

North Dakota Spring Wheat Yield in Relation to Temperature and Precipitation

**A Thesis Presented by
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Overview

- Introduction
- Methodology
- Results
- Discussion
- Questions and Answers






Introduction



- Purpose of this study and importance to this region
 - World food demand may increase by 70 percent by 2050 particularly in Asia, Eastern Europe and Latin America (ABARES 2012)
 - Global mean temperature has increased 1°C to 3°C since pre-industrial times (IPCC 2014 report)
 - To assess climatic effects on North Dakota Red Hard Spring Wheat production



Research questions

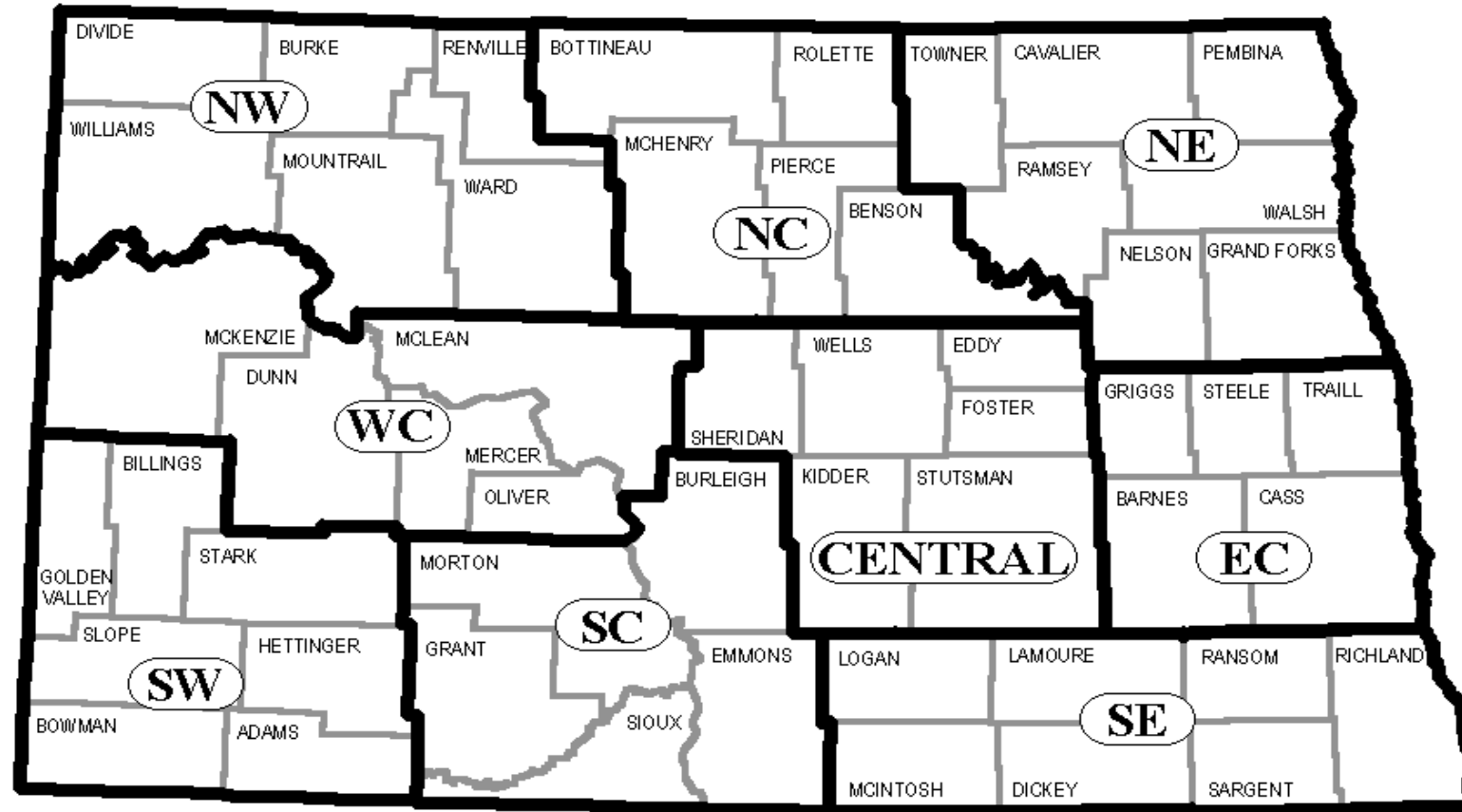
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- Do temperature and rainfall variability influence North Dakota Red Hard Spring Wheat (spring wheat) production during the growing season?
 - What are the impacts on yield for spring wheat in North Dakota in the period of 1986-1990 vs. the period of 1991-1995?

Hypothesis

- First period (1986-1990) expecting less wheat yield
- Second period (1991-1995) expecting greater wheat yield

