Planting and Harvesting Crops

Chesapeake Bay Program Agricultural Workgroup's Building a Better Bay Model Workshop

05/22/2013

Gary Shenk

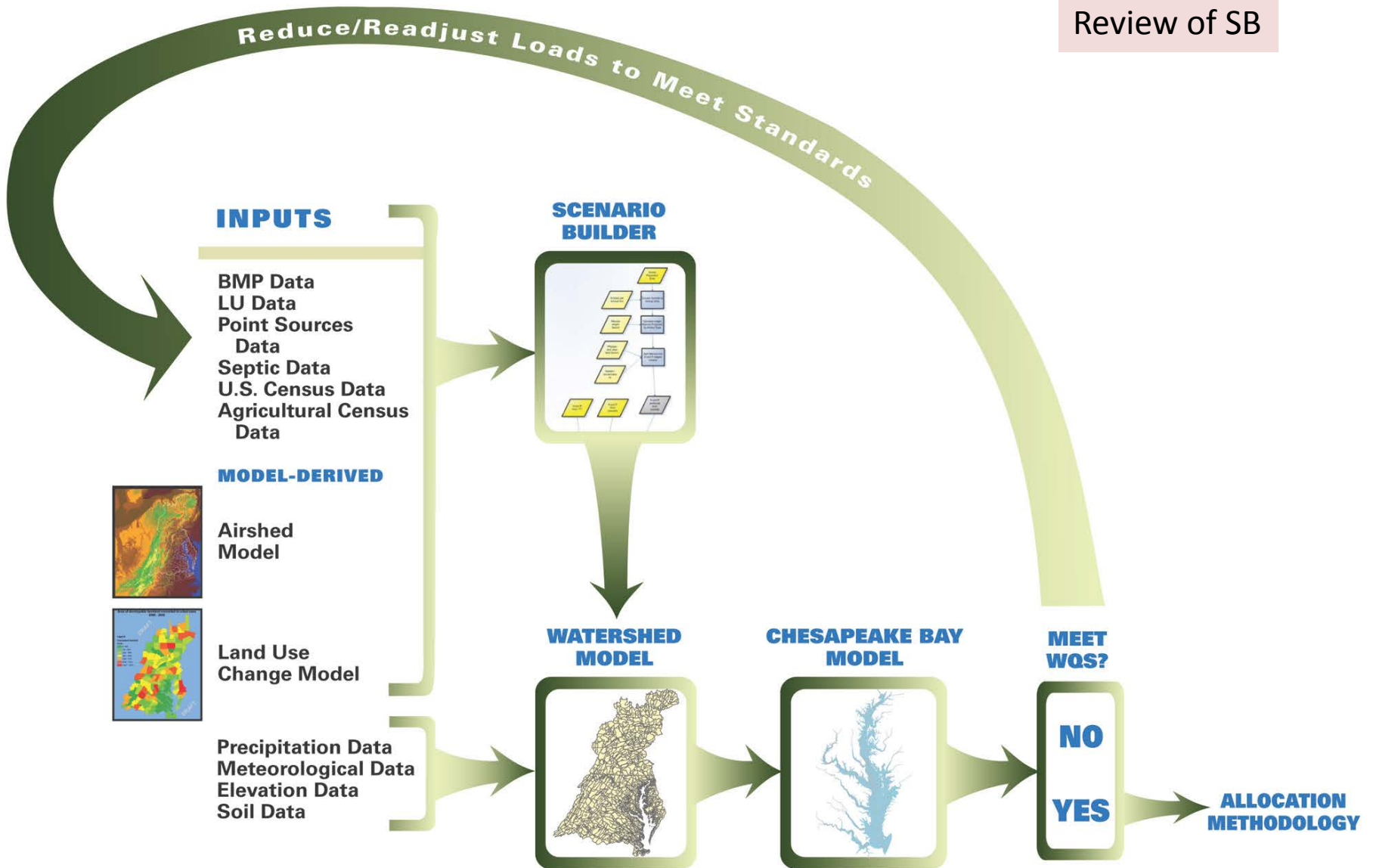Chesapeake Bay Program's Integrated Analysis Coordinator

