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Ag Economics, Kansas State University

Kansas Farm Income and Conservation Practices (Part 1)

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Chapter I

Motivation

Conservation practices

- An increasing number private initiatives and USDA programs offer \$\$\$ for adoption of practices or some type of carbon offset
- Conflicting information on costs and benefits of conservation practices
- Practices that are not profitable are not sustainable



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- The impacts of conservation practices on profitability are challenging to measure and quantify
 - Data availability
 - Combinations of practices
 - Intensity of practices
 - Duration of adoption
 - Correlation vs causation?
 - Are more (or less) profitable farms more likely to adopt conservation practices or do these practices have direct impacts that impact profitability



Research Questions

The BIG question

Is adoption of conservations practices related to farm profitability?

In partnership with KFMA (Kansas Farm Management Association)

- Do KFMA farms that adopt conservation practices experience a larger increase in profitability over time than farms who do not?
 - Yields
 - Expense measures
- Does the timing and combination of practices make a difference?

Previous findings

Many case studies for individual farms or small groups of farms, most focus on yield

Findings of larger studies on specific practices and yields tend to be mixed, especially for cover crops (Schnitkey et al, 2023)

Meta-analysis of studies on select practices: No relationship with yield gains or losses (Jordon et al., 2022)

Farmer interviews suggest adoption of multiple practices adds stress for producers due to delayed realization of expected yield or profitability benefits (Miller-Klugesherz & Sanderson, 2023)

Studies using USDA farm survey data (ARMS)

- Adoption of a larger number of 'sustainable practices' is related to higher yields and lower yield variability for corn farms (Dong and Mitchell, 2023)
- Relationship of best management practices (BMPs) with profitability varies by practice, may benefit from adoption of precision ag technologies (Schimmelpfennig, 2019; Schimmelpfennig, 2015)
- Farms that use crop insurance have higher adoption of some environmentally beneficial practices (Ifft and Jodlowski 2024)

Research contribution

Complementary to studies using large-scale field level data only, USDA cross sectional data, case studies

High quality production and financial data from KFMA over several years, combined with data on practices

Adoption of conservation practices “in the wild”, outside of a controlled setting

Survey tailored to KFMA farms with substantial stakeholder input

Analysis can contribute to understanding of capturing intensity, duration, and aggregation in measuring practice adoption

Causal claims may require relatively strong assumptions, but analysis can account for farm-level trends

Data & Methodology

Data

- **Kansas Farm Management Association**

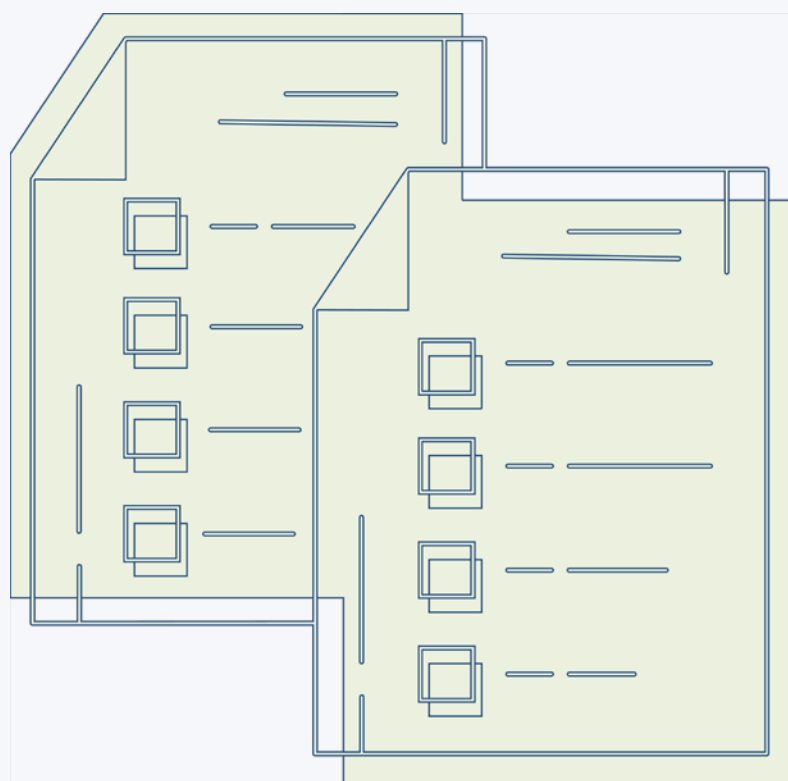
- Comprehensive Kansas farm-level information over multiple decades
- Detailed data on farm characteristics, crop and livestock production, income, expenses, and financial metrics
- Used widely in agricultural economics research

- **Survey**

- Supplementary data on the adoption of conservation practices



Survey Approach & Format



Survey approach

- Survey designed to capture conservation practices based on the five principles of regenerative farming (focus is more soil health than nutrient management), questions based on ease of recall and relevance for KFMA farms

Principles of Regenerative Farming

1. Minimize Soil Disturbance: Reduced or continuous no-till
 2. Keep the Soil Covered: Cover crop, mulch
 3. Maintain Living Roots in the Soil: Year-round plant cover
 4. Maximize Plant Diversity: Crop rotation
 5. Reintroduce Livestock: Grazing
- + Context!

Survey Approach & Format

Practice	Yes-Y No-N	First year of use	% acres on average
----------	---------------	----------------------	-----------------------

Do you have fields where you typically practice reduced or minimum* tillage?

Do you have fields that are typically continuous no-till*?

Do you have fields where you rotate 2 crops?

Do you have fields where you rotate 3 crops?

Do you have fields where you rotate 4 or more crops?

Survey Approach & Format

Practice	Yes-Y No-N	First year of use	% acres on average
----------	---------------	----------------------	-----------------------

**Do you use winter cover crops? Circle the most typical species:
(a) grass/cereal crops (b) legumes (c) mix**

**Do you use summer cover crops? Circle the most typical species:
(a) grass/cereal crops (b) legumes (c) mix**

If you have cover crops, do you typically graze them?

Do you use rotational grazing* practices (on any field/land)?

Do you typically graze crop residue?

Do you ever plant annual forage crops* for grazing livestock? Circle the most common type (a) single species (b) mix

Survey Approach & Format

Practice	Yes-Y No-N	First year of use	% acres on average
----------	---------------	----------------------	-----------------------

**Do you regularly test* your soil for NPK and organic matter? How often?
(a) Every year (b) every 2 years (c) less than every 2 years**

**Do you regularly test* your soil for biological matter, micronutrients, or other soil health factors or indicators*? (for example, Haney test, tests for infiltration, aggregate stability) If yes, how often?
(a) Annually (b) every 2 years (c) less than every 2 years**

Survey Approach & Format

How would you characterize your use of 'conservation practices' relative to producers in your county and surrounding counties? 1. More than average 2. Average 3. Less than average.

If you use cover crops, why? (Select more than 1 if relevant)

1. Forage/grazing 2. Weed control 3. Organic Matter. 4. Herbicide reduction 5. Erosion 6. Soil health 7. Other _____

In the past two years, have you been to a meeting or workshop on soil health? YES NO

How important is soil health to your economic decision making on a scale of 1 to 5? (1=very little, 5=very important) 1 2 3 4 5 (circle one)

Survey Details

KFMA Members: (1246 farm-observations in 2022 data set)

Survey responses: 630

Final survey responses used for analysis: 605

48.5 % response rate

Methodology – Part 1

1. Survey responses / summary statistics

2. Conservation practices by farm type

3. Development of a conservation intensity ranking measure

4. Financial outcomes

- Net Farm Income Ratio (NFR) measures the percent of gross farm income represented by net farm income or profit. A relatively low net farm income ratio would indicate the firm needs to assess production cost levels, productivity.
- Operating Expense Ratio (OER) measures the percent of gross income used for operating expenses. A lower operating expense ratio is preferred to a high ratio.

