

# **Pigweed Resistance: How Much? To What ? And Where ?**

**Robert Nichols**  
**Cotton Incorporated**



# Definition: Weed Resistance

**“Inherited ability of a weed population to survive and reproduce after exposure to an herbicide dose (rate) that would control an unselected population”**

*--- Weed Science Society of America*



## Determination of Resistance

1. Investigate Report of Field Failure (P = F0)
2. Collect Seed (F1)
3. Plant seed of suspected and known susceptible populations in the greenhouse.
4. Treat with range of herbicide rates.
5. Compare response of suspected and susceptible population. If significantly different, the suspected population is likely resistant.
6. Cross survivors. Seed are F2. Repeat the test. If the F2 generation is also resistant, the trait is clearly heritable.





# North Carolina 2006



**Untreated**



**88 oz. Glyphosate (4x)  
3 times**



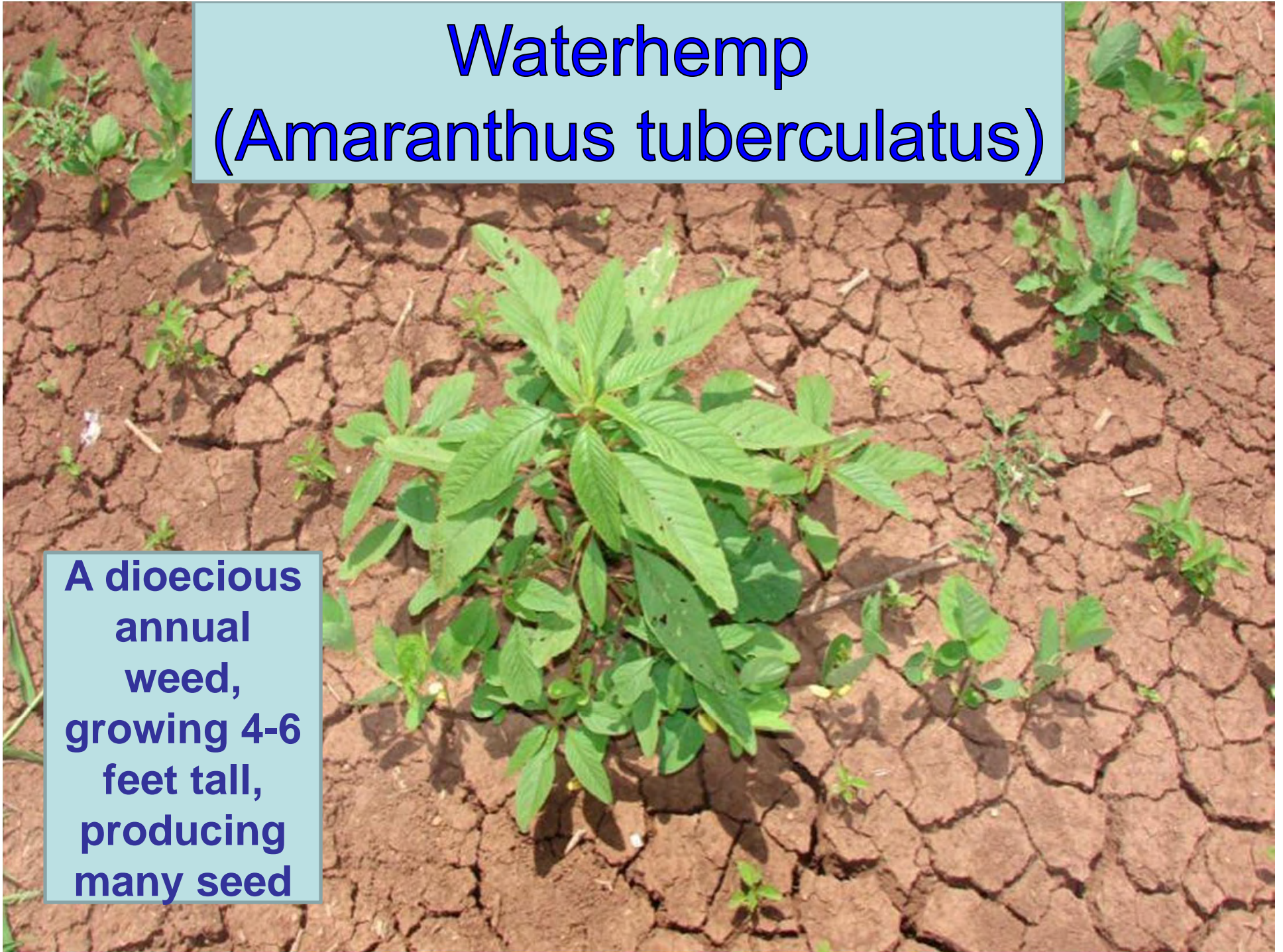
# Weedy Pigweed Species

- *Amaranthus retroflexus* – Red Root Pigweed
- *A. rudis, tuberculatus* - Waterhemp
- *A. hybridus* – Smooth Pigweed
- *A. plameri* – Palmer amaranth
- Several others
  
- Bryson & DeFelice. 2009. Weeds of the South. Univ. of GA Press



# Waterhemp (*Amaranthus tuberculatus*)

**A dioecious  
annual  
weed,  
growing 4-6  
feet tall,  
producing  
many seed**



A photograph of a field densely populated with Palmer Amaranth plants. The plants are tall, green, and have many small, serrated leaves. Some plants have long, thin, upright stems with small flowers or seed heads at the top. The background shows a line of trees under a blue sky with scattered white clouds.

# ***Palmer Amaranth*** ***(Amaranthus palmeri)***

**A dioecious  
annual weed,  
growing  
4-8 feet tall,  
producing  
up to 500,000  
seed per year**



# Dioecious *Amaranth* Species

*Palmer Amaranth*



Waterhemp



# Herbicide Mode of Action

“The way an herbicide kills a plant”

ALS = Acetolactate Synthase:

Cadre, Pursuit, Staple, Osprey, many others

EPSPS = Enolpyruvyl Shikimate Synthase:

Glyphosate

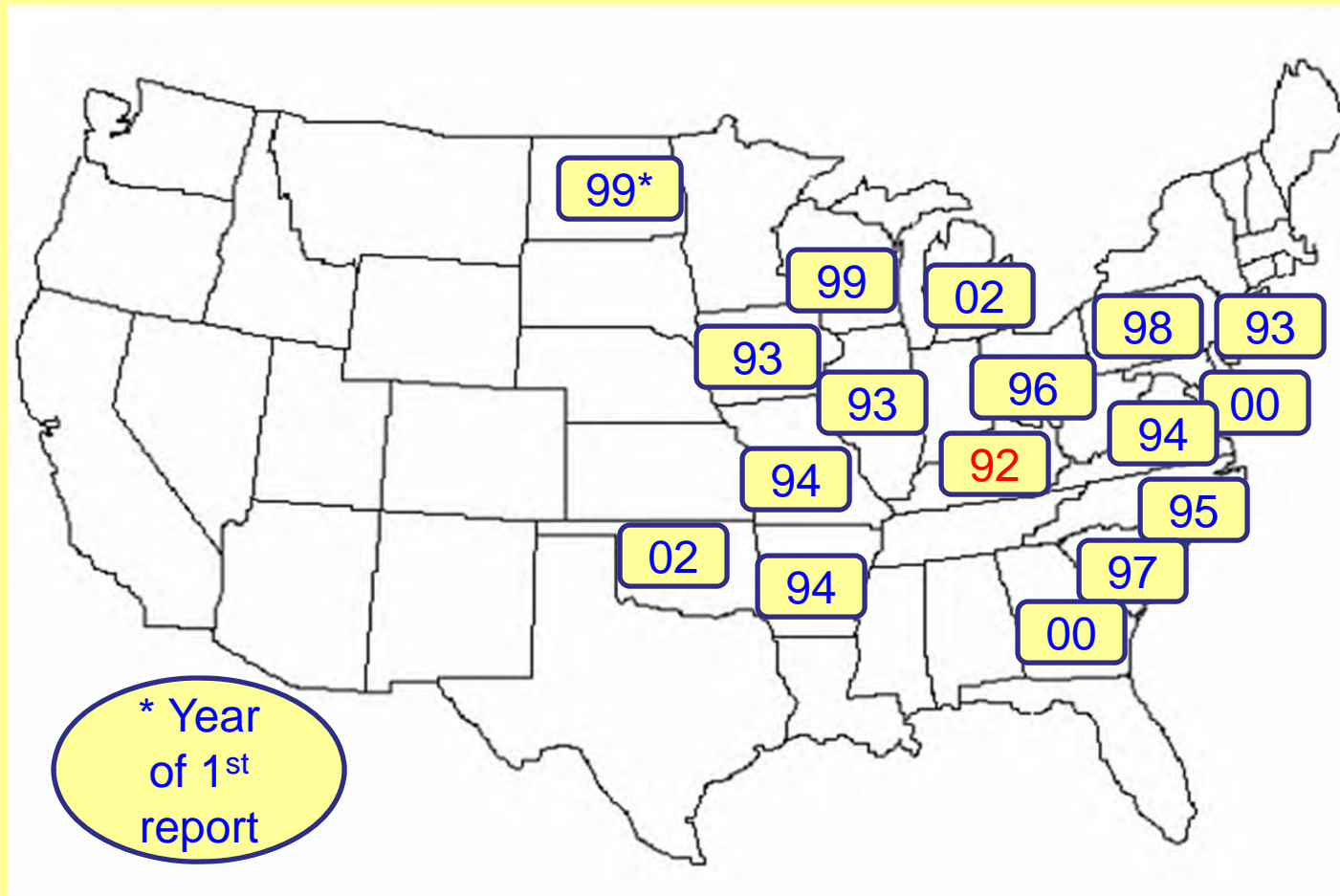
PPO = Protoporphyrinogen Oxidase

Valor, Reflex, Flexstar, Cobra, Goal

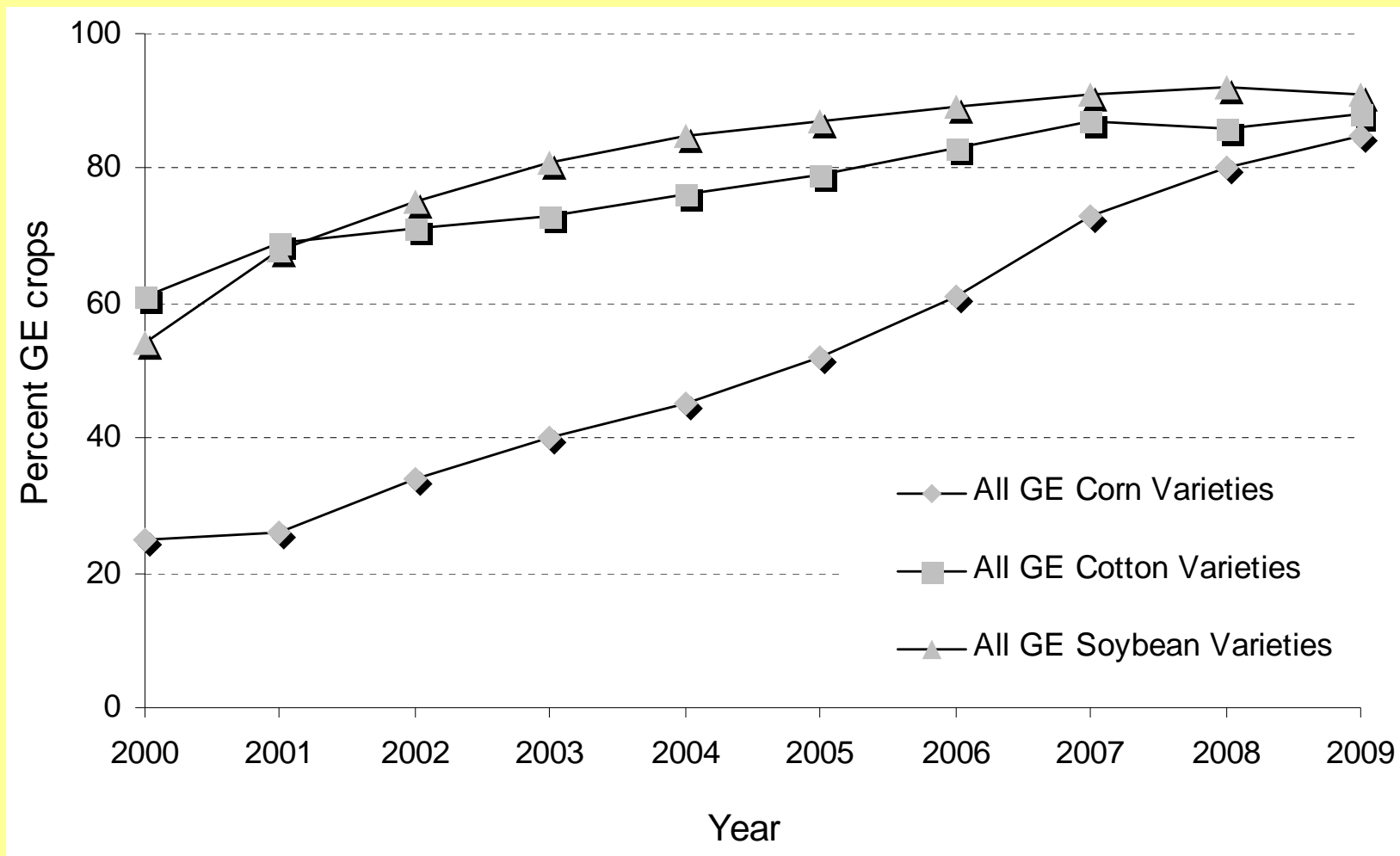
Glutamine Synthetase - Ignite



# Acetolactate Synthase (ALS) Resistant *Palmer Amaranth*



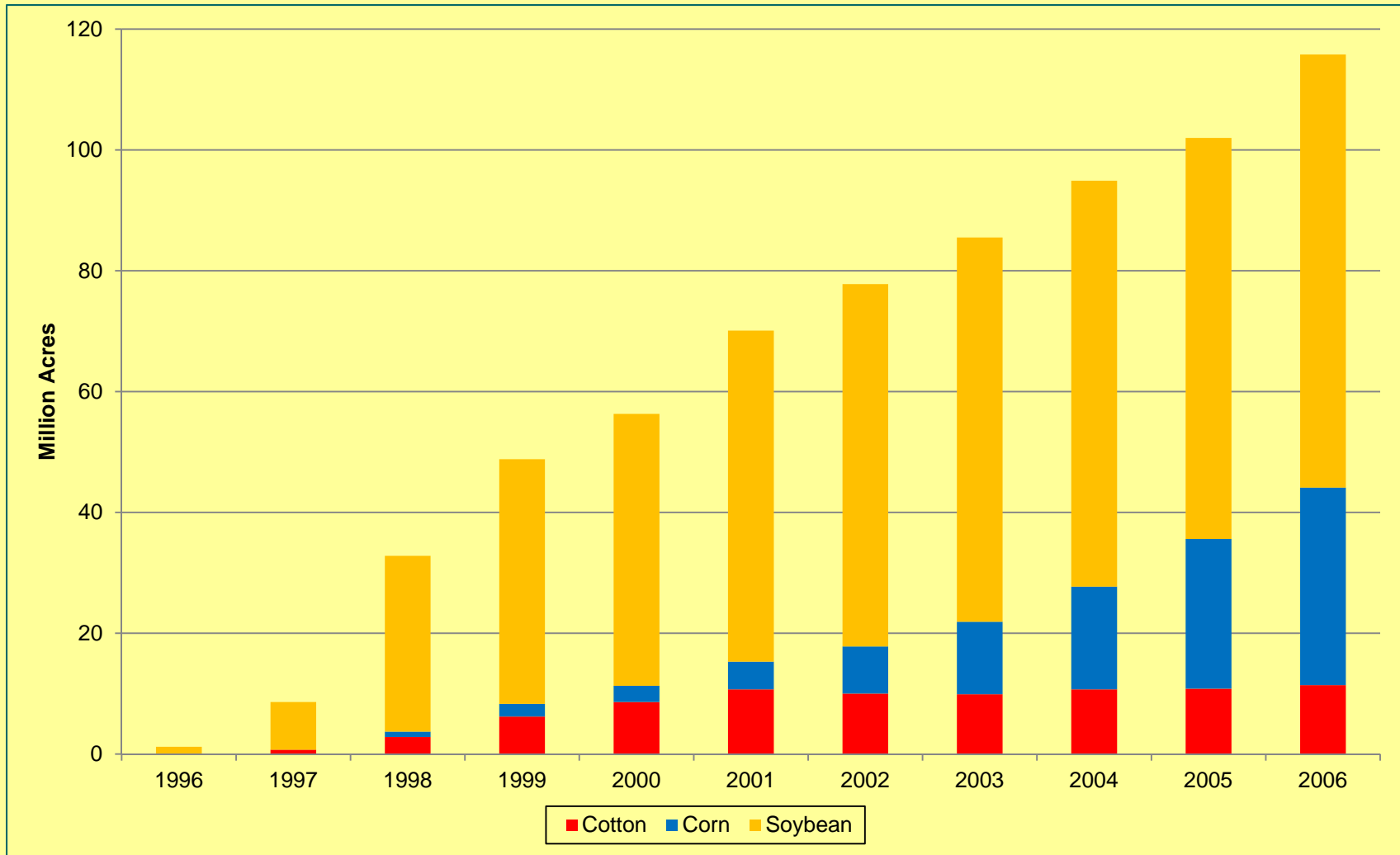
## Nationwide acres of glyphosate-resistant soybean, cotton, and corn as a percent of all acres of the crops



