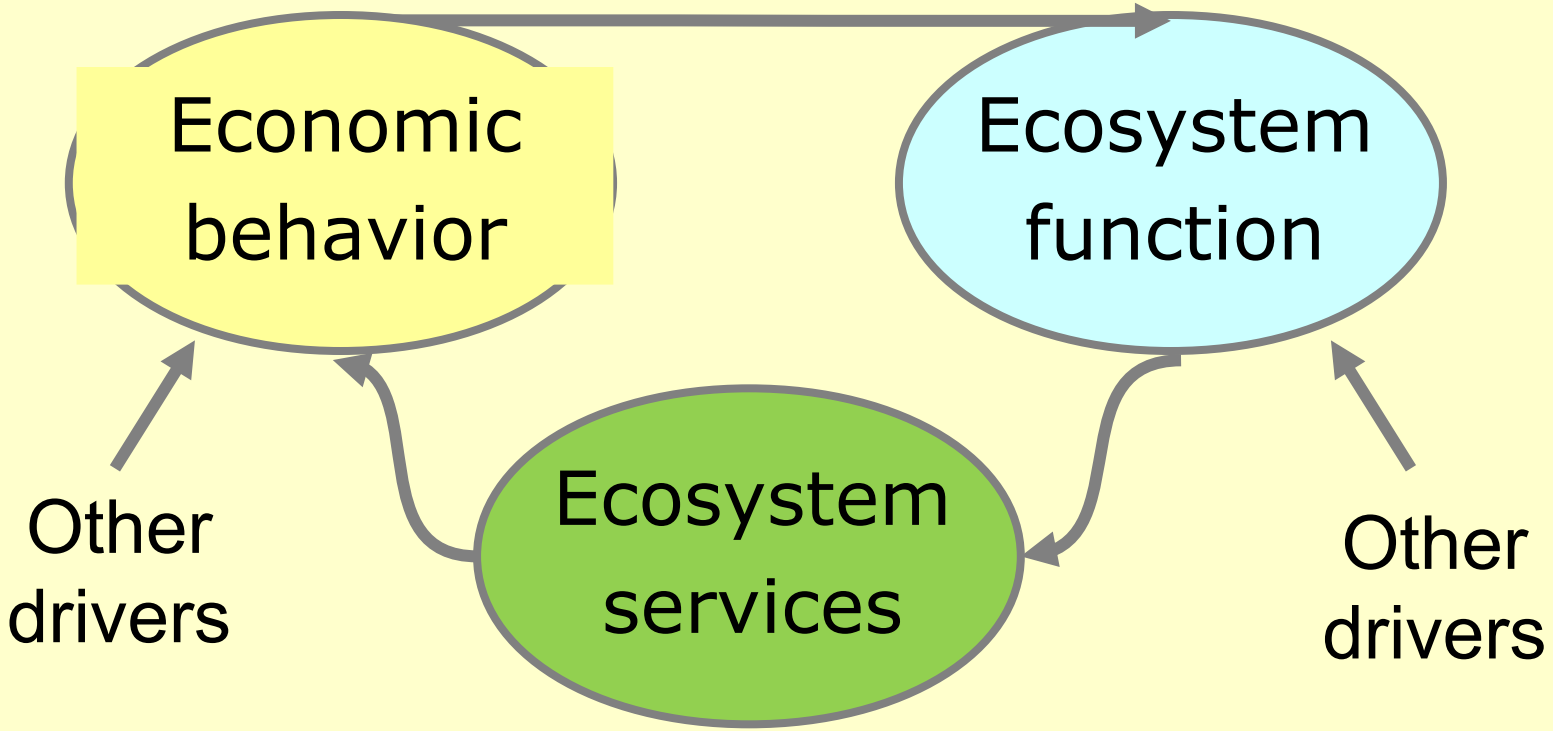
Ecosystem Services from Crop Management: What They Cost to Supply and What Citizens Will Pay

Scott M. Swinton and Shan Ma
Michigan State University

Ecosystem Services and Sustainable Agriculture
Michigan SWCS seminar, Mar. 9, 2011

Human interaction with ecosystems

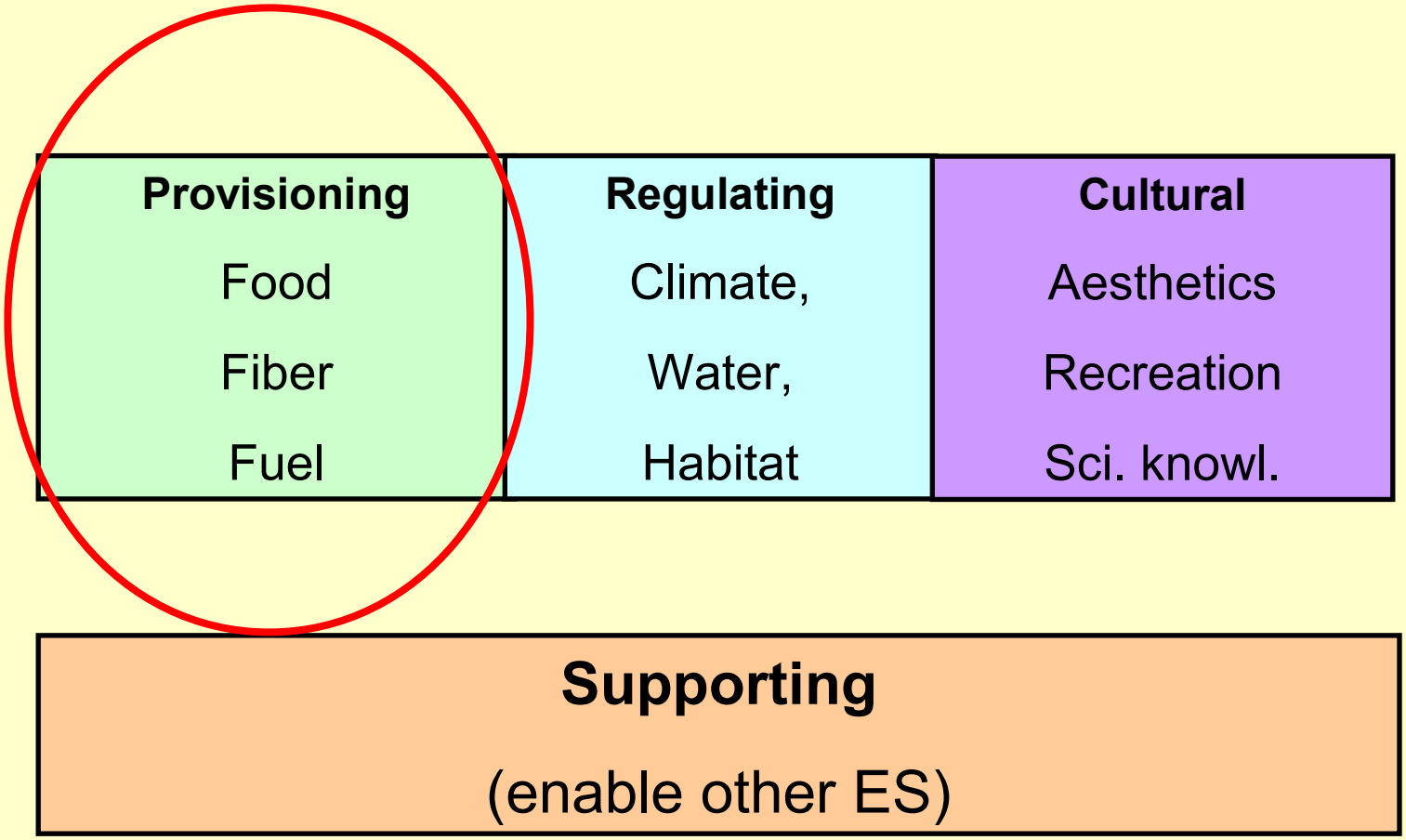


“Ecosystem services are the benefits that people obtain from ecosystems.”
U.N. Millennium Ecosystem Assessment, 2005.

