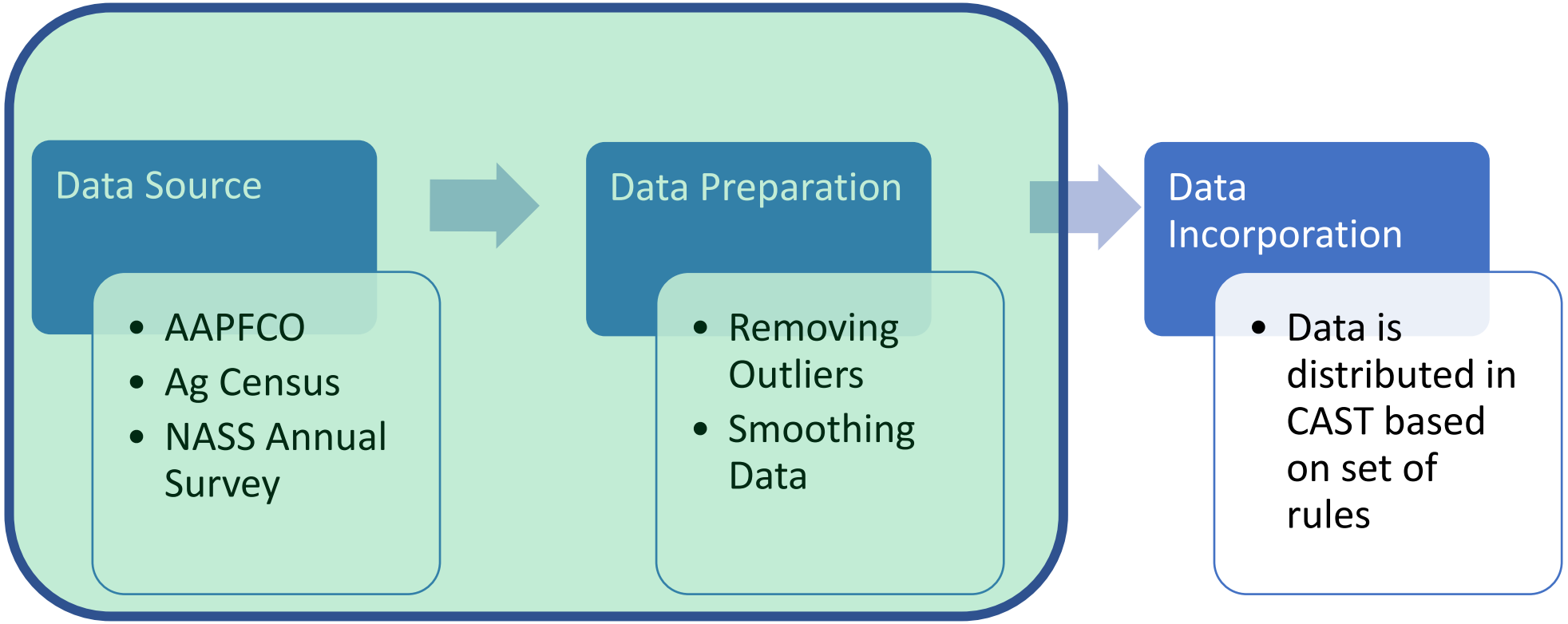
Sourcing and Preparing Ag Fertilizer Data: Phase 6 Watershed Model

Agriculture Workgroup

March 17, 2022

For Today:

- Phase 6 Agricultural Modeling Subcommittee
- Where does CAST fertilizer data come from?
- How does the CBPO prepare data to estimate ag fertilizer use?



Phase 6 Agricultural Modeling Subcommittee (AMS)

- Provided enhanced ag modeling assistance
- Supported technical decisions for development of Phase 6 modeling tools for:
  - Agriculture Workgroup
  - Expert Review Panels
- Decisions (2015-2017)

- Phase 7 AMS
  - *Charge, membership & function TBD with AgWG*

Where does CAST fertilizer data come from?

