Modelling mid-western corn yield response to phosphorus fertilizer in Michigan

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Presentation Flow

- Background
- Motivation
- Research questions and contribution
- Data
- Methodology
- Results
- Future Work
- Conclusion

Background

- We need fertilizer for food security, but are we using more, less, or optimum?
- What happens when we use more than we need?
- Excess N and P leads to eutrophication of water bodies
- Agriculture is a primary non-point source of excess nitrogen and phosphorus in watersheds (EPA)

Why we focus on P, Corn, and Michigan?

1) Limiting nutrient

2) Stored in soil – P buildup

3) Less focus on P

1) Nutrient dependent

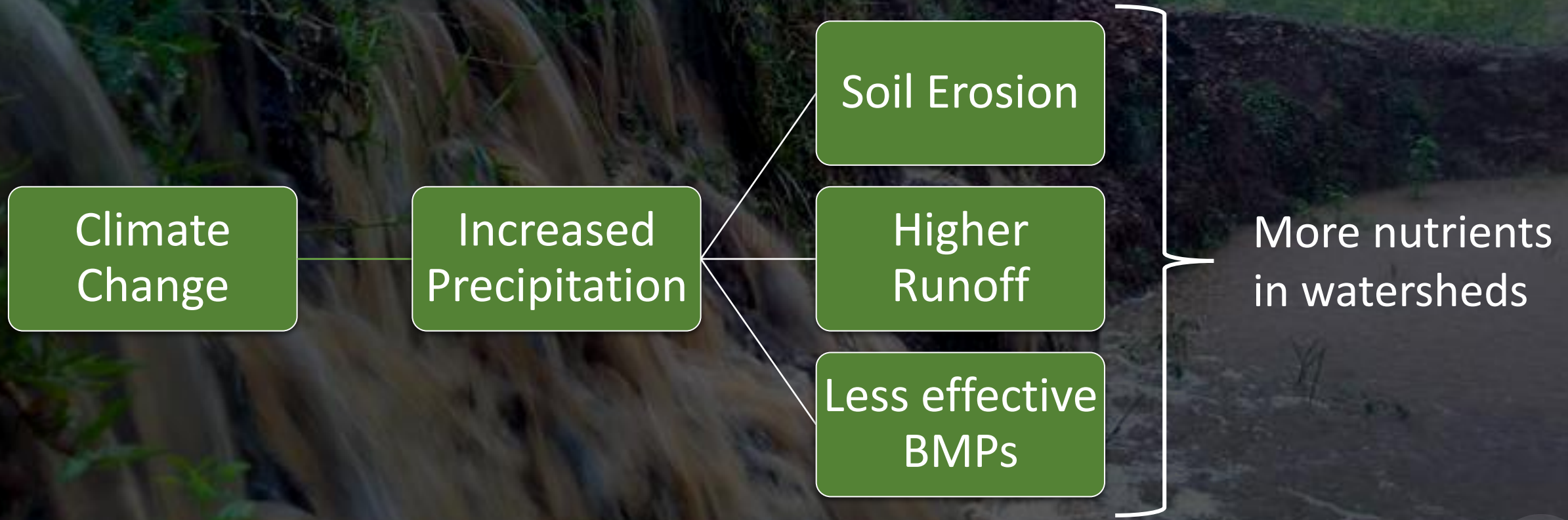
2) Abundant in MI

3) Valuable

1) Crop application – major P source;

2) Freshwater surrounded

Why our research is important?



