

*Exceptional service in the national interest*

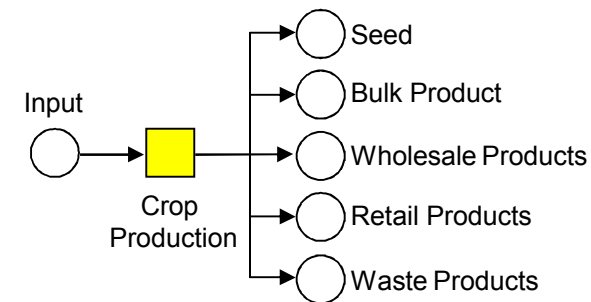
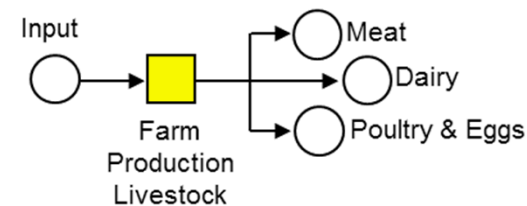
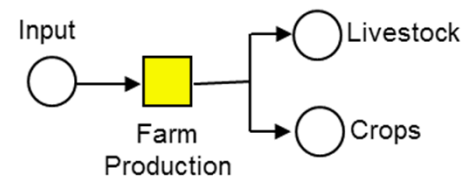


# Modeling and Data Requirements: Agriculture and Food

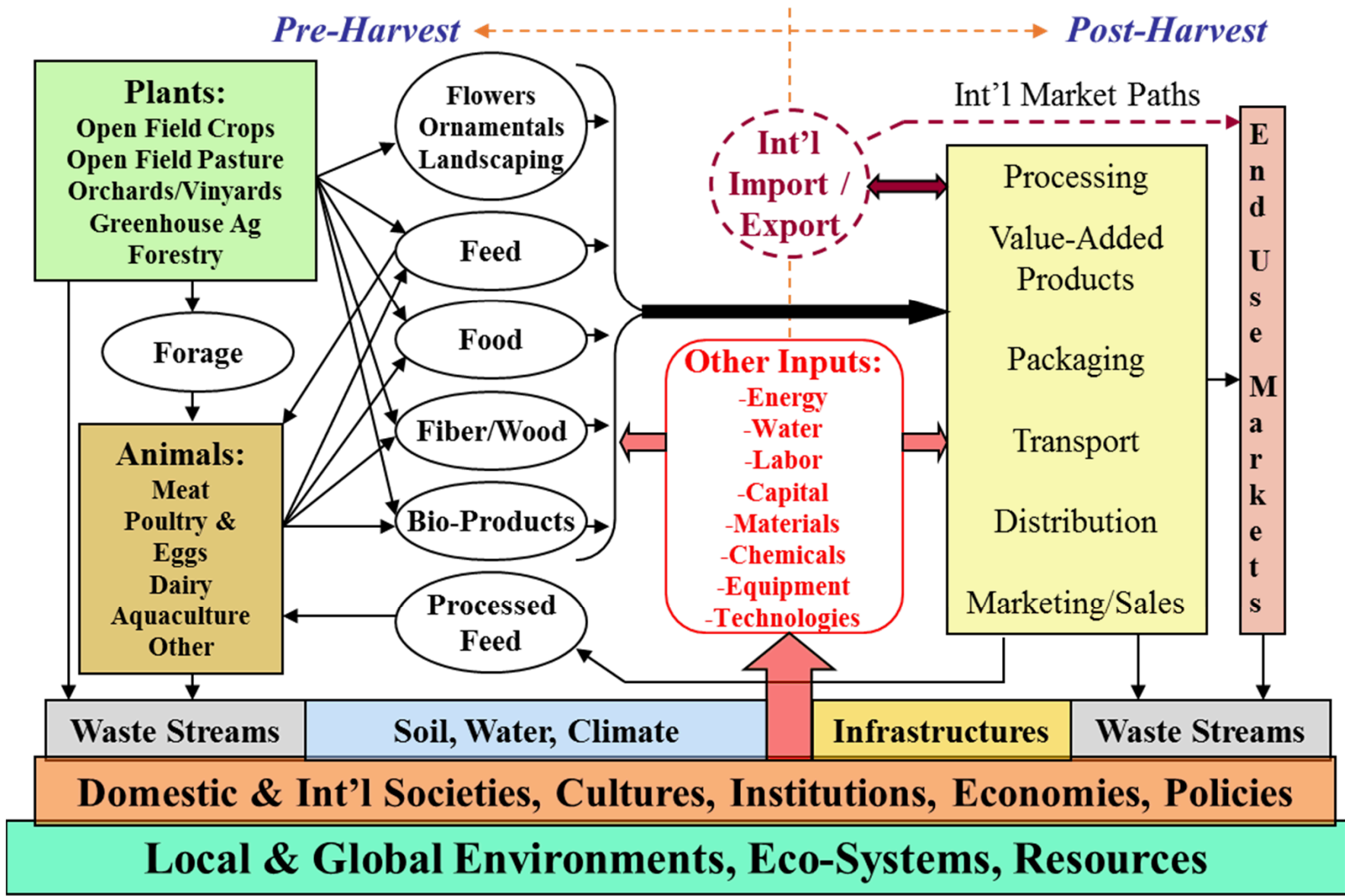
Ron Pate, Terrence Kraus, Vince Tidwell and Theresa Brown