Agriculture as managed ecosystem

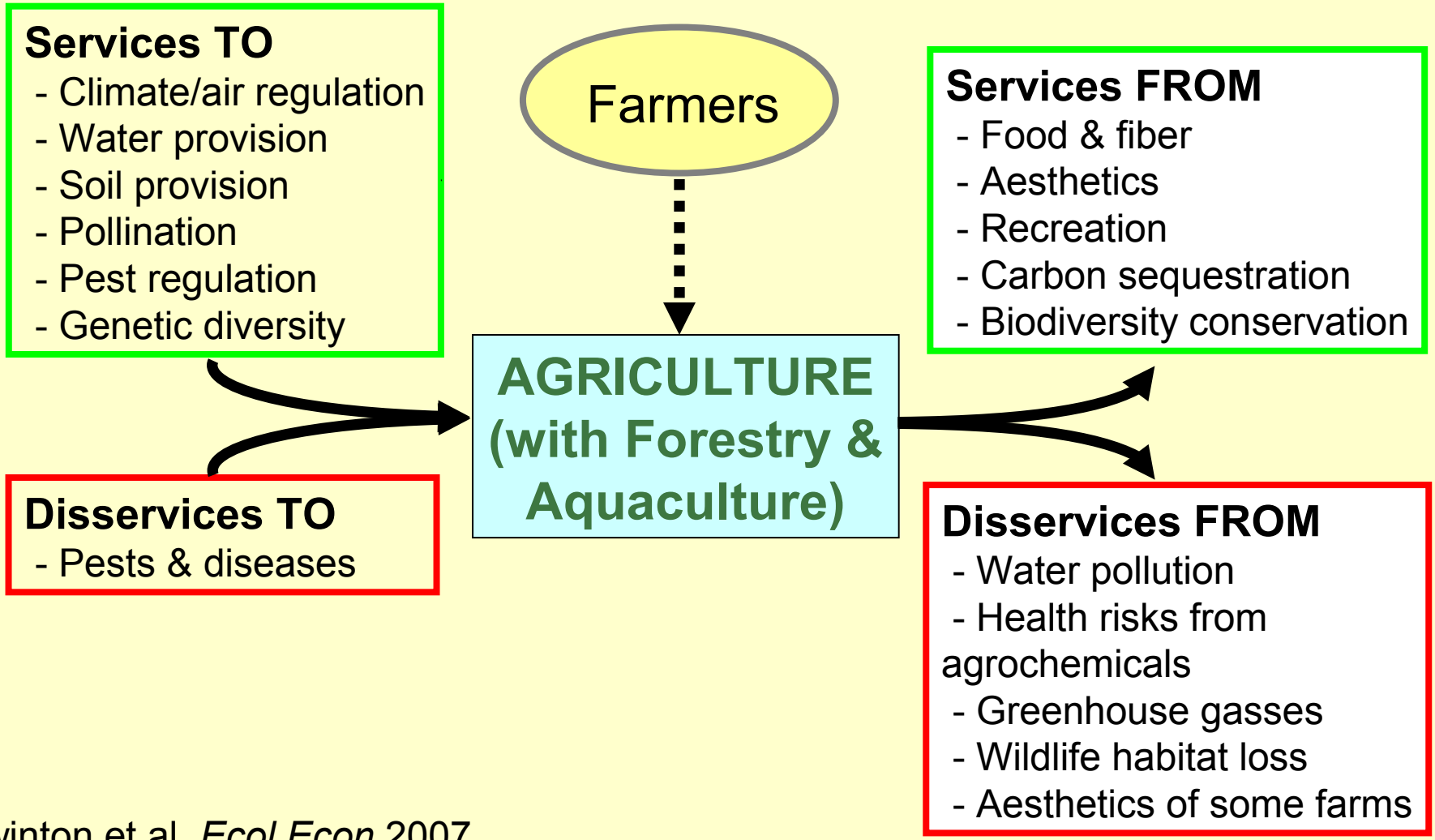
- Agriculture is humanity's oldest and largest managed ecosystem

But does agriculture provide the array of *ecosystem services* (ES) we would like?



Millennium Ecosystem Assessment, 2005

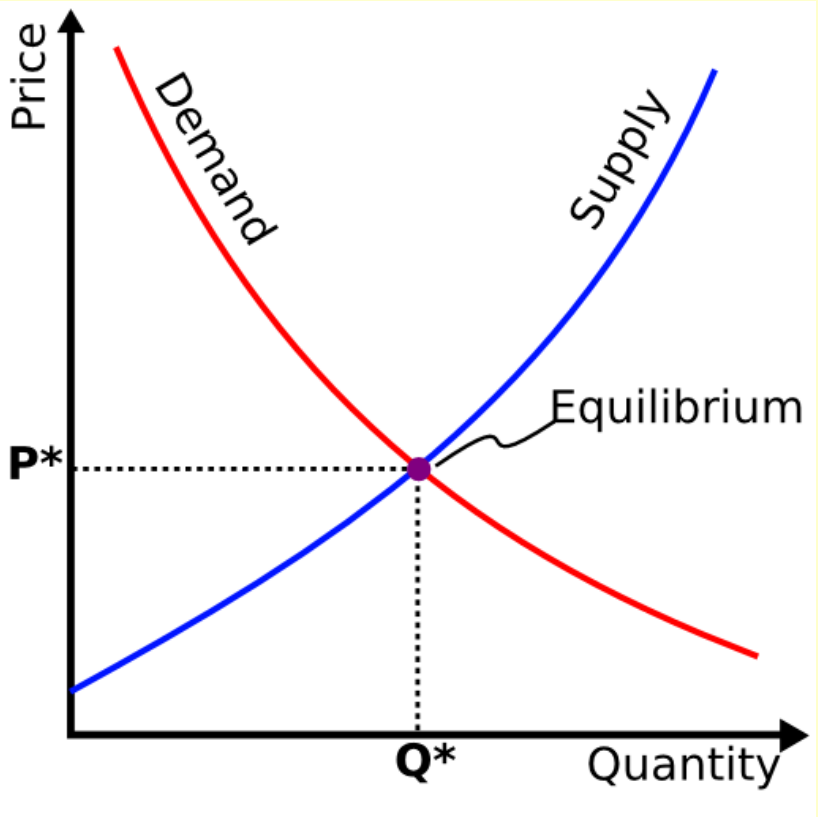
Ecosystem services flows and agriculture: Opportunity to improve



Swinton et al, *Ecol Econ* 2007

Supply and Demand of a Market Good

- Supply
  - How much of a good producers will offer (cost to supply)
- Demand
  - How much of a good buyers desire (willingness to pay)
- Equilibrium
  - Demand=Supply
  - All goods are sold at acceptable price



source: *wikipedia.org*

Problem:
Sometimes markets don't work

- Many ecosystem services are ***public goods***
  - No way to exclude others from benefitting
    - Climate improvements
    - Water quality
  - → So cannot force users to pay for provision
- Many ecosystem disservices are ***externalities***
  - Producer does not face social costs
    - Disposal of excess nutrients in streams & lakes
  - → So cannot force producers to incur costs of abating disservices

Question: Could a market exist for ecosystem services from crop farming?

