Assessment of the Agricultural Risk of Temporary Water Storage for FM Diversion

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FM Diversion Authority

Land Management Committee Meeting

NDSU NORTH DAKOTA STATE UNIVERSITY

Research Question and Scope

- Issue: How would temporary water storage affect crop production and agricultural revenues?

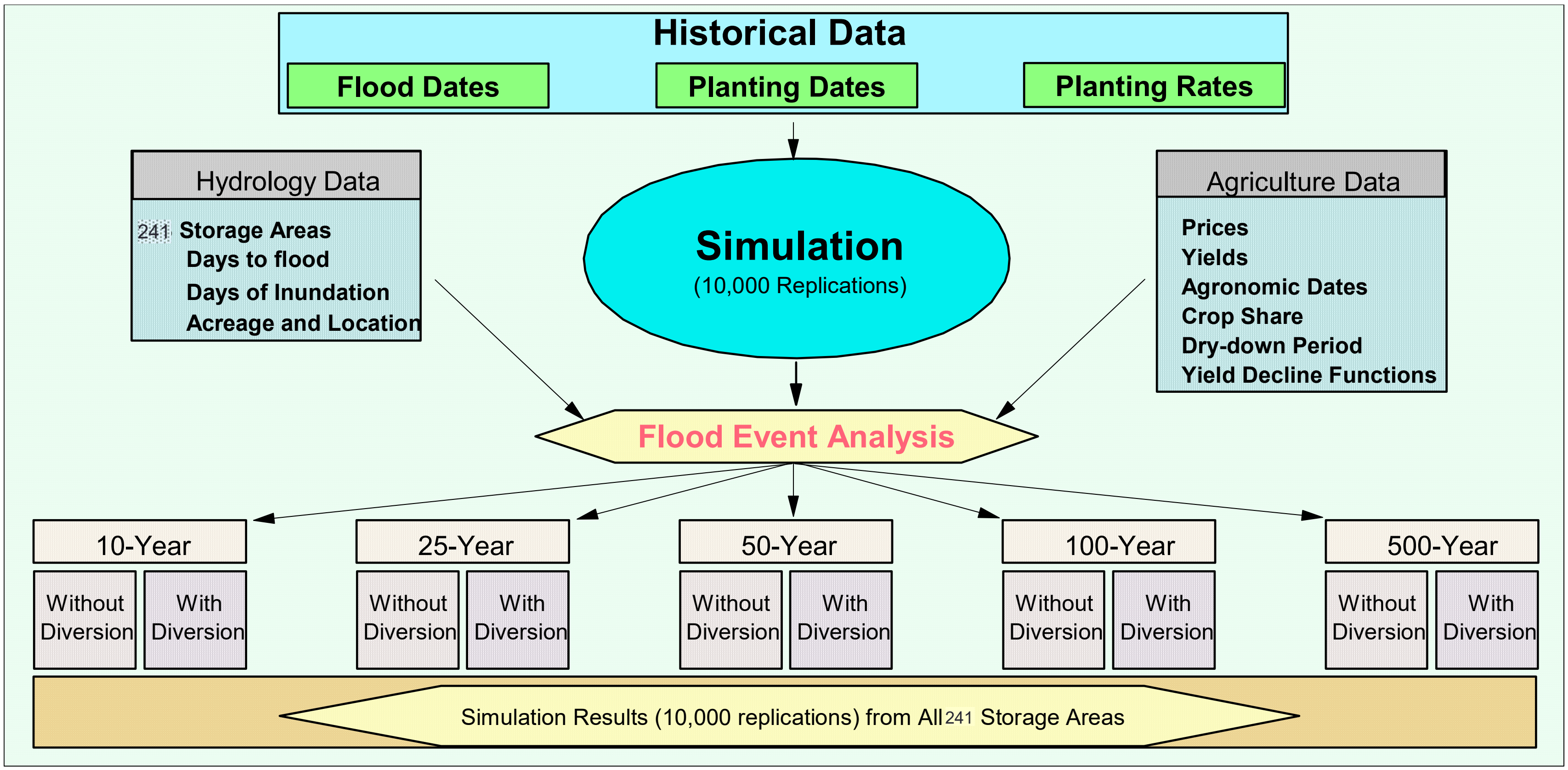
- Study Focus: Examined planting delays caused by Diversion
  - Frequency—likelihood or probability of planting delays
  - Magnitude—what would be the revenue losses
  - Geography—how effects vary among storage areas

- Previous Work: Provided insights on how the effects of flooding align with regional planting, which increased the understanding of how Diversion may impact planting delays

Analytical Outline

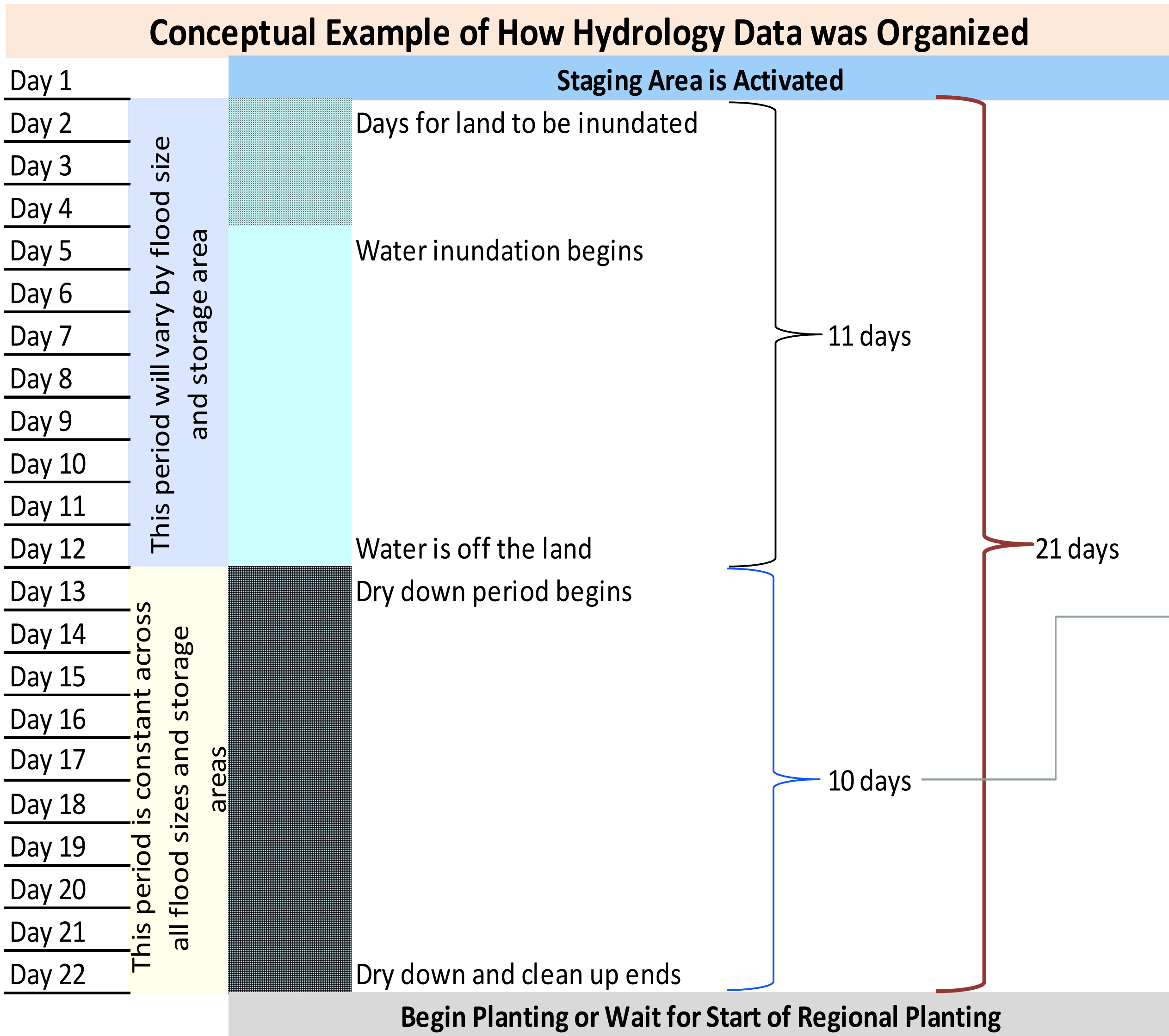
Modeling has Remained Consistent Across All Studies

Key Components		
Hydrology	Historical Data	Economic Factors



Evaluation of Hydrology Data from Perspective of Ag Producers

(components that vary by size of flood)



Timeline

NDSU study links hydrology data from staging activation, with a dry down period, to estimate when the effects of inundation are gone.