# Description of the Sector

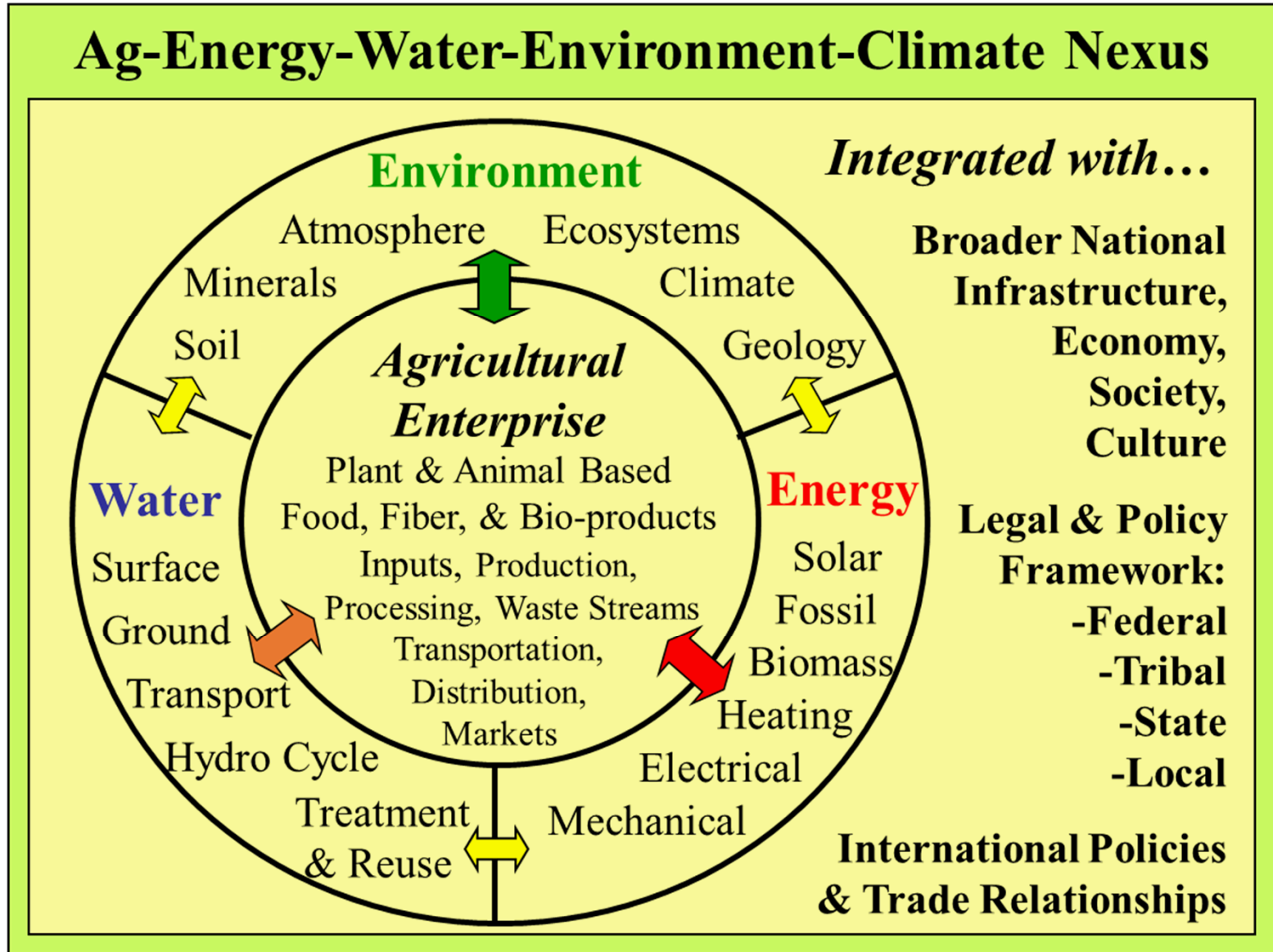
Agriculture is the production, sale and distribution of seed, vegetable, fruit, grain and other crops; raising of animals for meat, dairy, poultry, and egg products; and the growth and harvesting of wood & fiber products