Farm size based on Gross Revenue:

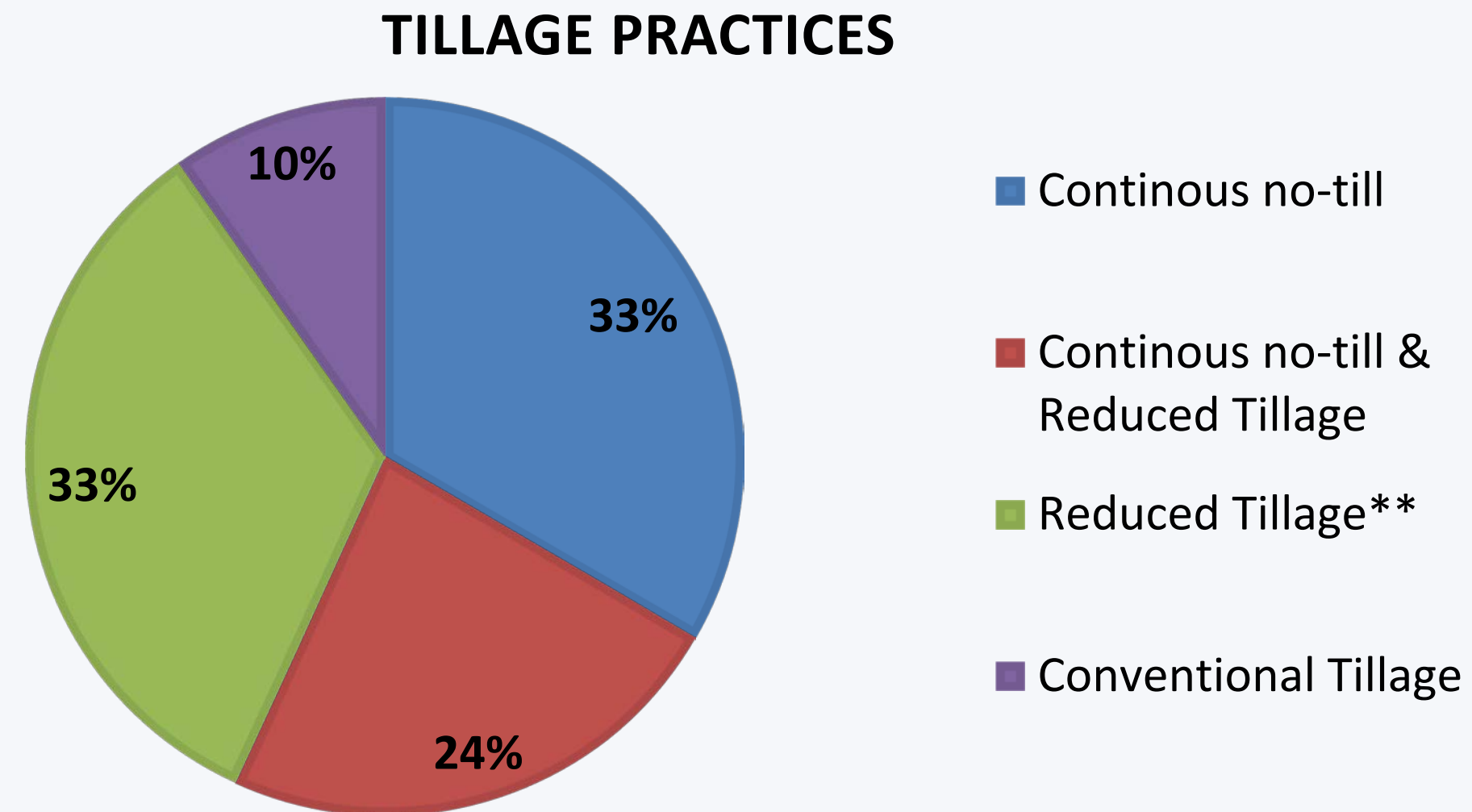
- Small : Gross Revenue < \$350,000 **(10% of farms)**
- Medium : Gross Revenue between \$350,000 and < \$1,000,000 **(58% of farms)**
- Large : Gross Revenue \geq \$1,000,000 **(32% of farms)**

Methodology – Part 2

- **Outcomes**
 - Profitability metrics (Net Farm Income Ratio; cluster analysis based on Yi and Ifft, 2019)
 - Yields: corn, soybeans, sorghum, wheat
 - Expenses: Operating Expense Ratio
- **Measures of adoption and intensity of conservation practices**
 - Expert opinion (agronomists/soil health experts)
 - Principal component analysis (Dong & Mitchell, 2023)
 - Cluster analysis (group farms by practices with the highest level of correlation)
 - Threshold models (Grouped by number and intensity of practices)
 - Single practices
- **Econometric methods.**
 - PSM, farm fixed effects