- **AAPFCO:** Association of American Plant Food Control Officials

- **Provides the following fertilizer sales information per year:**
  - county of sale
  - tons of fertilizer sold
  - designated use: farm, non-farm or unknown
  - conc. of nutrients in fertilizer sold (translated into mass of total N & total P phosphorus)
  - **(sales = tons of total N or total P sold)**

Why is AAPFCO data used?

Rationale From AMS:

- No reliable data source for countywide inorganic fertilizer
- Other organizations (e.g., NuGIS*, USGS SPARROW) use AAPFCO data for countywide estimates
- AMS developed a fertilizer use estimation procedure/methodology

*Nutrient Use Geographic Information System (NuGIS) presents cropland nutrient balances for the conterminous United States of America from 1987

How does the CBPO prepare AAPFCO data for use in CAST?

Ag Fertilizer Data is summed to CBW then redistributed at county-level

AAPFCO data cannot be directly used to estimate fertilizer use in a county

- Fertilizer sales area does not necessarily equal fertilizer use area
  - Fertilizers may cross state or county lines after sale
- Reliability of sales data varies year-to-year
  - Data may be missing
  - Designation may be missing (farm, non-farm, unknown)

How does the CBPO prepare AAPFCO data for use in CAST?

Step 1:

Remove outliers and smooth variability of fertilizer sales from AAPFCO through history

Step 2:

Calculate a regionwide fertilizer amount by summing all states

Step 3:

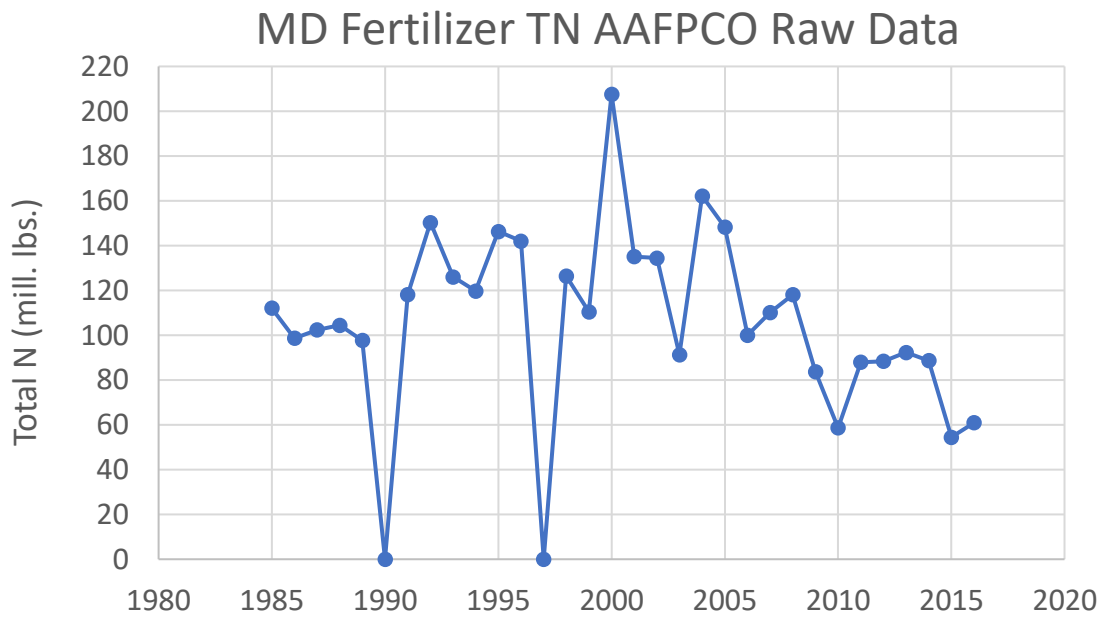
Estimate pounds of farm fertilizer nutrients in CBW

