

# **META-ECONOMICS OF COVER CROPS**

---

**Paul D. Mitchell**

Agricultural and Applied Economics, UW-Madison

**Science of Cover Crops**

**Madison, WI**

**March 14, 2014**

# What is Meta-Economics?

- The Economics of Cover Crops
  - Start by putting a dollar value estimate to some benefits of cover crops
- The Meta-Economics of Cover Crops
  - The Economics of the Economics of Cover Crops
  - Deeper and broader economic principles that drive human behavior relative to cover crops

# Cover Crop Benefits

- Reduced soil erosion
- Nutrient capture and release for crop use
- Additional forage
- Suppression of weeds, insects, pathogens
- Improved soil health

# What is the Value of a Ton of Soil?

- Suppose you prevent some soil erosion, what's it worth?
- Hansen and Ribaudó (2008) "Economic Measures of Soil Conservation Benefits: Regional Values for Policy Assessment" USDA ERS TB 1922
- Lit review, multiple impacts, by county for policy analysis
- Irrigation ditches & canals, **Recreational fishing**, Freshwater & marine fisheries, Flood damages, Road drainage ditches, Municipal & industrial water use, Municipal water treatment, Steam power plants, Soil productivity, Dust cleaning, **Water-based recreation**, Navigation, Reservoir services
- **Lower bound on value of eroded/saved soil**

Figure 5

Range and distribution of all water-erosion benefit values, by county

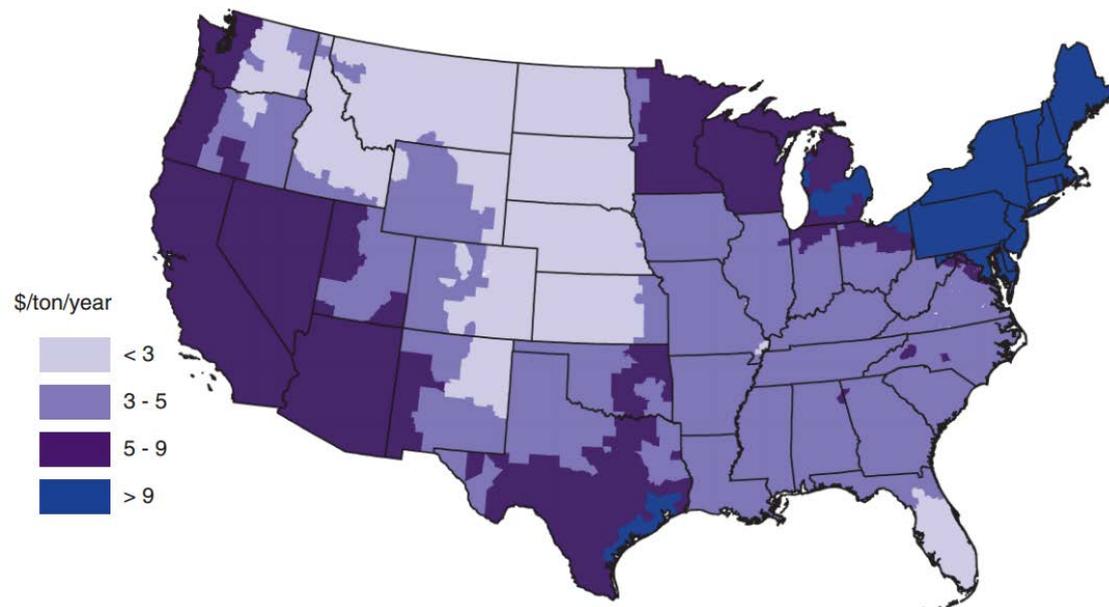
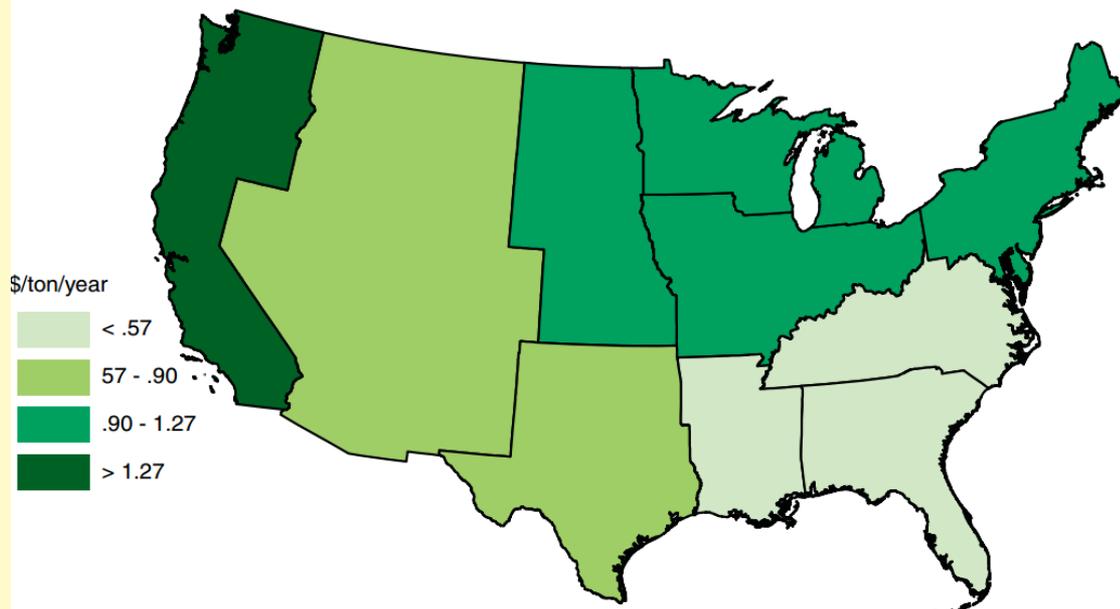


Figure 6

Range and distribution of all wind-erosion benefit values, by county



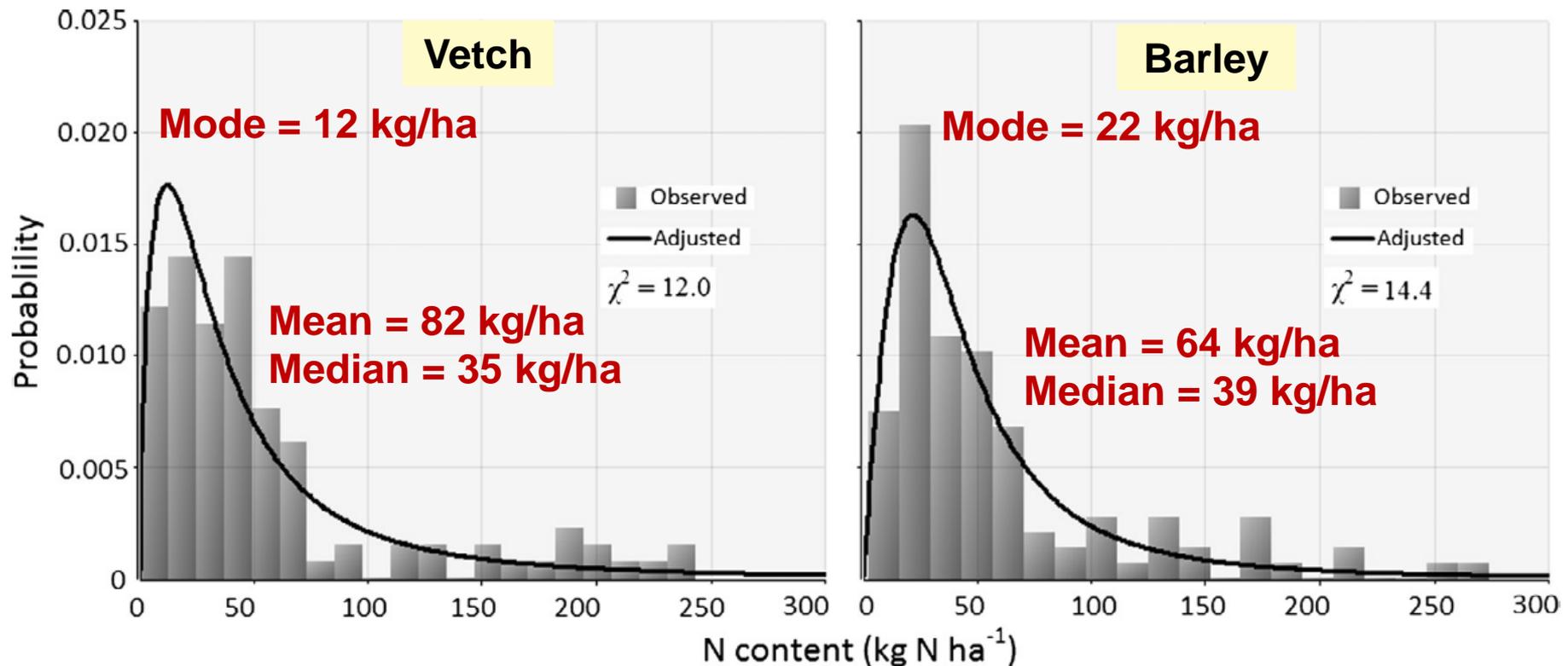
- Benefit in WI ranges from \$8.81 to \$6.57/ton
- \$1.21/ton of this is for Soil Productivity
- Fairly constant across WI counties