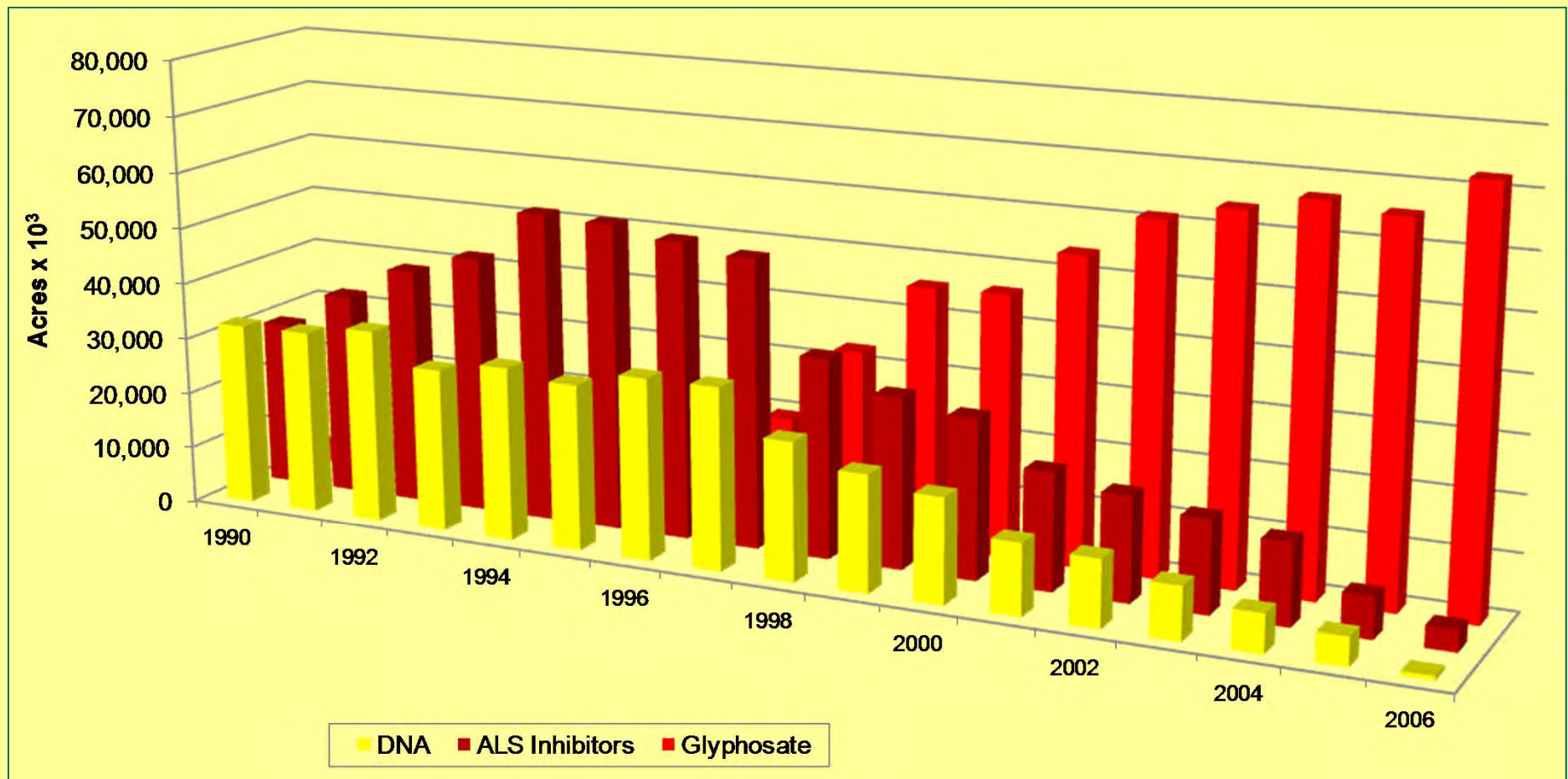
Source: USDA-NASS (2001, 2003, 2005, 2007, 2009b).



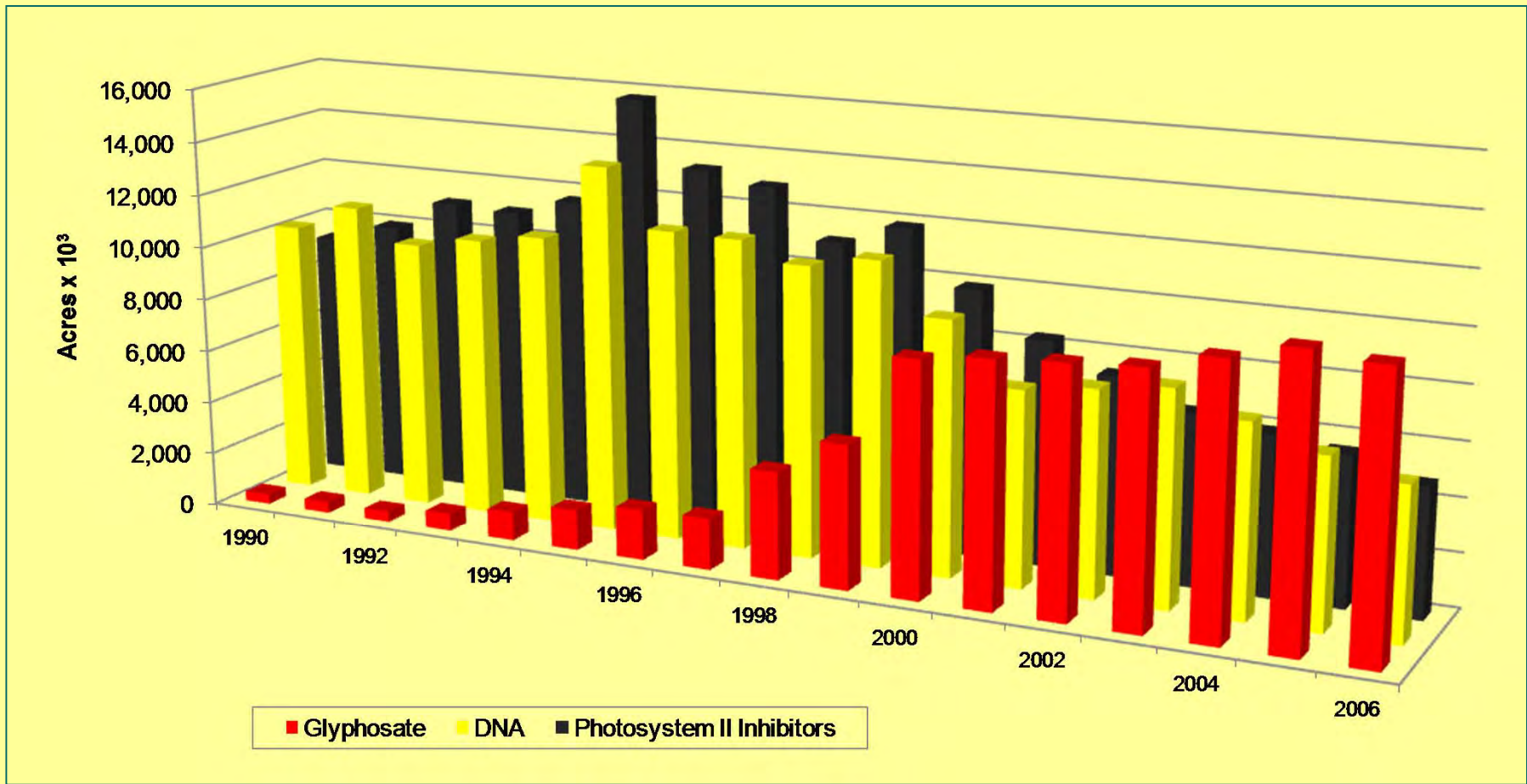
## Acres of Glyphosate-Resistant Crop Cultivars



