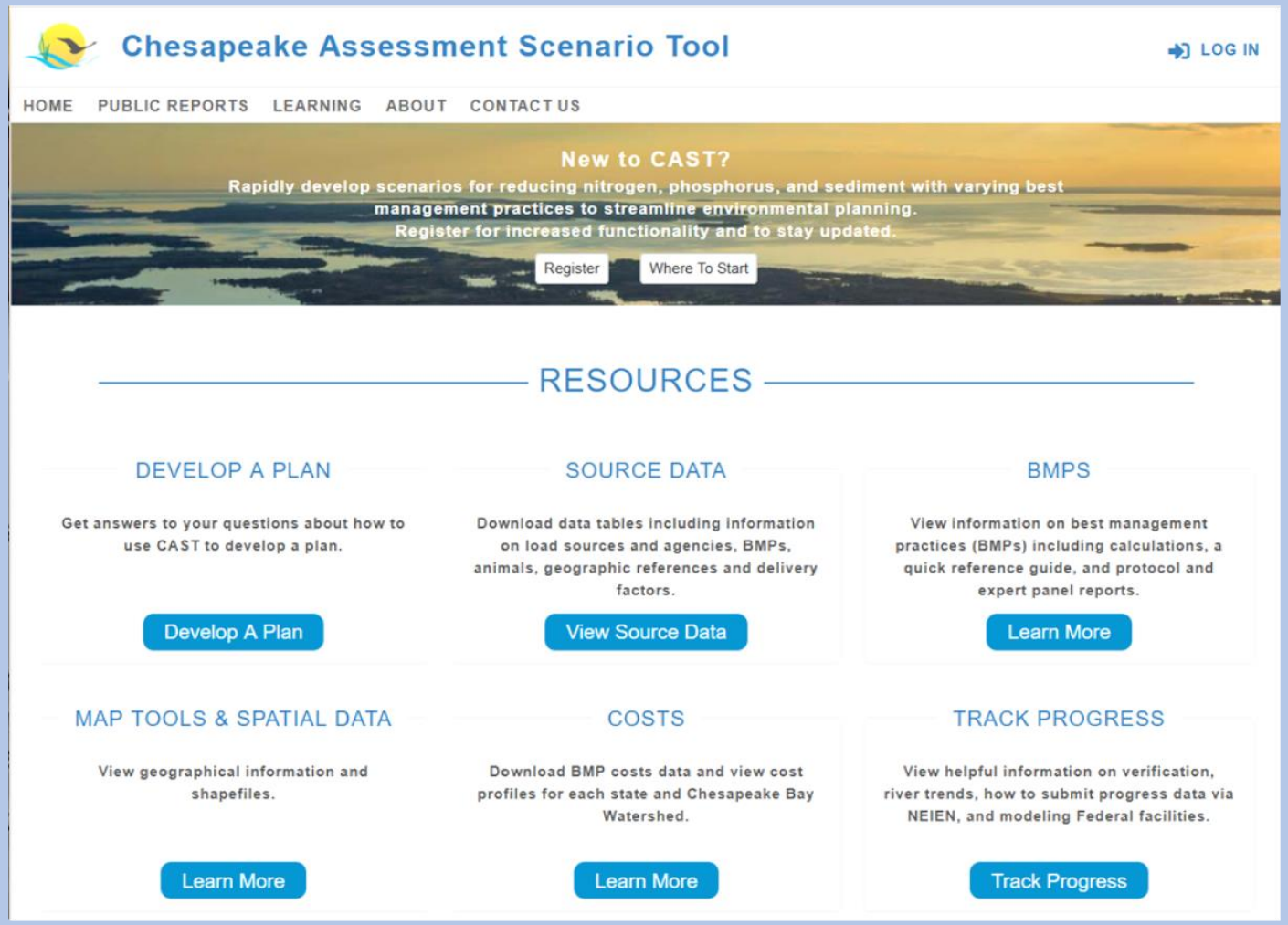
Planning Ahead: Phase 7 of the Bay Watershed Model

Includes animated slides – Please use Slide Show view option



Agricultural Workgroup, September 16, 2021

Olivia Devereux

Outline

- Purpose of CAST
- Complexity vs. Simplification
- Examples
    1. Land Use
    2. Timing of Nutrient Applications