- **Supply**: Examine farmers' willingness to accept (WTA) payment for providing enhanced ES

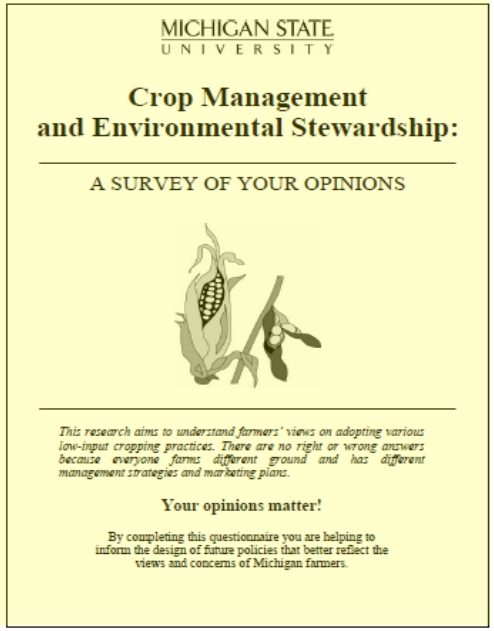
- **Demand**: Measure residents' willingness to pay (WTP) for added ES that farmers can provide

Research Questions

- Supply
  - Are farmers willing to change their land management practices for a payment, and how much?
  - Which farmers are willing to change their practices?
- Demand
  - Are residents willing to pay for better environmental quality, and how much?
  - Which residents are willing pay?
- Equilibrium
  - 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?

Contingent Valuation Method

- Hypothetical markets
- Ask willingness to pay/accept by mail survey



MICHIGAN STATE
UNIVERSITY

Crop Management and Environmental Stewardship:

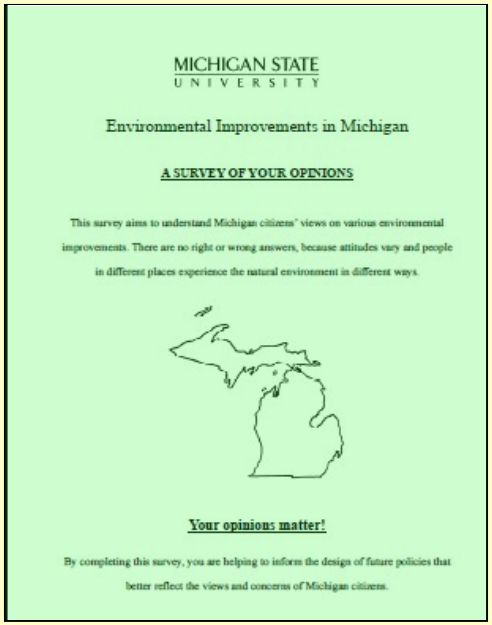
A SURVEY OF YOUR OPINIONS

This research aims to understand farmers' views on adopting various low-input cropping practices. There are no right or wrong answers because everyone farms different ground and has different management strategies and marketing plans.

Your opinions matter!

By completing this questionnaire you are helping to inform the design of future policies that better reflect the views and concerns of Michigan farmers.

3000 MI corn and soybean farmers (56% response)



MICHIGAN STATE
UNIVERSITY

Environmental Improvements in Michigan

A SURVEY OF YOUR OPINIONS

This survey aims to understand Michigan citizens' views on various environmental improvements. There are no right or wrong answers, because attitudes vary and people in different places experience the natural environment in different ways.

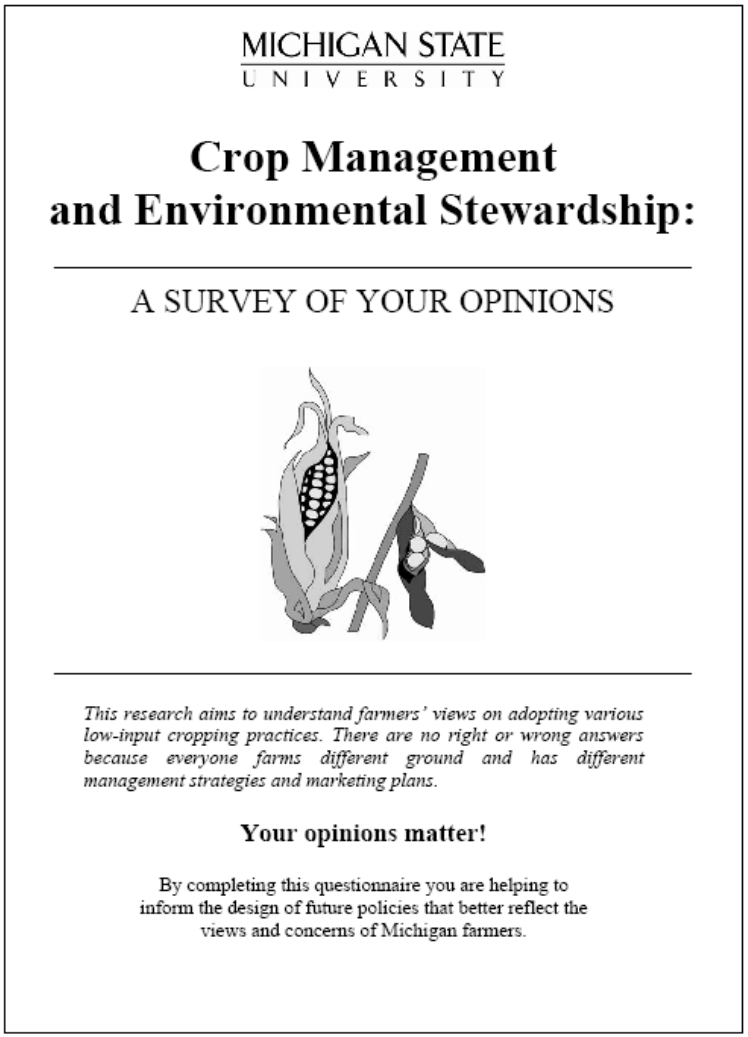
Your opinions matter!

By completing this survey, you are helping to inform the design of future policies that better reflect the views and concerns of Michigan citizens.