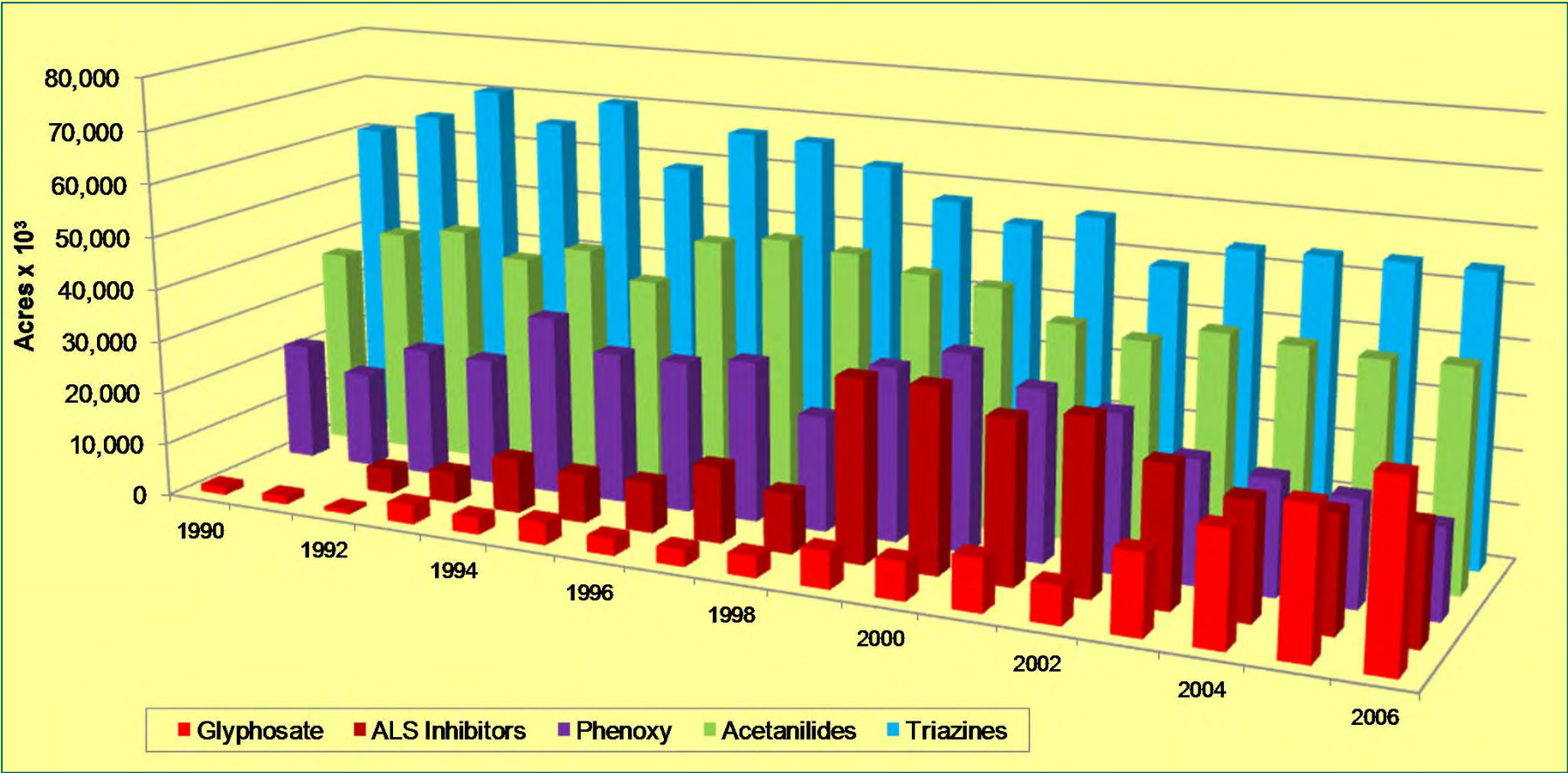
# Soybean Acres Exposed to Herbicide Modes of Action



