

Nutrient Management BMP & Full-Season Soybeans

Agriculture Workgroup

May 20, 2021

Task 6: Consider additions to current methods for “crediting” Nutrient Management on soybeans and propose options

Participating Entities: Agriculture Workgroup, Watershed Technical Workgroup, WQGIT, CBPO technical staff

Timeline* – Findings Presented to **Lead** Participating Entity for Decision: May 2021

Concern:

Nutrient management on full-season soybeans?

YES: “core NM”

NO: “supplemental NM” for N rate, placement & timing

Why? NM on soybeans is controlling for P...

Given the same acreage...

A shift from double-crop to full-season soybeans will result in an increase in attributed N load.

CRITICAL CONCEPT:

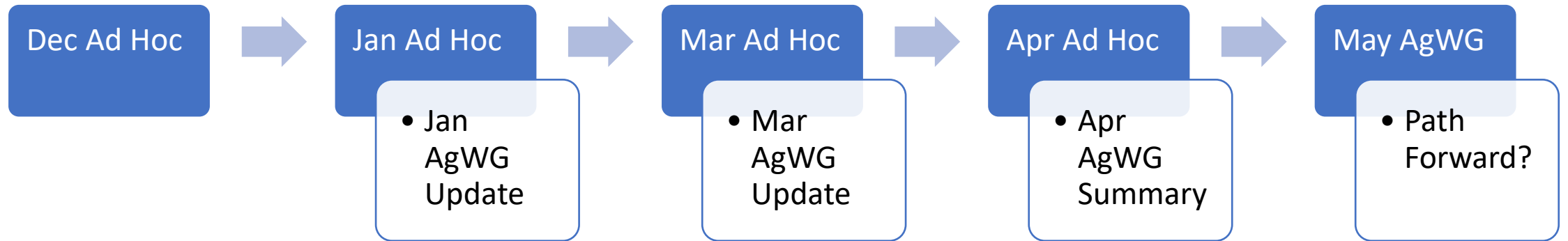
N load attributed to soybean acres includes estimated leaching/runoff of residual N based on scientific literature review.

Ag Loading Rate Review Steering Committee

[Agricultural Loading Rates](#)

AgWG CAST Concerns Ad Hoc

7 hours discussion + outside communications with EP members, CBPO staff, stakeholders



Resulting Ask (PA): Change Nutrient Management Expert Panel Recommendations

- Apply Non-Zero Reduction Efficiency Value for Supplemental Nitrogen Nutrient Management BMP on Full-Season Soybean Load Source (Rate, Timing, and/or **Placement**).

Task 6: Consider additions to current methods for “crediting” Nutrient Management on soybeans and propose options

Ask: Change Nutrient Management Expert Panel Recommendations

- Apply Non-Zero Reduction Efficiency Value for Supplemental Nitrogen Nutrient Management BMP on Full-Season Soybean Load Source (Rate, Timing, and/or Placement).

Summary of Concern

- Establishment of Load Without a Means to Reduce that Load Through Control & Uptake (PA)
- Supplemental NM Practices Will Have Some Beneficial Effect that Should be Reflected in the Model- Emphasis on “Placement” (PA)

Summary of Ad Hoc Discussion

- Need for Change?: No Consensus Among Group
 - Split Among “No”, Stand Aside, Endorse...
- Need to Better Understand Ag Management (Baseline Assumptions) & Apply to CAST
 - Manure Application is Not NM... BUT if it Happens, Can We Incentivize Responsible Application?

Task 6: Consider additions to current methods for “crediting” Nutrient Management on soybeans and propose options

Decision Requested:

The AgWG CAST Concerns Ad Hoc was not able to achieve consensus to support a change to the Supplemental Nitrogen Nutrient Management BMP on the full-season soybean load source (Rate, Timing, and/or Placement).

The AgWG is asked to **endorse** or **not endorse** application of a non-zero reduction efficiency for the Supplemental Nitrogen Nutrient Management BMP on the full-season soybean load source (rate, timing, and/or placement).

Long-term recommendations discussed in the Ad Hoc group include:

- review of ag loading rates
- continued efforts to improved accuracy of crop data sources
- improved understanding of real-world soybean management for future incorporation into CAST (watershed model).