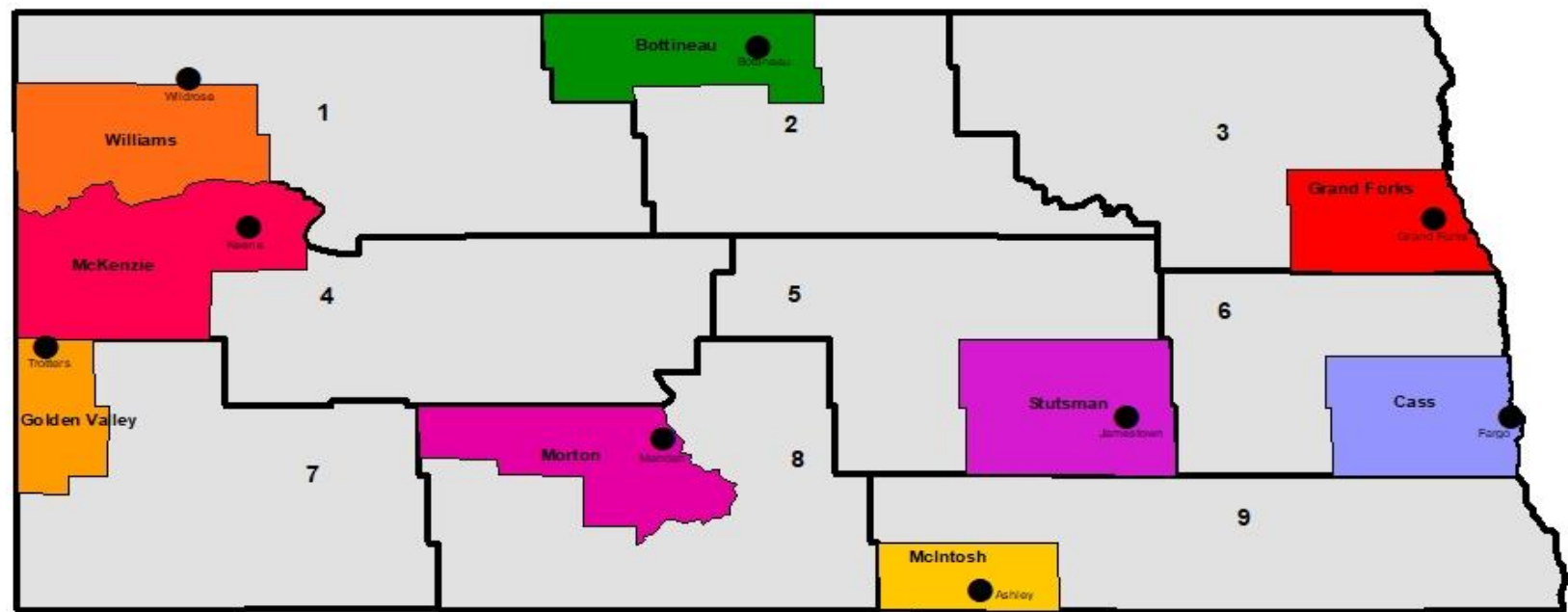
Research Methods











NORTH DAKOTA AGRICULTURAL STATISTICS DISTRICTS

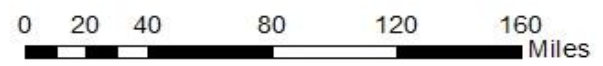


- Study Area and site selection
- Source: USDA

Study Areas: North Dakota



Study Areas		Agriculture Regions	
	Bottineau		McKenzie
	Cass		Morton
	Golden Valley		Stutsman
	Grand Forks		Williams
	McIntosh		Weather Station
		1	North West
		2	North Central
		3	North East
		4	West Central
		5	Central
		6	East Central
		7	South West
		8	South Central
		9	South East



Map Created By: Manna Khan
 Sources: US Census Boureau TIGER/Line Shapefiles;
 ESRI ArcGIS 10.6; Long-Lat (NOAA)

Data Collection and Procedures


- Climate Data: NOAA
 - Temperature measured in °F
 - Precipitation measured in inches
- Agricultural Data and comparisons for spring wheat: USDA and NASS
 - Bushels per acre (bu/acre)
 - 1 bushel of wheat: 60 pounds or 77.2 kilograms
 - A bushel of wheat yields 42 commercial loaves of white bread
 - Acre harvested and planted

Results

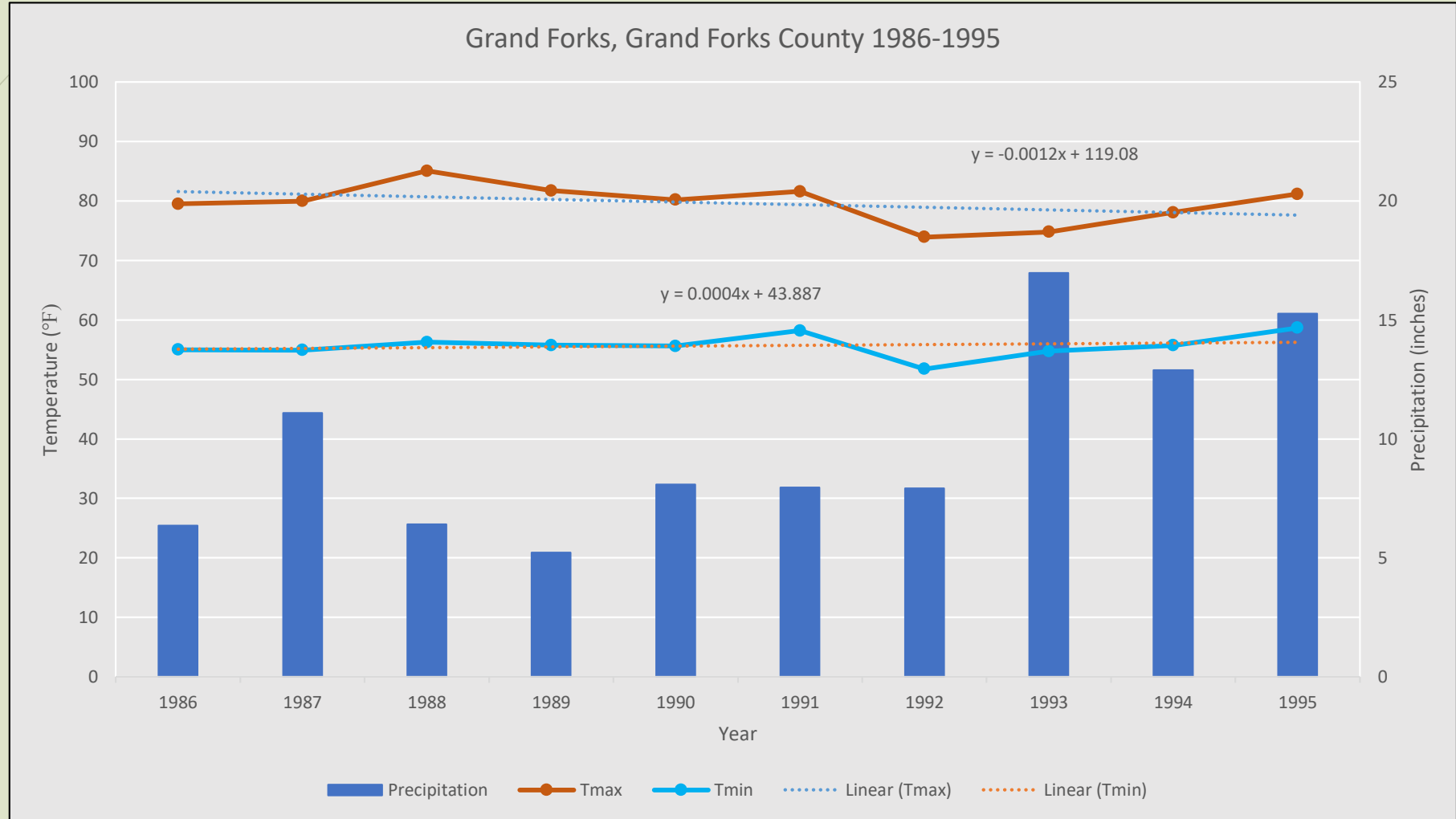
- ▶ Eastern North Dakota
 - ▶ Grand Forks County
 - ▶ Cass County
 - ▶ McIntosh County
- ▶ Central North Dakota
 - ▶ Bottineau County
 - ▶ Stutsman County
 - ▶ Morton County
- ▶ Western North Dakota
 - ▶ Williams County
 - ▶ McKenzie County
 - ▶ Golden Valley County