# Agricultural Sector Scope & Context

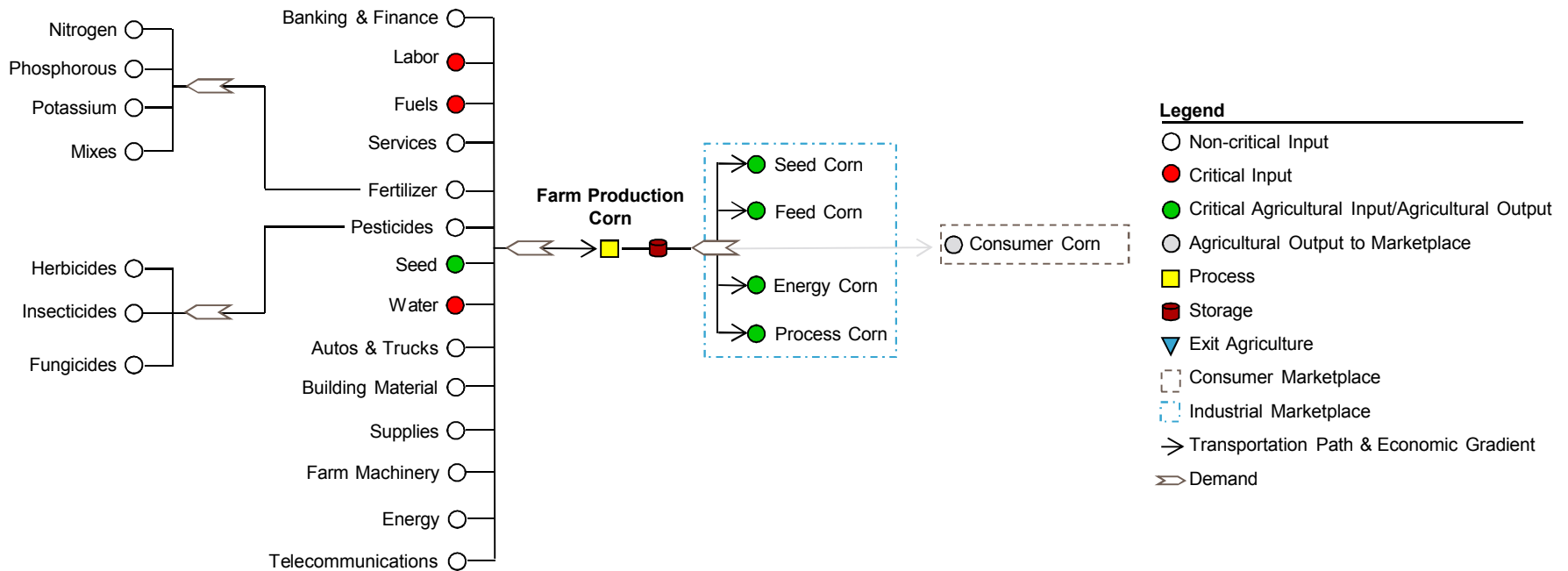


# Ag Sector's Complex Interdependencies



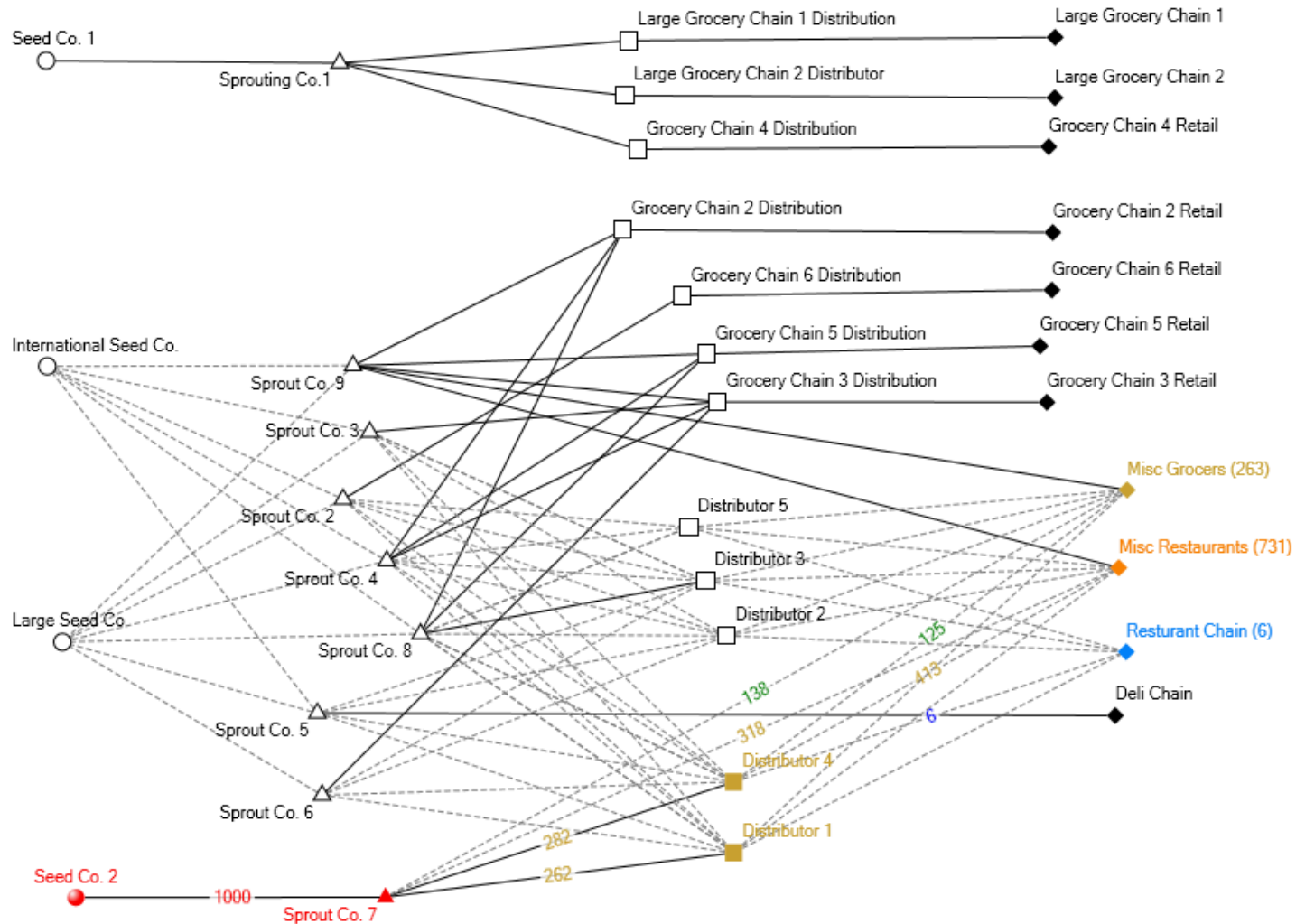
# Models for specific purposes

Structural Models: Identify dependencies, represent supply-chains, stochastic mapping of contamination pathways



# Seed Contamination Scenario

## Impacting Fresh Sprout Products and Effects on Consumers



# Models for specific purposes

Dynamic Models: Evaluate sector risks and resilience to stresses and design mitigation strategies

