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U.S. DEPARTMENT OF AGRICULTURE

Research Brief

Diversified Grain Rotations can be Highly and Reliably Productive in Unstable Climates

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Key Findings:

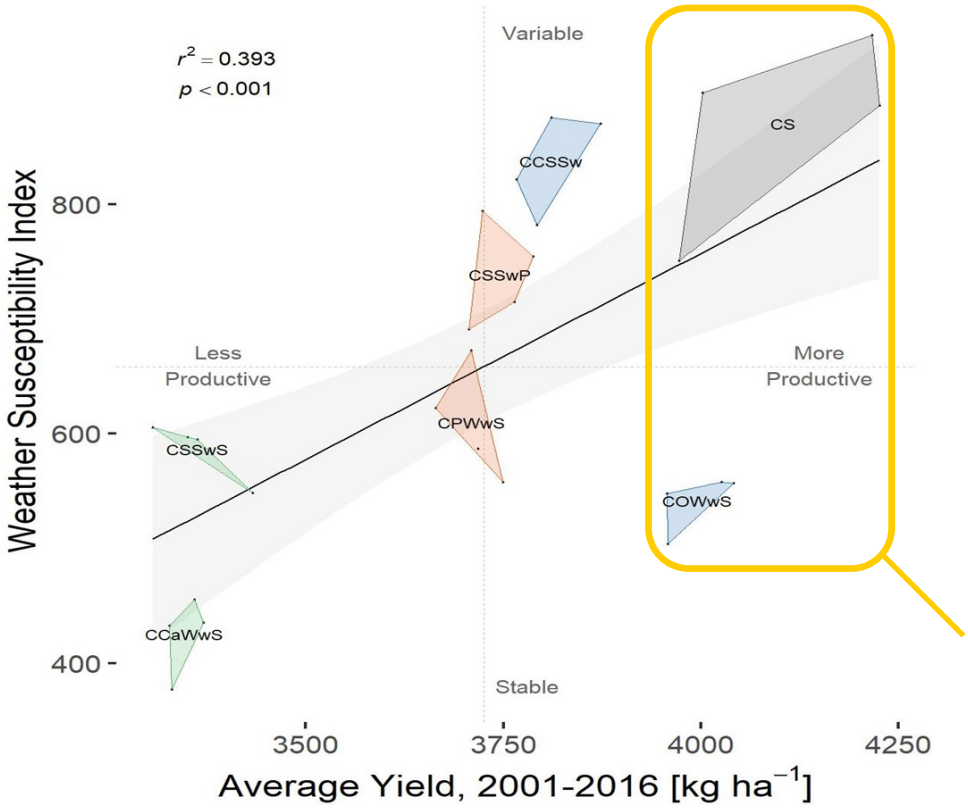
- Farming practices are continuously evolving to meet changes in markets, policies, and social demands.
- Selection and sequencing of crops grown in rotation is an effective approach to climate change adaptation and risk mitigation that need not reduce overall productivity.
- Principles to design such rotations in temperate, humid regions can help growers adapt to changing weather, markets, and policies by incorporating complementary, productive crops in ideal sequences within rotations.

Background

Crop rotation is a farm-scale management choice that dictates agronomic output, ecological impacts, and farm viability. Rotations have become less diverse recently. Re-diversifying may help agricultural systems meet the growing, dynamic demands from society and challenges from climate change. Research was conducted to evaluate multiple 4–year diversified crop rotations compared to a simple 2-year corn/soybean rotation.

Objective

In a long-term experiment, we tested whether diversified rotations could a) match the productivity (grain yield) of simplified rotations while b) stabilizing productivity against variable weather in the western U.S. Corn Belt