# Soil Erosion: Farmer Cost

- Farmer's direct cost as Soil Productivity Loss = \$1.21/ton
- In 1990 dollars, so convert to current dollars using CPI:  
$$\$1.21 \times 1.79 = \$2.17/\text{ton annually}$$
- Wisconsin state average soil loss is 4.6 tons/A in 2007  
(Google "Soil Erosion on Cropland 2007 NRCS")  
$$\$2.17/\text{ton} \times 4.6 \text{ ton/A} = \$9.98/\text{A annually}$$
- Soil erosion costs WI farmers on average about \$10/A in lost productivity each year
- Maximum average erosion reduction benefits cover crops can generate for farmers if they completely eliminated soil erosion

# Cover Crops and Nitrogen

- How much N do cover crops immobilize for follow crops?
- Gabriel et al. (2013), 5-year study in Spain, cover crops before corn, estimated probability functions
- Very skewed, with lots of low values, fewer high values



# Cover Crops and Nitrogen

- Just because a cover crop immobilizes N does not mean the follow crop gets it!
- Depends on cover crop termination method, soil temperature and moisture, timing relative to the major uptake period of the follow crop, cover crop species, ...
- Gabriel et al. (2013): average uptake rate by corn
  - 90% for barley
  - 81% for vetch
  - 65% for rapeseed
- Some cover crops consume soil N as they decompose
  - Ruark and Stute: “Cover Crop Considerations for 2012”

# Cover Crops and Nitrogen

- UW Extension, Ruark and Stute: N credits vary by cover crop species, size and planting date
- **Can credit about 40 lbs N per acre, sometimes more**
- Enough N to justify the cost?

**Table 9.5.** Green manure nitrogen credits.

| Crop          | < 6" growth                  | > 6" growth          |
|---------------|------------------------------|----------------------|
|               | ----- lb N/a to credit ----- |                      |
| Alfalfa       | 40                           | 60-100 <sup>a</sup>  |
| Clover, red   | 40                           | 50-80 <sup>a</sup>   |
| Clover, sweet | 40                           | 80-120 <sup>a</sup>  |
| Vetch         | 40                           | 40-90 <sup>a,b</sup> |

<sup>a</sup> Use the upper end of the range for spring seeded green manures that are plowed under the following spring. Use the lower end of the range for fall seedings.

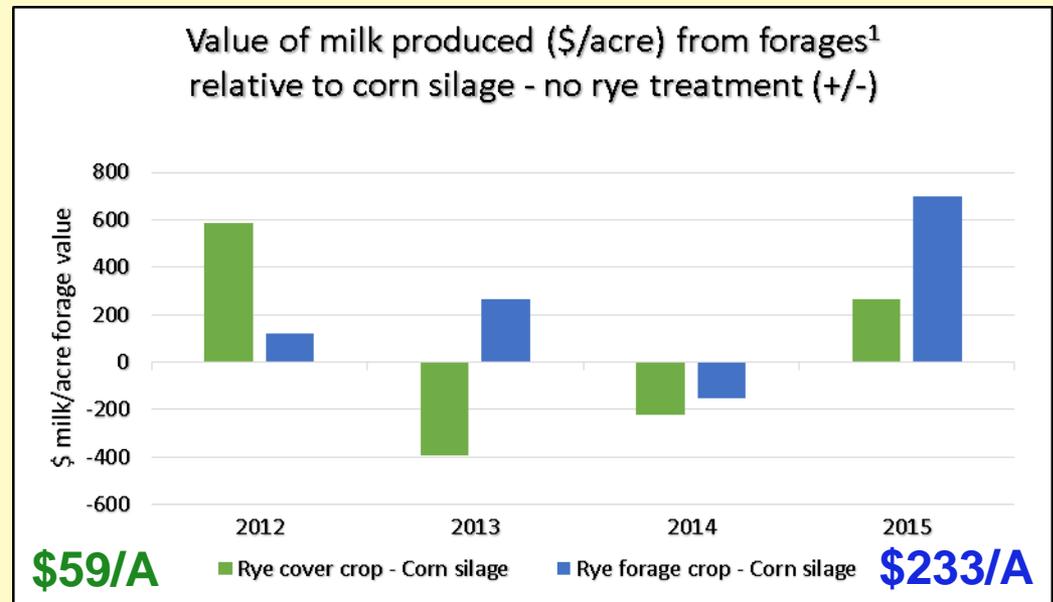
<sup>b</sup> If top growth is more than 12 inches before tillage credit 110-160 lb N/a.

| N Price   | N Value at 40 lbs/A | N Value at 60 lbs/A |
|-----------|---------------------|---------------------|
| \$0.35/lb | \$14                | \$21                |
| \$0.40/lb | \$16                | \$24                |
| \$0.45/lb | \$18                | \$27                |
| \$0.50/lb | \$20                | \$30                |

# Benefits of Cover Crops: Forage

- Early season rye forage before plant corn silage
- Affects quantity and quality of following corn silage crop

- Shelley, West & Ruark
- No-till continuous corn silage compared to
  - Corn silage with rye cover crop
  - Corn silage with rye forage crop



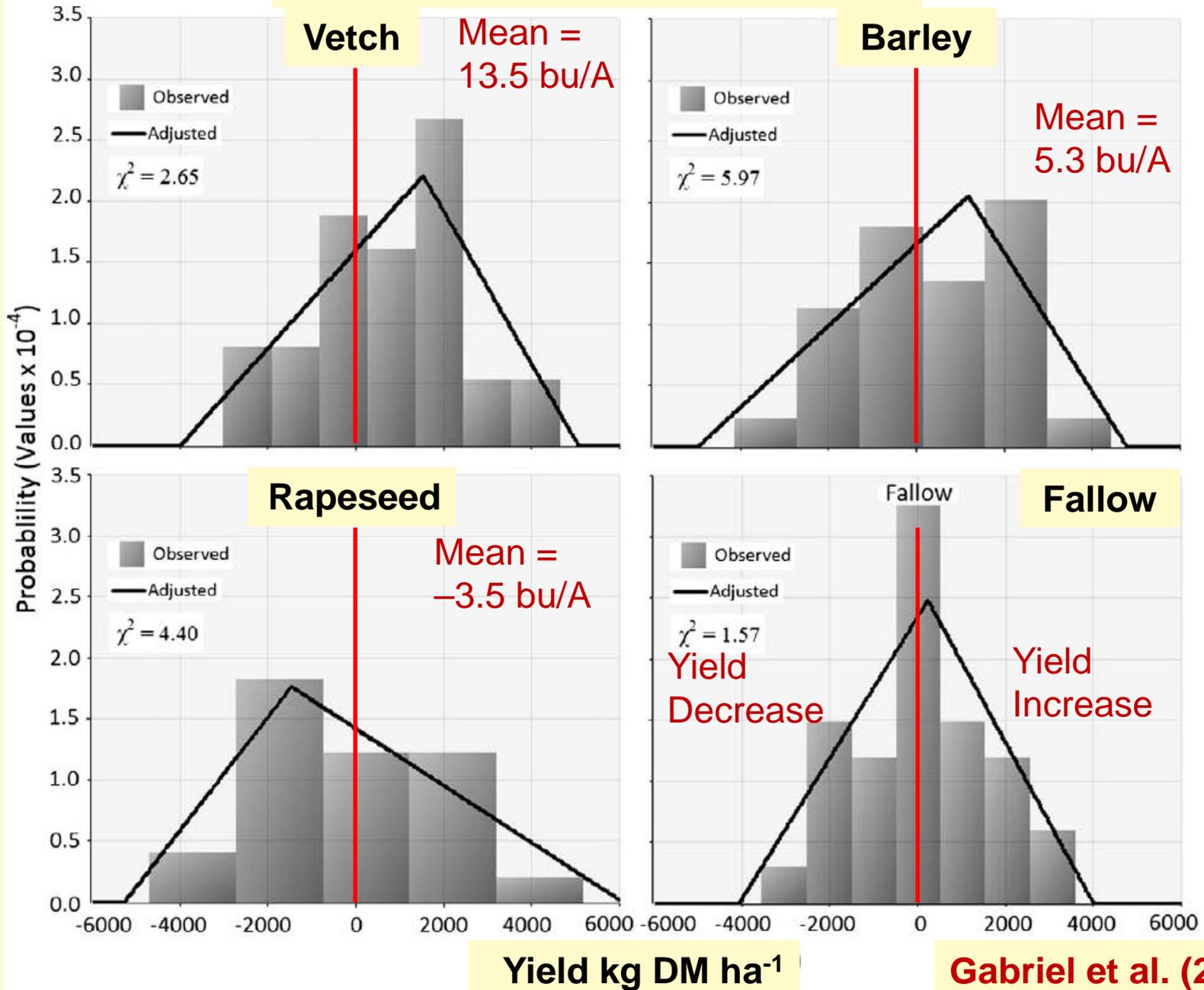
- Net gain as extra milk produced (\$/A) relative to continuous corn silage; pay for seed, planting, herbicide, extra forage harvest, additional nutrients removed