Meat/Meat Products

Corn Price

Dairy/Dairy Products

Beef Simulation

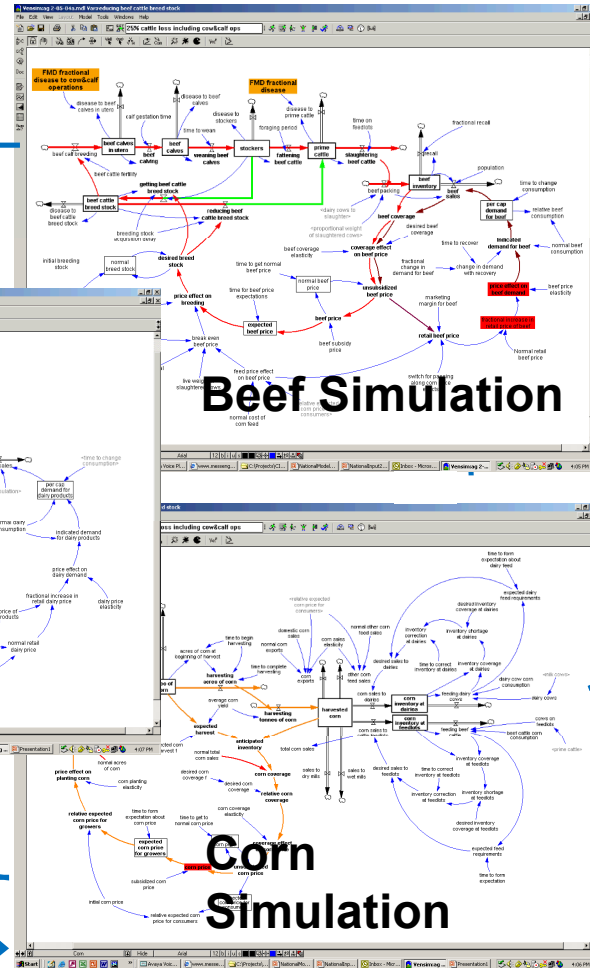
Dairy Simulation

Corn Price

Demand for Corn

Corn Simulation

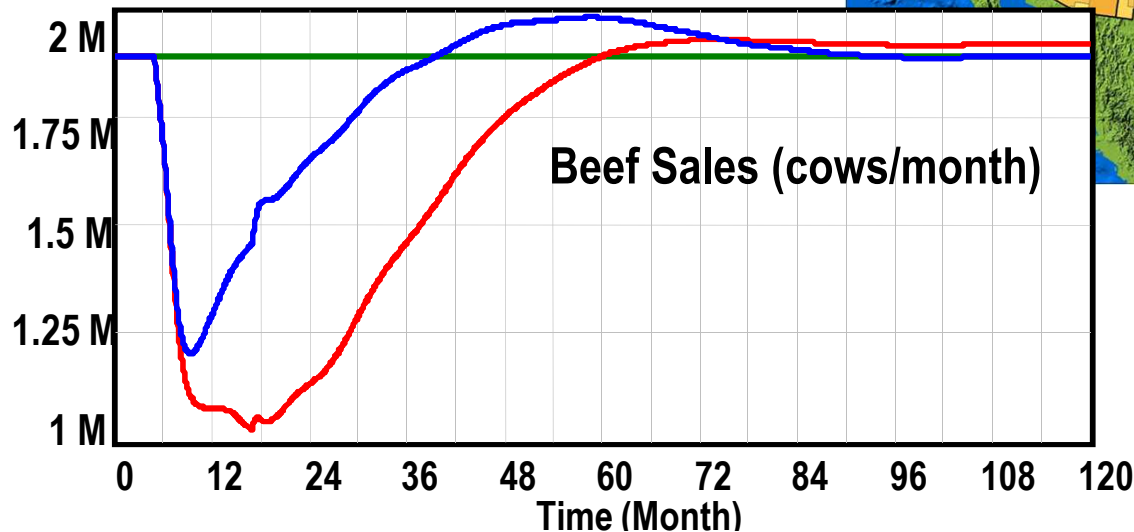
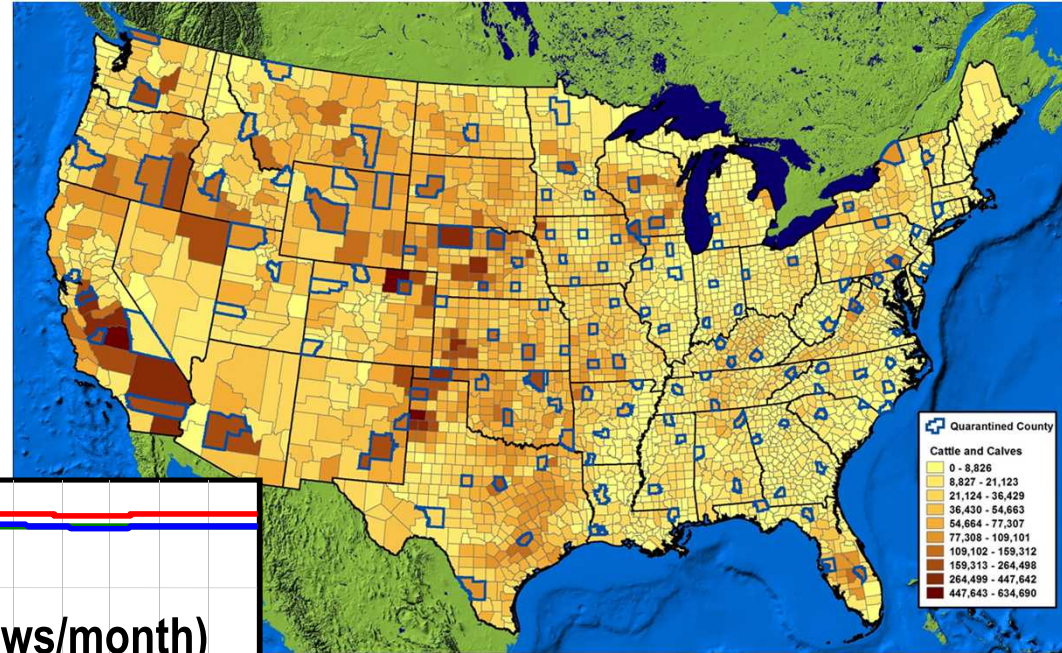
Demand for Corn



# Models for specific purposes

Disease Models: Evaluate animal disease spread, impacts and mitigation strategies

## Foot and Mouth Disease (FMD) Impact Assessment for Alternative Scenarios

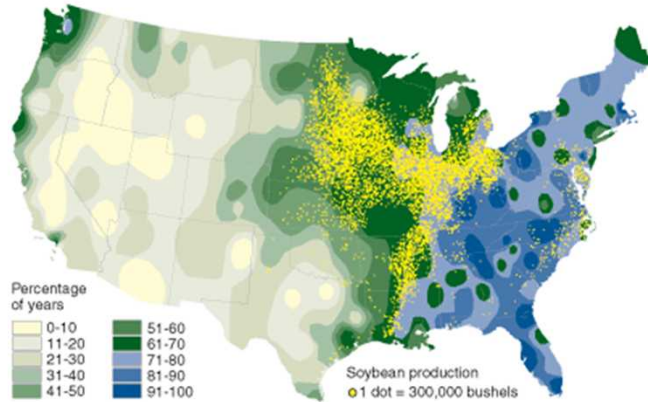


Alternate Incident ——— (blue line)  
Base Incident ——— (red line)  
No Disruption ——— (green line)

