Morris Extreme Weather Project
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Abdullah A. Jaradat
USDA-ARS, Morris, MN

Mission

Enhance productive conservation of agricultural and natural resources base, improve environmental health, and contribute to national food security through "*diversified, competitive, and resilient agro-ecosystems*" in the upper Midwest.

Research Program: Natural Resources Conservation

Crops & Climate Change

Agriculture & Climate Change

- Agriculture will continue to be significantly affected by GCC
- Existing adaptation strategies effective …short term
- Improving its resilience to GCC .. Requires:
  - Protection of natural resources base (Soil & Water)
  - New strategies, tools & practices for adaptation

USDA Climate Change Hubs

USDA Climate Change Hubs

- **Vision:**

Agricultural production and natural resources maintained and strengthened under increasing climate variability and climate change

USDA Climate Change Hubs

- **Mission:**

To develop and deliver science-based, region-specific information and technologies to agricultural and natural resources managers that enable climate-smart decision-making

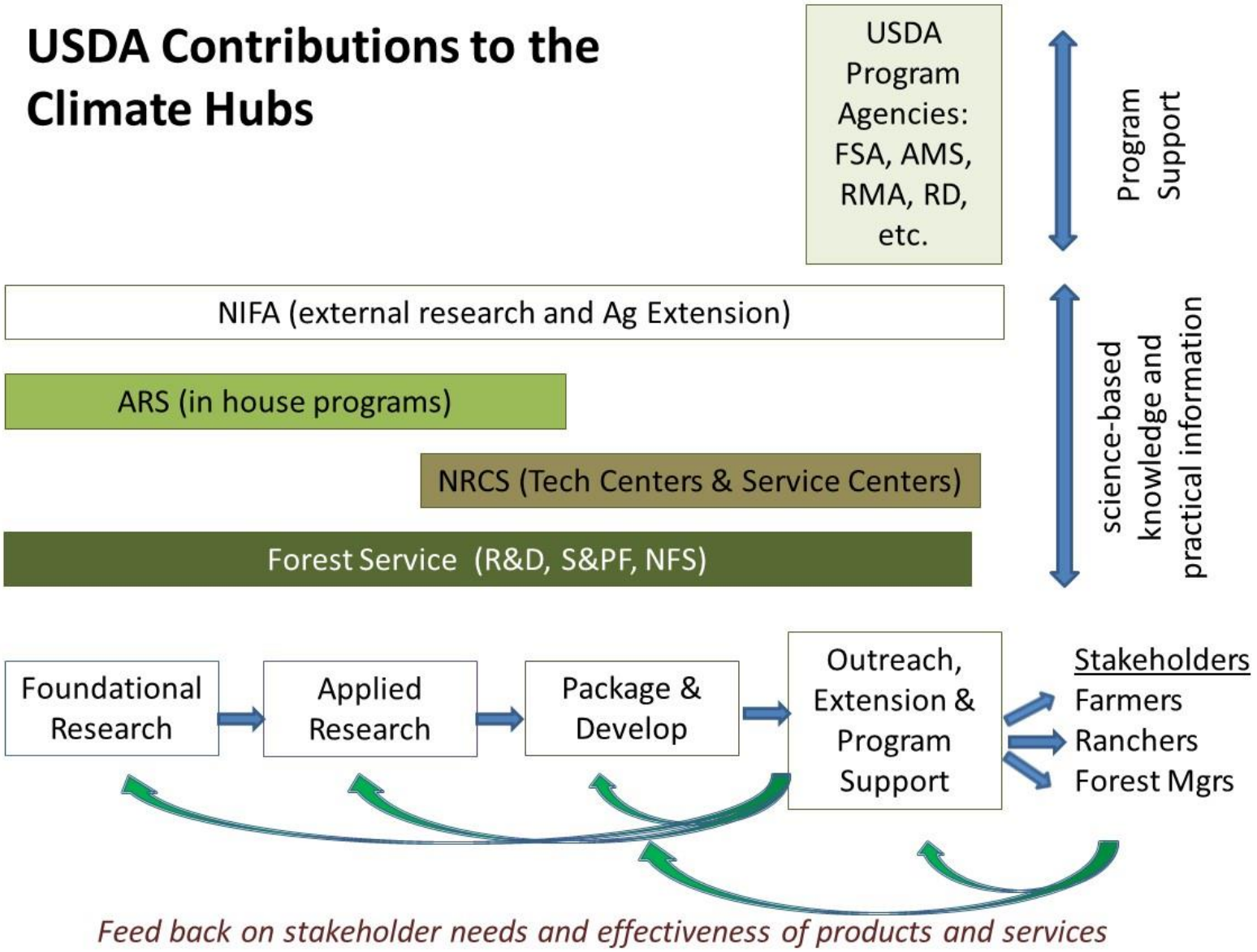
USDA Climate Change Hubs

- **Develop Tools & Technologies**:
  - Drought
  - Heat
  - Excessive moisture
  - Longer growing season
  - Changes in pest pressure

USDA Climate Change Hubs

- Foundational Research
- Applied Research
- Technology Transfer
- Outreach & Education

USDA Contributions to the Climate Hubs



USDA Climate Change Hubs

- Extreme Rainfall/Flooding
- Increased heat events
- Growing seasons have lengthened by almost two weeks since 1950
- Wetter springs/fewer workable field days

1.

Most significant concerns associated with extreme weather events:

1.1.

1. Biophysical impact of extreme events associated with climate change and global warming on:
    1. Land, soil and water resources, and
    2. Provisioning, regulating, cultural, and supporting ecosystem services.
2. Projected increases in rainfall intensity that includes more extreme events will increase soil erosion in the absence of conservation practices.
3. Large increase in number of days with heavy rainfall in early spring:
    1. Fewer number of workable days and
    2. Delayed planting.

1.2.

1. Extreme weather events:
    1. Produce sudden increases in water flow,
    2. Often carrying debris and pollutants,
    3. Can decrease the natural capacity of ecosystems to cleanse contaminants;
2. Likely increased potential for pollutants, including:
    1. Off-site nonpoint source pollution (e.g., nitrogen, agro-chemicals),
    2. Runoff, and
    3. Contamination of underground and surface water resources due to higher risk of flash floods during early spring.

1.3.

