Impact of the **Gannon** Storm on **Corn**

Economic Assessment of **Agricultural** Production and Revenue **Losses** due to **GNSS** Signal Degradation

SpaceWx Economics

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Introduction

During GNSS signal degradation, farms using **precision agriculture** to perform critical field operations are disadvantaged especially planting. In 2024, 90.6M acres of **corn** (*Zea mays* L.) were planted in the USA valued at $73.9B (USDA NASS, 2025). Calculations for Illinois are demonstrated then applied to **12 Midwestern states** (Figure 1).

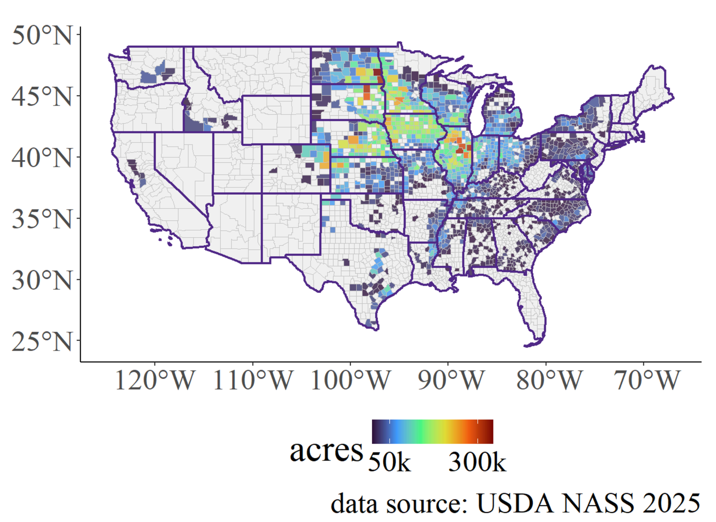

Figure 1: planted acres, corn

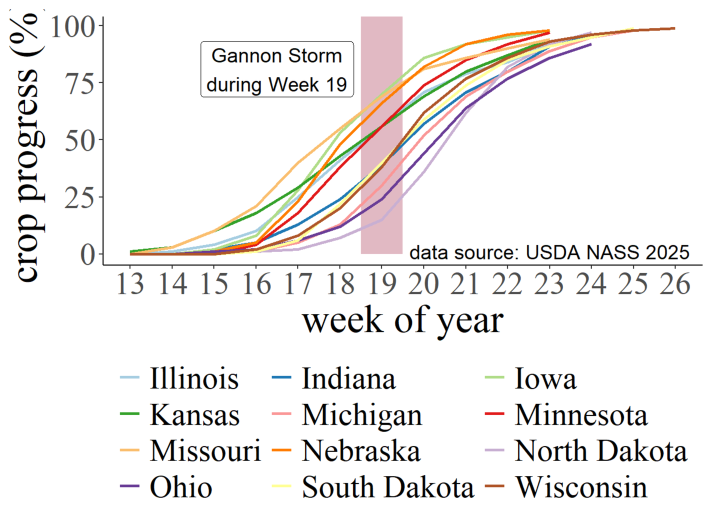

Figure 2: planting progress, corn

Data and Methods

The **Gannon Storm** occurred during active corn planting (Figure 2). Acreage adversely affected by GNSS signal degradation were calculated for representative farms then extrapolated to the state. Foregone bushels due to **delayed planting** were estimated using yield penalties for displaced acres, acres displaced per hour, and duration of outage.

$$\frac{bu}{ac} \times \frac{ac}{hr} \times \frac{hr}{\text{outage}} = \frac{bu}{farm}$$

Corn planted Week 19, 20, 21, and 22 had 98%, 94%, 84%, and 74% potential yield. **4-year average** Illinois corn yield is **203 bu ac^{-1}**; acreage planted Week 19 is 199 bu ac^{-1} (203 bu $\times$ 98% = 198.9 bu). If planted Week 22, 150 bu (203 bu $\times$ 74% = 150.2 bu); with **delayed planting yield penalty** of 49 **bu ac^{-1}** (198.9 bu - 150.2 bu = 48.72 bu).

