FACETS

Floridan Aquifer Collaborative Engagement for Sustainability

Environmental and Economic Tradeoffs of Land Use and Management in the Floridan Aquifer Region

Nathan Reaver, Dogil Lee, Sagarika Rath, Unmesh Koirala, Fei He, Henrique Haas,Rob De Rooij, Damian Adams, Tatiana Borisova, Latif Kalin, Amanda Smith, David A Kaplan, and Wendy D Graham

USDA United States Department of Agriculture National Institute of Food and Agriculture

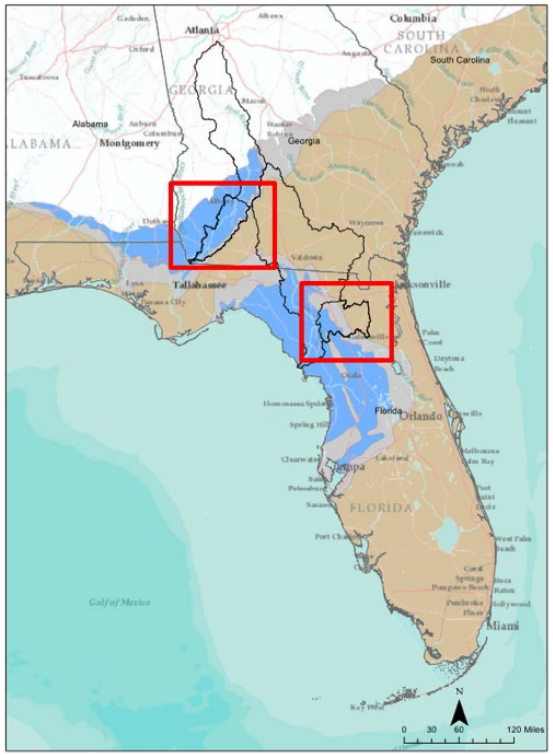
UNIVERSITY OF GEORGIA

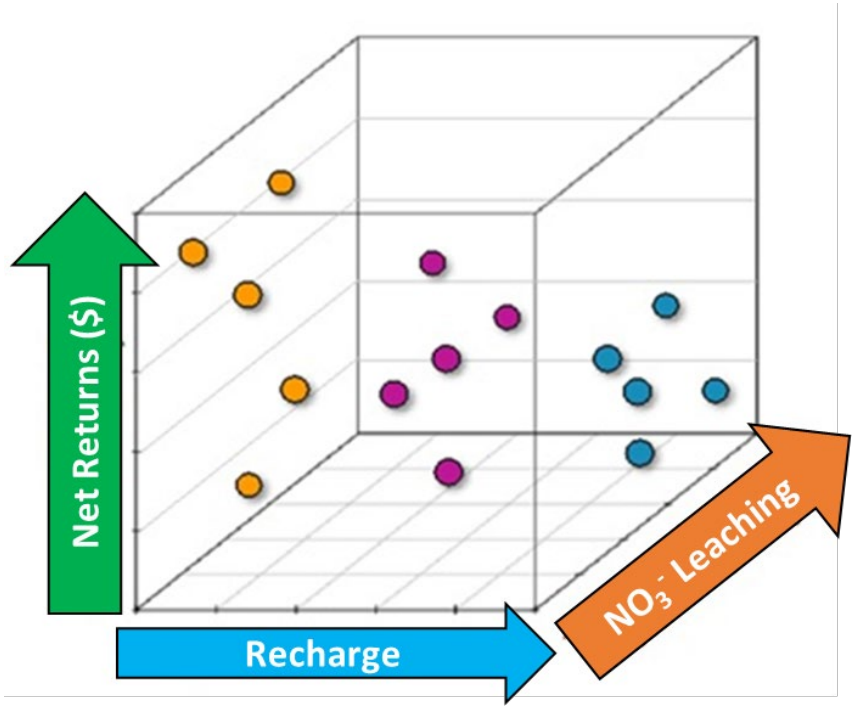
Albany State University University System of Georgia

UF Water Institute UNIVERSITY of FLORIDA

Award Number: 2017-68007-26319

Graphical Overview





Land Use and Management Practices → **Floridan Aquifer and Agricultural Economy** → **Economic and Environmental Tradeoffs**

FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

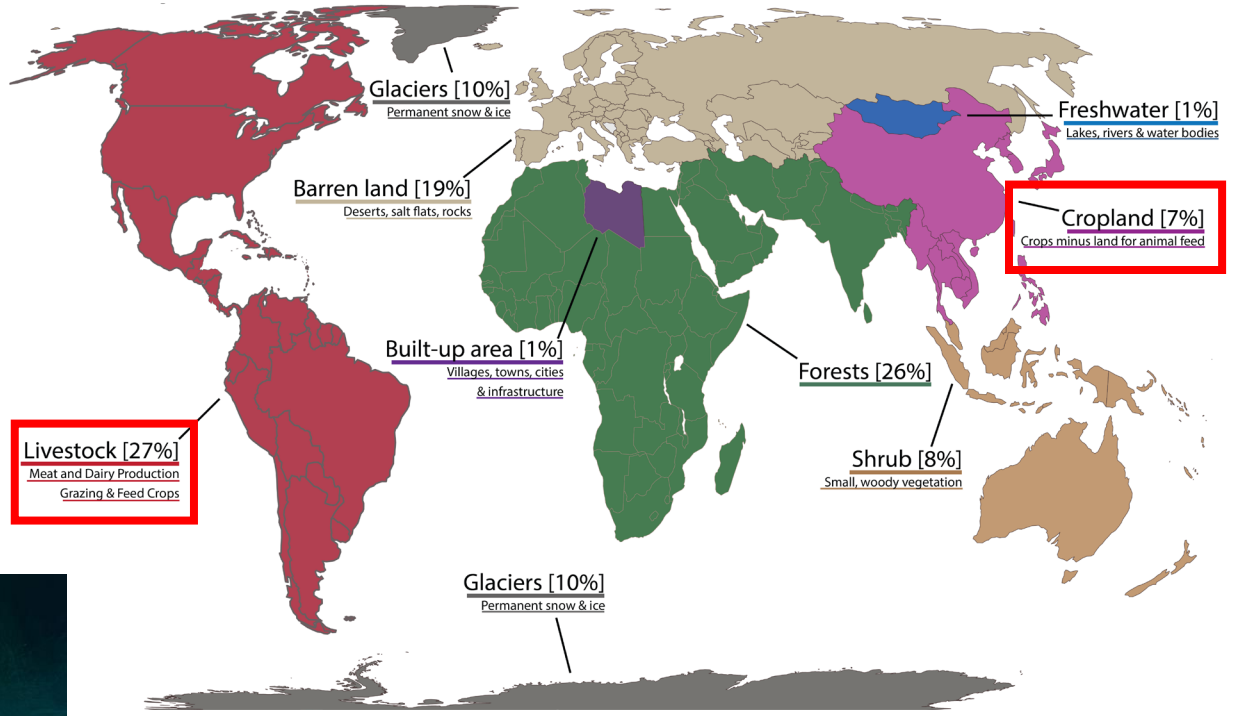
Global Agricultural and Silvicultural Impacts

Economic

- **Agriculture directly employs 884 million people, ~27% of global workforce (FAO)**
- **Forestry employs ~45-50 million people (UNFF - Arce, 2019)**

Biophysical

- **Production systems use a lot of land**
- **Land use and management can alter water and nutrient cycles**
- **Impacts to receiving surface and groundwater**
  - **e.g, water scarcity and harmful algal blooms**



Aral Sea

Lake Erie

https://commons.wikimedia.org/wiki/File:The_dramatic_retreat_of_the_Aral_Sea.gif

https://research.noaa.gov/Portals/0/EasyDNNnews/635/2000600p587EDNmain11357lakeeriehab2015_nasa.jpg

https://www.fao.org/3/cb1329en/online/cb1329en.html#chapter-1

https://ourworldindata.org/land-use

FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

Floridan Aquifer

- **Among the largest, most productive aquifers in the world**
- **Water supply for ~ 10 million people**
- **Supports >$7.5 billion worth of agricultural activities**
- **Unique groundwater-fed ecosystems**