Agricultural Loading Rates

Long-Term (post CAST-21): Phase 7 Review of Ag Loading Rates/Ratios

- Identification & Consideration of New Literature Sources
 - N Fixation
 - Soybeans (& other crop/pasture land uses)

Census of Agriculture

Short-Term:

- Landcover & LiDAR Imagery to Define Changes in Total Ag Acres May Improve Accuracy of Modeled Crop Acres

Long-Term (post CAST-21):

- On-going Efforts to Supplement/Complement Ag Census with other data sources (subject to CBP partnership approval)

NM Expert Panel
Recommendations

Land Use:
Full-Season Soybeans

Long-Term (post CAST-21):

- Improve Understanding of Real-World Soybean Management
 - Reconsider Baseline Assumptions
 - Are NM BMPs Sufficient for Representing Use of “4R” Practices?
 - Incorporate in CAST (watershed model)

*<https://nutrientstewardship.org/4rs/>

Prioritizing Concerns (post CAST-21)

- AgWG Home Page

https://www.chesapeakebay.net/who/group/agriculture_workgroup

Projects and Resources

Agriculture Workgroup Chesapeake Assessment Scenario Tool (CAST) Issues Tracker

The below Chesapeake Assessment Scenario Tool (CAST) Issues Tracker records concerns that have been raised by jurisdictions in relation to agricultural data inputs. The tracker is a living document and will be updated regularly as progress is made on the issues or new issues are raised.

CAST Issue Tracker 02.15.2021 (15.21 KB)

Agriculture Workgroup Governance Protocol & Membership

Governance Protocol (Approved 3/15/18) (491.87 KB) 

AgWG At- Large Membership, Feb. 2021 (88.47 KB) 

AgWG Signatory Membership, Mar 2021 (35.1 KB) 

Ad Hoc November Recommendation: Create a tracking mechanism for jurisdictions' wish list for 2-year CAST updates & the next model phase.

Reference

Comments on CAST-19 (May 2020): Soybean nitrogen application (p.2)

- With the increase in full-season soybeans and decrease in double cropped soybeans in CAST-19, the N application rates were examined. Chris Brosch-DDA, Jill Whitcomb-PA-DEP; James Martin-VA-DEQ

Comments on CAST-19 (May 2020):

Soybean nitrogen application → Response (p.3)

- N applications on soybeans depend on whether the soybeans are full season or double cropped.
- Double-cropped receive 0 N applications.
- Full season have a N crop need of 0.12 lb./bu (5.70 lbs./ac)
 - watershed-wide avg
 - 2.23 inorganic lbs./acre applied
 - 1.35 organic lbs./acre applied
- The University of Maryland, Penn State, and Virginia Tech nutrient management guidelines recommend zero N on full-season or double-cropped soybeans.

Comments on CAST-19 (May 2020): Soybean nitrogen application_Resolution (p.3)

- A comparative analysis of changing full-season soybeans to corn and the resulting nitrogen loads was provided to PA-DEP.
- The soybean N application and N fixation assumed for Lancaster County and the average in the rest of PA's watershed were provided to Jill Whitcomb, PA-DEP.
- The CBP will provide to Jill Whitcomb, PA-DEP, and other states the peer reviewed research and other sources that document nutrient runoff/leaching rates from legumes, and how it is applied in the modeling tools (e.g., is it a constant throughout the year or is there a difference in seasonality, is there a difference depending on what crop preceded/followed, etc.) by the May 25, 2020 WQGIT.
- The AgWG will be asked to consider establishing a group to evaluate nutrient management BMPs for nitrogen on full season soybeans. *[see CAST-21 Workplan Task 6]*