# Cover Crops and Soil Moisture

- Cover crop X crop X environment X management interactions matter: **Sometimes worse off with cover crops**
- Cover crops use soil moisture, which is good in wet years and heavy soils, but bad in dry years and lighter soils
- 2012 drought year versus 2013 wet spring
- Rye cover crop harvested May 10, corn planted in both areas same day
- Cover crop used soil moisture in a year that it mattered (2012)
- Same effect if were cover cropping for 20 years???

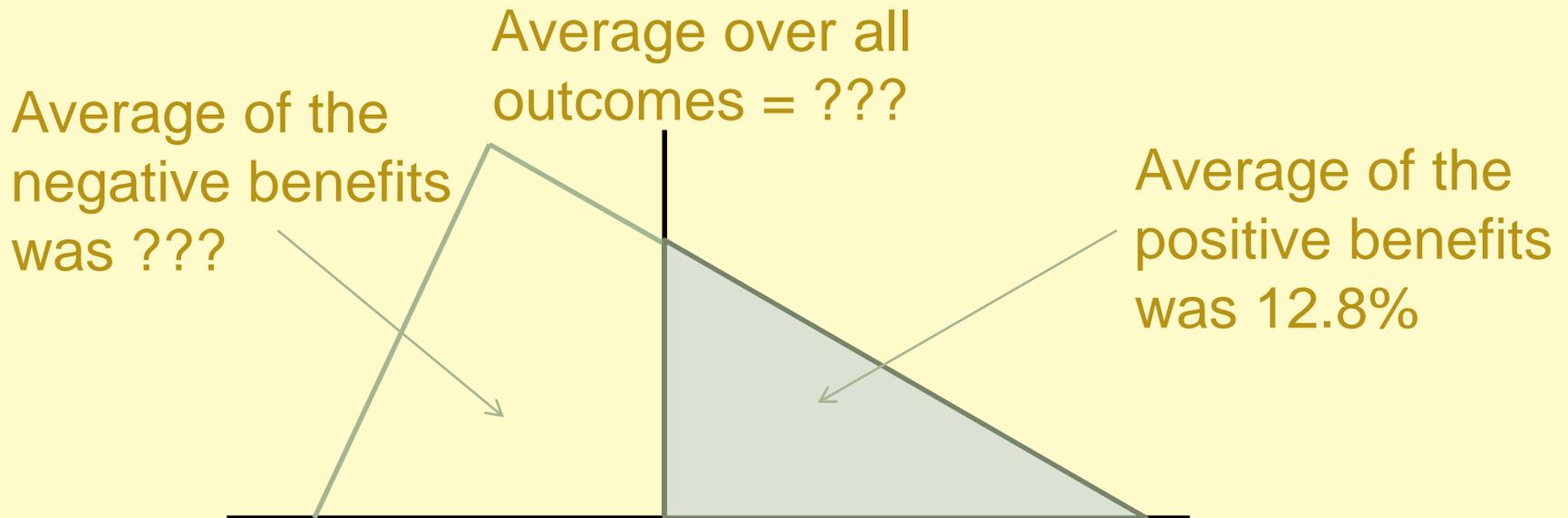


# Yield and Cover Crops



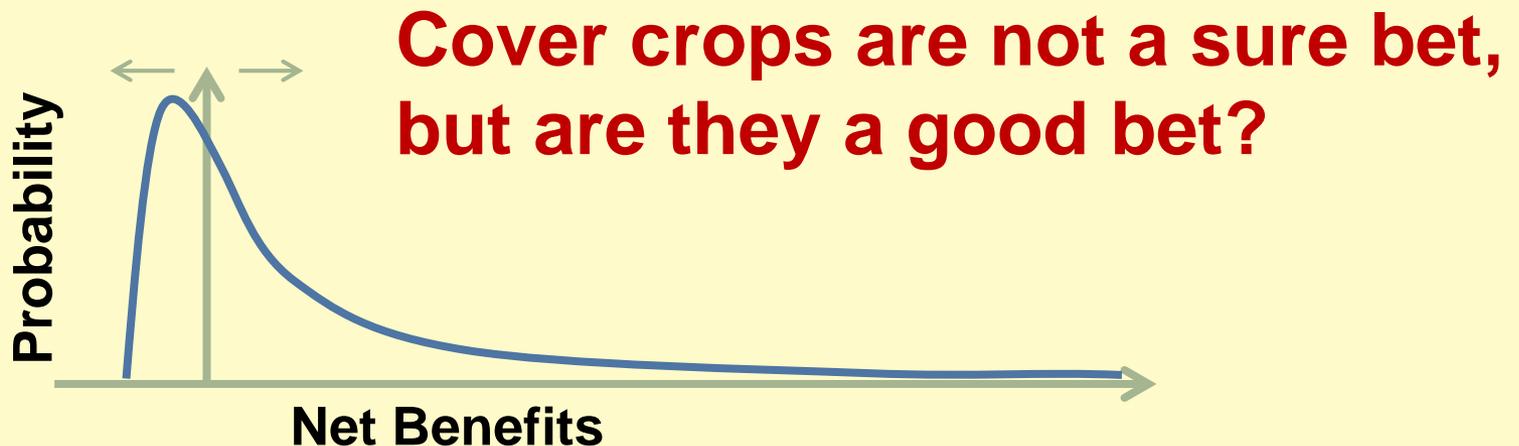
# Benefits of Cover Crops: Yield

- Bergtold et al. (2012) survey of 300 Alabama farmers
- 67% had used cover crop in last three years
- 37% of adopters perceived a yield benefit (63% did not)
- Of those perceiving a benefit, average benefit was 12.8% across crops