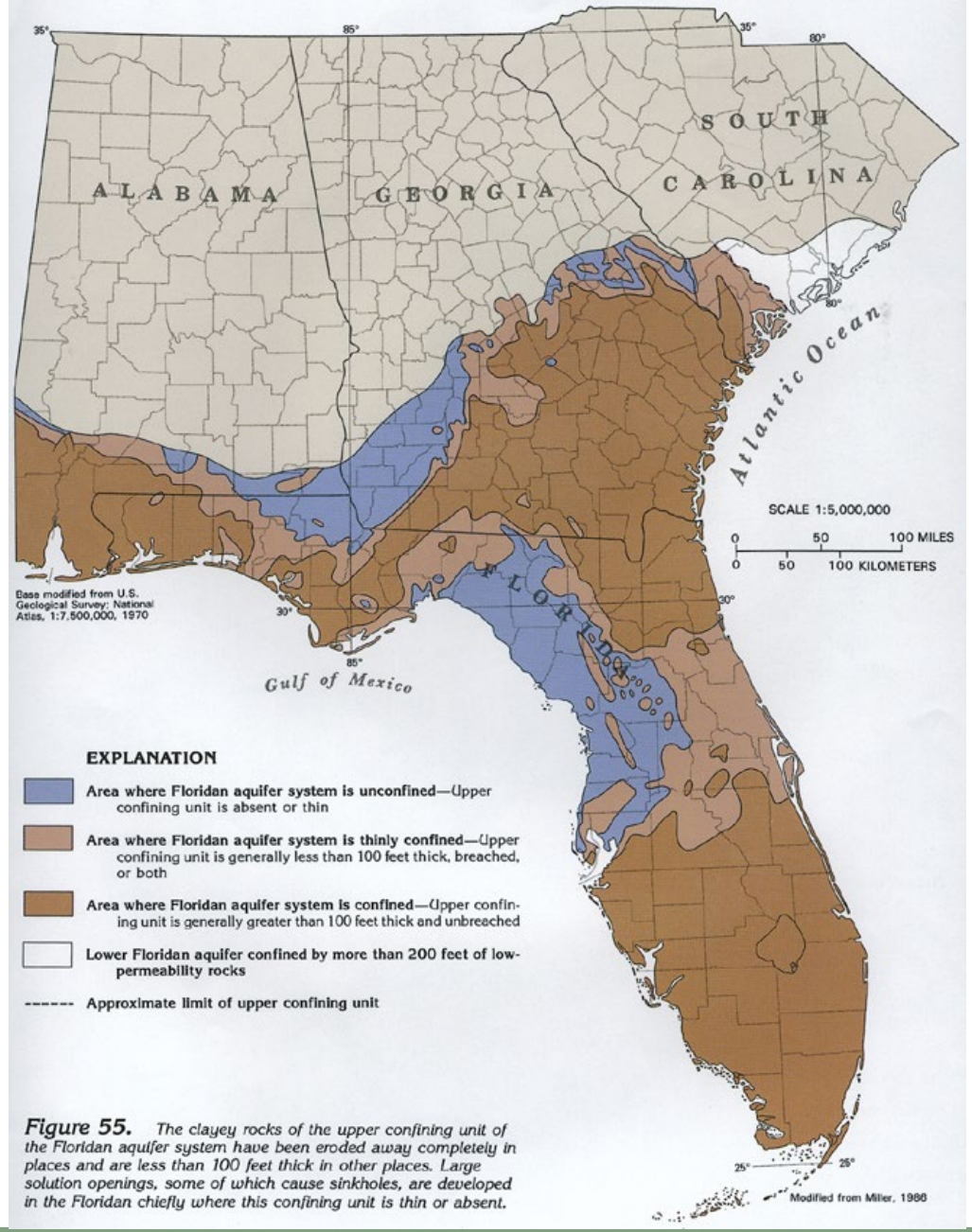


Figure 55. The clayey rocks of the upper confining unit of the Floridan aquifer system have been eroded away completely in places and are less than 100 feet thick in other places. Large solution openings, some of which cause sinkholes, are developed in the Floridan chiefly where this confining unit is thin or absent.

Miller, J. A. (1990). Ground water atlas of the United States alabama, florida, georgia, and south carolina (HA 730-G). US Geological Survey. Available: http://pubs.usgs. gov/ha/ha730/ch_g/G-text6. html.

FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

Floridan Aquifer Region Agriculture and Silviculture

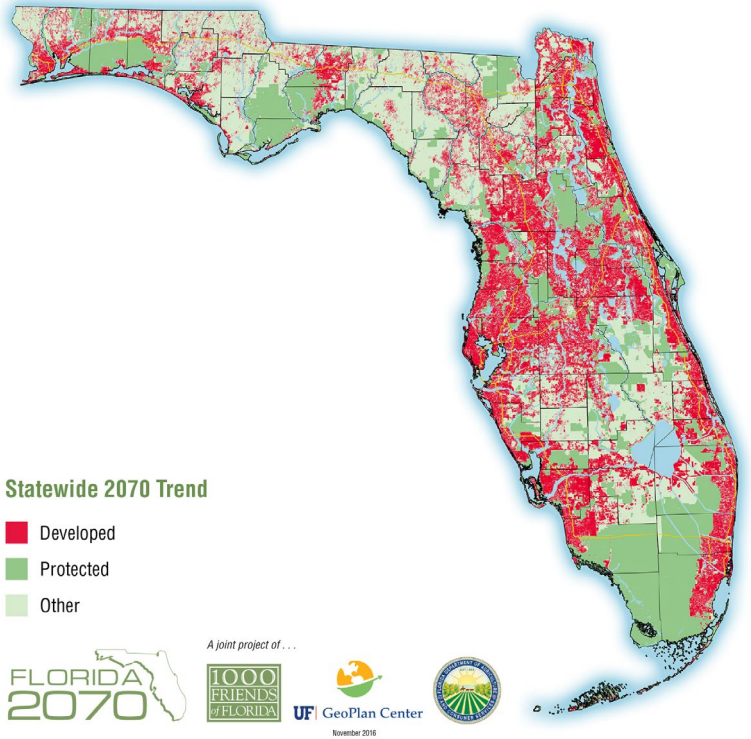
- **Agronomic Crops (e.g., Corn, Peanut, Cotton)**
- **Vegetable Crops (e.g., Carrot, Tomato, Watermelon)**
- **Forages (e.g, Bermuda Grass)**
- **Forest Products (e.g., Timber, Paper Pulp, Pine Straw)**
- **Connected to ~ 1.5 million jobs**

https://gardeningsolutions.ifas.ufl.edu/plants/edibles/fruits/watermelon.html http://rawlingsforestry.com/photos/stacked_straw/1024x512.jpg https://www.flchamber.com/dyk-14-percent-florida-jobs-connected-agriculture-industry/

FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

Floridan Aquifer Impacts

- **Increasing water use for population growth and agricultural intensification**
- **Reduced spring and river flows**
- **Increases in nitrate concentration in surface and groundwater**
- **Changes in freshwater and nutrient flow to coastal ecosystems and aquaculture**

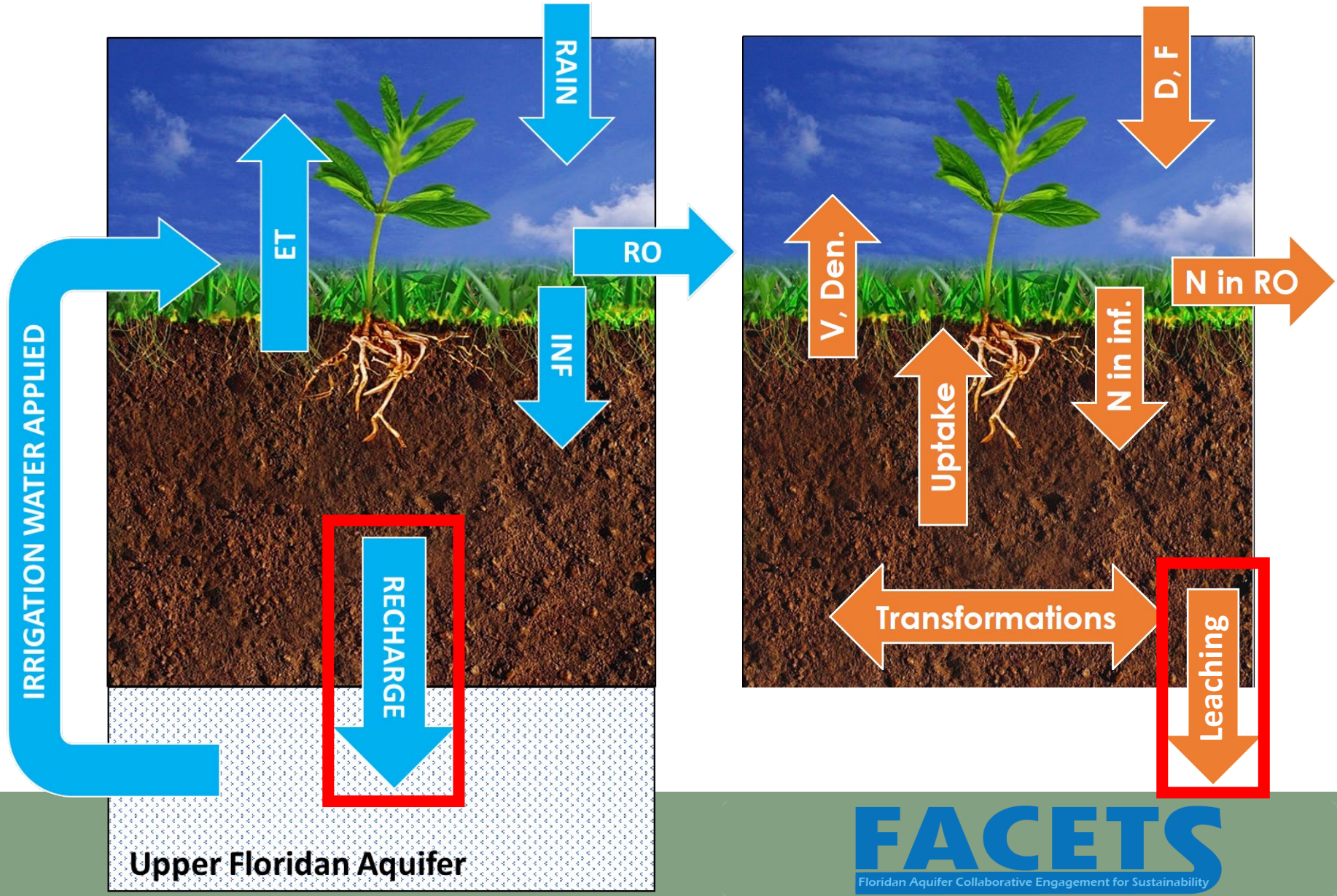


https://eoimages.gsfc.nasa.gov/images/imagerecords/144000/144147/suwannee_oli_201551_lrg.jpg

FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

Role of Land Use and Management Practices

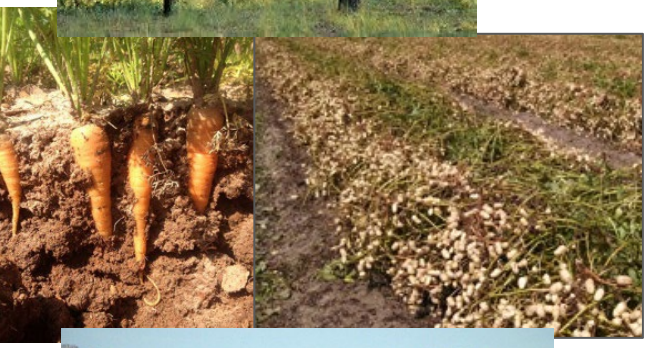
- **Different production systems can have different impacts on water and nutrient cycles**
- **Ultimately interested in Aquifer impacts – Recharge and Nitrate Leaching**

