

# Edge Effects on Intra-field Crop Yield Variability

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## INTRODUCTION

- Field edges often have different microclimate, traffic, pests, and neighboring land cover, leading to systematic yield suppression but these "edge effects" are rarely quantified or included in yield models [1].
- Most studies use single years, coarse data, or assume a fixed buffer distance and ignore edge orientation and adjacent land cover [2].

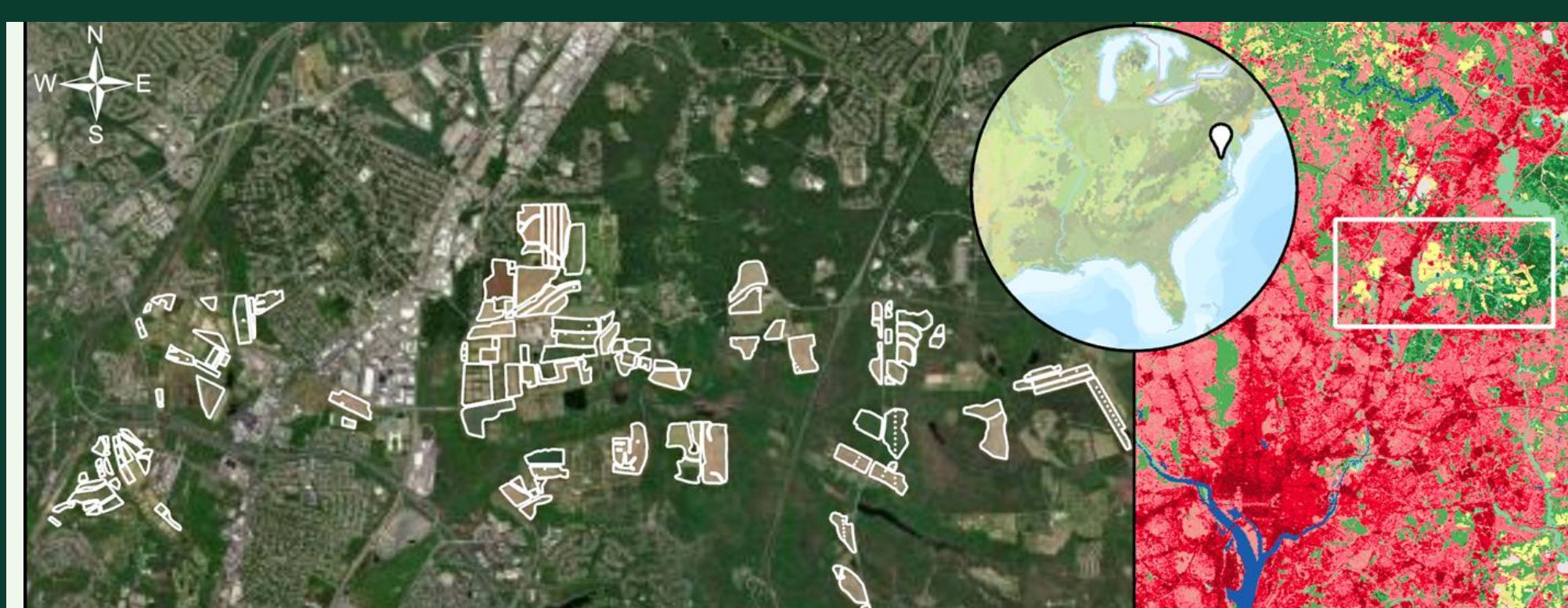
### Objectives:

- locate where yields stabilize away from edges,
- measure how edge distance and yield penalties vary by crop and year, and
- test how surrounding land cover and edge orientation modify these edge effects.

## DATASET OVERVIEW

- Data source:** United States Department of Agriculture - Agricultural Research Service (USDA - ARS) [3]
- Number of Fields:** 118
- Number of Years:** 11 (2014 - 2024)
- Resolution:** 5m
- Crop Yield:** Soybeans, Corn, Wheat
- Climate Data:**
  - Precipitation: gridMET
  - Land Surface Temperature: Landsat 8/9