Eastern North Dakota: Grand Forks County

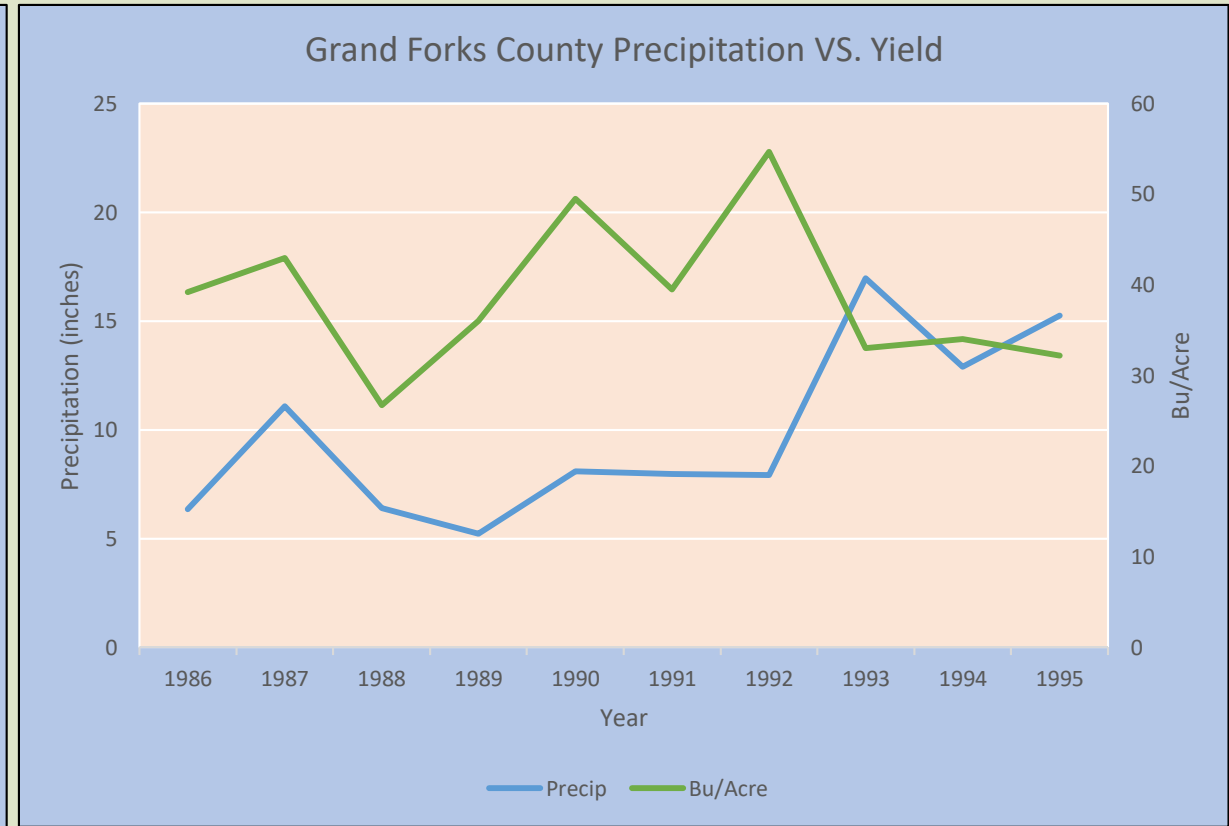
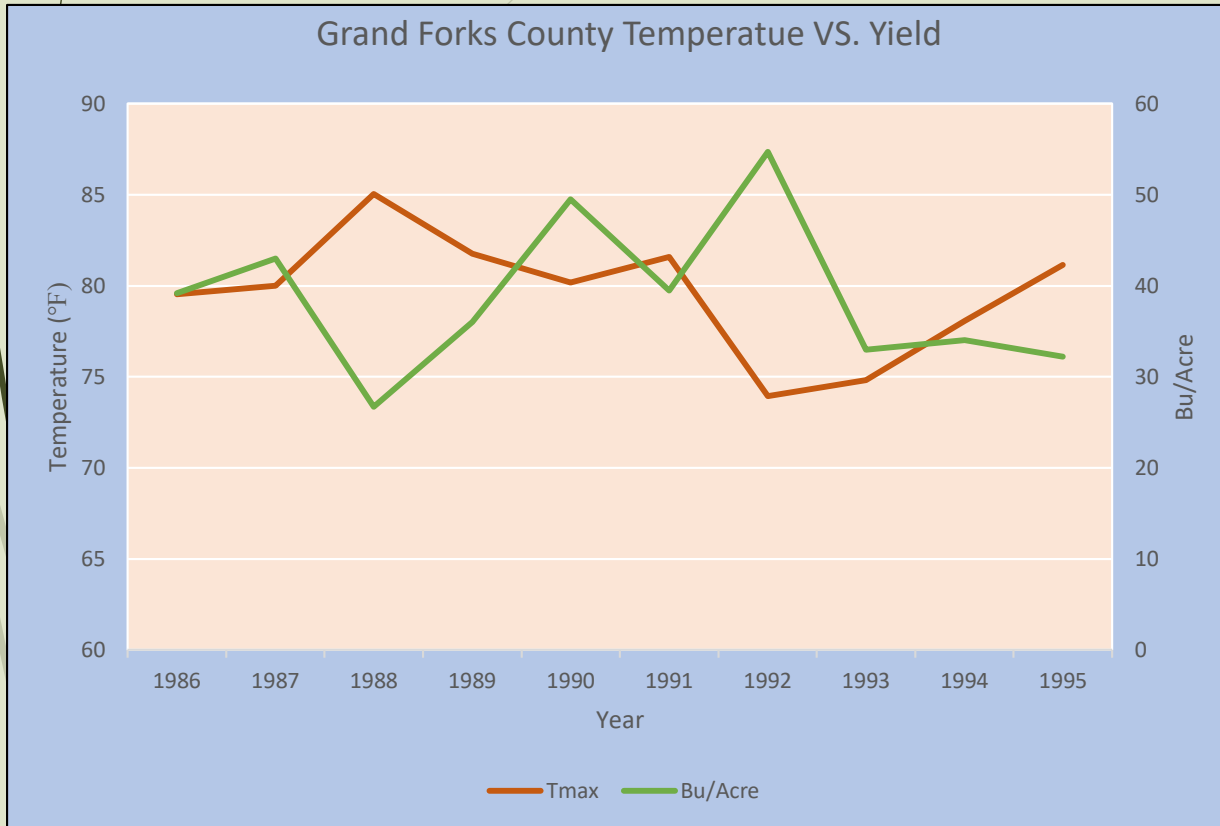
- Temperature
 - 81.3°F in the 1st period
 - 77.9°F in the 2nd period
 - Precipitation
 - 37.17 inches 1st period
 - 61.01 inches 2nd period
 - Spring Wheat Yield
 - 39.88 (bu/acre) 1st period
 - 38.68 (bu/acre) 2nd period
- 