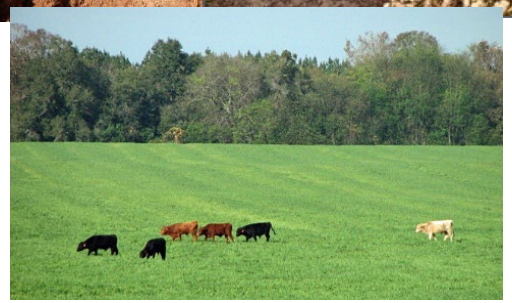


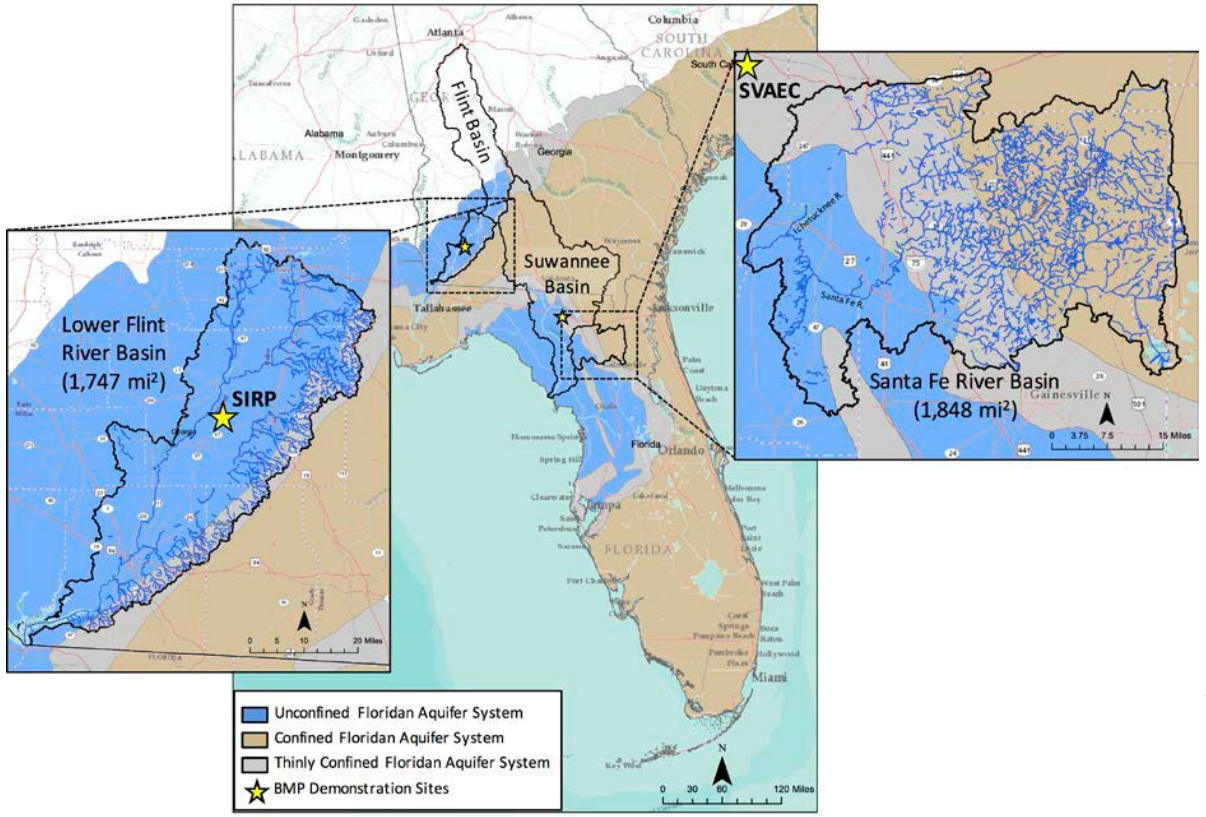
FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

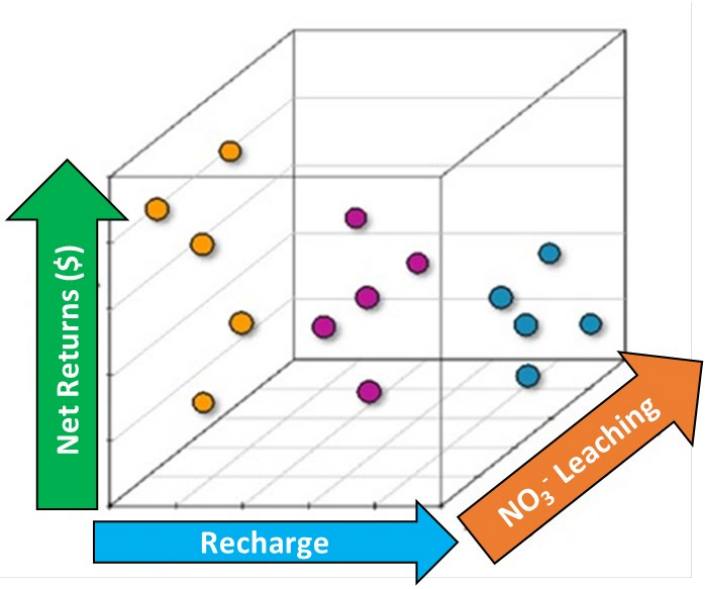
Quantifying Environmental and Economic Tradeoffs

FACETS
Floridan Aquifer Collaborative Engagement for Sustainability





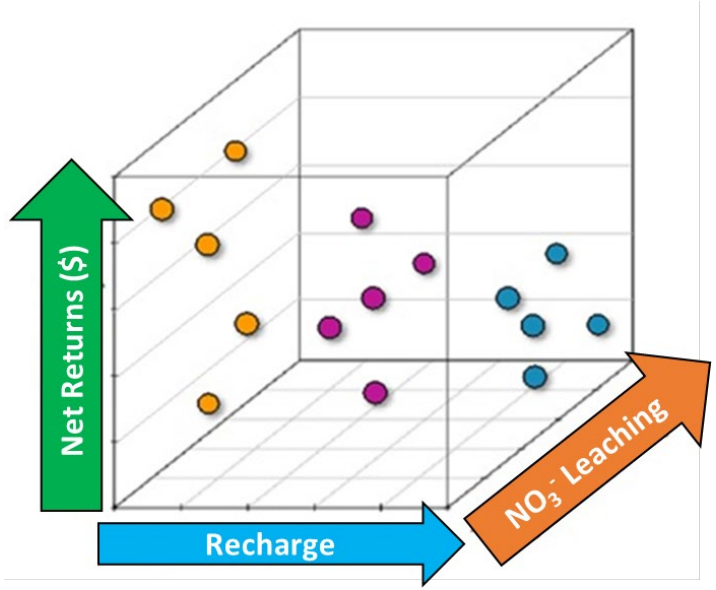


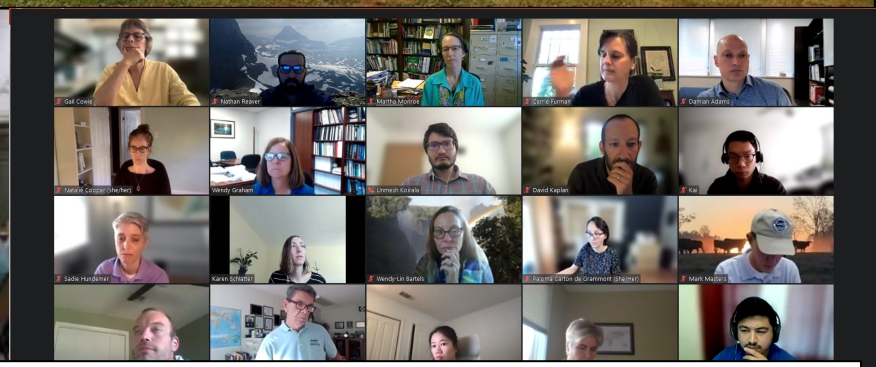


FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

Participatory Modeling Process (PMP)

- **Co-developed our model with stakeholders**
- **Reduces risk of model outputs inaccurately representing regional realities**





The Room Where It Happens: Co-Producing Scenarios for the FACETS Project

Wendy-Lin Bartels

FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

PMP Production and Management Systems

Production Systems

CROPS
Corn-peanut
Corn-carrot-peanut

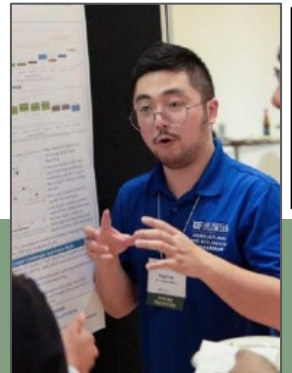
FORAGES
Hay (Bermuda)
Pasture (Bermuda)

FORESTS
Slash pine
Loblolly pine
Longleaf pine

Management System Summaries

	Crop	Forage	Forests
MS1	• Most Efficient irrigation • Lowest fertilization • Rye cover crop	• Lowest fertilization • Lowest number of cuttings (hay)	• No thinning • No fertilization • Longer rotation age • Lower initial planting density
MS2	• Efficient irrigation • Medium N rate • Oat cover crop	• Medium fertilization • Medium number of cuttings (hay)	• Thinning • Medium N rate • Medium rotation age
MS3	• Least efficient irrigation • Highest fertilization • No cover crops	• Highest fertilization • Most number of cuttings (hay)	• Thinning • Highest N rate • Shortest rotation age

