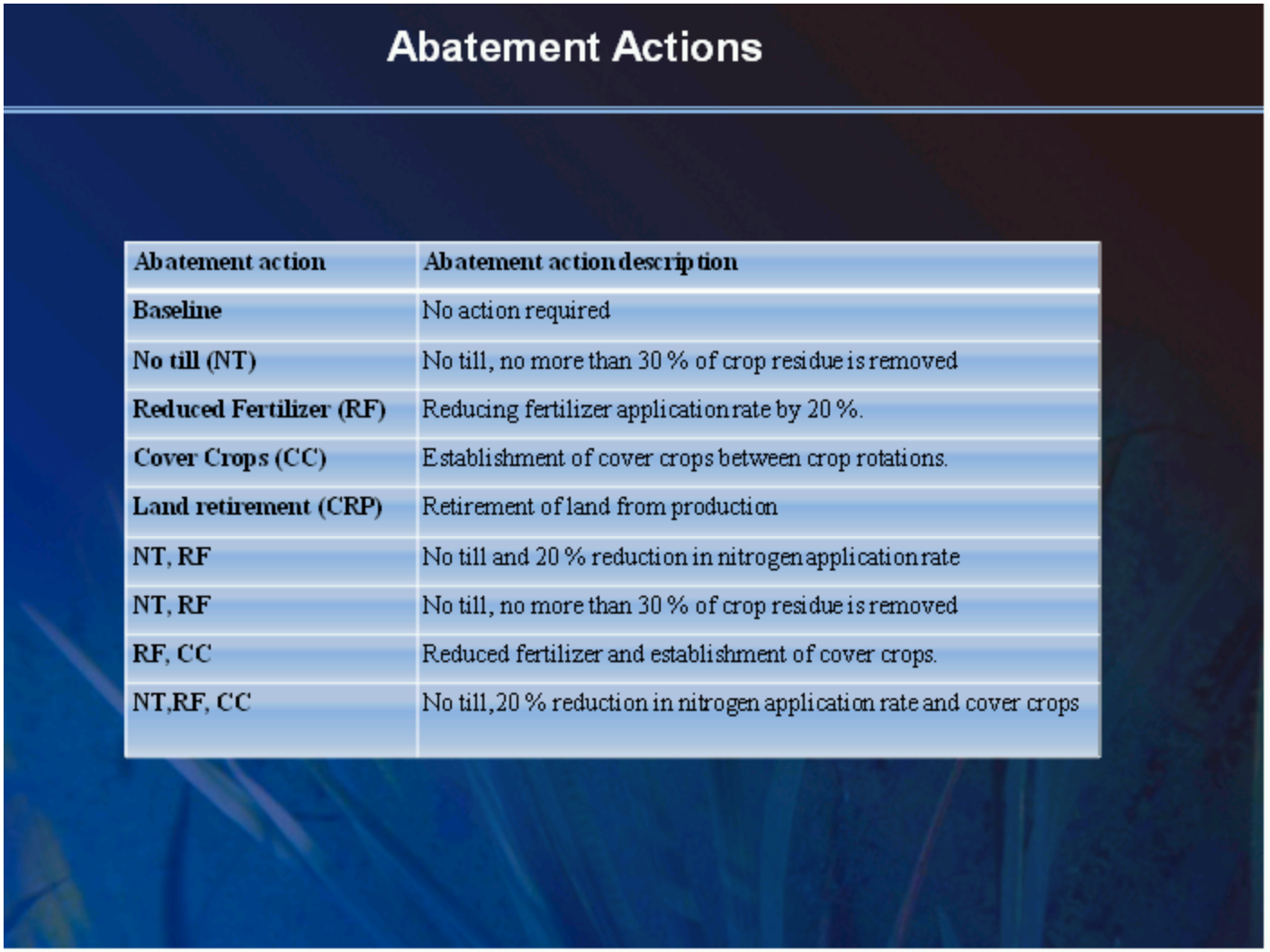
Abatement Actions
Abatement action
Abatement action description
Baseline
No action required
No till (NT)
No till, no more than 30 % of crop residue is removed
Reduced Fertilizer (RF)
Reducing fertilizer application rate by 20 %.
Cover Crops (CC)
Establishment of cover crops between crop rotations.
Land retirement (CRP)
Retirement of land from production
NT, RF
No till and 20 % reduction in nitrogen application rate
NT, RF
No till, no more than 30 % of crop residue is removed
RF, CC
Reduced fertilizer and establishment of cover crops.
NT,RF, CC
No till,20 % reduction in nitrogen application rate and cover crops