1. Abrupt changes in ***hydrothermal*** regimes associated with extreme events and their joint impact on:
    1. Yield of current and future crops, pastures and grazing land, and
    2. Food and feed availability and quality,
    3. Due to intensive/extensive biotic (diseases, insects) and abiotic stresses (floods, drought, heat) stresses.
2. *So far*, long-term crop production in Stevens County is more affected by available soil water during the growing season than by temperature;
    1. Increased variation in seasonal precipitation,
    2. Shifting patterns of precipitation within the season, will create more variation in soil water availability.

1.4.

1. Ecophysiological responses of current (corn, soybean, wheat) and alternative crops (e.g., oilseed crops, bioenergy and biomass crops, perennials) to extreme events (e.g., high temperature; hot, dry winds) during:
    1. Sensitive phenological growth and reproductive stages (e.g., pollination; seed growth and development), and
    2. Impact on nutritional value of crops and products.

2. Adaptive Strategies

2.1.

1. Use of (*down-scaled*) biophysical process-based models, agro-ecosystem models, and statistical analyses of historical data to:
    1. Forecast potential impacts of future climate change, and
    2. Increased probability of extreme weather events on:
        1. Future agricultural productivity,
        2. Food and feed quality, and
        3. Soil and water quantitative and qualitative attributes.
2. An early warning system can be developed on the basis of these models to provide daily weather predictions and seasonal forecasts.

2.2.

1. Extensive use of moisture-conserving tillage practices, such as no-till, ridge-till, and mulch-till during extremely dry spells.
2. Management strategies have been based on years of soil and water conservation research specific to local conditions which was carried out by the Soils Lab, and based on producer experience.
3. Changes in production practices can have more effect than climate change on soil erosion;
    1. Changes in climate and extreme events will exacerbate the effects of management practices that do not protect the soil from the forces of rainfall.

2.3.

1. Development of short- and long-term farm- and watershed-level resource management innovations to address risks of extreme hydrothermal events. These innovations may include:
    1. Diversified crops, crop rotations, cropping systems (e.g., organic vs. conventional) and livestock genotypes;
    2. Changes in production intensities to address environmental variations and economic risks associated with extreme weather events; and
    3. Adjusted farm operations (e.g., planting and harvest time; altering input use) to buffer the impact of hydrothermal extremes.