Eastern North Dakota: Grand Forks County



Source: NOAA

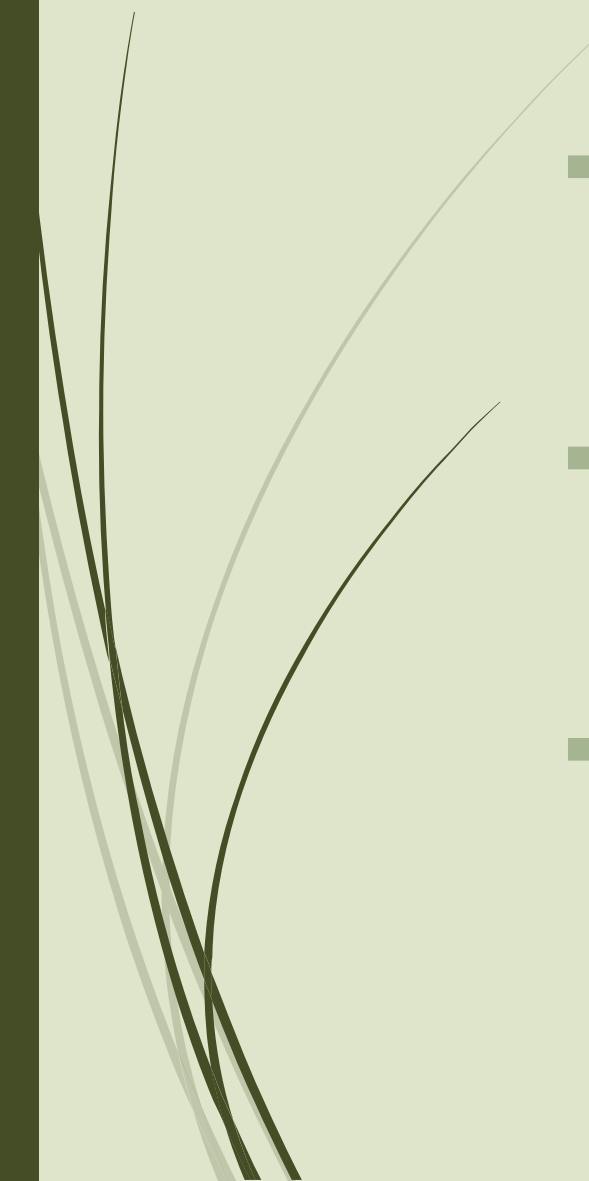
Spring Wheat Yield



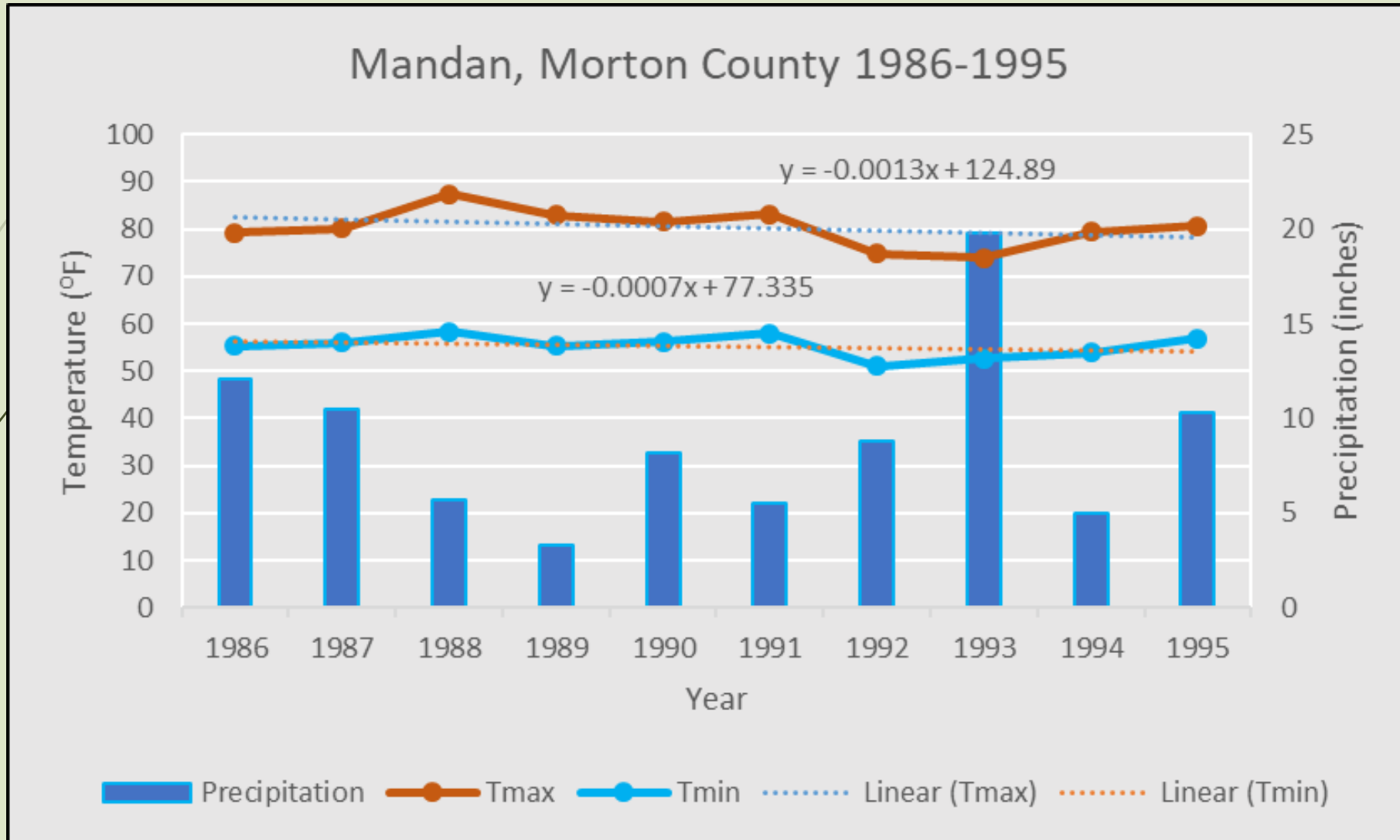
Sources: NOAA; USDA; NASS



Central North Dakota: Morton County

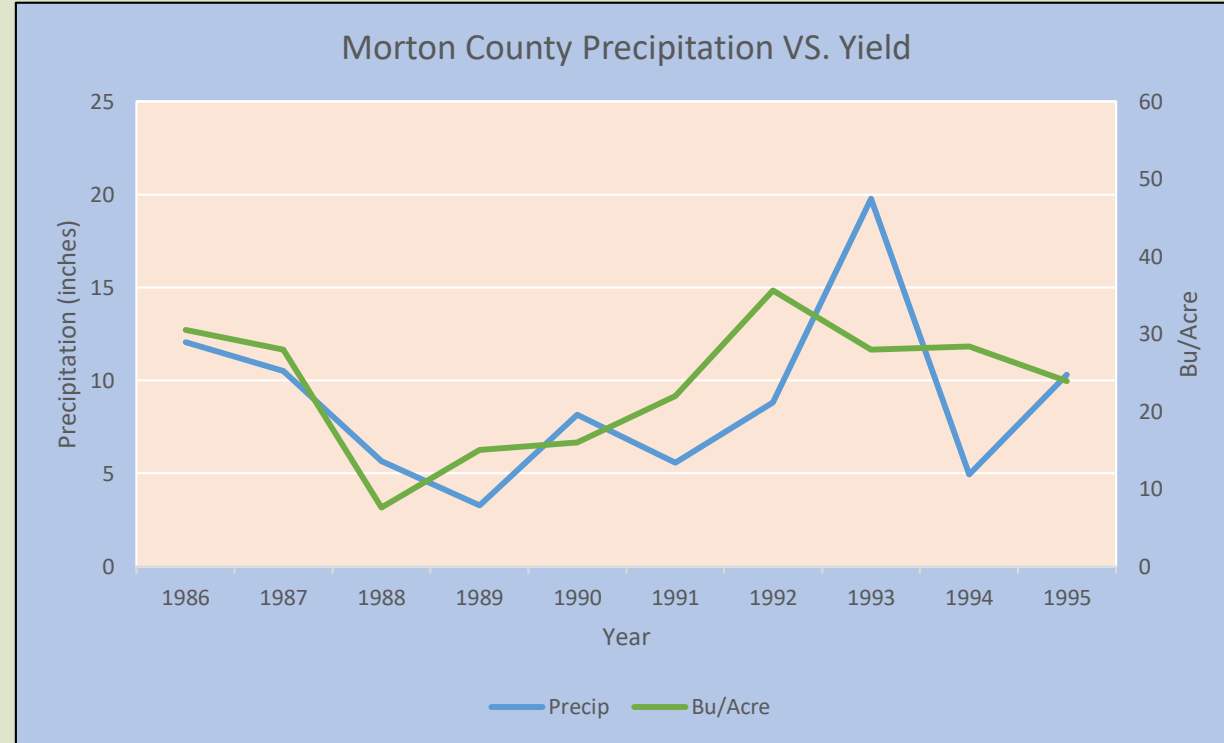
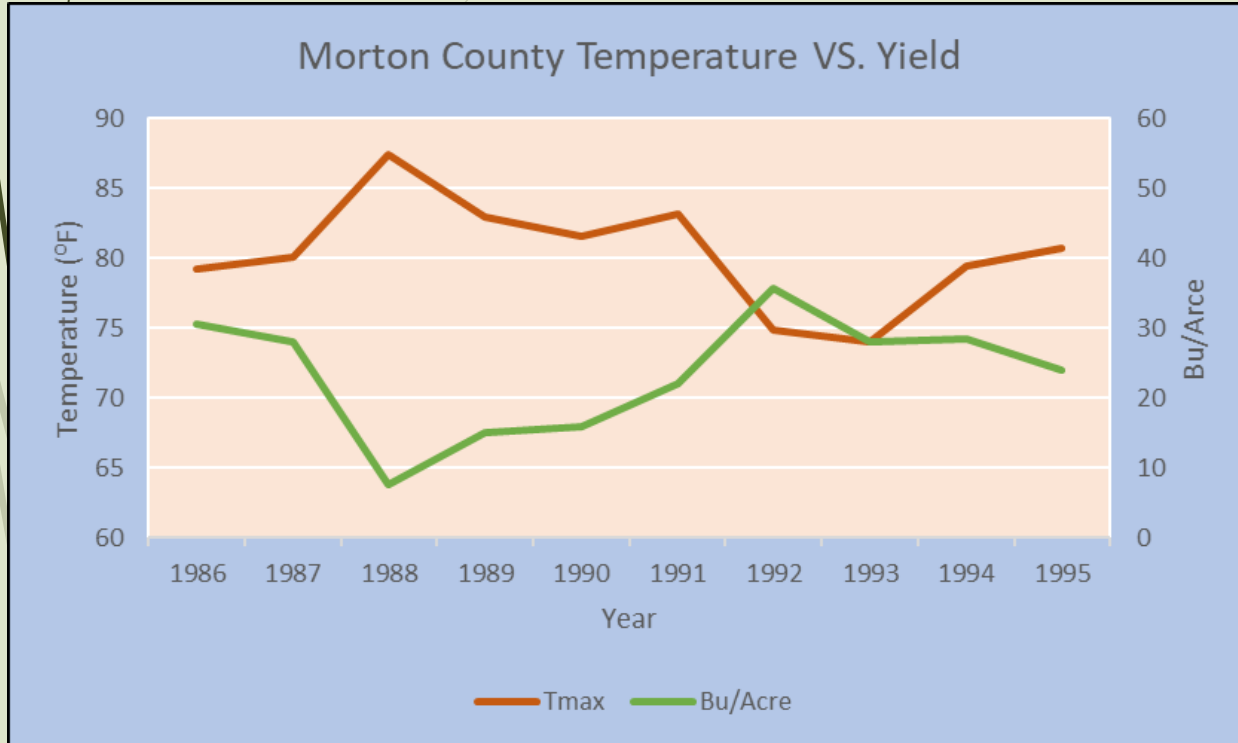
- Temperature
 - 82.3°F in the 1st period
 - 78.44°F in the 2st period
 - Precipitation
 - 39.64 inches 1st period
 - 49.4 inches 2nd period
 - Spring Wheat Yield
 - 19.42 (bu/acre) 1st period
 - 27.58 (bu/acre) 2nd period
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Central North Dakota: Morton County