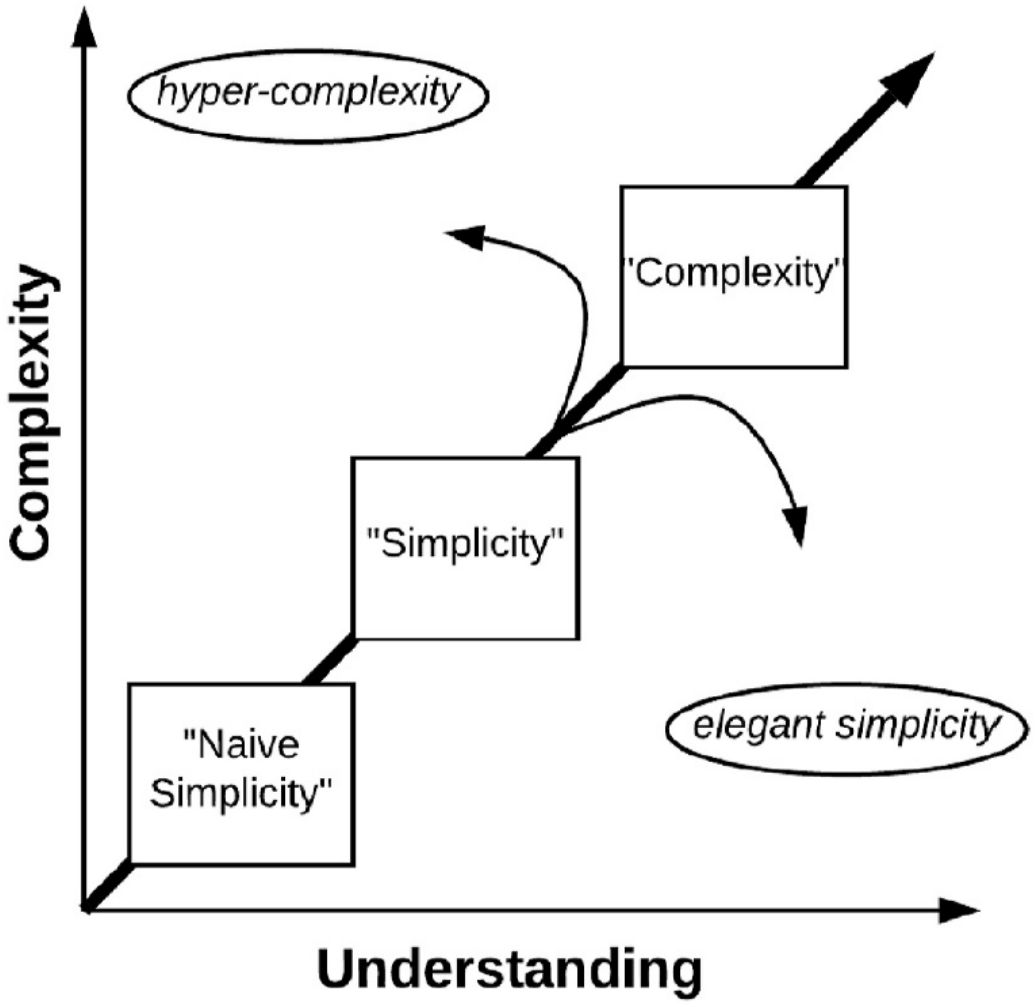


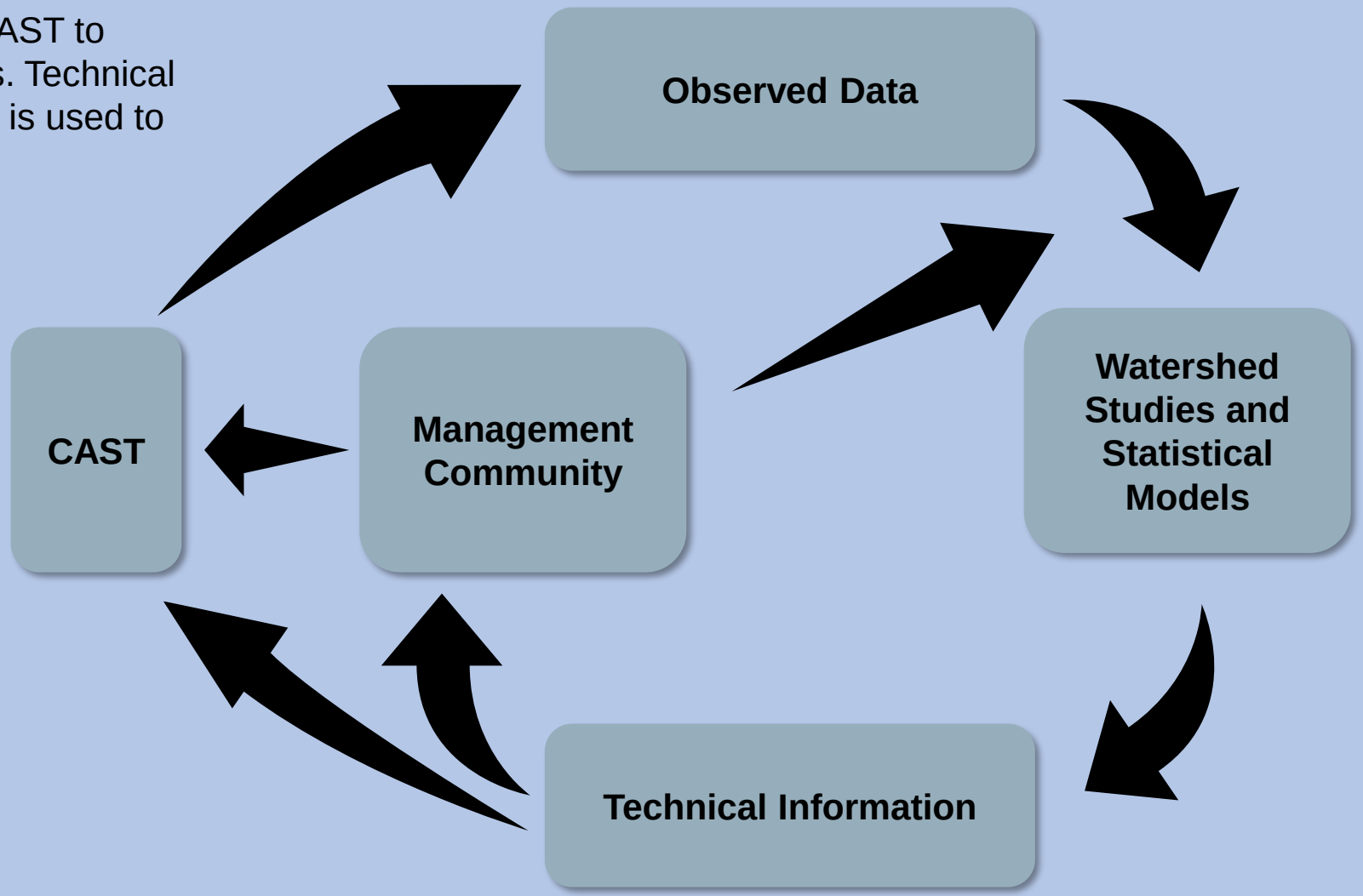
Fig. 1. Adaptation of the simplicity cycle by Schwartz et al. (2017).

Lim, T.C., 2021. Model emulators and complexity management at the environmental science-action interface. *Environmental Modelling & Software*, *135*, p.104928.

The Chesapeake Bay watershed model (CAST) is a comprehensive synthesis of knowledge that can help direct management

