Defining the Landscape

Chesapeake Bay Program Agricultural Workgroup's Building a Better Bay Model Workshop
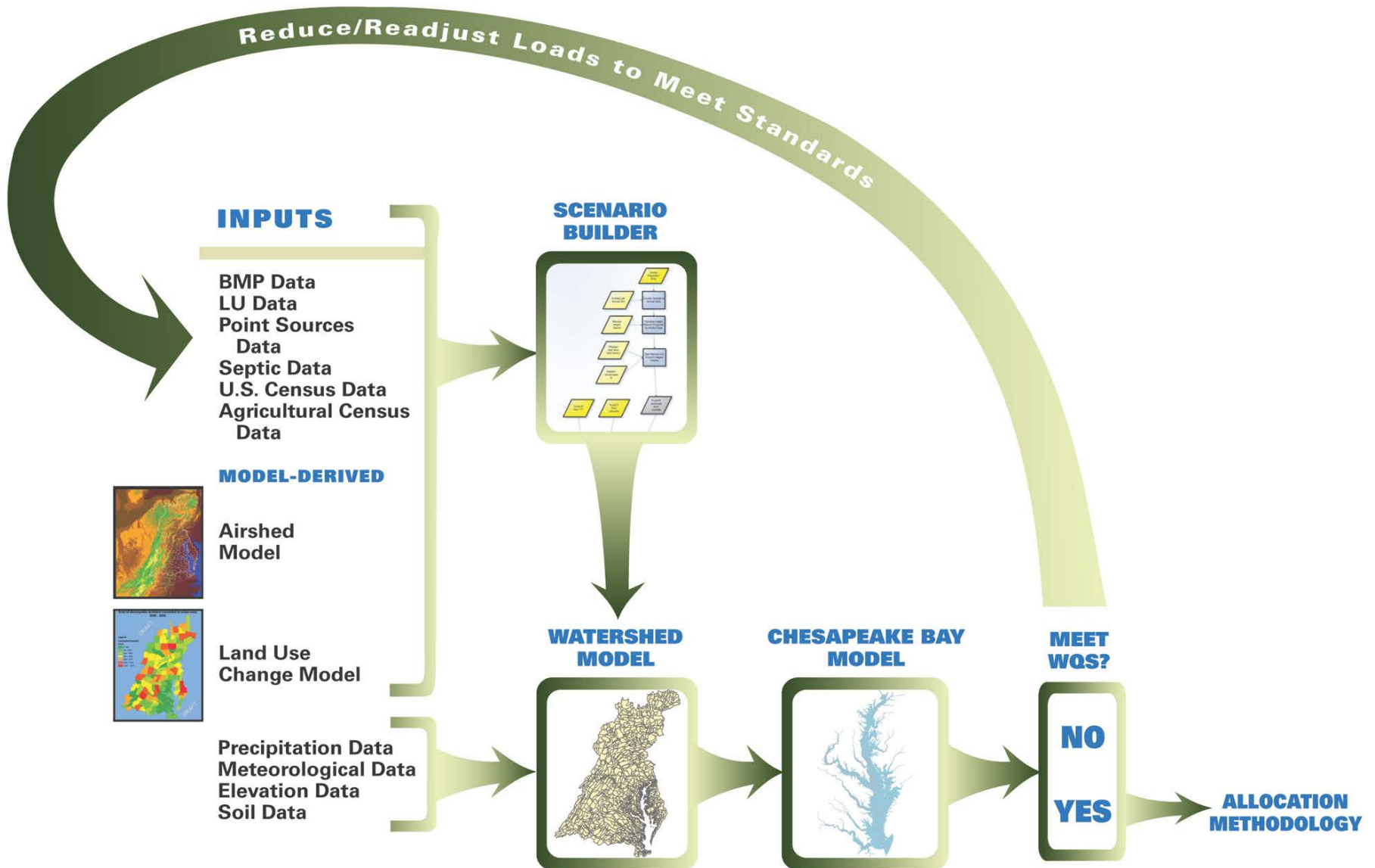
05/22/2013