## STUDY AREA OVERVIEW



**Beltsville Agricultural Research Center (BARC), Maryland, USA**

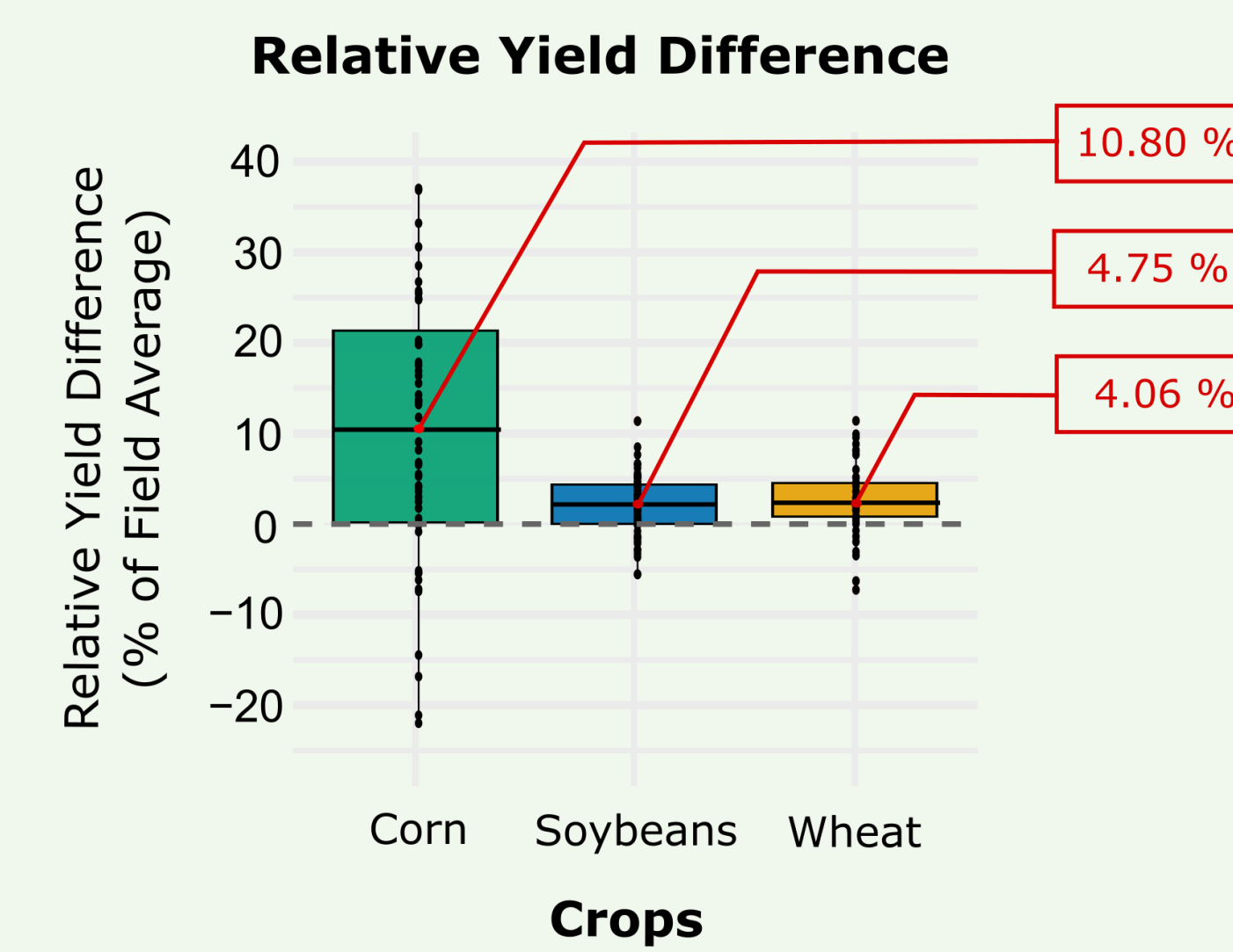
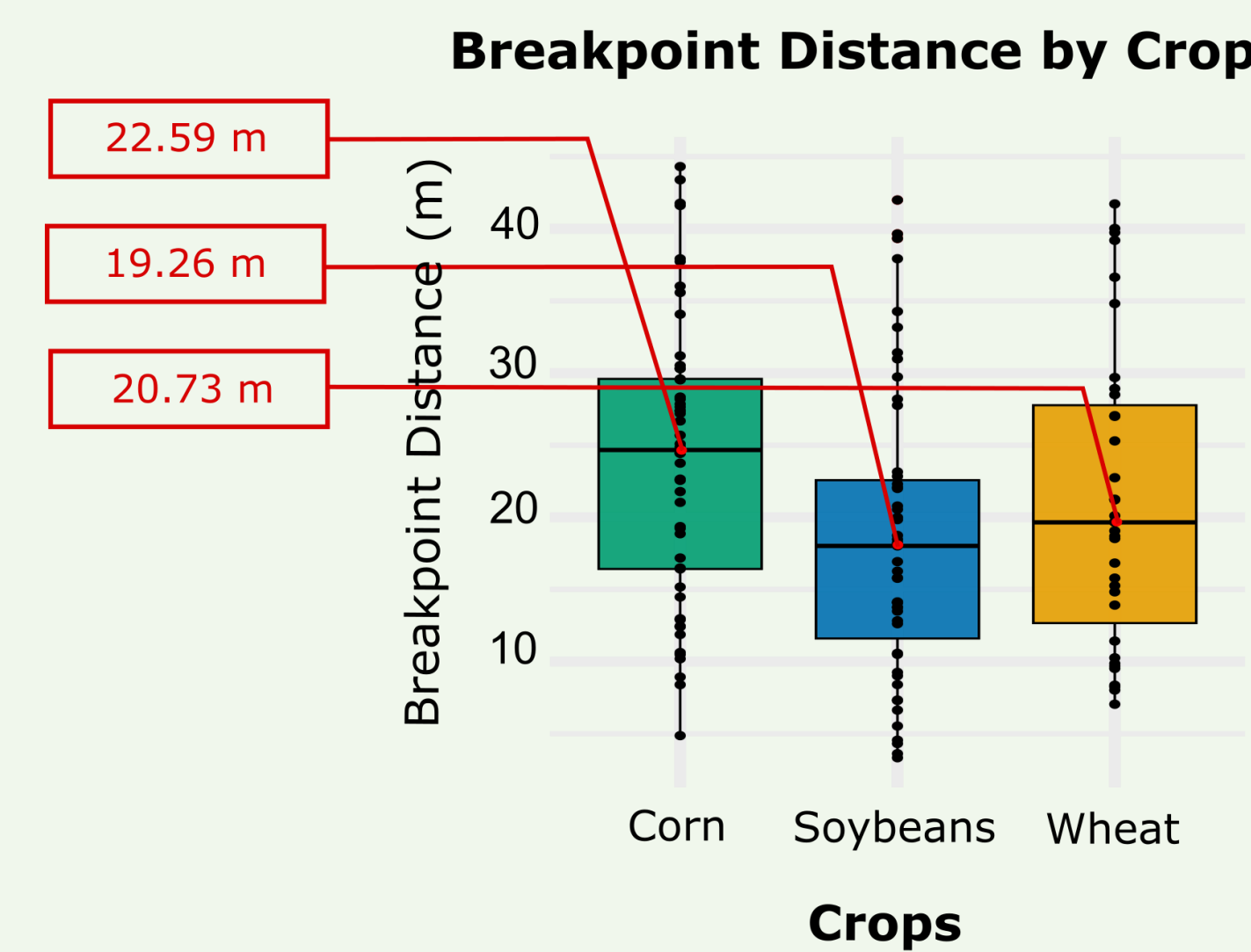
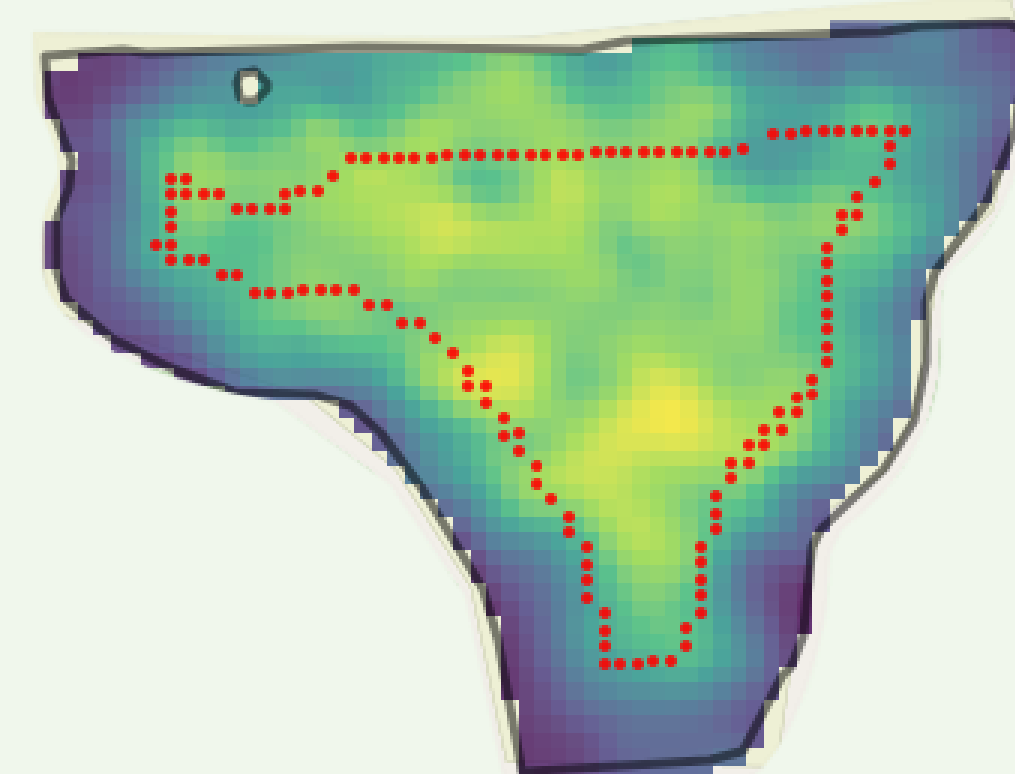
Open Water	Developed Low Intensity	Mixed Forest
Developed Open Space	Developed Medium Intensity	Moss
Developed High Intensity	Deciduous Forest	Cultivated Crops
	Evergreen Forest	