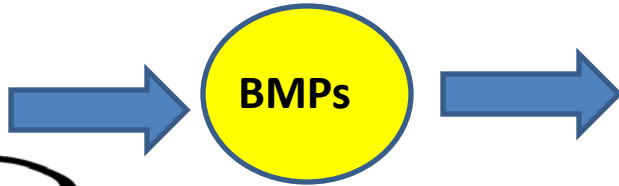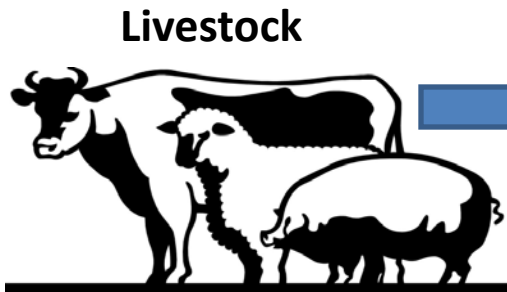Photos and graphics courtesy of USDA Image Gallery and CBP

Topics

- General review of Scenario Builder
- Placement of crops across the landscape
- Plant and Harvest Dates
- Exposed Soil and Plowing Effects
- Maximum uptake of nutrients by crops
- Nutrient application needs
- Application Timing
- Legume Fixation
- Manure and inorganic fertilizer

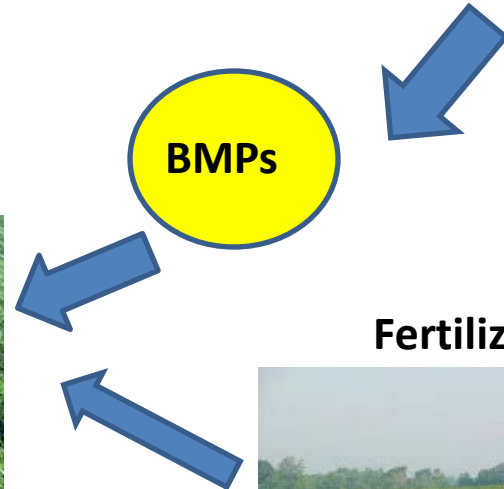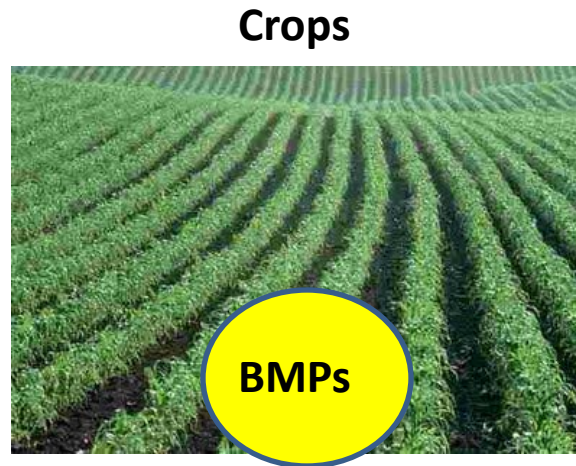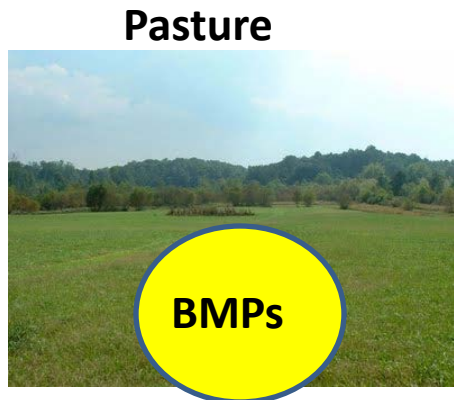# Chesapeake Bay Program Modeling Tools