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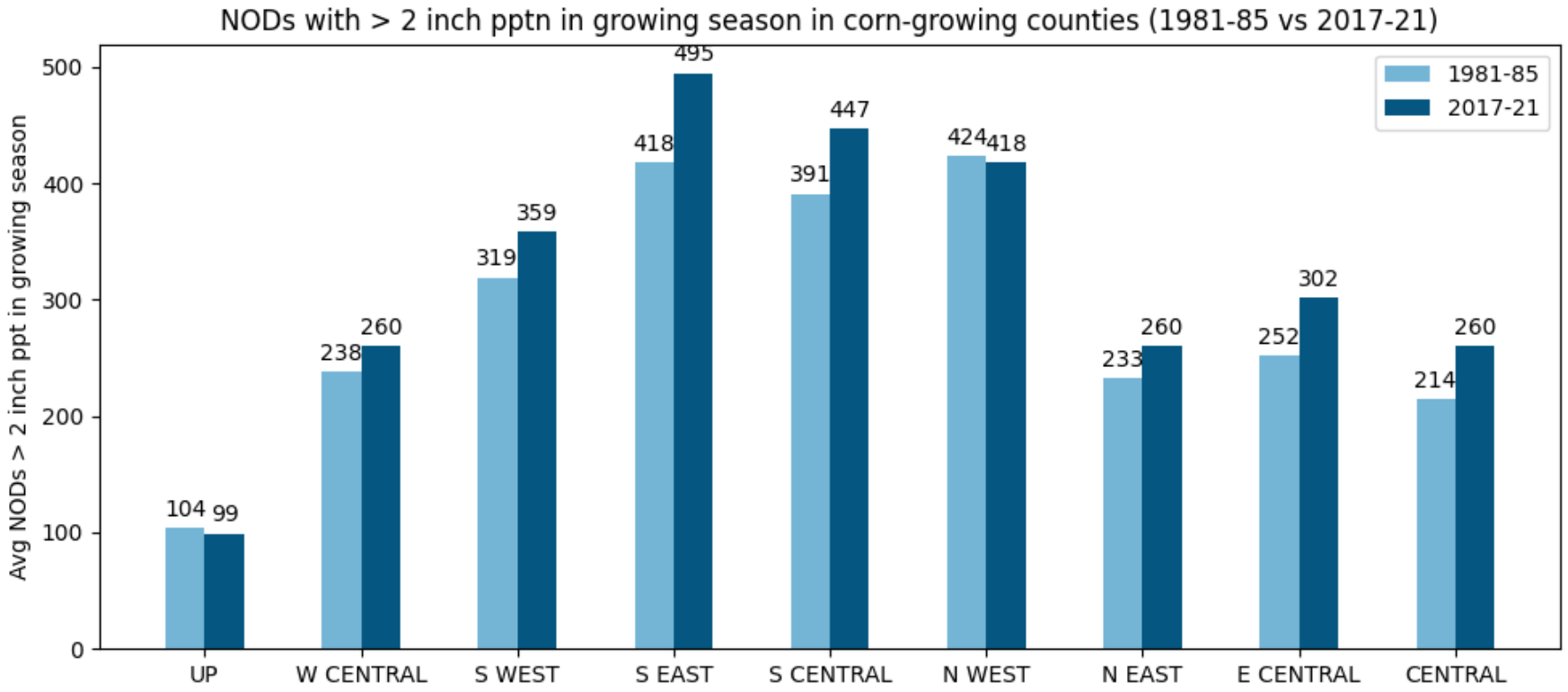
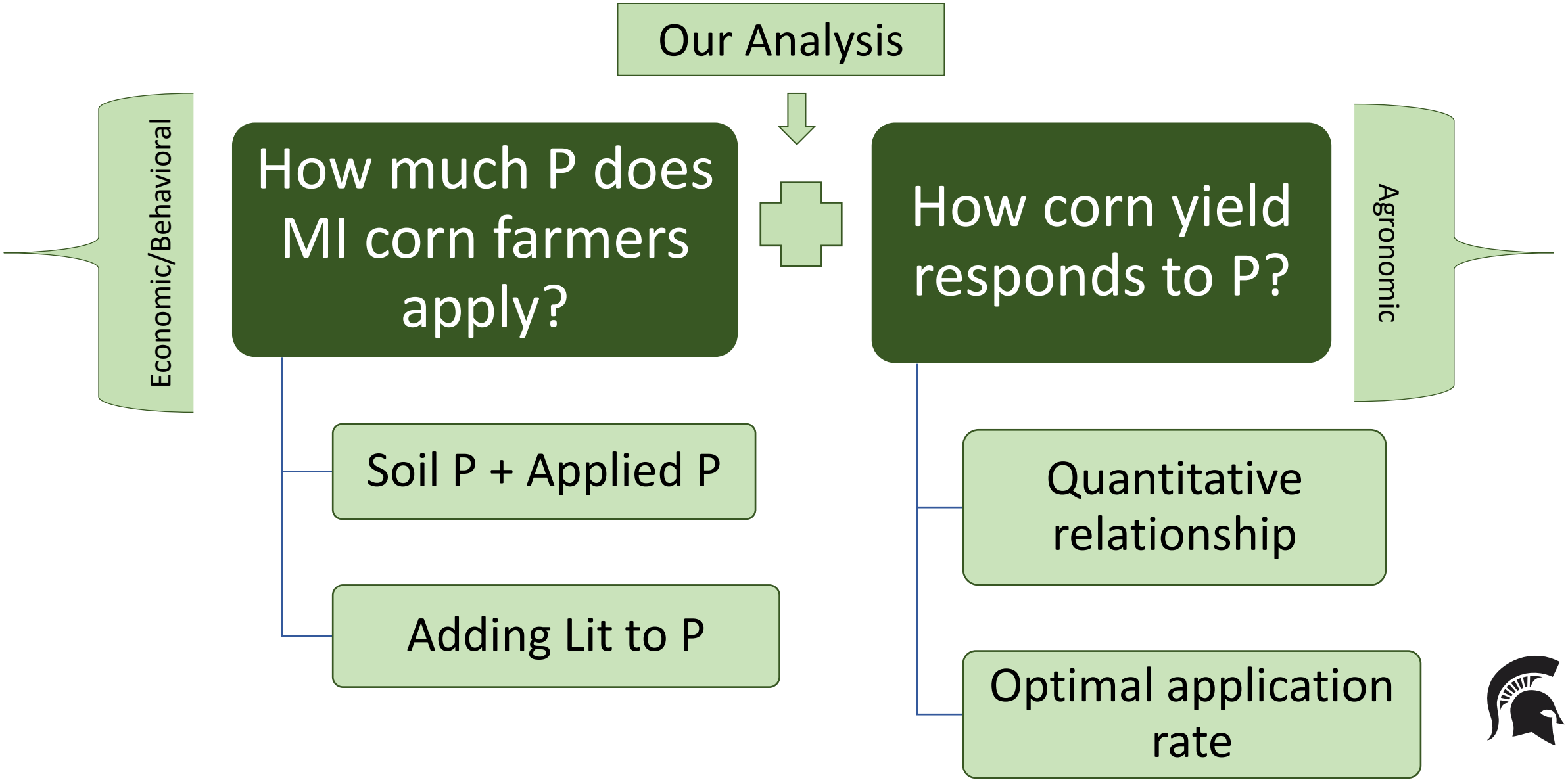