Matt Johnston

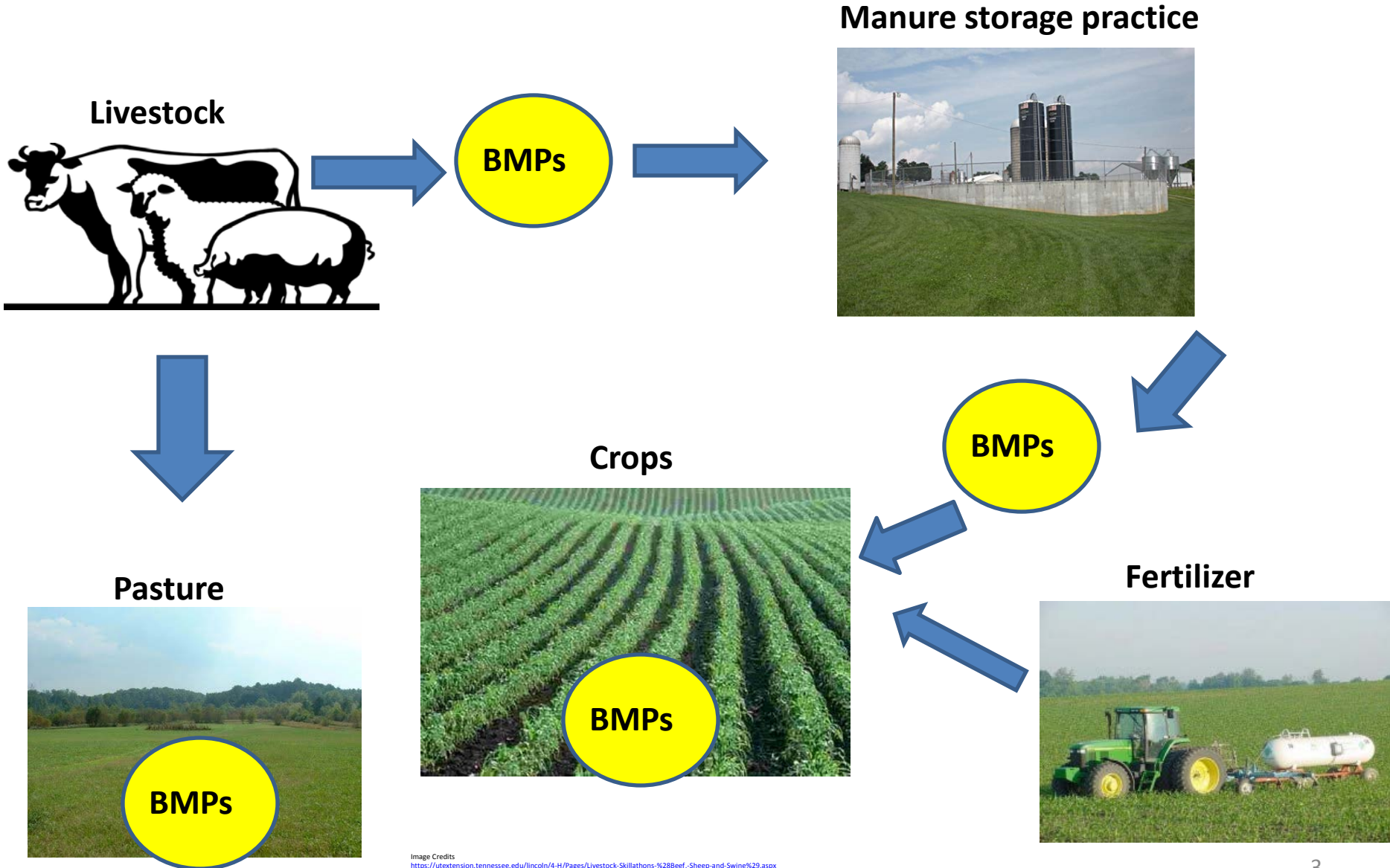Chesapeake Bay Program's Non-Point Source Data Analyst