2.4.

1. Screening of diverse germplasm conserved in national genebanks, and collecting germplasm from hotspots around the world, to:
    1. Select adapted genoptypes and
    2. Develop new crop varieties (e.g., novel genetic combinations optimal for future climates) with increased tolerance (i.e., higher threshold) and suitability (i.e., adaptation) to hydrothermal extremes.
2. Adaptive genetic enhancement of traits (such as tolerance to extreme heat and drought) will contribute to long-term response to the challenges of extreme weather events.

3.
Opportunities for the Farming Community Development

3.1.

1. Adjust land-use, including the introduction of new crops such as bioenergy crops, oilseed crops or perennials for:
    1. Soil conservation,
    2. Reduced runoff, and
    3. Production of new ecosystem services
2. Potential use of innovative land-management decisions to maintain, if not to improve soil and water quality (e.g., precision irrigation) where needed, and
3. Sub-surface drainage during early spring to cope with:
    1. New production strategy shaped by climate change, and
    2. Associated extreme hydrothermal events.

3.2.

1. Increase and diversify agricultural production:
    1. In areas with increased moisture availability and higher CO_2 concentration, even under thermal stress;
    2. Diversify crop rotations and cropping systems:
        1. Better nutrient cycling, and
        2. High nutrient and water use efficiencies under extreme hydrothermal events.

3.3.

1. Properly apply adaption and mitigation strategies in time and space; this practice can be effective in altering the local/regional climate and in reducing agricultural vulnerability to extreme events.
2. This may open future opportunities to expand the planting areas in the Midwest northwards because of a favorable hydrothermal regime (in parts of MN, SD and ND).
3. However, the suitability of the soils to support traditional and new crops remains a challenge; also, late spring and early fall rain events may influence the timing and reduce the efficiency of field management operations. In addition,
4. Farmers may benefit from longer growing seasons:
    1. Exploit more land area that could be available for traditional or new crops
    2. If this trend continues in the future as predicted by simulation models.

4.

How to Capitalize on Opportunities in Responding to Extreme Weather Events?

4.1.

1. The establishment of new institution (e.g., Climate Change Hubs for Risk Adaptation and Mitigation of Climate Change of USDA-ARS;
2. The Soils Lab is a member of the Midwest Hub; activities include:
    1. Technical support,
    2. Assessment and regional forecast, and
    3. Outreach and education to develop new technologies and facilitate appropriate, informed framer/producer response to extreme events of a changing climate.
3. The development and testing of "*multifunctional agroecosystems*" would be the best potential outcome in responding to extreme weather events.

4.2.

1. Incorporation of even small amounts of perennial vegetation (as cover crops on susceptible landscapes or perennials for biomass/bioenergy production) will create an opportunity for enhancing the provision of a wide range of ecosystem services to farmers and to society;
2. ES include:
    1. Water purification, hydrologic regulation (in view of expected higher frequency of intense rainfall events),
    2. Pollination services,
    3. Control of pest and pathogen populations,
    4. Diverse food and fuel products, and
    5. Greater resilience to climate change, in general, and extreme events, in particular.
3. Increased perennials would produce tangible social benefits such as connectedness and civic engagement.

4.3.