Dry Down Period

This study used both **10-day** and **14-day** periods. Previous studies only used a 10-day period.

Separate evaluations for **Without** and **With Diversion** Conditions

Hydrology Effects With and Without Diversion

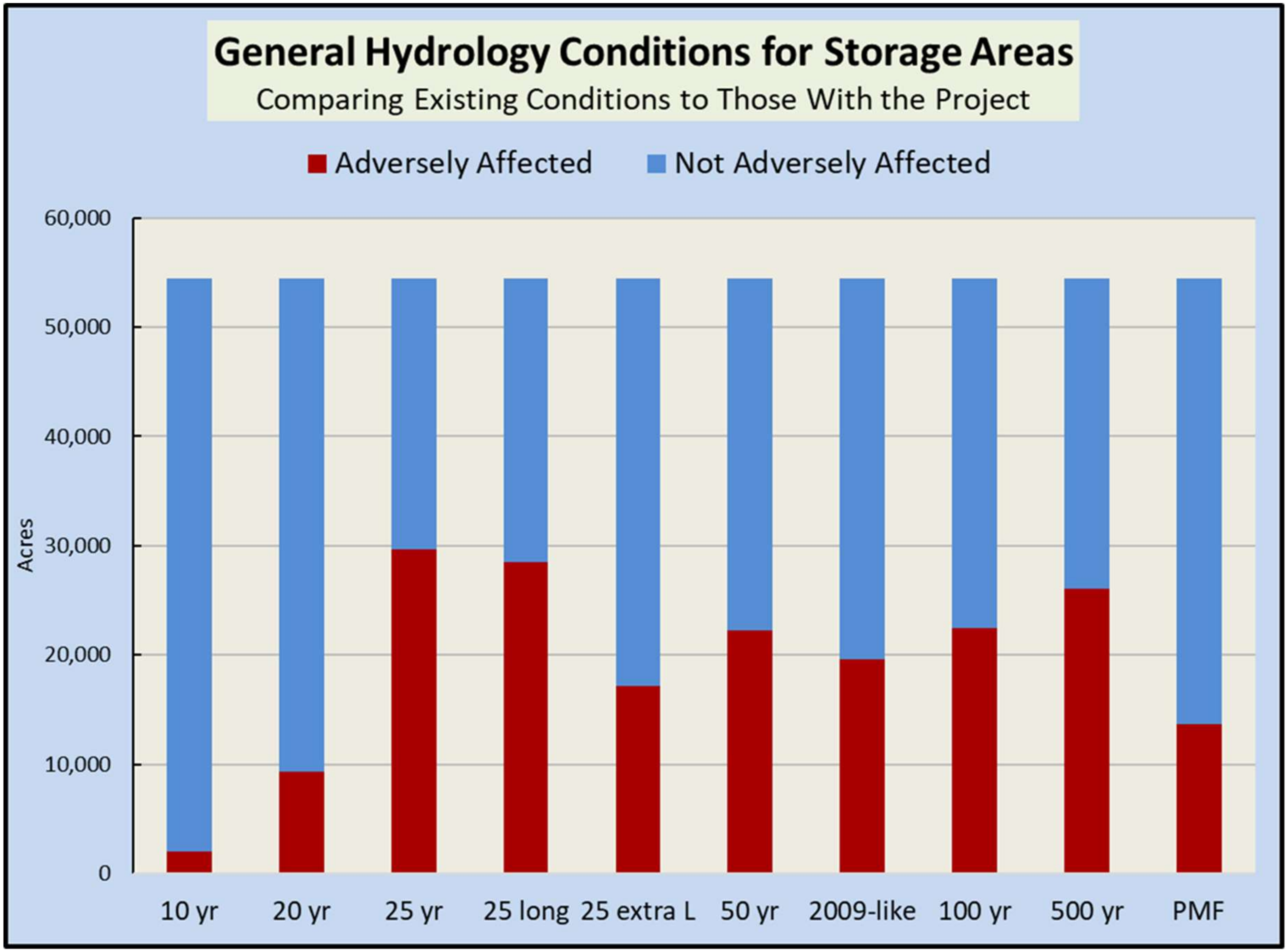
Identified five conditions:

- Group 1 - Land that **does not flood**
- Group 2 - Land already floods, but **floods same duration**
- Group 3 - Land already floods, but **floods longer****
- Group 4 - Land already floods, but **floods shorter**
- Group 5 - Land that would not flood, **but now floods (new flooding)****

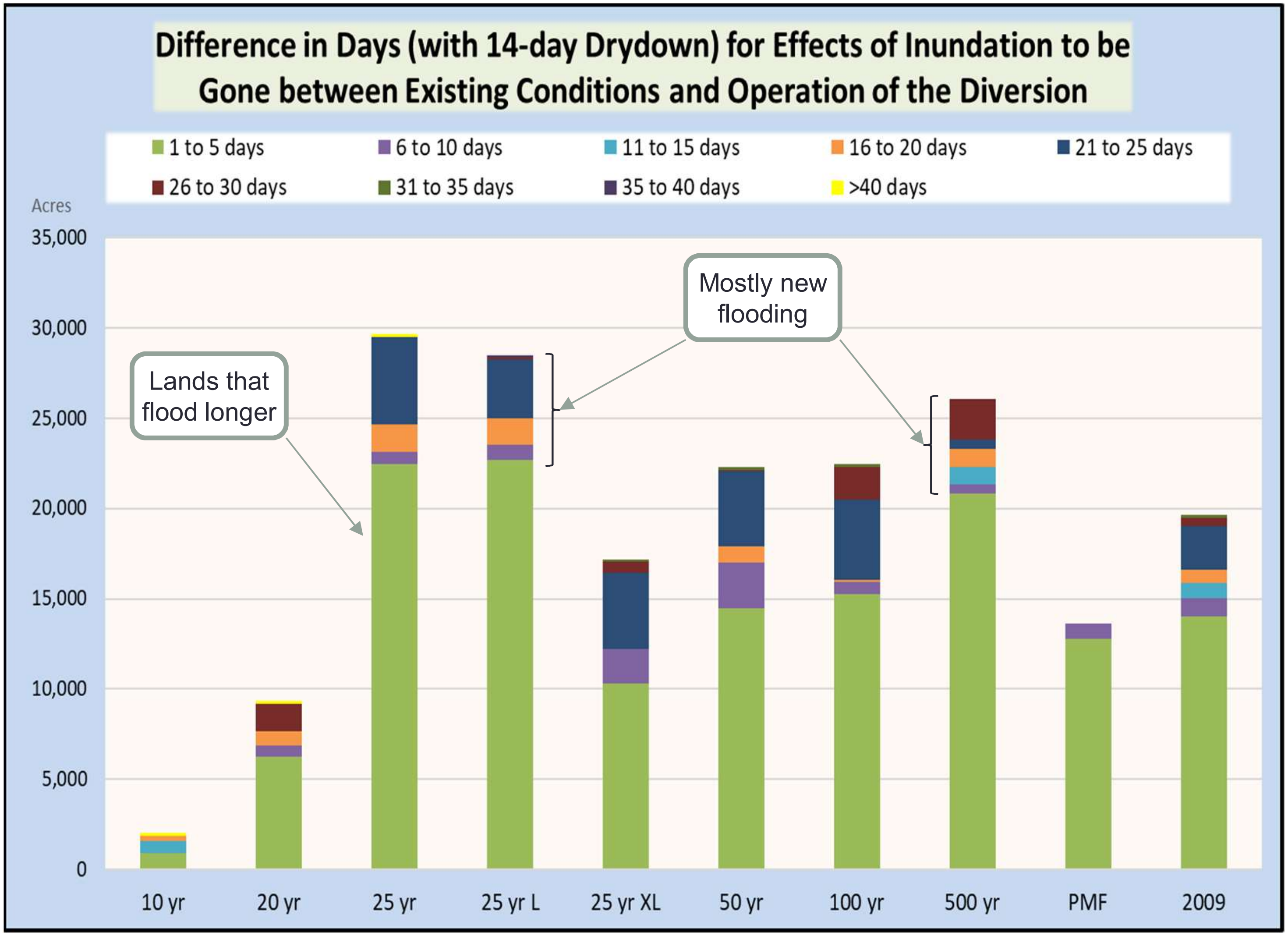
Hydrology effects vary among the 241 storage areas across all 10 flood events -- complicates reporting of results.