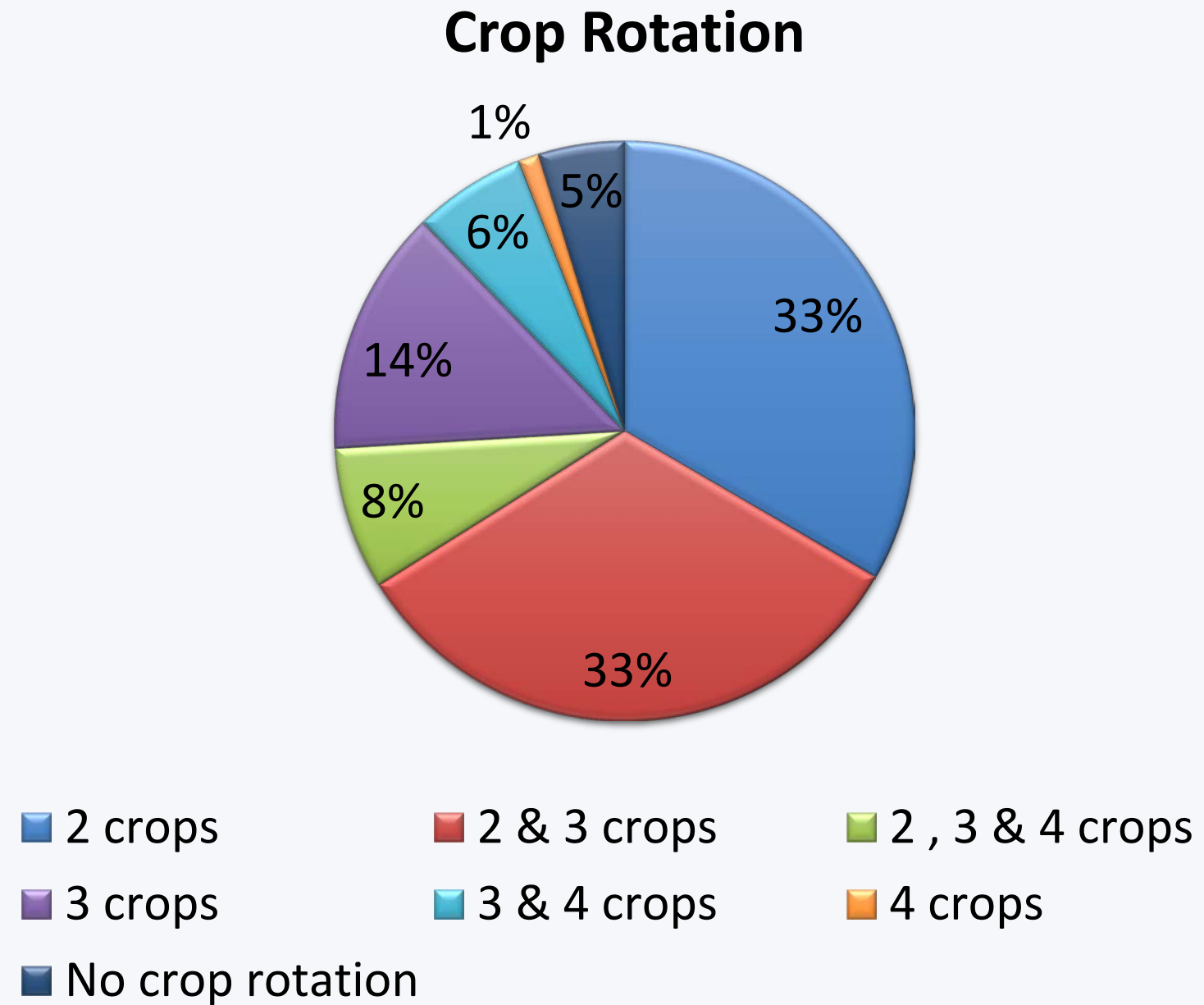
Analysis

Tillage Practices



** Reduce tillage includes partial continuous no-till

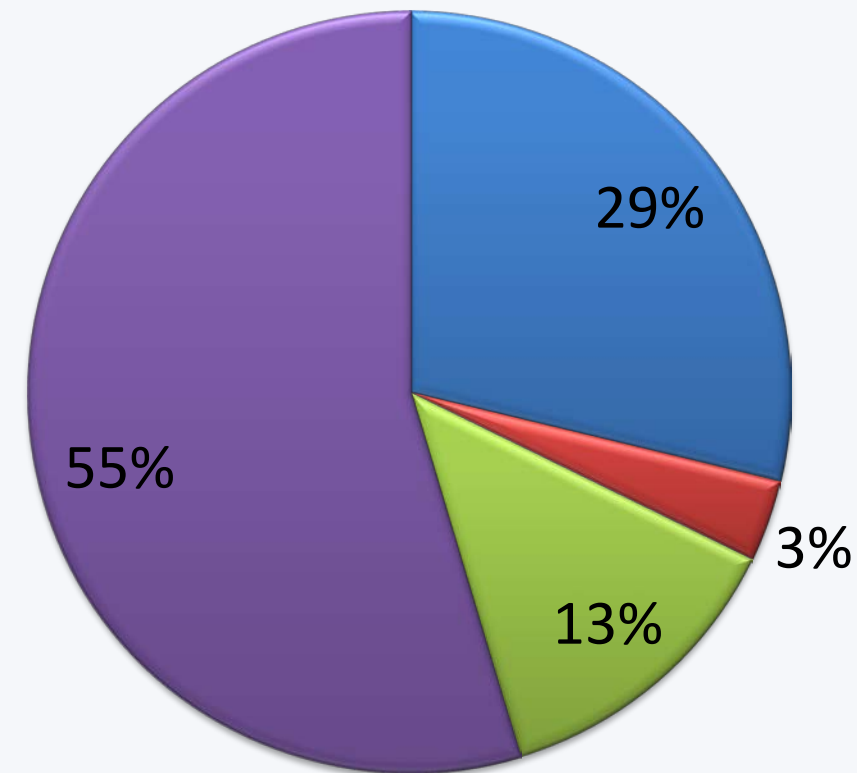
Rotation practices



*120 farms (20%) include
perennials in their
typical crop rotation.*

Use of Cover Crops

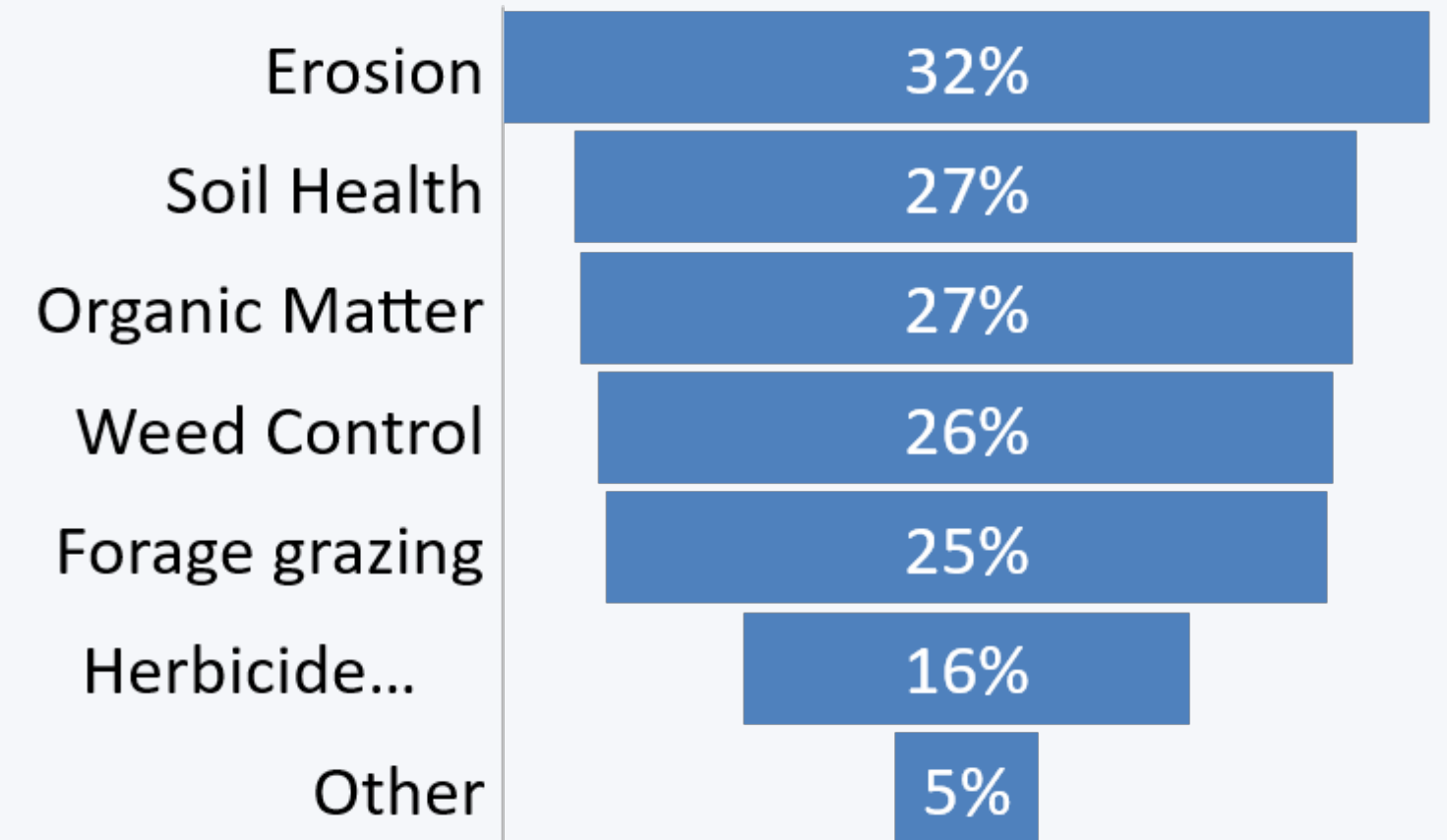
Cover Crop



■ Winter only ■ Summer only ■ Summer & Winter ■ No cover crop

605 responses

Reasons for using cover crop



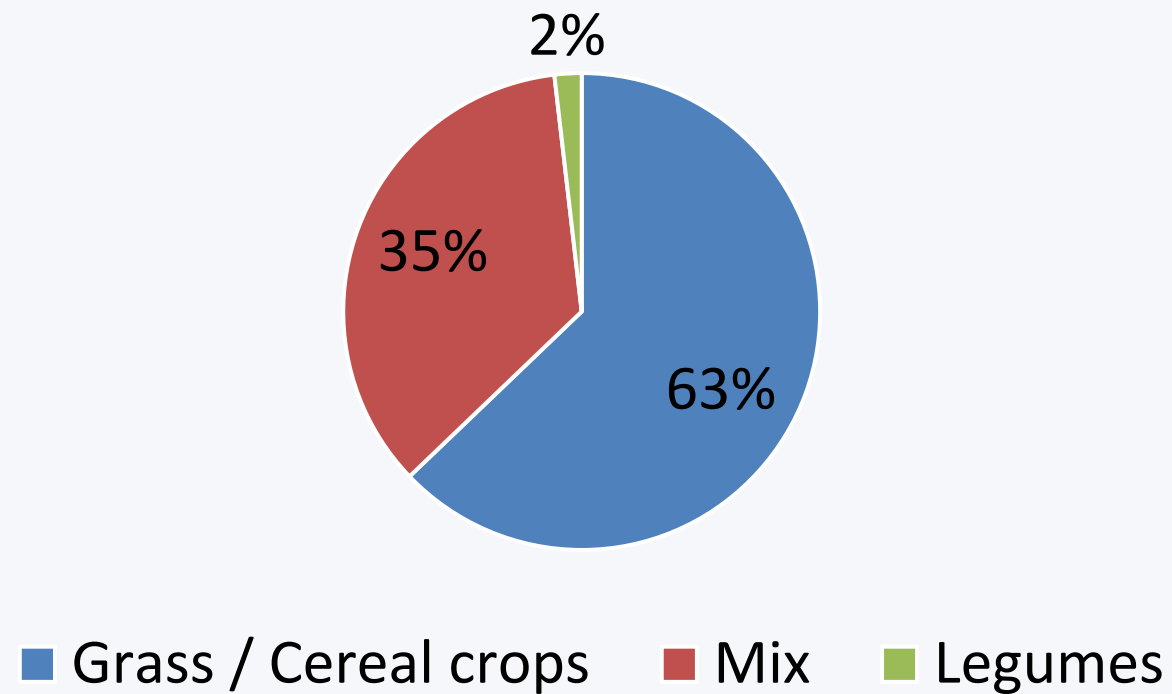
605 responses

Reasons for using cover crop by region

	North Central	South Central	Southwest	Southeast	Northeast	Northwest
Erosion	58%	77%	50%	67%	75%	0%
Soil Health	65%	60%	25%	56%	63%	0%
Organic Matter	58%	49%	75%	55%	60%	0%
Weed Control	65%	54%	50%	50%	55%	0%
Forage grazing	58%	51%	25%	44%	65%	0%
Herbicide Reduction	44%	40%	38%	20%	40%	0%