Nitrogen Core Nutrient Management

Land-Grant University Recommendations for N Applications @ Field Level

Manure Analysis & Volume

- Test or Book Values to Determine N Content

Calibration of Spreader/Applicator

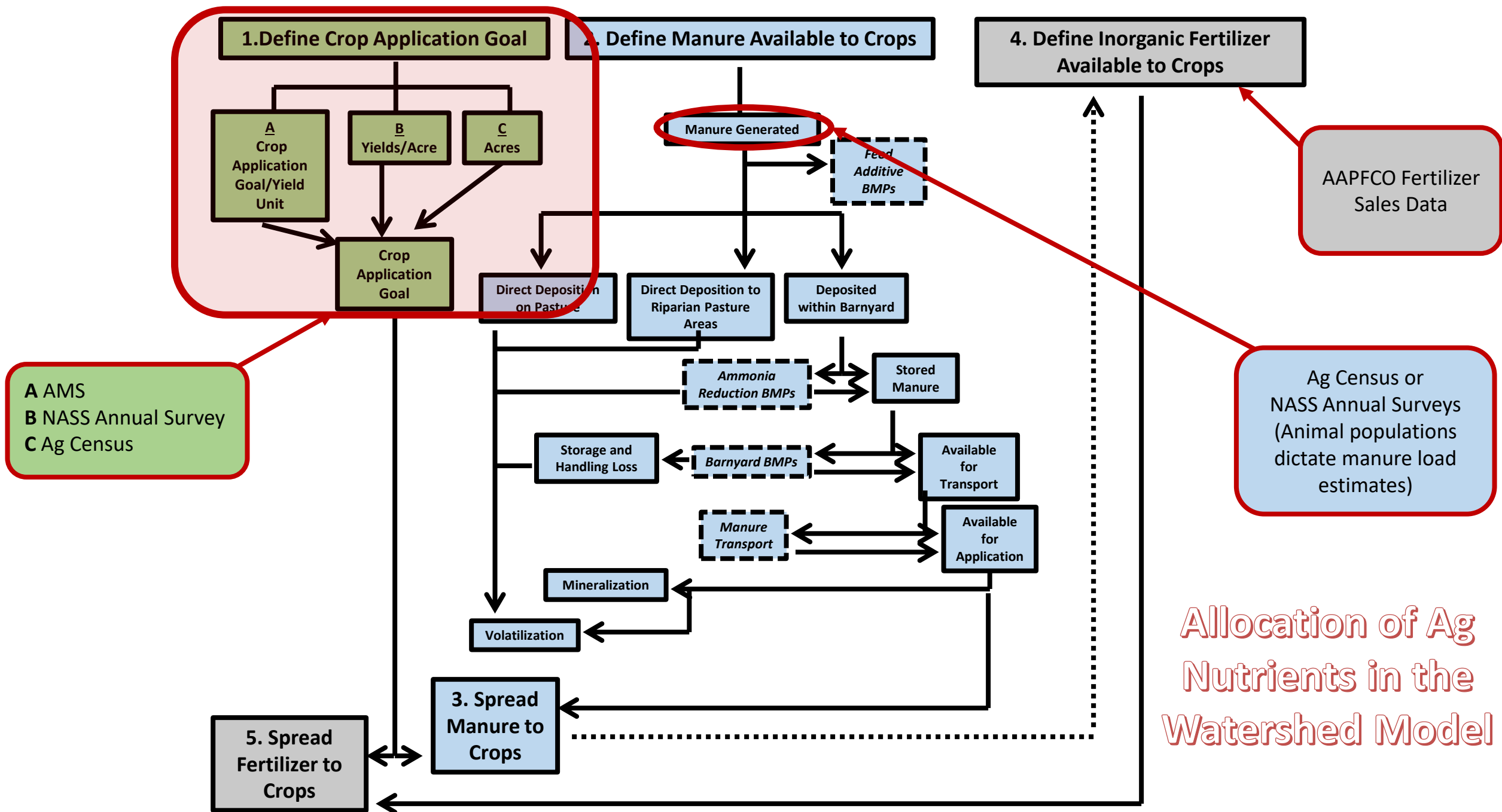
Yield Estimates & Cropping Plan @ Field Level

Cropping & Manure Application History @ Field Level

CRITICAL CONTEXT:

Core NM controls for nutrients applied to the crop.

NM on full-season beans is controlling/managing for phosphorus!