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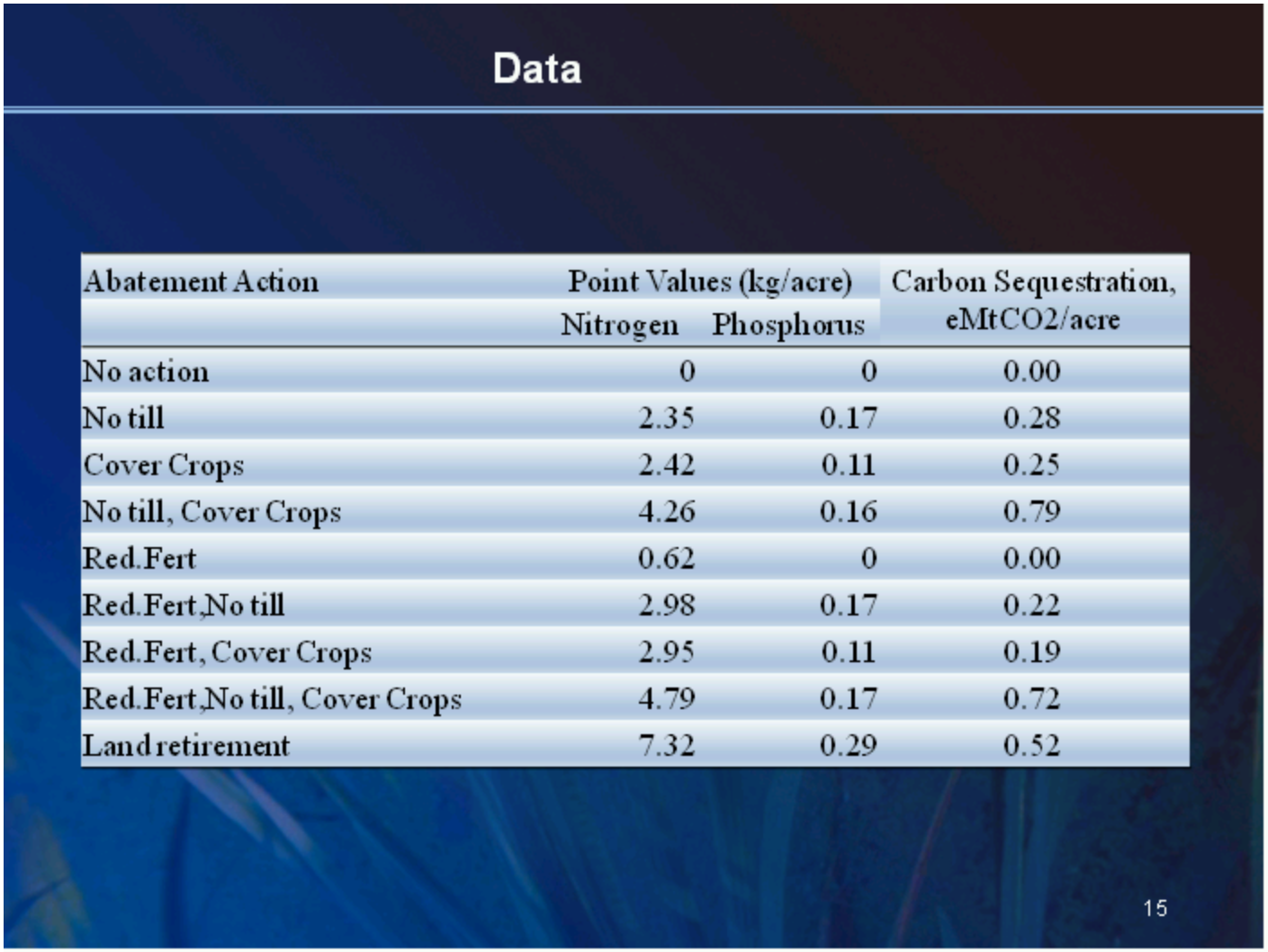