Type of flooding does not necessarily correlate with duration of inundation.

** Storage areas adversely impacted by FM Diversion



General Hydrology Conditions for Storage Areas
Comparing Existing Conditions to Those With the Project
Adversely Affected
Not Adversely Affected
Acres
60,000
50,000
40,000
30,000
20,000
10,000
0
10 yr
20 yr
25 yr
25 long
25 extra L
50 yr
2009-like
100 yr
500 yr
PMF



14-day dry down presented, 10-day dry down would reduce impacts for some lands.

The “1 to 5 days” acres already flood without Diversion, so dry down periods affect W and WO conditions equally.

Most of the other lands will experience new flooding, and dry-down requirements are new additions to the time for effects of flooding to be over.

Simulation Elements

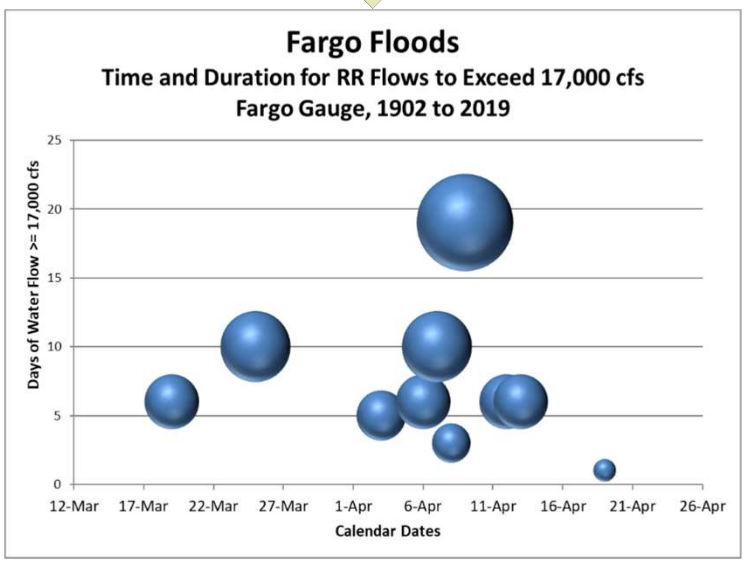
(key components that vary based on historical, weather-related data)

Flood Dates Associated with Staging Area Activation

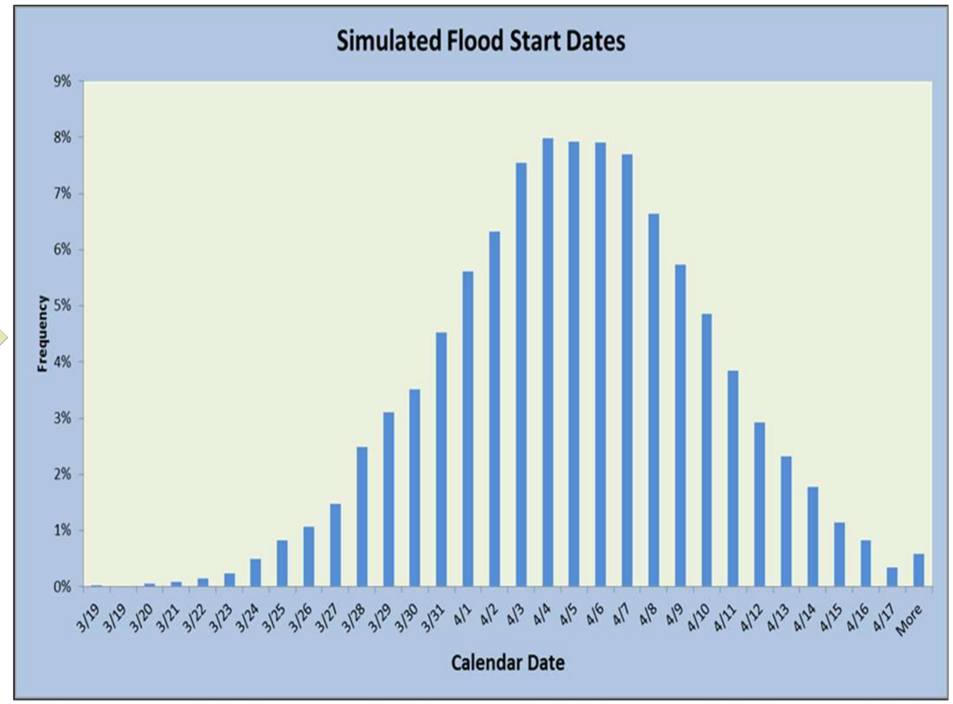
(historical data used to produce a range of outcomes)

Historical Data

Flood Dates | **Planting Dates** | **Planting Rates**



Source: U.S. Geological Survey.



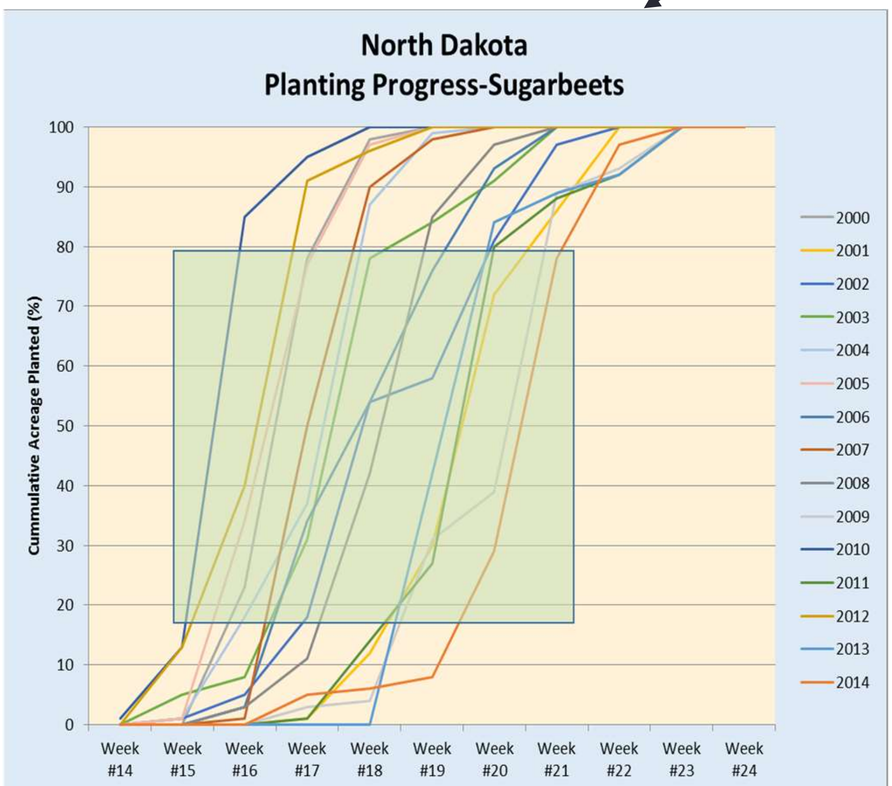
Point of Clarification: Staging activation threshold will be 21,000cfs in Fargo. The 21,000cfs threshold has occurred only 5 times, whereas, the 17,000cfs has been observed 10 times. The average difference between those thresholds is 2 days later for 17,000cfs. The analysis used the 17,000cfs threshold for generating the distribution of staging activation dates in the simulation.