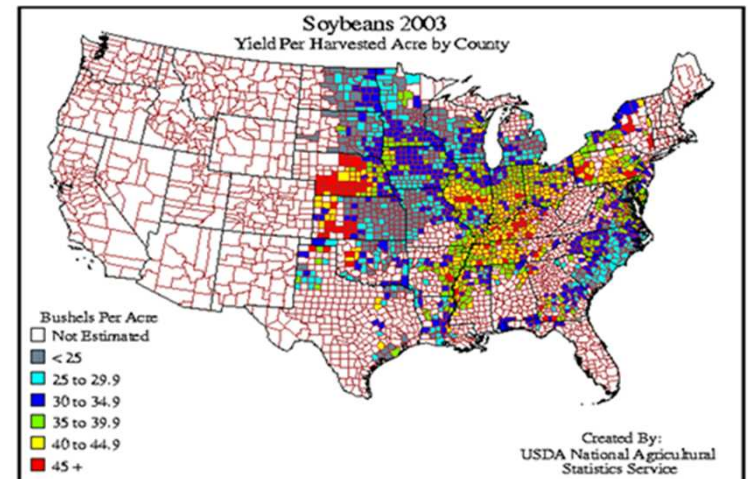
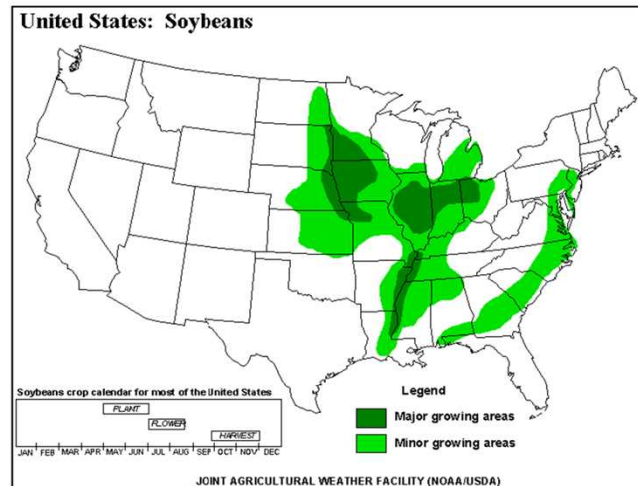
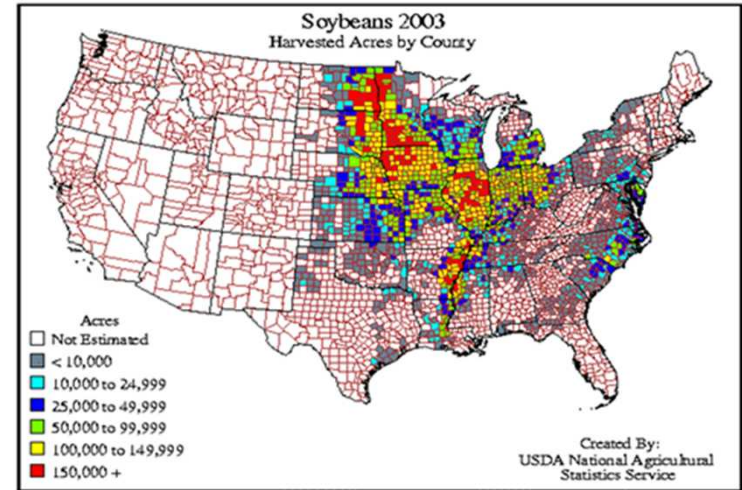
# Models for specific purposes

## Disease Models: Evaluate crop disease spread, impacts and mitigation strategies

Percentage of years out of 30 that climatic conditions are expected to support establishment of soybean rust



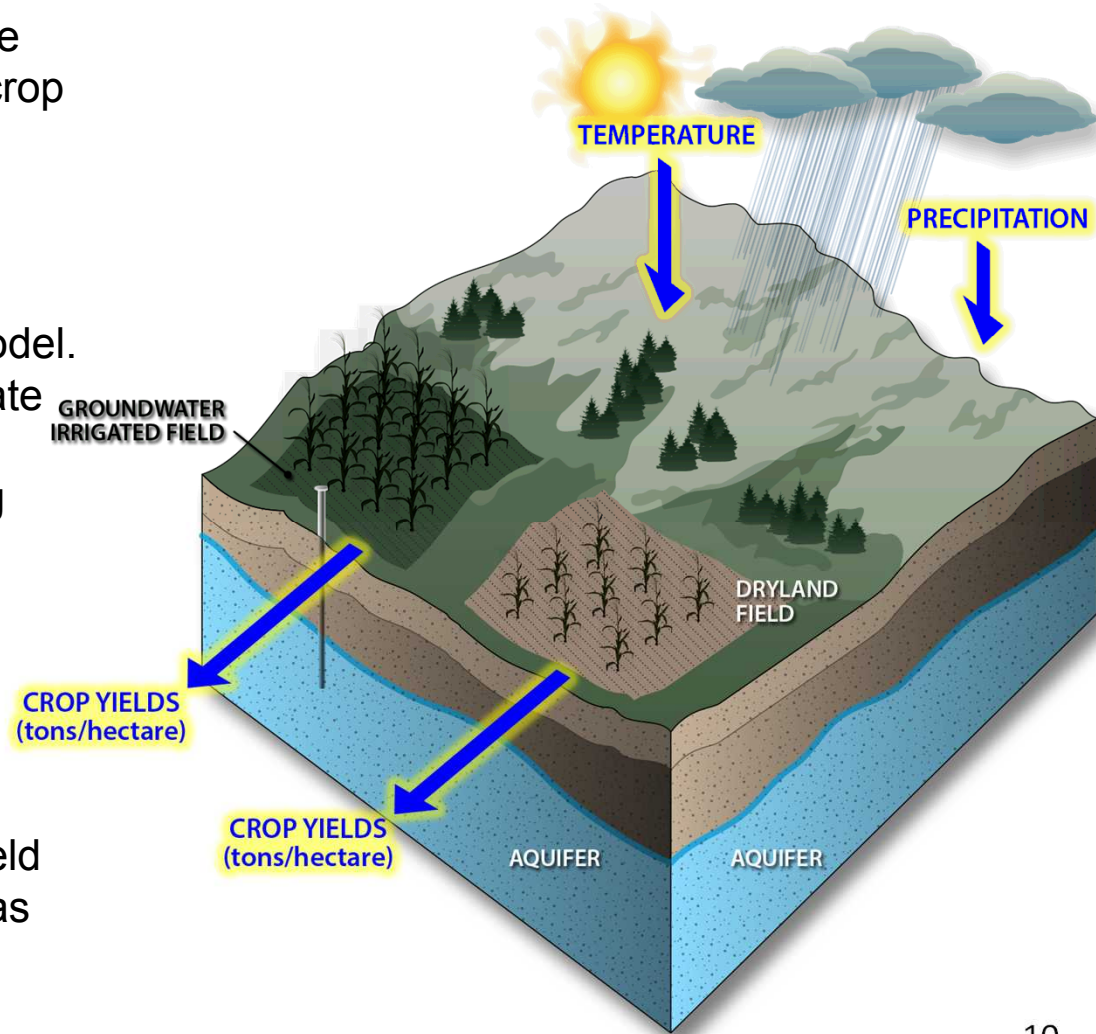
Source: USDA's Animal and Plant Health Inspection Service and National Agricultural Statistics Service.