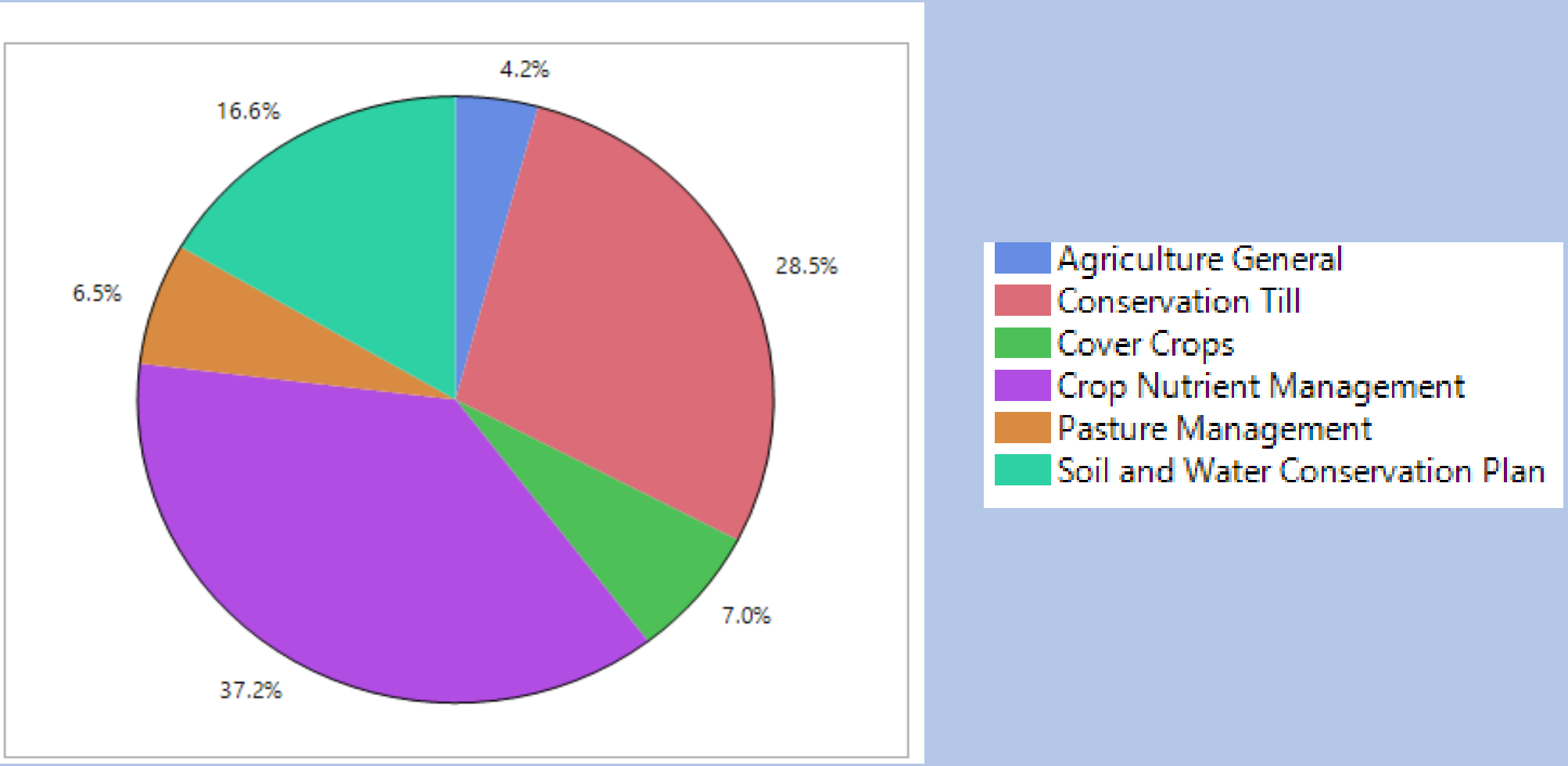
The management community largely relies on CAST to understand and improve water-quality conditions. Technical information about water-quality loads and trends is used to improve and assess modeled predictions.

- **Observed data** are used to develop **watershed studies and statistical models**, based on priorities identified by the **management community**.
- **Watershed studies and statistical models** provide **technical information** that are communicated to the **management community** and used to improve **CAST**.
- The **management community** uses **CAST** to develop management strategies.
- **Community Engagement** using structured decision making.



What are the most commonly used types of BMPs?

This question can be answered with CAST using the data shown below.

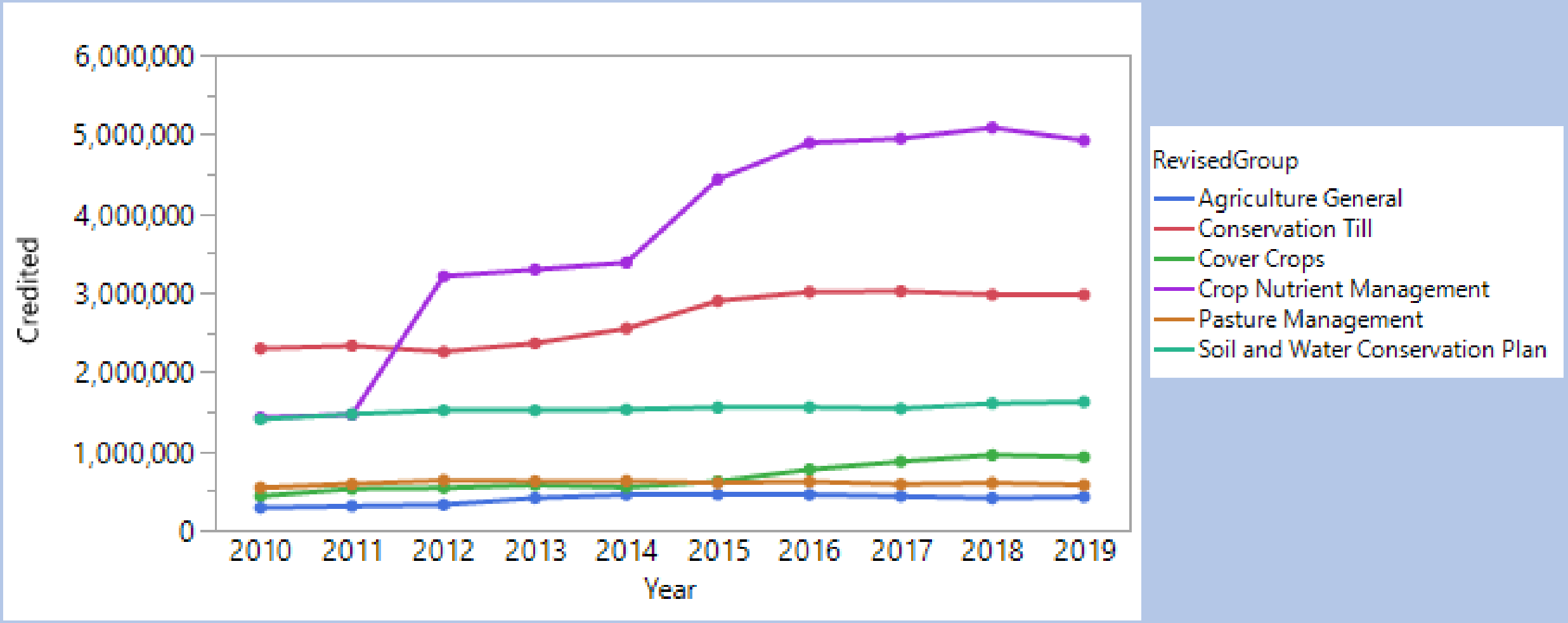


Above: *The percent of total agricultural BMP acres represented by practice groups.*

Explore BMP patterns by source sector or geography: cast.chesapeakebay.net/TrendsOverTime/BMPs

How has BMP implementation changed over time?