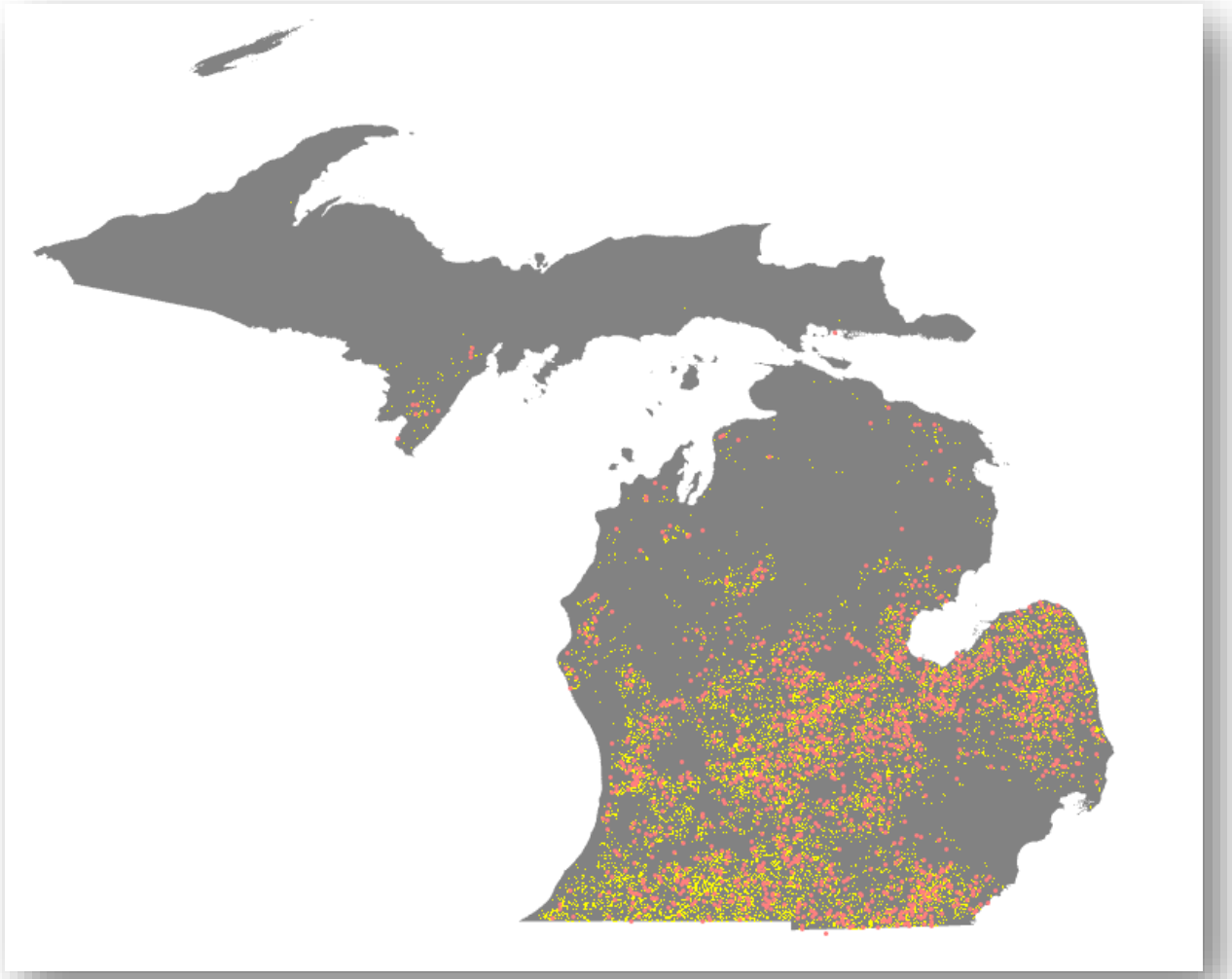
B/w 2002-2013, **70-90%** of P & N discharged from the Maumee River occurred during the 10 largest storm events each year (Baker et al. 2014)