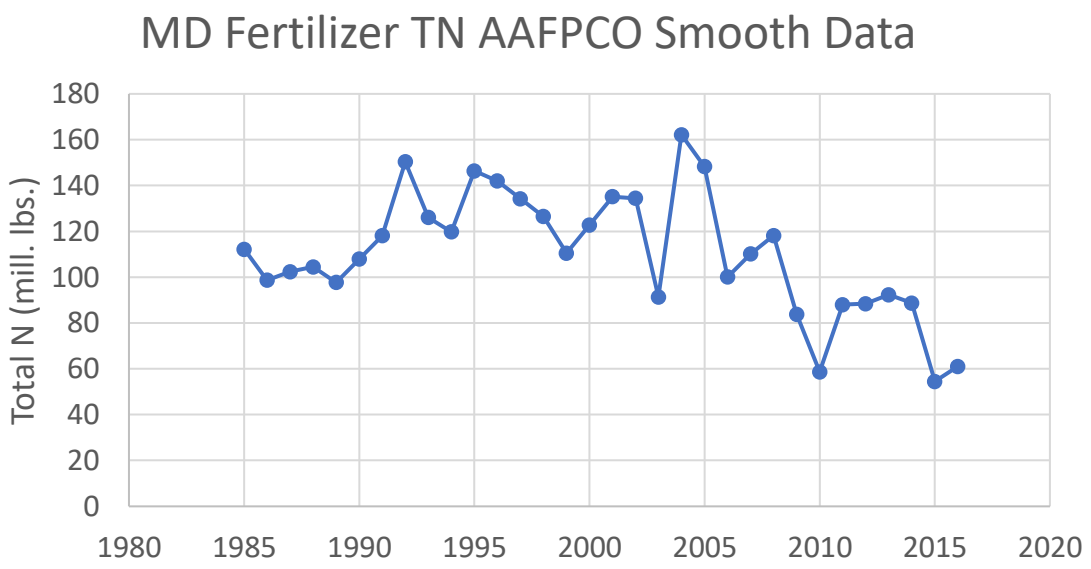
https://cast-content.chesapeakebay.net/documents/P6ModelDocumentation%2F3TerrestrialInputs.pdf **(Section 3.5 Inorganic Fertilizer Nutrients)**

How does the CBPO prepare AAPFCO data for use in CAST?

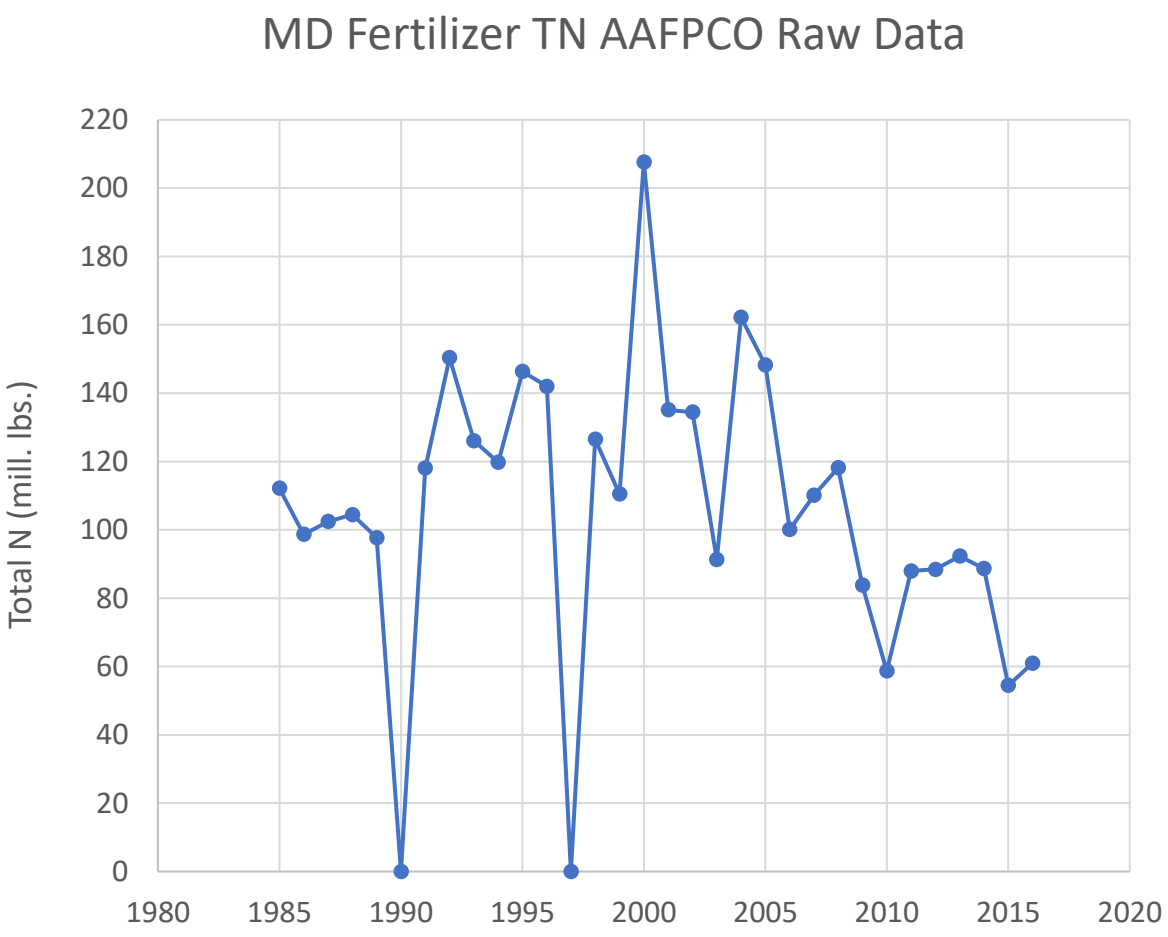
Step 1: Remove outliers and smooth variability of fertilizer sales from AAPFCO through history

