Comparative Assessment of *Organic* and *Conventional* Production of Row Crops under Climate Change: Empirical and Simulated Yield Variation in the Chippewa River Watershed, MN.

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Introduction

- The long-term provision of ecosystem services, including stable crop yields over time, provided by the traditional corn-soybean cropping system in the Chippewa River Watershed (CRW) in west-central Minnesota are being threatened by several anthropogenic and climatic factors.
- We conducted an empirical and simulated study to:
  1) Provide an improved understanding of the role of projected global climate change (GCC) and its interaction with soil types, land use, and management practices on yield variation of conventional (CNV) and organic (ORG) cropping systems, and
  2) Develop prediction models to scale up cumulative yield and its temporal variation from plot to watershed level and predict future impacts on agroecosystem services.

Procedures

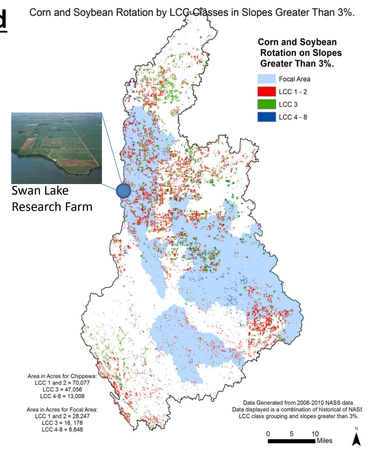
- We quantified the long-term ORG and CNV temporal yield variation of current and expanded, more diverse crop rotations under current (2002-2009; A0), past and future 50-year climate change conditions using four GCC scenarios (A0, A2, A1B & B1)and five representative soil types in CRW.

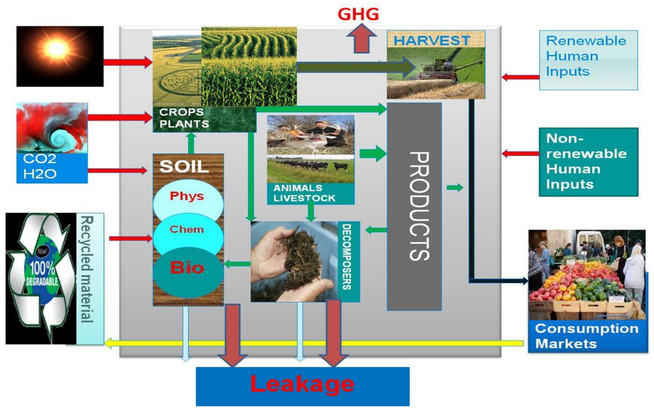
Results

- ORG can enhance a number of ecosystem services, but may have lower and more stable yields compared with CNV;
- Cumulative yield of ORG crop rotations were improved and ranged from 80 to 90% of CNV by expanding crop rotations to include greater crop diversity, especially under projected GCC;
- The largest portion of variation in cumulative yield and its temporal variation within each GCC scenario was attributed to differences between the five soil types, followed, in decreasing order by differences between:
  - ORG and CNV,
  - Crop rotations, and
  - Management practices
- Differences in management practices among ORG and CNV contributed differently to cumulative yield and its temporal variation depending on length and composition of crop rotations and soil types;
- Temporal yield variation under current, past and future GCC in ORG was consistently less than CNV;
- Both can be further reduced by inclusion of perennial crop and adopting improved management practices;
- ORG farmers in CRW can diversify current cropping systems, enhance the buffering capacity of their land, and help mitigate the impact of GCC by:
  - Reducing external inputs, and
  - Adjusting land-use to accommodate more perennials in future crop rotations;
- Significant and positive effect of a perennial forage crop on cumulative yield and its temporal variation is anticipated by the 3rd to 4th year of its inclusion in a crop rotation that includes a small grain crop in addition to corn and soybean

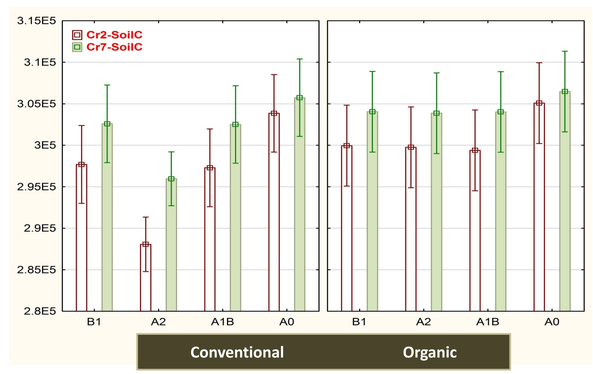
Chippewa River Watershed

- Drains 5,387 km² of mixed natural and managed ecosystems
- Several Land Capability Classes
- Commodity production: Corn, Soybean, Wheat, Livestock, Fruits & Vegetables
- Forests, Lakes & Streams