Abatement Action	Point Values (kg/acre)		Carbon Sequestration, eMtCO2/acre
	Nitrogen	Phosphorus	
No action	0	0	0.00
No till	2.35	0.17	0.28
Cover Crops	2.42	0.11	0.25
No till, Cover Crops	4.26	0.16	0.79
Red.Fert	0.62	0	0.00
Red.Fert,No till	2.98	0.17	0.22
Red.Fert, Cover Crops	2.95	0.11	0.19
Red.Fert,No till, Cover Crops	4.79	0.17	0.72
Land retirement	7.32	0.29	0.52

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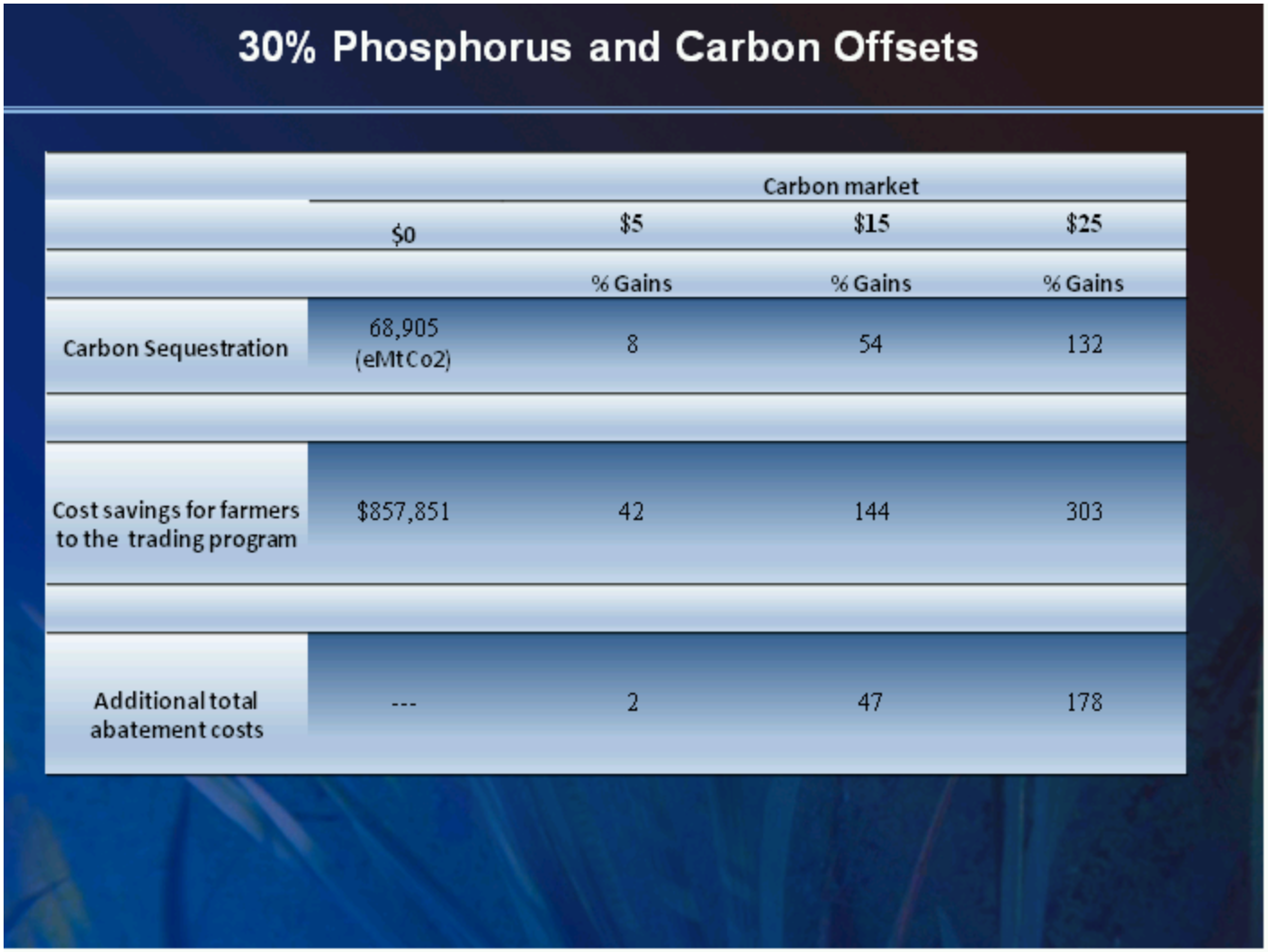
30% Phosphorus and Carbon Offsets
Carbon market
$0
$5
$15
$25
% Gains
% Gains
% Gains
Carbon Sequestration
68,905 (eMtCo2)
8
54
132
Cost savings for farmers to the trading program
$857,851
42
144
303
Additional total abatement costs