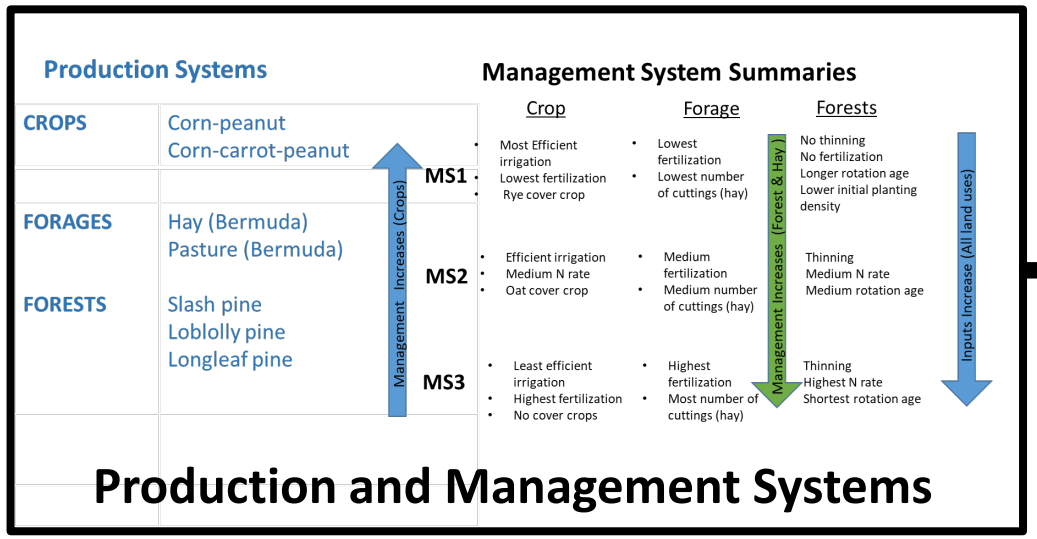
Inputs Increase (All land uses)

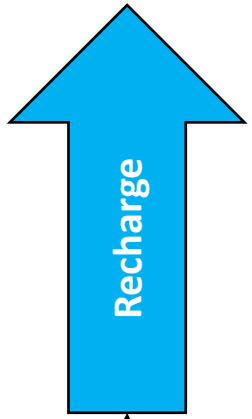


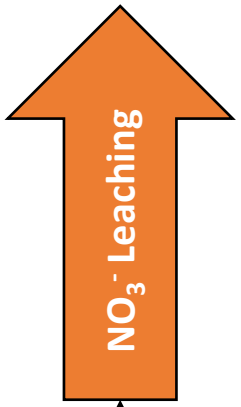
POSTER:
Modeling the Impacts of Agricultural Management Practices on Groundwater in the Santa Fe River Basin
Dogil Lee

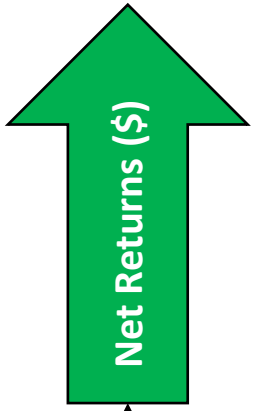
FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

Translate PMP input into Modeling Language



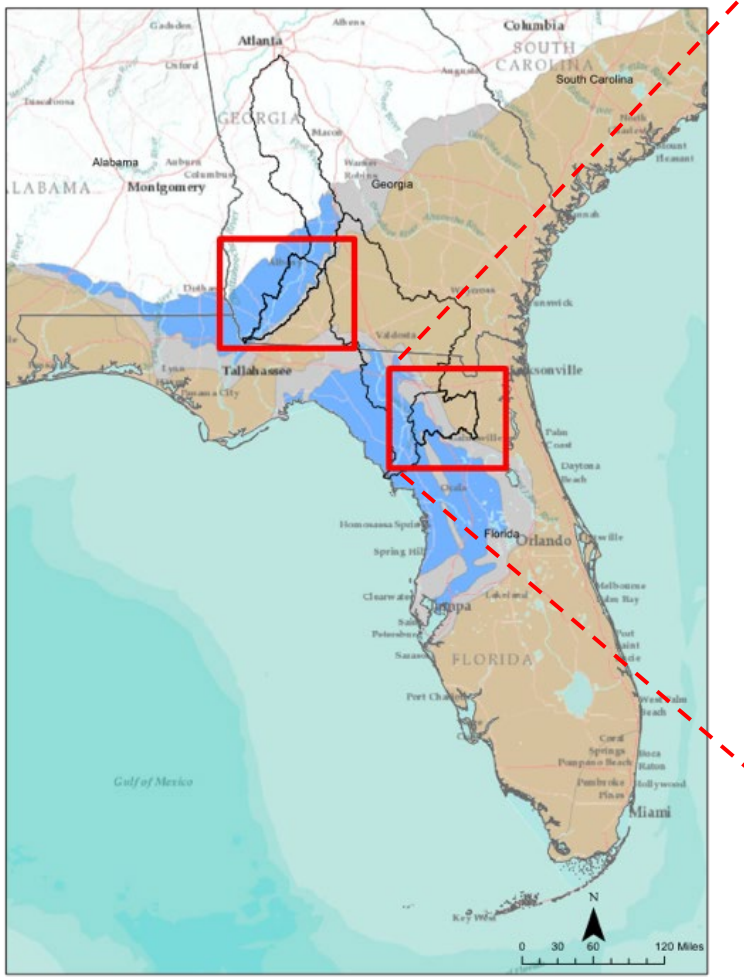


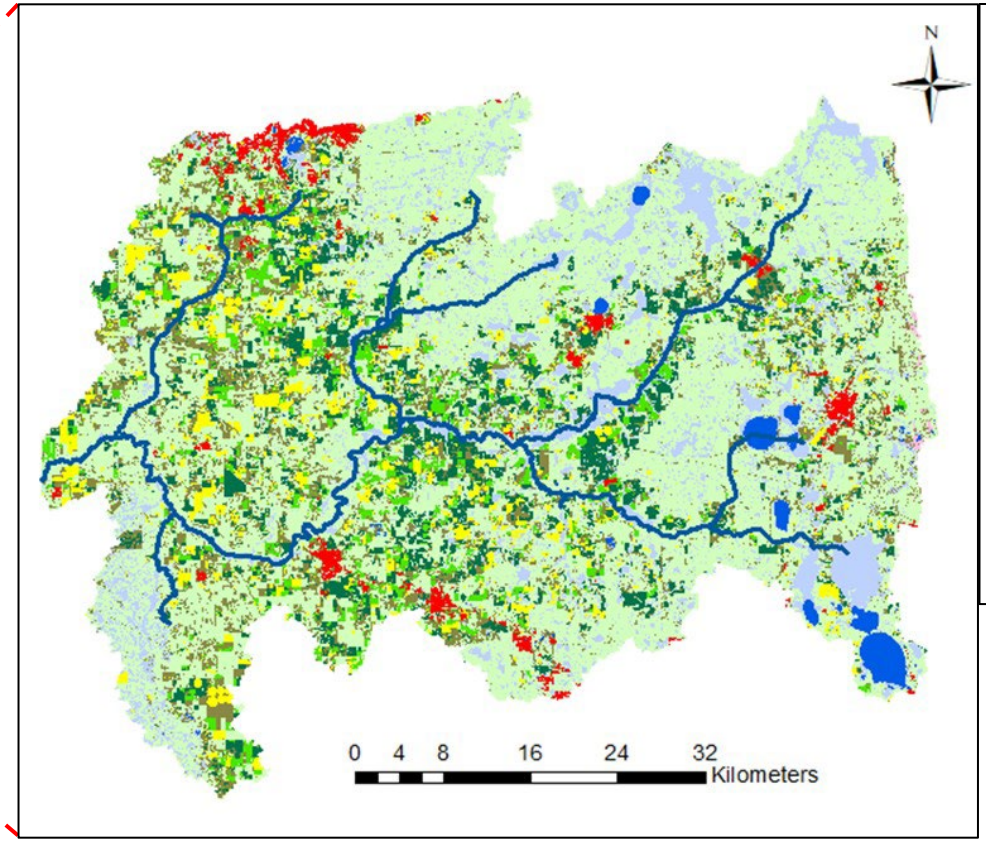


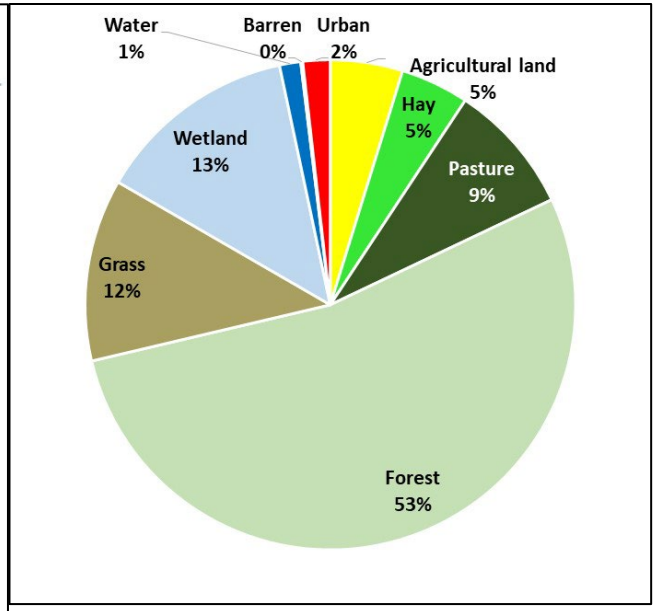


FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

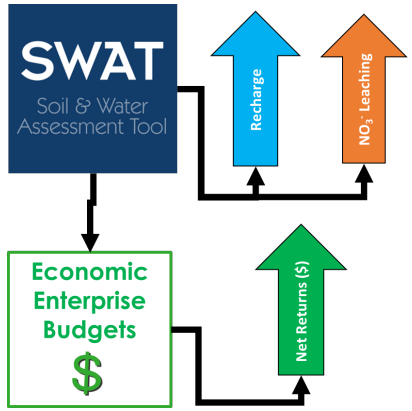
Simulate Management Practices Across Floridan Aquifer Region