# Cotton Acres Exposed to Herbicide Modes of Action

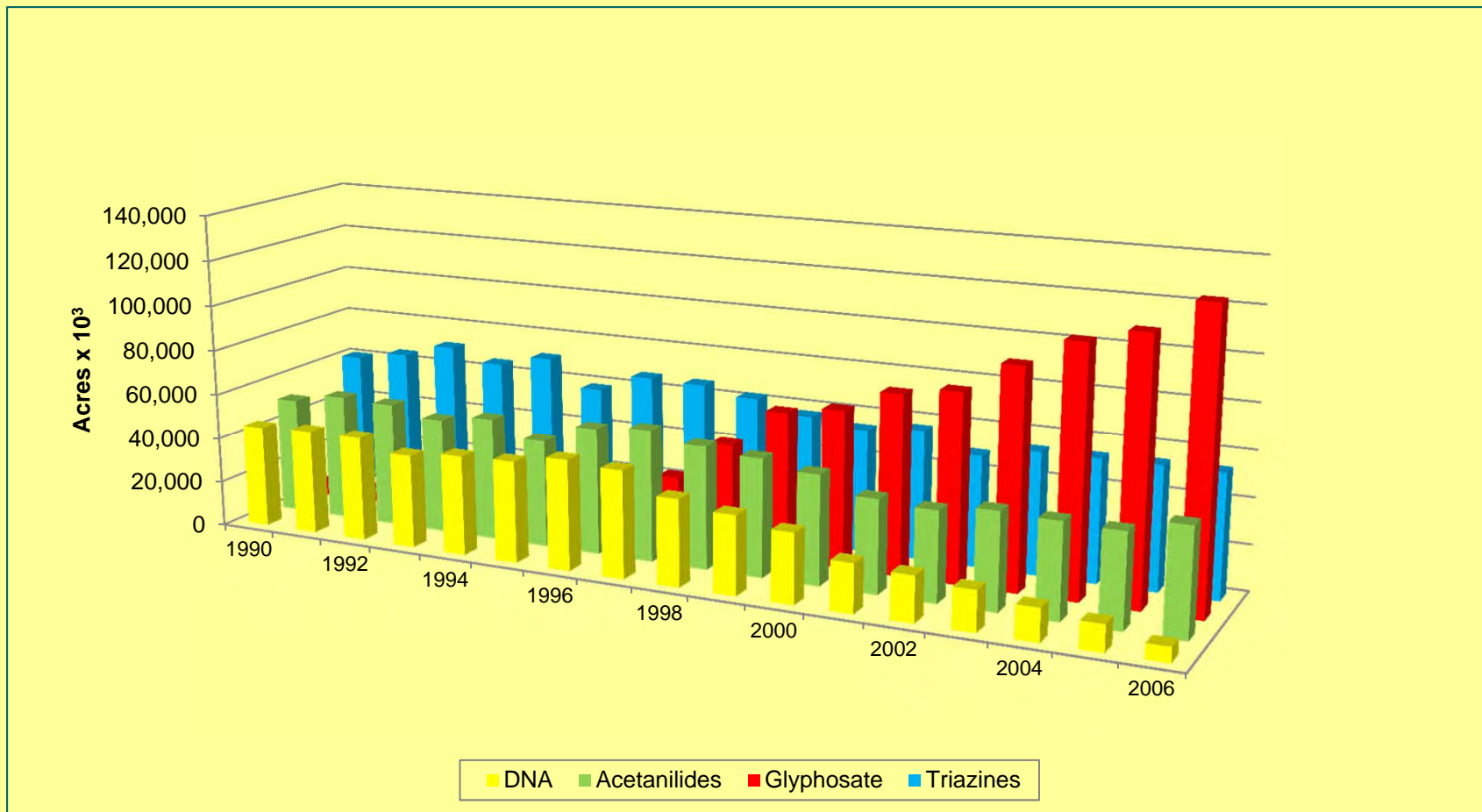


# Corn Acres Exposed to Herbicide Modes of Action

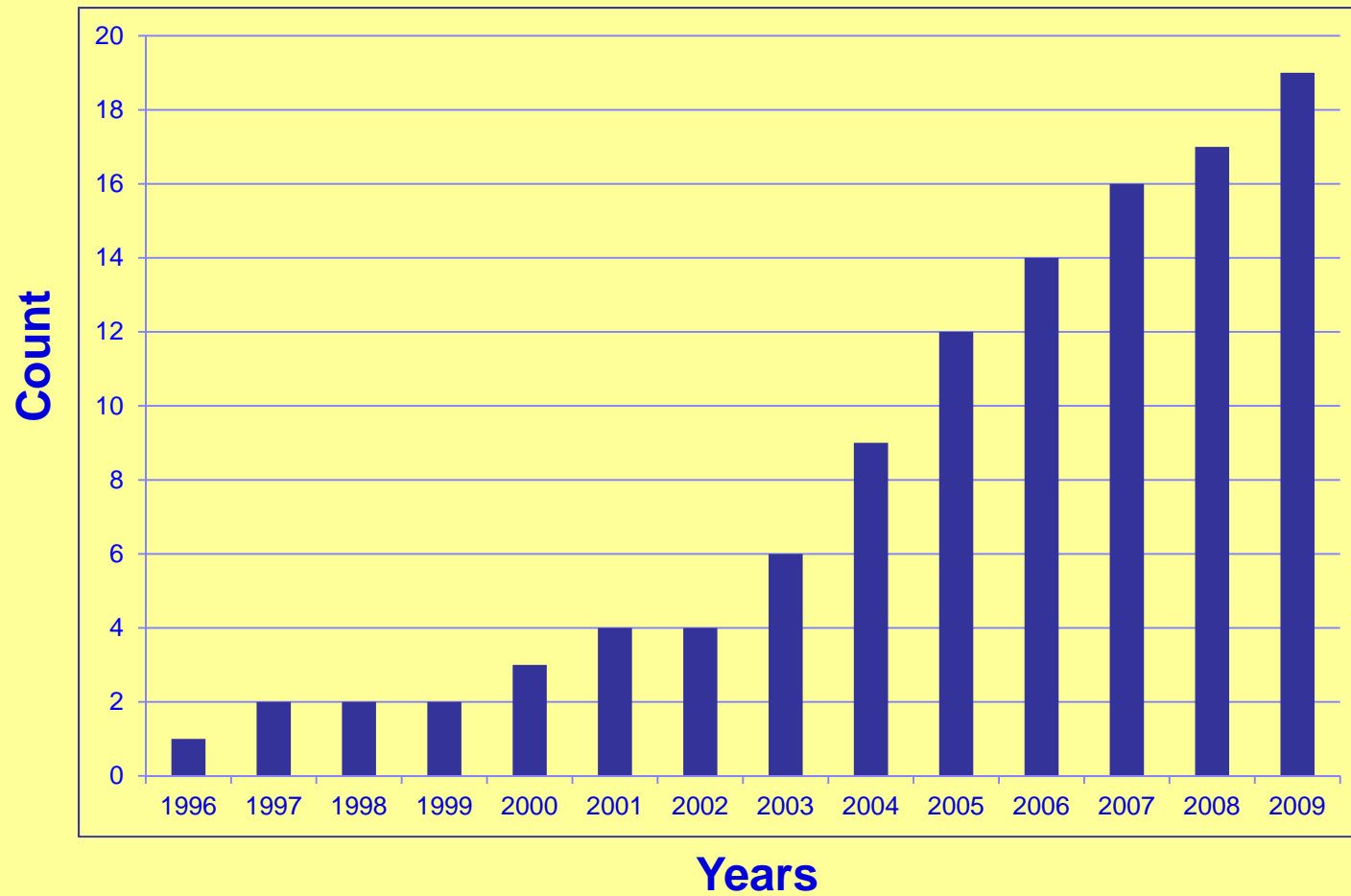




# Total Acres Exposed to Herbicide Modes of Action for Corn, Soybean, Cotton



## Number of Glyphosate-Resistant Species



# **Glyphosate Resistant Weeds in United States**

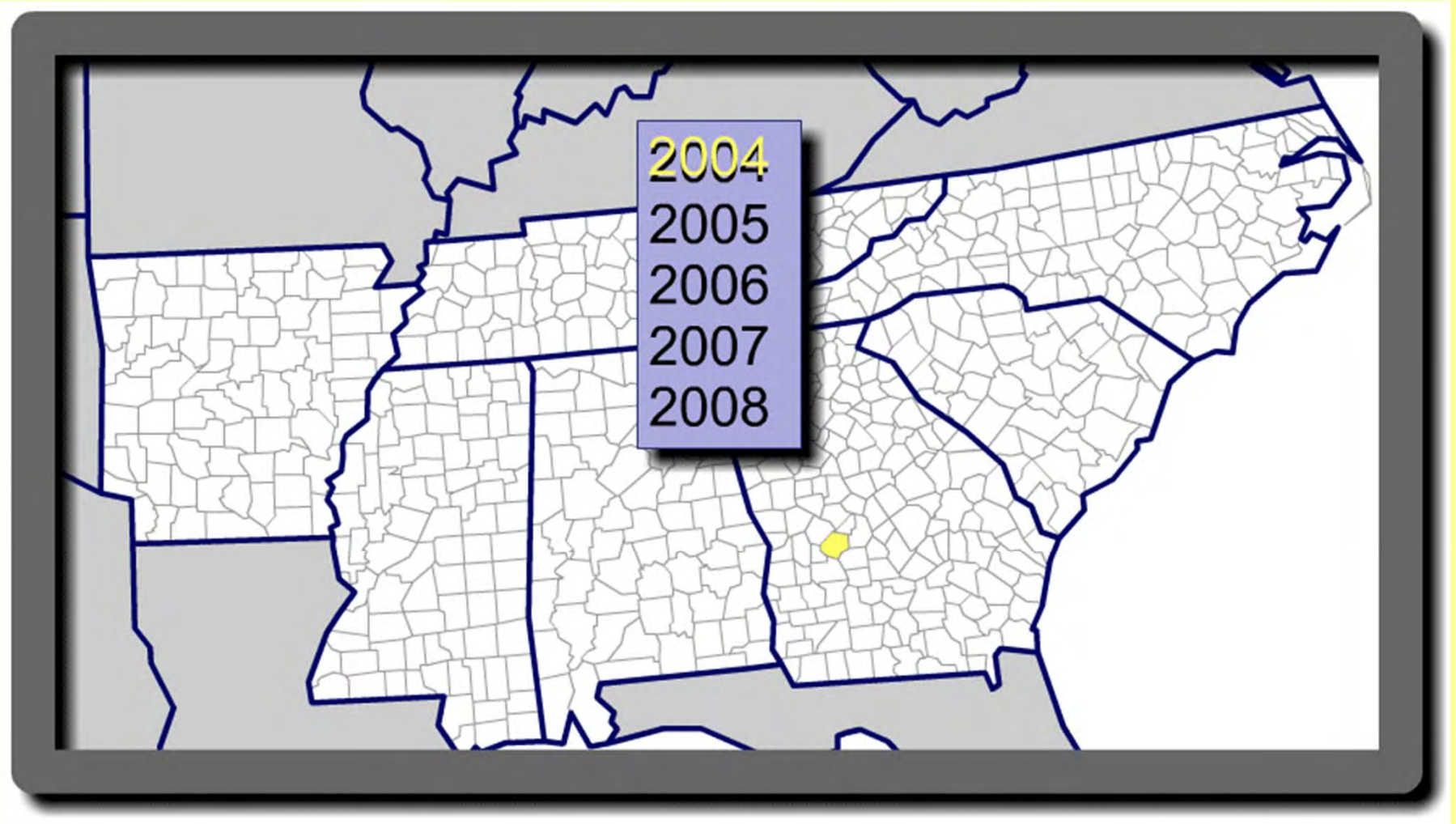
- **Horseweed – 2000 (DE)**
- **Palmer amaranth – 2004 (GA)**
- **Giant Ragweed – 2005 (AR)**
- **Waterhemp – 2005 (MO)**
- **Ryegrass – 2005 (MS)**
- **Johnsongrass – 2007 (AR)**