University of Maryland

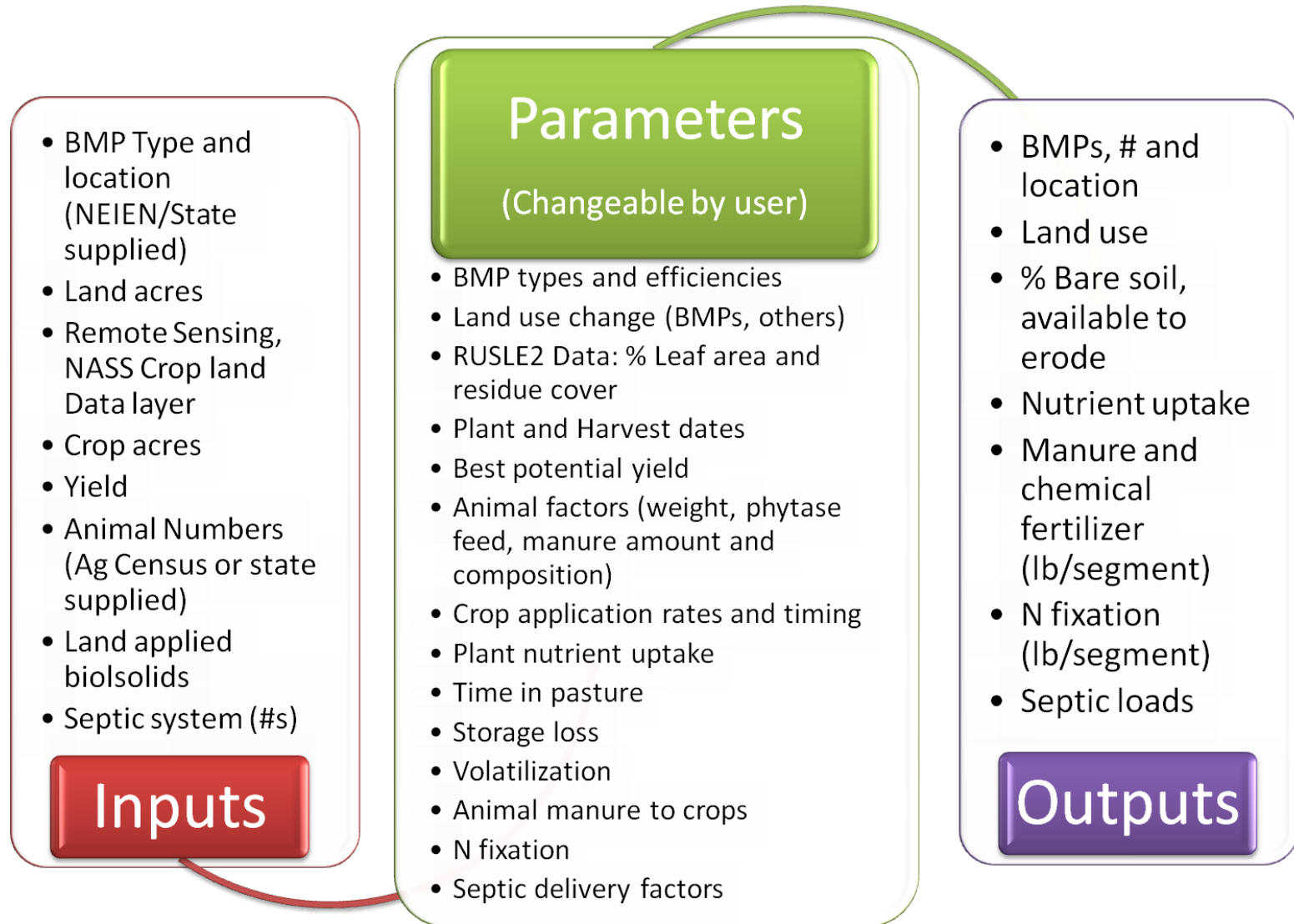Photos and graphics courtesy of USDA Image Gallery and CBP

# Chesapeake Bay Program Modeling Tools

Scenario Builder

Livestock

BMPs

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)
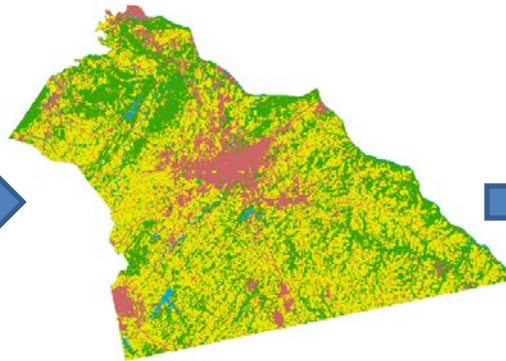- N fixation (lb/segment)
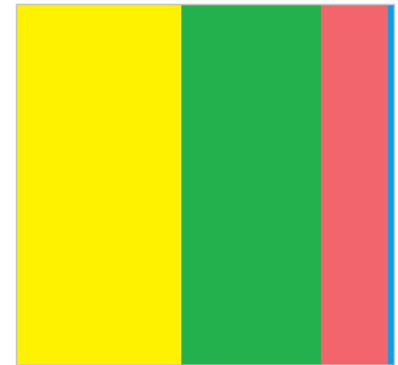- Septic loads