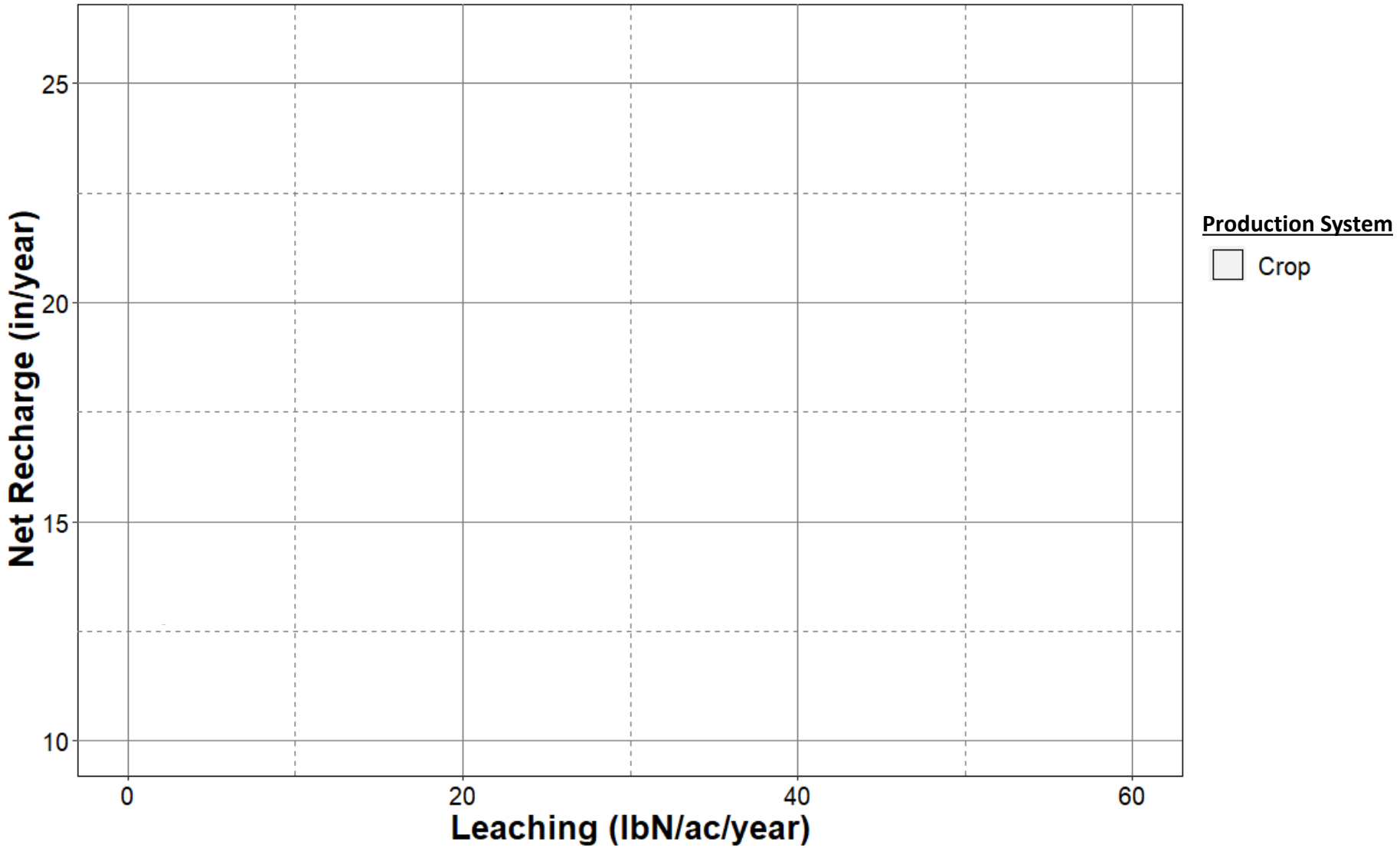
Variation in soils and weather (40 years)



FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

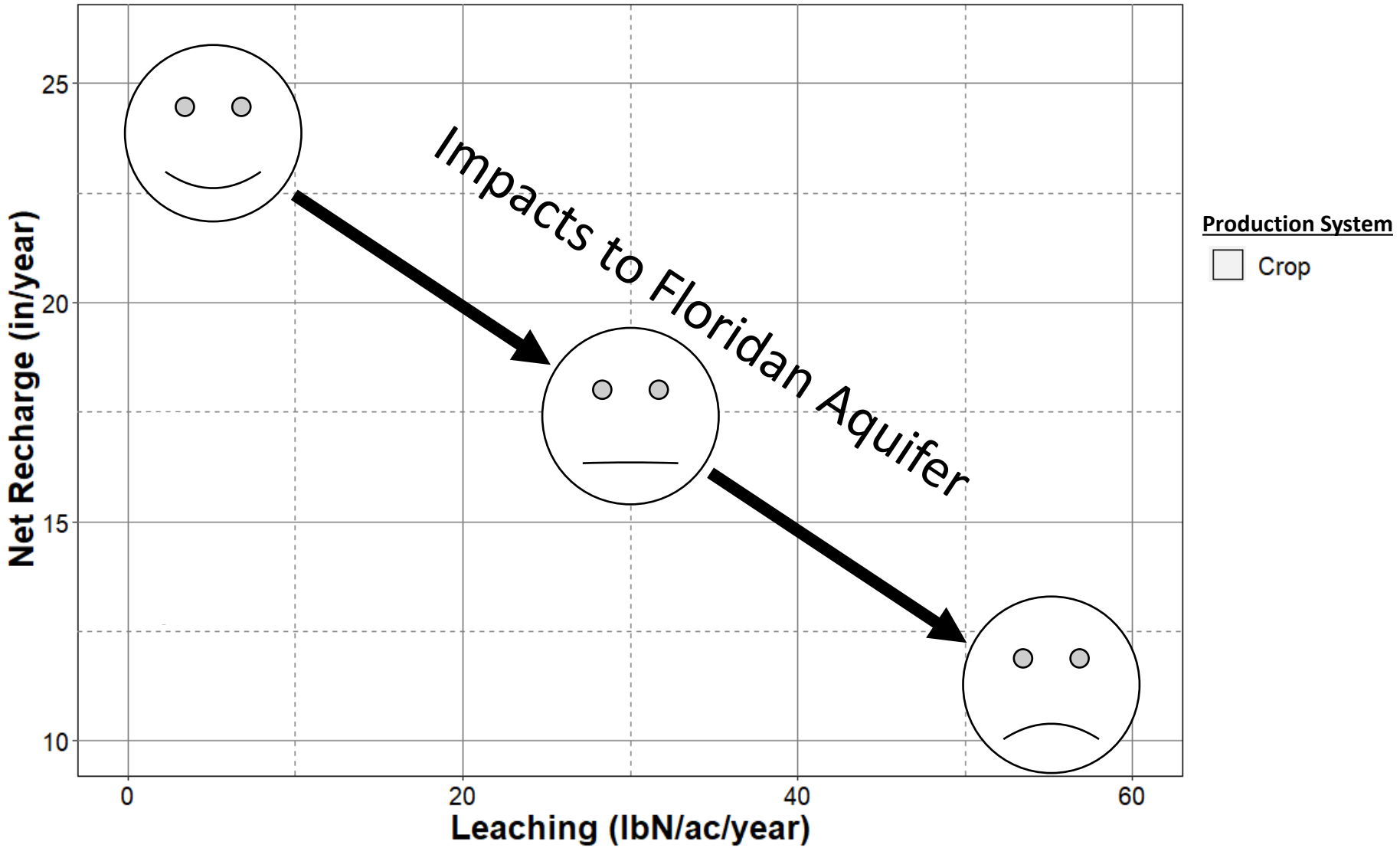
Results

CROPS	Corn-peanut Corn-carrot-peanut
FORAGES	Hay (Bermuda) Pasture (Bermuda)
FORESTS	Slash pine Loblolly pine Longleaf pine