6000 MI residents (40% response)

Supply side: Farmer willingness to change practices for payment

- Mail survey to 3,000 Michigan corn or soybean growers in 2008
- Responses from 60%
- Broad diversity of field crop farms



MICHIGAN STATE
UNIVERSITY

Crop Management and Environmental Stewardship:

A SURVEY OF YOUR OPINIONS

This research aims to understand farmers' views on adopting various low-input cropping practices. There are no right or wrong answers because everyone farms different ground and has different management strategies and marketing plans.

Your opinions matter!

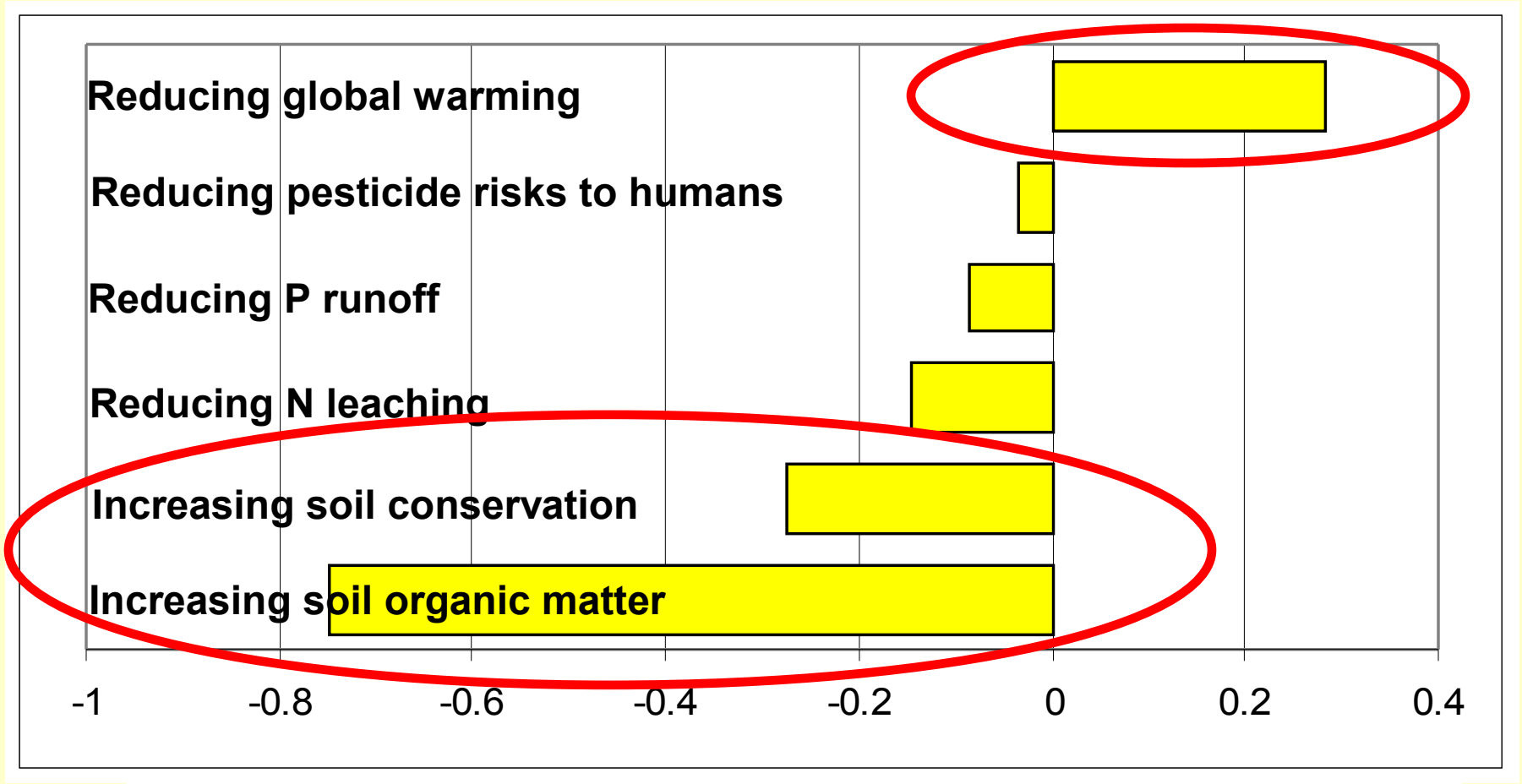
By completing this questionnaire you are helping to inform the design of future policies that better reflect the views and concerns of Michigan farmers.

Current use of environmental crop management practices

- Practices adopted
  - Reduced tillage (83%)
  - Wheat rotated with corn & soybean (65%)

- Practices rarely adopted
  - Nitrogen fertilizer banded to reduce rate (23%)
  - Cover crop before corn (19%)

Attitude & incentives: Global warming less important “to Me” than “to Society”



Incentives needed? Consider four low-input crop systems

ES level, management complexity, & payment →

System:	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
Pesticide	Broadcast at label rate			**Band** apply
Tillage	Chisel plow with cultivation as needed			
Soil Test	Pre-sidedress Nitrate Test (PSNT)			

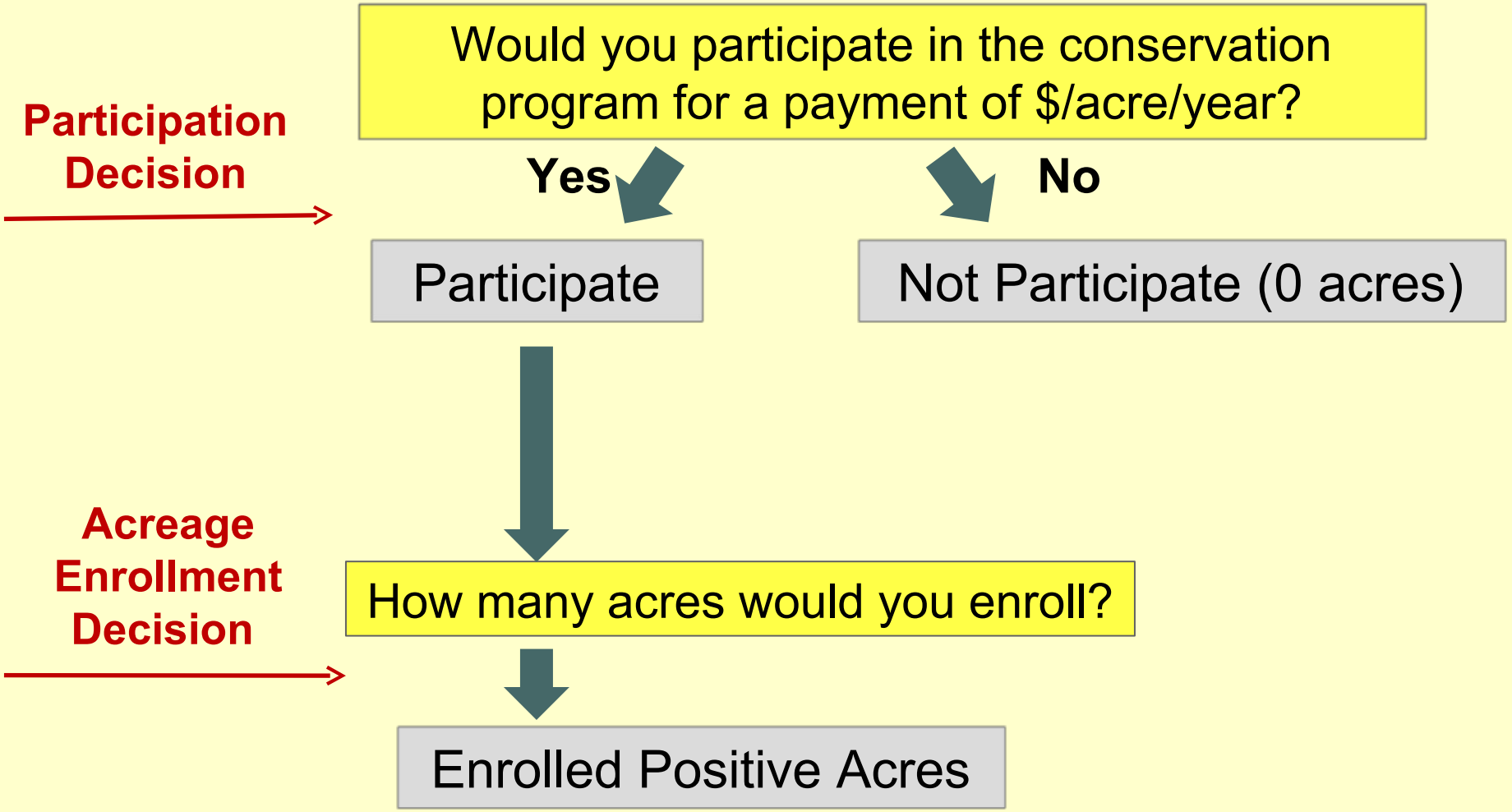
Payment for Environmental Services: Farmer willingness to change