Scenario Builder

Livestock

BMPs

Manure storage practice

BMPs

Crops

BMPs

Pasture

BMPs

Fertilizer

Scenario Builder Data Inputs and Outputs

Inputs

- BMP Type and location (NEIEN/State supplied)
- Land acres
- Remote Sensing, NASS Crop land Data layer
- Crop acres
- Yield
- Animal Numbers (Ag Census or state supplied)
- Land applied biolsolids
- Septic system (#s)

Parameters

(Changeable by user)

- BMP types and efficiencies
- Land use change (BMPs, others)
- RUSLE2 Data: % Leaf area and residue cover
- Plant and Harvest dates
- Best potential yield
- Animal factors (weight, phytase feed, manure amount and composition)
- Crop application rates and timing
- Plant nutrient uptake
- Time in pasture
- Storage loss
- Volatilization
- Animal manure to crops
- N fixation
- Septic delivery factors

Outputs

- BMPs, # and location
- Land use
- % Bare soil, available to erode
- Nutrient uptake
- Manure and chemical fertilizer (lb/segment)
- N fixation (lb/segment)
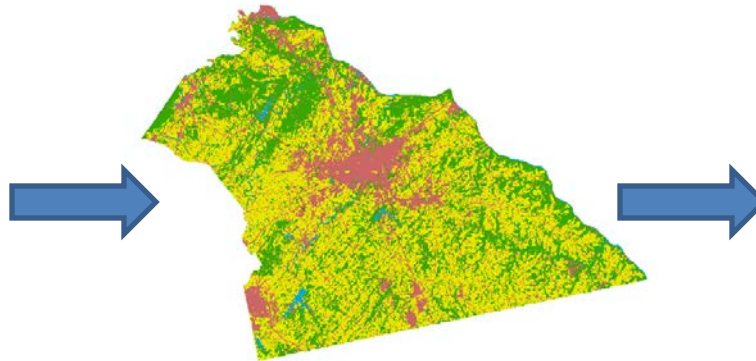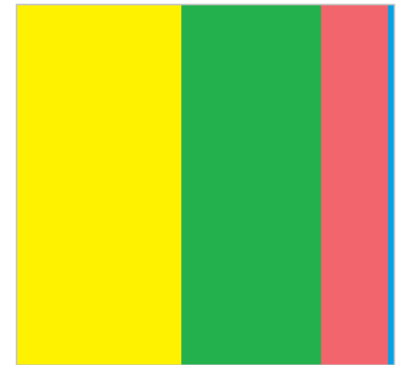- Septic loads

Digital Landscape

- Scenario Builder creates a "digital landscape" of land uses bases upon data from the Land Change Model and the USDA's Census of Agriculture.
- The new "digital landscape" is an aggregated representation of the county's land uses.
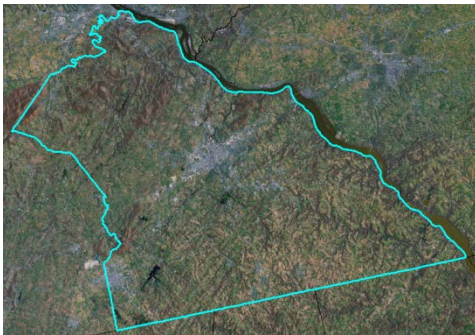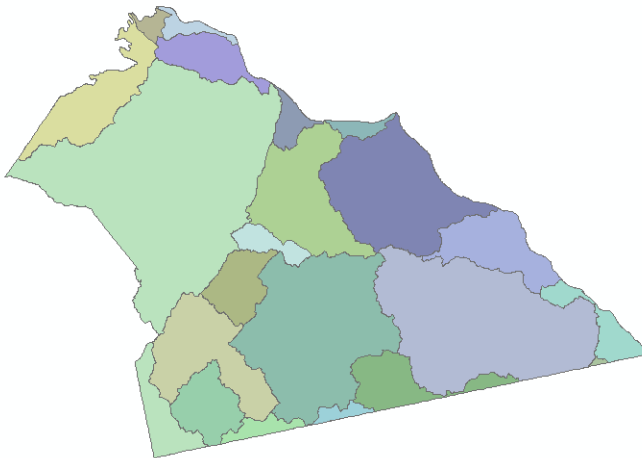