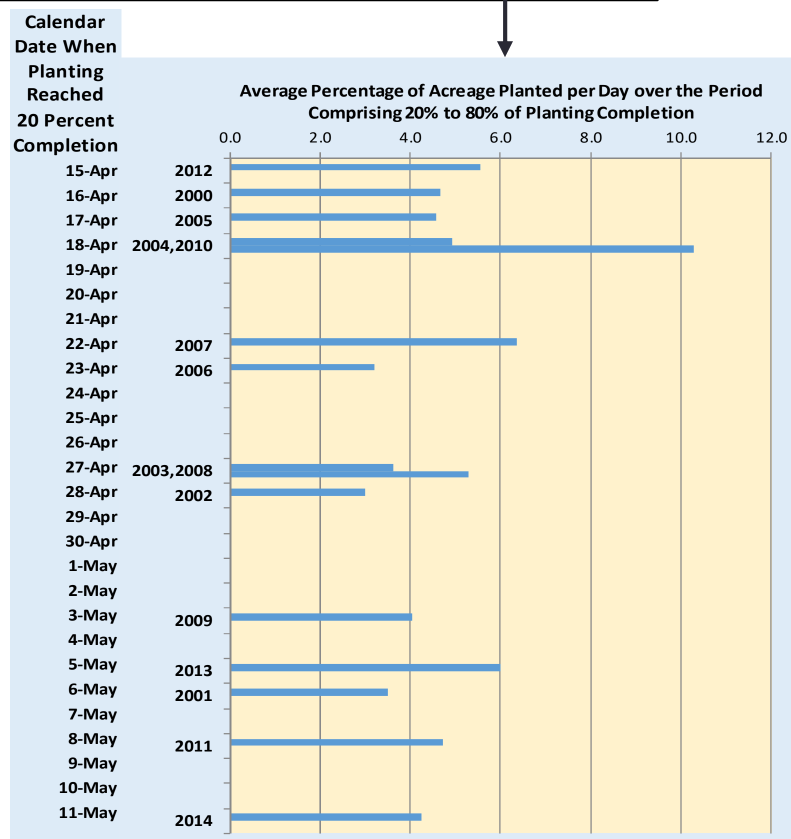
Planting Dates and Planting Rates

(historical data used to produce a range of outcomes)

Historical Data

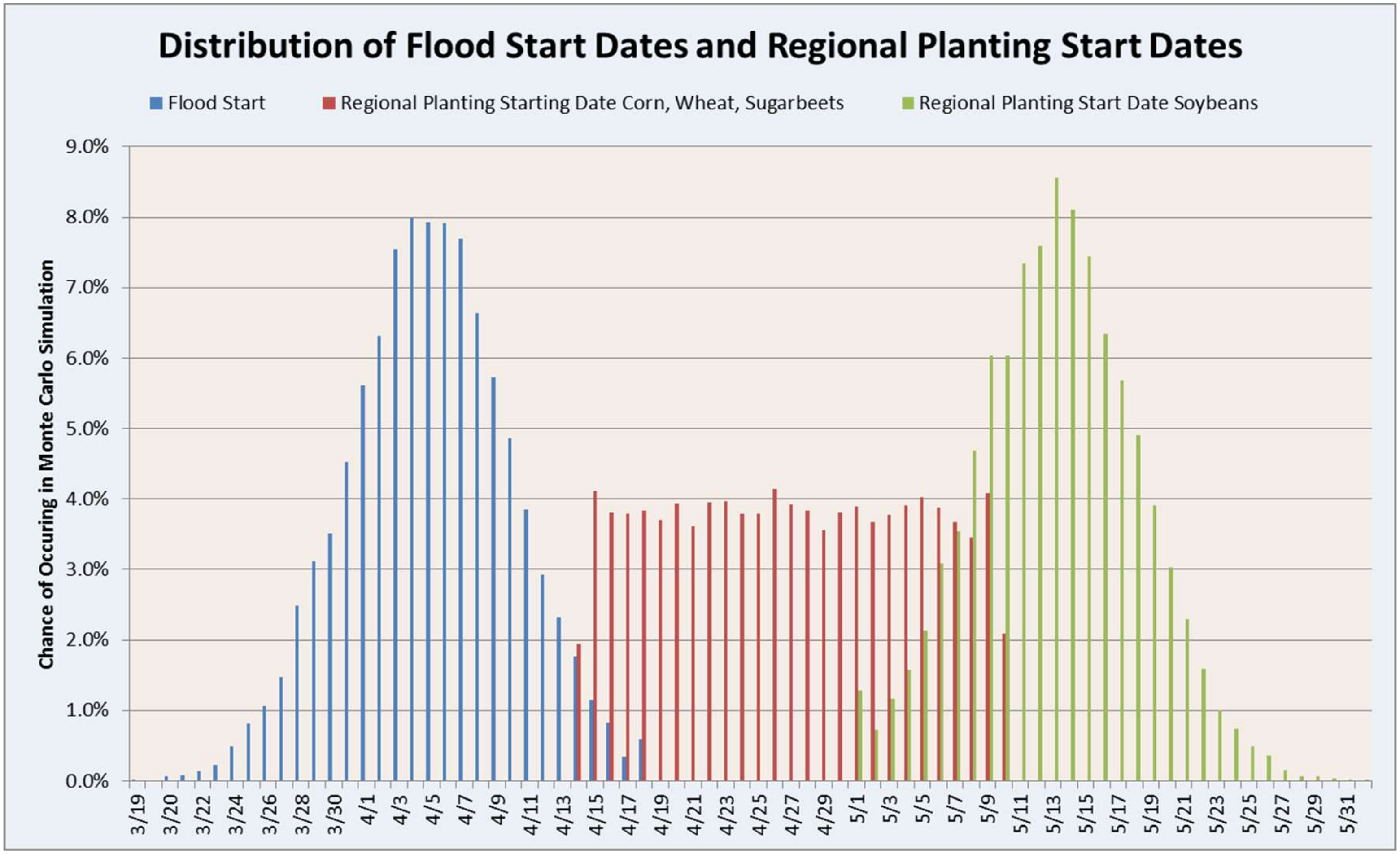
Flood Dates | **Planting Dates** | **Planting Rates**





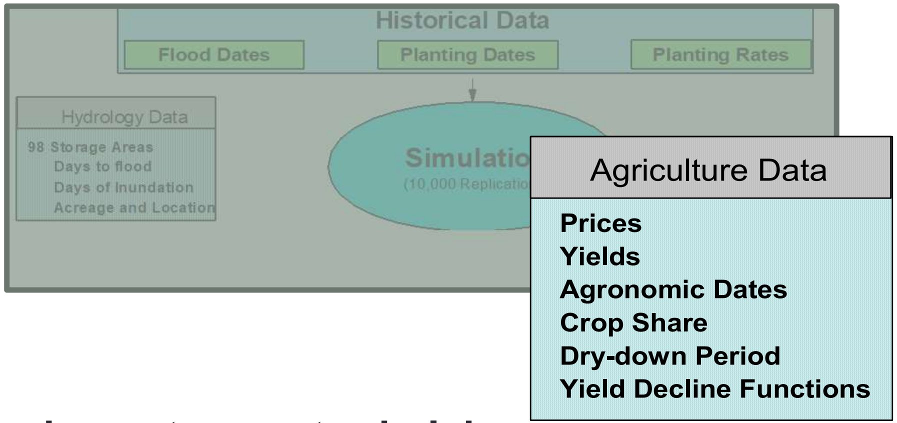
Sources: National Agricultural Statistics Service; input from Producer Focus Group.