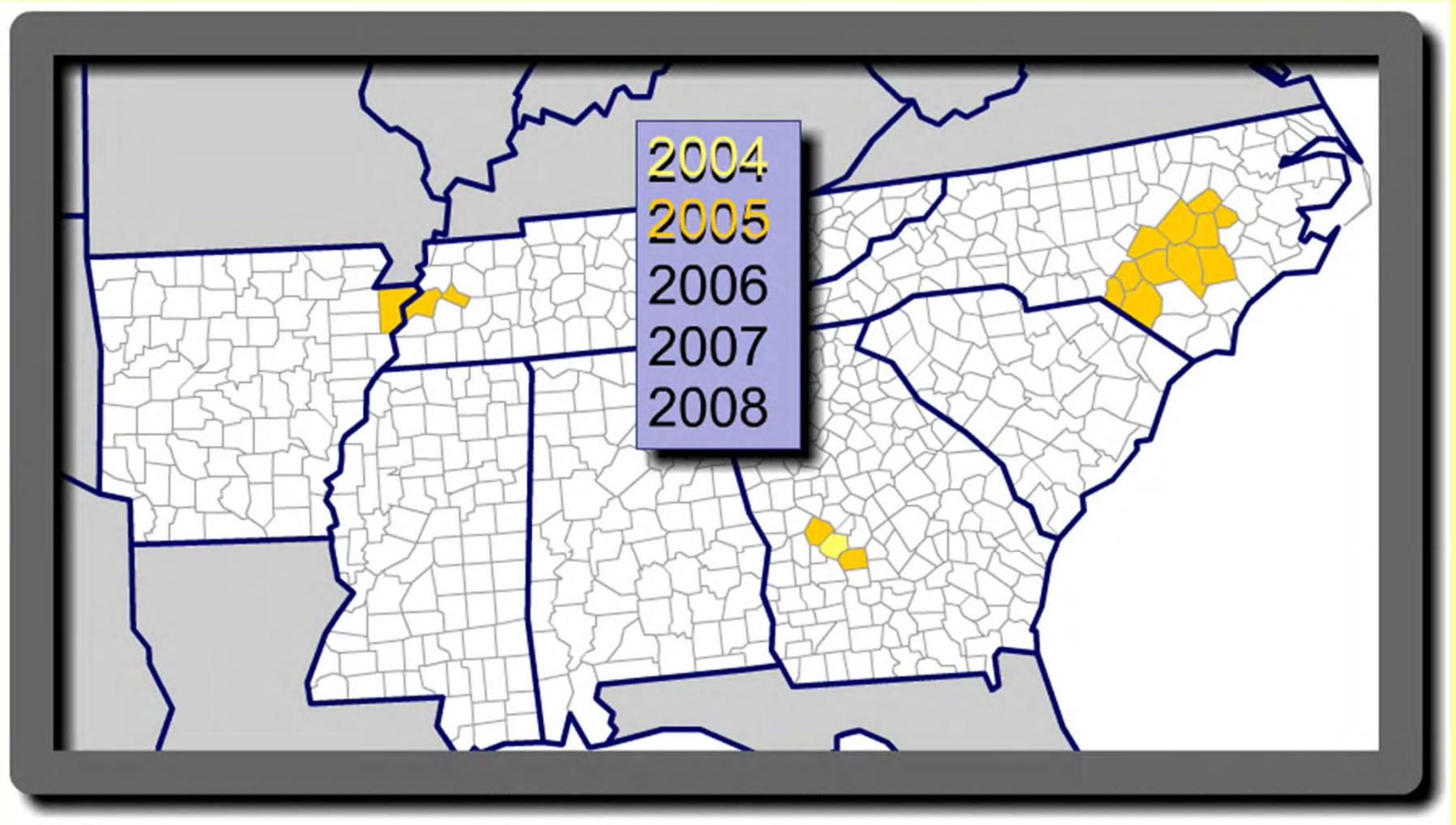


**Macon County, Georgia - 2005**

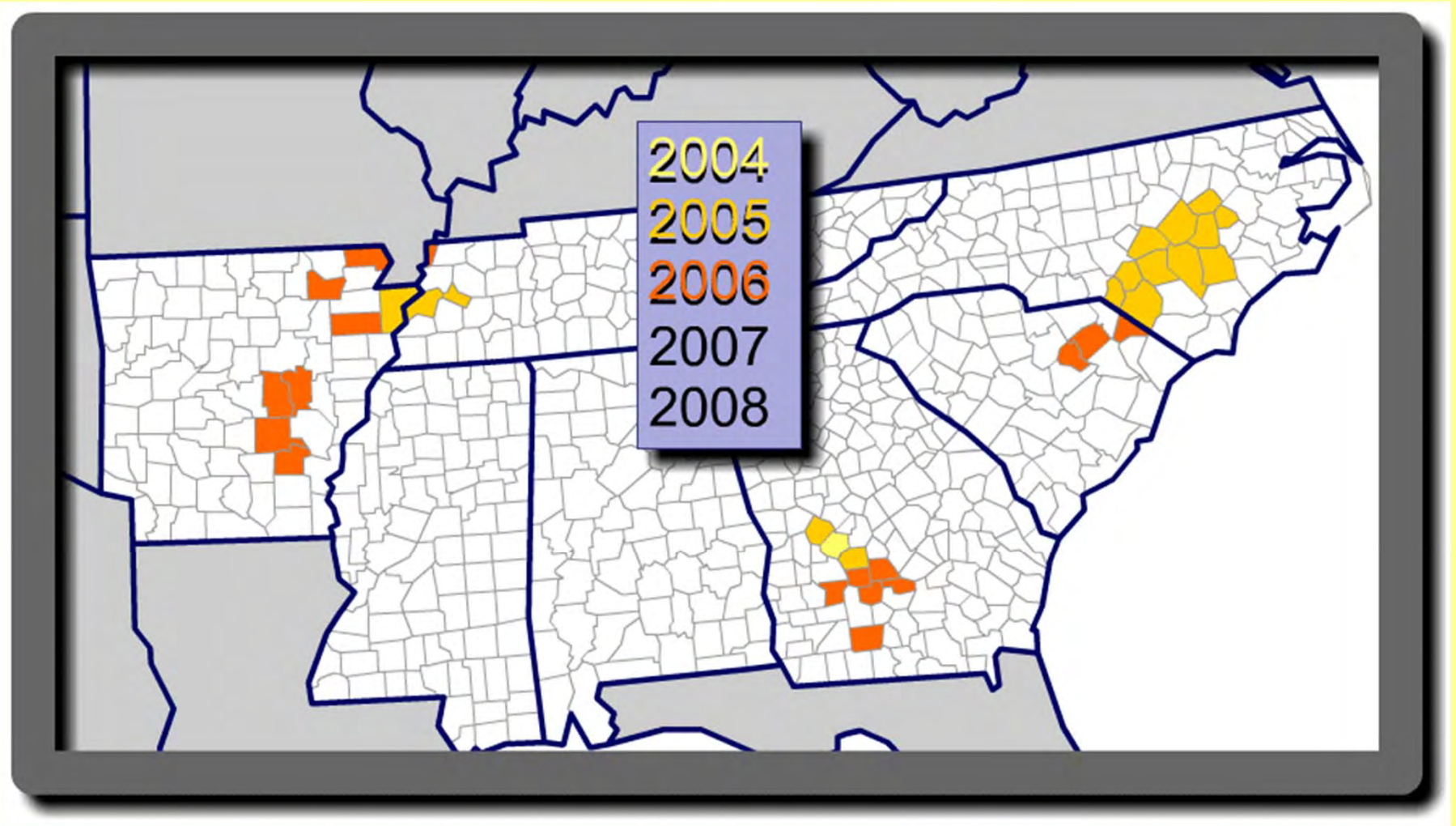
# Counties with Confirmed Populations of Glyphosate-Resistant Palmer Amaranth 2004