Satellite Imagery   **Land Cover**   **Digital Landscape**

Land-River Segments

Land-River Segments

Percent County Acres in LRSEG

Land-River Segment ID	Land Cover Group	Percent Acres in LRSEG
1	agriculture	1.4%
2	agriculture	0.1%
3	agriculture	0.0%
4	agriculture	3.0%
5	agriculture	0.6%
6	agriculture	0.1%
7	agriculture	0.0%
8	agriculture	25.3%

- Each county is further broken down into modeling segments that contain sets of unique sub-watershed, political and hydrogeomorphic or climatic characteristics.
- The Land Change Model provides Scenario Builder the percent of a county's agricultural acres that exist within each LRSEG.

Scenario Builder Growth Regions
Chesapeake Bay Watershed
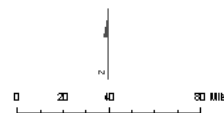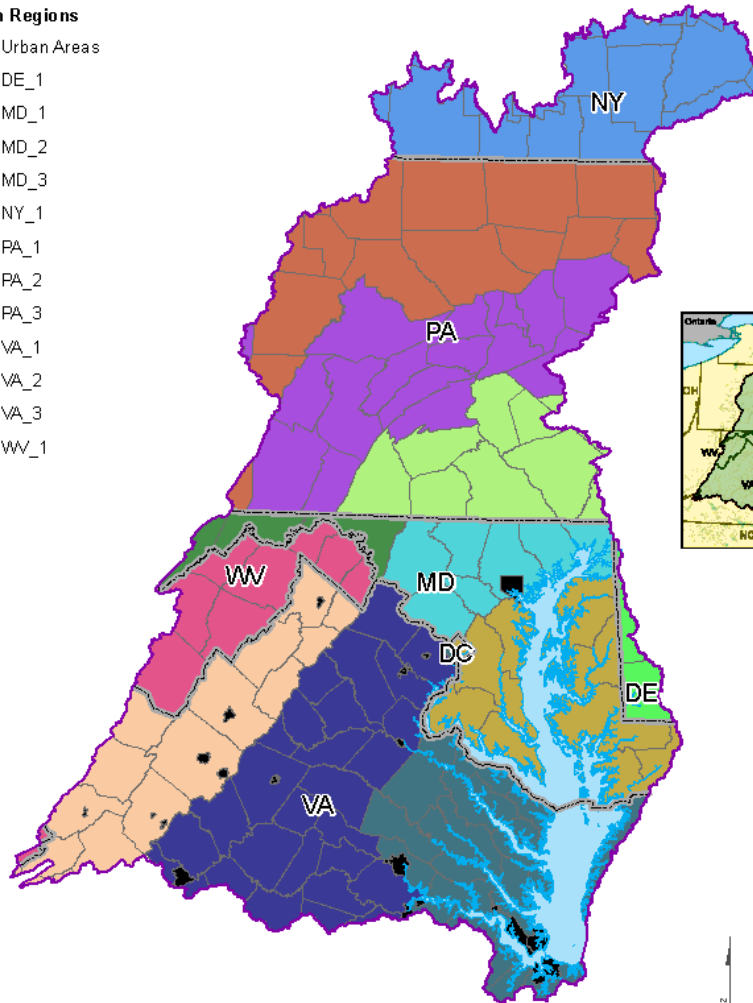
- Scenario Builder has 12 growth regions that inform plant and harvest dates for all crops based on freeze and frost data.