Crop Application Goal on Major Crops

Crop
Application
Goal

$\text{lbs of N/Year} = \text{State-Supplied lbs of N/Application Goal Yield Unit/Year} \times \text{Yield/Year} \times 1.1^*$

Crop	DoubleCrop	Nutrient	Yield Unit	DE_1	MD_1	NY_1	PA_1	VA_1	WV_1
Alfalfa Hay Harvested Area	N	TN	dry tons	1	1	1	1	1	1
Alfalfa Hay Harvested Area	N	TP	dry tons	5	5	5	6	5	5
Corn for Grain Harvested Area	N	TN	bushels	0.92	0.92	0.92	0.92	0.92	0.92
Corn for Grain Harvested Area	N	TP	bushels	0.12	0.12	0.12	0.12	0.12	0.12
Corn for Grain Harvested Area	Y	TN	bushels	0.92	0.92	0.92	0.92	0.92	0.92
Corn for Grain Harvested Area	Y	TP	bushels	0.12	0.12	0.12	0.12	0.12	0.12
Wheat for Grain Harvested Area	N	TP	bushels	0.31	0.31	0.31	0.31	0.31	0.31
Wheat for Grain Harvested Area	N	TN	bushels	1.25	1.25	1	1	1.25	1.25
Wheat for Grain Harvested Area	Y	TP	bushels	0.465	0.465	0.465	0.465	0.465	0.465
Wheat for Grain Harvested Area	Y	TN	bushels	1.25	1.25	1	1	1.25	1.25
Pastureland and rangeland other than cropland and woodland pastured Area	N	TN	acres	15	15	15	15	15	15
Pastureland and rangeland other than cropland and woodland pastured Area	N	TP	acres	4	4	4	4	4	4
Soybeans for beans Harvested Area	N	TN	bushels	0.12	0.12	0.12	0.12	0.12	0.12
Soybeans for beans Harvested Area	N	TP	bushels	0.33	0.33	0.33	0.33	0.33	0.33
Soybeans for beans Harvested Area	Y	TN	bushels	0	0	0	0	0	0
Soybeans for beans Harvested Area	Y	TP	bushels	0	0	0	0	0	0

Data provided by states after consultation with nutrient management program staff.

Chesapeake Bay Program Phase 6 Beta 3 Watershed Model Webinar
July 11, 2016

*AMS elected to multiply yearly yield by 1.1 assuming farmers are optimistic, and average yields are often under-estimated.

CRITICAL CONTEXT:
“Crop Application Goal”
assumes Core NM is in place

Full Season Beans receive
0.12 lb N/bu
&
0.33 lb P/bu

Double Crop Beans
(application is on sm gr)
0 lb N/bu
&
0 lb P/bu

*NM on full season beans is
controlling/managing for
phosphorus!*

Soybean Crop Application Goal

Full Season Soybeans

- 0.12 lbs N/bu (~5.7 lbs N/ac)
- CBW Average: (~3.58 lb/N ac)
- UME, Penn State, VT recommend zero N application

Double Cropped Soybeans

- Zero N applications
- UME, Penn State, VT recommend zero N application

Assumption: “Nitrogen application is not recommended for soybean production, however, **use of commercially available fertilizer formulations may result in application of up to 50 lb N / acre when fertilizer formulation and application rate is determined by crop P2O5, K2O, S, or other nutrient needs.** Organic waste nitrogen application to full-season soybean is not recommended because it is an agronomically inefficient use of applied nutrients. Organic wastes should only be applied to small grain - double-crop soybean rotations at rates and timings to supply the recommended nitrogen rate to the small grain crop.” – [UME SFM-1](#)

Application Goal Multipliers (CORE)

Land Use	<u>Non</u> NM N Multiplier	NM N Multiplier	<u>Non</u> NM P Multiplier	NM P Multiplier
Full Season Soybeans	1.2	1.0	1.5	1.0
Grain with Manure	1.3	1.0	3	1.0
Grain without Manure	1.2	1.0	1.5	1.0
Legume Hay	1.2	1.0	1	1.0
Silage with Manure	1.4	1.0	3	1.0
Silage without Manure	1.2	1.0	1.5	1.0
Small Grains and Grains	1.2	1.0	1.5	1.0
Small Grains and Soybeans	1.2	1.0	1.5	1.0
Specialty Crop High	1.3	1.0	2	1.0
Specialty Crop Low	1.2	1.0	2	1.0
Other Agronomic Crops	1.1	1.0	1.5	1.0
Other Hay	1	1.0	1	1.0
Pasture	1	1.0	1	1.0

CRITICAL CONCEPT:
Multipliers are applied to
Crop Application Goal

Full Season Soybeans:
 40 bu/ac @ 100 ac

Core NM:

40 bu/ac x 0.12 lbs N/bu x 1.0 x 100 ac =

480 lbs N applied

40 bu/ac x 0.33 lbs P/bu x 1.0 x 100 ac =

1,320 lbs P applied

Non NM:

40 bu/ac x 0.12 lbs N/ac x 1.2 x 100 ac =

570 lbs N applied

40 bu/ac x 0.33 lbs P/bu x 1.5 x 100 ac =

1,980 lbs P applied

Data provided by [Phase 6.0 Nutrient Management Expert Panel](#)

Nitrogen Supplemental Nutrient Management

*Pre-requisite: *Applications made in accordance with all elements of the Nitrogen Core practice**

Rate

One or more of the following practices implemented:

- Application rate < land-grant university recommendations.
- Applications split across the growing season, *resulting in lower-than-planned applications.*
- Applications are made using variable rate goals, *resulting in lower-than-planned applications.*

Placement

One or more of the following practices are implemented:

- Applications of N are injected into the subsurface or incorporated into the soil.
- Applications of N are made with setbacks from surface water features.

Timing

- Split across the growing season into multiple applications

CRITICAL CONCEPT:
Supplemental NM is applied to Edge of Stream Delivery

NM Supplemental Percent Reductions

(Only after Core NM is applied)

CRITICAL CONCEPTS:

Supplemental NM is applied to Edge of Stream Delivery

N Fixation is the Main Driver of N Loads for Soybean Land Use

Land Use	Nutrient Management BMP			Nutrient Management BMP		
	N Rate Supplemental	N Placement Supplemental	N Timing Supplemental	P Rate Supplemental	P Placement Supplemental	P Timing Supplemental
Full Season Soybeans	0%	0%	0%	5%	10%	1%
Grain w/ Manure	15%	5%	10%	10%	20%	20%
Grain w/o Manure	5%	3%	5%	5%	10%	1%
Legume Hay	0%	0%	0%	1%	10%	1%
Silage w/ Manure	15%	5%	10%	10%	20%	20%
Silage w/o Manure	5%	3%	5%	5%	10%	1%
Small Grains and Grains	5%	3%	10%	5%	10%	1%
Small Grains and Soybeans	5%	3%	10%	5%	10%	1%
Specialty Crop High	15%	5%	5%	5%	10%	1%
Specialty Crop Low	5%	3%	5%	5%	10%	1%
Other Agronomic Crops	5%	3%	5%	5%	10%	1%
Other Hay	0%	3%	5%	0%	10%	1%
Pasture	0%	0%	0%	0%	0%	0%

Data provided by [Phase 6.0 Nutrient Management Expert Panel](#)

What is
Driving N
Loads
Increases?
(attributable to
soybeans in CAST-19)

Agricultural Loading Rates?

- Ag Loading Rate Review Steering Committee:
 - [Agricultural Loading Rates](#)

Ag Census (i.e., Source Of Crop Data) ?

- 2017 Ag Census (input for CAST-19)

NM BMP Recommendations?

- Changing an Approved Expert Panel Recommendation Must Follow Science (BMP Protocol)
 - [Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model](#)