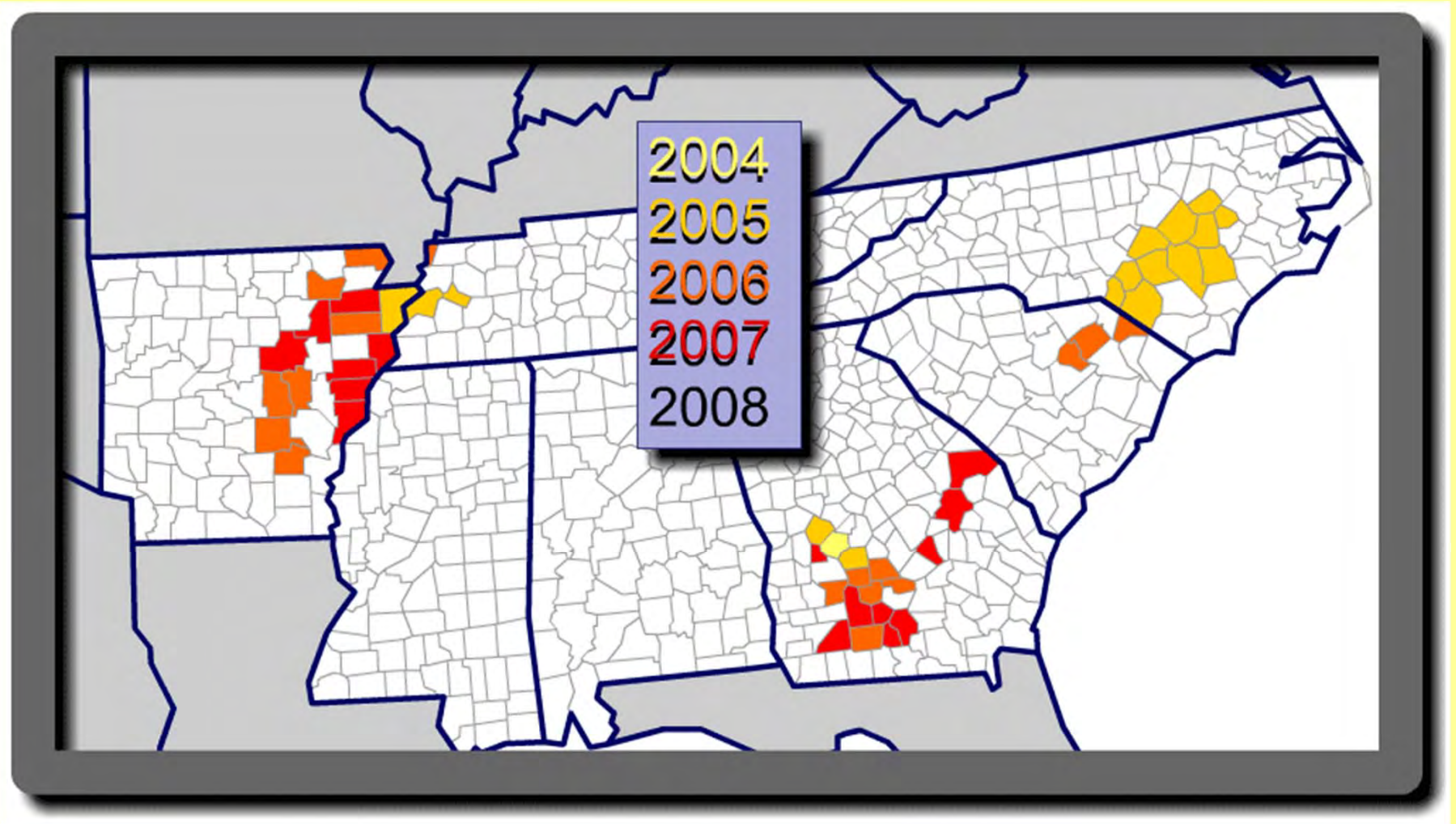
# Counties with Confirmed Populations of Glyphosate-Resistant Palmer Amaranth 2005



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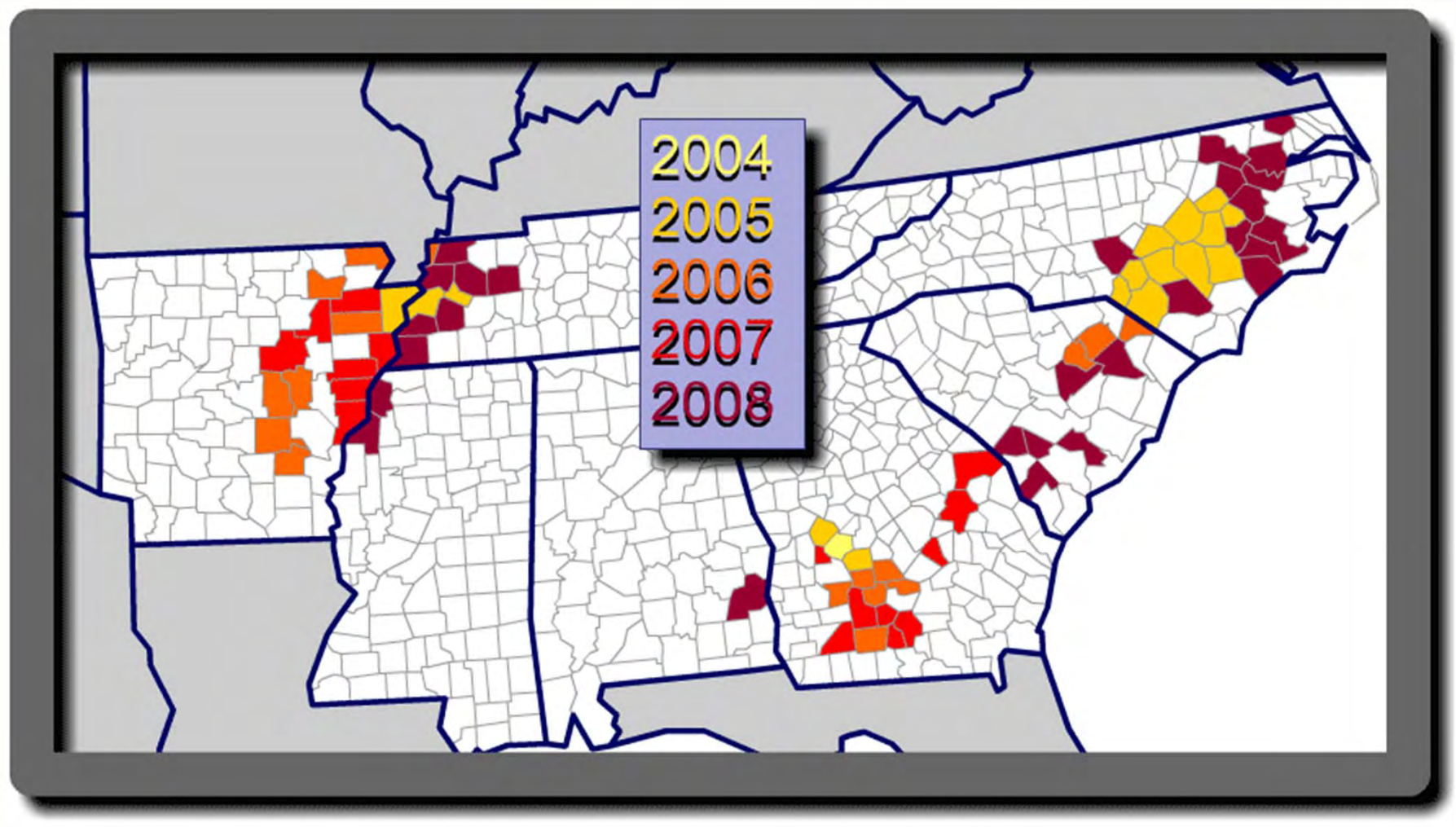