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.
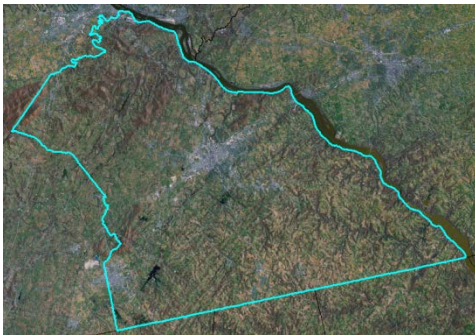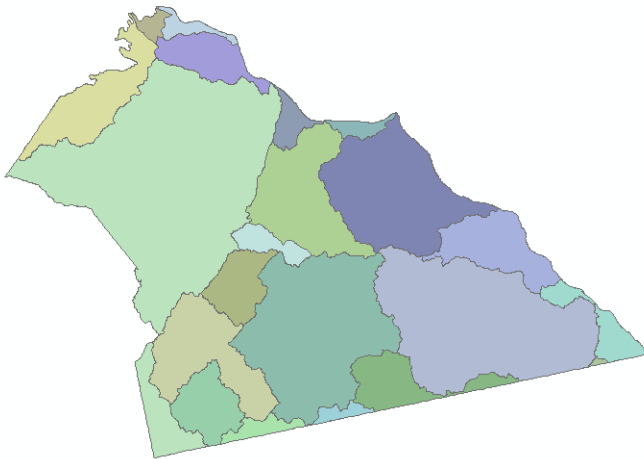

Satellite Imagery

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.

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

Watershed's Harvested Cropland Acres Over Time
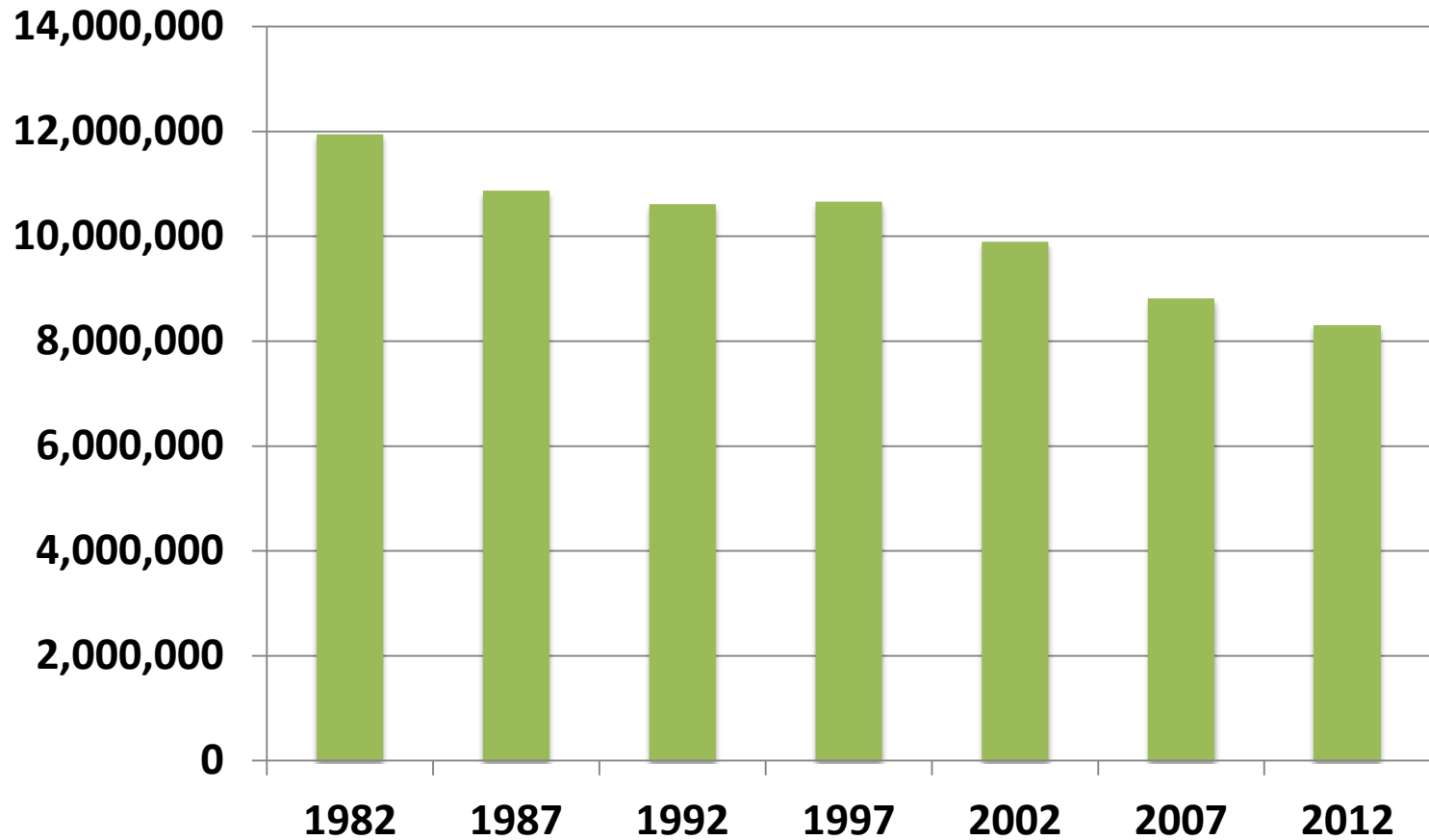
Agricultural Land Uses

- **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

Double Cropping

- In reality, 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.