- State Agronomy Guides were used to determine growth regions.

- USDA 1990 Hardiness Zones were also used to determine growth regions.

Agricultural Land Uses

- **Animal Feeding Operation**
- **Concentrated Animal Feeding Operations**
- **Alfalfa***
- **High-Till without Manure***
- **High-Till with Manure***
- **Hay without Nutrients**
- **Hay with Nutrients***
- **Low-Till with Manure***
- **Pasture***
- **Degraded Riparian Pasture**
- **Nursery**

* Also has nutrient management version

- Each crop in the Census of Agriculture maps to a land use.

Crop Name	Land Use
Alfalfa Hay Harvested Area	Alfalfa
Corn for Grain Harvested Area	High-Till with Manure
Lettuce, All Harvested Area	High-Till without Manure

Census of Agriculture

- Scenario Builder uses the Census of Agriculture's acres of crops (including fallow acres) to determine the total agricultural acres for each county.

- Total agricultural acres in each county are then placed in each LRSEG according to fractions from the Land Change Model.

State	County Name	Crop Name	1997	2002	2007
DE	Kent	Corn for Grain Harvested Area	42,274	43,548	55,105
DE	Kent	Soybeans for beans Harvested Area	80,709	68,647	57,251
DE	Kent	Wheat for Grain Harvested Area	26,229	20,509	22,367

