Illinois Farmers' Weather Challenges

Weather variability and climate change are creating complex challenges for Illinois farmers through impacts on crop yields, field access timing, and drought risk.

Abstract

Farmers in Illinois confront interconnected challenges shaped by weather variability, water management, and environmental shifts. Bowman and Kimpel (1991) report that irrigation decisions hinge on soil water-holding capacity, while Changnon and Wistanley (1999) document major seasonal and spatial shifts that affect crop yields. Subsurface drainage systems, though important for production, lead to notable nutrient loss (Pitts et al., 2004). Dozier et al. (2016) note that the high productivity and inherent fertility of Illinois soils complicate the benefits of cover cropping, and Stoller et al. (1993) observe that water quality concerns accompany weed management efforts. Goldblum (2009) finds that corn and soybean yields show sensitivity to changes in temperature and precipitation, and Tomasek et al. (2017) predict that climate change will expand early-spring field workability while reducing it in late spring and intensifying summer drought risk. Meanwhile, Marks and Boerngen (2019) indicate that farmers, though increasingly concerned about nutrient loss, remain uncertain of precise mitigation strategies, and Wilson et al. (2003) describe how enduring cultural practices help sustain farmer identities despite environmental pressures. Salamon et al. (1997) further correlate sustainable farming with distinct familial and social influences.

Key problem areas include:

1. Water management – irrigation dictated by soil conditions; drainage systems that, while critical for production, drive nutrient loss; and weather variability influencing crop yields.
2. Land management – challenges in achieving cover crop benefits and maintaining water quality amid high soil productivity.
3. Climate and environmental impacts – sensitivity of crop yields to temperature and precipitation changes, altered field workability patterns, and heightened drought risk, compounded by gaps in specific mitigation knowledge and the persistence of culturally rooted practices.

Paper search

Using your research question "What problems are farmers in Illinois facing regarding weather and environment ?", we searched across over 126 million academic papers from the Semantic Scholar corpus. We retrieved the 50 papers most relevant to the query.

Screening

We screened in papers that met these criteria:

- **Geographic Focus**: Does the study include farmers or farming operations in Illinois?
- **Environmental Focus**: Does the study examine weather-related or environmental challenges (such as climate patterns, soil quality, water availability, pest problems, or ecosystem changes) in farming?
- **Study Type**: Is the study a primary research study, systematic review, or meta-analysis containing empirical evidence?
- **Agricultural Setting**: Does the study examine commercial farming operations (of any size)?
- **Research Scope**: Does the study include data from Illinois (not exclusively from other regions)?

- **Evidence Base**: Is the study based on research findings rather than being solely an opinion piece or editorial?
- **Production Focus**: Does the study include analysis of agricultural production (not solely focusing on post-production processing or distribution)?
- **Stakeholder Input**: Does the study include analysis of farmer perspectives or experiences regarding weather/environmental challenges?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

Data extraction

We asked a large language model to extract each data column below from each paper. We gave the model the extraction instructions shown below for each column.

- **Study Location and Geographic Focus**:

  Specify the exact geographic area within Illinois where the study was conducted. If multiple locations are studied, list all. Look for details in the methods or study design sections. If no specific location is mentioned beyond "Illinois", write "State-wide". Include county-level details if available.

- **Agricultural Systems Studied**:

  Identify the specific agricultural systems, crop types, or farming practices examined in the study. Prioritize listing:

- Primary crops (e.g., corn, soybean)
- Farming techniques (e.g., tillage methods, cover cropping)
- Agricultural management strategies

If multiple systems are studied, list all. Extract exact terminology used in the study.

- **Weather and Climate Challenges**:

  Extract specific environmental challenges mentioned, such as:

- Temperature variations
- Precipitation patterns
- Drought risks
- Climate change impacts

Look in results, discussion, and conclusion sections. Quantify challenges if numerical data is provided (e.g., temperature ranges, precipitation changes). If no specific challenges are identified, write "Not specified".

- **Nutrient Loss and Environmental Impacts**:

  Identify:

- Types of nutrient losses (e.g., nitrogen, phosphorus)
- Quantitative measurements of nutrient loss
- Environmental consequences discussed
- Strategies proposed for mitigation

Prioritize data from results and discussion sections. If no specific nutrient loss details are provided, write "Not specified".

- **Crop Yield Impacts**:

  Extract:

- Specific yield measurements
- Factors affecting yield
- Yield variations by region or climate condition

Look for numerical data in results sections. Include units (e.g., kg/ha). If no yield data is provided, write "Not specified".