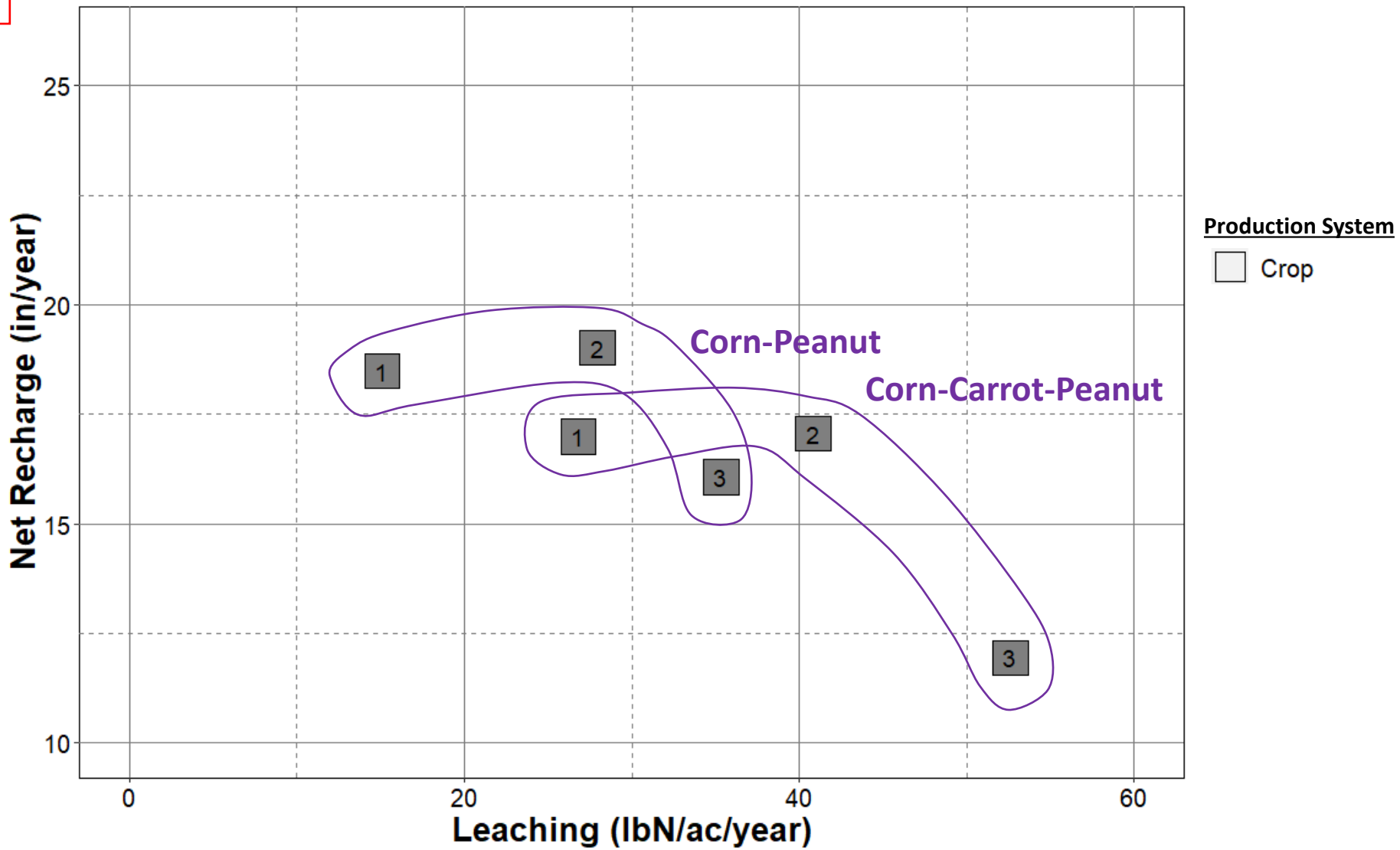
Results

CROPS	Corn-peanut Corn-carrot-peanut
FORAGES	Hay (Bermuda) Pasture (Bermuda)
FORESTS	Slash pine Loblolly pine Longleaf pine



Results

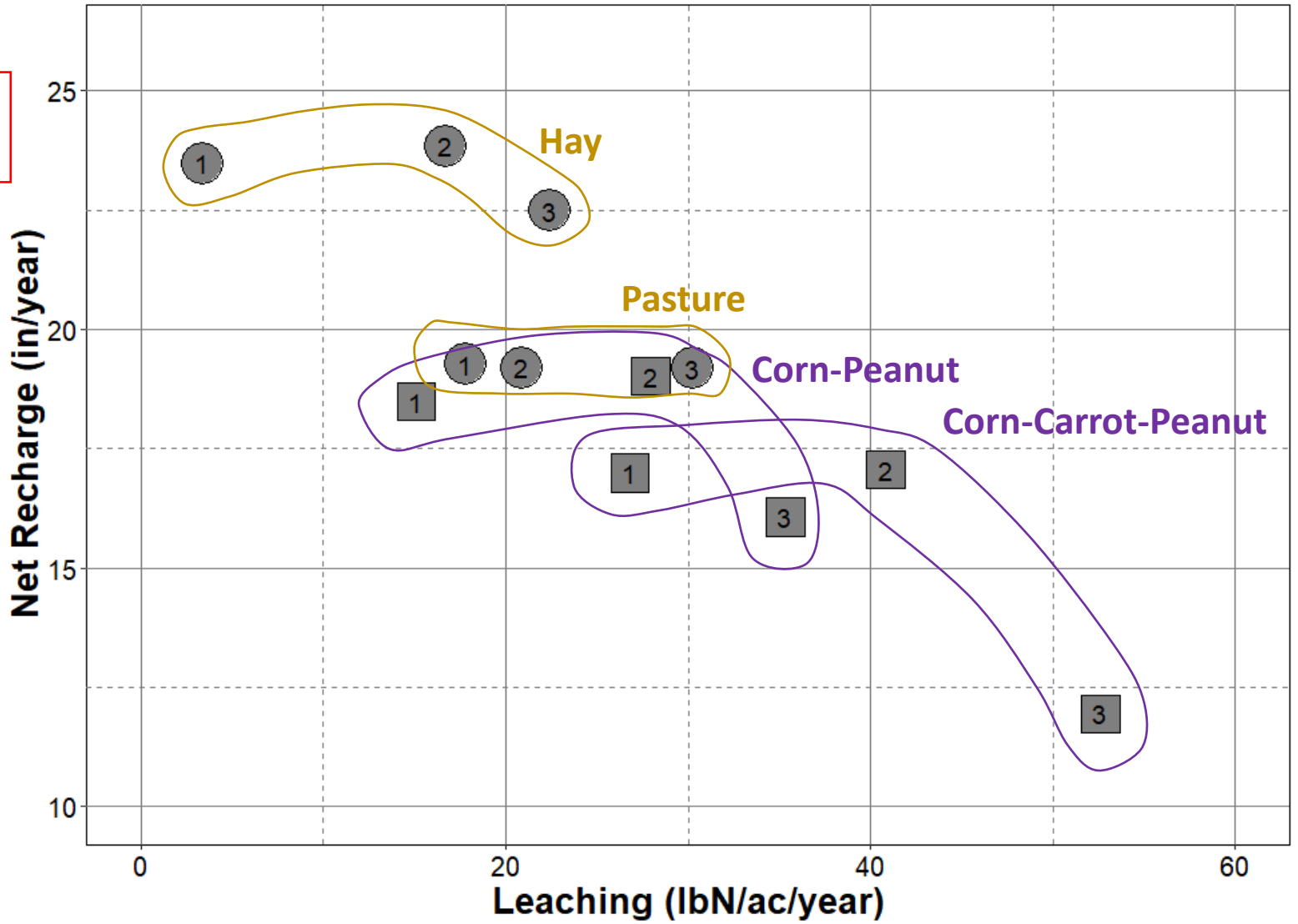
CROPS	Corn-peanut Corn-carrot-peanut
FORAGES	Hay (Bermuda) Pasture (Bermuda)
FORESTS	Slash pine Loblolly pine Longleaf pine



FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

Results

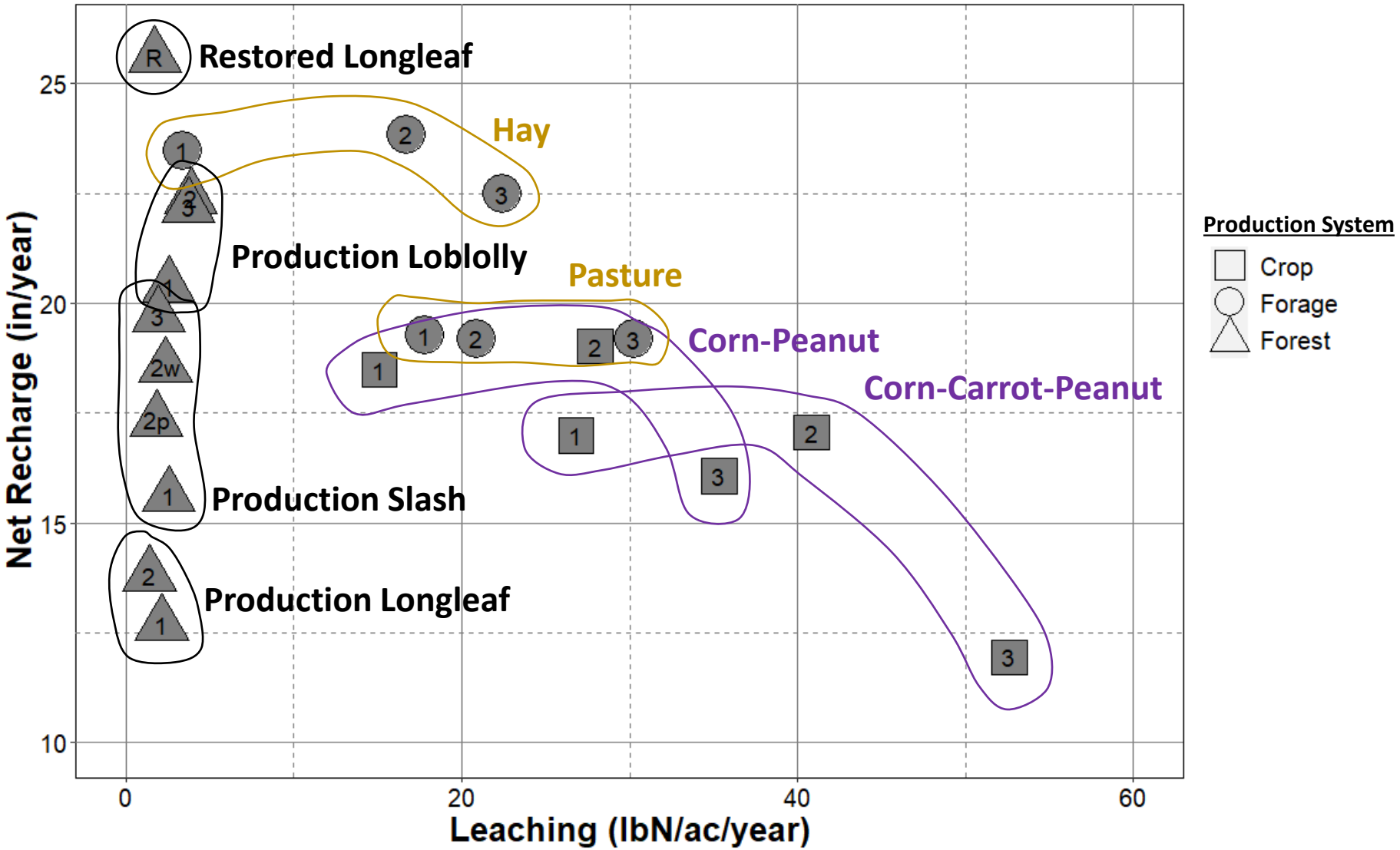
CROPS	Corn-peanut Corn-carrot-peanut
FORAGES	Hay (Bermuda) Pasture (Bermuda)
FORESTS	Slash pine Loblolly pine Longleaf pine



FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

Results

CROPS	Corn-peanut Corn-carrot-peanut
FORAGES	Hay (Bermuda) Pasture (Bermuda)
FORESTS	Slash pine Loblolly pine Longleaf pine