- This impacts the amount of nutrients applied to the land to meet crop need of all harvested crops.

Degraded Riparian Pasture

- States defined degraded riparian pasture acreages for Tributary Strategies planning.

- Acres are removed from pasture acres.

- Direct excretion rates on degraded riparian pasture are 9 times that of regular pasture.

AFO/CAFO Land Uses

Farm Animal Type	Acres per farm
Cattle and Calves	0.5
Total Hogs and Pigs	0.2
Any Poultry	0.25
Sheep and Lambs	0.1
Milk Goats	0.05
Angora Goats	0.05

- AFO/CAFO land uses are meant to simulate production areas upon which stored manure can be lost from storage and transportation.
- Acres are not defined by number of animals. Census of Agriculture farm counts by animal type are multiplied by fractions in table to achieve animal production area acreages.

Wooded / Other

- "Wooded and Other" land use is primarily forest, but also includes other areas not classified as agricultural or developed.

- Wooded and Other is calculated as a "left over" acreage for each segment after combining acres from the Census of Agriculture with acres from the Land Change Model.

Revised Digital Landscape
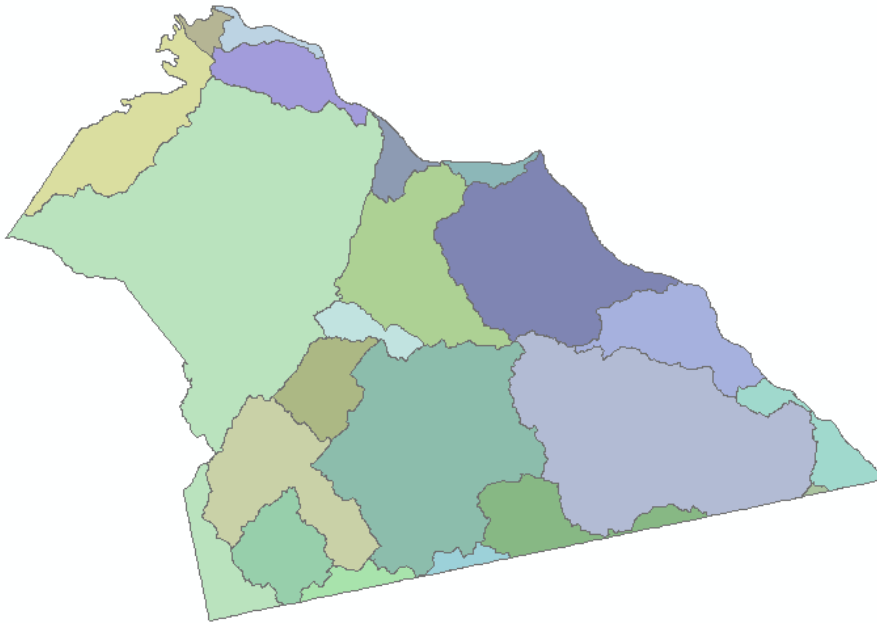
| Land Use	LRSEG Acres
AFO	5
CAFO	0
Alfalfa	26
Forest	53,761
High-Till without Manure	1,170
High-Till with Manure	8,523
Hay without Nutrients	57
Hay with Nutrients	653
Pasture	958
Degraded Riparian Pasture	50
Nursery	37

- At this point, Scenario Builder has aggregated model land uses for each LRSEG.
- The next step is to apply BMPs that can impact the LRSEG's final set of land uses, nutrient generation and application, and nutrient runoff into streams.

Land Use Loading Rates

- Loading rates from literature sources used as a starting point for each land use type. Final rates are based on regional conditions and calibration to observed flows and concentrations and estimated loads. Median edge-of-stream loading rates per acre for calibration are listed below.

| Land Use	Median N Loading Rate	Median P Loading Rate
Forests	3.1	0.13
Hay without Nutrients	6.2	0.03
Pasture	8.2	0.92
Hay with Nutrients	9.5	0.05
Alfalfa	9.5	0.87
Low-Till with Manure	39.6	1.73
High-Till without Manure	40.2	3.08
High-Till with Manure	44.8	2.05
Degraded Riparian Pasture	45.9	10.97
Nursery	253.8	111.98