Land Cover Types:

## RESULTS AND FINDINGS

(1) How far from the field edges do crop yields stabilize, and how large are the edge v/s interior yield differences?

Breakpoint Visualization: Central Farm 4-23A

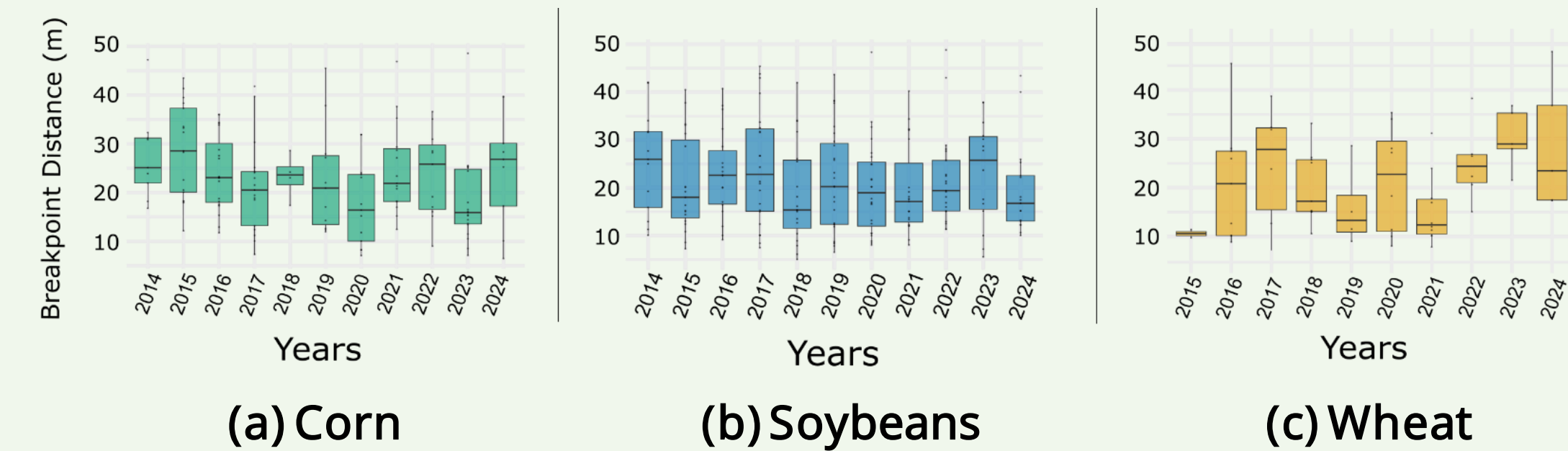


### Key Takeaways

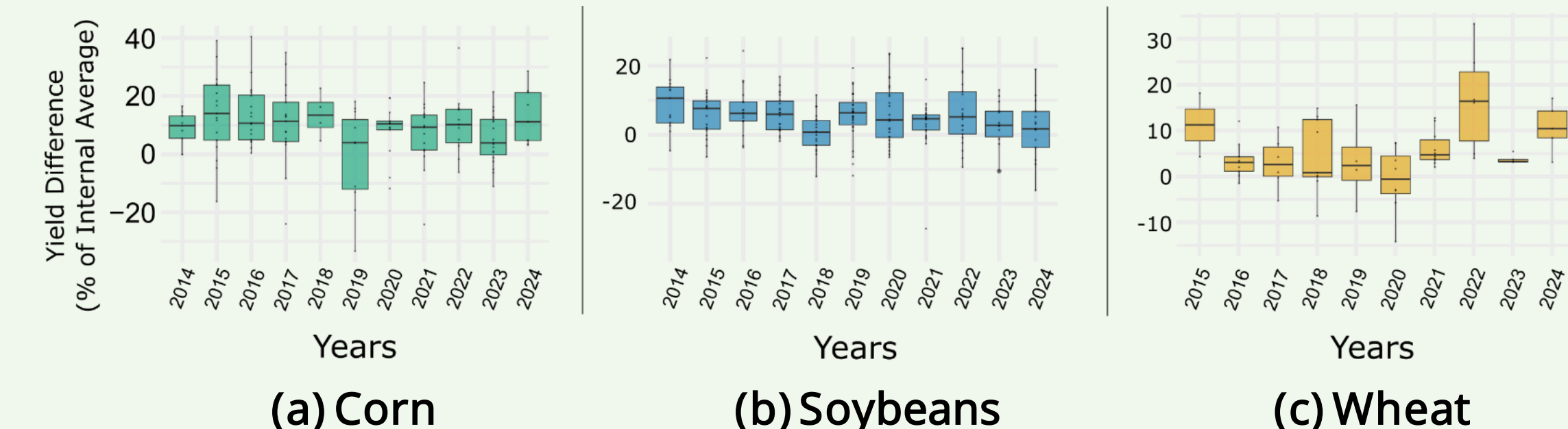
- Significant breakpoints in ~66% of field-crop dataset, typically 10–30 m from edges.
- Interior yields are ~10–15% higher than edge zones in corn and ~4–5% higher in soybean and wheat, so the outer 1–2 passes often behave as a distinct, lower-return "edge zone."