Flood Start and Planting Start Dates
Distributions from Existing Data (simulation)



Point of Clarification: while the statistical distributions resulted in overlap between flood start dates (blue) and regional planting start dates (red), the model did not allow those combinations in the analysis.

Agricultural Production Factors

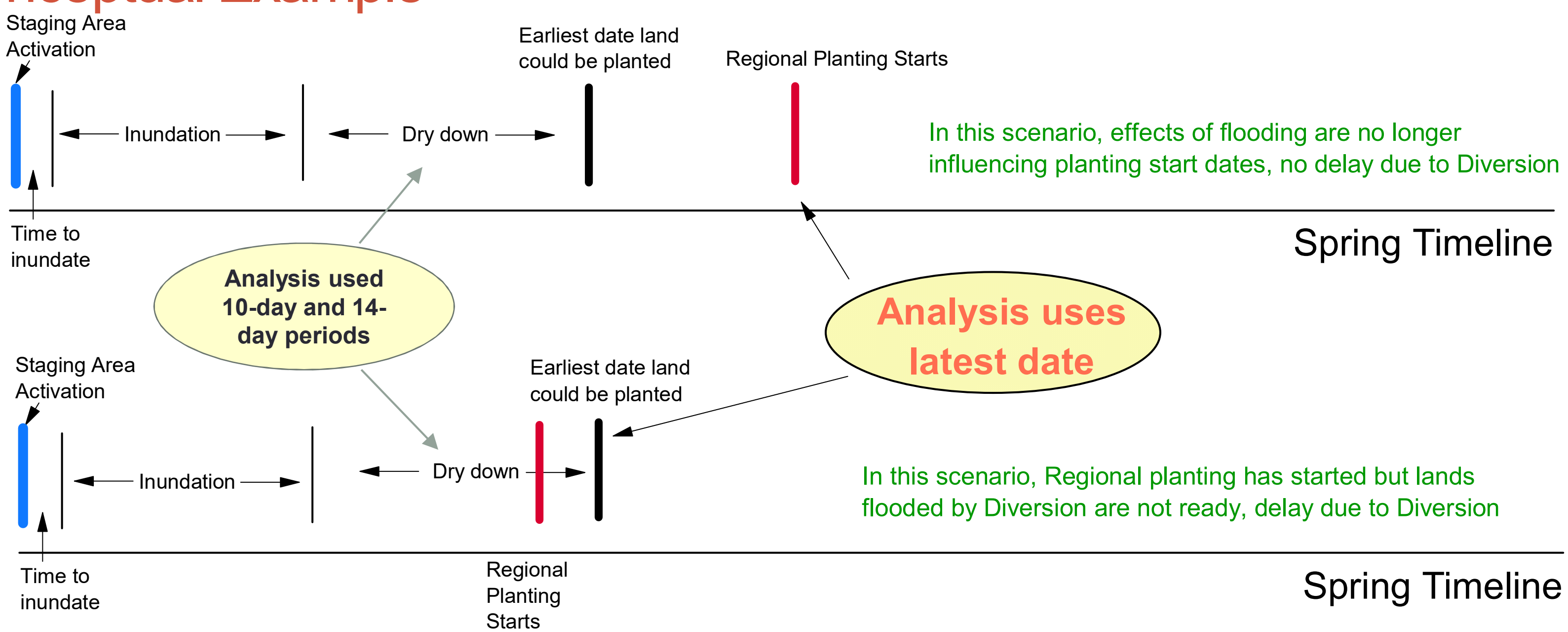


- Yield reduction functions based on <u>target</u> yields
  (estimate yield loss associated with delayed planting)
- Agronomic dates - periods with best yields, periods with declining yields, time to switch crops, prevent plant
- Crop prices (7-yr Olympic average)
- Crop percentages (corn, wheat, sugarbeets, soybeans)
- Key factors developed/vetted with collaboration from NDSU specialists and producers in focus group meeting

How Does the Analysis Work

Selecting a Planting Date

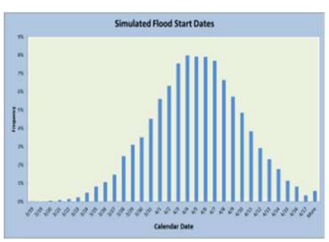
Conceptual Example



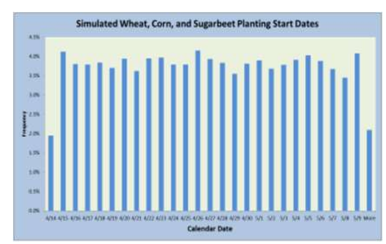
Staging area activation (flood start) varies in the study simulation

Earliest date when land <u>may</u> be ready to plant driven by <u>hydrology</u> and <u>flood start</u>

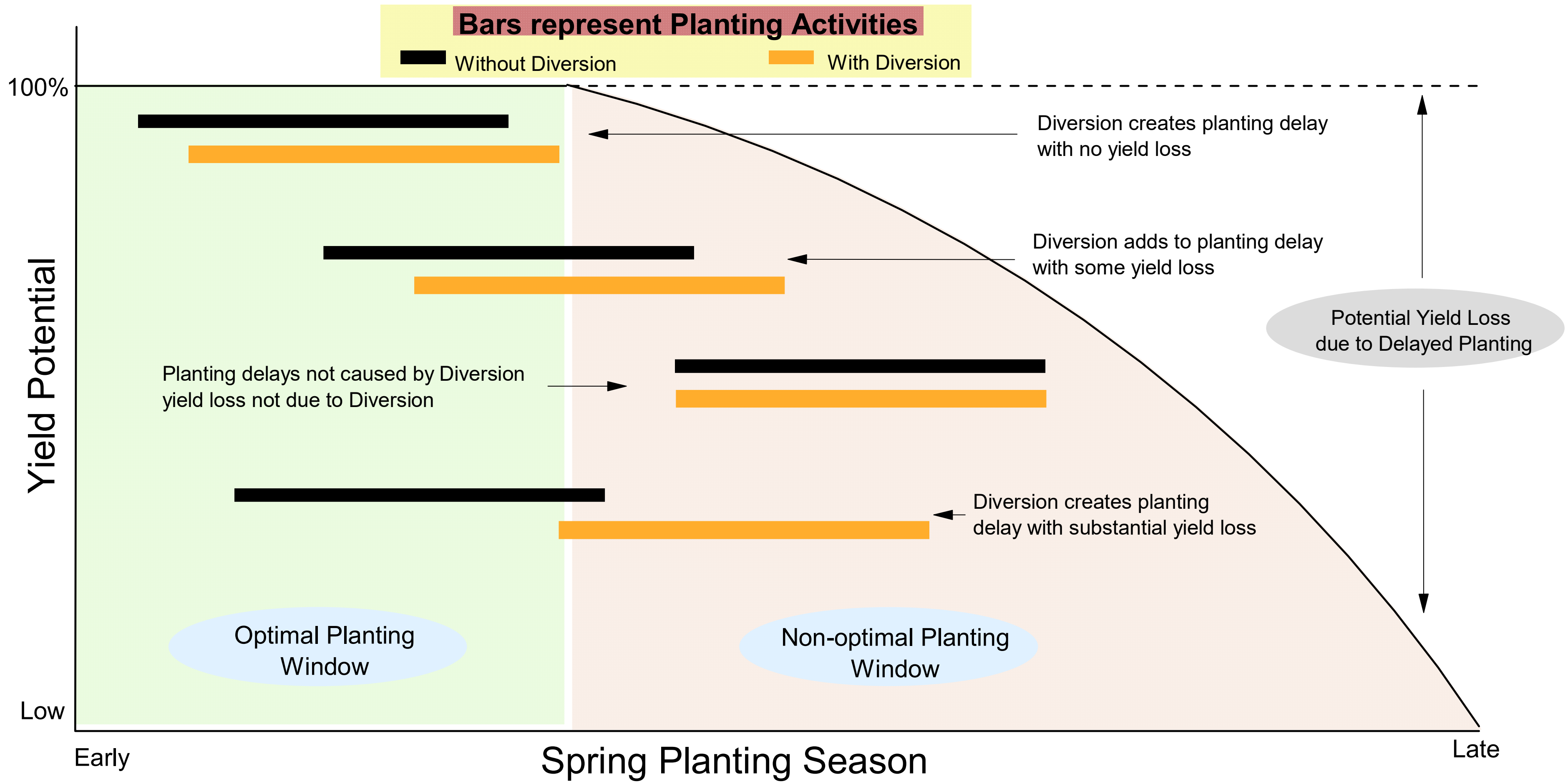
Regional planting start dates vary in the study simulation