This question can be answered with CAST using the data shown below.



***Above**: Agricultural BMP acres by practice group*

Explore BMP patterns by source sector or geography: cast.chesapeakebay.net/TrendsOverTime/BMPs

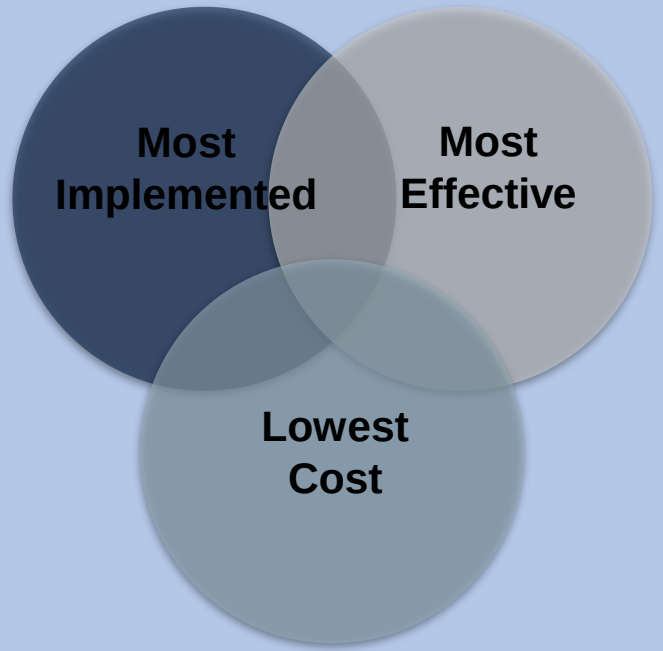
Are most BMP investments being made in the highest loading areas of the watershed?

This question can be answered with CAST using the data shown below.

CAST provides estimates of BMP costs and expected nutrient/sediment reductions, customized by geography, that can be used to target cost effective BMPs.

In addition to targeting BMPs in high loading areas, BMPs can be targeted that offer the largest nutrient and sediment reductions at the lowest cost.

The most commonly used BMPs are not always the most cost effective. Understanding local conditions, BMP co-benefits, and cost effectiveness are some of the considerations that make up an effective management strategy.



Below: *Average cost effectiveness of nitrogen and phosphorus BMPs by source sector, as estimated by CAST.*

Source Sector	Average Cost Effectiveness ($/lb reduced)	
	Nitrogen	Phosphorus
Agriculture	$108	$10,100
Developed	$7,724	$80,349
Septic	$1,006	NA
Natural*	$548	$2,461

*BMPs in the natural sector include practices such as wetland enhancements, forest harvesting practices, oyster practices, and non-urban shoreline management and stream restoration.

Learn more about these data and developing management plans by viewing CAST training videos: cast.chesapeakebay.net/Learning/FreeTrainingVideos

Phase 7—Hyper Complexity vs. Elegant Simplicity

- Example 1—Land Use
  - 14 agricultural land uses
  - Loading rates variation
  - Planning scales
  - BMP reporting geographies

- Example 2—Timing of Nutrient Applications

Percent of Land in Each Land Use in 2020

Land Use	Acres	% of Total
Pasture	2,521,870	21.79
Other Hay	2,168,902	18.74
Full Season Soybeans	1,304,797	11.27
Leguminous Hay	959,460	8.29
Grain without Manure	931,826	8.05
Other Agronomic Crops	918,416	7.94
Grain with Manure	880,171	7.61
Double Cropped Land	571,788	4.94
Silage with Manure	367,953	3.18
Ag Open Space	327,728	2.83
Small Grains and Grains	318,698	2.75
Specialty Crop Low	173,745	1.50
Silage without Manure	64,933	0.56
Specialty Crop High	62,957	0.54
Total	11,573,244	100

Loading Rates for Calibrating Phase 6

Table 2-11: Cropland and pasture loading rates. Cropland is relative to grain without manure and the pasture group is relative to the pasture land use.

Land class	Land Use	Total Nitrogen	# of observations	Standard Error
cropland	Silage with Manure	1.62	1	NA
cropland	Grain with Manure	1.4	12	0.2
cropland	Specialty Crop High	1.34	1	NA
cropland	Silage without Manure	1.16	NA	NA
cropland	Grain without Manure	1	Reference	Reference
cropland	Small Grains and Grains	0.84	NA	NA
cropland	Double Cropped Land	0.79	2	0.09
cropland	Full Season Soybeans	0.71	6	0.11
cropland	Other Agronomic Crops	0.45	1	NA
cropland	Specialty Crop Low	0.31	NA	NA
pasture	Other Hay	1.04	4	0.24
pasture	Pasture	1	10	0.20
pasture	Legume Hay	0.74	4	0.08
pasture	Ag Open Space	0.43	2	0.04

Chesapeake Bay Program Phase 6 Watershed Model – Section 2 – Average Loads
Final Model Documentation for the Midpoint Assessment – 5/11/2018

State	Conservation Tillage		Cover Crops		Nutrient Management	
	Land Use Group	Percent Reported on the Land Use Group	Land Use Group	Percent Reported on the Land Use Group	Land Use Group	Percent Reported on the Land Use Group
DE	Row	100.00	Row	100.00	Row	100.00
MD	Row	100.00	Row	100.00	Crop-hay	77.67
					Pasture	22.33
NY	Row	100.00	Row	100.00	Legume-hay	29.55
					Pasture	32.40
					Row	38.05
PA	Row	100.00	Row	100.00	Row	100.00
VA	Row	100.00	Row	100.00	Hay	7.34
					Pasture	4.68
					Row	87.13
					Specialty	0.84
WV	Row	100.00	Row	100.00	Hay	33.33
					Pasture	33.33
					Row	33.33

State	Conservation Tillage		Cover Crops		Nutrient Management	
	Geography	Percent Reported on the Geography	Geography	Percent Reported on the Geography	Geography	Percent Reported on the Geography
			County	0.14	County(CBWSOnly)	94.74
			HUC12	5.30		
DE	County	100.00	HUC12(CBWSOnly)	94.57	HUC12	5.26
MD	County(CBWSOnly)	100.00	County(CBWSOnly)	100.00	County(CBWSOnly)	100.00
NY	County(CBWSOnly)	100.00	County(CBWSOnly)	100.00	County(CBWSOnly)	100.00
					County	99.79
PA	County	100.00	County	100.00	State	0.21
			County	1.02	County	0.04
			HUC12	98.96	HUC12	99.14
VA	County	100.00	State	0.02	State	0.82
WV	County	100.00	County	100.00	County	100.00