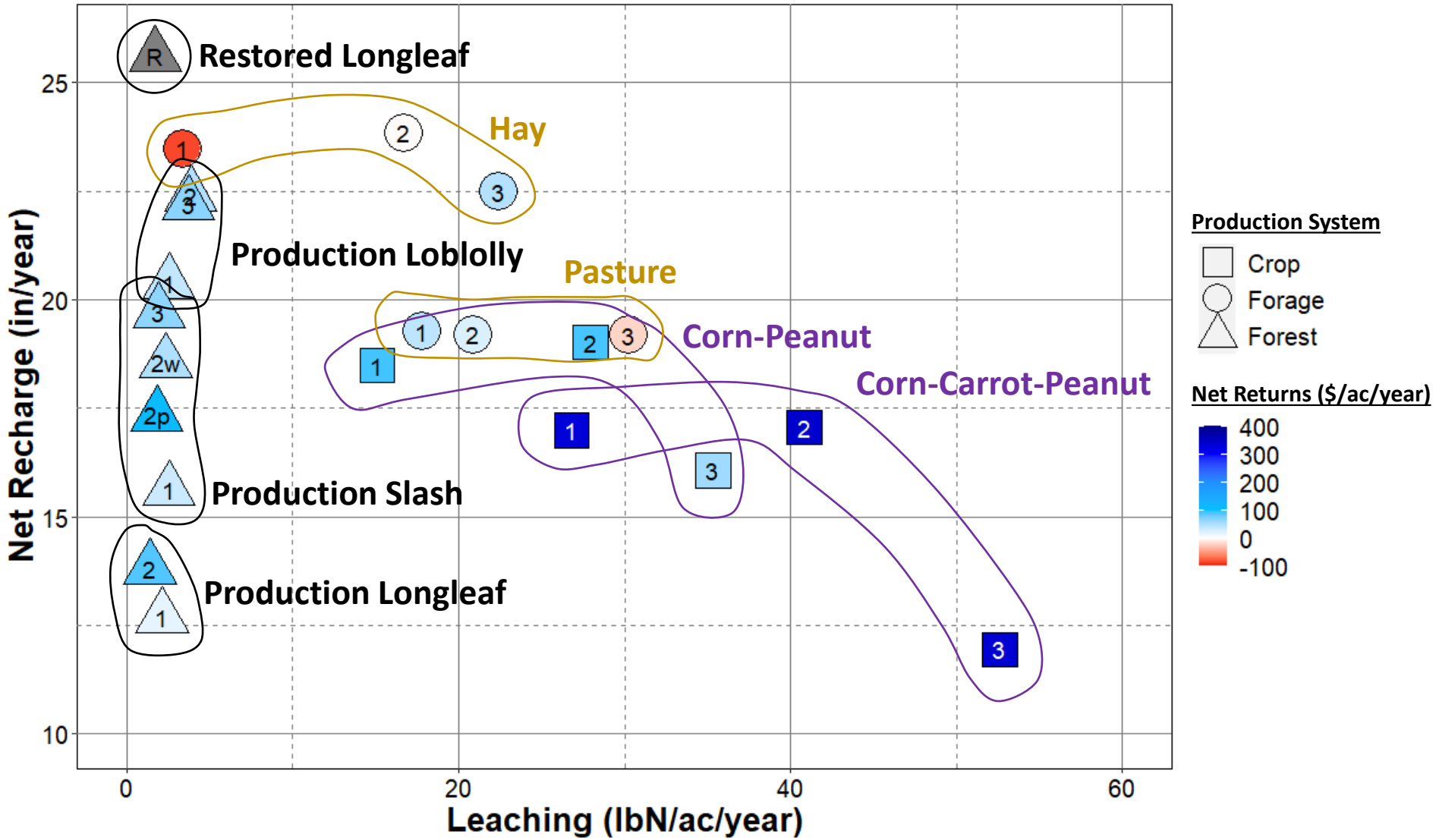
FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

Results

CROPS	Corn-peanut Corn-carrot-peanut
FORAGES	Hay (Bermuda) Pasture (Bermuda)
FORESTS	Slash pine Loblolly pine Longleaf pine

Economic Enterprise Budgets

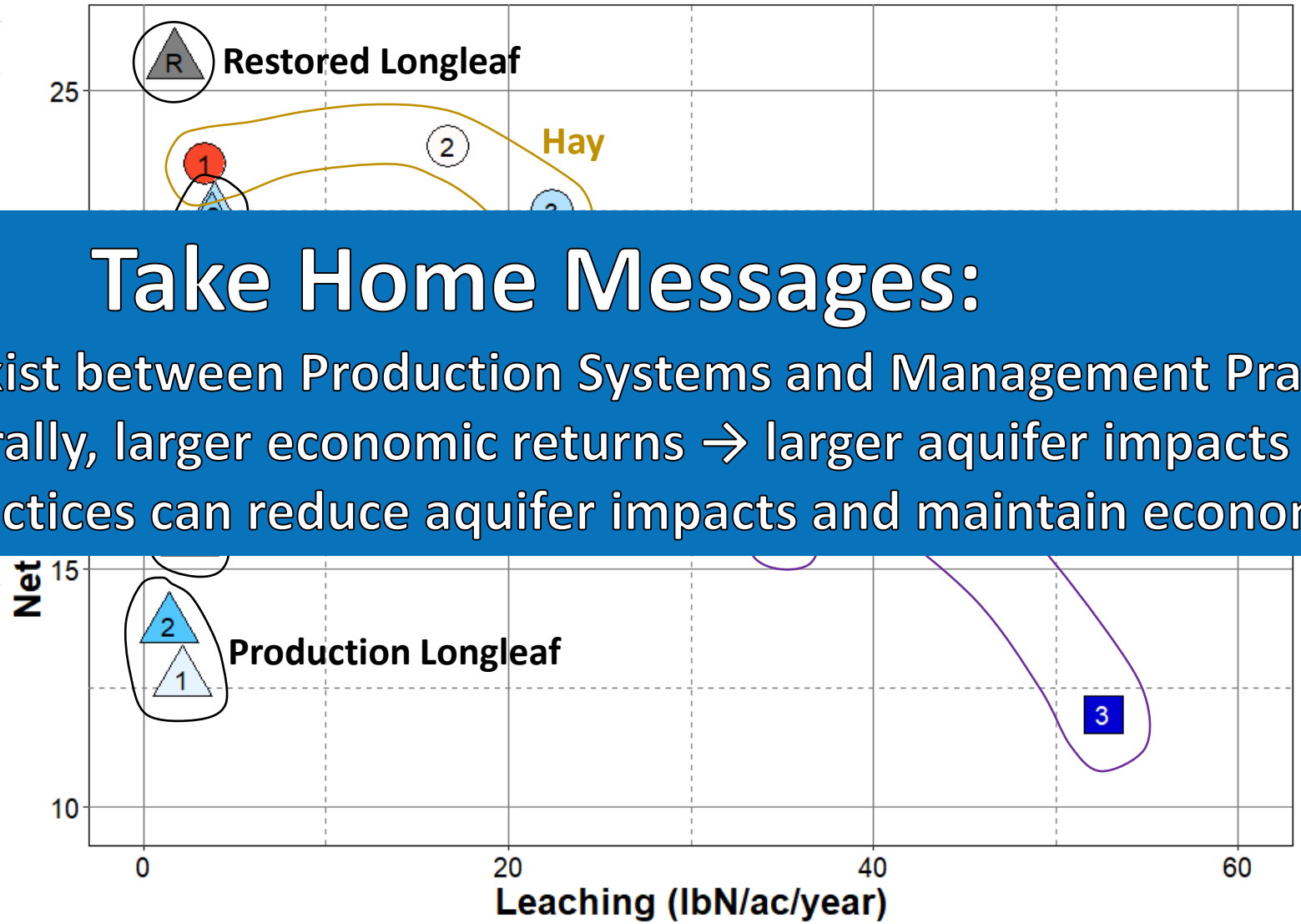
$



FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

Results

CROPS	Corn-peanut Corn-carrot-peanut
FORAGES	Hay (Bermuda) Pasture (Bermuda)



Take Home Messages:

1). Tradeoffs exist between Production Systems and Management Practices

2). Generally, larger economic returns → larger aquifer impacts

3). Management Practices can reduce aquifer impacts and maintain economic returns

Enterprise Budgets

$

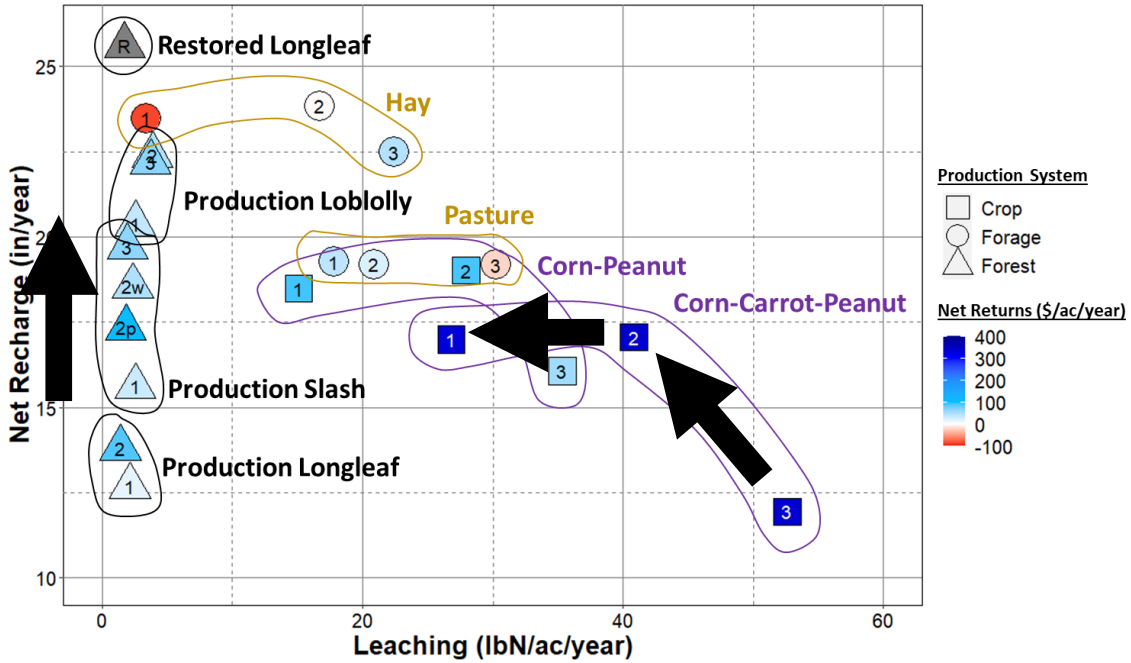
FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