- The 4 Rs (right source, right rate, right time, and right place) becomes more important.
- We focus on **right rate**!

Research Questions and contributions



Data



Corn growing fields in 2017

Approximate corn-growing fields from our survey

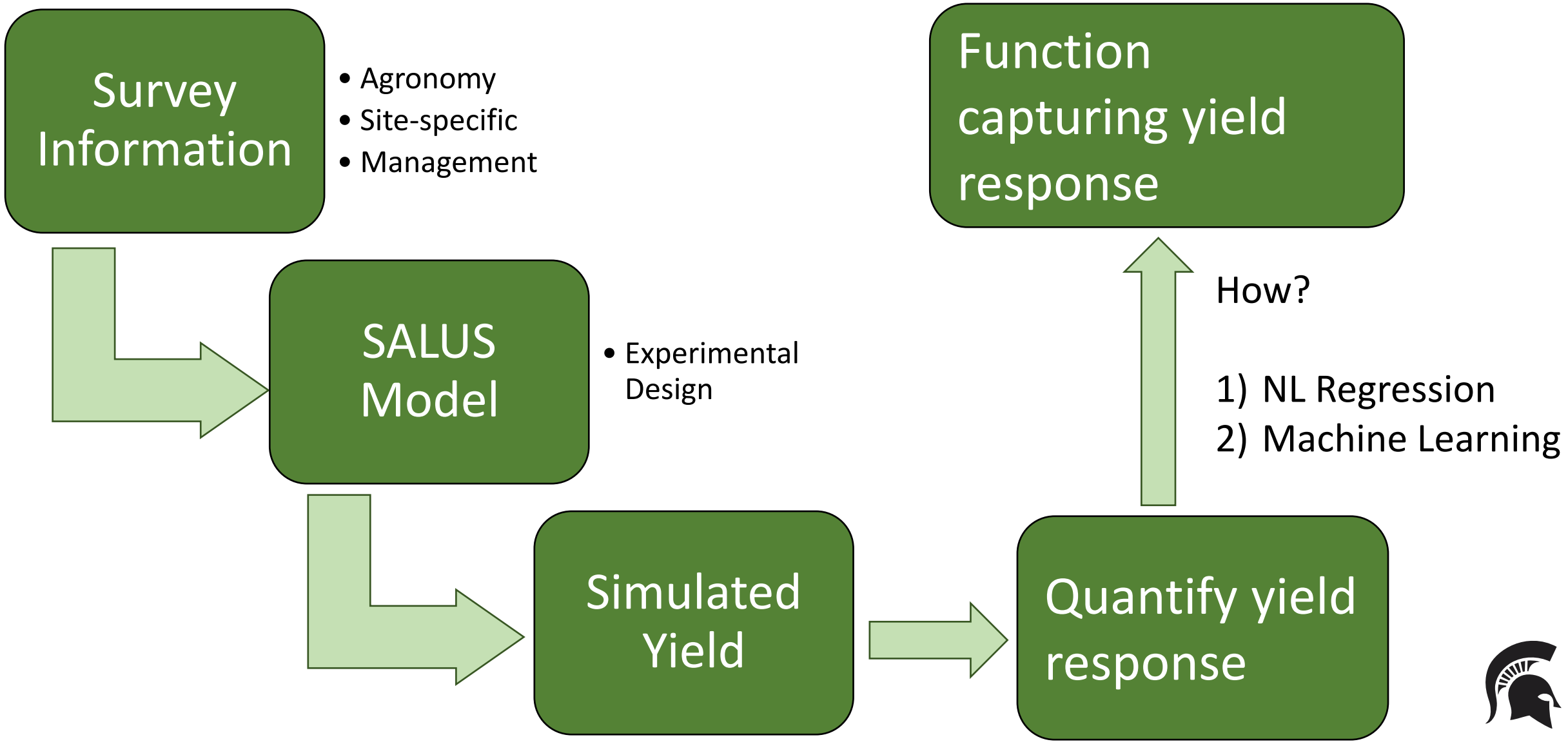
- Survey Data to understand farmer behavior
- Survey of corn-growing farmers in Michigan in 2018 with 1650 respondents
- Survey provided data on agronomic, management, behavioral, demographic & other variables