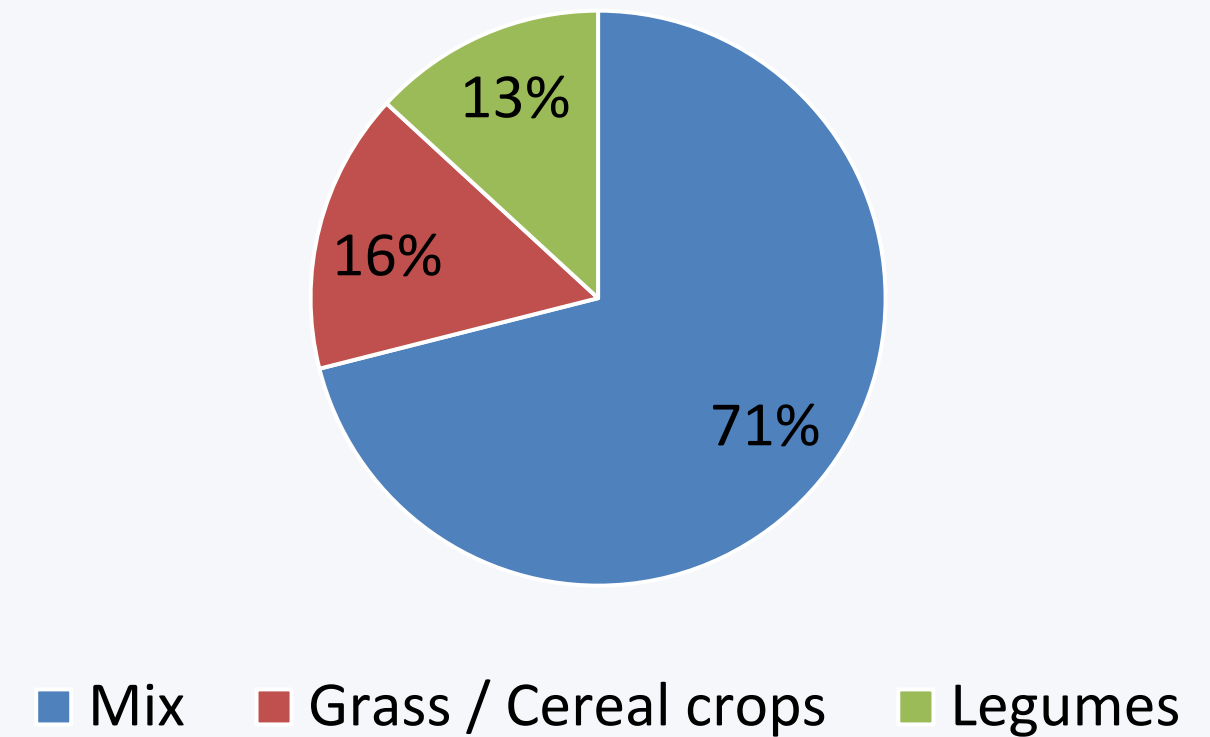
Conservation Practices in KFMA Farms

Most Typical Winter Cover Crop Species



218 responses out of the 254 that use winter cover crop

Most Typical Summer Cover Crop Species



76 responses out of the 100 that use summer cover crop

Grazing Practices

	Graze Cover Crop	Rotational Grazing	Graze Crop Residue	Annual Forage Crop for Grazing	Any Grazing Practice
	7%	6%	8%	7%	11%
# respondents	596	604	602	604	604