(2) How do the yield breakpoint distance and breakpoint strength change annually under varying climatic conditions?

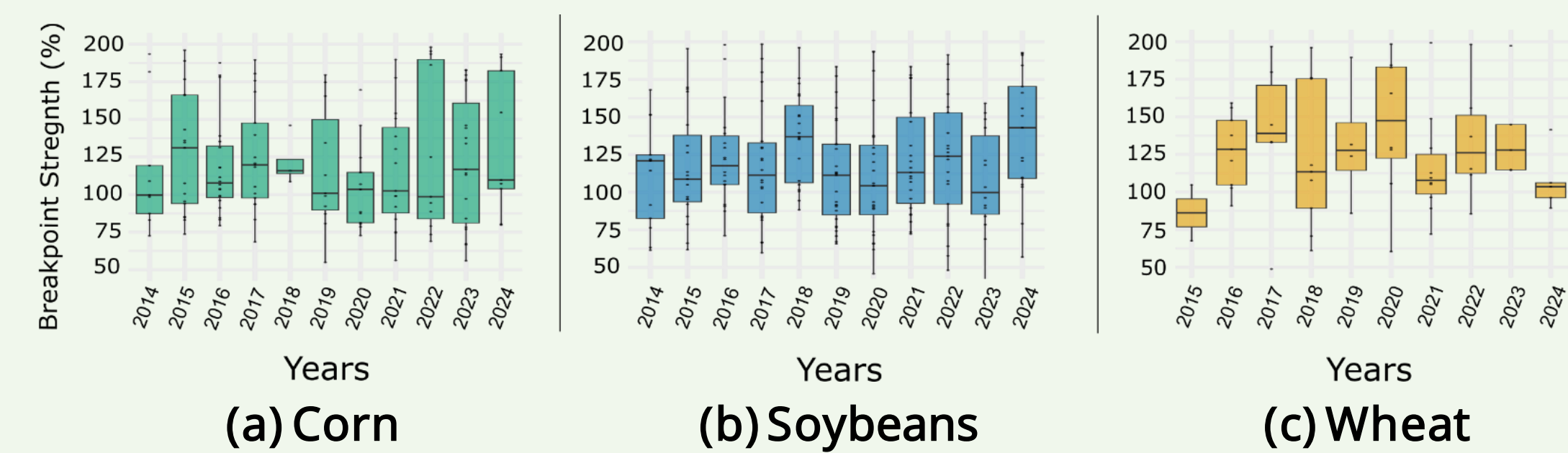
Yearly Yield Difference at Breakpoints



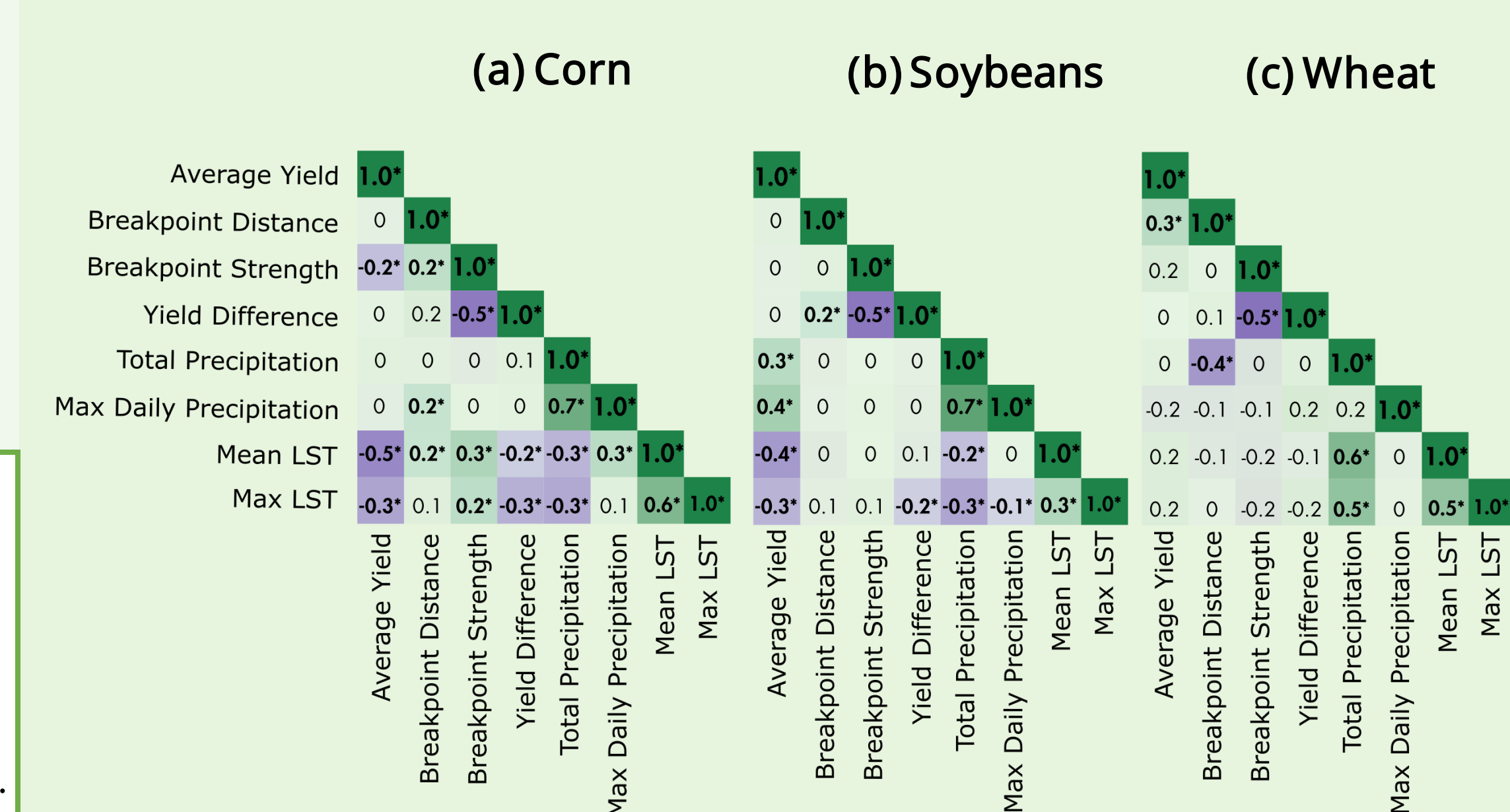
Yearly Yield Breakpoint Distribution



Yearly Breakpoint Strength (Change in Gradient)



Correlation Matrices:

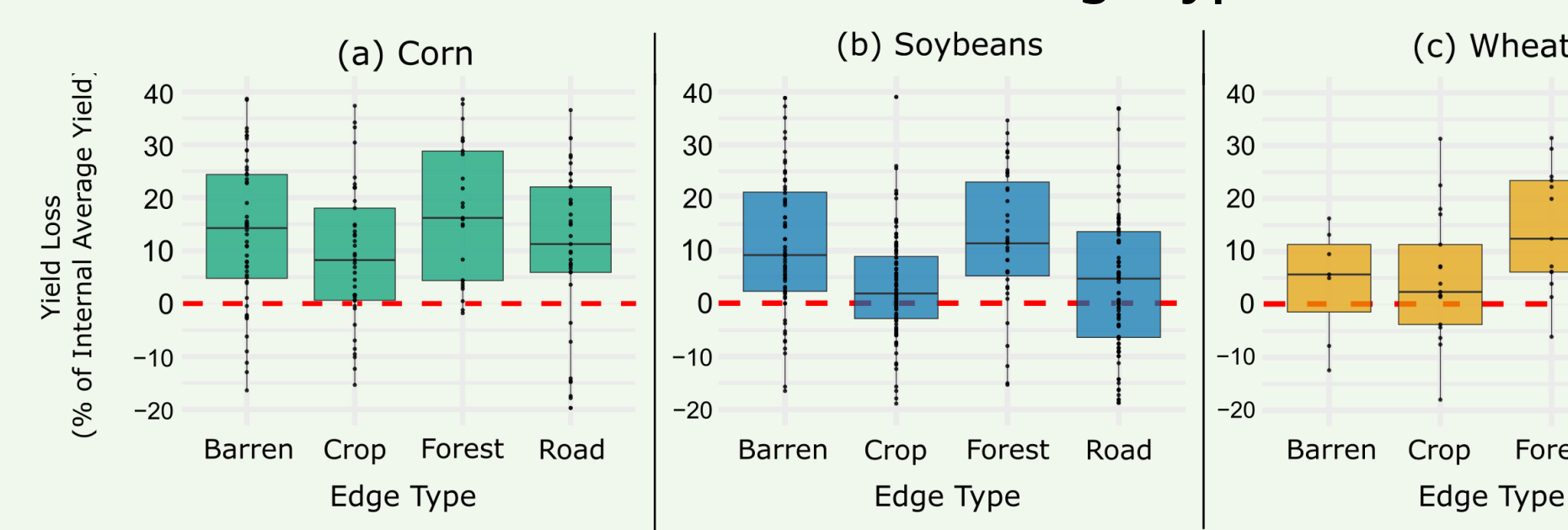


### Key Takeaways

- Breakpoint distance change considerably between growing seasons, median distances are deepest in corn, most stable in soybeans and most erratic in wheat.
- Hotter or more stressful seasons tend to extend corn edge effects farther into fields, while soybean breakpoints remain more tightly clustered and wheat shows large year-to-year swings, mostly guided by precipitation.
- Edge Penalties are crop specific: corn (~4-14%); soybeans (0-11%); wheat (-1-16%); larger edge losses are seen in fields with weaker breakpoint gradients.