Data

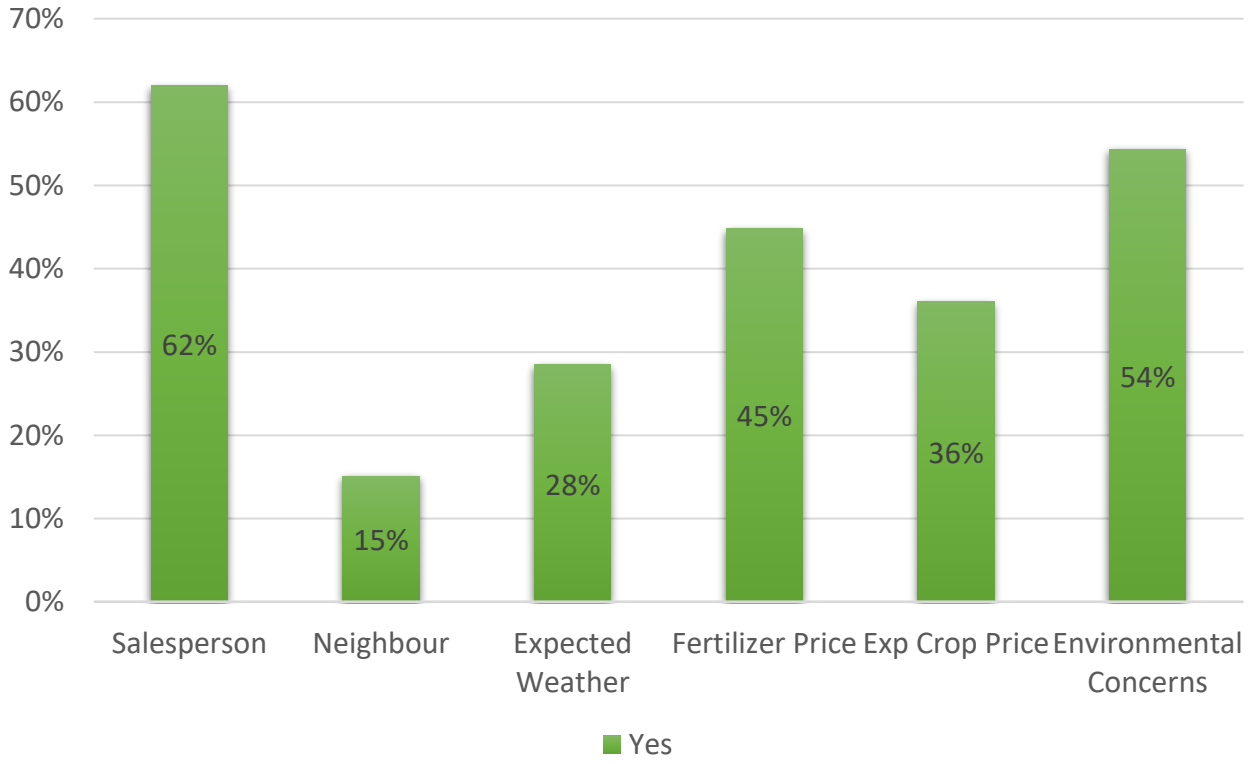
Attribute 1: Applied P (lb/acre)	Attribute 2: Soil P (ppm)	Attribute 3: Weather
0	0-5	Good
15	15-20	Normal
30	Average (79 ppm)	Worst
60		
90		
120		
Levels = 6	Levels = 3	Levels = 3
Total = 54 scenarios (= 6*3*3 levels for weather, P applied, and soil P)		