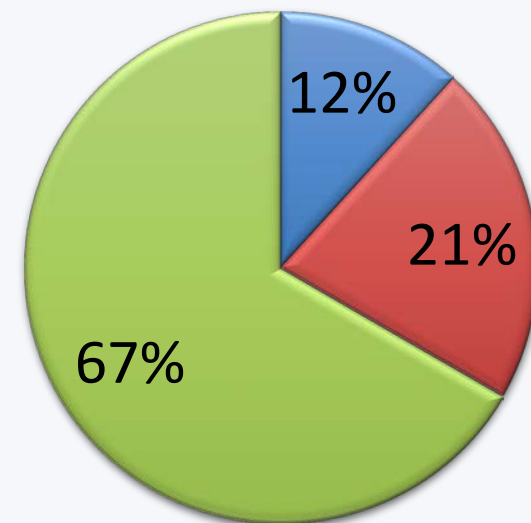
Soil testing

Test	Farms
NPK & Organic Matter	98% *
Biological Matter & Other nutrients	32% **

*594 responses

** 592 responses

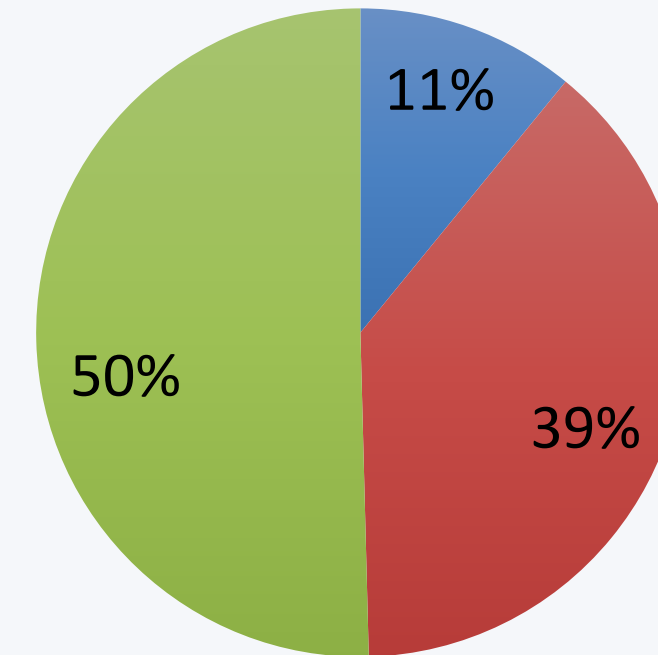
Frequency of Biological Matter Testing



■ Annually ■ Every 2 years ■ More than every 2 years

162 responses out of 193 who test for biological matter

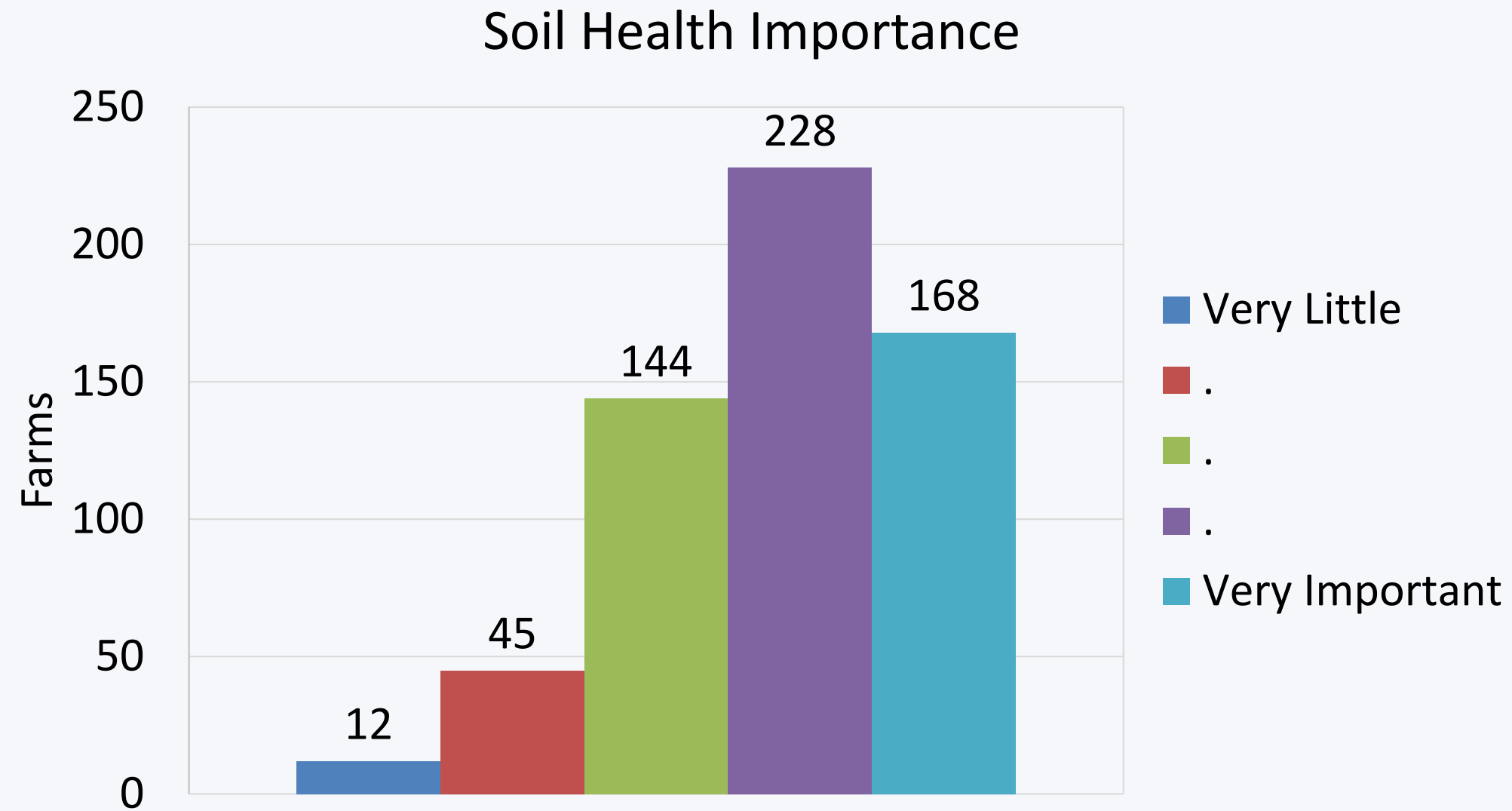
Frequency of NPK & Organic Matter Testing



■ Annually ■ Every 2 years ■ More than every 2 years

594 responses

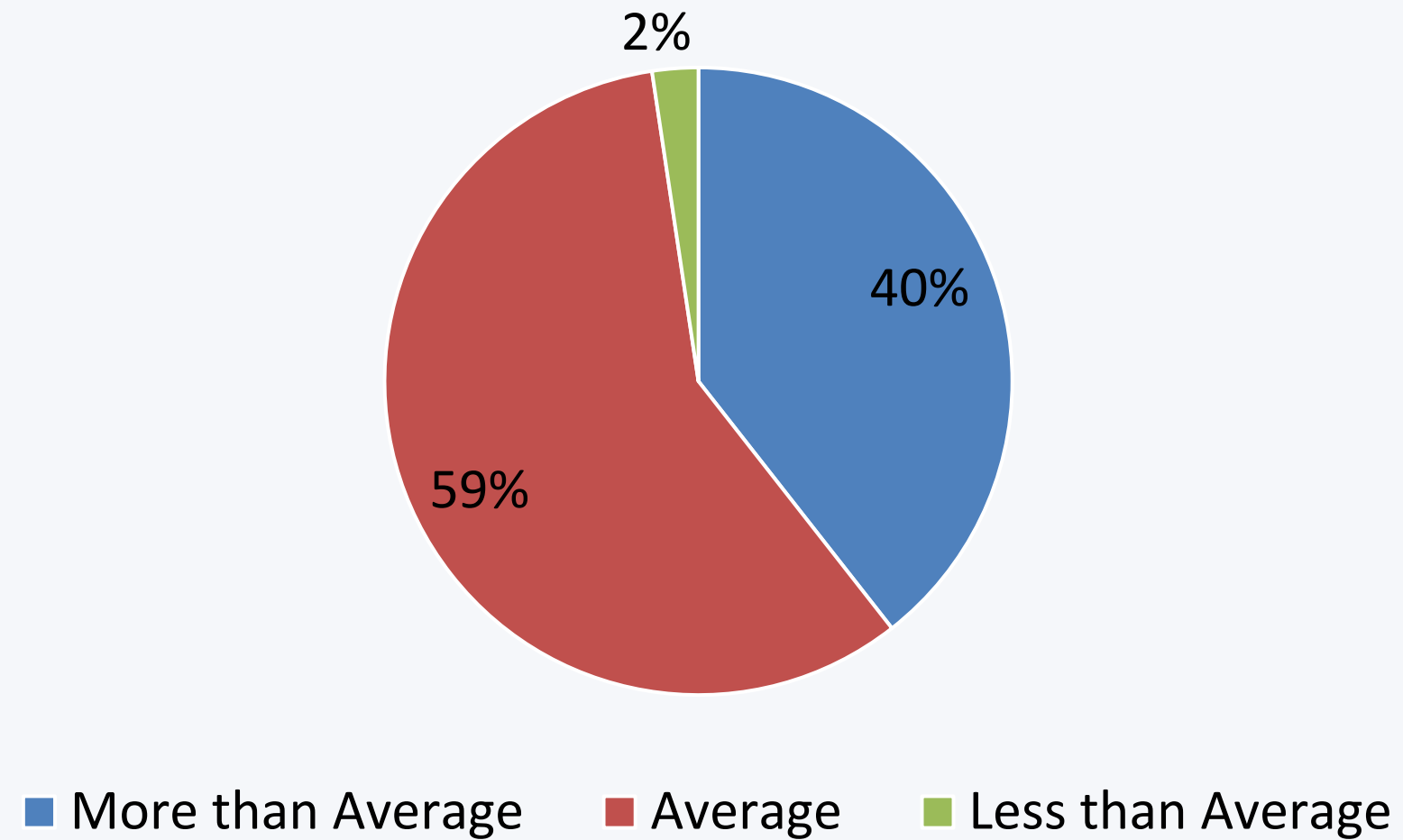
Management Factors



209 farms (35%) have been to a meeting/workshop on soil health in the past two years

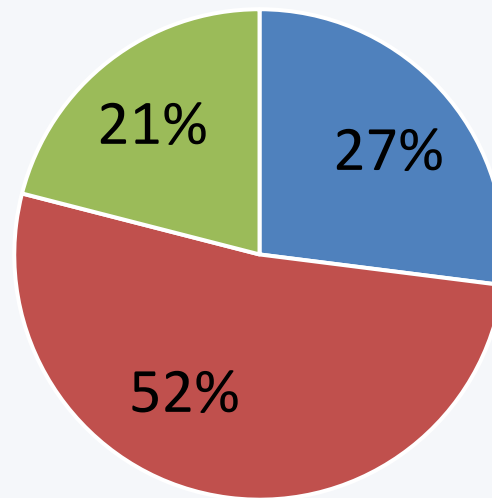
Conservation Practices in KFMA Farms

Use of Conservation Practices relative to surroundings farms



Conservation Practices by Operator Age

Operators' Age



■ Under 45 years old
 ■ 45 to 65 years old
 ■ Over 65 years old

Age	Conservation Practices		
	Cover Crop	Continuous no-till	3 or more Crop Rotation
Under 45 years old	76%	53%	31%
45 to 65 years old	59%	44%	23%
Over 65 years old	27%	26%	22%