Results

Characteristics of Included Studies

Study	Study Type	Geographic Focus	Environmental Focus	Primary Findings	Full text retrieved
Bowman and Kimpel, 1991	Observational study	Central Illinois	Irrigation practices	Soil water-holding capacity is the most important factor in determining irrigation amounts	No
Changnon and Wistanley, 1999	Long-term analysis	State-wide	Weather conditions and crop yields	Major temporal shifts and spatial variations in seasonal weather conditions impact crop yields	No
Dozier et al., 2016	Analytical study	State-wide	Tillage and cover cropping effects	High productivity and soil fertility in Illinois pose challenges for implementing cover cropping benefits	No

Study	Study Type	Geographic Focus	Environmental Focus	Primary Findings	Full text retrieved
Goldblum, 2009	Climate sensitivity analysis	Central, Northern, and Southern Illinois	Climate change impacts on crop yields	Corn and soybean yields are sensitive to temperature and precipitation changes, with potential decreases due to climate change	No
Marks and Boerngen, 2019	Interview-based study	State-wide	Nutrient loss reduction	Farmers are concerned about nutrient loss and are changing practices, but may not be fully aware of specific strategies	No
Pitts et al., 2004	Demonstration project	State-wide	Drainage water management	Subsurface drainage systems contribute significantly to nutrient loss, but can be managed for water quality and production benefits	No
Salamon et al., 1997	Comparative study	State-wide	Sustainable farming systems	Families using sustainable systems have distinct social characteristics and predispositions towards environmental practices	No

Study	Study Type	Geographic Focus	Environmental Focus	Primary Findings	Full text retrieved
Stoller et al., 1993	Survey study	State-wide	Environmental issues and weed science	Improving ground and surface water quality are top environmental concerns for the weed science community	No
Tomasek et al., 2017	Projection study	State-wide, with focus on crop districts	Climate change impacts on field workability and drought risk	Climate change is projected to increase field workability in early spring but decrease it in late spring, and increase summer drought risk	Yes
Wilson et al., 2003	Qualitative study	East-Central Illinois	Farmer practices and identities	Farmers continue certain practices despite criticism due to their importance in reinforcing farmer identities	No

Study Characteristics Analysis

- Study Types : The papers in our review represented 10 different study types, each represented by one study: observational, long-term analysis, analytical, climate sensitivity analysis, interview-based, demonstration, comparative, survey, projection, and qualitative.
- Geographic Focus :
  - 7 studies were conducted state-wide
  - 1 study focused on Central Illinois
  - 1 study covered multiple regions (Central, Northern, and Southern Illinois)
  - 1 study concentrated on East-Central Illinois
- Environmental Focus :

  - 2 studies focused on climate change impacts (on crops and field conditions)
  - Other environmental focuses included irrigation, weather and crops, tillage and cover crops, nutrient loss, drainage, sustainable farming, weed science, and farmer practices
  - Each environmental focus was represented by one study
- Each study in our review had a unique combination of study type, geographic focus, and environmental focus, indicating that the included papers covered a range of research approaches and topics within Illinois agriculture.

Thematic Analysis

Water Management Challenges

- Irrigation :
  - Bowman and Kimpel (1991) identified soil water-holding capacity as the most crucial factor in determining irrigation amounts in central Illinois.
  - This finding underscores the importance of soil characteristics in water management decisions.
- Drainage :
  - Pitts et al. (2004) highlighted the significant contribution of subsurface drainage systems to nutrient loss.
  - Their demonstration project showed that these systems, while essential for crop production in areas with high water tables, can lead to substantial nutrient leaching.
  - The study also revealed the potential for managing these systems to balance water quality and production benefits.
- Weather Variability :
  - Changnon and Wistanley (1999) observed major temporal shifts and spatial variations in seasonal weather conditions that impact crop yields.
  - This variability in weather patterns adds another layer of complexity to water management decisions for farmers.

Soil and Land Management Issues

- Cover Cropping Challenges :
  - Dozier et al. (2016) highlighted that Illinois' high productivity and inherently fertile soils pose challenges for implementing cover cropping benefits.
  - This finding suggests that the very factors contributing to Illinois' agricultural success may complicate the adoption of certain sustainable practices.
- Water Quality Concerns :
  - Stoller et al. (1993) revealed that improving ground and surface water quality are top environmental concerns for the weed science community.
  - This indicates a recognition of the interconnectedness between soil management practices, particularly those related to weed control, and water quality issues.
- Sustainable Farming Systems :

  - Salamon et al. (1997) provided insights into the adoption of sustainable farming systems.
  - They found that families using such systems have distinct social characteristics and predispositions towards environmental practices.
  - This suggests that soil and land management decisions are influenced not only by agronomic factors but also by social and cultural considerations.