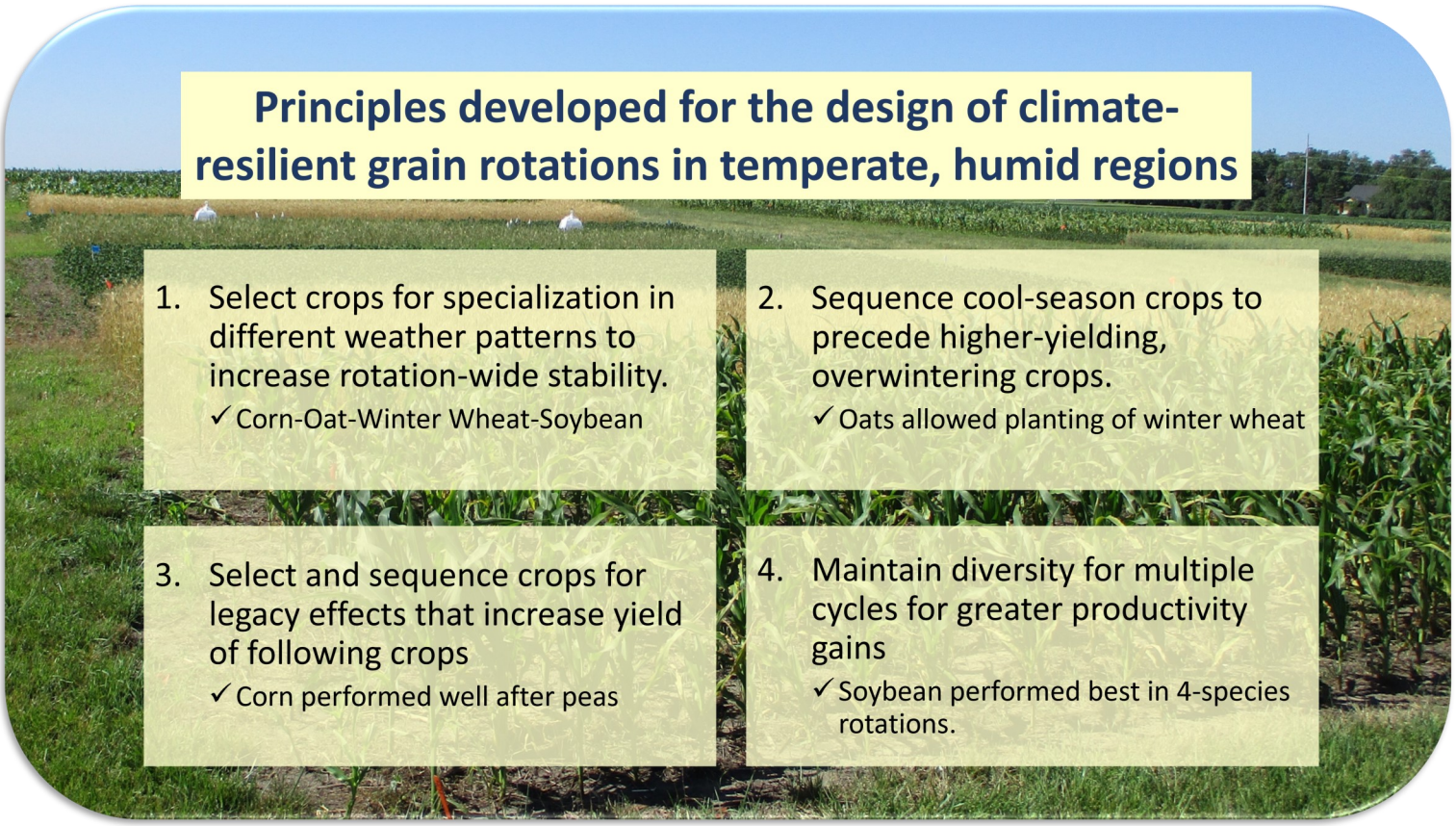
Relationship between total yield production and weather susceptibility.

Points are average yield and weather susceptibility of each replicate of each rotation. Polygons denote all points in a rotation as labeled.

Results showed that 4-year Corn-Oat-Winter wheat-Soybean rotation was just as productive as the 2-year Corn-Soybean rotation, but was less susceptible to changes in weather.

Methods

Data were obtained from a long-term experiment established in 2000 at the Eastern South Dakota Soil and Water Research Farm in Brookings, SD. The experiment contained six 4-year crop rotations and a 2-year rotation. Rotations were Corn-Canola-Winter wheat-Soybean (CCaWwS), Corn-Soybean-Spring wheat-Pea (CSSwP), Corn-Pea-Winter wheat-Soybean (CPWwS), Corn-Oat-Winter wheat-Soybean (COWwS), Corn-Soybean-Spring wheat-Soybean (CSSwS), Corn-Corn-Soybean-Spring wheat (CCSSw) and the regionally dominant Corn-Soybean (CS). These rotations were selected based on crops historically adapted to the region's growing conditions, in consultation with local growers and extension professionals. Plots were established in the fall of 2000 with winter wheat planting, all other crops were established the spring of 2001, when data collection began. The experiment was managed as no-till with reduced inorganic fertilizer and synthetic herbicide inputs.



Results

Rotation designs showed differences in total production and susceptibility to weather changes. The Corn-Oat-Winter wheat-Soybean rotation was a) no less productive than the highly unstable Corn-Soybean rotation; and b) only marginally less stable than the most stable rotation. Crop selection and sequencing were critical to this outcome. High productivity was due to a) overyielding of individual crops in diversified rotations that increased with time; b) sequencing to allow higher-yielding winter crops; and c) beneficial crop legacy effects. These results suggest four principles for the design, future study, and implementation of diversified grain rotations that are stable under erratic weather and are as productive as current standard practices.

Next Steps

Long-term research will be continued with a goal to enhance and improve cropping principles by including additional sustainable management practices such as cover crops. We will evaluate the impact of diversified crop rotations, no till soil management, reduced fertilizer inputs, and cover crops on ecosystem services including beneficial insects, pollination, crop quality and yield, soil microbial communities, disease suppression, and soil health.

For more about our study, check out this article: Ewing, P.M., Chim, B.K., Lehman, R.M., and Osborne, S.L. Diversified grain rotations can be highly and reliably productive in unstable climates. Field Crop Res. Vol 310. http://doi.org/10.1016/j.fcr.2024.109361

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About NCARL

The North Central Agricultural Research Laboratory (NCARL) is a USDA-Agricultural Research Service laboratory located in Brookings, SD. The goal of NCARL is to develop, document, and promote soil, crop, and pest management practices that are ecologically sustainable while maintaining producer profitability.