Source: NOAA

Spring Wheat Yield

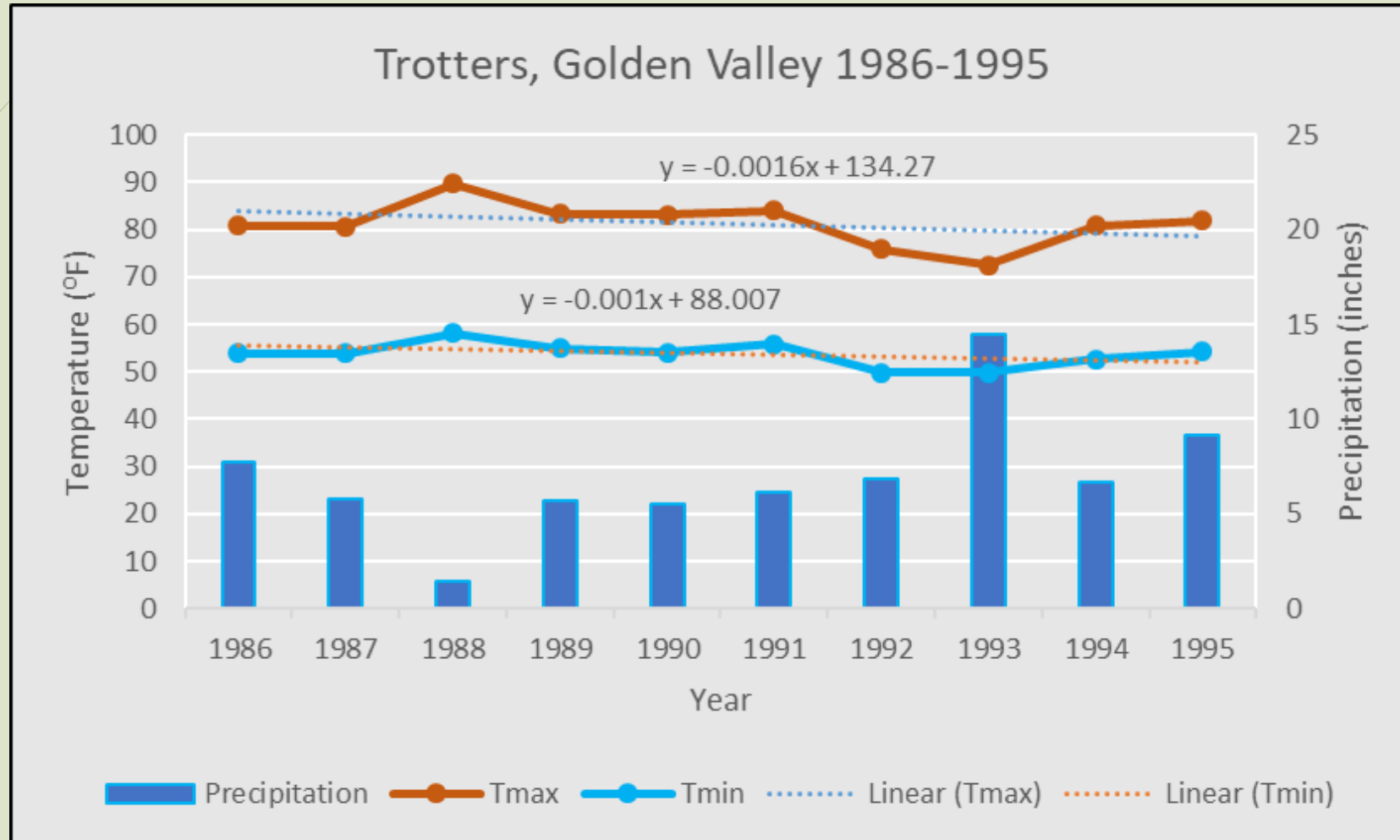


Sources: NOAA; USDA; NASS

Western North Dakota: Golden Valley County

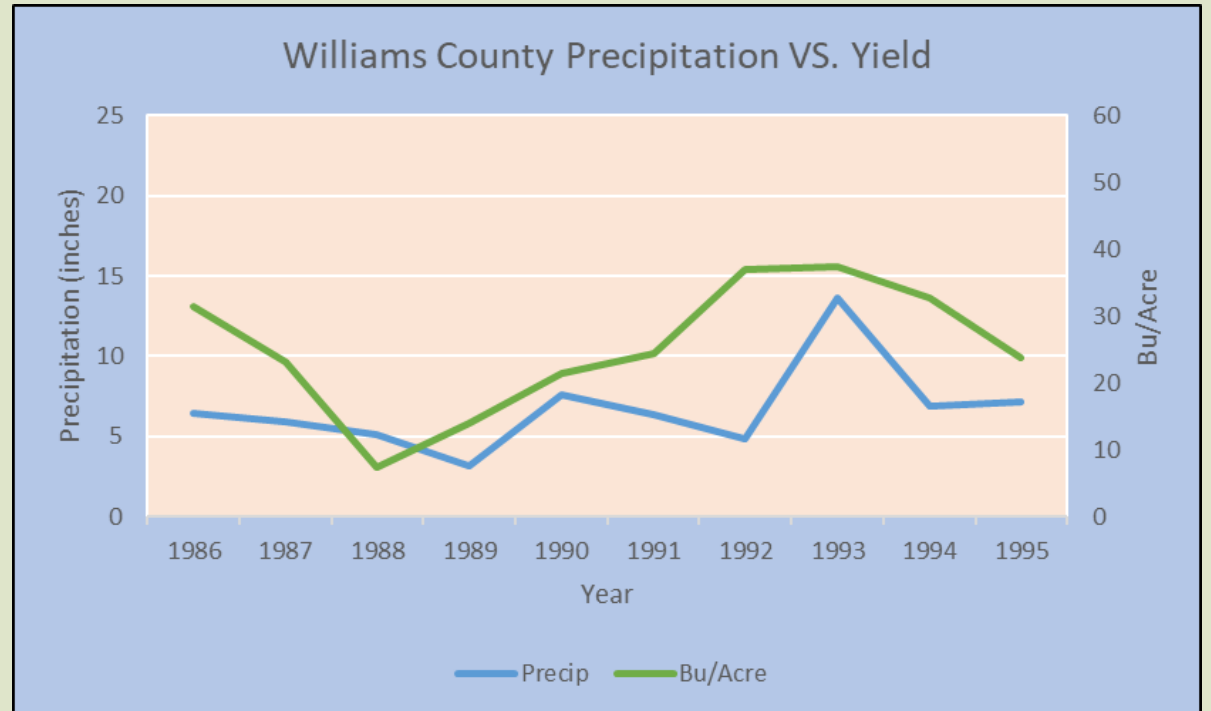
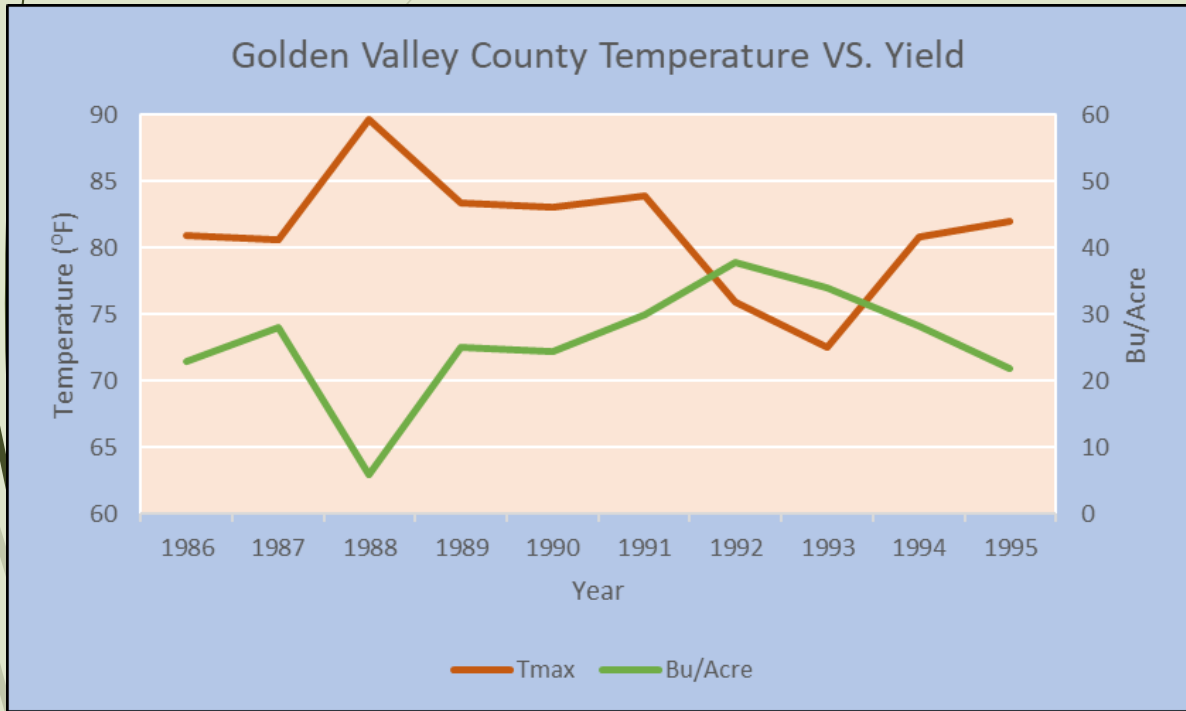
- Temperature
 - 83.5°F in the 1st period
 - 79.4°F in the 2st period
- Precipitation
 - 26.24 inches 1st period
 - 43.3 inches 2nd period
- Spring Wheat Yield
 - 21.3 (bu/acre) 1st period
 - 30.36 (bu/acre) 2nd period