- If a program run by the federal government would pay you $X per acre each year for 5 years for using this cropping system, would you enroll in this program? (Yes) (No)

- If Yes, how many acres would you enroll in this program? _____

Farmers at focus group, 2007

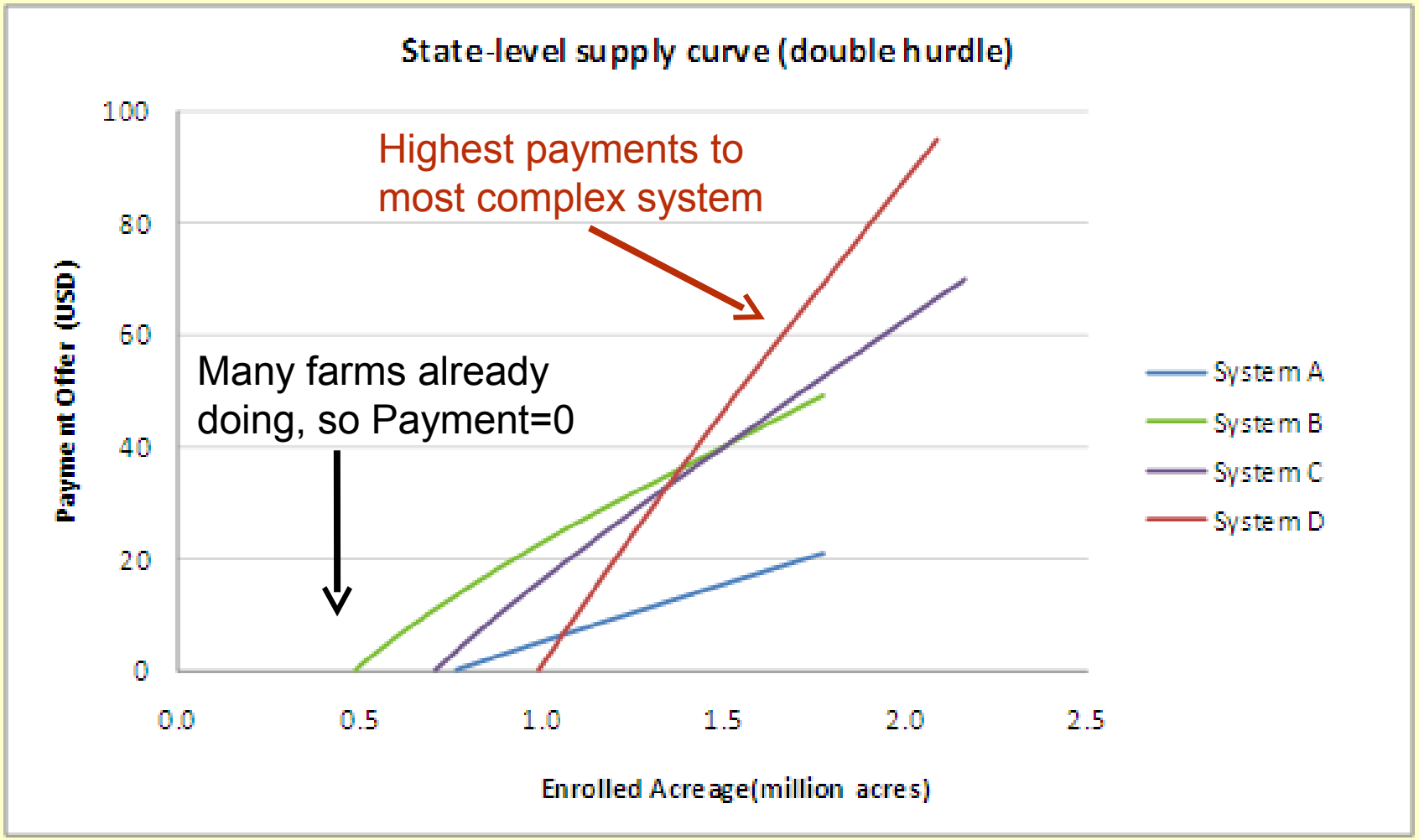
Farmer decision sequence



Farmers Who Would Participate

- Many farmers who would not otherwise adopt these ES-providing practices will do so if paid.
- Farmers who would ***participate in the program*** (adopt new cropping system) tend to:
  - Have higher educational level
  - Perceive more environmental improvement
  - Follow similar practices.
- Farmers who ***enroll more land acreage*** tend to:
  - Be younger
  - Own larger farms
  - Rely on the farm for income.

