Combining Supply and Demand Estimates for Ecosystem Services from Cropland

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Motivation

- Agricultural ecosystems are mainly managed to produce goods that can be sold at market, such as food, fiber and fuel. By the choice of production inputs and management practices, farmers can also supply important ecosystem services that benefit the public but are not priced in the market (e.g., carbon sequestration and water regulation).
- A number of **Payment-for-Ecosystem-Services (PES)** programs have been implemented around the world to facilitate the supply of non-market ecosystem services by providing economic incentives to farmers. However, none of these programs was designed based on a comprehensive understanding of the underlying supply and demand.
- To examine the empirical foundation for designing efficient PES programs, this study combines **farmers' supply** of ecosystem services from low-input cropping systems with **public's demand** for resulting environmental improvements.

Research Questions

Supply

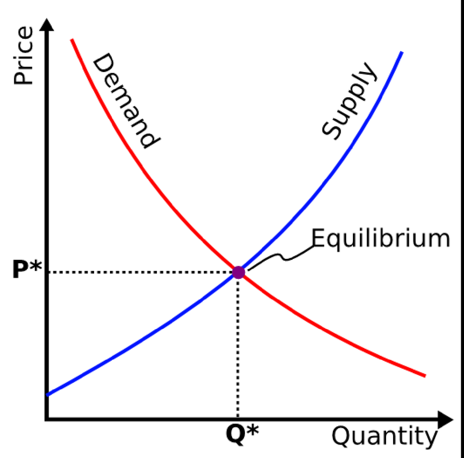
- Are farmers willing to adopt low-input land management practices for a payment, and how much?
- Which farmers are willing to adopt these practices?

Demand

- Are residents willing to pay for better environmental quality, and how much?
- Which residents are willing to pay?

Supply & Demand

- Is there a price for ES from cropland at which supply equals demand?
- Could one design a system of payment for ecosystem services from agriculture?

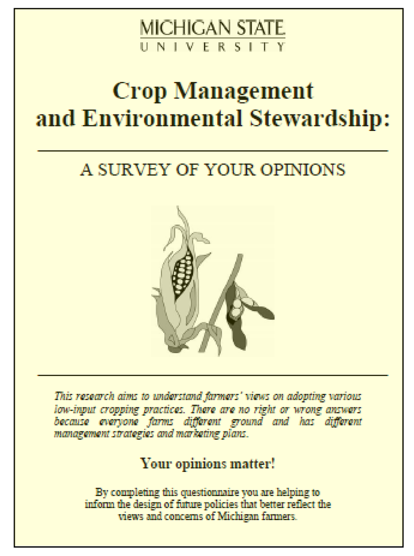


Method

- The supply and demand are estimated by **Contingent Valuation**, a stated preference method**,** in which farmers/residents are directly asked for their willingness to adopt/pay for providing/obtaining ecosystem services in a hypothetical market by mail surveys.
- The aggregate supply and demand is estimated by linking ecological processes with economic benefit-cost function.

Supply Analysis

- A mail survey was conducted in 2008 with 3000 randomly selected Michigan corn and soybean farmers (56% response rate).



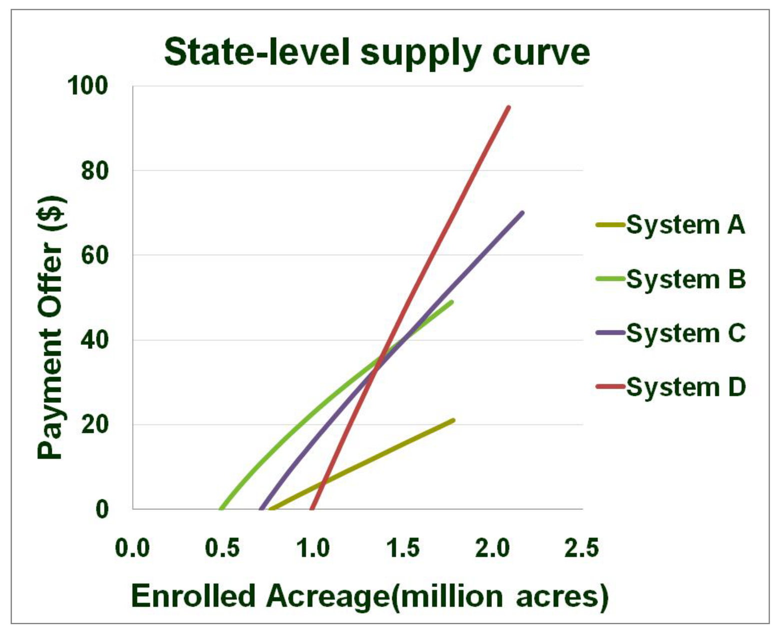
- Each respondent was presented with four hypothetical cropping systems that provide sequentially increased levels of ecosystem services, management complexity, and payment.
- In each system, farmers were asked:

"*how many acres of land would you enroll if a governmental or NGO program pay you $(X) per acre each year for 5 years ?*"

Systems	A	B	C	D
Cover Crops	None	Any type over winter		
Rotation	Corn-Soybean		Corn-Soybean-**Wheat**	
Fertilization	Broadcast at full MSU rate; Split N based on PSNT			**Band** apply at reduced rate
Pesticide	Broadcast at label rate			**Band** apply at reduced rate
Tillage	Chisel plow with cultivation as needed			
Soil Test	Pre-sidedress Nitrate Test (PSNT)			

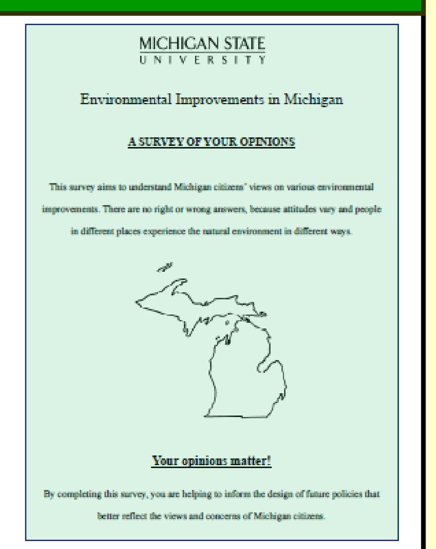
Results:

- Many farmers who would not otherwise adopt these ES-providing practices will do so if paid.
- Farmers' decisions on participation and acreage enrollment depends on age, educational level, perceived environmental improvement, current practices, farm size and primary source of income.



Demand Analysis

- A mail survey was conducted in 2009 with 6000 randomly selected Michigan residents (41% response rate).

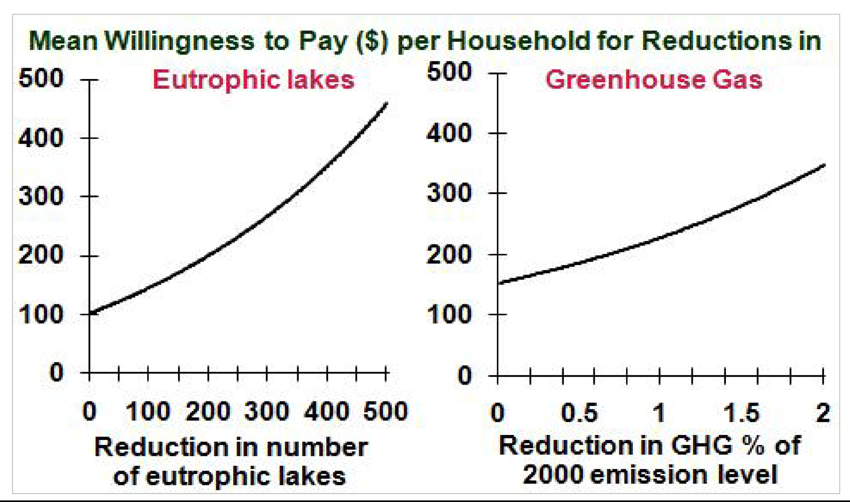


- Each respondent was presented with three hypothetical government programs that provide different levels of greenhouse gas (GHG) and eutrophic lake reductions for different income tax payment. (Example at right.)
- Residents were asked whether to vote for the program given the tax payment (or no cost).

	Now	Program A is going to ...	After
Number of Lakes with excess nutrients	3,400	Reduce by 70 (2%)	3,330
Greenhouse gas reduction needed to slow global warming	Need 30% reduction	Reduce by 0.6	Need 29.4% reduction
Your share of costs for the program	$ 0 per year in increased income tax	Increase by $10	$10 per year in increased income tax

- **Results:**

Reducing global warming and eutrophic lake were of value to residents. The value depends on the scope of environmental changes, attitudes towards global warming, age, income, education and whether they are voters.