Agricultural Loading Rates

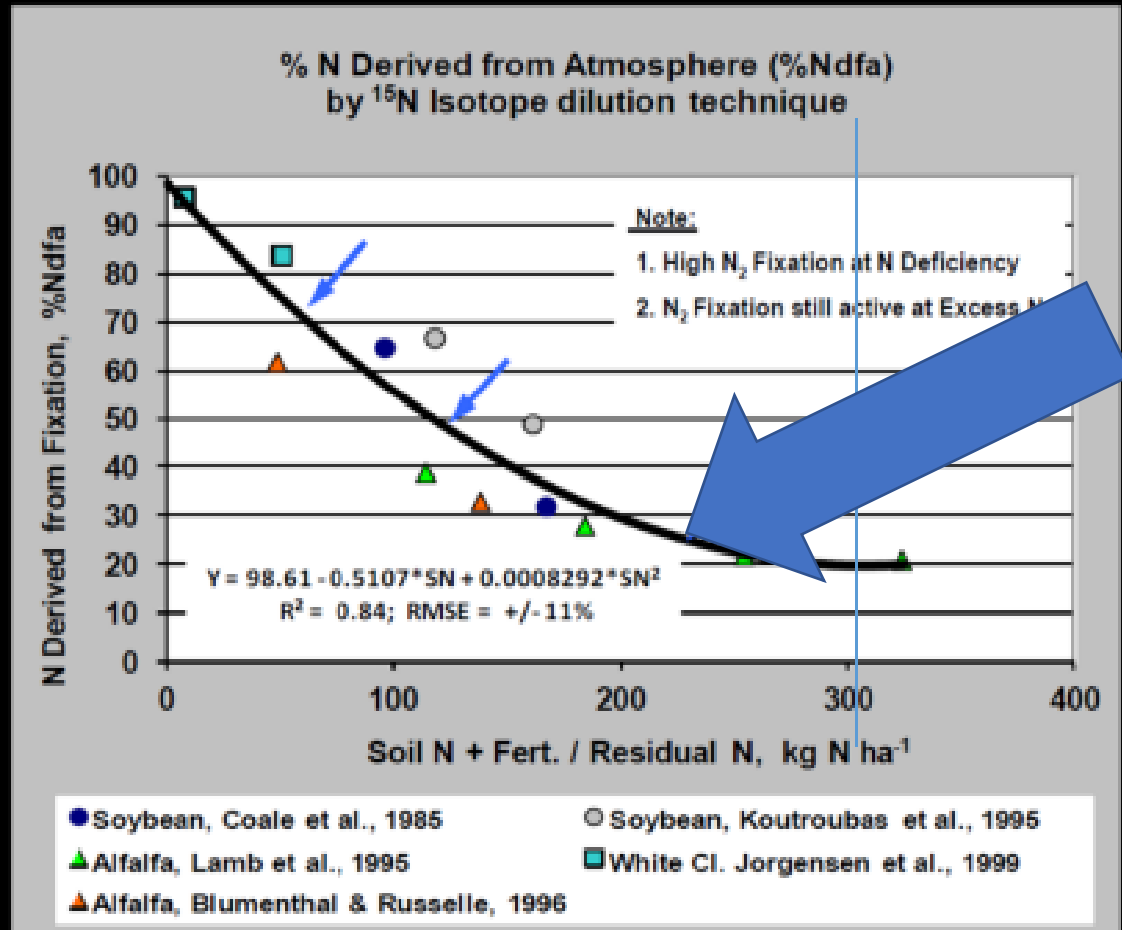
Based on Available Literature &
Best Professional Judgement

(Phase 6 Ag Loading Rate Review Steering Committee)

“N losses from soybeans are only somewhat lower than corn, because N fixation inputs (which are poorly characterized) are apparently substituting for fertilizer inputs.” (p.11)

ACTION: Clarify with CBPO how the simulation of how N assumptions are handled in the model (e.g. reduction of N fixation in the model with applied N).

Estimating N₂ Fixation: Percent of Crop N Yield from N₂ Fixation and Influence of Soil N



CRITICAL CONCEPTS:

N Fixation is the Main Driver of N Loads for Soybean Land Use

Increase in Soil N or Applied N Will Decrease N Fixation

One Supplemental BMP @ 5% efficiency would remove more N than was applied. NM controls applied nutrients.

Figure 3-15: Nitrogen fixation as a percent of crop yield

Census of Agriculture

Concern Regarding
Accuracy of Ag Census
Crop Acres

Spatially Distributed Land Use
from the Land Cover/Land Use
Data Team Starting With the
CAST-21 Could Mitigate Concern

Method of Modeling Double-
Crop Soybeans Approved by
CBP Partnership

Determined Sound by USDA-NASS

CAST-21 Workplan
TASK 4

CAST-21 Workplan
TASK 5

NM Expert Panel Recommendations

Land Use:
Full-Season Soybeans

NM on Soybeans Controls for P (*not N*)

Land Grant Universities Do Not Recommend N Application (Via Fertilizer or Manure)

Core NM BMP → **N & P**

- Applies to Crop Application Goal (What is Applied/Distributed to Crop)
 - Small CAG for N on soybeans allows for appropriate distribution of nutrients across land uses (see reference slides)

Supplemental NM BMPs (Rate, Timing, Placement) → **P only**

- Applies to Soybean **Edge-of-Field Total N Load**
 - **TN Load is Primarily Residual N From Fixation**
 - Applied (CAG) N is Tiny Fraction of TN Load
- Rate: Excess N Reduced is Still Excess N Subject to Loss...
- **Timing & Placement** of Excess N Irrelevant (Still Subject to Loss)

ACTION:

PA will work on gathering information to better understand what real-world soybean management looks like. Other jurisdictions are encouraged to do the same.