Supply of ES: Smaller changes cost less, bigger changes cost more



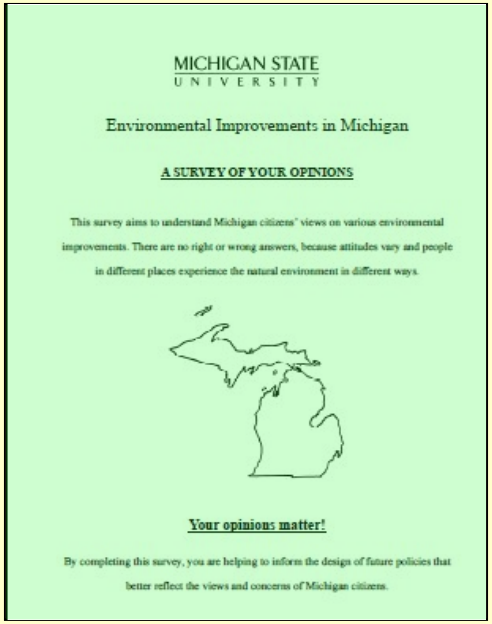
Shan Ma, PhD 2011

Lessons from the farm survey: Understand the cultivators, Create incentives

- Farming ***can*** supply enhanced ecosystem services
- Farming is both ***life style*** and ***livelihood***
  - Environmental stewardship matters
  - Income matters too
- Trade-offs (there are many) require incentives
  - Should farmers bear costs if society benefits?
  - → Payment for Environmental Services
    - Emerging markets for greenhouse gasses
    - Government programs for soil & water conservation

Demand Side Analysis

Residents' willingness to pay for ecosystem service improvements from croplands



MICHIGAN STATE
UNIVERSITY

Environmental Improvements in Michigan

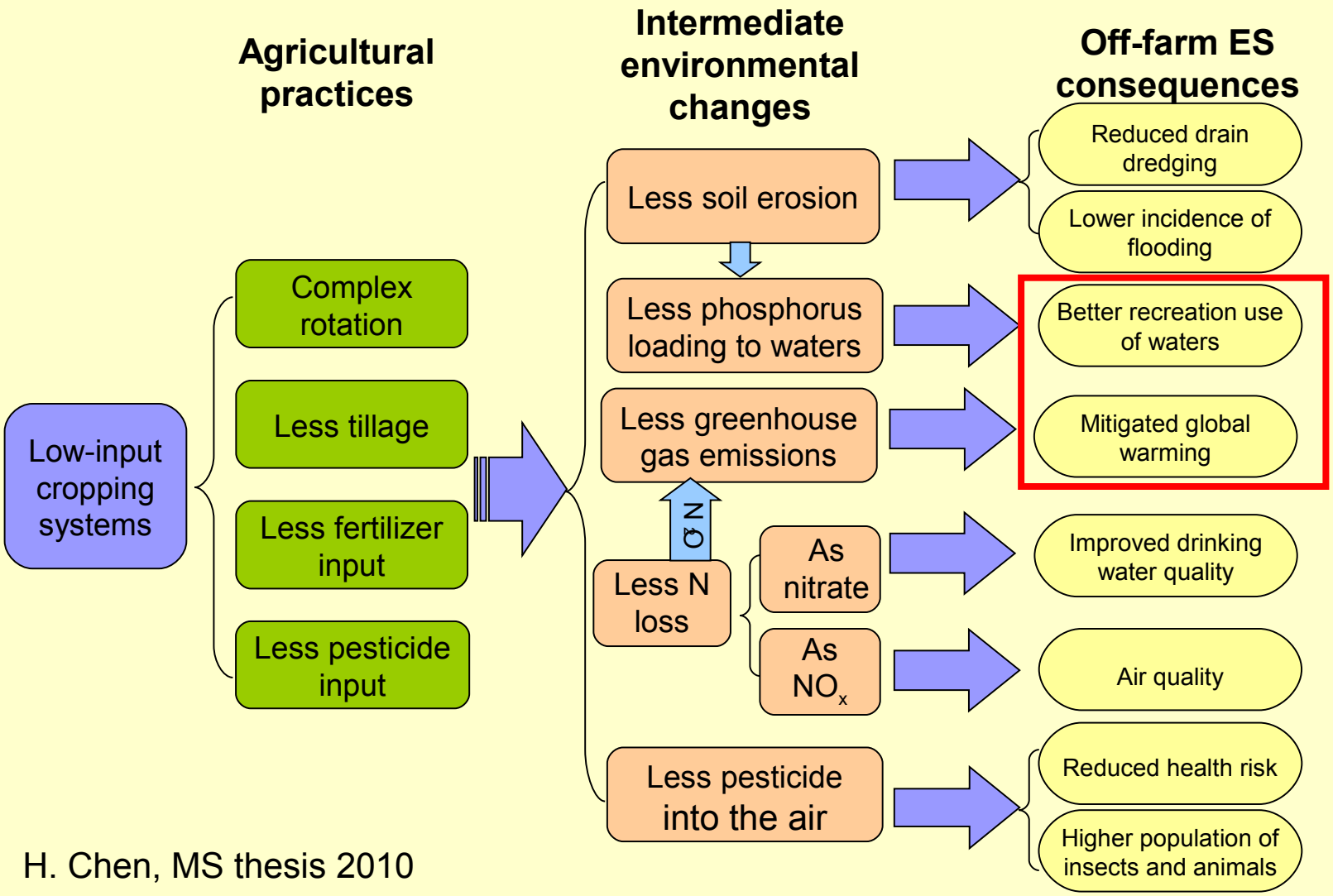
A SURVEY OF YOUR OPINIONS

This survey aims to understand Michigan citizens' views on various environmental improvements. There are no right or wrong answers, because attitudes vary and people in different places experience the natural environment in different ways.

Your opinions matter!

By completing this survey, you are helping to inform the design of future policies that better reflect the views and concerns of Michigan citizens.

Farm farming to ES consumption



H. Chen, MS thesis 2010

Questionnaire design

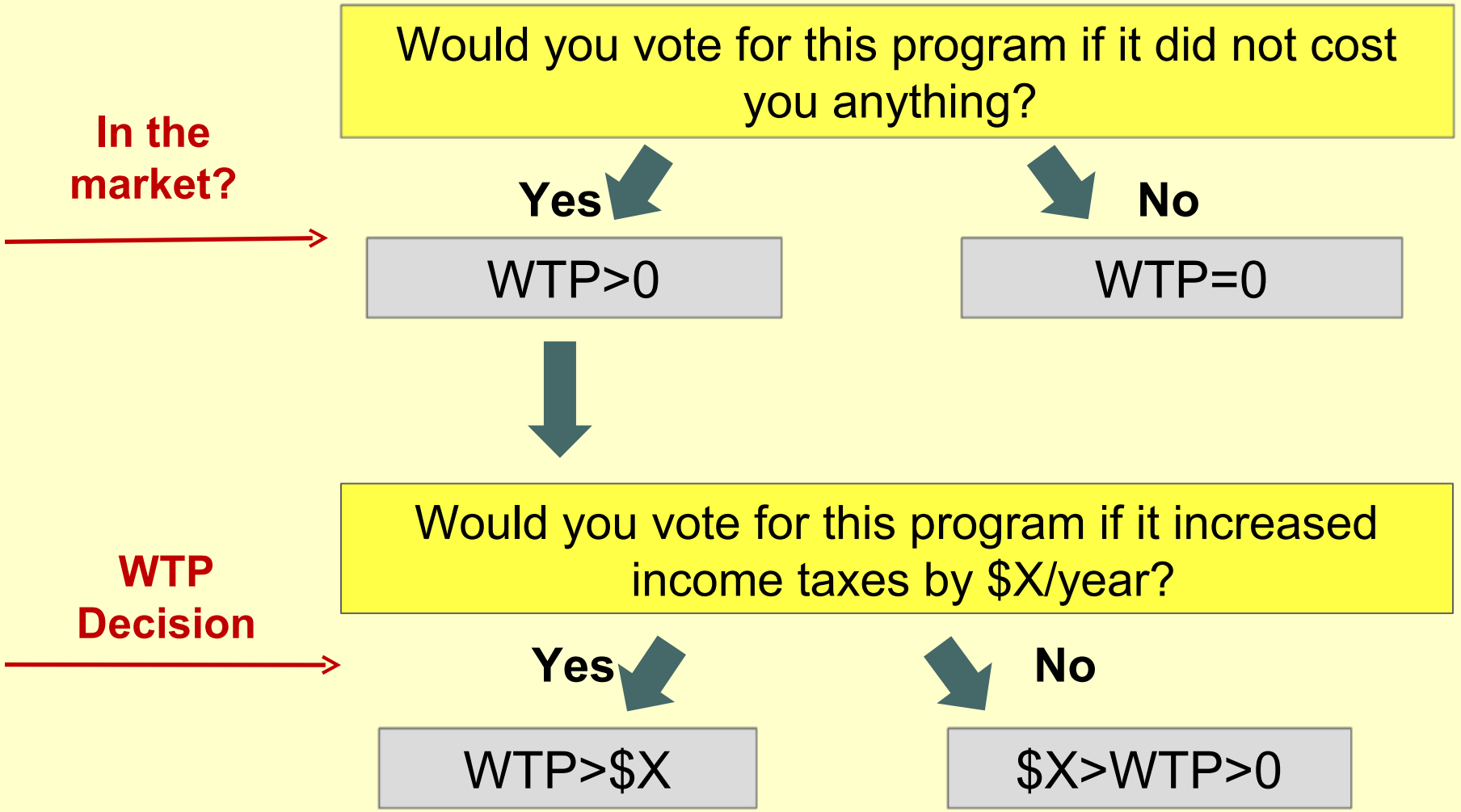
	Now	*Program A is going to …*	*After*
Number of lakes with excess nutrients levels	**3,400**	Reduce by **200** (6%)	**3,200**
Greenhouse gas (GHG) reduction needed to slow global warming	Need **30%** reduction	Reduce by **1.2**	Need **28.8%** reduction
Your share of the costs for the program	**$ 0 per year** in increased income tax		**$10 per year** in increased income tax