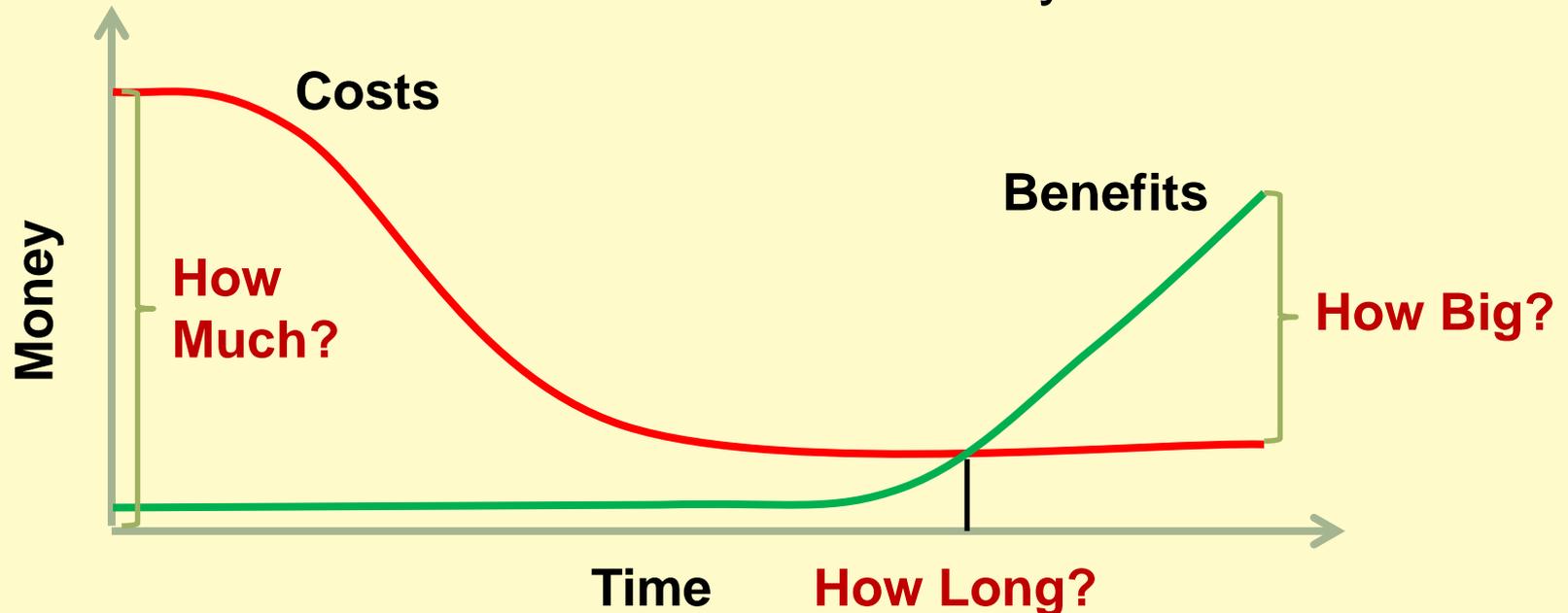
# Economics of Cover Crops

- **Net Benefit = Price x Extra Yield – Extra Costs**
- Is the yield increase on average enough to justify the cover crop cost? To justify the risk?
- Is the N cost savings enough to justify the yield risk?
- Depends on your costs and your willingness and capacity to bear risk, how much you discount the future, and your value from the non-monetary benefits of cover crops



# Costs, Benefits and the Human Condition

- A common issue underlying many human problems
- Pay high costs now, wait a long time before benefits become apparent and eventually exceed costs
- Switch costs and benefits: Benefits large now and high costs not paid until the future
- Add the variability and it becomes even more unclear: Good or bad outcomes due to luck or your choices?