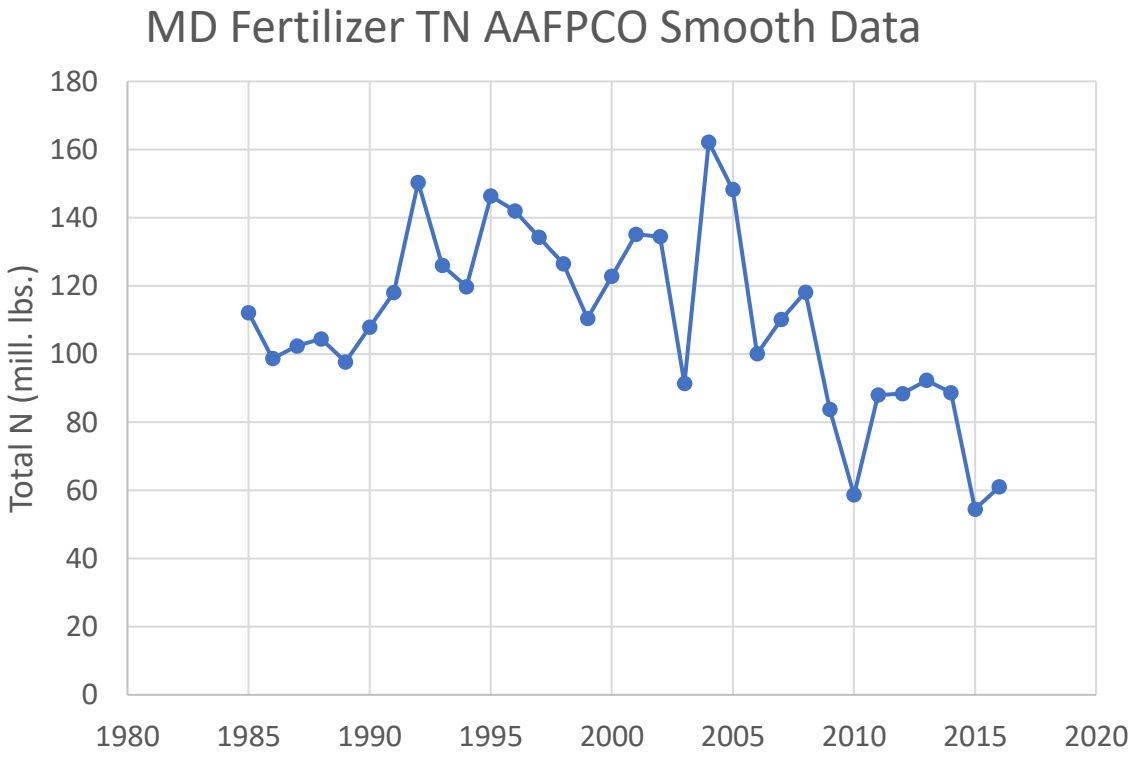
- Sum annual data for each nutrient type **by state** for all six states for areas inside and outside of the CBW
- Calculate median and standard deviation for each nutrient and flag outliers





Step 1: Remove outliers and smooth variability of fertilizer sales from AAPFCO through history





How does the CBPO prepare the data for use in CAST?