Corn, Soybeans and Wheat Harvested Acres Through Time

Placement of crops
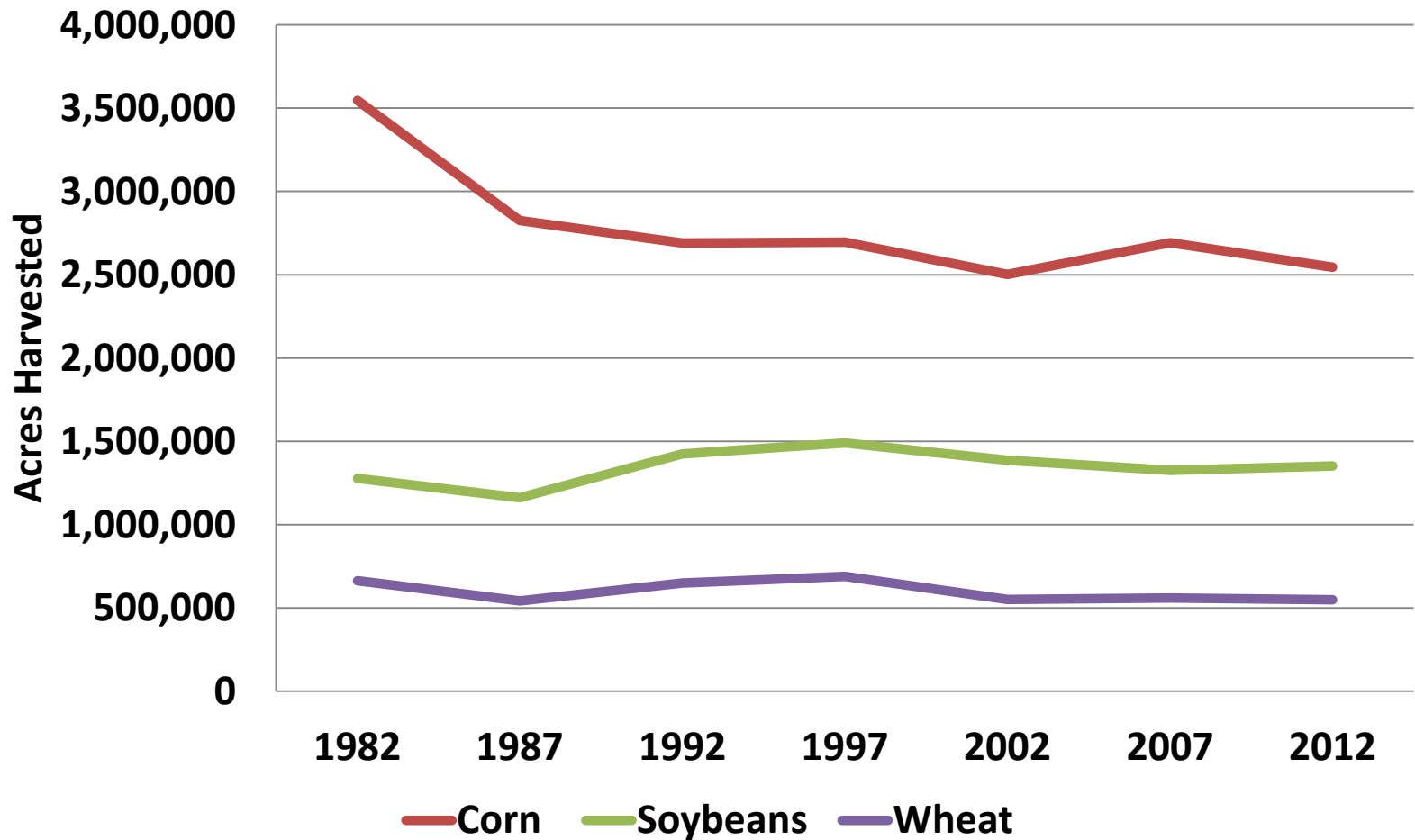
Double Cropping

- Many agricultural acres produce more than one crop per year.
- Acres of Total Harvested Area reported by the Census of Agriculture should include double cropped acres.
- Scenario Builder breaks crops into those which are eligible for double cropping and those which are not
- Scenario Builder then breaks up the Total Harvested Area amongst cropped acres and double cropped acres.

Plant and Harvest Dates

- Plant and harvest dates for crops inform timing of plant uptake, legume fixation and nutrient application.

- Data sources for plant and harvest dates include:
  - Freeze/frost data from National Climatic Data Center
  - Cooperative Extension factsheets
  - Zadok's growth stages
  - RUSLE 2 crop canopy estimates

Somerset County, MD

Crop	Plant Date	Harvest Date
Corn for Grain	5/1	10/1
Soybeans	5/1	10/1
Tomatoes	7/1	9/1

Adams County, MD

Crop	Plant Date	Harvest Date
Corn for Grain	5/1	10/1
Soybeans	6/1	10/1
Tomatoes	6/1	10/1

Hay, Alfalfa and Vegetables

- Scenario Builder currently uses only one date for planting and one for harvesting for each crop.

- Hay, alfalfa and most vegetables are harvested multiple times each year.

- First planting date and last harvest date are used for hay and alfalfa, while last planting data and last harvest date are used for vegetables.

Sediment Area Available to Raindrop Erosion

- Scenario Builder provides an aggregated area of land for each land use that is exposed and susceptible to raindrop erosion.

- Unexposed area is the greater of
  - crop canopy cover
  - crop residue cover

- Derived from RUSLE 2 for nearly 100 crop types.

Detached Sediment

- Along with the amount of land available to be eroded, Scenario Builder calculates the tons of sediment per acre that is detached by plowing.

- Detached sediment for plowing routines was informed by RUSLE 2.

Nutrient Uptake

- Scenario Builder defines nutrient uptake as all the nutrients removed from harvest AND from the roots and shoots of crops.

- **Theoretical Nutrient Uptake** values for each crop are calculated by combining Ag Census and literature.

- This theoretical uptake is transformed into **Monthly Nutrient Uptake** for each crop for each growing region based upon crop yield information and the number of growing degree days in each month.

Maximum Uptake

- Max Uptake for a crop is the 95th percentile yield multiplied by the uptake per yield unit and adjusted downward 30% for typical maximum.

- Max uptake is a theoretical maximum that applies everywhere in the basin.