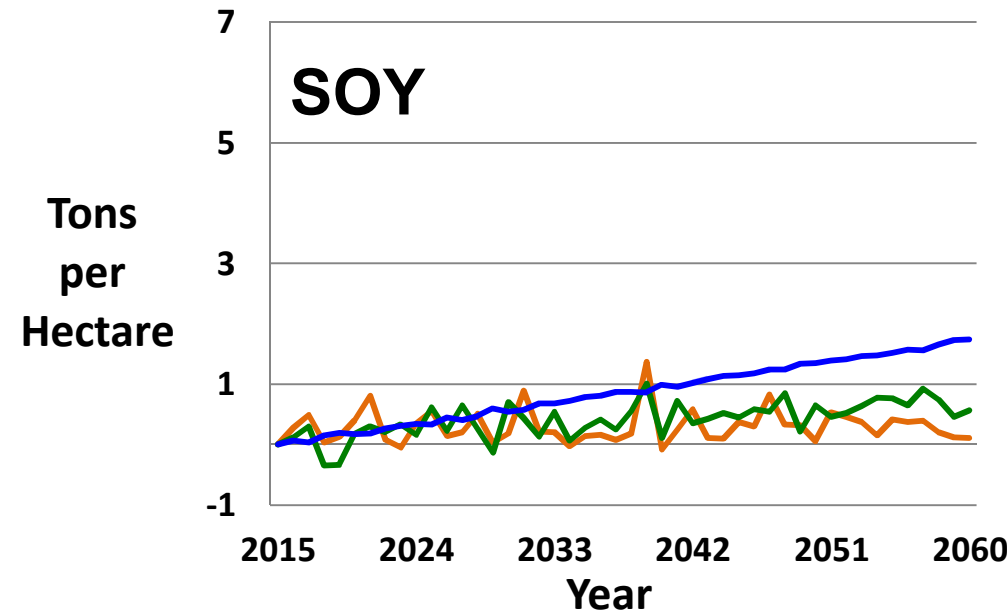
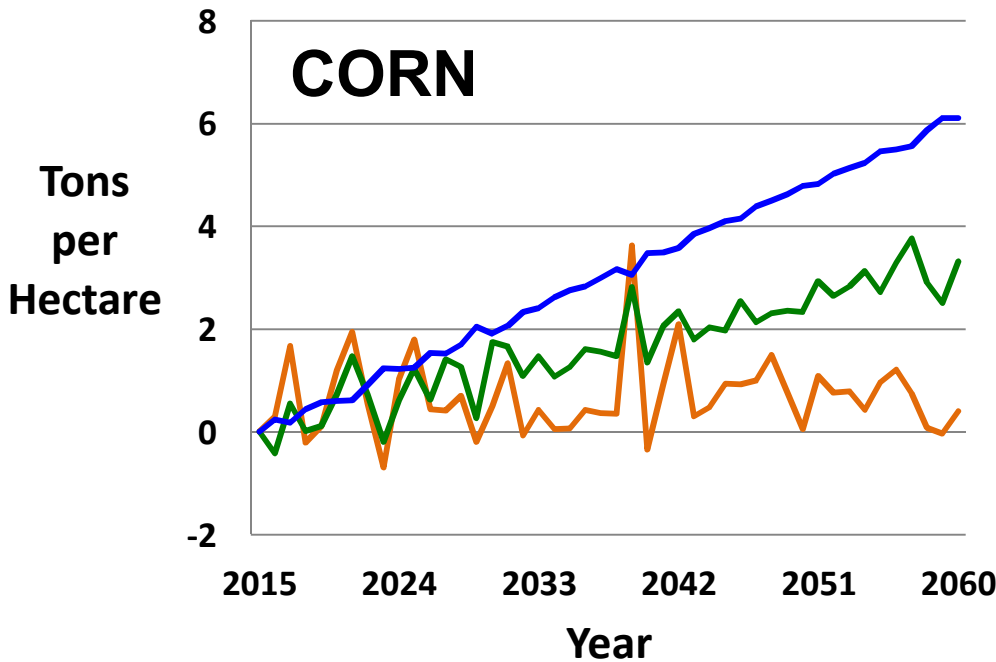
# Models for specific purposes

## Crop Models: Crop productivity projections

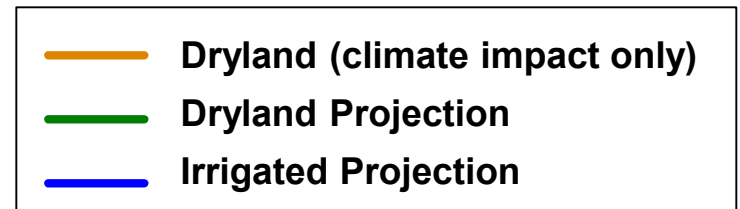
- Application: Analyze impacts of climate and groundwater depletion on future crop yields in the High Plains
- 2 crop models used
  - Both incorporate projected temperature and precipitation generated by a global climate model.
- Environmental Policy Integrated Climate (EPIC) model
  - Physical process-based cropping system model
    - Shows climate impact only
- Statistical model
  - Calculates yield as a function of precipitation, temperature, and historical trend
  - Accounts for improvements in yield due to non-climate factors such as irrigation and technology



# Dundy County Nebraska

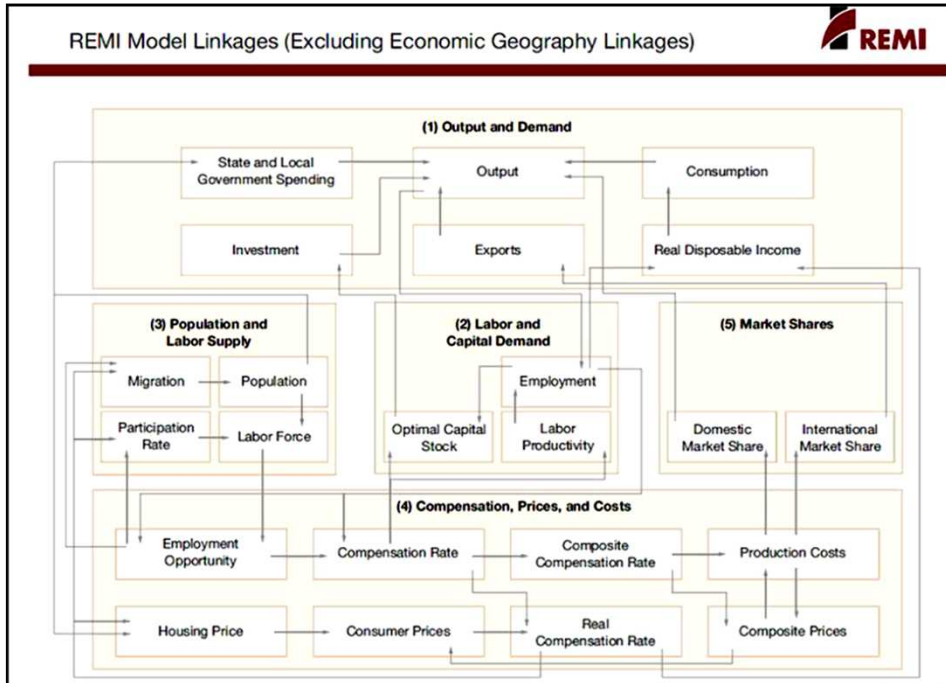


- Small downward trend due to climate impact alone
- It may be possible to overcome climate impact through agricultural innovation
- Conversion to dryland farming possible as groundwater resources decline
  - Corn yield reduced by 70%
  - Soy yield reduced by 43%
- Similar results found in all 14 representative counties