PA

Nutrients are being applied to full season soybeans in advance of planting.
Model's assumption of applied nutrients to these fields is conceptually correct.

MD

Statewide average (2020): 2.5 lbs N of manure/per acre.
Statewide average (2020): 6.9 lbs. N of commercial fertilizer per acre.
Numbers do not take yield into consideration.

NY

N application not recommended but sometimes unavoidable.
Guidelines available if N must be applied.

VA

N application not recommended.
Emergency disposal guidelines for manure.
Applications of N fertilizer for high yielding soybeans (90 bu/ac) may occur, but unusual.

Soybean Crop Application Goal

Full Season Soybeans

- 0.12 lbs N/bu (~5.7 lbs N/ac)
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Assumption: “Nitrogen application is not recommended for soybean production, however, **use of commercially available fertilizer formulations may result in application of up to 50 lb N / acre when fertilizer formulation and application rate is determined by crop P2O5, K2O, S, or other nutrient needs.** Organic waste nitrogen application to full-season soybean is not recommended because it is an agronomically inefficient use of applied nutrients. Organic wastes should only be applied to small grain - double-crop soybean rotations at rates and timings to supply the recommended nitrogen rate to the small grain crop.” – [UME SFM-1](#)

ACTION: Obtain E3* clarification related to NM on full-season soybeans for communication to the AgWG and CBP stakeholders.

* E3 = Everything by Everyone Everywhere

Does the 0% N supplemental NM efficiency for full season soybeans inhibit WIP goals due to E3 assumptions?

Does the 0% N supplemental NM efficiency for full season soybeans inhibit WIP goals due to E3 assumptions?

Short answer: No

CRITICAL CONCEPT:

All approved BMPs with approved effectiveness values are a part of E3 scenario, including:

- Supplemental N Nutrient Management for ag land uses.
 - Efficiency for edge-of-stream loss ranges 0%-15% (depending on land use)
 - **E3 assumes 0% N efficiency for full season soybeans** (per Expert Panel report)