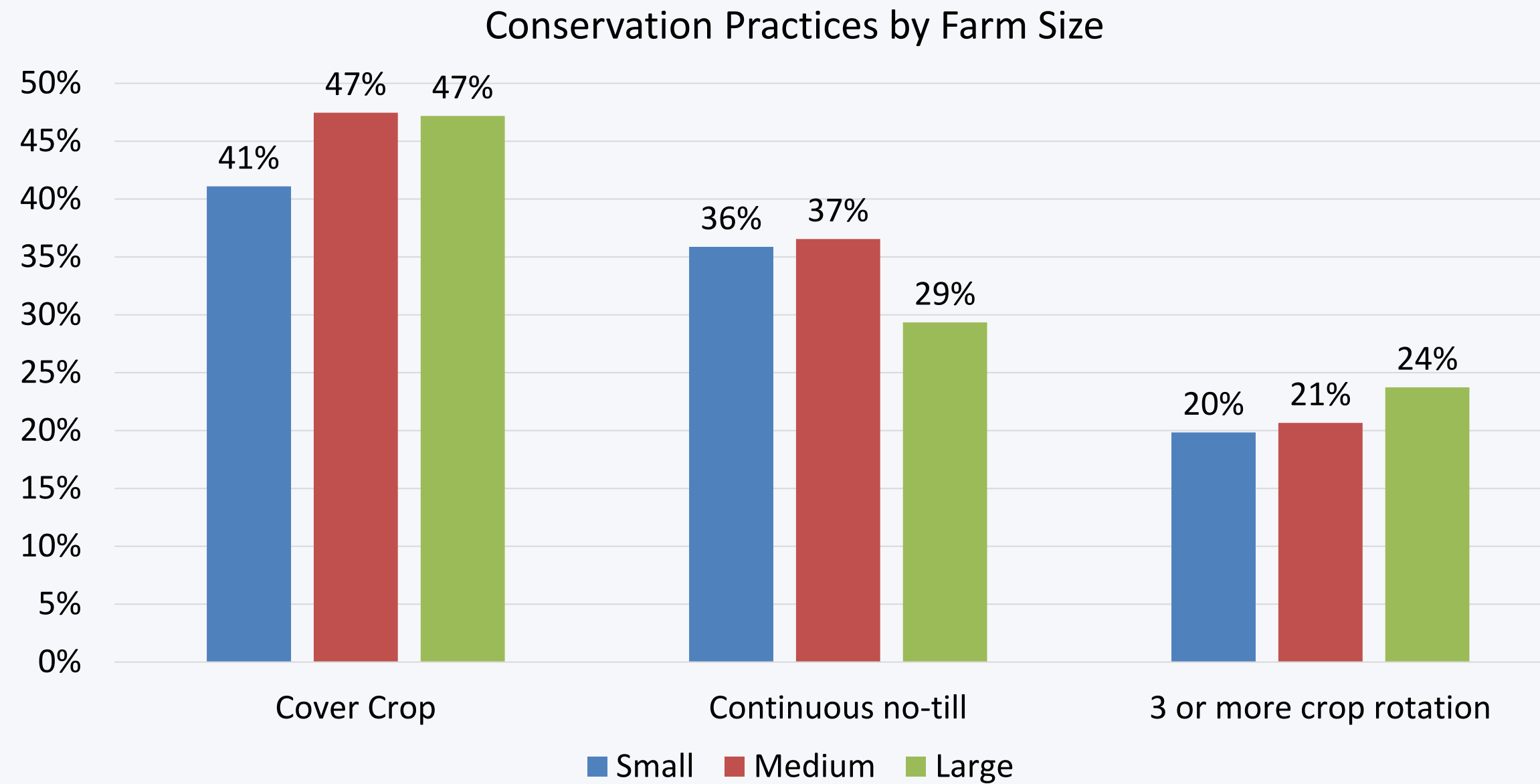
*Farms with 2 crop rotation are not included

546 responses

Conservation Practices by region

Region	Number Farms	% with Cover Crop	% with Continuous no-till	% with 3 or more crop rotation
North Central	140	62%	63%	32%
South Central	94	44%	29%	26%
Southwest	24	36%	9%	22%
Northeast	78	63%	46%	11%
Northwest	11	30%	23%	14%
Southeast	199	50%	33%	25%

Conservation Practices by Farm Size



546 responses

Conservation Intensity – High

Practice	Criteria
Tillage	Continuous no-till
Rotations	2 or 3 or 4; 3; 3 or 4; 4
Cover crops	Winter or summer or both
Grazing	Graze cover crops or residue or annual forage crop or rotational grazing
Management	Test for biological matter or attend soil health workshop or soil health important 4 or 5

A farm must have all or 4 out of 5 practices to be considered high intensity. 128 farms or 21% of farms with sufficient data reported met this condition.

Conservation Intensity – Medium

Practice	Criteria
Tillage	Continuous no-till or reduced till
Rotations	2 or 3; 2 or 3 or 4; 3; 3 or 4; 4
Cover crops	Winter or summer or both
Grazing	Graze cover crops or residue or annual forage crop or rotational grazing
Management	Test for biological matter or attend soil health workshop or soil health important 4 or 5

A farm must have all or 4 out of 5 of these practices to be classified as medium intensity. Farms that had 3 out of 5 high intensity practices (previous slide) were classified as medium intensity. 189 farms or 31% of farms with sufficient data reported met this condition.

The remainder of farms are classified as low intensity.

Average NFIR & OER by Intensity of Conservation Practices

	2022		
	Average Net Farm Income Ratio	Average Operating Expense Ratio	#farms
High Intensity	0.14	0.76	95
Medium Intensity	0.14	0.76	137
Low Intensity	0.17	0.71	201

NFIR and OER were statistically different for low intensity relative to both medium and high. *The 0.03 difference in NFIR indicates that, on average, low-intensity farms retain 3% more of their gross revenue as net farm income compared to medium- and high-intensity farms. This would be equivalent to an average 8% increase in NFI for all farms in this sample.*

Average NFIR & OER by Intensity of Conservation Practices

	2018-2022		#farms
	Average Net Farm Income Ratio	Average Operating Expense Ratio	
High Intensity	0.19	0.71	109
Medium Intensity	0.18	0.72	161
Low Intensity	0.20	0.69	236

Over a longer period, low intensity has statistically different average OER only; NFIR is not statistically different for any category. These differences are generally small and could be attributable to either conservation practices or farm practices correlated with conservation practices.

Conclusion & Discussions

Current findings



Conservation practice adoption rates tend to be higher than the national averages, especially for cover crops, but with substantial variation.



The survey was effective at finding key differences in conservation practices.



Younger producers have higher levels of conservation practice adoption.



North Central producers have higher intensity of conservation practice adoption.



Differences between key financial performance metrics by conservation intensity are non-existent to small. More research is need to determine if these differences can be explained by observable farm characteristics such as age.

Next steps

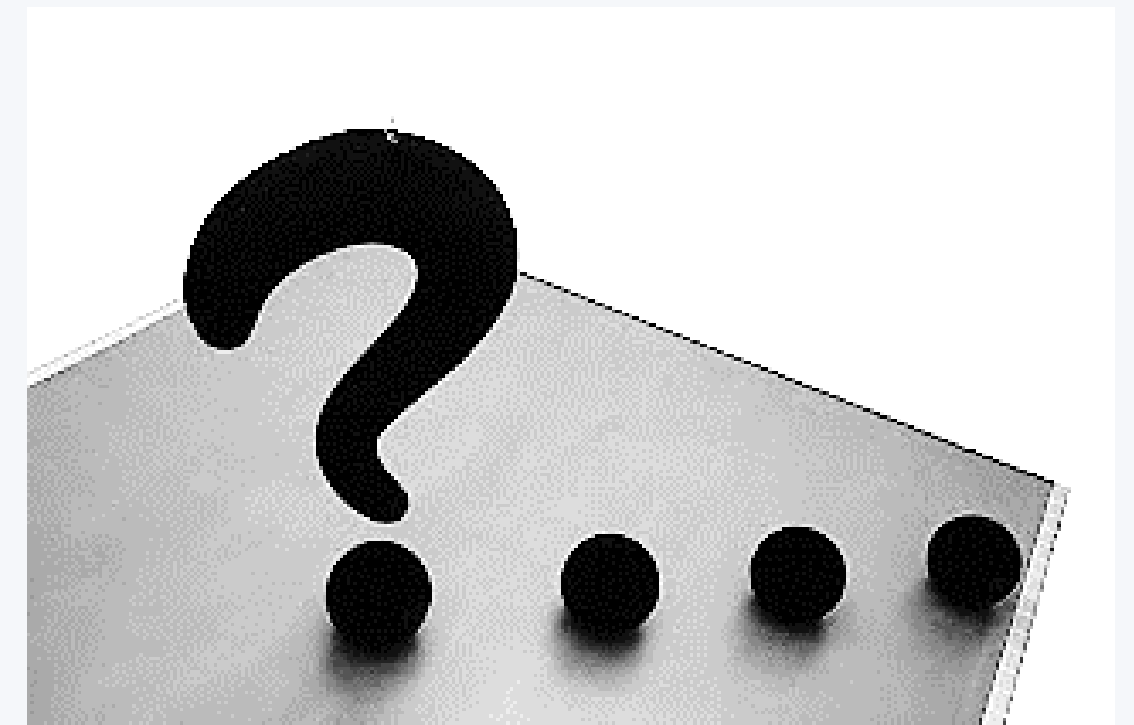
Development of different measures of conservation practice adoption