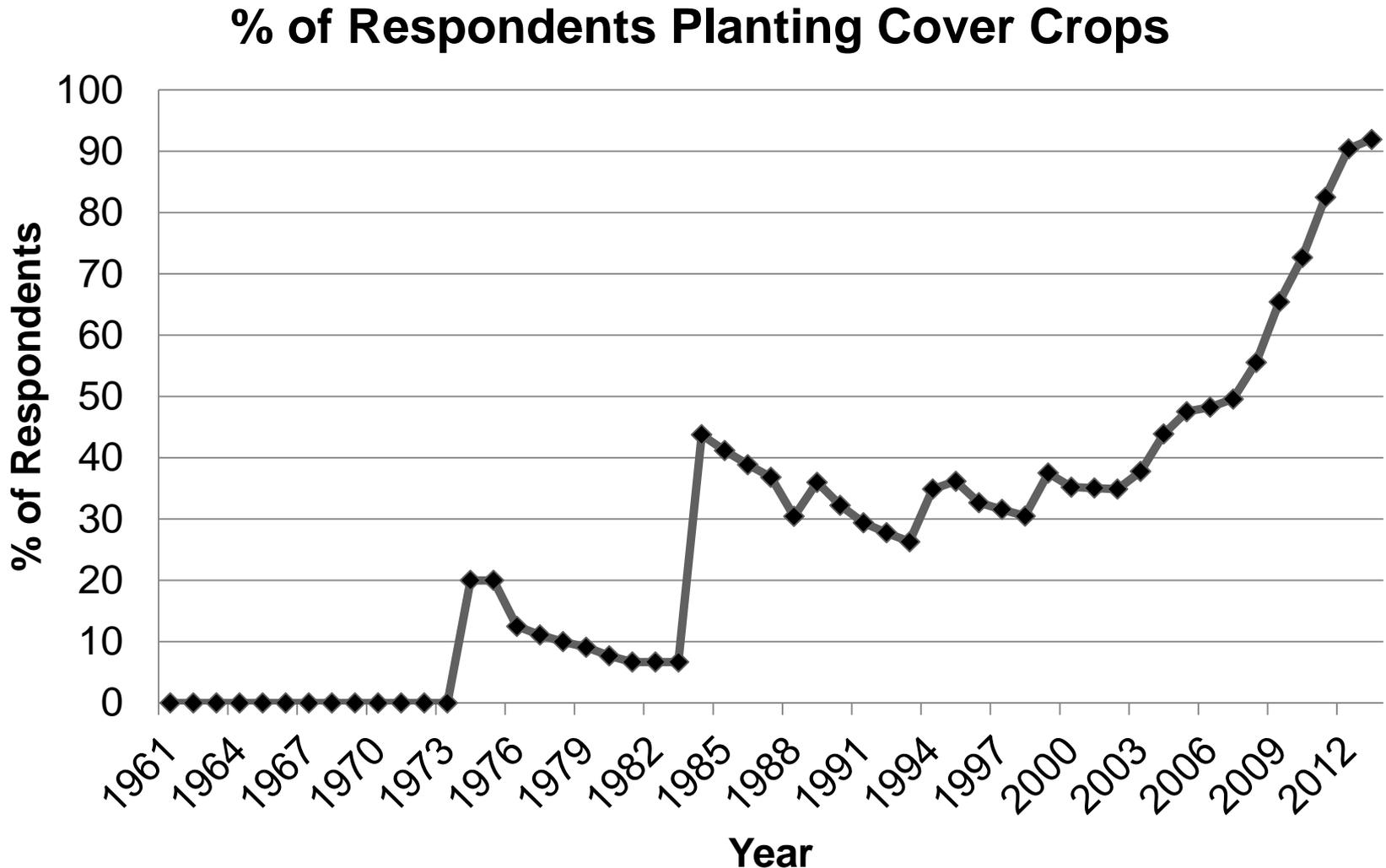


# Survey of WI Organic Vegetable Growers (Moore et al. *In Review*)

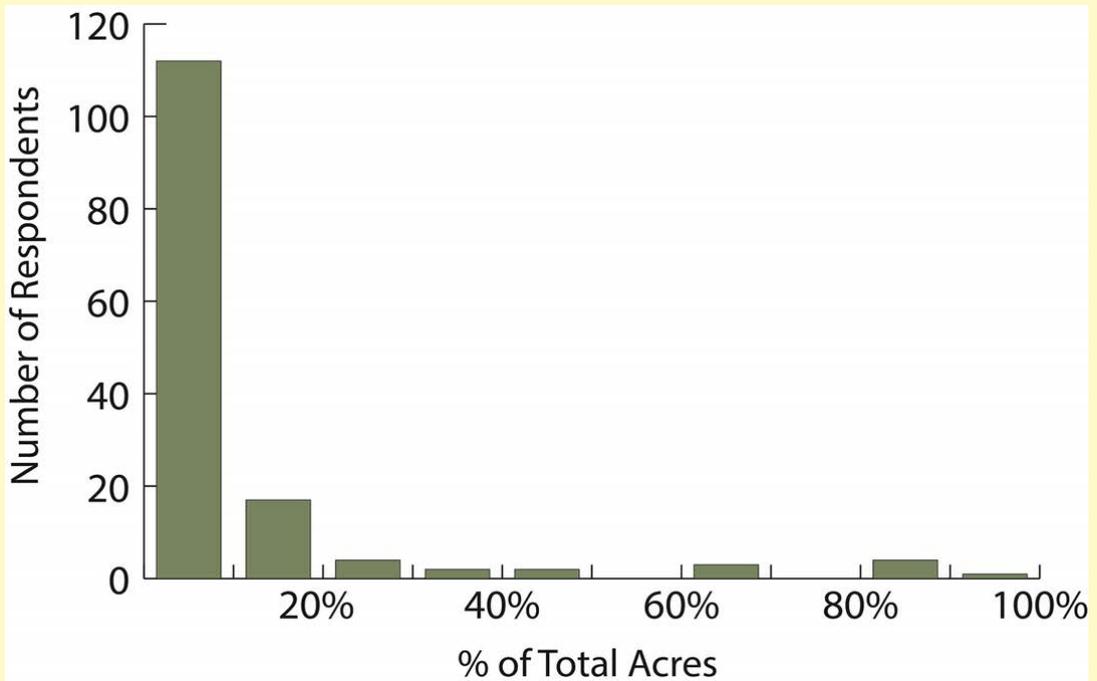
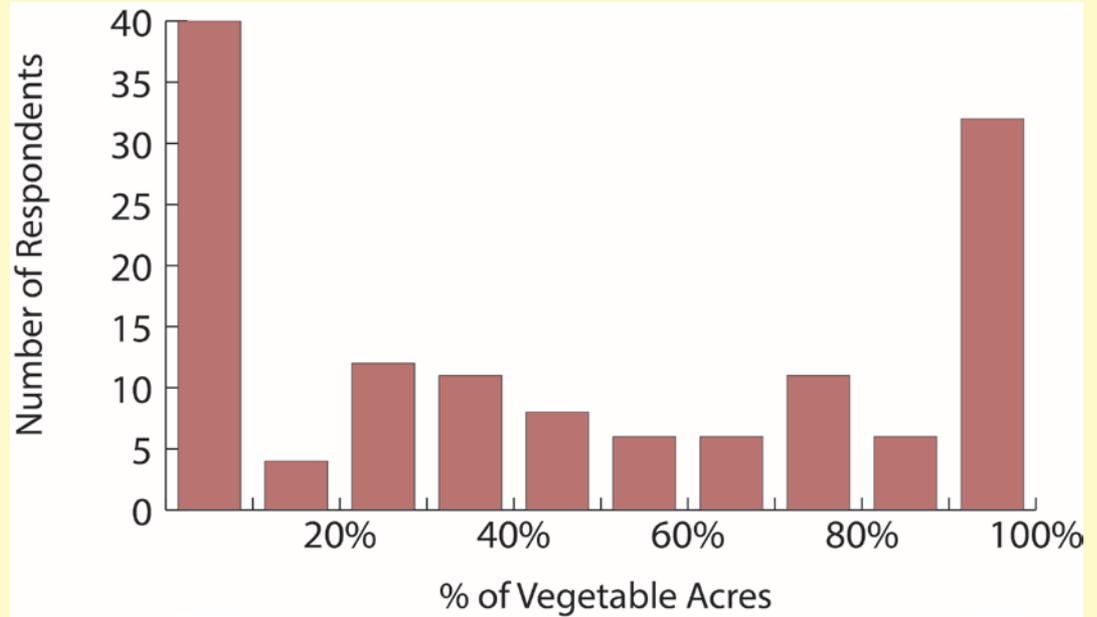
- **Let's look at organic vegetable growers as a group of "Good Farmers" who generally use cover crops**
- 2014 survey, 152 responses
- Size range  $\frac{1}{4}$  acre to 2,100 acres
  - Mean of 36 acres, Median of 4 acres
- Farm revenue from vegetables: Median of 78%
- Median of 7 different vegetable crops
- Top 3 vegetable crops account for a median of 73% of their acreage



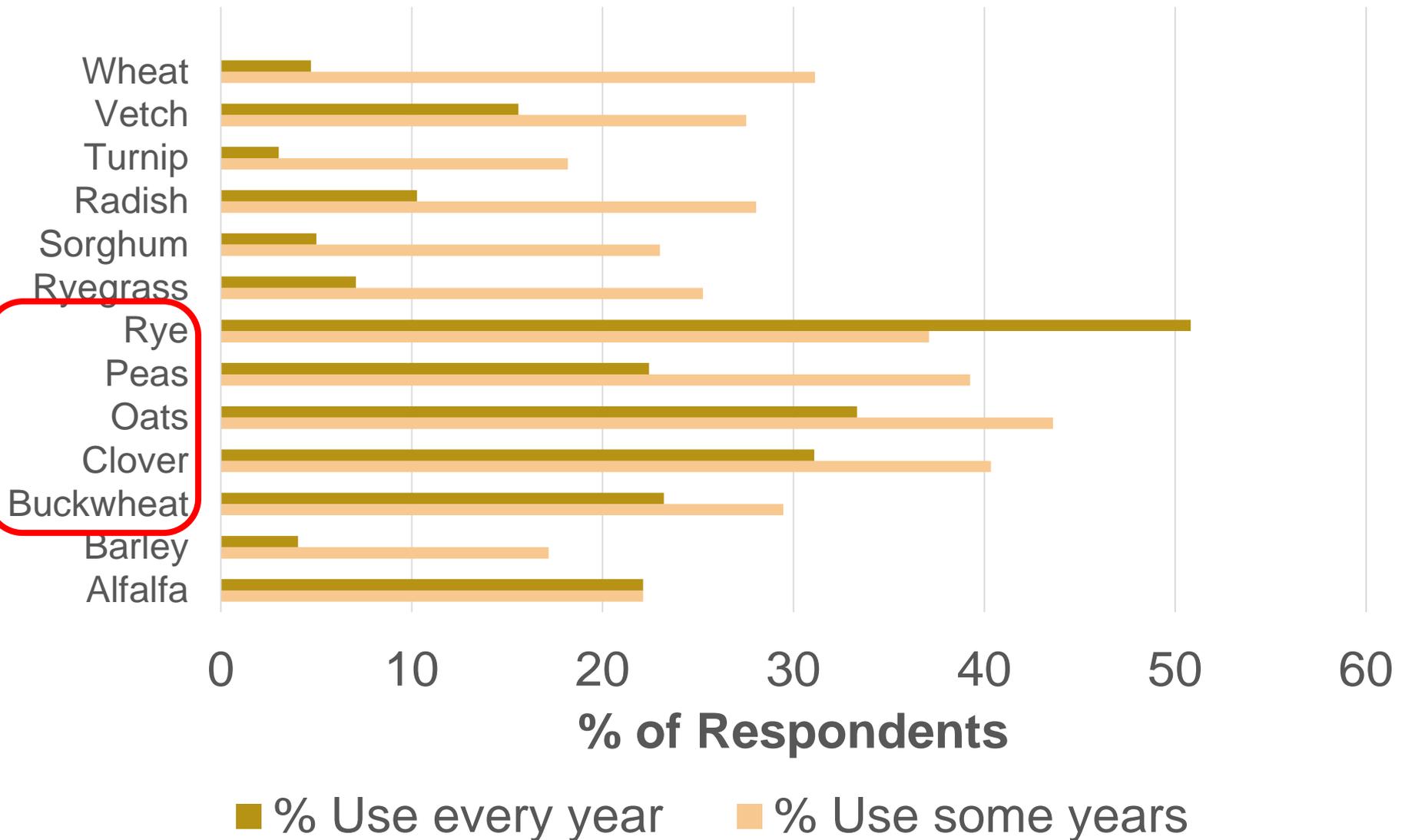
# Adoption Rapidly Increased in the 2000s



