Assessing Yield Stability in Long-Term Trials

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INTRODUCTION

- Climate change adaptation requires crop management systems that are resilient to variable weather.
- Yield stability is a key indicator of system resilience.
- "Stability analysis"[1,2] provides a visually intuitive method to assess and present differences in yield stability among treatments in long-term trials.
- **We demonstrate the use of stability analysis with data from two cropping systems trials.**

THE CROPPING SYSTEMS TRIALS

Maine Potato Ecosystem Project[3]

Presque Isle, ME
Caribou silt loam
Potato–barley rotation
1992-2004 data used

Soil Management Treatments:

Amended	Designed to make rapid increases in soil quality. Annual applications of manure and/or compost supplemented with synthetic fertilizers
Nonamended	Synthetic fertilizers at industry recommended rates

Kellogg Biological Station Long-term Ecological Research site (KBS LTER)[4]

Hickory Corners, MI
Kalamazoo and Oshtemo well-drained loam
Corn–soybean–winter wheat
1993-2012 data used

Cropping Systems Treatments:

Conventional	Standard varieties, conventional tillage, and chemical inputs at university and industry recommended rates.
No-till	Same as CONV except no-till planted and additional herbicides as needed.
Reduced Input	Same as CONV except reduced rates of fertilizers and herbicides and inclusion of cover crops.
Biologically based	Certified organic with legume-based N additions only (no manure or compost)

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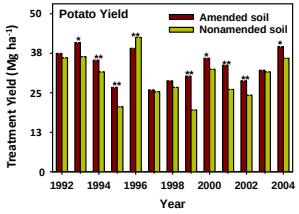
STABILITY ANALYSIS

Maine Potato Ecosystem Project

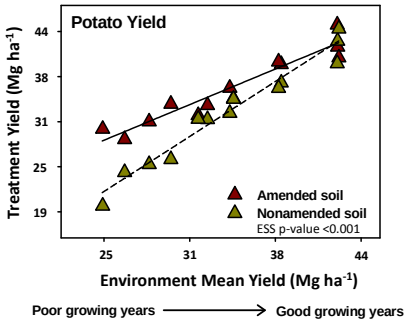


- Year-to-year variation in yields can be measured as the coefficient of variation (CV) of individual plots over years but CVs do not reflect productivity.
- CVs for Amended vs. Nonamended were: 24.5% vs. 28.8%.
- Soil moisture in Amended was always greater than or equal to moisture in Nonamended.

Stability Analysis Method:

- Annual yield data are rearranged.
- Annual treatment yields are regressed on the annual mean yield of all treatments combined.
- The X-axis, "Environment Mean Yield", reflects overall growing conditions for each year (weather, pest pressure, etc.).
- Slopes indicate how responsive treatments are to growing conditions.

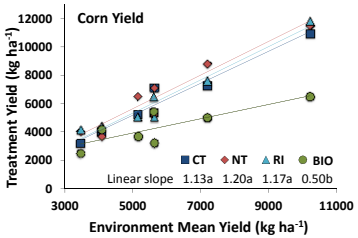
Amended soil management demonstrates resilience



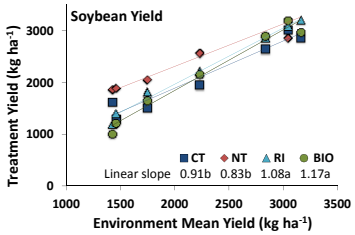
Amended soil management:

- ❖ Increased yields.
- ❖ Increased yield stability by reducing the negative impacts of poor growing conditions, primarily low rainfall.
- ❖ Provided resilience.

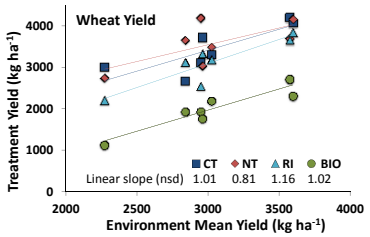
Kellogg Biological Station Long-term Ecological Research site (KBS LTER)



- ❖ BIO increased yield stability, but by not responding to good growing conditions, likely due to nitrogen limitation.
- ❖ CT, NT, RI performed equally.



- ❖ NT had greatest yield stability, greatest yields, and improved soil quality.
- ❖ BIO yielded equal to CT and RI for this leguminous crop.



- ❖ BIO had lowest yields followed by CONV.
- ❖ Yield stability was equal among treatments.

CONCLUSIONS

- ❖ Stability analysis provides a visually intuitive method to evaluate and communicate differences in resilience among different production systems.
- ❖ In Case 1, a soil management system designed to increase soil quality increased yield stability by reducing the impacts of negative environmental conditions.
- ❖ In Case 2, as compared with a conventional system,
  - Reduced tillage and reduced input systems did not compromise yield nor yield stability.
  - A biologically based system that relied solely on legumes for nitrogen increased yield stability but only by producing consistently low yields.

References:

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