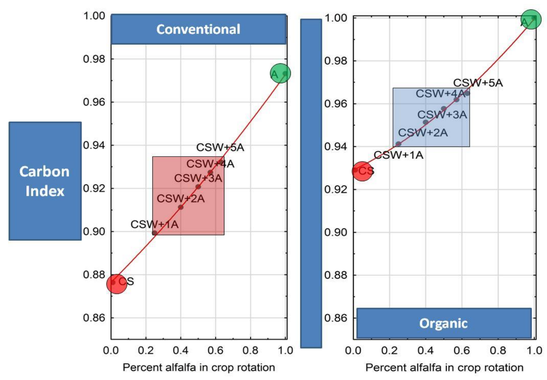




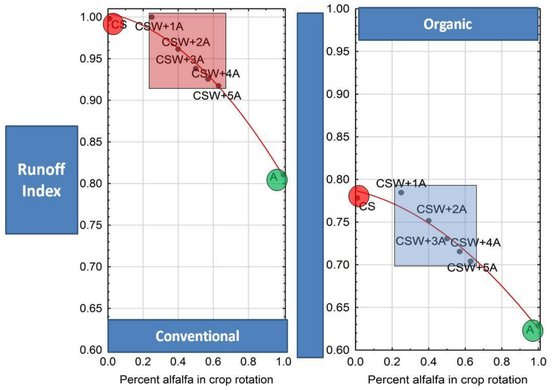
Organic System: [Semi-Closed]..<u>Maximize</u> Renewable Inputs, Decomposers, & Recycling; <u>Minimize</u> non-Renewable Inputs, Leakage & GHG emissions



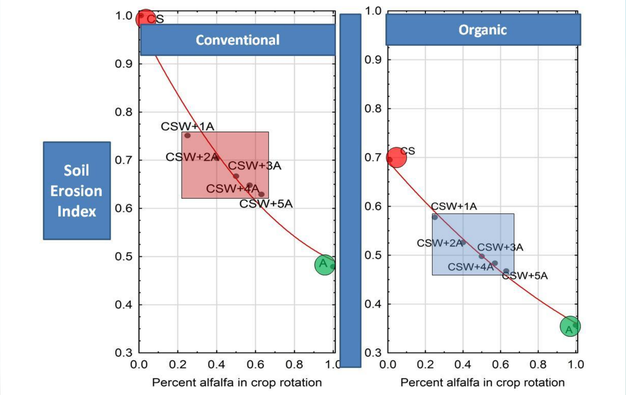
<u>Carbon Sequestration</u> in CNV & ORG due to 2 Yr (Corn-Soybean) & 7 Yr (Corn-Soybean-Wheat- 4 Yr Perennial) Crop Rotation under 4 Climate Change Scenarios)



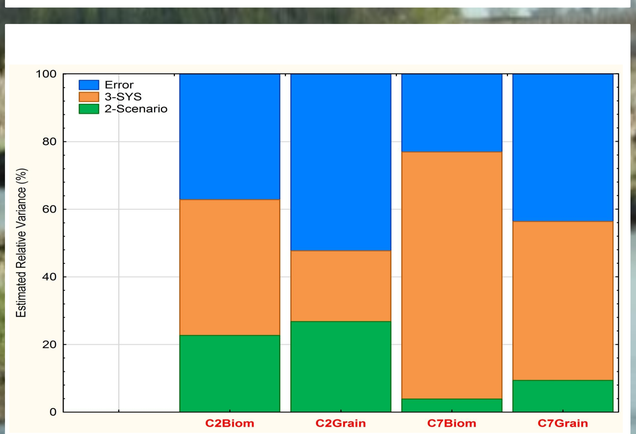
<u>Higher Carbon Index</u>: Effect of Organic Management, Long Crop Rotations & Perennial Crop



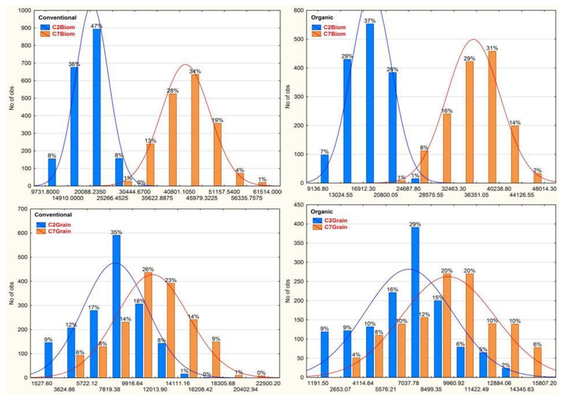
<u>Reduced Runoff</u>: Effect of Organic Management, Long Crop Rotations & Perennial Crop.



<u>Reduced Erosion</u>: Effect of Organic Management, Long Crop Rotations & Perennial Crop



<u>Organic System</u>: More Resilient than CNV. Larger Variances due to "Systems"; Smaller Variance due to "Climate Change Scenarios."



Differences in Biomass & Grain Yield Distribution between Short (C2) and Long (C7) Crop Rotations in CNV & ORG.

Conclusions

- *The combined empirical and simulated results provided guideline to develop multifunctional Organic production systems that can:*
  - *Produce standard commodities (Corn, soybean, wheat, etc.),*
  - *Stabilize crop yields over time, and*
  - *Provide a wide range of other ecosystem services (More Carbon, Lower Runoff, Lower Soil Erosion, Lower N leaching).*

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