2
47
178

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30% N Water quality and Carbon Offsets

	No carbon Market	Carbon market		
	$0	$5	$15	$25
		% Gains	% Gains	% Gains
Total Carbon Sequestration	135,833 (eMtCo2)	9	26	40
Cost savings for farmers to the trading program	2,515,932	28	92	166
Additional total abatement costs	---	1	11	28

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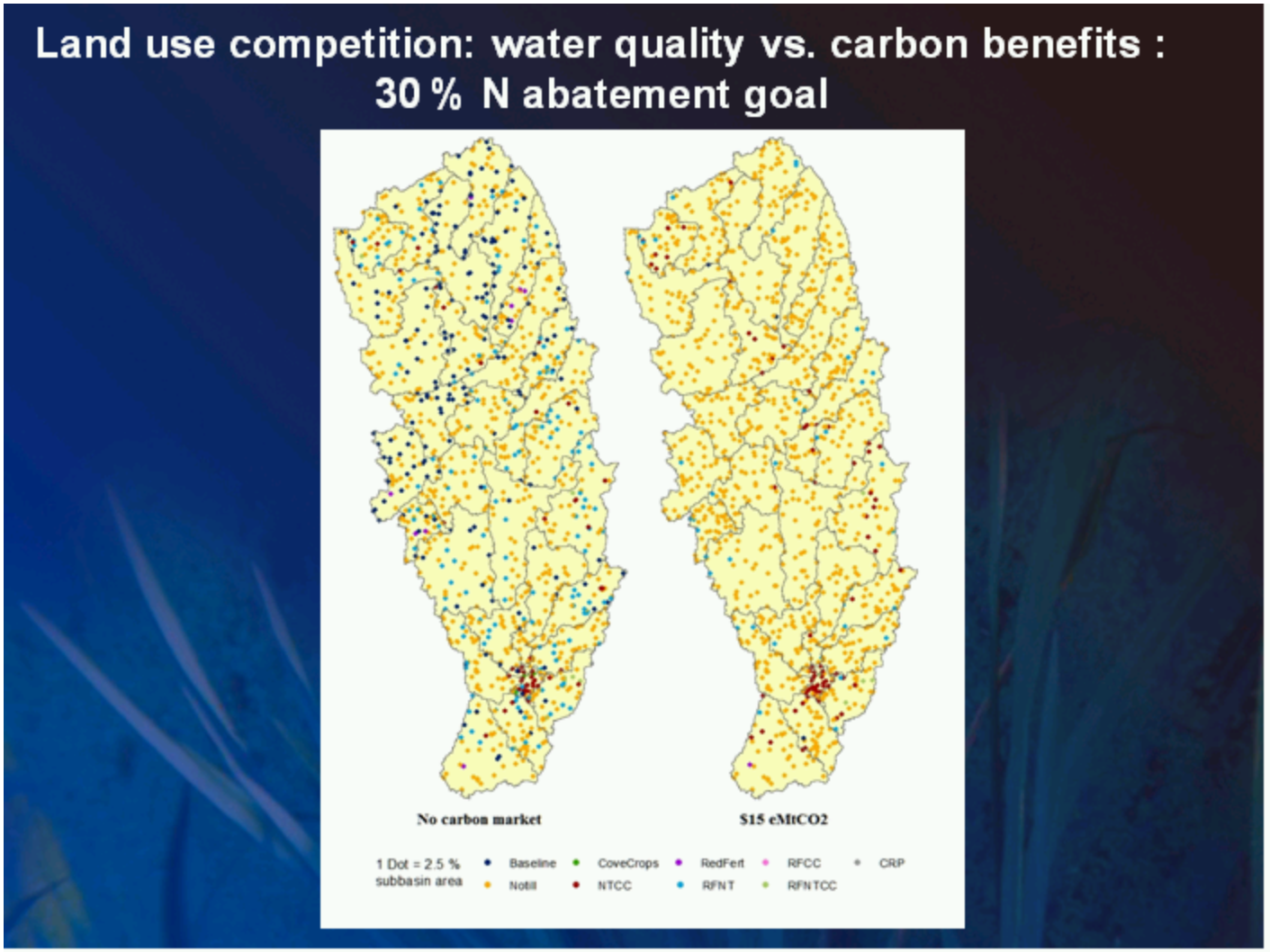