Western North Dakota: Golden Valley County



Source: NOAA

Spring Wheat Yield

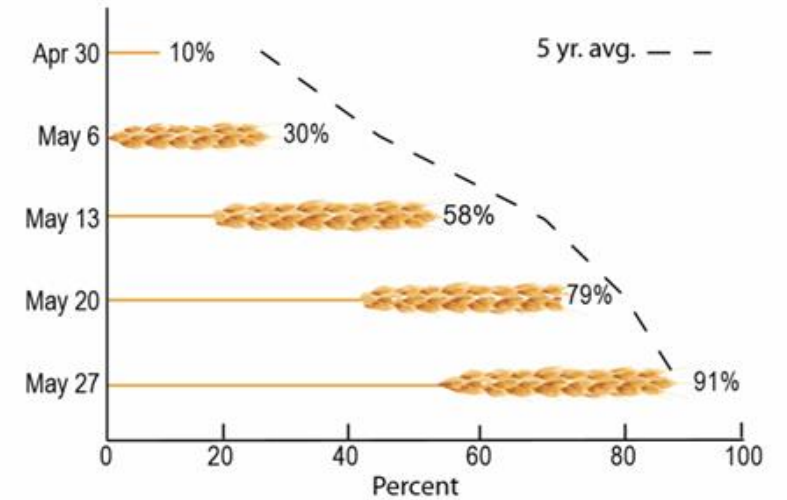


Sources: NOAA; USDA; NASS

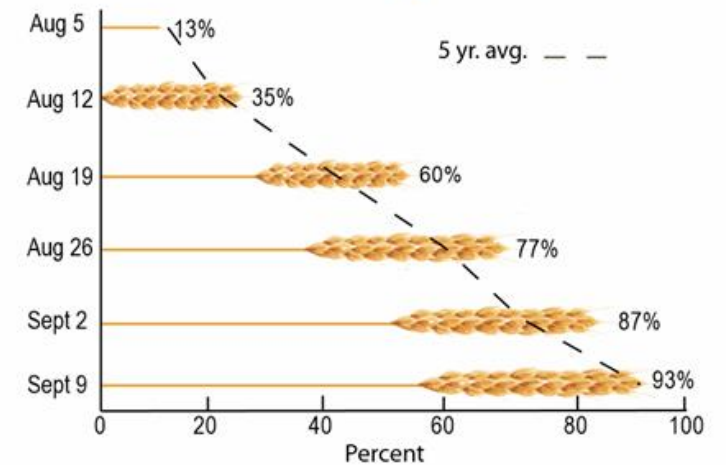
Discussion

- Optimum temperature
 - 75°F-77°F (25°C)
 - 37.4°F (3°C) to 39.2°F (4°C)
 - 86°F (30°C) to 89.6°F (32°C)
 - exceed 90°F
- Optimum precipitation
 - 14.7 inches (375 mm) to 34.4 inches (875mm)
- Optimum spring wheat yield
 - Average spring wheat yield 46 bu/acre (USDA 2016)
- Growing season
 - April to August