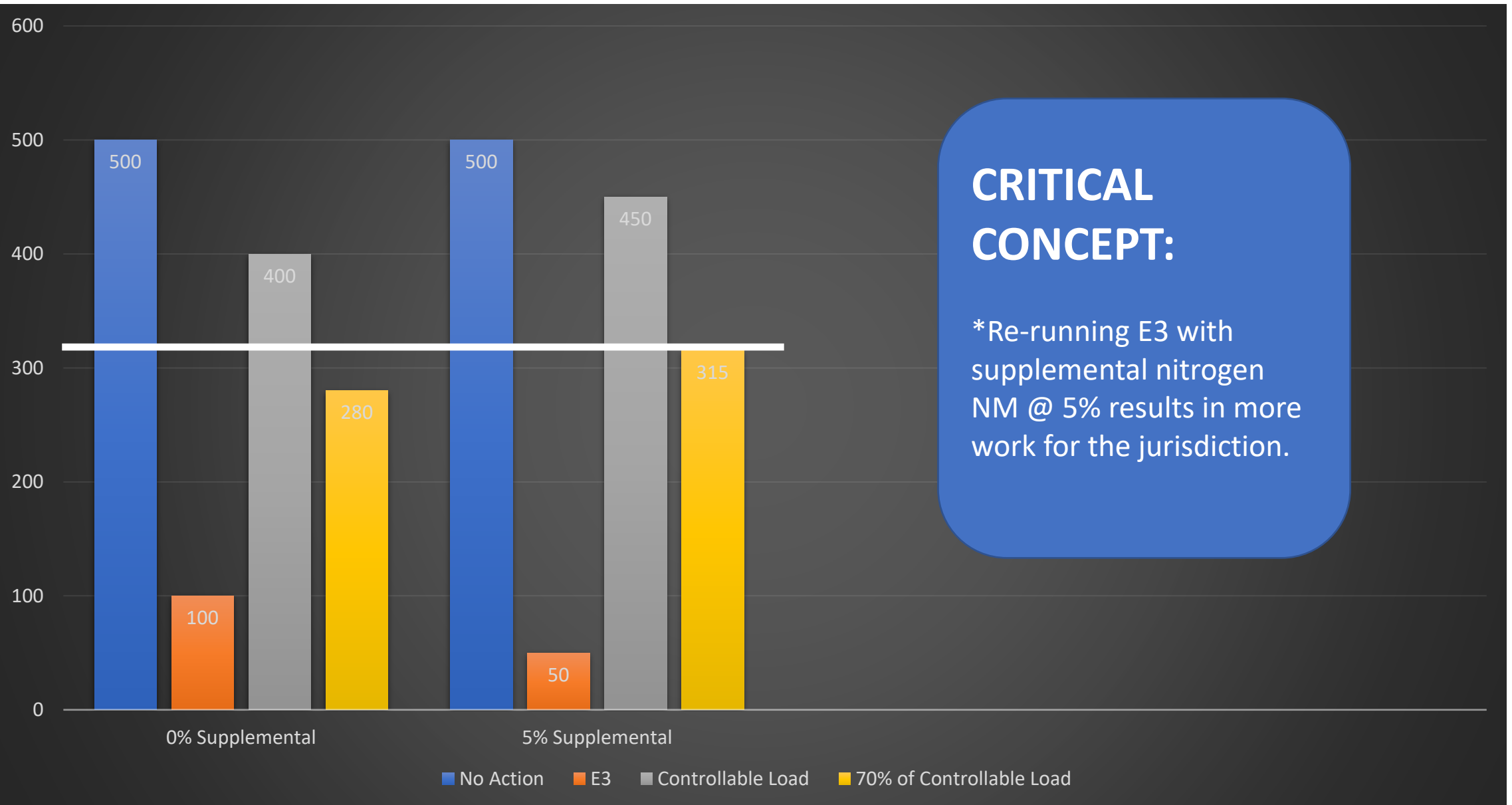
WIP III SNAPSHOT:

Nutrient Application Management Core **Nitrogen**

State	2019 Progress % Implementation	WIP 2025 % Implementation
DE	70.90%	85.00%
MD	64.90%	63.10%
NY	8.70%	20.50%
PA	12.20%	70.20%
VA	20.80%	49.10%
WV	22.00%	22.40%

<https://cast.chesapeakebay.net/Reports>

Pulled 04/13/21



<i>Agriculture Practices</i>	Duration	Unit	Delaware (CBWS Portion Only)	Delaware (CBWS Portion Only)	Maryland (CBWS Portion Only)	Maryland (CBWS Portion Only)	New York (CBWS Portion Only)	New York (CBWS Portion Only)	Pennsylvania (CBWS Portion Only)	Pennsylvania (CBWS Portion Only)	Virginia (CBWS Portion Only)	Virginia (CBWS Portion Only)	West Virginia (CBWS Portion Only)	West Virginia (CBWS Portion Only)
			2019 Progress	WIP 3 CAST-2019 version	2019 Progress	WIP 3 CAST-2019 version	2019 Progress	WIP 3 CAST-2019 version	2019 Progress	WIP 3 CAST- 2019 version	2019 Progress	WIP 3 CAST-2019 version	2019 Progress	WIP 3 CAST- 2019 version
Nutrient Application Management Core Nitrogen	annual	Acres	70.90%	85.00%	64.90%	64.10%	8.70%	20.50%	12.20%	70.20%	21.80%	49.10%	22.00%	22.40%
Nutrient Application Management Rate Nitrogen	annual	Acres	0.00%	60.00%	20.00%	28.40%	7.50%	20.50%	0.90%	11.90%	1.70%	39.20%	0.00%	0.00%
Nutrient Application Management Placement Nitrogen	annual	Acres	0.00%	60.00%	6.20%	18.30%	7.80%	20.50%	0.00%	9.80%	0.40%	22.40%	0.00%	0.00%
Nutrient Application Management Timing Nitrogen	annual	Acres	0.00%	60.00%	3.90%	8.10%	7.30%	20.50%	0.00%	14.60%	1.30%	22.40%	0.00%	0.00%

<https://cast.chesapeakebay.net/Reports>

Pulled 04/13/21