Phase 7—Hyper Complexity vs. Elegant Simplicity

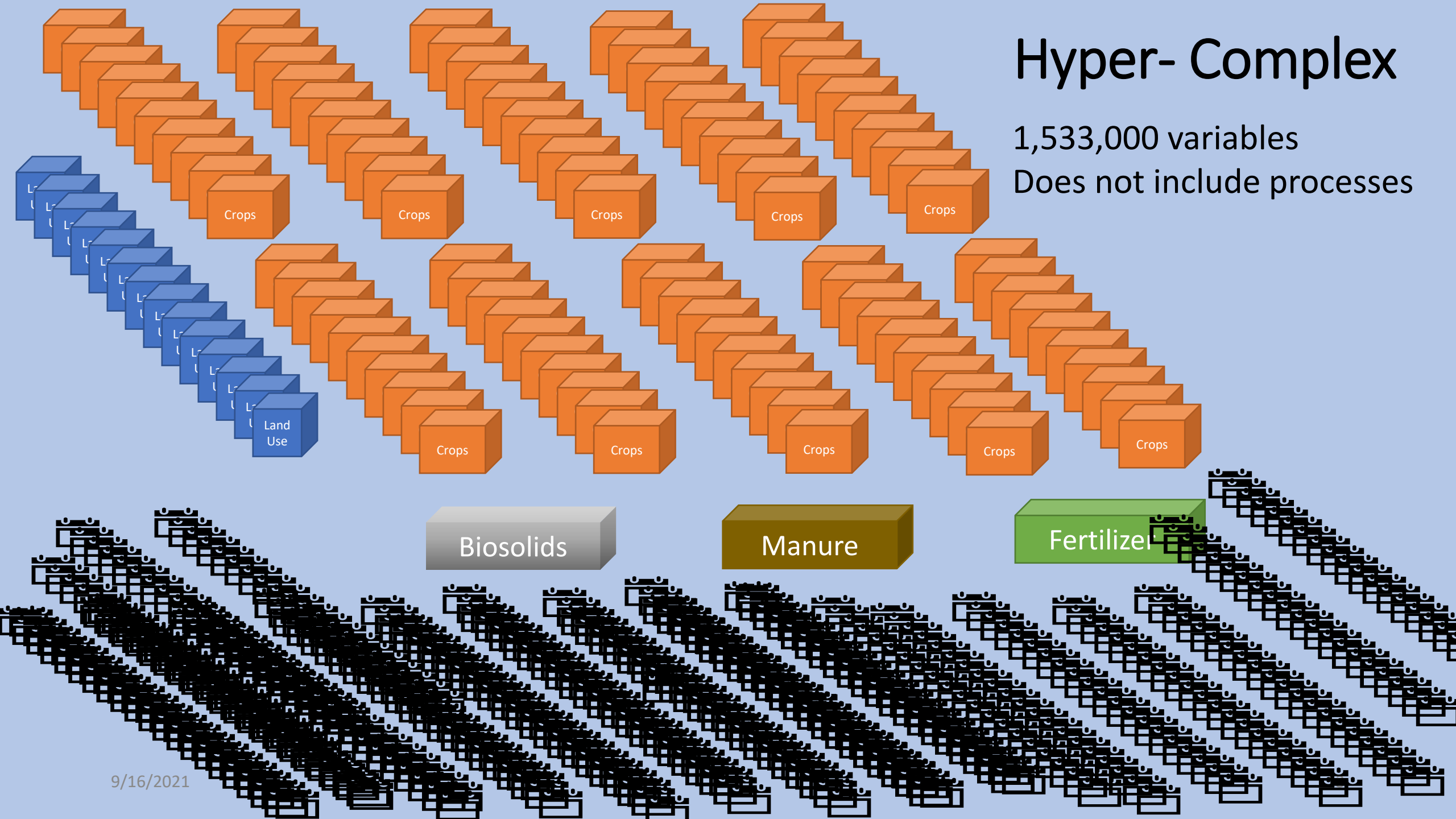
- Example 1—Land Use
  - 14 agricultural land uses
  - Loading rates variation
  - Planning scales
  - BMP reporting geographies

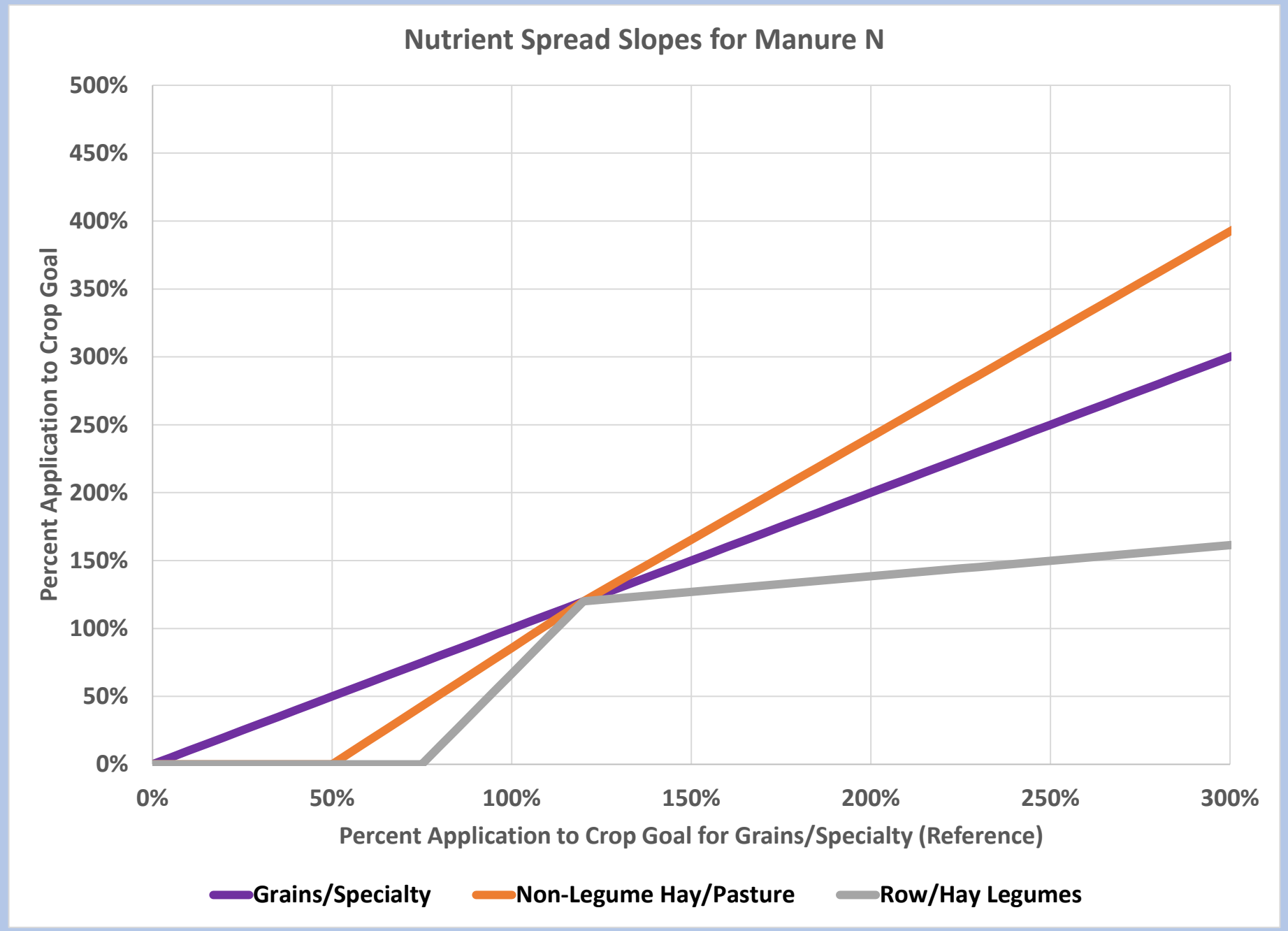
- Example 2—Timing of Nutrient Applications
  - Split into 14 land uses X 100 crops X 3 nutrient sources X 365 days for timing
  - Relative applications—Curves
  - BMPs that affect timing