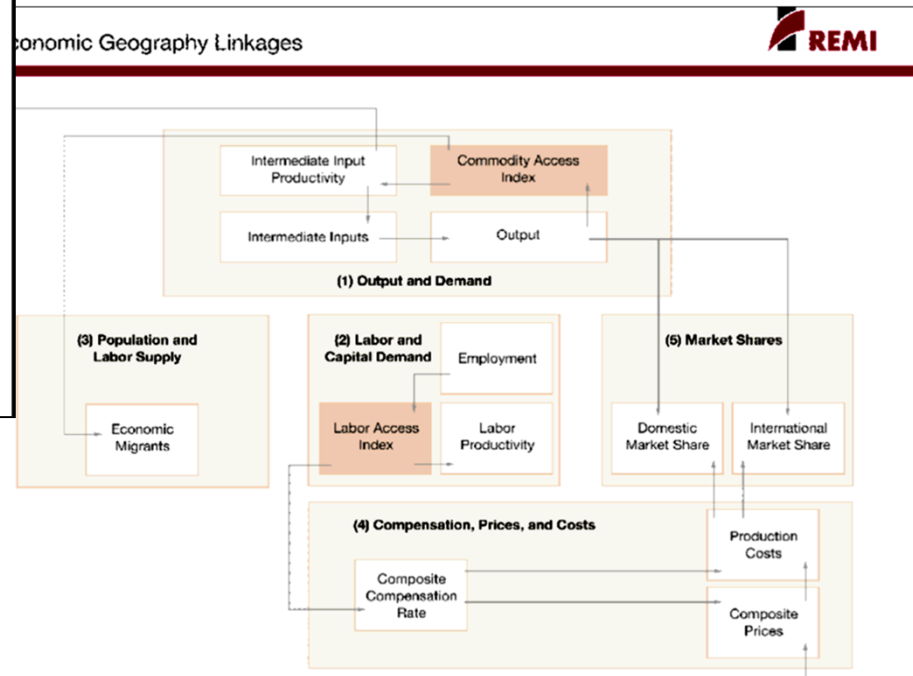


# Models for specific purposes

Ag-Econ Models: Evaluate economic risks and stresses and adaptations, quantify economic risks



REMI PI+



Sandia – Farm Exit Model (empirical, NASS data)

# Potential Climate Change Impacts on Ag and Food Production in the Southeastern Region of the U.S.

## Example of Climate Scenario Forecast Implications for Poultry & Egg production Relevance :

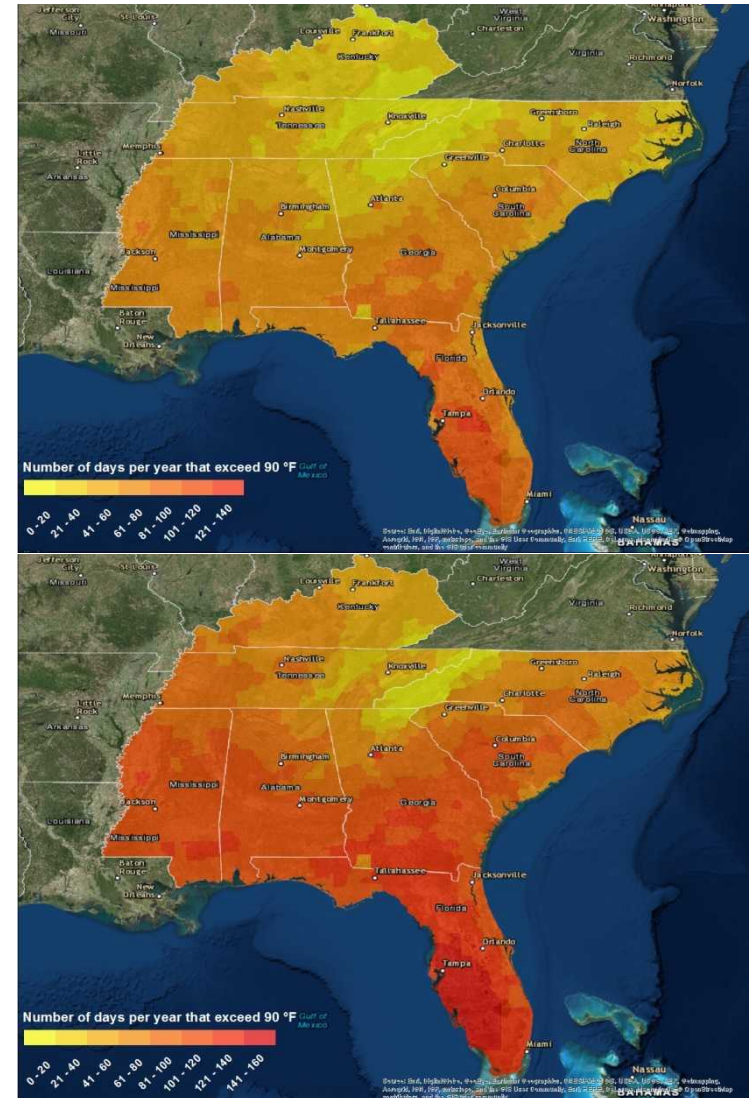
- Poultry & Egg production represents
  - The #1 Ag Sector revenue category in AL, GA, MS, NC, SC
  - The #2 Ag Sector revenue category in KY
  - The #3 Ag Sector revenue category in TN
  - Combined product value of ~ \$19.1 billion (sold in 2012)

## Potential Impacts and Ripple Effects:

- Increasing risks and operating costs to Poultry & Egg producers due to increased energy demand to cool facilities during periods of high temperatures, and especially during high *Heat Index* conditions\*
- Increasing demand and stress on electric power production infrastructure and water supplies for thermal plant cooling due to climate-driven load increases throughout the Southeastern Region
- High heat index risks to personnel doing outdoor labor

\*Note: Conditions with temperatures  $\geq 90^{\circ}\text{F}$  and relative humidity  $\geq 80\%$  results in *Heat Index* levels that can impose severe stress and impacts on agricultural livestock, poultry, outdoor workers

Annual Average Days w/ Temperatures  $\geq 90^{\circ}\text{F}$   
2030-2040 change relative to 1980-1990 average



# Case Study - Citrus Greening Impacts on FL Industry

## An Existential Threat to the Florida Citrus Industry

### The Disease

Huanglongbing (HLB)  
aka, *Citrus Greening*  
*Candidatus Liberibacter asiaticus* (Asian bacteria)

No cure yet !