These distributions are independent of each other



Examples of Variability in Delays and Effects



Probability and Magnitude of Planting Delays and Reduction in Producer Revenues

High Probability of Revenue Loss (average of all crops)

Storage Areas that Flood Longer (group 3)						
		Average of Storage Areas within the Hydrology Group (based on 10,000 simulations)				
		25-Year	25-Year XL*	50-Year	2009-like	100-year
10-day Dry Down						
	Any Revenue Loss	53.4%	100%	56.1%	91.9%	99.2%
	$1 to $25 per acre	53.4%	100%	56.1%	91.8%	99.9%
	More than $25 per acre	<0.1%	<0.1%	<0.1%	0.1%	<0.1%
14-day Dry Down						
	Any Revenue Loss	69.9%	100%	71.2%	97.5%	99.9%
	$1 to $25 per acre	69.9%	100%	71.2%	96.4%	99.8%
	More than $25 per acre	<0.1%	<0.1%	<0.1%	1.1%	0.1%

*Approximates the 1997 flood.

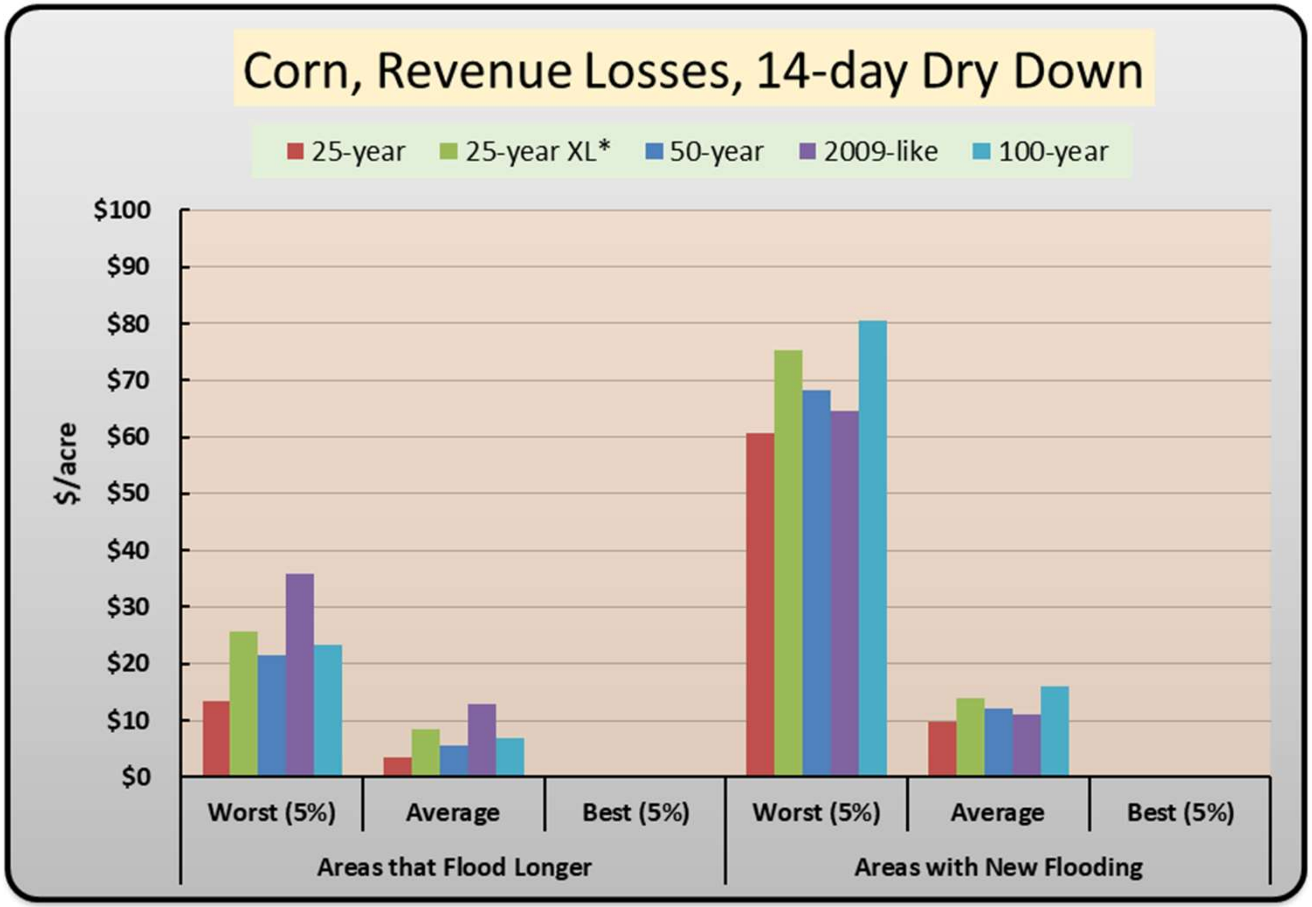
High Probability of Revenue Loss (average of all crops)

Storage Areas that Experience New Flooding (group 5)						
		Average of Storage Areas within the Hydrology Group (based on 10,000 simulations)				
		25-Year	25-Year XL*	50-Year	2009-like	100-year
10-day Dry Down						
	Any Revenue Loss	44.9%	56.1%	52.5%	48.9%	59.8%
	$1 to $25 per acre	42.1%	51.2%	48.6%	45.6%	52.7%
	More than $25 per acre	2.8%	4.9%	3.9%	3.3%	7.1%
14-day Dry Down						
	Any Revenue Loss	59.8%	71.2%	67.4%	63.7%	74.7%
	$1 to $25 per acre	49.1%	54.7%	53.2%	51.3%	53.9%
	More than $25 per acre	10.7%	16.5%	14.2%	12.4%	20.8%

*Approximates the 1997 flood.

Range of Per-Acre Revenue Losses

High and Low 5% of Observations



Worst – least favorable conditions for agricultural producers
Best – most favorable conditions for agricultural producers

Interpretation

The figure shows the range of per-acre values observed given study data and averaging techniques of the statistical output from 10,000 simulations.