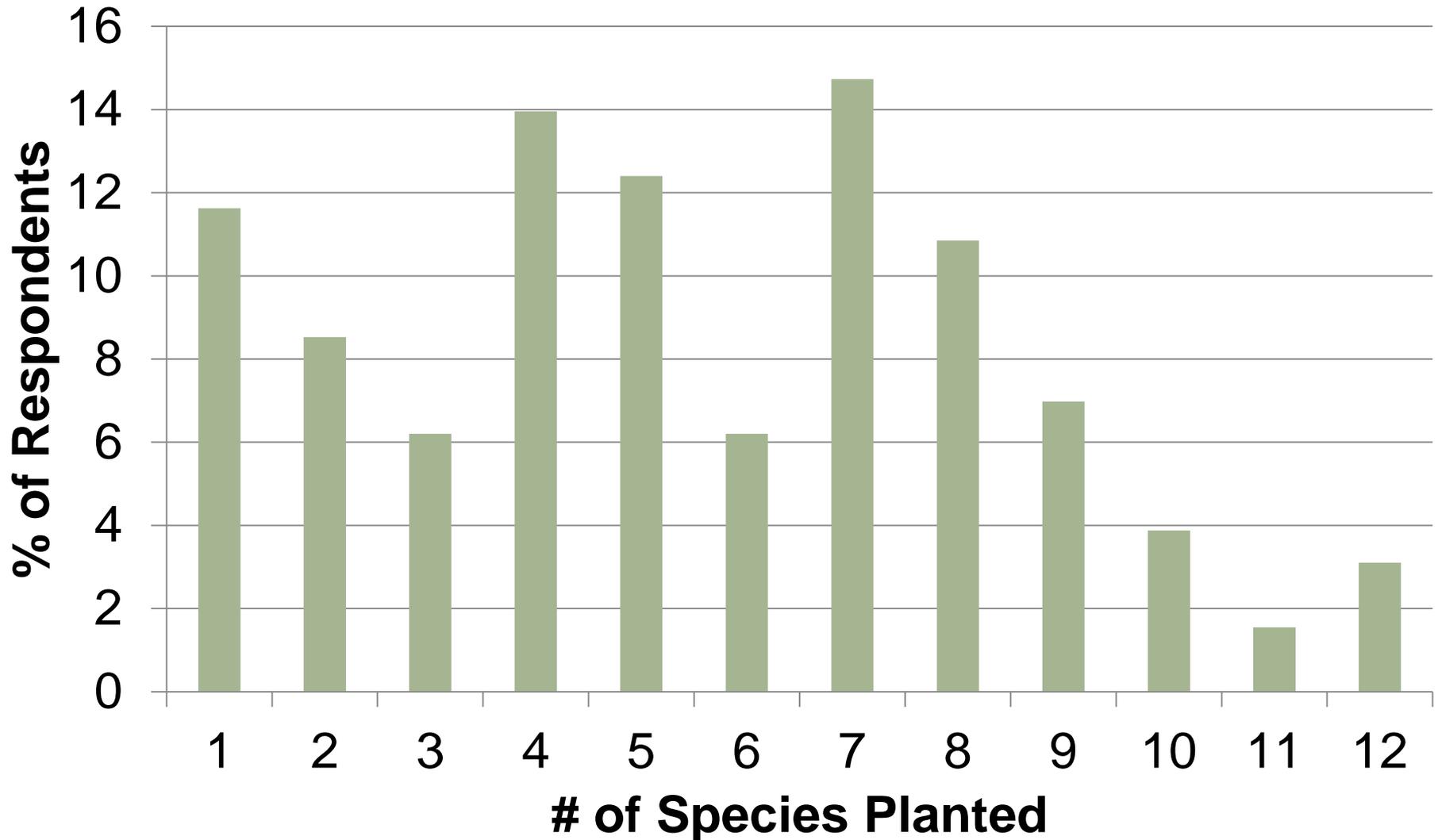
- Most growers use cover crops on their organic vegetable acres
- About 1/3 use on a few of their acres
- About 1/3 use on some of their acres
- About 1/3 use on most of their acres
- Use of cover crops does not carry over to their other acres



# A diverse portfolio, but **rye** dominates



# On-farm diversity is variable



# What challenges were the most important impediments?

## Direct costs, managerial costs and opportunity costs

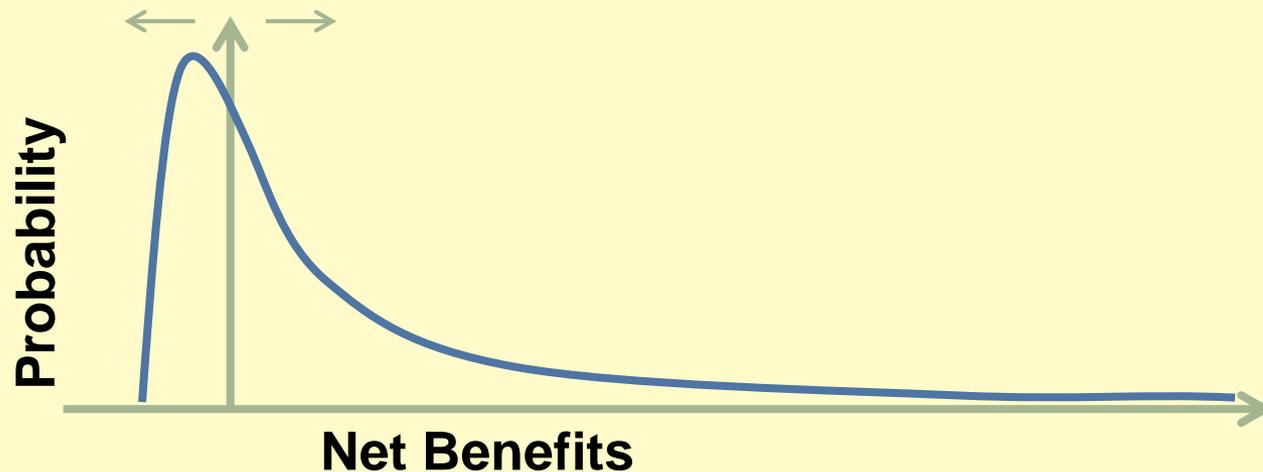
1. Seed expense
2. Extra time to manage
3. Short planting window
4. Management difficulty
5. Special equipment
6. Decreased income if it replaces a cash crop

# Meta-Economics of Cover Crops

- **Cost Matters for Cover Crop Adoption, A Lot**
  - **Cost share is and will continue to be an important driver for adoption**
    - Even among farmers who “believe in” cover crops
    - Direct costs, managerial costs, and opportunity costs
    - Expect cover crop dis-adoption by grain farmers due to current tight margins

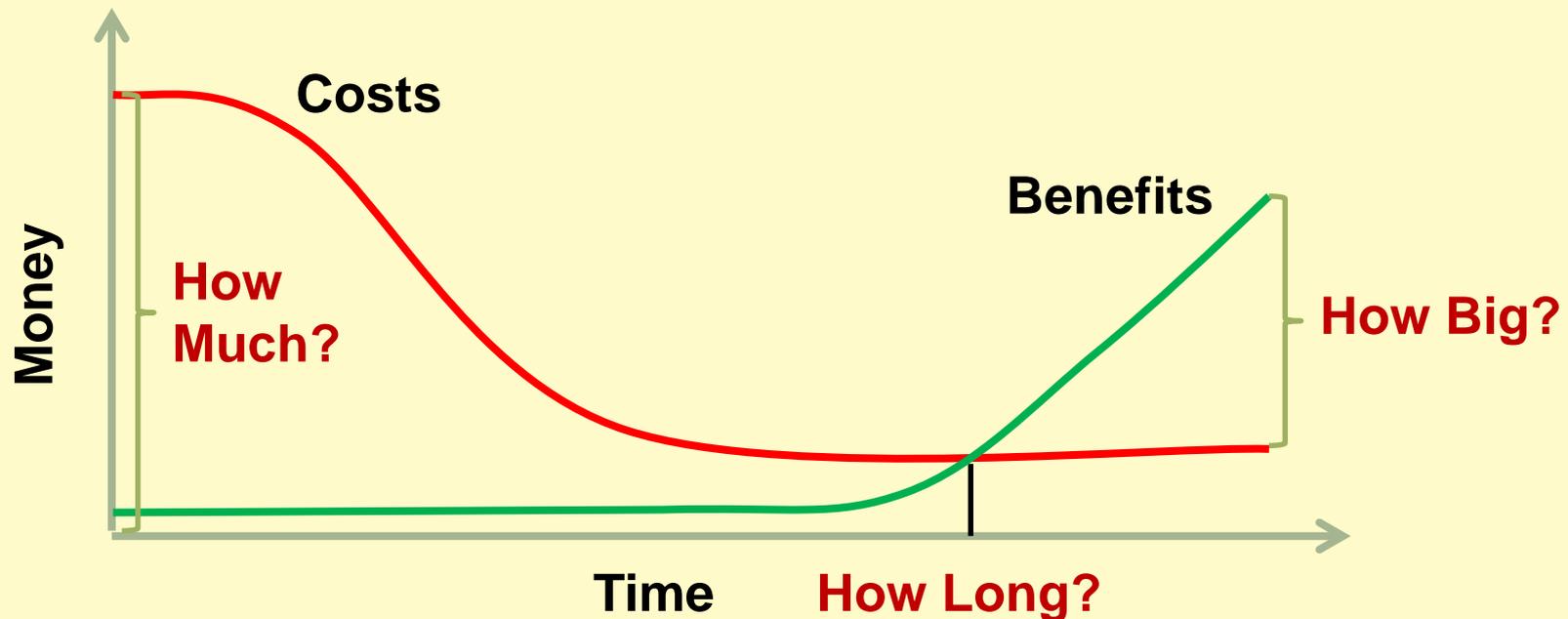
# Meta-Economics of Cover Crops

- **Cover Crops are Risky**
- Cover crops are not a sure bet, but they can be a good bet
- Sometimes cover crops make farmers worse off
- Are good outcomes due to good luck or good practices?
- **We need honest statements and assessments of the benefits and risks to manage farmer expectations and to maintain legitimacy/credibility**