Statistical analysis (PART 2)

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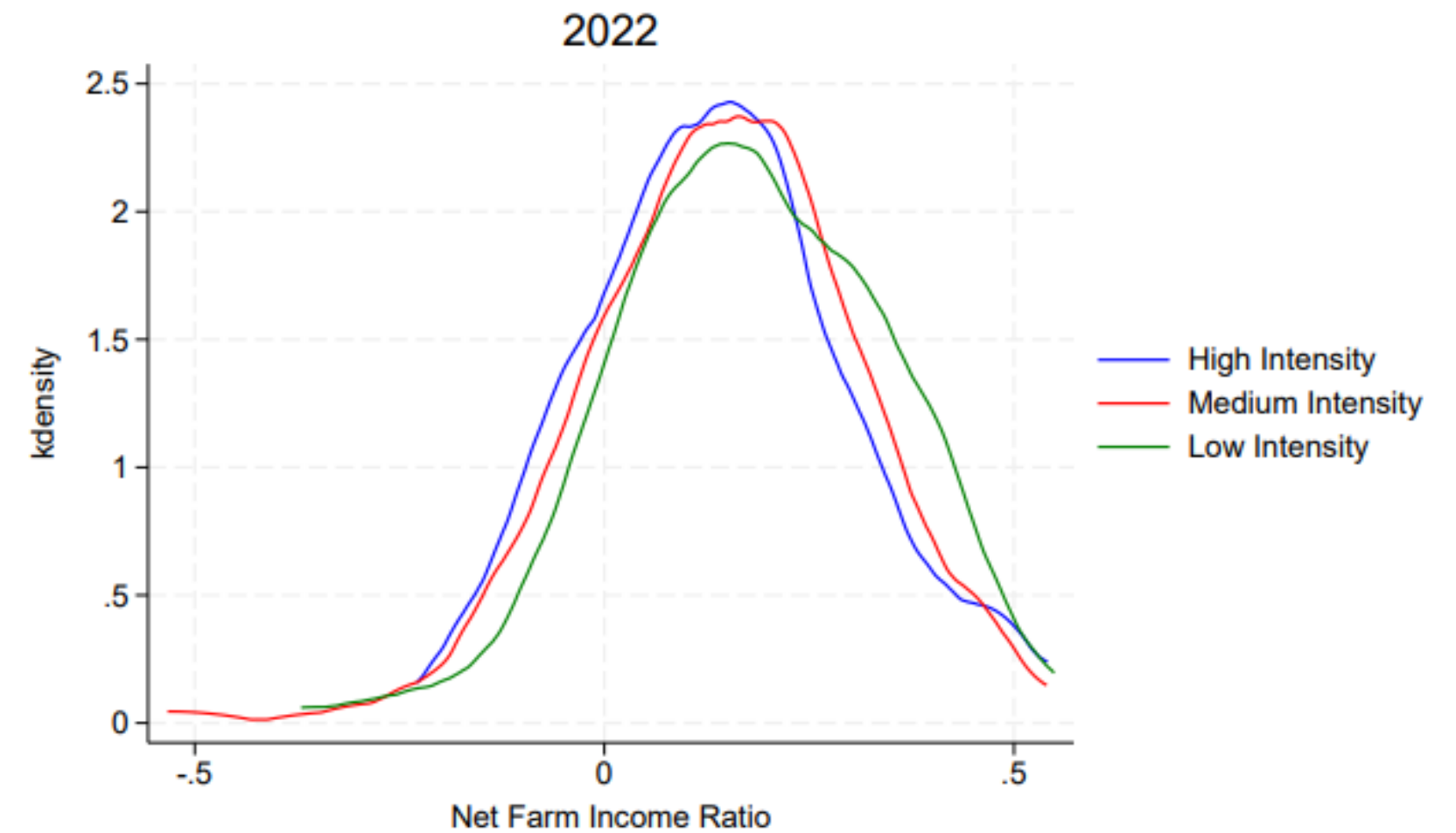
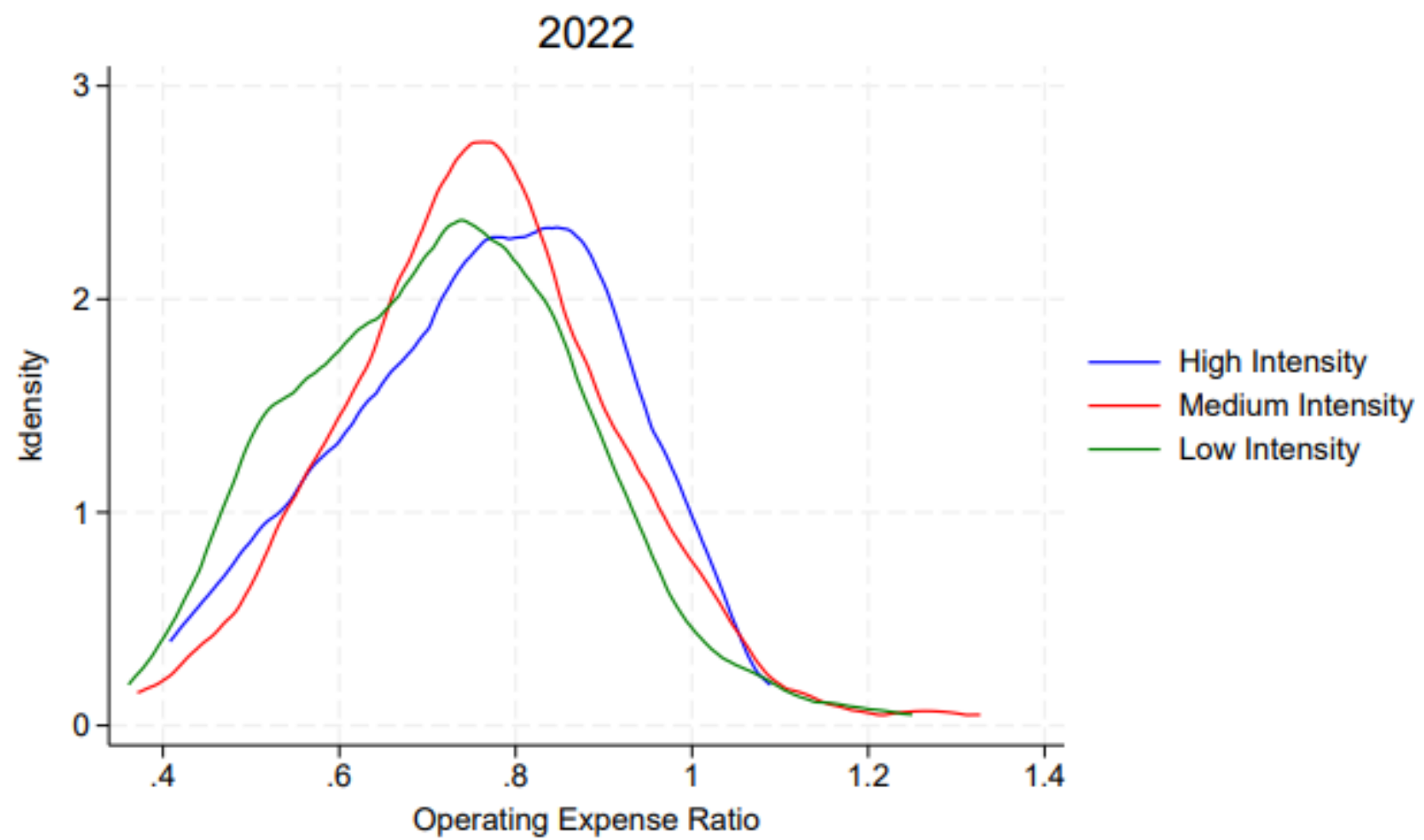
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Thank you for your attention!