# Counties with Confirmed Populations of Glyphosate-Resistant Palmer Amaranth 2007

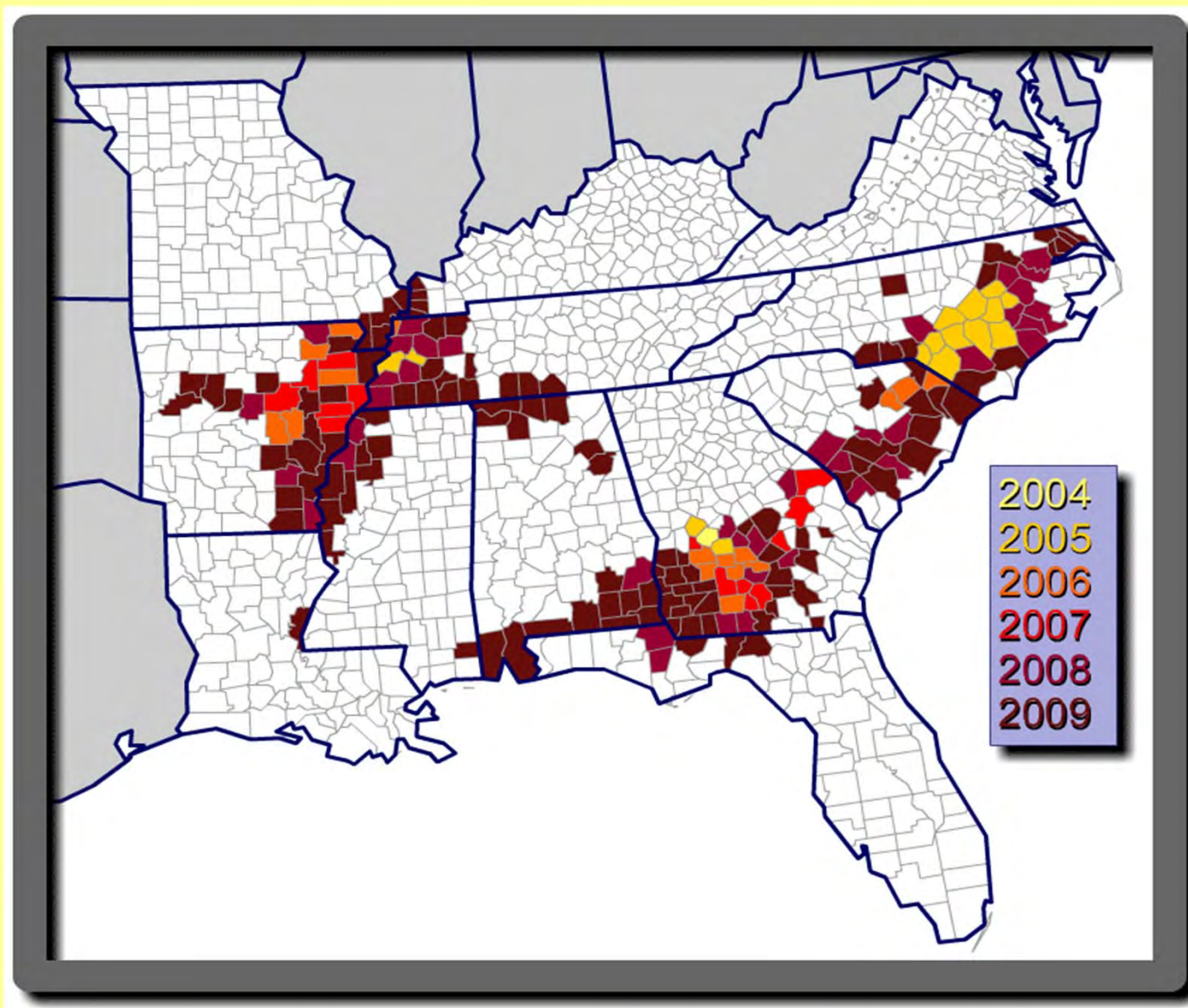




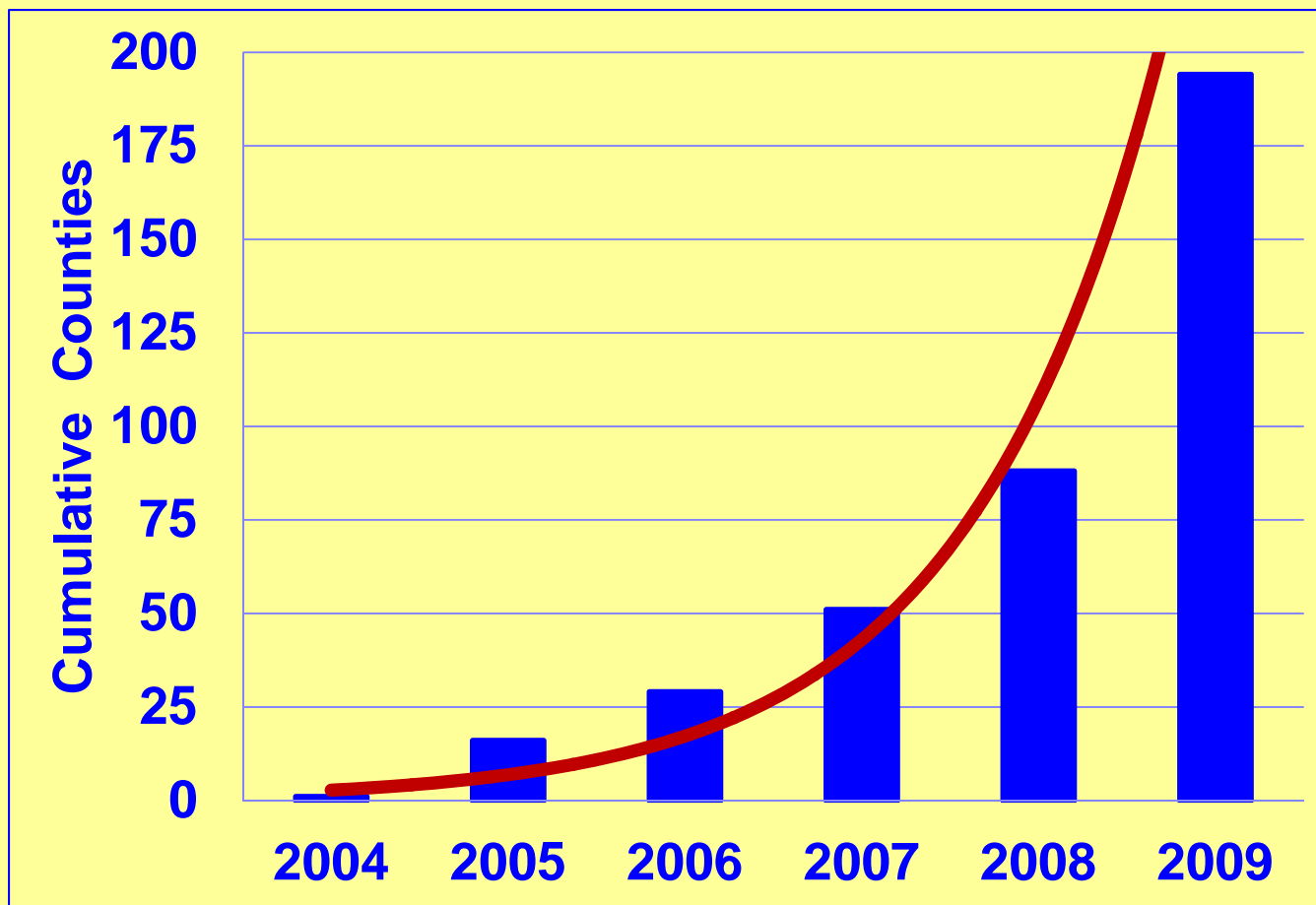
# Counties with Confirmed Populations of Glyphosate-Resistant Palmer Amaranth 2008



# Counties with Confirmed Populations of Glyphosate-Resistant Palmer Amaranth - 2009



# Counties with Glyphosate-Resistant Palmer Amaranth



# **Impacts of Glyphosate-Resistant *Palmer Amaranth***

- **Increase complexity and costs of weed management in cotton and soybean**
- **Compromise conservation tillage in the short-term and possibly the long-term**
- **May precipitate a cascade of resistance in post emergence broad-leaf herbicides**



# **Glyphosate Resistant *Palmer Amaranth***

## **Economic Threat to Soybeans**

**If ALS and glyphosate are compromised, PPO herbicides are the only post emergence option except glufosinate**

## **Economic Threat to Cotton**

**PPO herbicides are not an over-the-top option. If ALS herbicides and glyphosate are compromised, there are no selective post emergence options except glufosinate**



## **The Usual Problem:**

- **Costs of Post-Resistance Management Remain Unknown, until Resistance Develops.**
- **Therefore, Additional Current Costs are Rejected, and the Risks of Unknown Future Costs are Accepted.**

## **The New Problem:**

- **We Do Not Have the Next Mode of Action.**
- **A New Mode of Action, if Discovered Today, Would Probably Not be Registered in the U.S. for 7-10 Years.**



# Weed Science Society of America

- Vencill et al. Impact of Herbicide-Resistant Cultivars on the Development of Herbicide-Resistant Weeds. Special Report by the Weed Science Society to USDA-APHIS. 162 pp. (Submitted 11/5/10.)
- Barrett et al. Reducing the Development, Spread, and Adverse Economic and Environmental Impact of Herbicide Resistant Weeds. Grant Proposal to National Institute of Food and Agriculture. (Submitted 8/11/10; rejected 10/27/10.)
- Shaw et al. Management of Herbicide Resistant Weeds. Special Report by the Weed Science Society of America to USDA-APHIS. (in preparation)



# Palmer Amaranth

- **How Much, To What, and Where?**
- **Long-time resident of the Southwest; now frequently dominant in the Southeast and Mid-South.**
- **Often Resistant to ALS, especially in North Delta, GA, and Carolinas**
- **Generally Resistant to glyphosate in NC, SC, GA, AL, TN, AR, MO – north MS, central LA.**





# Current Situation

- **Need New Weed Management Programs.**
- **Need to Save Conservation Tillage.**
- **Need to Implement Resistance Management - Manufacturers and Growers.**
- **Does Resistance Management Include Trait Management?**