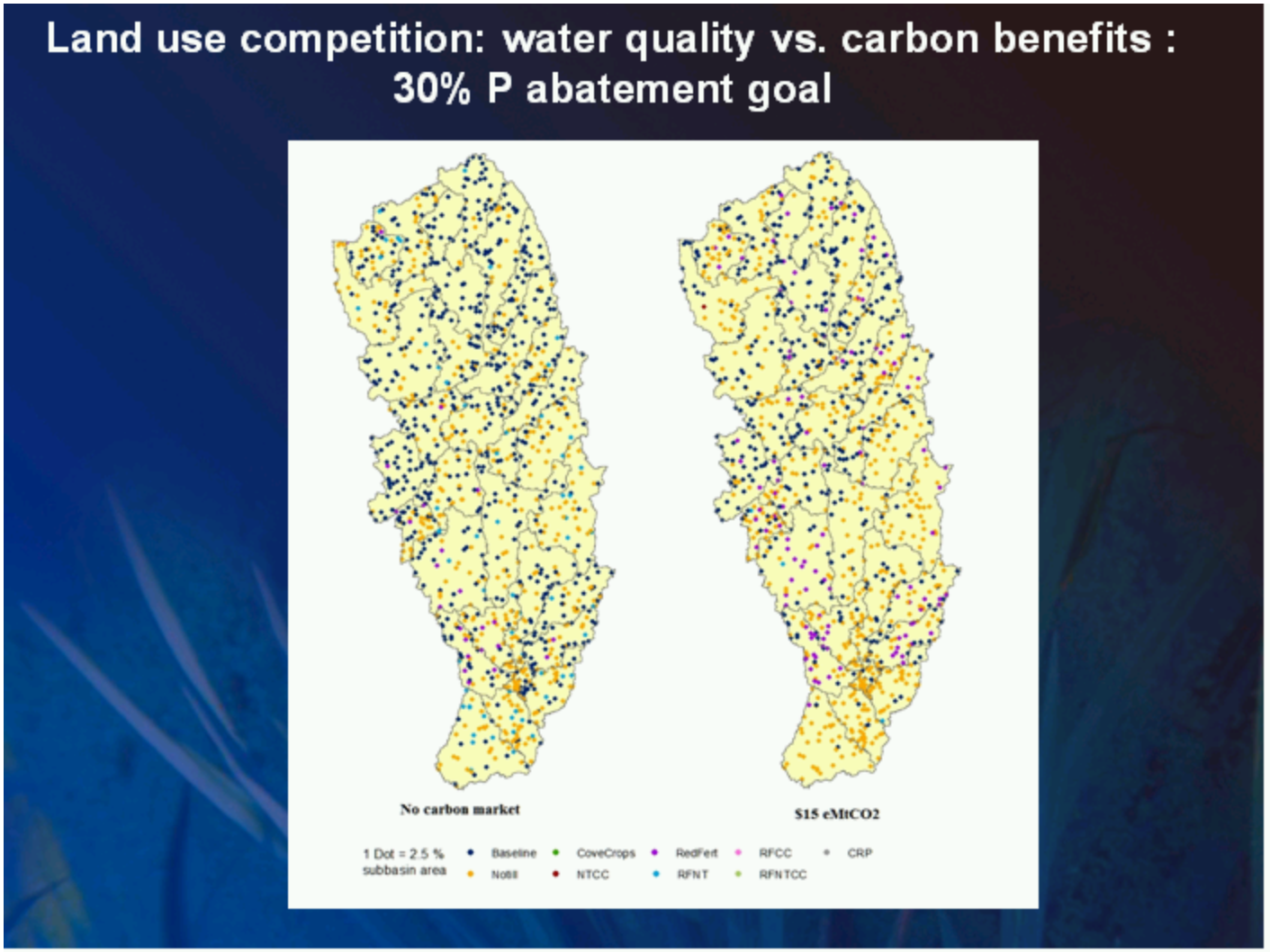
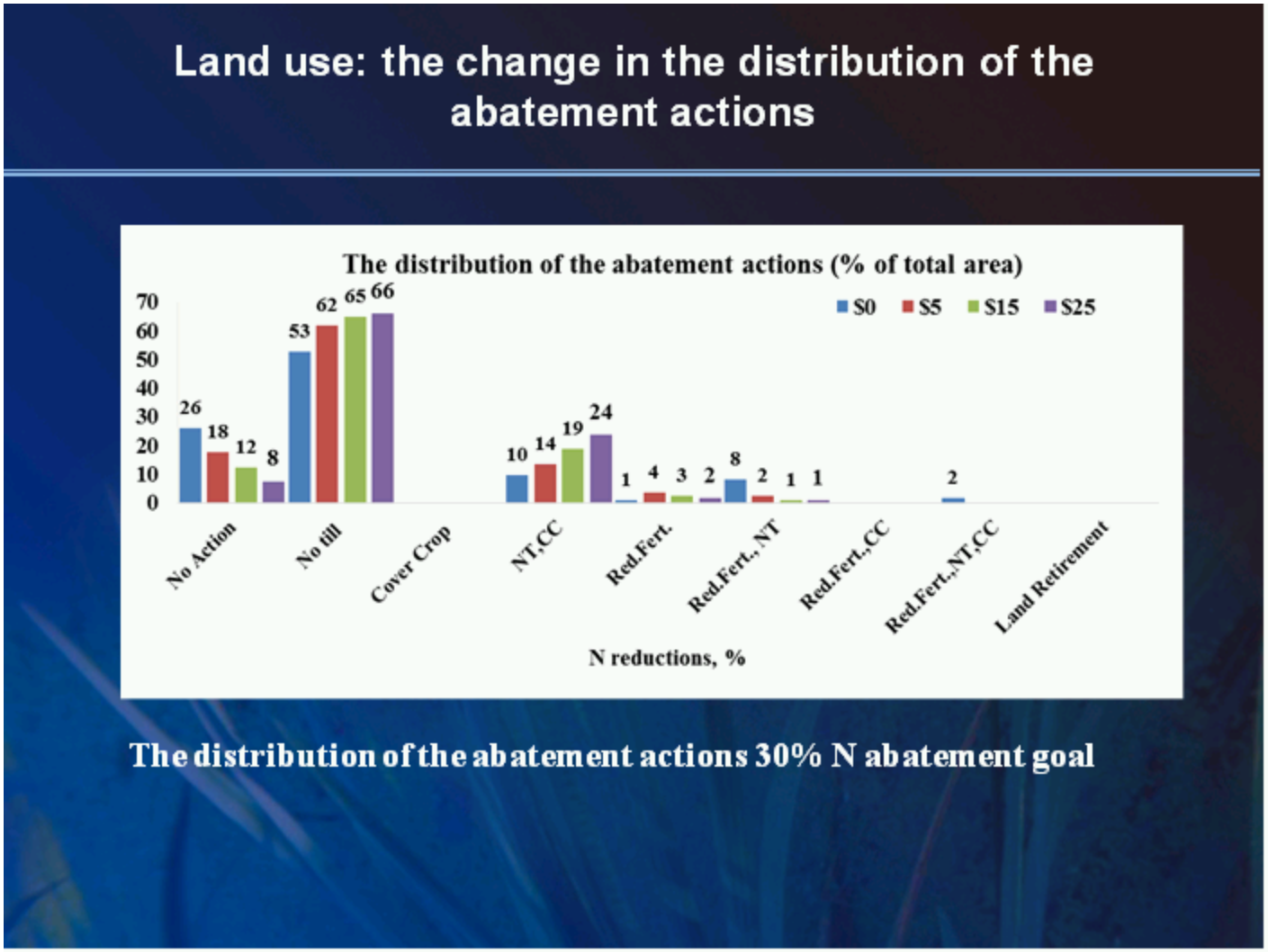


Land use competition: water quality vs. carbon benefits : 30 % N abatement goal



Land use competition: water quality vs. carbon benefits : 30% P abatement goal



Land use: the change in the distribution of the abatement actions

Final Comments

- At relatively modest carbon prices, the total program costs become negative, meaning that farmers obtain extra revenue by selling carbon offsets
- While the program cost is reduced, since more expensive abatement actions are adopted, the total cost of implementing the abatement actions increases.
- Loads of appreciation to the USDA ERS cooperative  that made this possible

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