Can Adjustment of Planting Dates Offset Warming Impacts for Kansas Sorghum Producers?

Noah Miller and Dr. Jesse Tack
Dept. of Agricultural Economics
Kansas State University

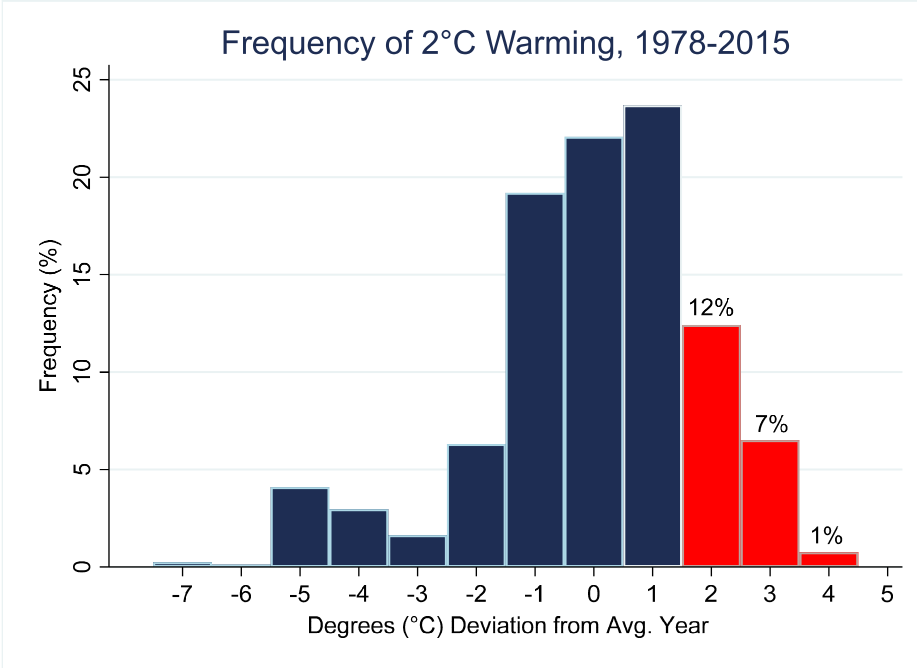
Special thanks: Kevin Herbel & KFMA extension economists

Risk and Profit Conference
Manhattan, KS August 16, 2018

Introduction

- Sorghum known for heat tolerance (relative to other crops)
  - Field trial experiments show intolerance to extreme heat
- 20% of past growing seasons have been (2°C) 3.6°F or greater then average years
  - Incorporating/replacing crops with sorghum
  - Farm-level impacts of extreme heat

Introduction



K·STATE
Research and Extension

Introduction

- Goals:
  - Run analysis w/ farm yield and local weather data
  - Show effect of increased temps on sorghum yields
  - Find out if changing plant date offsets yield losses
- Key results:
  - Temps over 91°F damage sorghum yields
  - Increase in daily temps → significant yield losses
  - Moving up planting partially offsets yield losses
  - ***Unexplained finding: sorghum's heat tolerance declined between 1978 and 2015***