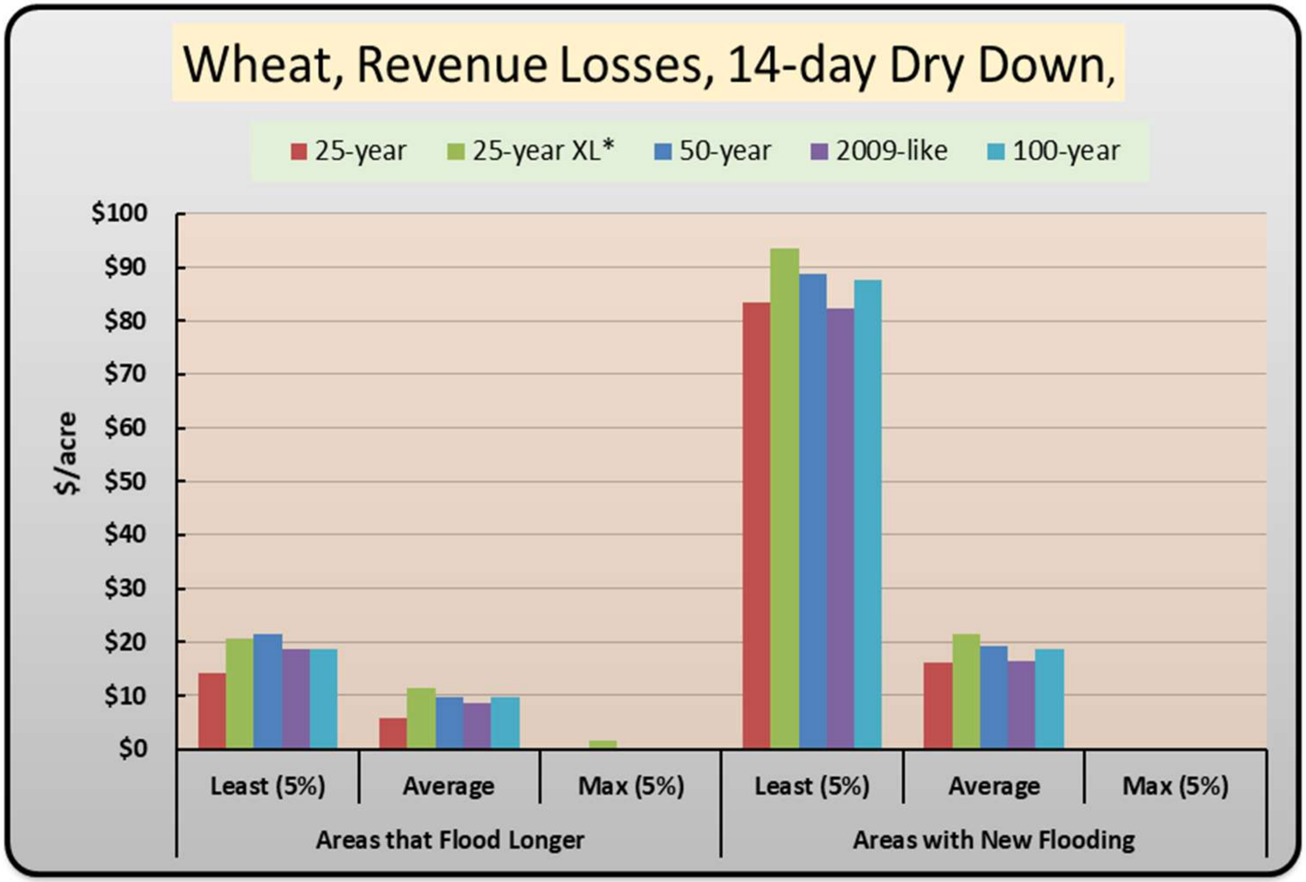
Average values mask the variability observed in the analysis.

Five percent average of minimum and maximum observations controls for low probability events

*Approximates 1997 Flood hydrology.

Range of Per-Acre Revenue Losses

High and Low 5% of Observations



Least – least favorable conditions for agricultural producers
Max – most favorable conditions for agricultural producers

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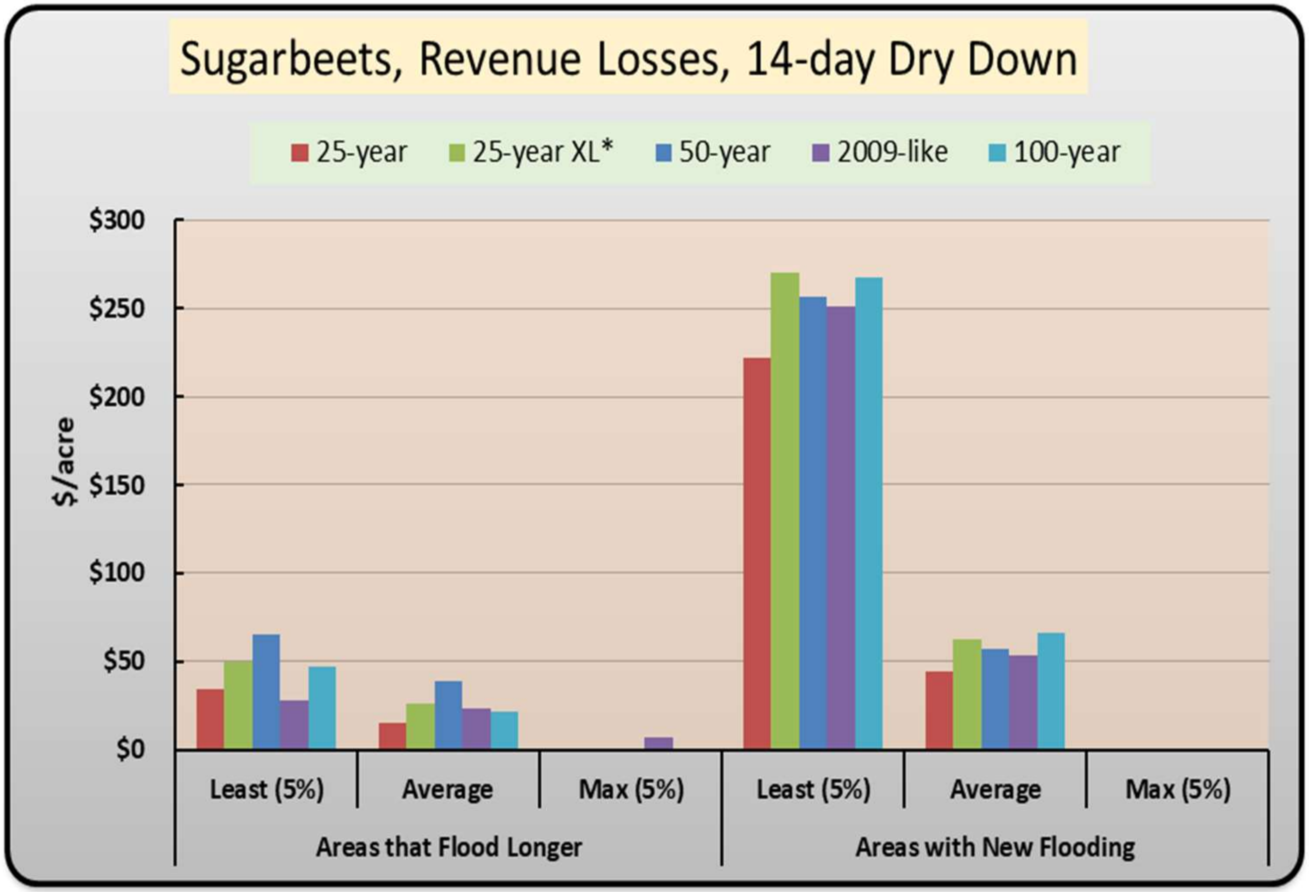