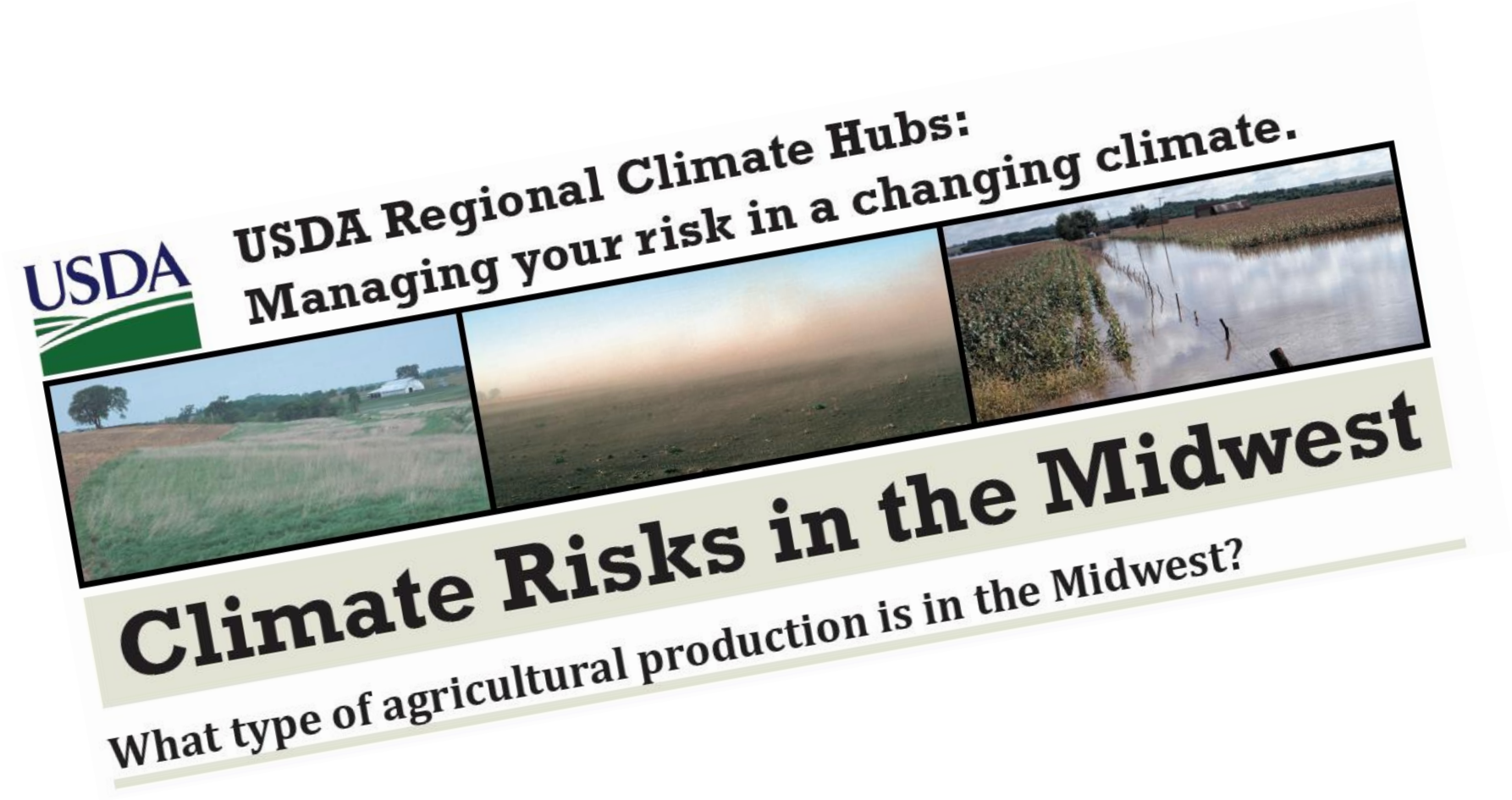
1. Pursue more transformative adaptive strategies, such as conversion to integrated crop-livestock farming,
    1. Reduce environmental impacts,
    2. Improve profitability and sustainability, and
    3. Enhance ecological resilience to climate change and its extreme events in livestock production systems.

4.4.

1. Establish and verify the effectiveness of linked *adaptation and mitigation* strategies at different scales and levels within Stevens County;
    1. Building codes and landscaping ordinances will likely need to be updated for:
        1. Energy efficiency,
        2. Conserve water supplies,
        3. Protect against disease vectors,
        4. Reduce susceptibility to heat stress or flash floods, and
        5. Improve protection against extreme events.

4.5.

1. Stakeholders' support of research to:
    1. Predict climate change, extreme events, and thresholds that could lead to abrupt changes in climate or ecosystems, at local scale, and
    2. Disseminate decision-relevant information on climate change and its impact to local government and the public.


USDA
USDA Regional Climate Hubs:
Managing your risk in a changing climate.
Climate Risks in the Midwest
What type of agricultural production is in the Midwest?