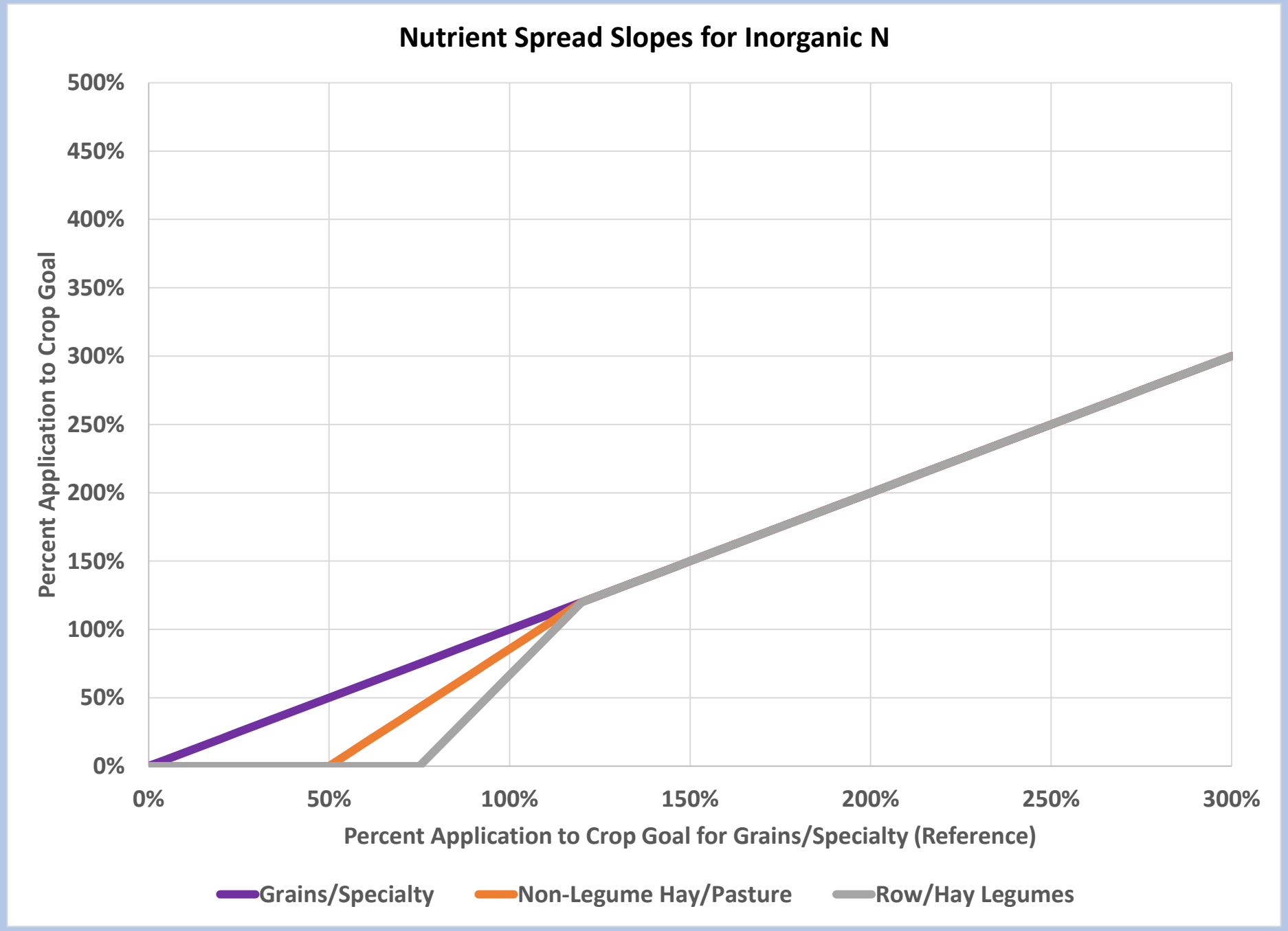
Hyper- Complex

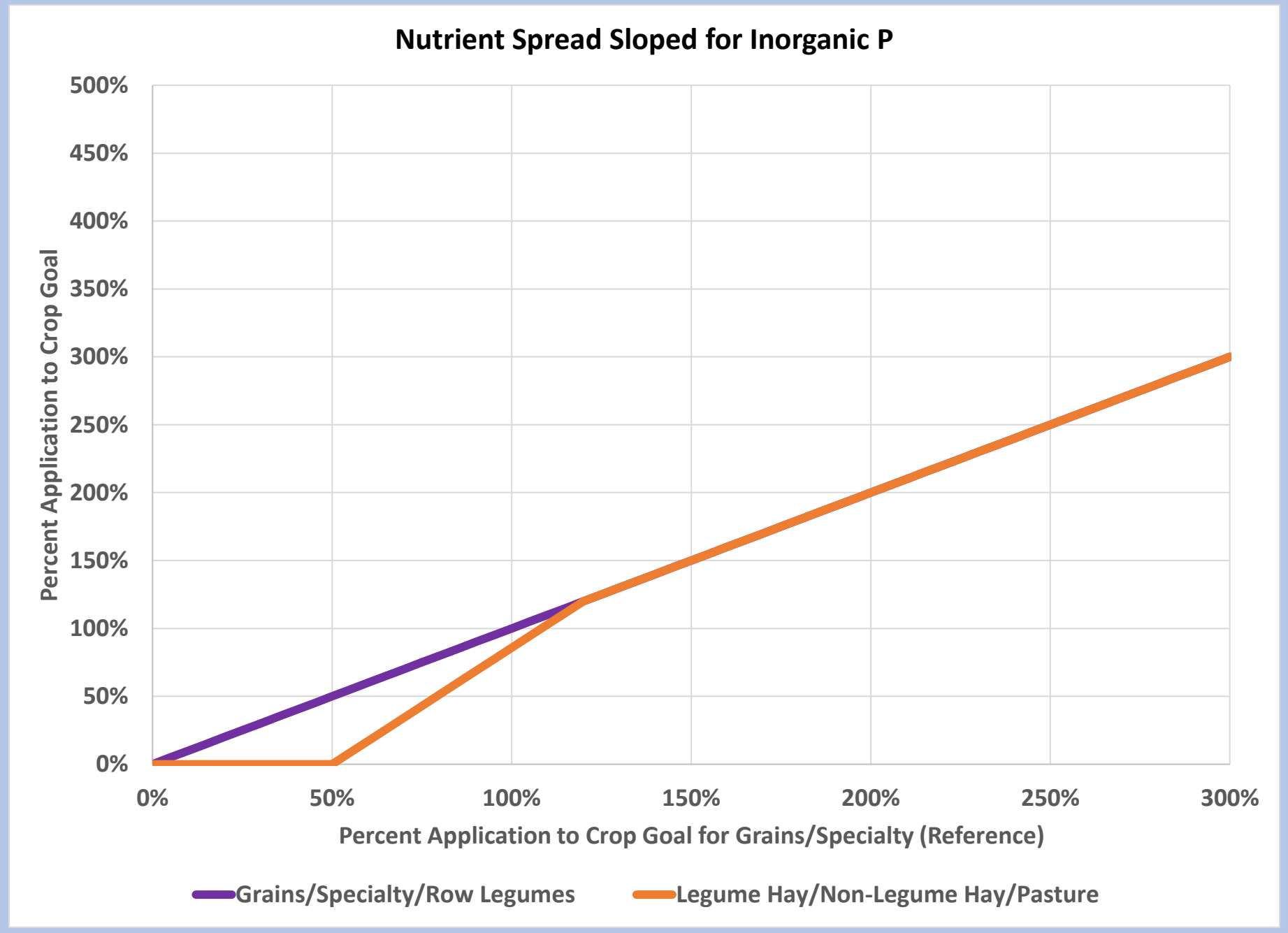
1,533,000 variables

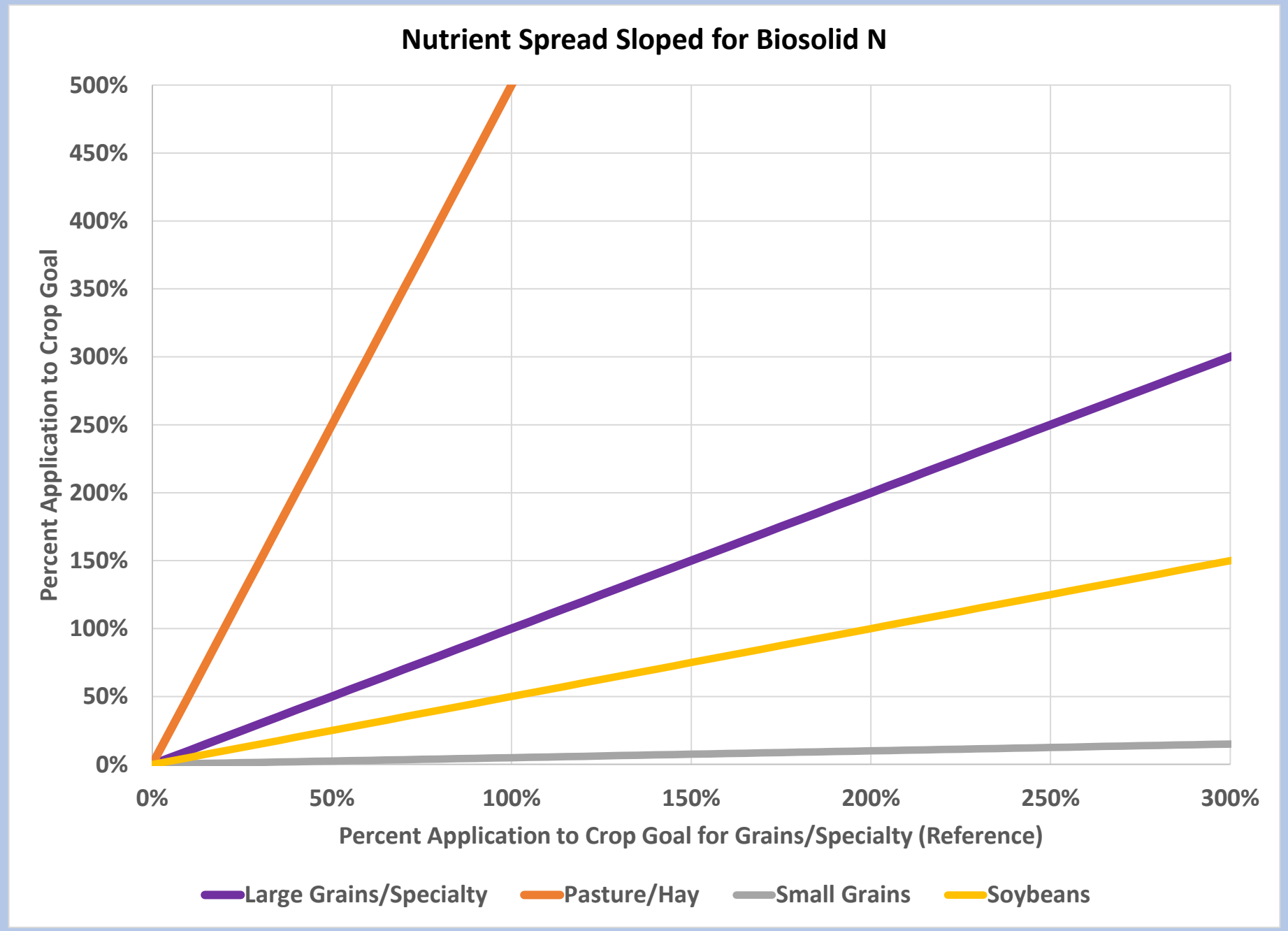
Does not include processes




Nutrient Spread Slopes for Manure N
500%
450%
400%
350%
300%
250%
200%
150%
100%
50%
0%
Percent Application to Crop Goal
0%
50%
100%
150%
200%
250%
300%
Percent Application to Crop Goal for Grains/Specialty (Reference)
Grains/Specialty
Non-Legume Hay/Pasture
Row/Hay Legumes