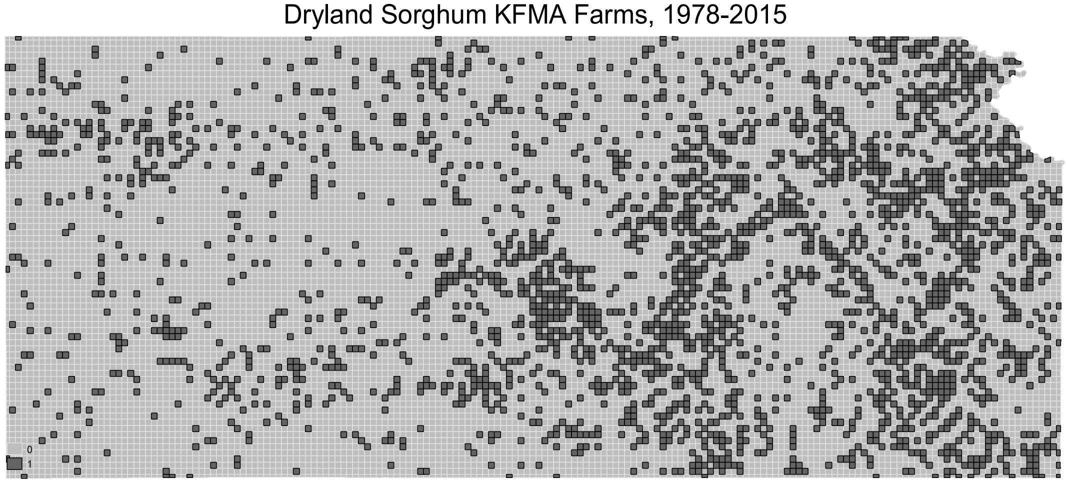
Farm Data, 1978-2015

- Dryland sorghum yields
  - Kansas Farm Management Assoc. (KFMA)
    - 38 Years, 1978-2015
  - 449-1676 annual observations
  - Total observations = 45,971 obs.
- Yields matched to weather data
  - Farm mailing addresses
    - Out-of-state addresses thrown out
  - Farm latitude & longitude

Knowledge for Life

Farm Data, 1978-2015

Dryland Sorghum KFMA Farms, 1978-2015



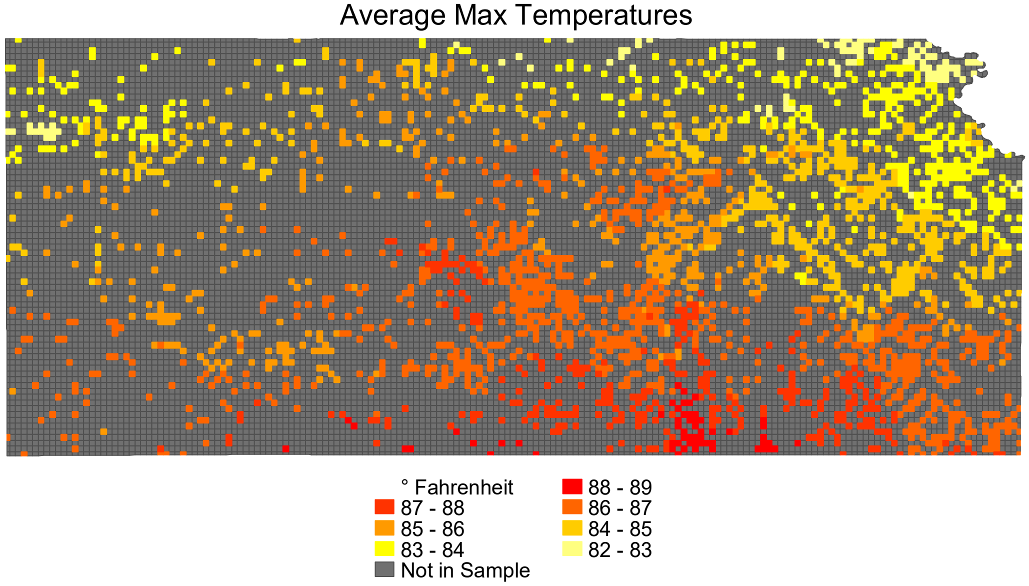
Knowledge for Life

Weather Data, 1978-2015

- 4x4 km, publicly available weather data
  - Daily precipitation (in mm)
  - Daily min and max temperature (in °C)
- Collected for:
  - Each farm location
  - Each year's (1978 – 2015) growing season
- Plant & harvest dates
  - USDA-NASS crop progress reports
  - 9 CRDs
- Plant date = 50% crop planted
- Harvest date = 50 % crop harvested