- Farmer's data was used to generate additional data for a yield prediction from a crop simulation model (SALUS).
- SALUS is designed to model continuous crop, soil, water, and nutrient conditions under different management strategies

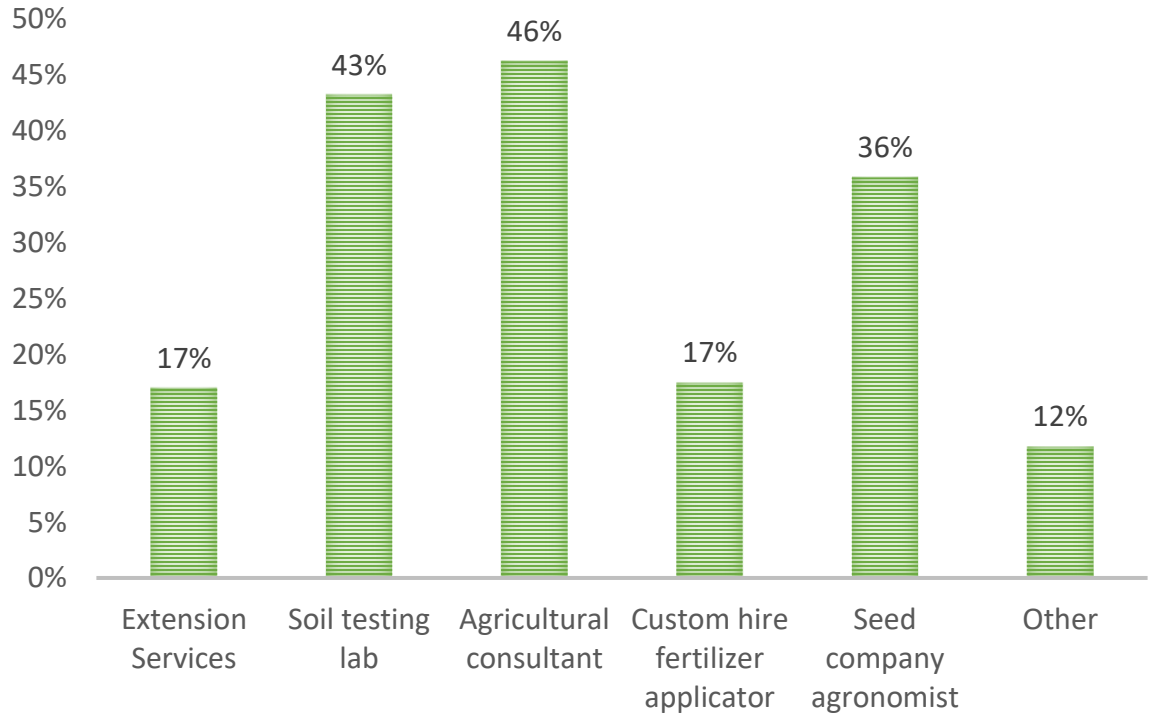
Methodology



Results from Survey Data

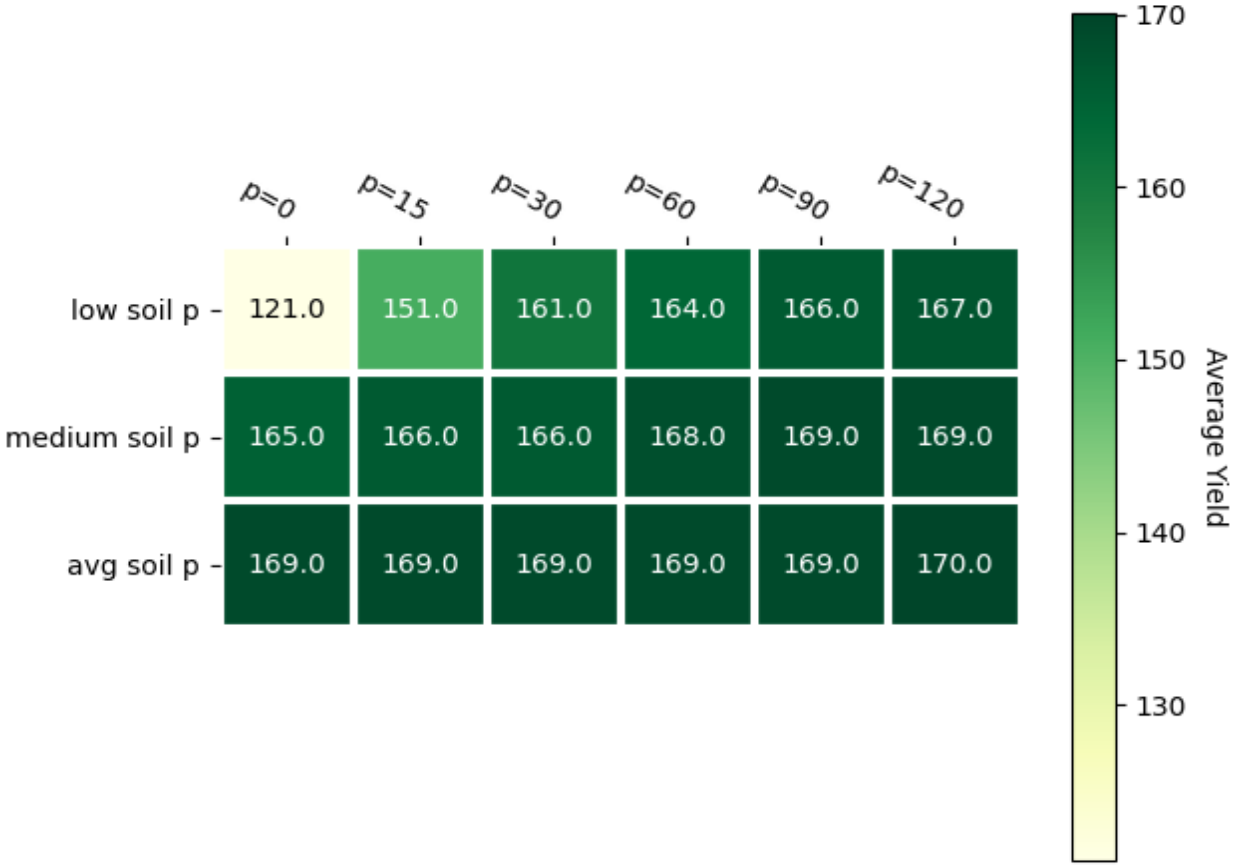


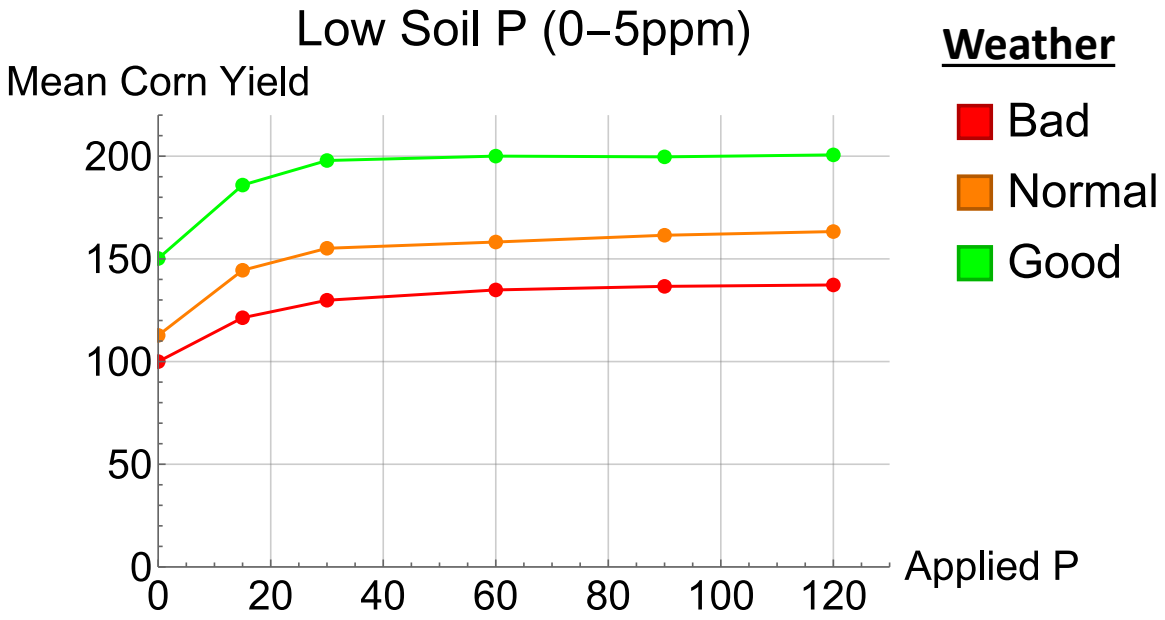
a) Factors that influenced Phosphorus management decision by farmers