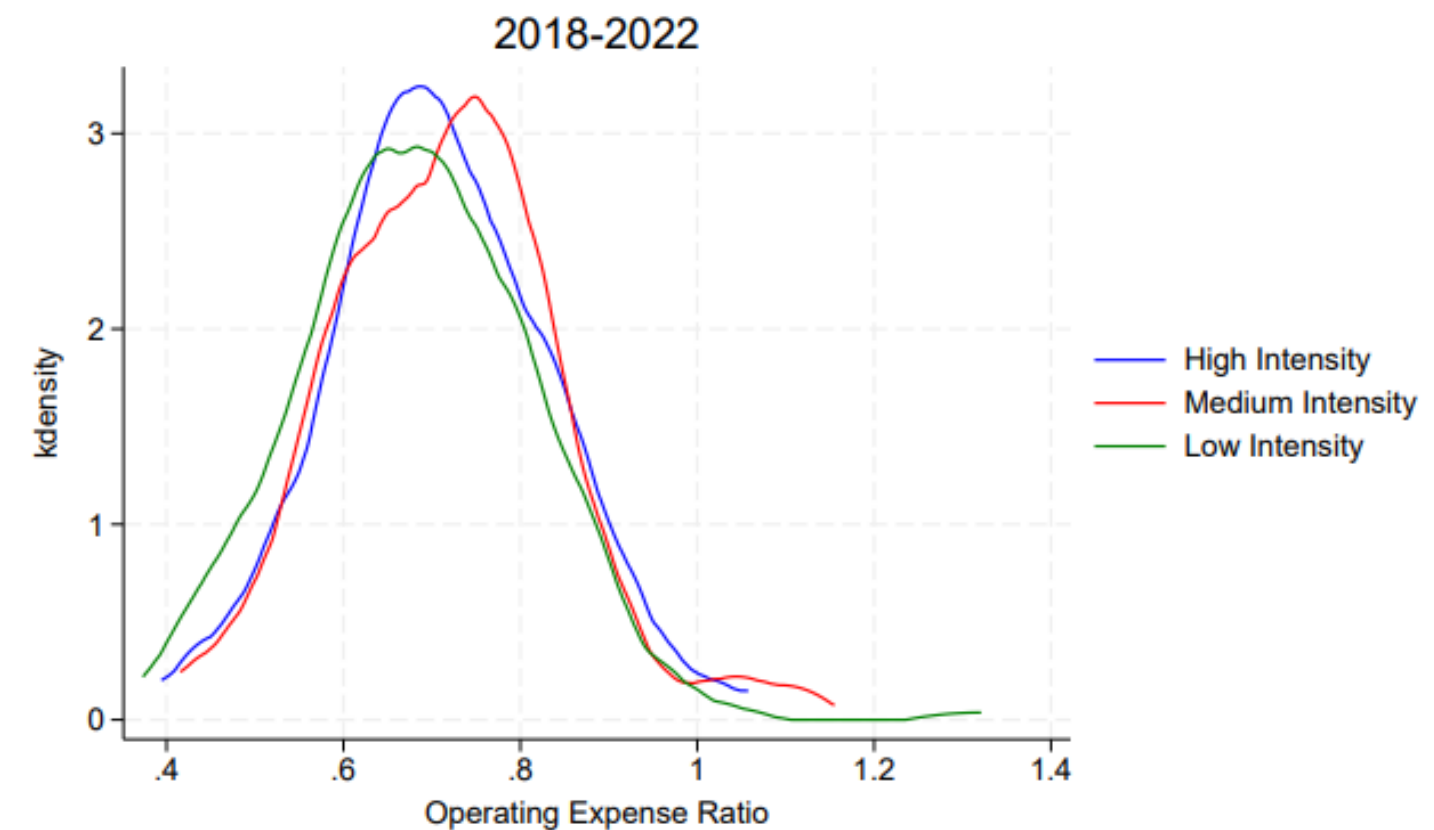
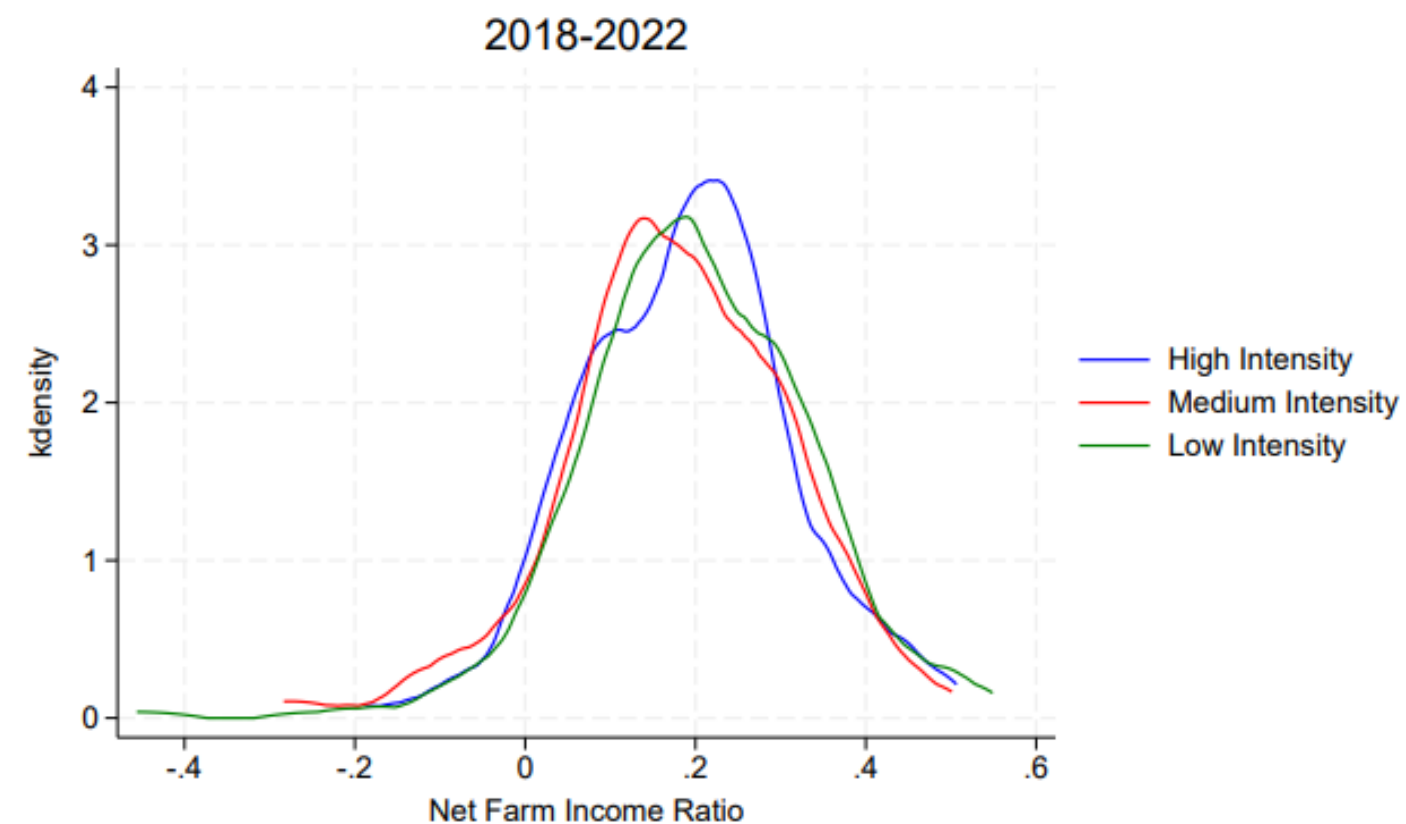
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Appendix: 2022 NFIR and OER Distribution



These charts were created using default setting for kdensity function in STATA for NFIR and OER for farms in each conservation intensity category. Categories and number of farms in each category were defined on previous slides.

Appendix: 2018-22 Average NFIR and OER Distribution



These charts were created using default setting for kdensity function in STATA for NFIR and OER for farms in each conservation intensity category. Categories and number of farms in each category were defined on previous slides. Average NFIR and OER are calculated for all years each farm that completed the survey was in the KFMA database.