# Meta-Economics of Cover Crops

- **Cover Crops are an Investment**
- Immediate costs, risky and uncertain long-term benefits
- This investment does not have a guaranteed payoff
- **Find long-term users to show benefits, to inspire and maintain long-term investments by farmers**

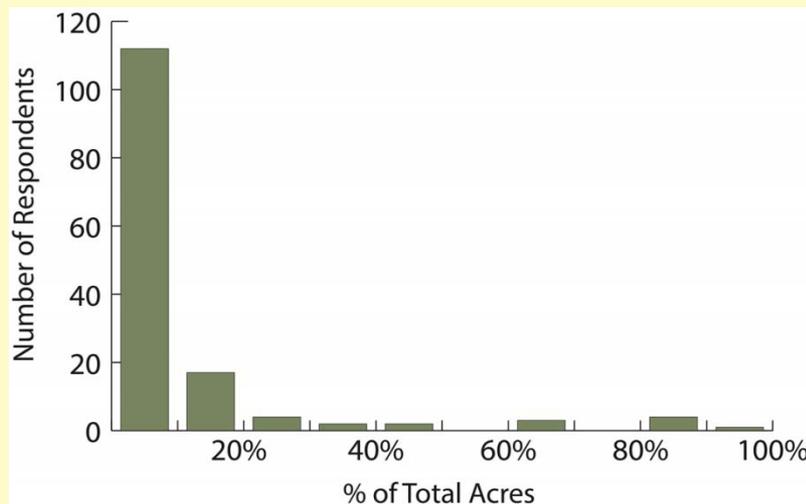
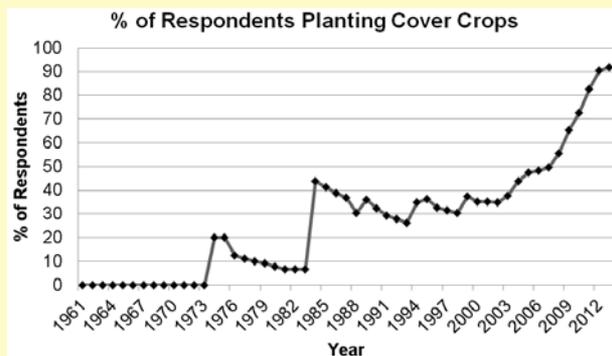


# Meta-Economics of Cover Crops

- **Cover Crops are Idiosyncratic and Diverse**
- Success depends on the specifics of each farmer, each farm, each field and each year
- Too diverse for a simple rule or research program
  - Use of a one-size-fits-all rule will always be second best
  - Too many research questions to answer
- **Farmers need to do their own research to figure out what works for them on their farm**
  - Species, timing, management practices, ...
  - Find low cost, simple and locally relevant practices
- **Rules should be as flexible as they can be**

# Meta-Economics of Cover Crops

- **Widespread and Highly Intense Adoption is Unlikely**
  - Organic vegetable farmers do not do so
  - Cover crops would have to become a “requirement”
    - NOP, Conservation Compliance, EU CAP



- **Institutions Matter**

- Crop insurance rules
- Rental arrangements: Could use example leases that require and/or reward good cover crop use