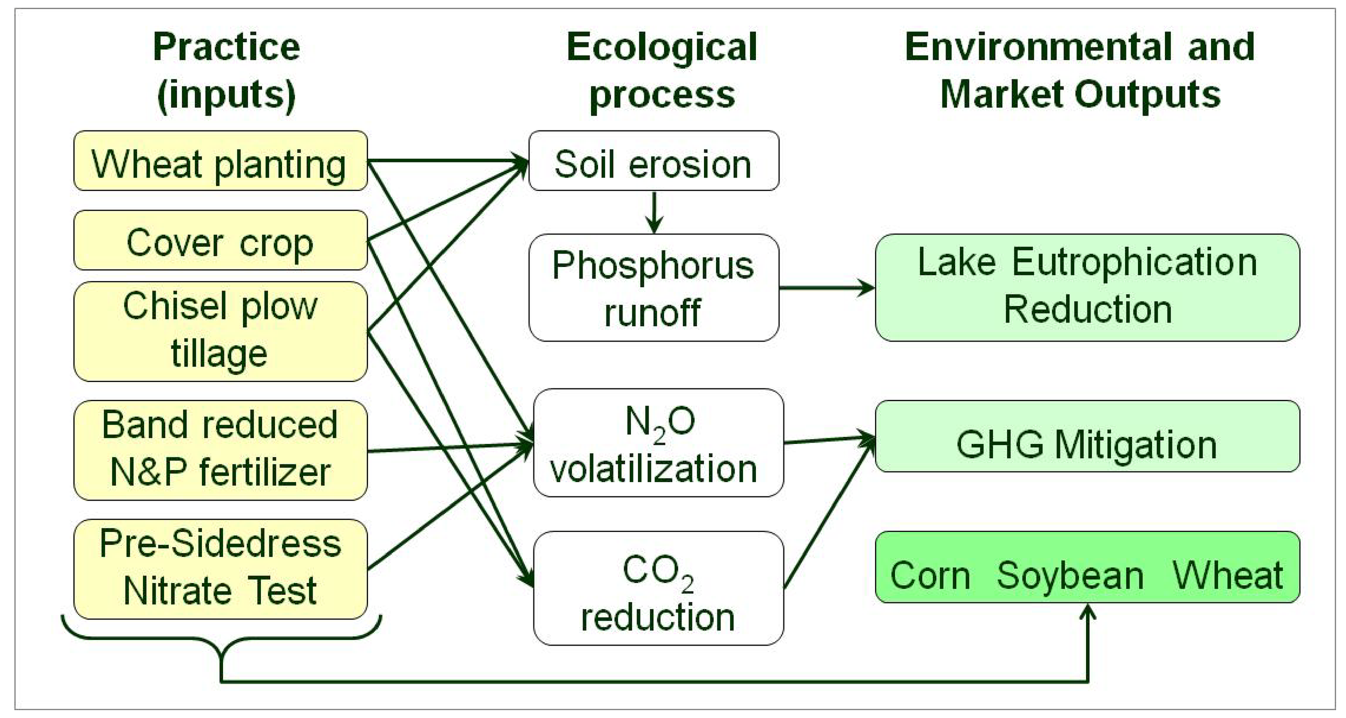


Aggregate Supply & Demand

1. Calculate real changes in farming practices

Insuring the additionality of ES supply is important to PES design. Real change for each practice is the acreage enrolled minus acreage where it was previously adopted.

2. Translate real changes in practices to quantitative improvements in lakes and GHG



3. Convert ES outputs to *Effective Additional Acreage (EAA)* — land that newly adopts all practices

Farmers adopt a bundle of practices with one payment offer and residents make one tax payment for two ES. *EAA* that represents the combination of all practices and ES enables tractable economic calculation.

4. Match supply and demand estimates for optimal levels of payment, land enrollment and ES

- Supply Function: Per-acre payment for farmer = *f (EAA)*
- Demand Function: Marginal willingness to pay = *g (EAA)*

5. Compare welfare for different policy scenarios

Calculate the welfare effects for farmers and residents under optimal conditions given changes in policy design on supply and/or demand (e.g., pay farmers for additionality only).

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