b) Source of information of yield response to fertilizer application for the informed farmers

Results from SALUS





Results from Estimation

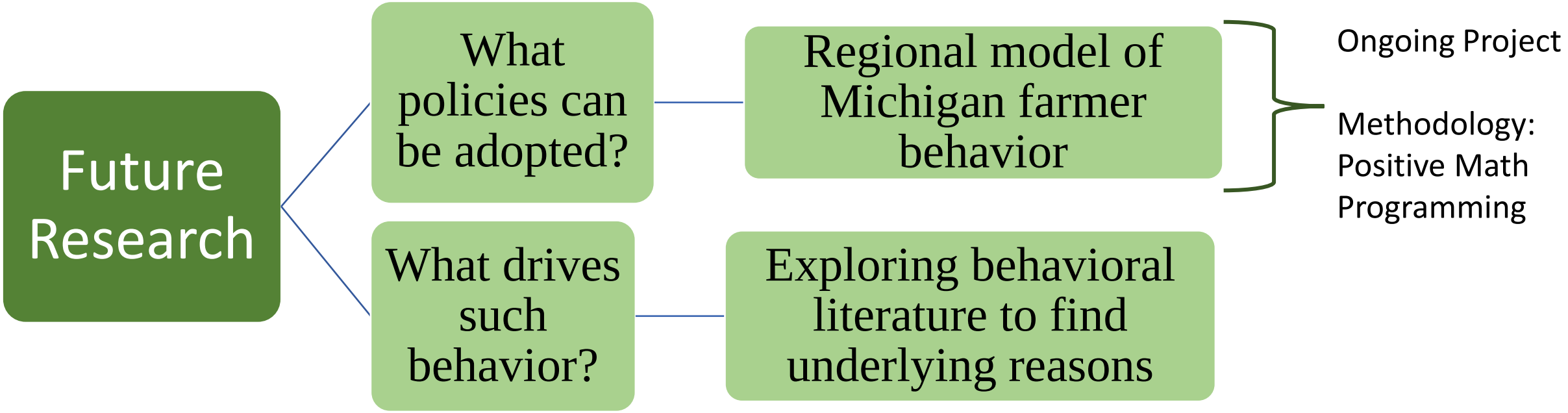
Regression	Symbolic Regression (ML)
• Optimal Yield = 30.61	• Optimal Yield = 31.8

Even in low soil P, if more than P = 31 is applied, corn yield doesn't respond to P!

Results from SALUS + Survey

- Optimal Yield at P = 30ppm, but survey reveals: out of farmers who apply P, 33.6% apply more than 30 ppm, 28% apply more than 35 ppm
- For farmers who overapply, average rate of application : P = 61ppm
- Farmers bear extra cost for no visible output
- If optimal P applied, farmers who apply 61ppm/acre save $13.18/acre approx.
- If optimal P applied: Farmers profit and water pollution decreases : win-win situation

Future Work



Silver Lining:

- 59% of respondents believe Michigan farmers should be doing more to reduce nutrient runoff

- 18% of respondents revealed that they plan on changing fertilizer management for their cornfield in the next two years

Key Takeaways

- Farmers are applying more than optimal P in their cornfield
- Applying P increases corn yield only when soil P is low
- The estimated yield-response curve in this study would be used to construct an optimization problem at a regional scale
- The results from the regional model would help us to suggest policies that could be adopted

THANK YOU!

- For any questions/feedbacks, please feel free to contact: **sarkars6@msu.edu**