(3) How do the surrounding land cover type and the edge orientation impact yields?

Yield Loss at Different Edge Types



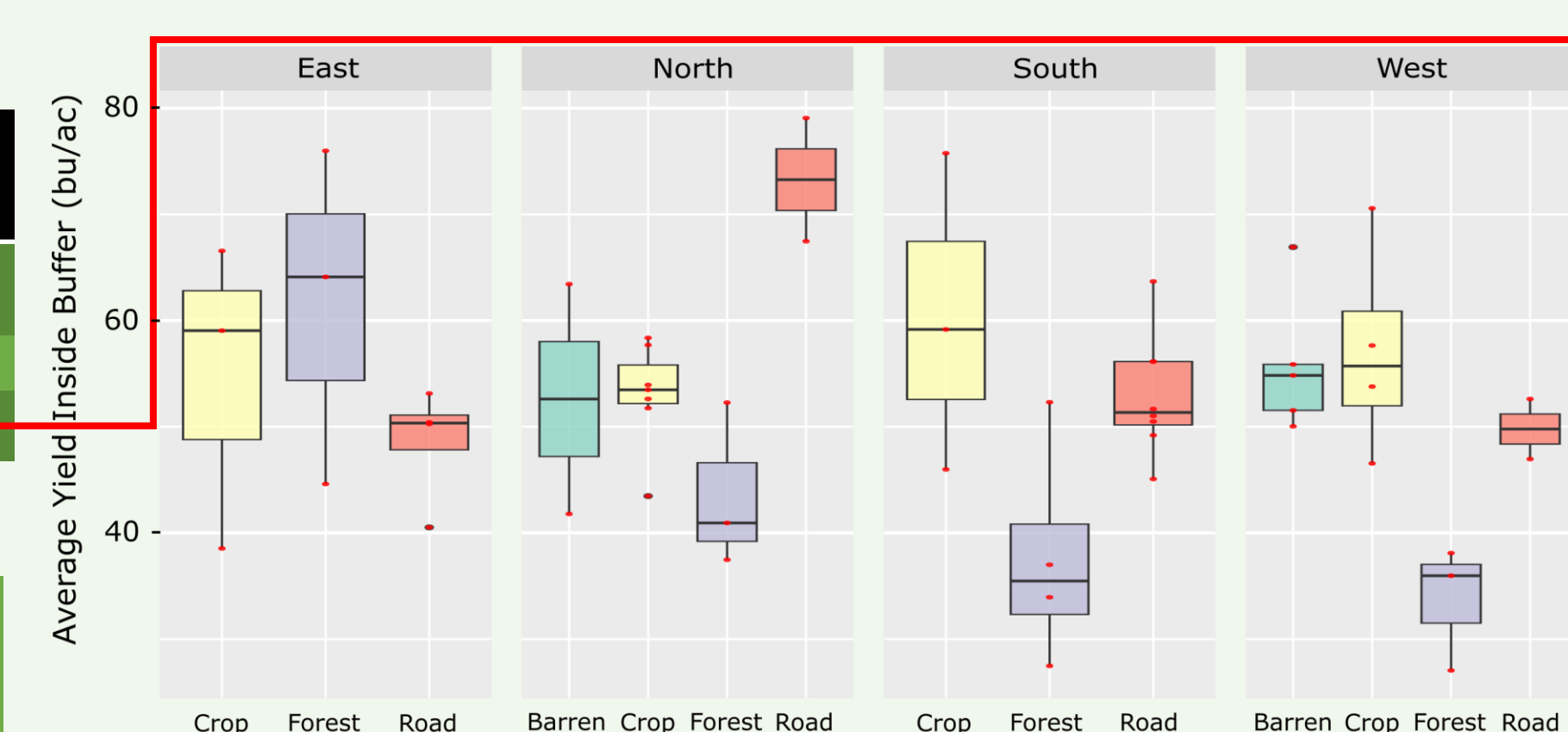
ANOVA Test:

Crop	Edge Type (p-value)	Edge Type x Orientation (p-value)
Soybean	< 0.001***	0.31
Corn	0.45	0.06
Wheat	0.004**	< 0.002**

