The Effects on Irrigation on Nitrate Transport to Groundwater
Delmarva Peninsula

Delaware Inland Bays STAC Meeting
September 8, 2017
Chesapeake Bay Watershed
Percent Irrigated Acres/Cropland Harvested, 1950-2012

Delmarva ~17.5%

Chesapeake Watershed ~4
BMP Hypothesis

• Nitrogen use efficiency is generally greater with irrigated than dryland farming resulting in less residual nitrogen in soils that can leach to groundwater
Study Sites

Andover Branch

Delmarva

Chesapeake

DE Bay

Bucks Branch
Bucks Branch
Hydrogeologic setting is variable across the Coastal Plain of the Delmarva Peninsula
- Effects the response time of groundwater and streams to changes in land management
- Effects natural processes that may mitigate nutrient transport
- Understanding local setting can help producers and other resource managers optimize BMP implementation.
- Surficial aquifer is about 30 ft thick (land surface to underlying fine-grained sediments)
- Groundwater flows from uplands towards stream—discharge is mostly to seeps
- Maximum time of travel of groundwater to the stream is less than 20 years
- Well-drained soil
- Dissolved oxygen present in groundwater
Andover Branch, Continuous Water Levels

8/12 2.9 in rain

IRR-1S  DRY-1S  DRY-5S  IRR-5M
Andover Branch
Soil Moisture and Rainfall, 8/2/2014-8/31/2014

Rainfall (inches), Kenton, DE
Andover Branch Lysimeter and Shallow Groundwater Data

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<th>Date</th>
<th>Specific conductance, uScm</th>
<th>NO3-N+NO2-N, mg/L</th>
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(Lysimeters: red = 1 ft, blue = 3 ft; Shallow well samples: black)
Dryland

Irrigated

Andover Branch, Shallow Groundwater

Prior to irrigation

Specific conductance, uS/cm

NO₃N+NO₂N, mg/L

Cl⁻, mg/L

Date
- Surficial aquifer 80-90 ft thick
- Groundwater discharges through the stream bed, with some shallow flow to wetlands; over 90% of streamflow is from groundwater
- Groundwater age exceeds 30 years along the deepest longest
- Predominant soils: Ingleside (IeA) and Rosedale (RoA) loamy sands; well drained
Bucks Branch, Lysimeter and Shallow Groundwater Data

(Lysimeters: dots, red = 1 ft, blue = 3 ft; Shallow well samples: +)
Bucks Branch, Nitrate Concentrations Relative to Apparent Age of Groundwater
Leaching of nitrate beyond zone of plant uptake occurs during growing season

- Nitrate concentrations in soil water are higher than during other times of the year
- Higher nitrate concentrations in leachate with irrigation because of greater amount available from recent nitrogen application and greater soil saturation

Question is: What is the significance of the increased amount of nitrate leached through the soil zone during the growing season to the total nitrate load to groundwater?
Modeling of leaching load during growing season at Bucks Branch and Andover Branch

- Unsaturated zone transport (VFM)
  - Preliminary results from Bucks Branch: VFM predicts an unsaturated zone velocity of 3 m/yr beneath the irrigated field, and 2 m/yr beneath the dryland field (based on 2014 and 2015 sampling)

- Threshold for groundwater recharge (ERM)

- Soil-water balance (SWB)

Bucks Branch/Andover Branch combined journal article on unsaturated zone transport of nitrate to groundwater (draft by Dec 2017)