Conservation Tillage and Land Use
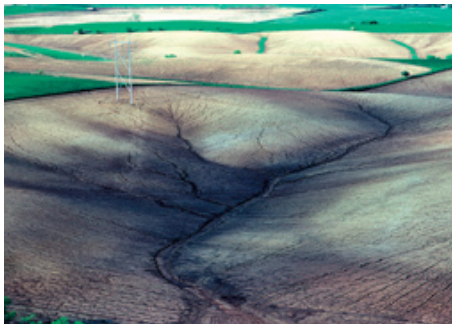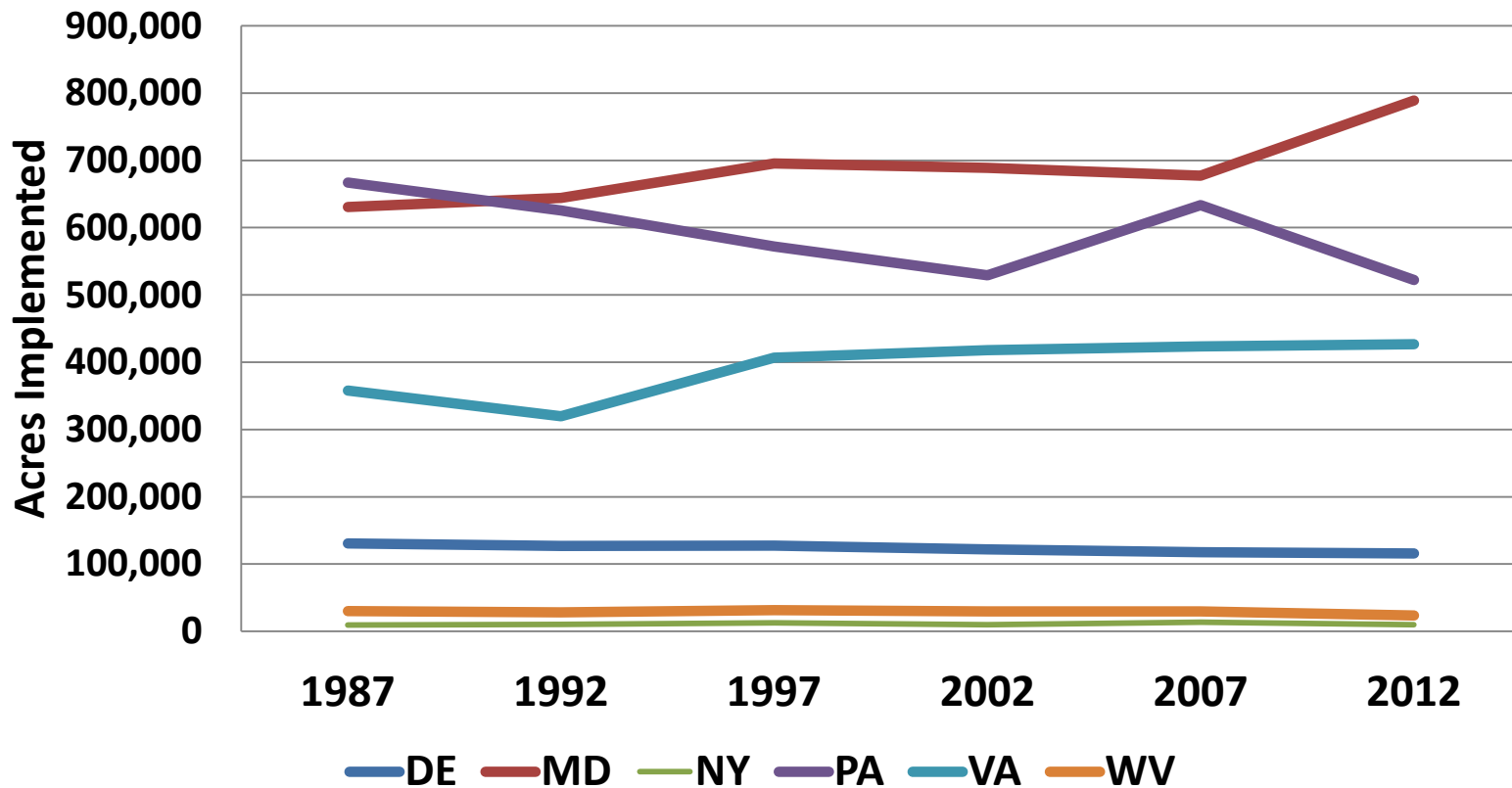
- All row crop acres are assumed to be high-till.
- Acres reported under conservation tillage convert high-till acres to low-till.