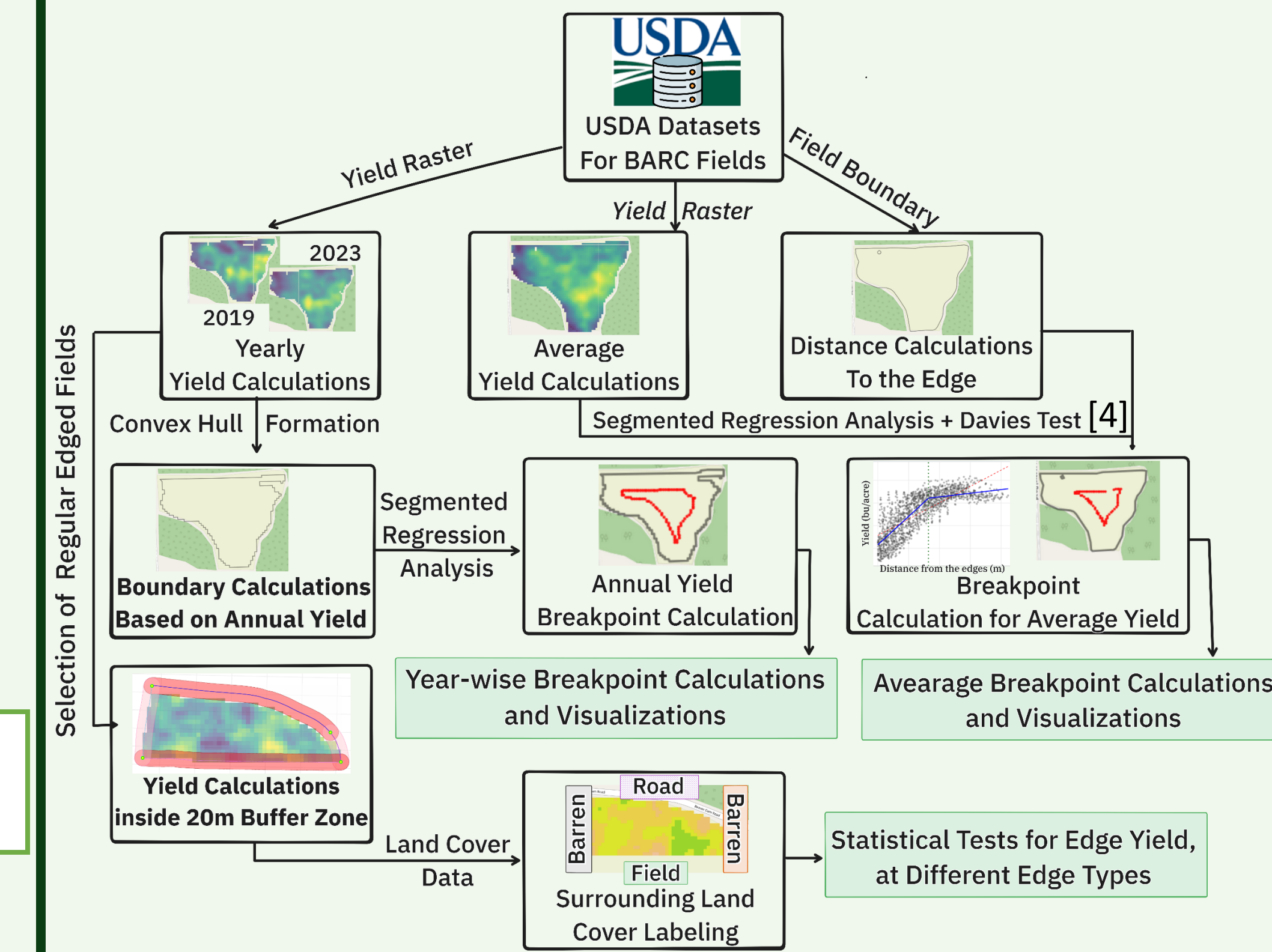
### Key Takeaways

- Forest edges are the costliest (up to ~60% yield loss), crop-crop edges show little or no penalty, and road/barren edges are intermediate.
- Orientation mainly matters for wheat. South-facing forest edges in wheat show the deepest losses, while orientation is weaker for corn and soybeans.

Wheat Yield in Edge Buffer by Edge Orientation and Edge Land Cover



## METHODOLOGY



$$\text{Yield Difference} = 100 * \frac{\text{Yield Outside Breakpoint} - \text{Yield Inside Breakpoint}}{\text{Yield Inside Breakpoint}}$$

$$\text{Breakpoint Strength} = \frac{|\beta_{\text{edge}} - \beta_{\text{interior}}|}{\max(|\beta_{\text{edge}}|, |\beta_{\text{interior}}|)} * 100$$

## IMPLICATIONS

- Edge zones are important factors in crop and yield modeling and should account for environmental variability such as heat stress, moisture stress, adjacent land cover, deer browsing and edge orientation. Moving beyond fixed-width buffers or static correction factors will support more accurate representation of edge effects.
- Controlled, edge-aware experiments can help evaluate and refine these effects and improve our understanding of trade-offs among yield, profit, and ecosystem services [5, 6].
- Because forest edges typically lose 10–20% (and up to ~60%) of yield, they are often best managed as low-return areas. For example, as conservation or wildlife strips or zones with reduced inputs. In wheat systems, the orientation of the edge and neighboring land cover type should also be considered

## REFERENCES

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