Step 2: Calculate a regionwide fertilizer amount by summing all states

- Calculate the fraction of farm fertilizer from total fertilizer.

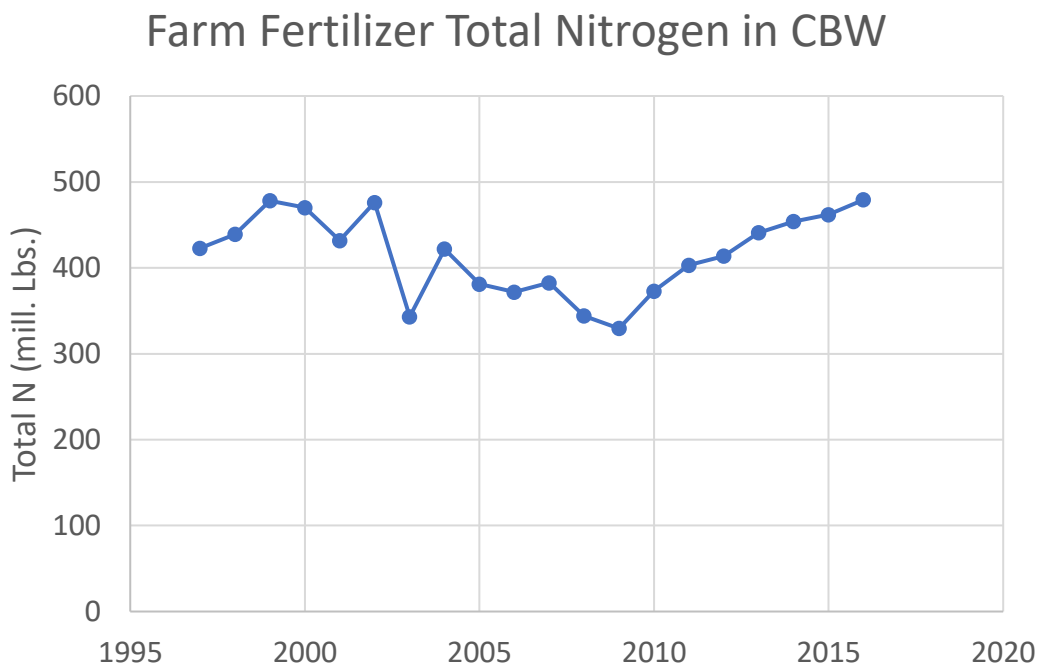
  FarmFractionNsales = (FarmNsales Lbs.) / TotalNsales
- Apply a rolling average to farm fraction to smooth any variability between years.
- Use the final farm fraction to calculate a value for farm N and P use.
- This becomes the **farm fertilizer amount for the entire six-state region**

How does the CBPO prepare the data for use in CAST?

Step 3: Estimate pounds of farm fertilizer nutrients in the CBW-only

Ag Census → "dollars spent on fertilizer and soil conditioners" by county

- calculate the **fraction of $ spent by CBW counties** from $ spent for all Bay state counties
- Determine CBW pounds of fertilizer: *(CBW $ fraction) x (regionwide fertilizer amount)*



How does the CBPO prepare data to estimate fertilizer use?

Fertilizer data is distributed based on crop yield & crop acres

- USDA 5-Year Census of Agriculture
- NASS Annual Surveys

How does the CBPO prepare data to estimate fertilizer use?

USDA 5-Year Census of Agriculture

- Crop Acres by County
  - Used with high-resolution mapped land cover data to improve land use assumptions*
  - Used with yield data & crop application goals to allocate annual fertilizer & manure applications across the watershed
- Yield Data for Minor Crops
  - Remove outliers

*5/20/21 DECISION: The AgWG supported adoption of land use methodology for determining the change in total agricultural area from 2013 to 2017→ proportioning of NASS crop types and pasture types to the spatially explicit crop and pasture acreages mapped in the high-resolution land use for 2013 and 2017.