Nutrient Application Management and Land Uses
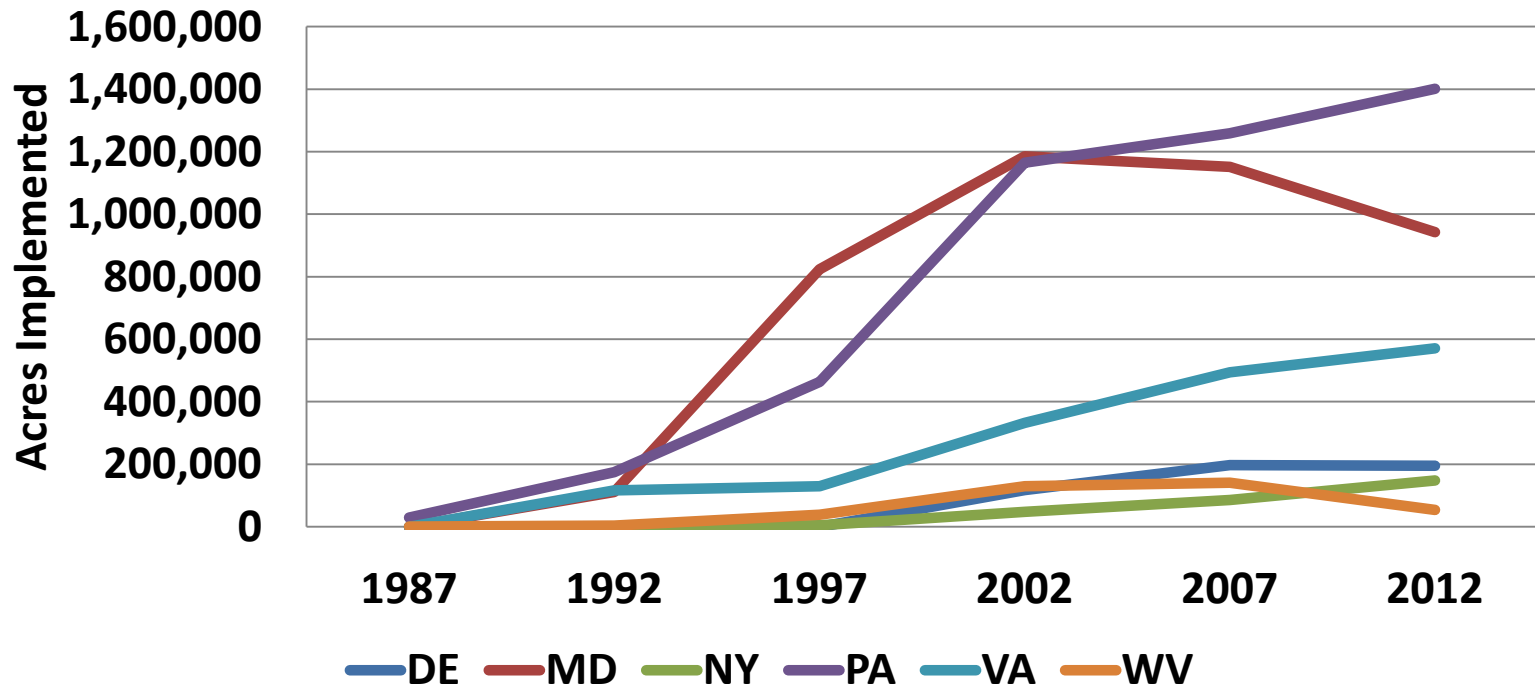
- Alfalfa*
- High-Till without Manure*
- High-Till with Manure*
- Hay with Nutrients*
- Low-Till with Manure*
- Pasture*

- Nutrient management acres are defined each year by states.
- Nutrient management acres result in lower crop need, and thus lower application of nutrients to meet crop need.

Land Conversion BMPs

- **Alternative Crops**
- **Conservation Tillage**
- **Nutrient Application Management (All Forms) –** *More appropriately characterized as a reduction in application for crop need.*
- **Forest Buffers**
- **Grass Buffers**
- **Land Retirement**
- **Stream Access Control with Fencing**
- **Tree Planting**
- **Wetland Restoration**