HRS Planting Progress



HRS Harvest Progress



Source: North Dakota Wheat Commission 2018

Counties	Weather Stations	Months	1988				1993			
			Days 90°F	Monthly Tmax	Precipitation (in)	Yield (bu/acre)	Days 90°F	Monthly Tmax	Precipitation (in)	Yield (bu/acre)
Grand Forks	Grand Forks	June	11	85.7	1.34	26.7	1	72.23	4.59	33
		July	9	86.4	3.73		0	74.41	7.49	
		August	4	83	1.34		1	77.77	4.9	
Cass	Fargo	June	13	87.63	1.24	19.1	0	73.5	4.28	32.3
		July	14	90.09	0.46		0	76	7.71	
		August	7	84.87	2.14		5	80.35	1.13	
McIntosh	Ashley	June	17	88.53	1.74	6	0	70.02	8.18	21.3
		July	17	89.67	0.38		0	73.54	7.6	
		August	10	85.45	1.57		1	77.09	4.73	
Bottineau	Bottineau	June	16	88	1.39	16.5	1	70.63	4.15	36.6
		July	8	83.29	2.34		0	70.12	5.27	
		August	6	81.8	1.36		1	75.09	3.14	
Stutsman	Jamestown	June	16	88.63	1.91	12.7	0	70.03	7.42	30.9
		July	18	90.87	1.58		0	72.87	11.06	
		August	9	84.38	1.31		3	77.19	2.32	
Morton	Mandan	June	21	91.1	0.91	7.6	1	71.03	4.48	28
		July	13	87.19	1.52		0	73.35	13.43	
		August	12	84.06	3.23		1	77.54	1.88	
Williams	Wildrose	June	14	88.9	1.93	7.5	1	68.6	3.19	37.3
		July	6	83.29	2.43		0	70.7	8.43	
		August	6	81.25	0.79		0	74.41	2.14	
McKenzie	Keene 3 S	June	22	92.26	2.67	9	2	70.63	4.6	36.6
		July	13	88.35	1.5		0	72.09	8.25	
		August	15	87.54	0.06		0	76.09	1.93	
Golden Valley	Trotters	June	21	92.63	0.98	6	2	70.06	4.75	33.9
		July	15	89.9	0.32		0	71.67	7.51	
		August	12	86.54	0.11		0	75.7	2.22	

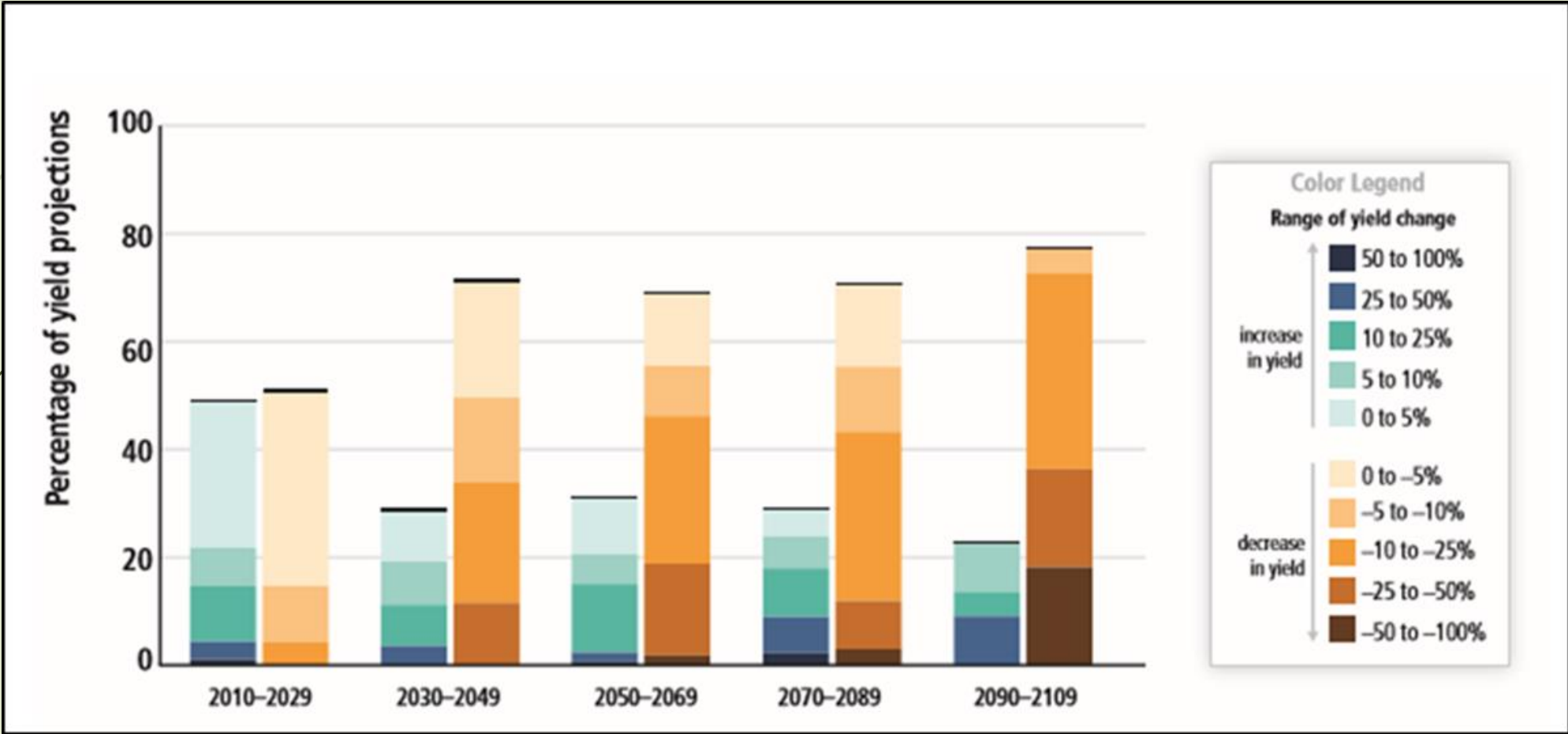
Summer 90 Degree Temperatures Versus Spring Wheat Yield

Nine Counties Two Critical Years 1988 and 1993

County	1919-1983 Average Yield (bu/acre)	1988 Average Yield (bu/acre)	1993 Average Yield (bu/acre)	2018 Average Yield (bu/acre)
Grand Forks	21.7	26.7	33.0	58.5
Cass	20.6	19.1	32.3	58.4
McIntosh	11.9	6.0	21.3	48.9
Bottineau	17.0	16.5	36.6	49.5
Stutsman	15.9	12.7	30.9	41.4
Morton	14.4	7.6	28.0	42.1
Williams	16.0	7.5	37.3	35.4
McKenzie	16.0	9.0	36.6	34.6
Golden Valley	15.7	6.0	33.9	38.8

Sources: Campbell 1987; USDA National Agricultural Statistic Service 2018;
and North Dakota Wheat Commission 2019

Future Risks and Impacts



Source: Summary for Policymakers: IPCC 2014 Report

Conclusion

- ▶ Both temperature and precipitation extremes are harmful to spring wheat yield in North Dakota
 - ▶ Higher temperatures worse impact than heavier precipitation
- ▶ Ramifications for Population
 - ▶ 2012 the world population reached 7.7 billion
 - ▶ 2050 projected to reach 9.8 billion
- ▶ Food demand will increase
- ▶ Options to meet food demand are on a spectrum of choices
 - ▶ Bayer pharmaceutical company
 - ▶ No-till farming with some chemical inputs
 - ▶ Organic farming
 - ▶ **Middle Road Sustainable farming practices now are most needed to address present climate changes most successfully for North Dakota spring wheat future production!**

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Questions and Answer

Thank you