How does the CBPO prepare data to estimate fertilizer use?

National Agricultural Statistics Service (NASS) Annual Surveys

- Incorporated every two years (milestone)
  - When the watershed model "opens" for changes (i.e., CAST-17, -19, -21)
- Yield data for the following major crops:
  - Alfalfa Hay; Barley; Buckwheat; Corn for Grain; Corn for Silage; Oats for Grain; Rye for Grain; Sorghum for Grain; Sorghum for Silage; Soybeans for Beans; and Wheat for Grain
    - Remove outliers
    - Average the highest 3 out of previous 5 years

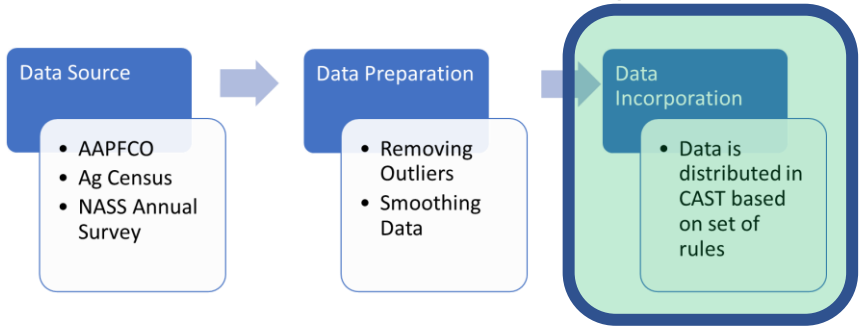
Appendix C. Establishing Yield Goals for Major Crops
https://cast-content.chesapeakebay.net/documents/P6ModelDocumentation%2F3ABCDG_TerrestrialInputsAppendices.pdf

Next: USDA-NASS on Crop Data

Followed by Questions & Discussion

Reference Slides

How is fertilizer data incorporated in CAST?



Step 4: Model distributes CBW fertilizer bucket to individual counties:

- Distribution is proportional to each county's crop acres, crop yields & *Crop Application Goals*
- Inorganic fertilizer applications are made to higher-value commodity crops before hay and pasture
- Available manure is distributed before fertilizer

Application Rate Calculation

Application rate is referenced in terms of **ratio applied**, the ratio of an estimate of the *amount of nitrogen and phosphorus available to be applied* with the amount that *should be applied in typical situations*. Sometimes, ratio applied is greater than 100%, indicating that more nitrogen and phosphorus are available than is necessary to achieve a crop yield in that typical situation.

- The amount of nitrogen available is derived from animal counts (manure sources) and fertilizer sales (inorganic sources).
- Example:
  - The amount of nitrogen available is 150 lbs
  - The typical amount needed is 100 lbs
  - The ratio applied is 150/100 or 150%
- Crop yield may be measured in bushels, tons, bales, etc. depending on the crop.
- Typical rate = TN lbs / crop yield
  - Data provided by states, typically drawn from land grant university recommendations + an increase for non-nutrient management amounts
- Actual rate = Typical rate * (NASS yield / acre)
- Actual rate = (TN lbs / crop yield) * (NASS yield / acre)
- Timing and specification of organic or inorganic are also factors

Table 34. **Specified Crops Harvested - Yield per Acre Irrigated and Nonirrigated: 2017**

[Totals may not add due to rounding. For meaning of abbreviations and symbols, see introductory text.]