Implications and Next Steps

Adoption of Improved Management Practices or Conversion to Lower Impact Land Uses

- Barriers
  - e.g., high costs, sunk capital, producer trust
- Quantified Impacts → Informed Incentives
  - e.g., cost share, CRP, ecosystem service payments

Quantify producer WTA and public WTP



Implications and Next Steps

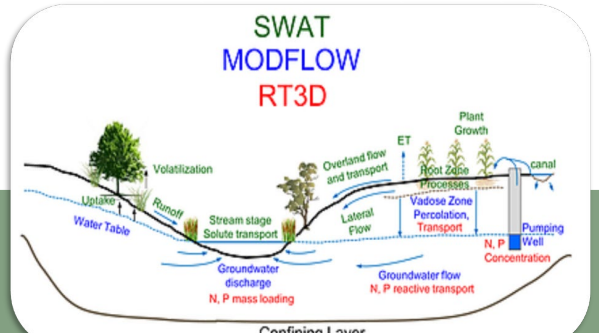
Adoption of Improved Management Practices or Conversion to Lower Impact Land Uses

- Barriers
  - e.g., high costs, sunk capital, producer trust
- Quantified Impacts → Informed Incentives
  - e.g., cost share, CRP, ecosystem service payments

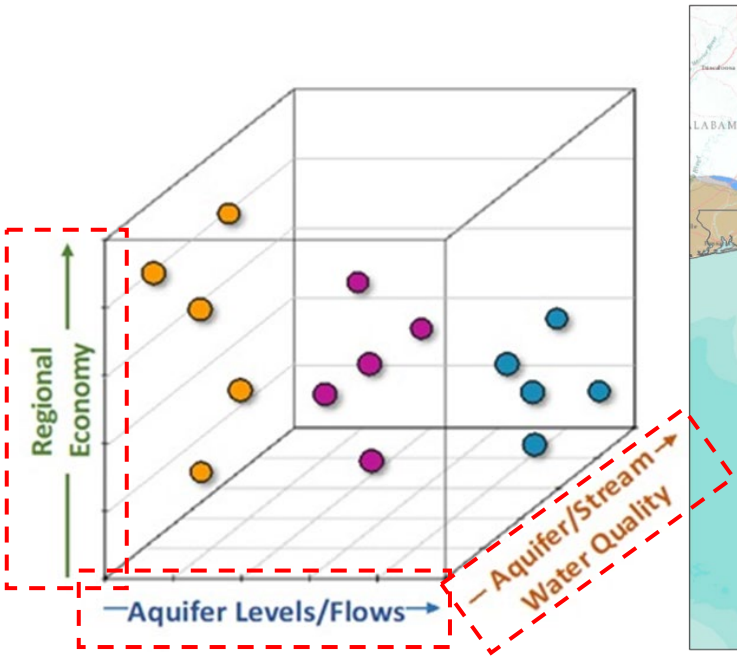
Quantify producer WTA and public WTP

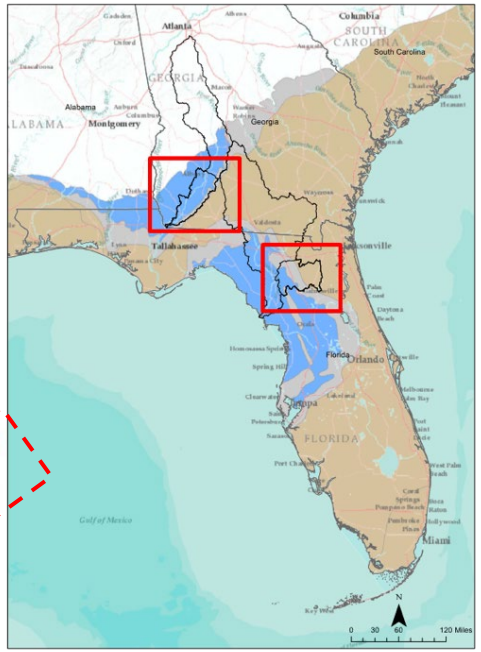
Integrating Farm-Forest-Producer scale results to the regional scale

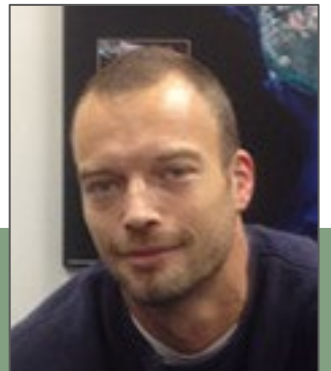
- SWAT-MODFLOW and IMPLAN



Bailey et al, 2016







Simulating Nitrate Transport to the Devil's Springs Complex Using SWAT-MODFLOW and MODPATH
Rob De Rooji

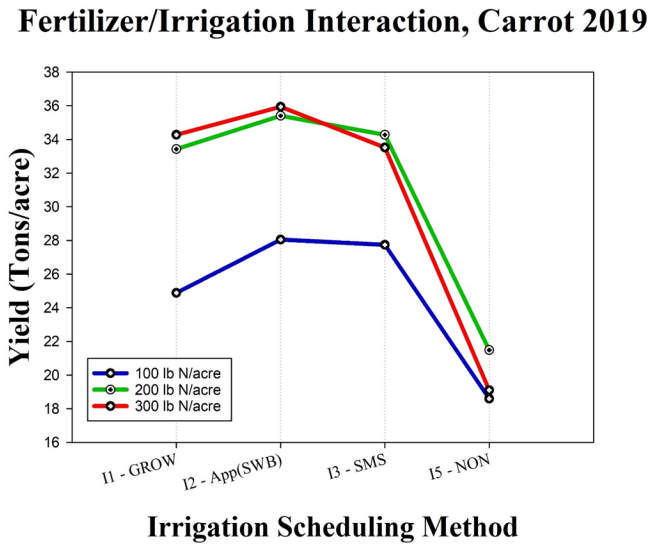
FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

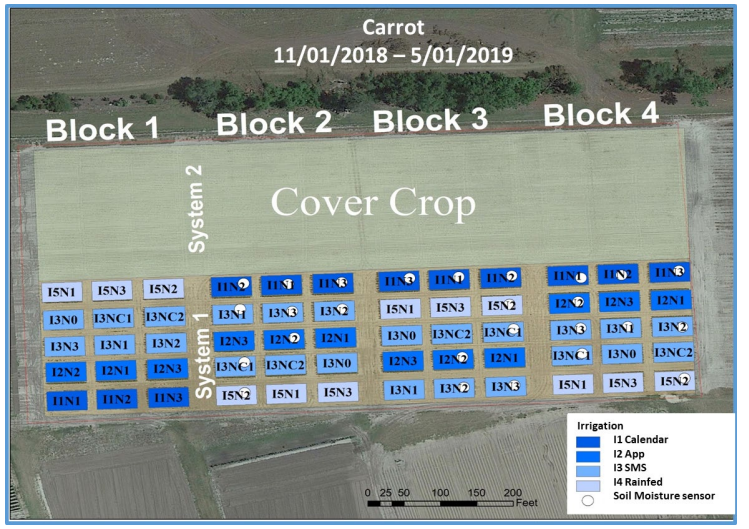

FACETS
Floridan Aquifer Collaborative Engagement for Sustainability

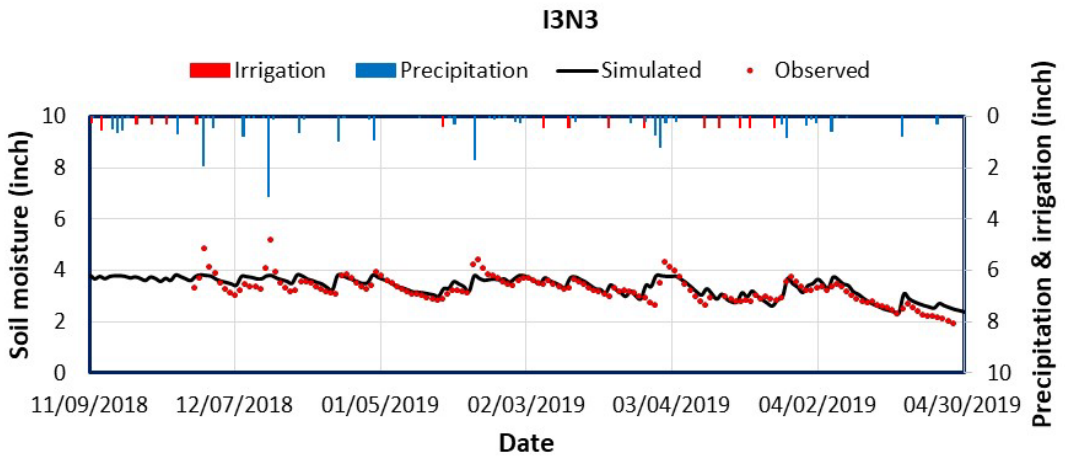
For more information http://Floridanwater.org

Model Calibration

- **SWAT was calibrated to existing data and field trials.**
- **Enterprise budgets were calibrated to existing data**







TimberMart-South

FACETS
Floridan Aquifer Collaborative Engagement for Sustainability