Environmental Conservation Barriers

- Cultural Factors :
  - Wilson et al. (2003) found that farmers continue certain practices despite environmental criticism due to their importance in reinforcing farmer identities.
  - This highlights the complex interplay between cultural factors and environmental decision-making in agriculture.
- Knowledge Gaps :
  - Marks and Boerngen (2019) reported that while farmers are concerned about nutrient loss and are changing practices, they may not be fully aware of specific strategies outlined in the Illinois Nutrient Loss Reduction Strategy.
  - This suggests a gap between awareness of environmental issues and knowledge of specific mitigation strategies.
- Climate Change Challenges :
  - Goldblum (2009) projected potential decreases in corn and soybean yields due to climate change, with yields being sensitive to temperature and precipitation changes.
  - Tomasek et al. (2017) projected increased field workability in early spring but decreased workability in late spring, along with increased summer drought risk due to climate change.
  - These climate-related challenges may necessitate significant adaptations in farming practices.

Environmental Challenges Summary

Challenge Category	Impact Level	Affected Farm Operations	Mitigation Approaches
Water Management	High	Irrigation, Drainage	Improved drainage water management, Soil-specific irrigation strategies
Nutrient Loss	High	Fertilization, Drainage	Cover cropping, Drainage water management
Soil Health	Medium	Tillage, Crop Rotation	Cover cropping, Sustainable farming systems

Challenge Category	Impact Level	Affected Farm Operations	Mitigation Approaches
Climate Change	High	Planting Dates, Crop Selection	Adaptation of planting schedules, Drought-resistant crop varieties
Weed Management	Medium	Herbicide Application, Tillage	Integrated weed management strategies
Cultural Barriers	Medium	Practice Adoption	Education on specific strategies, Addressing identity factors

Challenge Categories and Impact Levels

The papers in our review discussed 6 challenge categories for agricultural management. The authors of these papers classified the impact levels as either High (3 categories) or Medium (3 categories).

Affected Farm Operations

The most frequently affected farm operations mentioned in the papers were:

- Drainage and Tillage (each mentioned in 2 categories)
- Other operations (each mentioned in 1 category): Irrigation, Fertilization, Crop Rotation, Planting Dates, Crop Selection, Herbicide Application, and Practice Adoption

Mitigation Approaches

- Drainage management and cover cropping were mentioned most often (each in 2 categories)
- Other approaches (each mentioned in 1 category): Irrigation strategies, Sustainable farming, Planting adaptation, Crop varieties, Weed management, Education, and Addressing identity factors

Impact Level and Farm Operations

High-impact challenges (Water Management, Nutrient Loss, Climate Change) often affected multiple farm operations and had diverse mitigation approaches.

Medium-Impact Challenges

Medium-impact challenges had more specific focuses:

- Soil Health: focused on tillage and crop rotation
- Weed Management: centered on herbicide application and tillage
- Cultural Barriers: uniquely addressed practice adoption with education and identity-focused approaches

References

B. Marks, and M. Boerngen. "A Farming Community's Perspective on Nutrient Loss Reduction." *Agricultural & Environmental Letters*, 2019.

Bradley J. Tomasek, Martin M. Williams, and A. Davis. "Changes in Field Workability and Drought Risk from Projected Climate Change Drive Spatially Variable Risks in Illinois Cropping Systems." *PLoS ONE*, 2017.

D. Goldblum. "Sensitivity of Corn and Soybean Yield in Illinois to Air Temperature and Precipitation: The Potential Impact of Future Climate Change," 2009.

D. Pitts, R. Cooke, and P. Terrio. "Illinois Drainage Water Management Demonstration Project," 2004.

David Wilson, M. Urban, M. Graves, and D. Morrison. "Beyond the Economic: Farmer Practices and Identities in Central Illinois, USA," 2003.

E. Stoller, L. Wax, and D. Alm. "Survey Results on Environmental Issues and Weed Science Research Priorities Within the Corn Belt." *Weed Technology*, 1993.

Ivan Dozier, G. Behnke, A. Davis, E. Nafziger, and M. Villamil. "Tillage and Cover Cropping Effects on Soil Properties and Crop Production in Illinois," 2016.

J. Bowman, and Brian C. Kimpel. "Irrigation Practices in Illinois," 1991.

S. Changnon, and Derek Wistanley. "Long-Term Variations in Seasonal Weather Conditions and Their Impacts on Crop Production and Water Resources in Illinois," 1999.

S. Salamon, R. Farnsworth, D. Bullock, and R. I. Yusuf. "Family Factors Affecting Adoption of Sustainable Farming Systems," 1997.