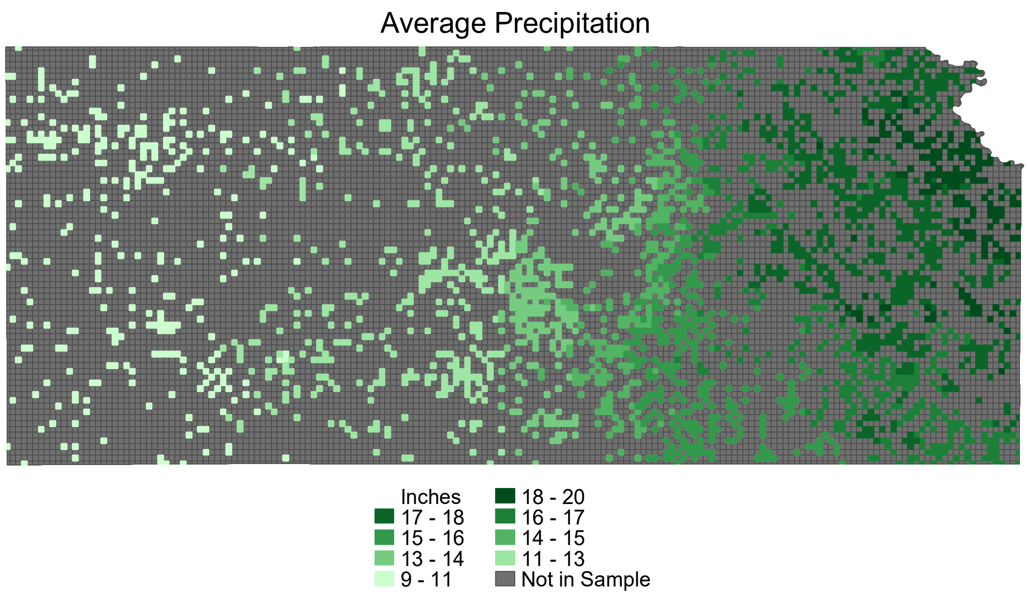
Weather Data, 1978-2015

Average Max Temperatures



K·STATE Research and Extension

Weather Data, 1978-2015

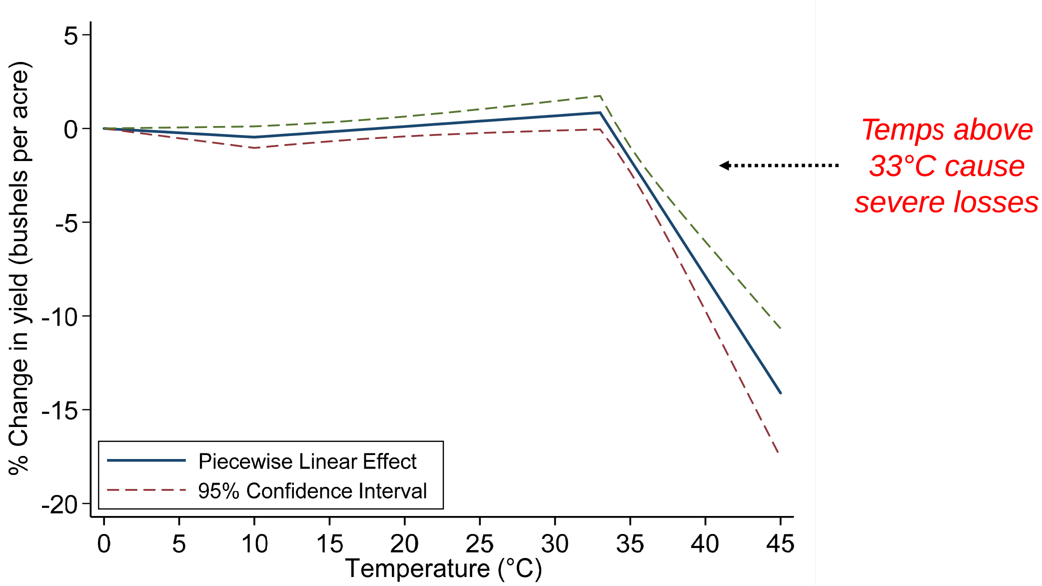


Knowledge for Life

K·STATE Research and Extension

Analysis & Results

- Statistical analysis (baseline): temperature on yield
  - Temps above (10°C) 50°F → yields increase
  - Temps above (33°C) 91°F → yields decrease