Crop	Entire crop irrigated			Part of crop irrigated				None of crop irrigated		
	Farms	Acres	Average yield per acre	Farms	Acres irrigated	Acres not irrigated	Average yield per acre	Farms	Acres	Average yield per acre
Barley for grain (bushels)	2,638	602,296	110.6	463	131,049	125,695	75.2	8,087	1,347,766	56.2
Corn for grain (bushels)	14,786	4,996,223	193.0	20,560	7,372,651	7,811,690	175.3	259,455	64,558,998	61.2
Corn for silage or greenchop (tons)	6,360	1,356,605	25.6	1,248	204,704	219,902	20.6	51,892	4,328,203	17.8
Cotton, all (bales)	3,442	1,932,082	2.3	4,283	2,194,642	2,687,493	1.7	8,424	4,587,748	1.7
Upland cotton (bales)	3,139	1,680,384	2.3	4,279	2,193,806	2,683,888	1.7	8,428	4,591,353	1.7
Pima cotton (bales)	453	252,534	2.7	-	-	-	-	-	-	-
Dry edible beans, excluding chickpeas and limas (cwt) (see text)	1,964	351,228	25.0	251	74,800	57,505	21.7	3,193	986,603	19.2
Oats for grain (bushels)	496	31,902	77.2	117	10,205	7,587	66.2	19,229	764,446	61.2
Peanuts for nuts (pounds)	1,287	352,543	4,147.5	1,405	320,314	303,150	4,116.2	3,687	810,760	3,806.9
Rice (cwt)	4,637	2,395,054	73.6	-	-	-	-	-	-	-
Sorghum for grain (bushels)	753	145,916	86.5	939	164,488	448,964	76.4	13,647	4,310,791	68.5
Soybeans for beans (bushels)	8,328	3,624,435	56.3	16,574	5,730,230	6,038,683	52.3	278,289	74,756,132	47.3
Sugarbeets for sugar (tons)	1,259	372,174	35.5	52	9,061	25,568	28.5	2,185	743,879	28.6
Sugarcane for sugar (tons)	197	(D)	40.7	7	(D)	(D)	(D)	423	(D)	(D)
Tobacco (pounds)	419	22,836	2,393.7	407	20,806	28,438	2,238.0	5,411	259,473	2,121.9
Wheat for grain, all (bushels)	5,218	1,335,074	88.2	4,183	1,064,111	2,414,501	52.4	95,391	34,007,934	43.8
Winter wheat for grain (bushels)	3,583	831,920	84.1	3,611	859,851	2,011,146	52.1	79,402	22,483,500	47.4
Durum wheat for grain (bushels)	509	168,066	93.3	49	14,704	25,067	49.0	2,535	1,998,332	22.8
Other spring wheat for grain (bushels)	1,735	394,255	94.2	486	120,389	195,134	52.1	17,855	9,709,255	39.9
Forage - land used for all hay and haylage, grass silage, and greenchop (tons, dry equivalent) (see text)	71,795	8,880,567	(X)	12,687	1,348,771	1,903,734	(X)	715,145	44,725,550	(X)
Alfalfa hay (tons, dry)	47,971	5,595,393	4.6	5,368	572,095	645,290	3.0	205,477	11,057,171	2.3
Other dry hay (tons, dry) (see text)	28,511	2,828,924	2.5	4,921	322,019	558,958	2.2	495,537	28,886,607	1.9
Haylage or greenchop from alfalfa or alfalfa mixtures (tons, green)	3,150	419,231	6.6	613	50,637	88,714	8.2	34,760	2,714,908	7.0
All other haylage, grass silage, and greenchop (tons, green)	6,721	631,076	9.9	936	60,254	78,846	8.2	78,607	3,472,054	4.0
Land in vegetables (see text)	28,458	2,574,006	(X)	8,139	375,959	222,185	(X)	37,679	793,471	(X)
Land in orchards (see text)	61,964	4,772,593	(X)	2,436	152,240	116,766	(X)	47,555	624,001	(X)
Land in berries (see text)	15,191	202,881	(X)	795	32,449	16,305	(X)	17,933	51,563	(X)

These data are available for each county

Application Rate Calculation (cont.)