# Thanks for Your Attention!

## Questions?

**Paul D. Mitchell**

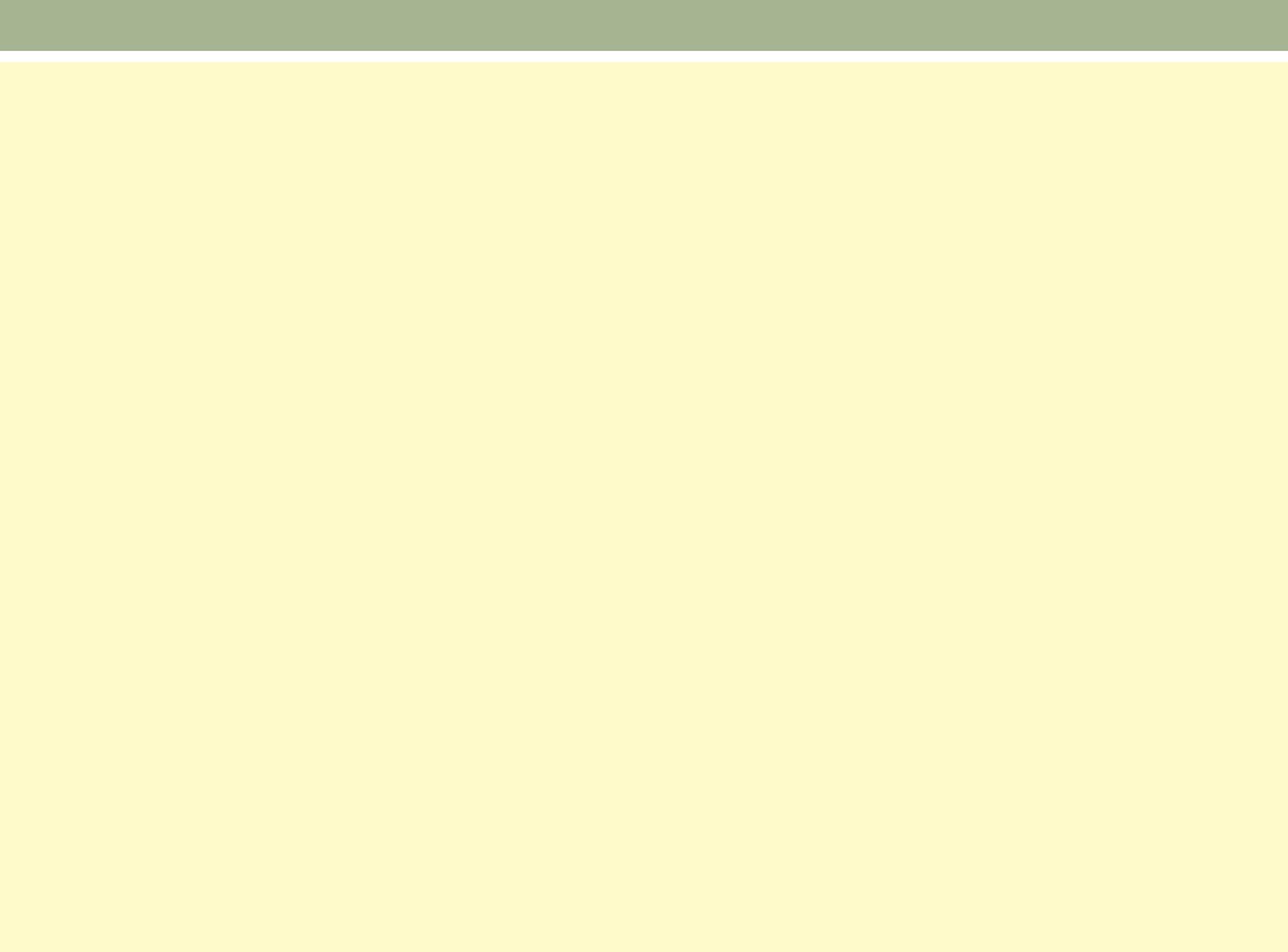
Agricultural and Applied Economics

University of Wisconsin, Madison, WI

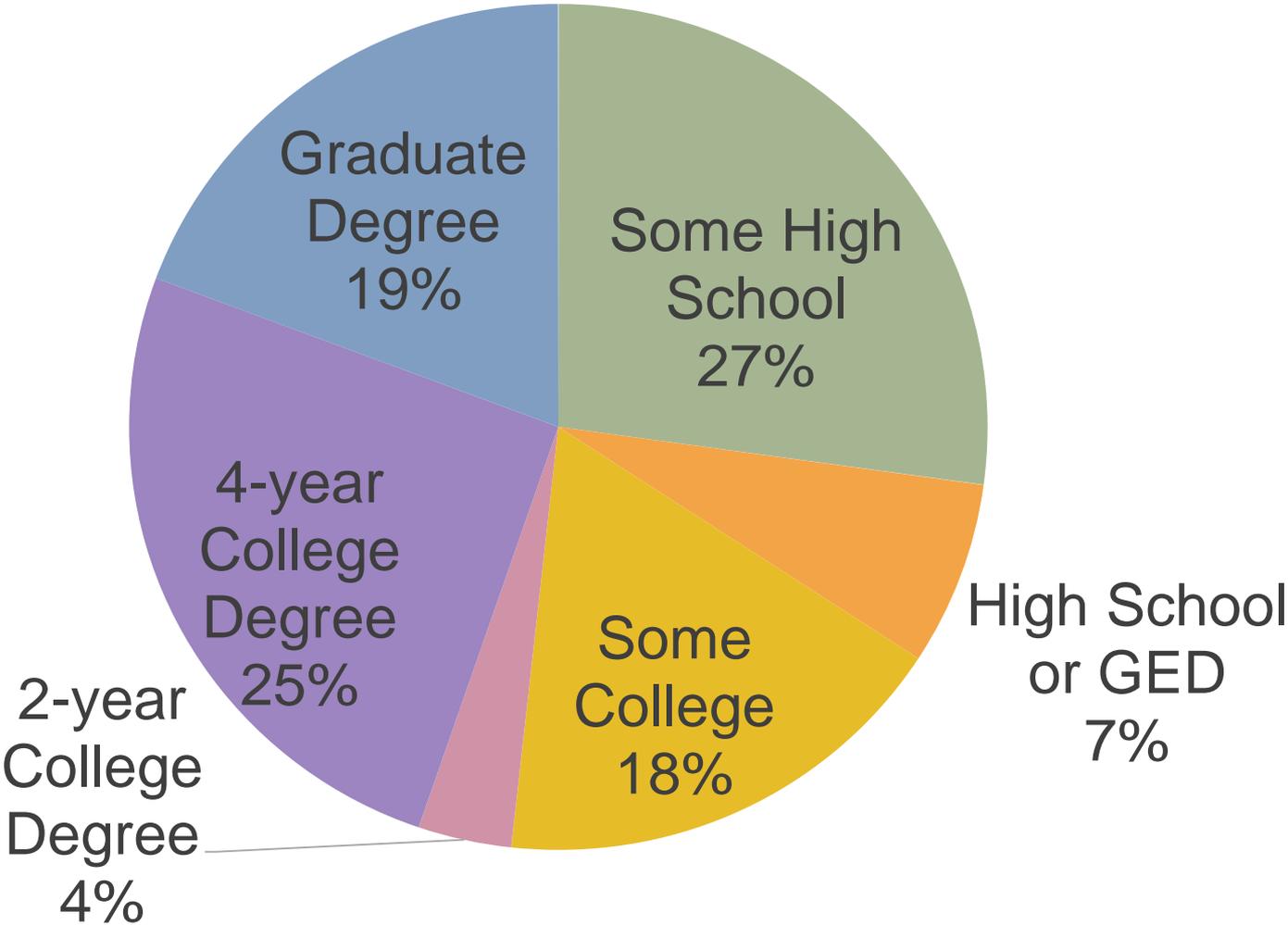
[pdmitchell@wisc.edu](mailto:pdmitchell@wisc.edu) 608-265-6514

<http://www.aae.wisc.edu/pdmitchell/extension.htm>

Follow me on Twitter: @mitchelluw



# Farmer Respondent's Education



# Cover Cropping Challenges

**14. In your experience, how challenging are the following problems for using cover crops in vegetable systems?**

|   | <i>Not at all<br/>challenging</i> | <i>Somewhat<br/>challenging</i> | <i>Unsure</i>            | <i>Very<br/>challenging</i> | <i>Extremely<br/>challenging</i> |
|---|-----------------------------------|---------------------------------|--------------------------|-----------------------------|----------------------------------|
| Cover crops require special equipment.                        | <input type="checkbox"/>          | <input type="checkbox"/>        | <input type="checkbox"/> | <input type="checkbox"/>    | <input type="checkbox"/>         |
| Cover crops require extra time to manage.                     | <input type="checkbox"/>          | <input type="checkbox"/>        | <input type="checkbox"/> | <input type="checkbox"/>    | <input type="checkbox"/>         |
| Useful information about cover crops is difficult to find.    | <input type="checkbox"/>          | <input type="checkbox"/>        | <input type="checkbox"/> | <input type="checkbox"/>    | <input type="checkbox"/>         |
| Cover crop seed is expensive.                                 | <input type="checkbox"/>          | <input type="checkbox"/>        | <input type="checkbox"/> | <input type="checkbox"/>    | <input type="checkbox"/>         |
| Cover crop residues are difficult to manage.                  | <input type="checkbox"/>          | <input type="checkbox"/>        | <input type="checkbox"/> | <input type="checkbox"/>    | <input type="checkbox"/>         |
| Cover crops are difficult to establish.                       | <input type="checkbox"/>          | <input type="checkbox"/>        | <input type="checkbox"/> | <input type="checkbox"/>    | <input type="checkbox"/>         |
| Cover crops increase pest pressure.                           | <input type="checkbox"/>          | <input type="checkbox"/>        | <input type="checkbox"/> | <input type="checkbox"/>    | <input type="checkbox"/>         |
| Cover crops become weeds.                                     | <input type="checkbox"/>          | <input type="checkbox"/>        | <input type="checkbox"/> | <input type="checkbox"/>    | <input type="checkbox"/>         |
| Planting cover crops instead of a cash crop decreases income. | <input type="checkbox"/>          | <input type="checkbox"/>        | <input type="checkbox"/> | <input type="checkbox"/>    | <input type="checkbox"/>         |
| Cover crops have a short planting window.                     | <input type="checkbox"/>          | <input type="checkbox"/>        | <input type="checkbox"/> | <input type="checkbox"/>    | <input type="checkbox"/>         |
| Other (please specify):                                       | <input type="checkbox"/>          | <input type="checkbox"/>        | <input type="checkbox"/> | <input type="checkbox"/>    | <input type="checkbox"/>         |

# Cover Cropping Benefits

13. How much do you agree or disagree with the following statements?

|  | <i>Strongly<br/>Disagree</i> | <i>Disagree</i>          | <i>Neutral</i>           | <i>Agree</i>             | <i>Strongly<br/>Agree</i> |
|--|------------------------------|--------------------------|--------------------------|--------------------------|---------------------------|
| Cover cropping improves farm profitability.                                | <input type="checkbox"/>     | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>  |
| Cover cropping improves soil health.                                       | <input type="checkbox"/>     | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>  |
| Cover cropping improves fertility.   | <input type="checkbox"/>     | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>  |
| Cover cropping decreases weed/pasture problems.                            | <input type="checkbox"/>     | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>  |
| Cover cropping increases biodiversity/habitat.                             | <input type="checkbox"/>     | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>  |
| Cover crop benefits are more long-term and only become apparent over time. | <input type="checkbox"/>     | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>  |

26. Below are 10 possible reasons to use cover crops. Please select the three reasons that are most important to you, ranking them 1, 2, and 3.

- |  |   |   |
|--|---|---|
| <input type="checkbox"/> Erosion protection              | <input type="checkbox"/> Improving fertility          | <input type="checkbox"/> Social pressure              |
| <input type="checkbox"/> Suppressing weeds               | <input type="checkbox"/> Improving soil structure     | <input type="checkbox"/> Reducing pests and disease   |
| <input type="checkbox"/> Adding organic matter           | <input type="checkbox"/> Improving water infiltration | <input type="checkbox"/> Preventing nutrient leaching |
| <input type="checkbox"/> Increasing biodiversity/habitat |   |   |

**SOIL AND WEEDS**

# Soil Erosion: Social Cost

- Most of the costs of soil erosion (benefits of soil erosion reduction) are off site: public or others pay the costs or get the benefits
- Off site costs \$5.36 to \$7.60/ton
  - $\times 1.79 \times 4.6 = \$44$  to  $\$63/\text{A}$  (convert to 2015 \$ and \$/A)
  - $\times 6$  million corn + soy acres in 2015
  - \$265 to \$375 million/year
  - Add another \$60 million for farmer benefits
- Maximum amount we should spend annually to eliminate soil erosion in Wisconsin to have cost:benefit ratio less than one

# Cover Crops and Nitrogen

- Cover crops immobilizes N for follow crops: How much?
- Wide ranges that vary based on the type of soil, weather, cover crop species, management, etc.
- Cornell Agronomy Extension Fact Sheet 43 “Nitrogen Benefits of Winter Cover Crops”
  - Cereals can immobilize 50 lbs N/A
  - Legumes can immobilize 100 lbs N/A
    - 50% of hairy vetch studies found >70 lbs N/A
    - 80% of hairy vetch studies found >50 lbs N/A
  - Cereal rye often showed negative effect likely from high C:N in cover crop residue
- Main Point: **N benefit of cover crops is variable**