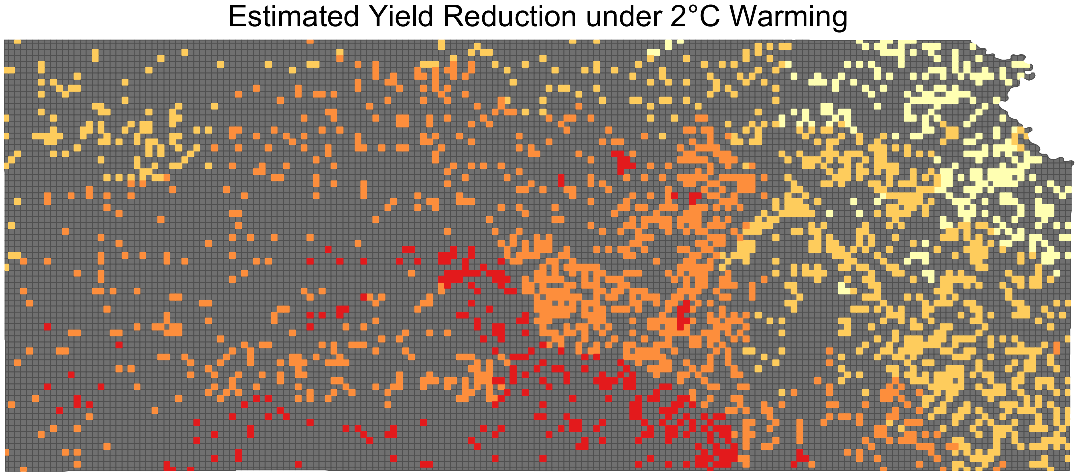
Knowledge for Life

Analysis & Results

- Statistical analysis (warming):
  - Increase daily weather temps by (2°C) 3.6°F
  - Rerun earlier analysis
  - Increased temps → 24% avg. decrease in yields
  - Yield losses different across the state

Analysis & Results

Estimated Yield Reduction under 2°C Warming



% 5 - 12.5 | 12.5 - 20 | 20 - 27.5 | 27.5 - 35 | Not in Sample

K·STATE Research and Extension

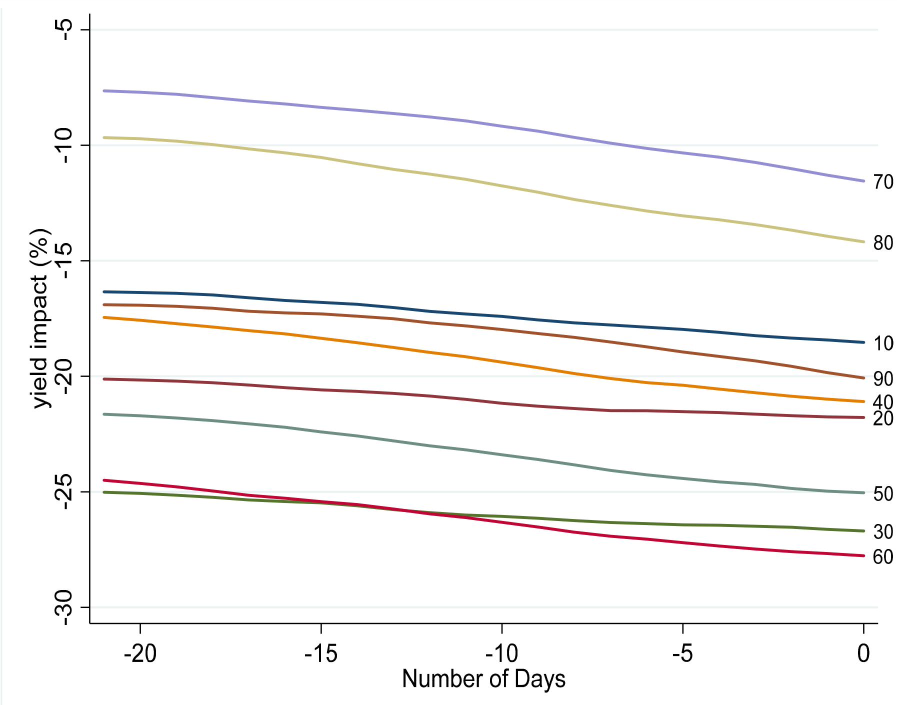
Analysis & Results

- Offset losses from warming by moving up plant date?
- Redefine historical growing season
  - Allow for up to 3 weeks earlier planting
  - Soil germination requirements
    - Avg. temp after (new) plant date must be the same as under baseline (no warming)
  - USDA-RMA best management practices
- Recalculate yield losses