Would you vote for this program

1) if it increased income taxes by $Y/year?
2) if it cost did not cost you anything

varied across residents

Consumer Decision Sequence



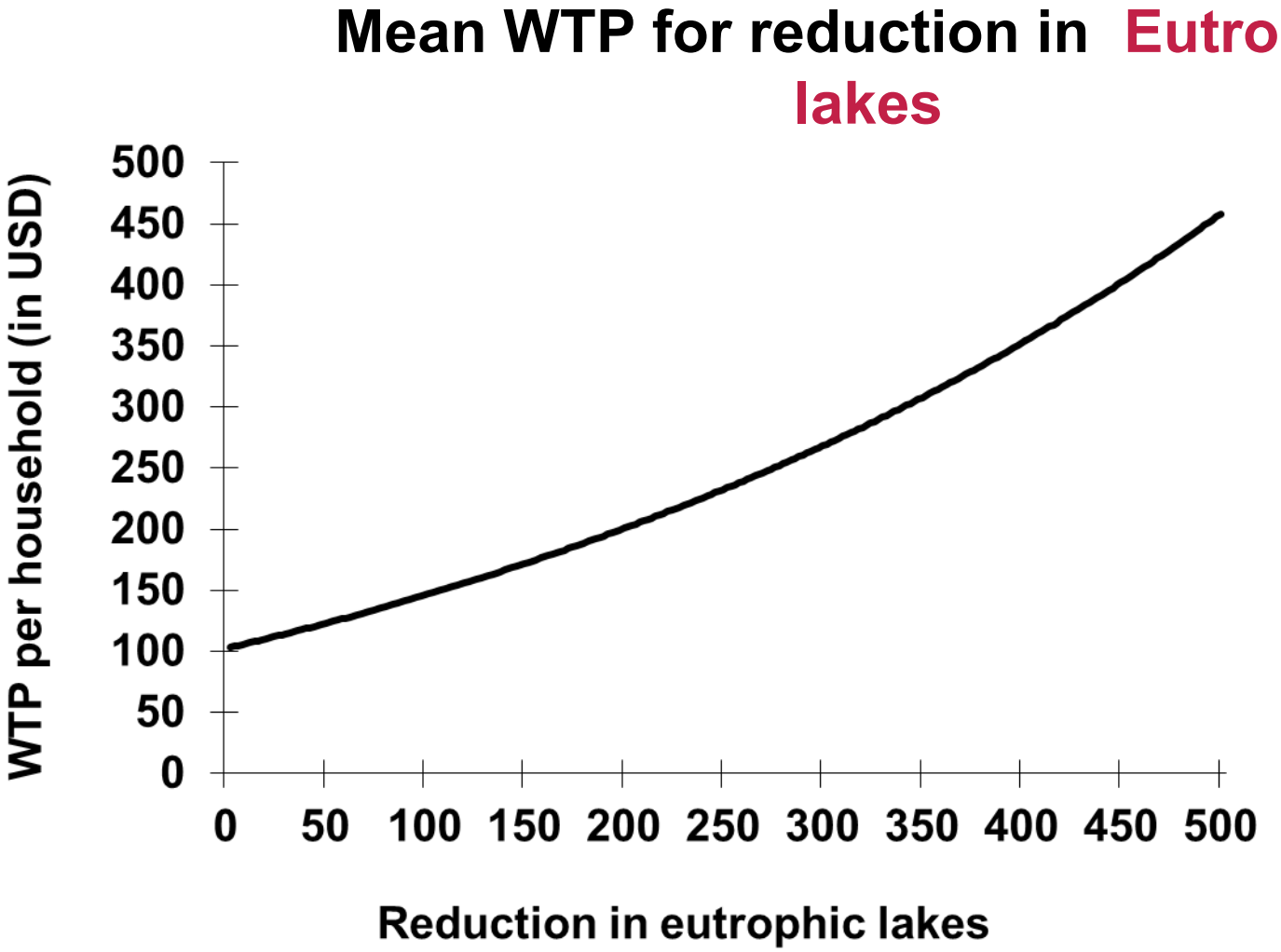
Residents' willingness to pay for ES

- Residents broadly aware of these two ES and most are willing to pay for enhanced ES
- Eutrophic Lakes Reduction
  - Significant effect on the WTP of all respondents
  - Marginal WTP: **$0.54 /person /year** for clean-up of one eutrophic lake
- Greenhouse Gas Reduction
  - Only affected the WTP of those who were concerned about global warming (40% in sample)
  - Marginal WTP: **$100 /person /year** for a 1% GHG reduction of the 2000 emission level (1.9 million tons)

