

Corn Production and Climate Variability in the Cumberland Valley, Pennsylvania



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I. Introduction

- Pennsylvania Farms
  - 52,000 farms; 7.3 million acres
  - $84 billion; 280,500 jobs
  - 118 million bushels of corn/year
- Analysis
  - 1960-2022
  - Corn yield data detrended due to agricultural advancements

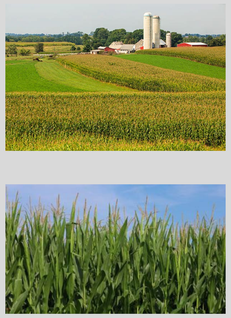


Figure 1. Cumberland Valley corn.

II. Study Area

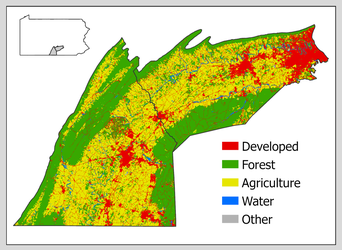


Figure 2 . Land use designations in the Cumberland Valley, Franklin and Cumberland counties, Pennsylvania.

Each county is about 50% agriculture with 170,000 and 242,600 acres of farmland, respectively.

III. Corn yield Correlations

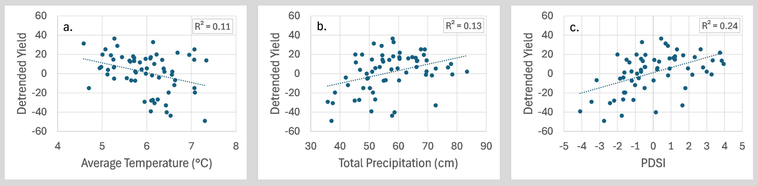


Figure 3. Scatter plots of seasonal a. average temperature, b. total precipitation, and c. average PDSI versus detrended corn yield.

Table 1. Monthly and seasonal correlation values between corn yield and temperature, precipitation, and PDSI. Shaded values are significant at $p < 0.05$.

	Apr	May	Jun	Jul	Aug	Sep	Seas
Temperature	0.09	-0.11	-0.13	-0.21	-0.46	0.01	-0.33
Precipitation	-0.06	0.16	0.29	0.16	0.18	0.24	0.36
PDSI	0.23	0.33	0.41	0.61	0.62	0.33	0.49

- PDSI correlations with corn yield stronger than temperature or precipitation.
- July and August most important months.

IV. PDSI Correlations

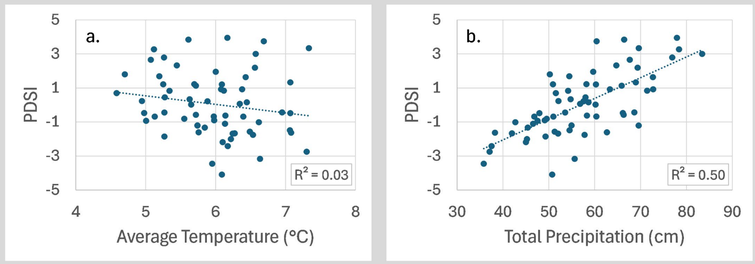


Figure 4. Scatter plots of seasonal a. average temperature and b. total precipitation versus PDSI.

Table 2. Monthly and seasonal correlation values between PDSI and temperature and precipitation. Shaded values are significant at $p < 0.05$.

	Apr	May	Jun	Jul	Aug	Sep	Seas
Temperature	-0.11	-0.07	-0.03	-0.22	-0.22	-0.01	-0.18
Precipitation	0.56	0.55	0.68	-0.04	0.50	0.19	0.71

- Precipitation more correlated than temperature with PDSI; especially early in growing season.
- July, August temperature correlations indicate impact of decreased soil moisture on PDSI.

V. Top/Bottom 10% Corn Yield Years

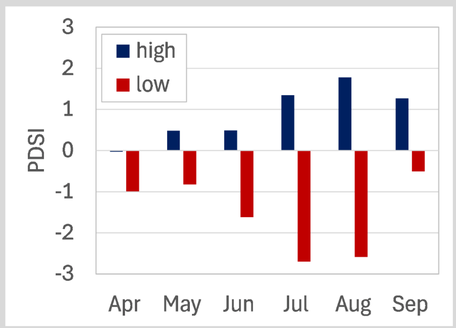


Figure 5. Monthly average PDSI for 10% highest and lowest detrended corn yield years.

For Figure and Table
High years = 2021, 2017, 2000, 1985, 1970, 1967.
Low years = 2011, 2002, 1999, 1991, 1988, 1983.

	High	Low
Detrended Yield Average	30.0	-39.3
Yield Average (bu/a)	131	65
Temperature Average (°C)	19.8	20.7
Precipitation Total (cm)	59.7	52.6
PDSI Average	0.9	-1.6

Table 3. Seasonal average and totals of temperature, precipitation, and PDSI for 10% highest and lowest detrended corn yield years.

- High yield years are cooler, wetter, and higher PDSI.
- July and August differences are largest.

VI. Atmospheric Composites

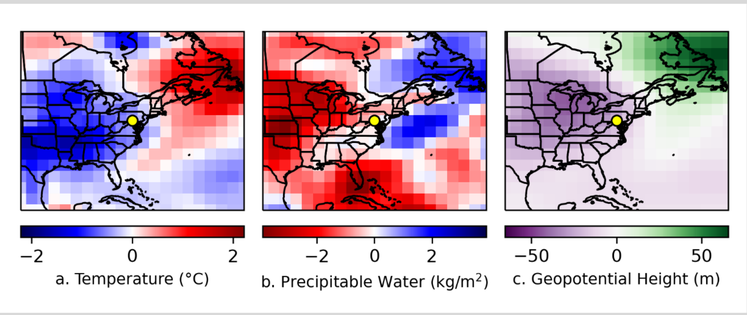


Figure 6. August composite maps of a. temperature, b. precipitable water, and c. 300 hPa geopotential height for differences between high and low corn yield years. The yellow point indicates the study location.

- High years cooler in July and August.
- Cooler temperatures from lower 300 hPa heights.

VII. Economic Analysis

	Gross	Net
2022 Yield	$13,637,033	$1,518,895
5% Yield Increase	$14,318,885	$2,200,746
10% Yield Increase	$15,000,736	$2,882,598
15% Yield Increase	$15,682,588	$3,564,450
5% Yield Decrease	$12,955,181	$837,043
10% Yield Decrease	$12,273,330	$155,191
15% Yield Decrease	$11,591,478	$-526,660

Table 10. Profits based on assumed corn yields and values from 2022 data USDA/NASS.

- Economics tied to corn yield and climate variability.

VIII. Summary

- PDSI most correlated with corn yields; especially July and August.
- Precipitation more correlated with PDSI. July and August temperature important too.
- Highest corn yield years driven by lower heights ushering cooler air in July and August.

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