### The Insect Vector

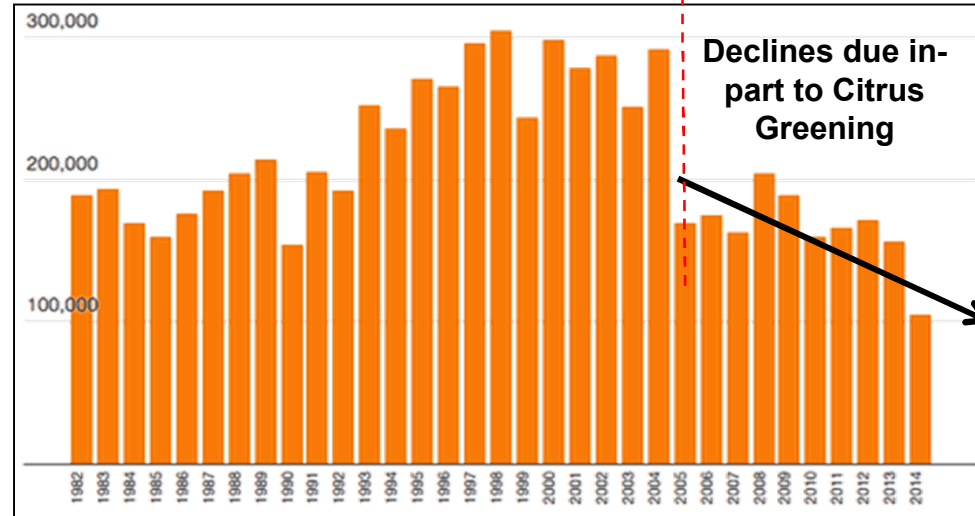
Asian Citrus Psyllid  
*Diaphorina citri*



**HLB first detected in Florida citrus in early-Sept 2005**

- Spread to all commercial citrus growing counties within 5 years!
- Introduction and spread possibly caused or aided by hurricanes

## Florida Citrus Production, Thousands of Boxes



Declines due in part to Citrus Greening

Future of Florida Citrus Industry ... Assessment of Farm Exits

## Farm Exit Analysis ... Purpose & Relevance:

- Assess the Ag Economy Impacts of Citrus Industry Decline in Florida
  - Largely due to HLB disease, the spread and impact of which is partly driven by climate
  - Exemplar for climate exacerbated disease & vector threats to Ag/Forest/Eco sectors
- Florida citrus Industry valued at ~\$10.7B and employed ~ 62,000 in 2012-13

### Approach:

- Use USDA Ag Census Data
- Apply regression model to estimate exit probabilities for farm operations;
- Metrics include variables such as sales, federal funds received, and other;
- Ten models used to derive predicted exit probabilities.

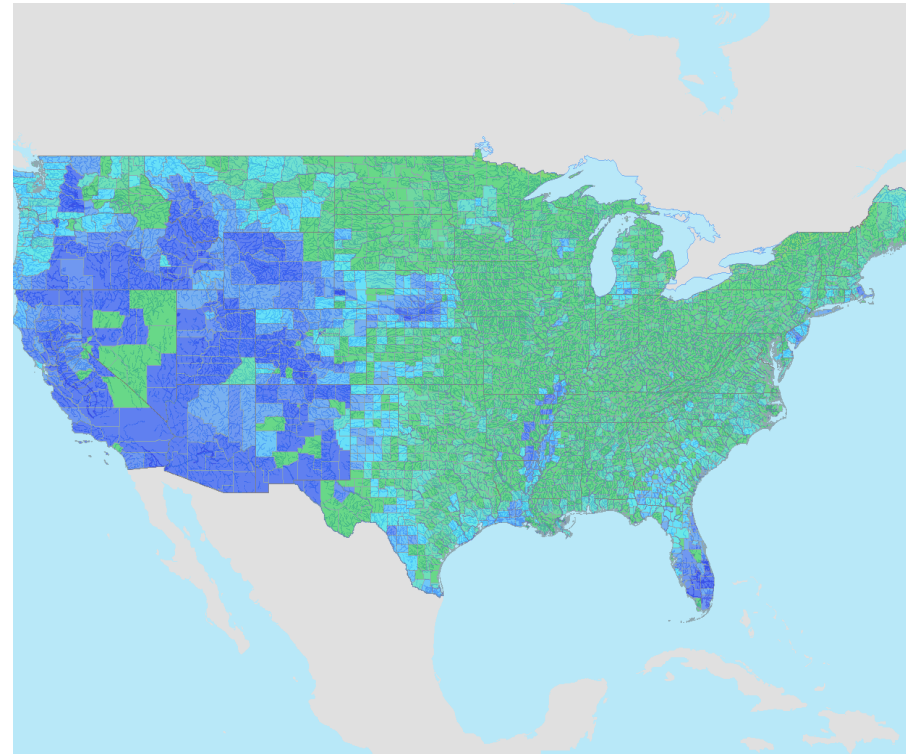
# Data Requirements

Depending on the question, type of model, agriculture sector and time frame of the analysis

- Population
- Existing land use
- Temperature, Precipitation, Wind
- Production Process (e.g. irrigation, free range)
- Crops
- Livestock
- Disease Vectors
  - Treatment/Prevention
  - Policy
- Product demand
- Substitutions
- Transportation modes
  - Specialized equipment
  - Regulation
- Costs

# Data Requirements: Census of Agriculture Data

- Data from surveys starting with 1982 to 2012
- Starting with the 2002-2012 Survey
  - 37 Sections, 158 questions
- The 1982-1997 Survey contained more questions and sections
- Farm Characteristics (examples)
  - Year farm operation began
  - Total value of production
  - Type of operation (crop, animal...)
  - Expenditure on fuels and oil
  - Expenditure on utilities
  - Loans received
  - Irrigated land harvested
  - Total acres harvested
  - Cattle by weight or dairy
  - Hours worked off farm



Percent of harvested cropland that is irrigated