Local application Rates

- States calculate "best potential yield" by crop and county
  - DE: Average the highest 4 of the 7 Ag Census yields
  - MD: Average the highest 60% of available Ag Census yields.
  - NY, PA, WV – Average highest 3 of last 5 Ag Census yields.
- The calculated value is limited to the 95th percentile of all years and counties

Application Rate – NM land

- **Maximum Application Rates** were taken from state agronomy guides or nutrient management recommendations.

- The **Maximum Application Rates** are used where the "Best Potential Yield" is greater than the 95th percentile of yields

- If the local yield is lower than the 95th percentile by 20%, then the application is lower by the same percentage.

Non-Nutrient Management Application Rate

- **Non-Nutrient Management Application Rates** are set between the maximum application rate and the local nutrient management rate:
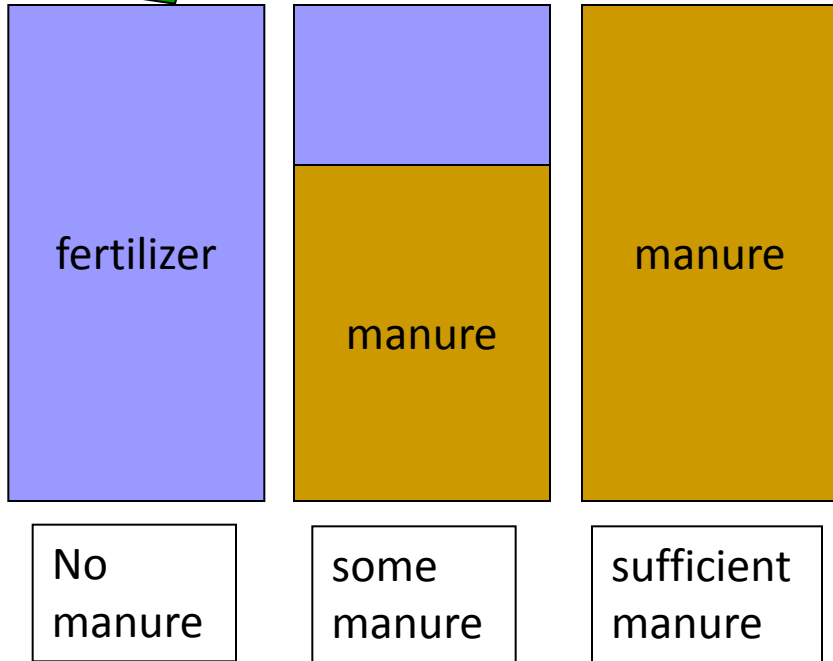
Non-nutrient management application rate =

Maximum Application Rate – ((1-fraction of Maximum Application Rate provided by organic nutrients) * 0.95 * (Maximum Application Rate - Nutrient Management Application Rate))

- This means that **Non-Nutrient Management Application Rates** in counties with sufficient organic nutrients (manure and biosolids) to fulfill crop need will be higher than in counties without sufficient organic nutrients.