Nutrient Spread Slopes for Inorganic N
500%
450%
400%
350%
300%
250%
200%
150%
100%
50%
0%
Percent Application to Crop Goal
0%
50%
100%
150%
200%
250%
300%
Percent Application to Crop Goal for Grains/Specialty (Reference)
Grains/Specialty
Non-Legume Hay/Pasture
Row/Hay Legumes


Nutrient Spread Sloped for Inorganic P
500%
450%
400%
350%
300%
250%
200%
150%
100%
50%
0%
Percent Application to Crop Goal
0%
50%
100%
150%
200%
250%
300%
Percent Application to Crop Goal for Grains/Specialty (Reference)
Grains/Specialty/Row Legumes
Legume Hay/Non-Legume Hay/Pasture


Nutrient Spread Sloped for Biosolid N
500%
450%
400%
350%
300%
250%
200%
150%
100%
50%
0%
Percent Application to Crop Goal
0%
50%
100%
150%
200%
250%
300%
Percent Application to Crop Goal for Grains/Specialty (Reference)
Large Grains/Specialty
Pasture/Hay
Small Grains
Soybeans

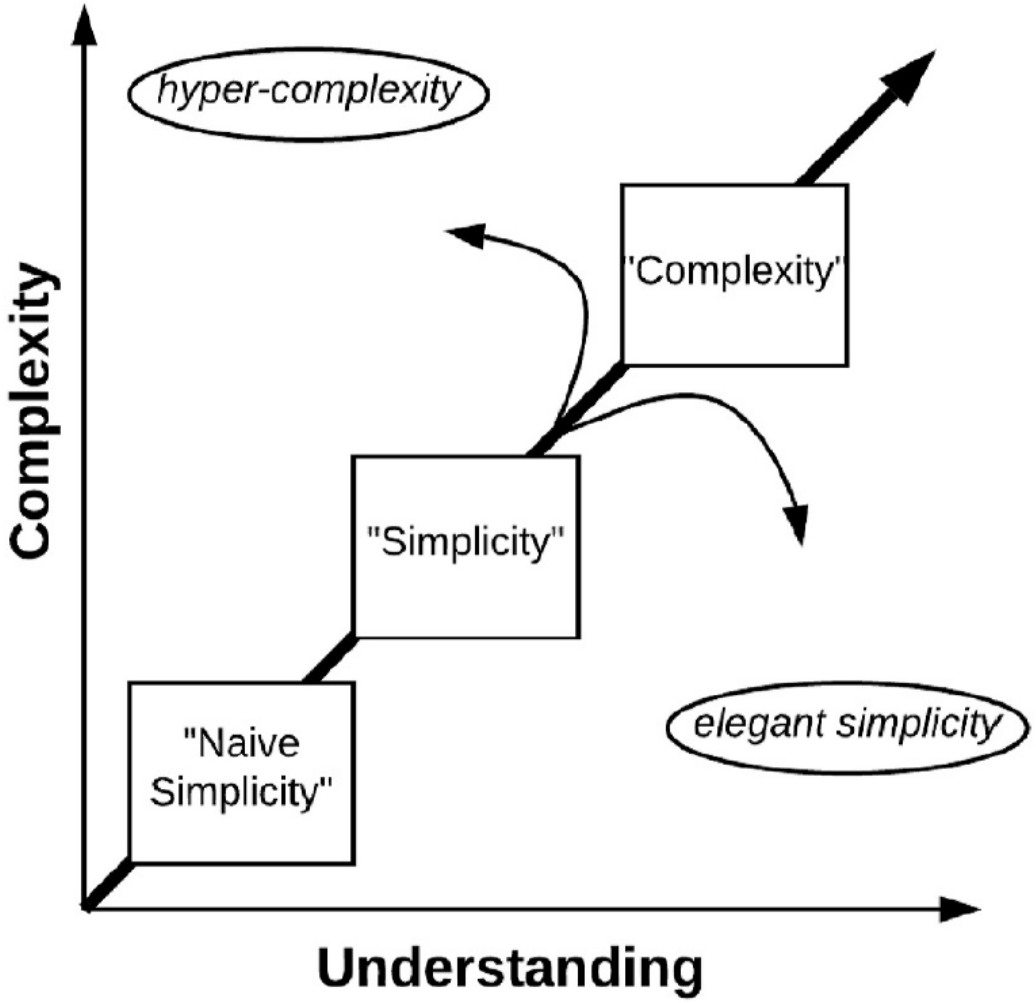
CAST Temporal Scale

- It is difficult to explain to CAST users that the load changes are due to the type of nutrient, timing and curves *AND* that there is a Nutrient Management Timing BMP for TN and TP
- All results are annual (per year)
- Hydrology is an average annual amount
- Source data is at county scale, farms are not modeled
- Crop and Pasture curves are applied separately depending on the timing and nutrient type

What about … ?

- It is tempting to ask “What About…” questions.
- We want to ask if this and that process or parameter is included.
- For a model, a better question may be,

  Do the “What Abouts…” impact the loads?



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Summary

- CAST Goals
  - Provide federal, state, and local partners and stakeholders **tools and information** for environmental improvement in the Bay
  - **Quantify** the link between BMPs and ecological conditions
- Options for Improving Phase 7 Model Results
  - Check recommendations by **evaluating results, less focus on farm management processes**
  - Check **boundary examples** for unrealistic results
  - Redesign the **interface**
- Near-term goals
  - Continue working with CAST users and the Agricultural Workgroup to **show why results are what they are**
  - Identify **unrealistic results across multiple farm management types**

Contaminated sites → Revitalized communities

Questions?

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