Knowledge for Life

K·STATE Research and Extension

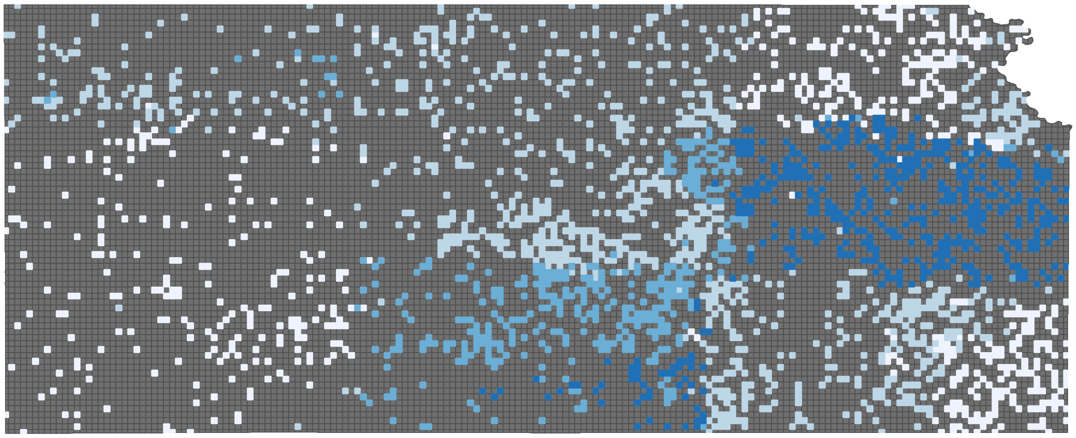
Analysis & Results



Knowledge for Life

Analysis & Results

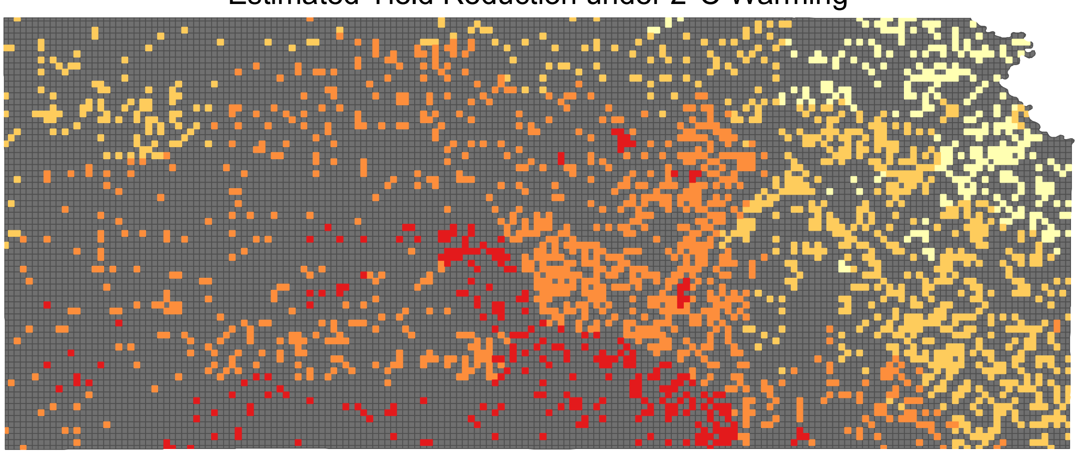
Optimal # of Days to Advance Planting



K·STATE
Research and Extension

Analysis & Results

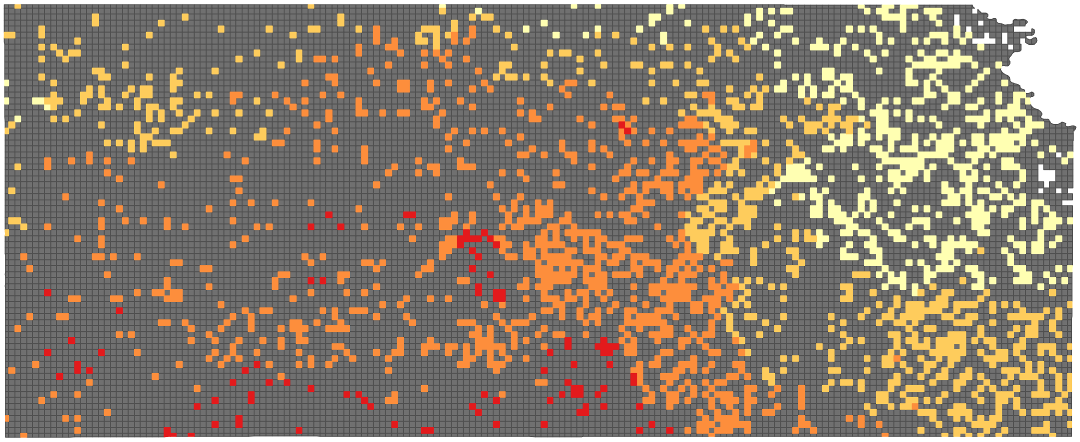
Estimated Yield Reduction under 2°C Warming



Knowledge for Life

Analysis & Results

Estimated Yield Reduction under 2°C Warming (Reoptimized)

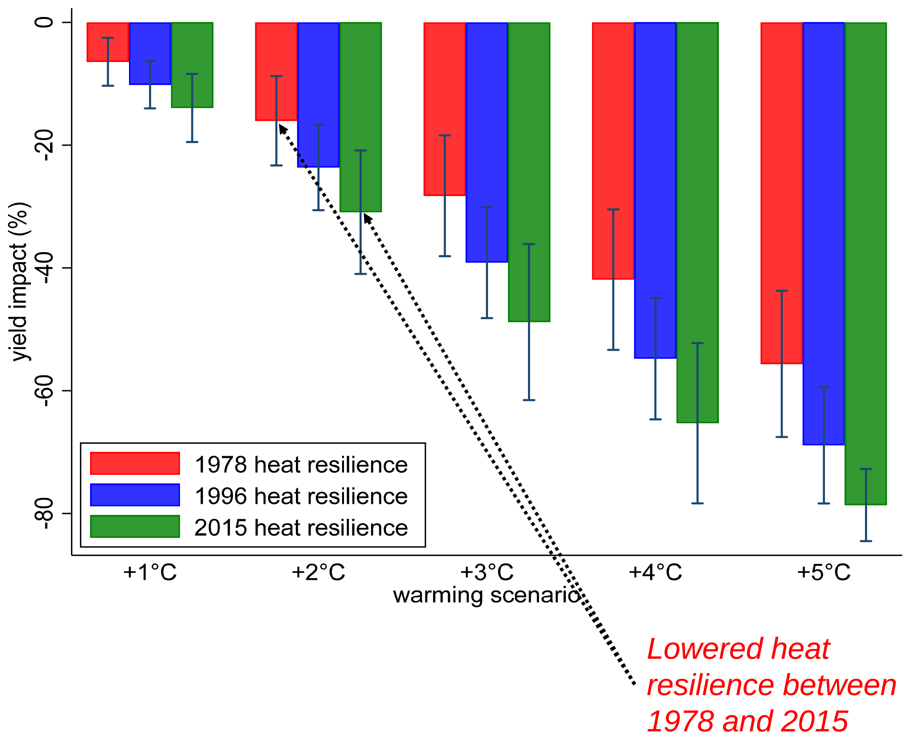


% 5 - 12.5 | 12.5 - 20 | 20 - 27.5 | 27.5 - 35 | Not in Sample

Analysis & Results

- Moving up the plant date helps w/ yield losses…
  - But not by much
    - Under old plant date → 24% yield losses
    - Under new plant date → 22% yield losses
  - Strategy works best in Eastern Kansas; works worst in Western Kansas
  - Suggests changing plant date might not help much

Change in Heat Resilience over Time ('78, '96, '15)



Knowledge for Life

Change in Heat Resilience over Time

- *What is the reason for lowered heat resilience?*
  - Seed genetics
    - Efforts at increasing avg. yield during normal climate years
  - Management practices
    - 50% increase in plant density over last 50 years
  - Some other unaccounted factor?

Knowledge for Life

K·STATE
Research and Extension

Thank you

We would be very grateful for your comments or insights!

Knowledge for Life