

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

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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 ($P = F_0$)
2. Collect Seed (F_1)
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 F_2 . Repeat the test. If the F_2 generation is also resistant, the trait is clearly heritable.





North Carolina 2006



Untreated



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

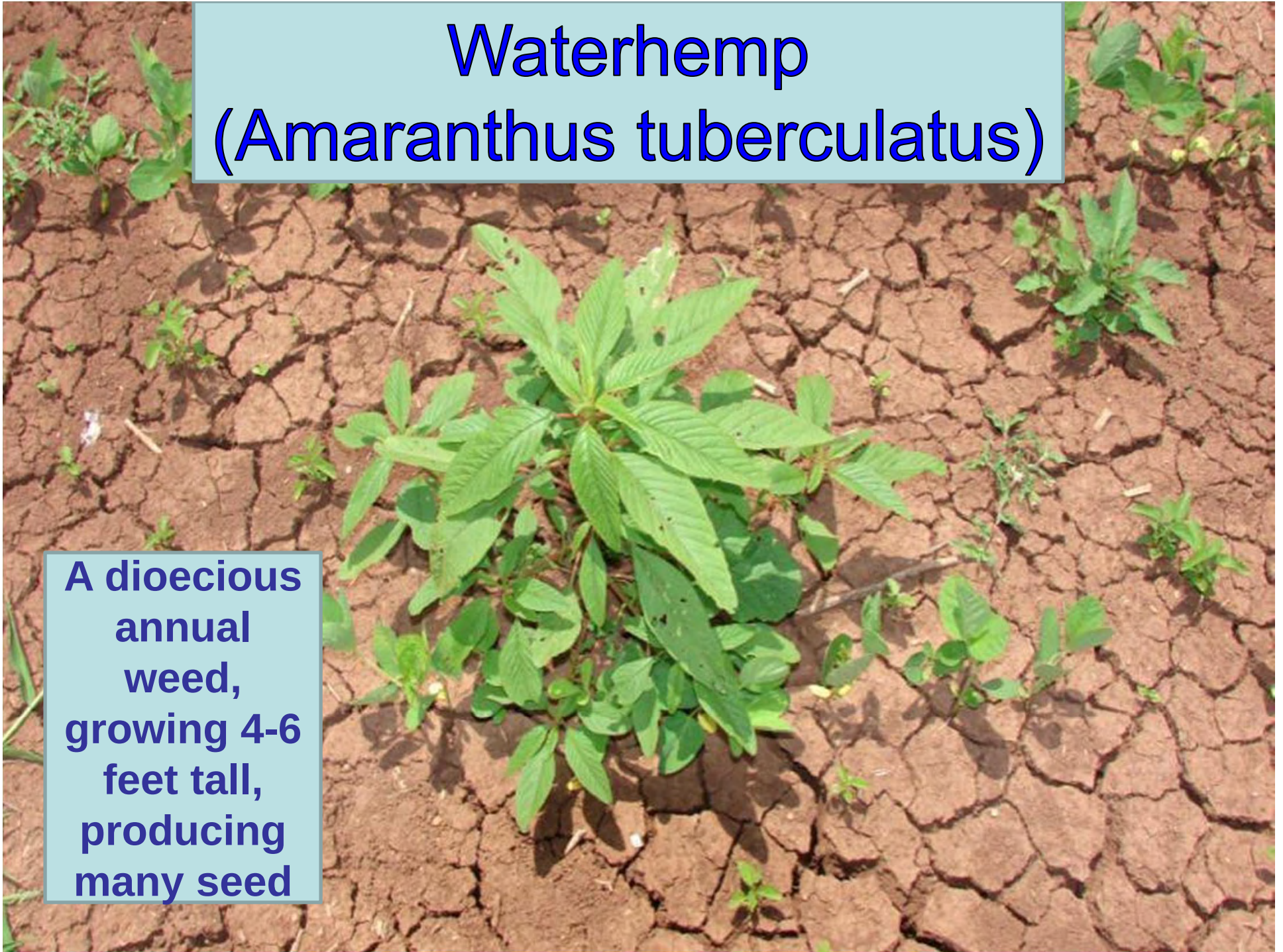
Weedy Pigweed Species

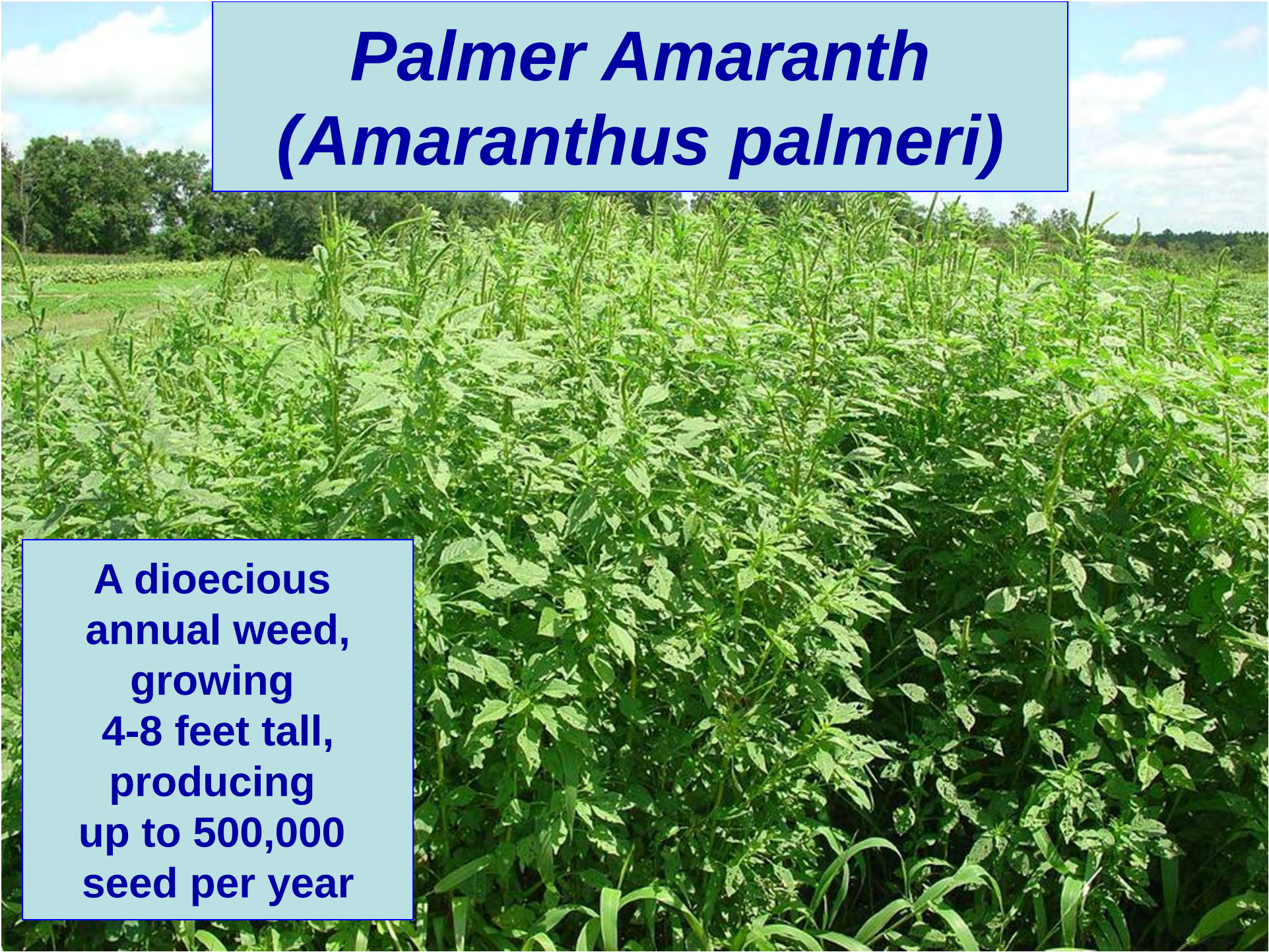
- *Amaranthus retroflexus* – Red Root Pigweed
- *A. rudis, tuberculatus* - Waterhemp
- *A. hybridus* – Smooth Pigweed
- *A. plameri* – Palmer amaranth
- Several others
- Bryson & DeFelice. 2009. Weeds of the South. Univ. of GA Press