Residents willing to pay for ES if they

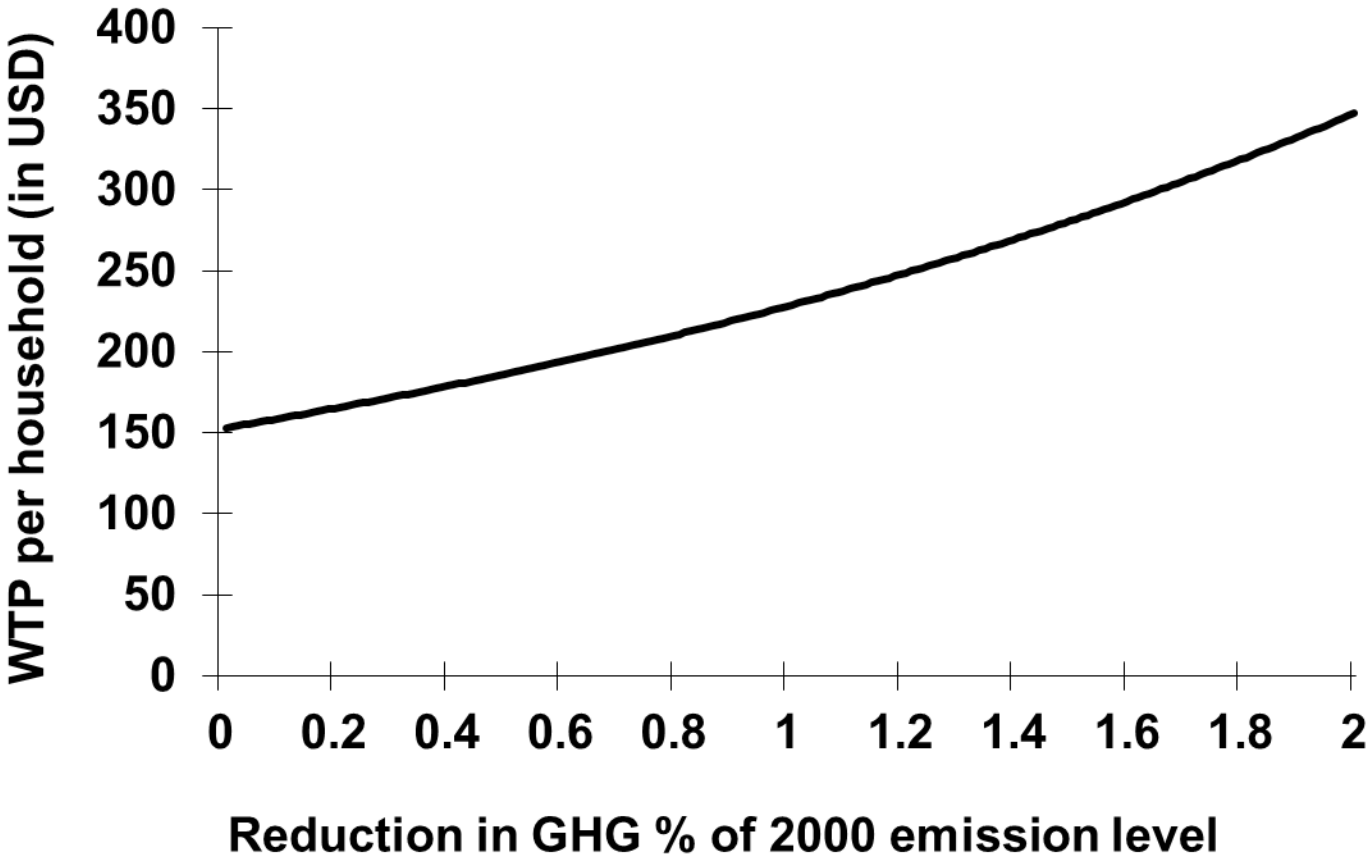
- Are offered more eutrophic lake and GHG reduction
- Perceive global warming is a problem
- Are younger & more educated
- Have higher income
- Vote

Mean WTP Curve Show Residents Will Pay More as Eutrophic Lakes Become Fewer



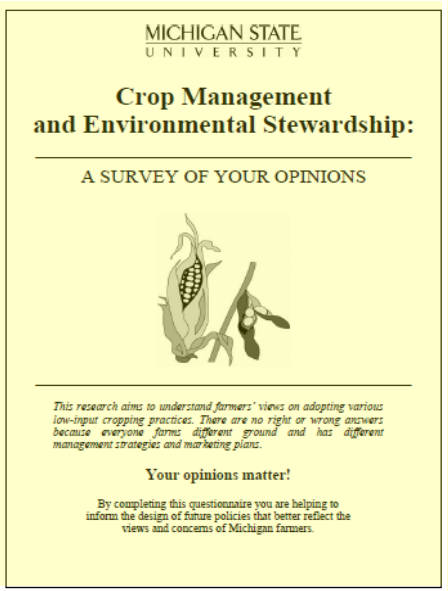
H. Chen, MS thesis 2010

Mean WTP Curve Show Residents Will Pay More as Greenhouse Gasses Abated



H. Chen, MS thesis 2010

Combining supply and demand


MICHIGAN STATE
UNIVERSITY

Crop Management
and Environmental Stewardship:

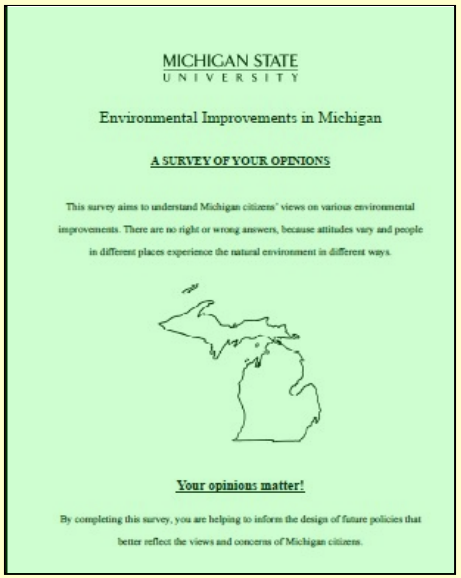
A SURVEY OF YOUR OPINIONS

This research aims to understand farmers' views on adopting various low-input cropping practices. There are no right or wrong answers because everyone farms different ground and has different management strategies and marketing plans.

Your opinions matter!

By completing this questionnaire you are helping to inform the design of future policies that better reflect the views and concerns of Michigan farmers.

+


MICHIGAN STATE
UNIVERSITY

Environmental Improvements in Michigan

A SURVEY OF YOUR OPINIONS

This survey aims to understand Michigan citizens' views on various environmental improvements. There are no right or wrong answers, because attitudes vary and people in different places experience the natural environment in different ways.

Your opinions matter!

By completing this survey, you are helping to inform the design of future policies that better reflect the views and concerns of Michigan citizens.

Different farming practices*

Tillage
PSNT test
Cover crops
Crop rotation
Fertilizer application

Environmental improvements*

Greenhouse gas reduction
Eutrophic lake reduction

* ES produced jointly; consumed separately.

Approach

- Calculate real change in farming practice
  - Additionality between adopted and current practice
- Link additional change in practice to change in environmental improvement
  - practice on 1 acre→ number of eutrophic lakes
  - practice on 1 acre→ tons of greenhouse gas
- Link payment needed to changing practices with WTP for resulting change in ES at the state level
- Preliminary findings: Willingness to pay is high enough to cover costs—*A market could exist!*

Study team

Contact: swintons@msu.edu

Thanks to the farmer & resident respondents, to many others, & to our funders.

Michigan State University AgBioResearch

HSD Human and Social Dynamics

NSF

KBS LTER Kellogg Biological Station Long-term Ecological Research