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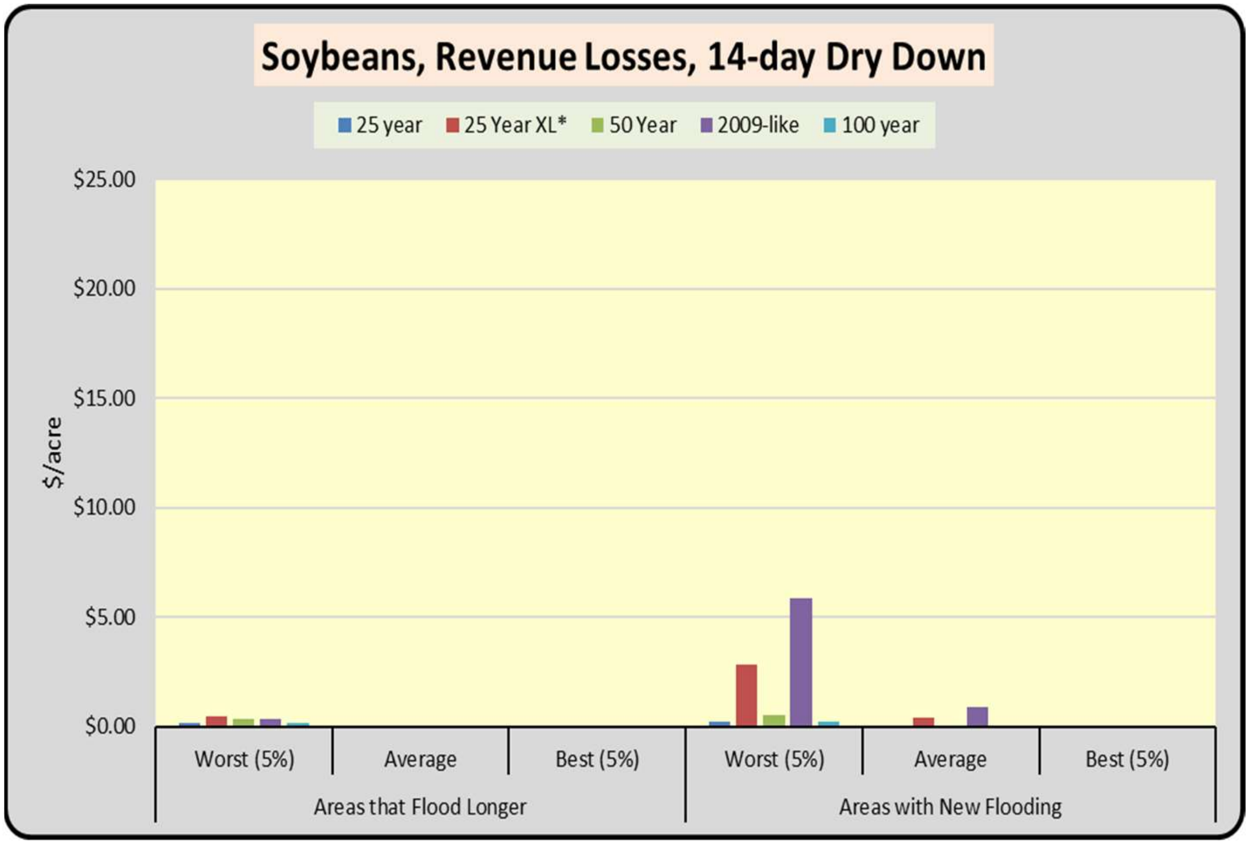

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Sensitivity to Dry Down Requirements

Going from 10-day to 14-day

	Average of All Storage Areas within the Group and Average of All Crops				
	25-Year	25-Year Extra Long	50-year	2009-like	100-year
Areas that Flood Longer (group 3)					
$/acre	-$1.23	-$2.27	-$1.92	-$3.24	-$2.08
% change ($/ac)	82.9%	60.5%	79.8%	56.9%	68.7%
% change in frequency or how often losses will occur	16.5%	0.0%	15.1%	5.6%	0.7%
Areas that Experience New Flooding (group 5)					
$/acre	-$4.67	-$5.89	-$5.42	-$5.03	-$6.74
% change ($/ac)	128.3%	114.0%	117.5%	120.4%	105.1%
% change in frequency or how often losses will occur	14.9%	15.1%	14.9%	14.8%	14.9%

Take Away

Increasing the dry down period increases the average losses per acre and increases the likelihood of incurring a revenue loss from planting delays.

Dry down requirements will effect the magnitude and frequency of losses.

Example of Detail in Main Report

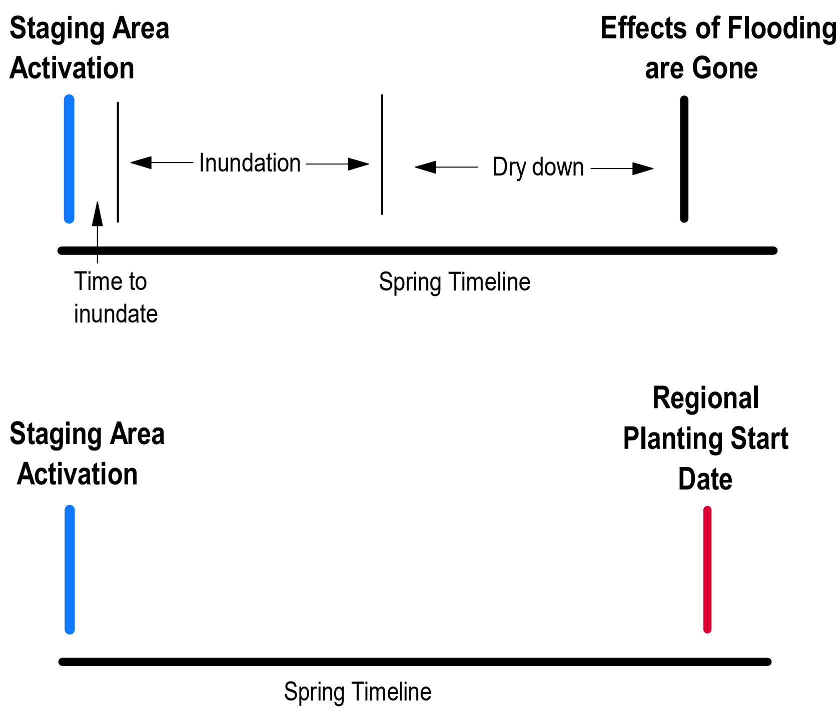
14-day Dry Down for 2009-event

	Time from Activation of Staging Area until Effects of Flooding are Over[a]										
Hydrology Group	Without Diversion	With Diversion	**Difference in Total Days**	No Loss	$0 to $25/acre[b] Loss	$26 to $50/acre[b] Loss	$51 to $75/acre[b] Loss	$76 to $100/acre[b] Loss	More than $100/acre[b] Loss	Any Loss	Acres
	------------------ days ------------------			------------------------ Based on 10,000 replications from Monte Carlo Simulation ------------------------							
3	20.3	22.8	1 to 5	2.5%	97.5%	0.0%	0.0%	0.0%	0.0%	97.5%	14,026
3	29.5	37.4	6 to 10	3.5%	13.4%	61.9%	17.5%	2.2%	1.4%	96.5%	1,023
3	23.0	35.8	11 to 15	4.7%	19.1%	34.6%	31.8%	7.5%	2.3%	95.3%	811
5	0	19.2	16 to 20	59.1%	36.1%	4.4%	0.4%	0.0%	0.0%	40.9%	773
5	0	21.8	21 to 25	43.8%	43.1%	11.5%	1.4%	0.1%	0.0%	56.2%	2,409
5	0	25.5	26 to 30	36.3%	35.9%	22.5%	4.4%	0.7%	0.1%	63.7%	434
3	29.5	61.5	30+	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%	150

[a] Total days are defined as the sum of 1) days from staging activation until land becomes inundated, 2) days of inundation, and 3) dry-down period. Zero days mean the storage areas do not flood with existing conditions, but zero days do not necessarily mean conditions in the region are suitable for planting.

[b] The range of losses per acre represent an average of all storage areas within the groups.

Fundamental Factor Driving Economic Effects



<u>Most Frequent Floods</u>

When placed on a calendar timeline, total time (days) required for the effects of temporary water storage to be over are similar to the calendar dates when spring planting begins.

Determined by Hydrology Data and NDSU modeling

<u>Less Frequent and Longer Floods</u>

Additional time for effects of flooding to be over will increase frequency and magnitude of revenue losses

Determined by Hydrology Data and NDSU modeling

<u>Take Away</u>

These two time periods are very similar in length. The likelihood (probability) of a planting delay will be sensitive to factors affecting those periods.

Additional Observations

- Hydrology Data
  - Substantial acreage within staging area not adversely affected
  - Majority of adversely affected acreage has potential planting delays of 1 to 5 days
  - Some storage tracks will have substantially adverse effects – hard to make generalizations that represent all situations
- Economic and Historical Data
  - Economic conclusions are influenced by high acreage of soybeans -- 50% of land is in soybeans (later planting dates, yield reductions less sensitive to timing of planting)
  - Economic losses are sensitive to dry-down requirements
  - Combinations of a long, or late-occurring flood and relatively early planting start dates are required to produce more pronounced levels of planting delays

Acknowledgements and Study Documentation

- The research team gratefully acknowledges the contributions from the following:
  - AE2S; Eric Dodds
  - Houston Engineering; Greg Thompson, Jun Yang

- Final Reports will be publically available pending departmental review: http://ageconsearch.umn.edu/

- Presentation posted on FM Diversion Web Site http://www.FMDiversion.com

- Research Team – contact information

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