NM and nonNM applications

Application Rate

Nutrient management land use

Non-Nutrient management land use

Nutrient Management Adjusted for local conditions

NM rate + 5% Toward Manure nonNM

Sliding scale

Maximum Application

fertilizer

manure

manure

fertilizer

manure

manure

manure

No manure

some manure

sufficient manure

No manure

some manure

sufficient manure
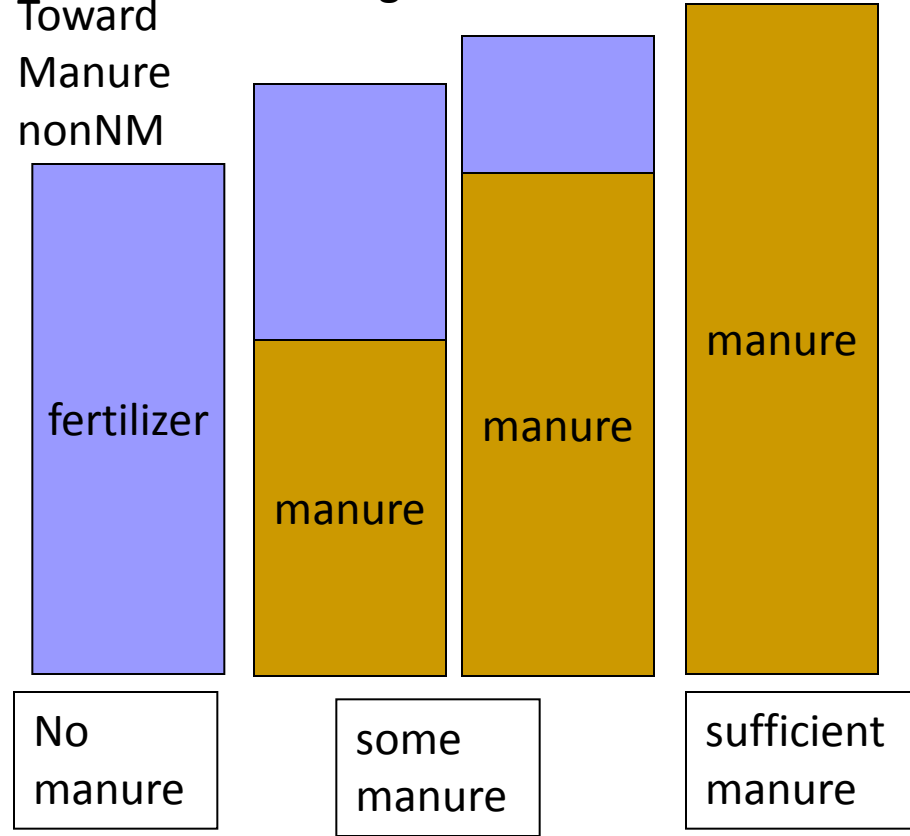
Nutrient Application Timing

- Application timing is informed by Zadok's growth stages and state nutrient management guides.
- The following methods are used in special cases:
  - If nutrient management guide recommends nutrients prior to planting, nutrients are applied **20 days before planting.**
  - If not specified, small grains, hay and pasture nutrients are applied **60 days after planting**.
  - If guides recommend application "when vines start to run," nutrients are applied **60 days after planting**.
  - If guides recommend nutrients "banded with planter," nutrients are applied **0 days after planting**.
  - If guides recommend nutrients "broadcast and disked in," nutrients are applied **20 days before planting**.

Legumes

- Some crops fix nitrogen from the atmosphere. This nitrogen fixation is accounted for in Scenario Builder as a source that fulfills a crop's nitrogen need.

Nitrogen Fixation for subset of PA crops

Crop	Nitrogen Fixation (Lbs/Acre/Year)
Alfalfa Hay	240
Green Lima Beans	300
Soybeans	130
Vetch Seed	300

Organic vs. Inorganic

- Scenario Builder "applies" both organic and inorganic nutrients to crops.
- Organic nutrients are estimated based upon animal populations, and are supplied to the crop through manure.
- Inorganic nutrients (fertilizers) are used in two ways:
  - To fulfill a crop whose need MUST be filled by inorganic nutrients as defined by agronomy guides, and
  - To fulfill the leftover crop need when all organic nutrients are applied.

Issues to Consider

- What data are available that could modify the Model's assumptions for nutrient needs, crop yields and uptake?

- What data are available from the fertilizer industry, state chemistry labs, or other sources that could inform the Model about fertilizer use across the watershed?

- Are there data available to reflect organic and inorganic nutrient use across crop types? e.g., Can we definitively say that a percent of cropland for X crop in Y county does NOT receive manure?

- What data are available that could inform how both organic and inorganic nutrients are transported throughout the watershed from sales or production sites to be used on individual farms?