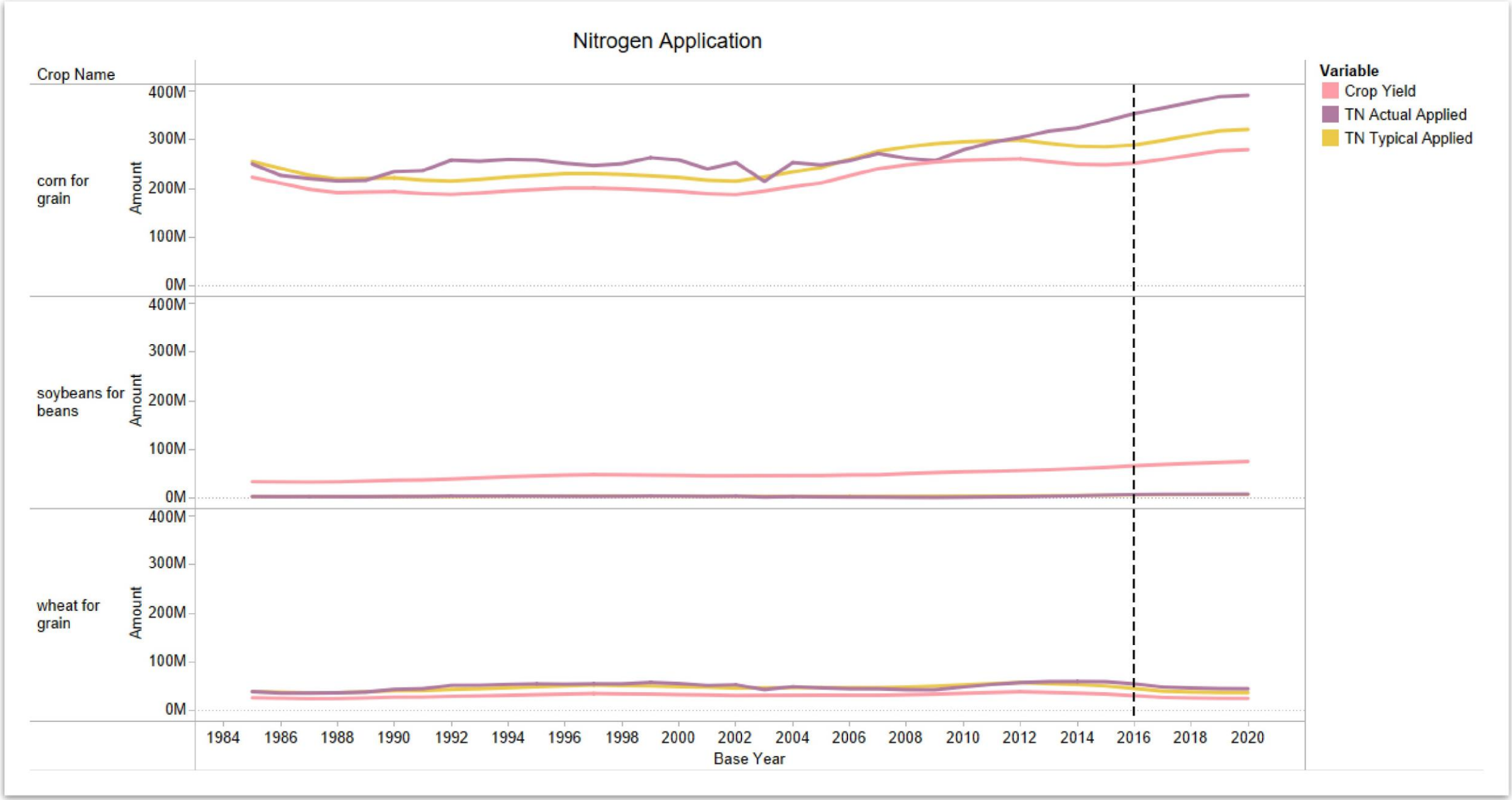
Beyond 2016

- Based on animal numbers and fertilizer sales, the amount applied in 2016 is used.
- If the amount applied in 2016 was 150% of ratio applied, then 150% will be applied in 2017 and later years.
- The same ratio is used even though the pounds vary with yields.

2016 and Prior

- The ratio applied is calculated based on manure, fertilizer sales data, and NASS yields for the progress scenario, for that year.

Timing and specification of organic or inorganic are also factors



Actual rate = (TN lbs / crop yield) * (NASS yield / acre)

https://www.chesapeakebay.net/what/event/wqgit_discussion_of_cast_2021_data_inputs_results_and_next_steps