Displaced acreage is calculated using **effective field capacity** (ac hr^{-1}), a function of speed (6.25 mph), width (40 ft), and field efficiency (70%). Because of GNSS, planters became wider due to physical markers not required (Figure 3). A **16-row 40-ft** planter covers **21.2 ac hr^{-1}**.

$$\frac{6.25 \text{ mph} \times 40 \text{ ft} \times 70\%}{8.25} = 21.2 \text{ ac hr}^{-1}$$

Subsets of all farms, farms$_t$, relying upon GNSS were considered.

$$\text{farms}_t \times \% \text{ adoption} = \text{farms}_p$$

where % adoption is uptake rate, and farms$_p$ are precision farms defined as having GNSS navigation (McFadden et al., 2023).

The **market share** of differential correction systems **vulnerable** to GNSS signal degradation, % DGPS, is likely within the interquartile range.

$$\text{farms}_p \times \% \text{ DGPS} = \text{farms}_a$$

where farms$_a$ is **adversely affected farms**. Potential foregone bushels were summed across affected farms for each state.

$$\frac{bu}{farm} \times \frac{farms_a}{state} = \frac{bu}{state}$$

Value of foregone bushels were calculated using **$4 bu^{-1}** sales price.

$$bu \times \$ \text{ bu}^{-1} = \text{ total } \$$$

Figure 3. imagine making parallel passes without markers or GNSS!

Results and Discussion

The impact of the Gannon Storm on corn production was sensitive to planter capacity, differential correction, and when displaced acreage planted. Estimates ranged from **$70M** to **$1.7B**. Upper bound of **vulnerable 16-row precision farms** are reported in **Table 1**.

Up to 18,040 Illinois precision farms relied upon vulnerable correction systems, with an expected loss of **$16k per farm**. If planting delayed to Week 22, 74.5M bu valued at $298M was foregone. Summing across the 12 Midwestern states, **424M bu** valued at **$1.7B** were foregone.

Evaluating **25%** lower bound of precision farms with **12-row** planters indicated a loss of **17.4M** to **105.9M bu** valued at **$69.6M** to **$423.6M**.

Analysis procedures using **publicly** available data were demonstrated so interested enthusiasts may enter parameters to arrive at their own conclusion. For additional details, more scenarios, and a citable form of this poster, see Griffin et al. (2025) available on AgManager.info.

Table 1: losses due to delayed corn planting on vulnerable farms

		bushels (millions)			revenue ($ millions)		
	affected farms	Week 20	Week 21	Week 22	Week 20	Week 21	Week 22
Illinois	18,040	12.4	43.5	74.5	$50	$174	$298
Indiana	6,170	4.1	14.2	24.4	$16	$57	$98
Iowa	20,148	13.4	46.9	80.4	$54	$188	$322
Kansas	11,370	4.9	17.1	29.4	$20	$68	$118
Michigan	2,913	1.6	5.7	9.8	$6	$23	$39
Minnesota	12,867	8.2	28.6	49.0	$33	$114	$196
Missouri	5,444	3.0	10.4	17.8	$12	$42	$71
Nebraska	11,379	6.9	24.3	41.7	$28	$97	$167
North Dakota	11,190	4.9	17.1	29.4	$20	$68	$118
Ohio	8,791	5.6	19.5	33.5	$22	$78	$134
South Dakota	5,582	2.7	9.6	16.5	$11	$38	$66
Wisconsin	4,841	2.9	10.2	17.4	$12	$41	$70
Total	**118,735**	**70.6**	**247.1**	**423.8**	**$282**	**$988**	**$1,695**

16-row planter, 4-hr downtime, $4 per bushel, 75% vulnerable precision farms
delay relative to planting 10 May 2024 (Week 19)

Although **unprecedented** during the **precision agricultural era**, events similar to the Gannon Storm may occur during descending phase of Solar Cycle 25 or near apex of Solar Cycle 26.

Future Work

- update with precise **duration** and **location** of GNSS signal degradation
- repeat analysis for **peanuts** (*Arachis hypogaea* L.) and other crops
- valuation of foregone georeferenced **sensor data**
- joint utility and **quality-of-life** implications of rural household

Acknowledgements and Bio

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Griffin is Professor and Extension **Precision Agriculture Economist** at Kansas State University. He is a member of the White House Office of Science and Technology Policy Space Weather Advisory Group (**SWAG**) where he estimates economic damages associated with space weather events in agriculture, construction, drilling, and mining.

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