- Some BMPs convert model land uses to land uses with lower nutrient export rates.
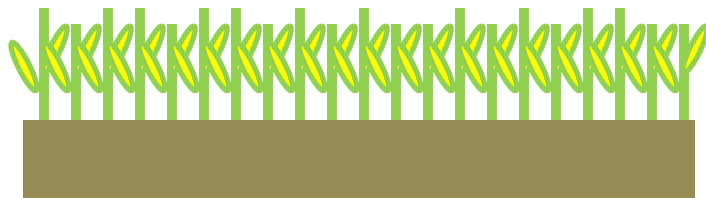
High-Till with Manure
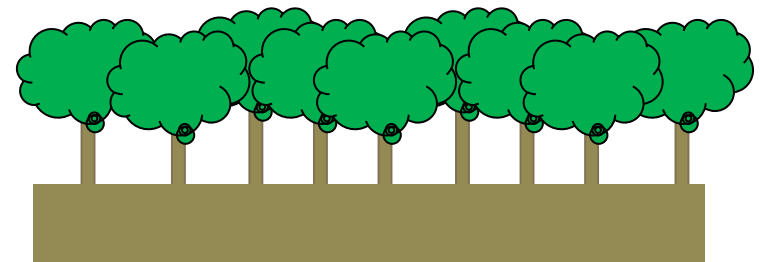
Forest

Animal Information

- **Angora Goats**
- **Beef**
- **Broilers**
- **Dairy**
- **Hogs and Pigs for Breeding**
- **Hogs for Slaughter**
- **Horses**
- **Layers**
- **Milk Goats**
- **Other Cattle**
- **Pullets**
- **Sheep and Lambs**
- **Turkeys**

- Animals are spread across the landscape in a similar way as crops.

- The Census of Agriculture provides animal counts by county.

Application of Manure and Nutrients

Animal Type	lb TN / lb of Manure	lb TP/lb of Manure
Angora Goats	0.011	0.0027
Beef	0.0059	0.0016
Broilers	0.0129	0.0035
Dairy	0.0052	0.0011
Hogs and Pigs for Breeding	0.0066	0.0021
Hogs for Slaughter	0.0062	0.0021
Horses	0.0059	0.0014
Layers	0.0131	0.0047
Milk Goats	0.011	0.0027
Other Cattle	0.0037	0.001
Pullets	0.0136	0.0053
Sheep and Lambs	0.0105	0.0022
Turkeys	0.0132	0.0049

- Organic nutrients are generated by animals across a county.
- Organic nutrients are applied to cropland after direct excretion on pasture, storage and handling losses on animal production areas and volatilization.
- Organic nutrients are applied to fulfill crop nutrient needs.
- Excess organic nutrients are applied in a sequence across land uses.
- Remaining crop need is fulfilled with inorganic fertilizer.

Potential Future Land Use Data

Courtesy FSA CLU

- **Common Land Units** from the Farm Service Agency and the **Cropland Data Layer** from NASS could be used to further define agricultural acres in each county.
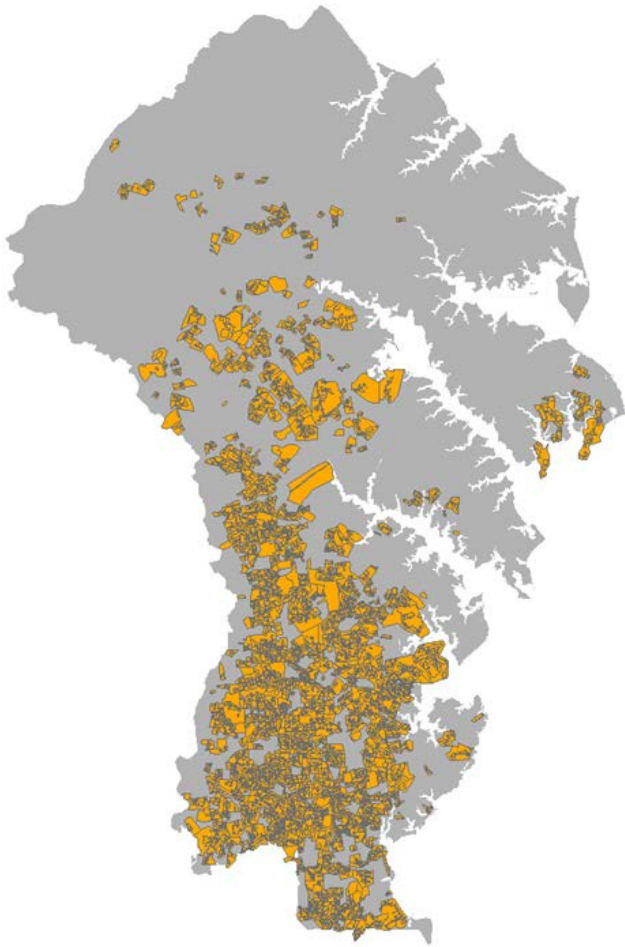
Courtesy of NASS CDL

Potential Discussion Items

- Is there sufficient data to include **soil nutrient content data** in a future version of Scenario Builder?

- Is there sufficient data or surveys available to update **conservation tillage implementation** on a more regular timescale?

- Is there sufficient data to define cropland that **does NOT receive manure**.