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, developing flower 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

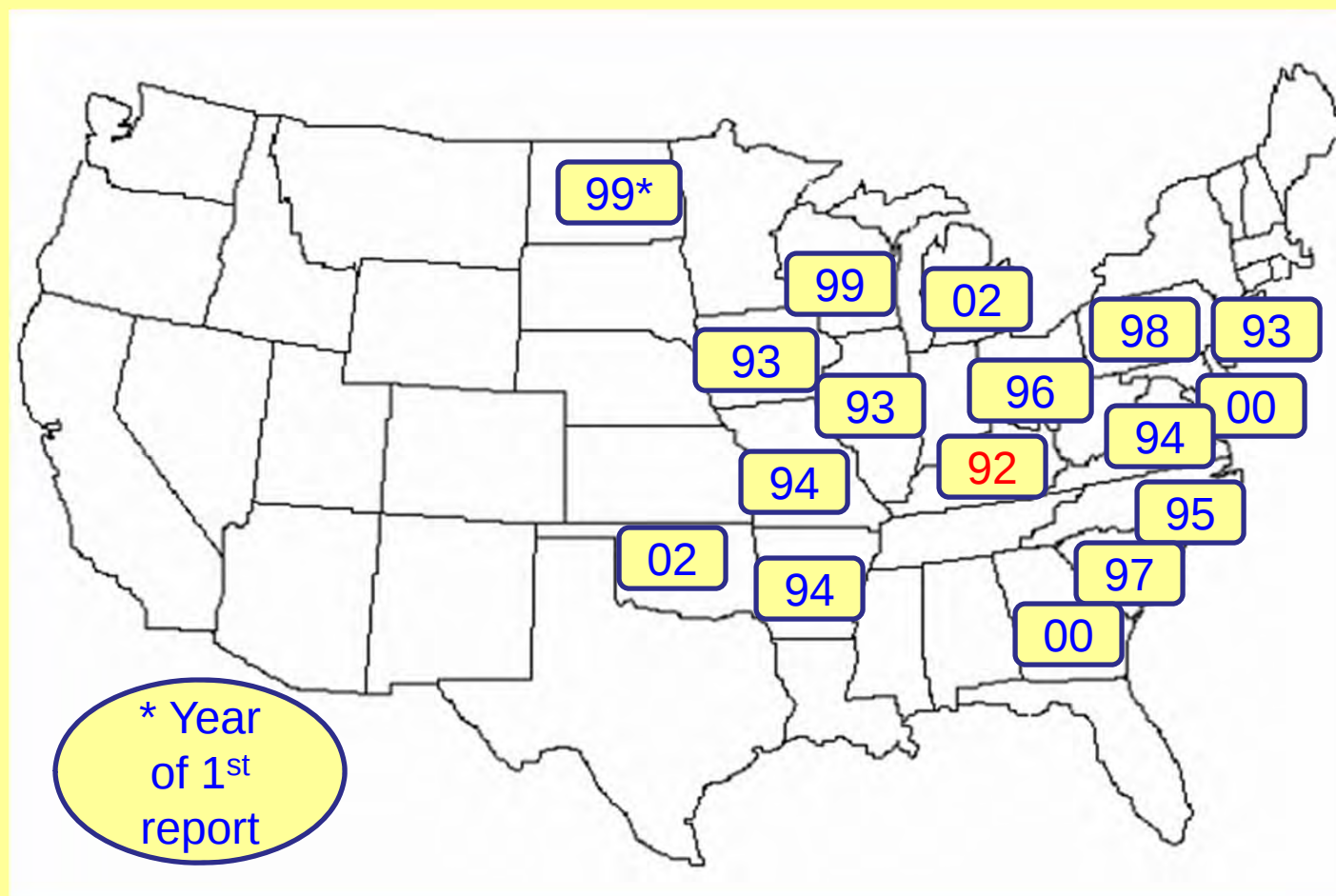
PPO = Protoporphyrinogen Oxidase

Valor, Reflex, Flexstar, Cobra, Goal

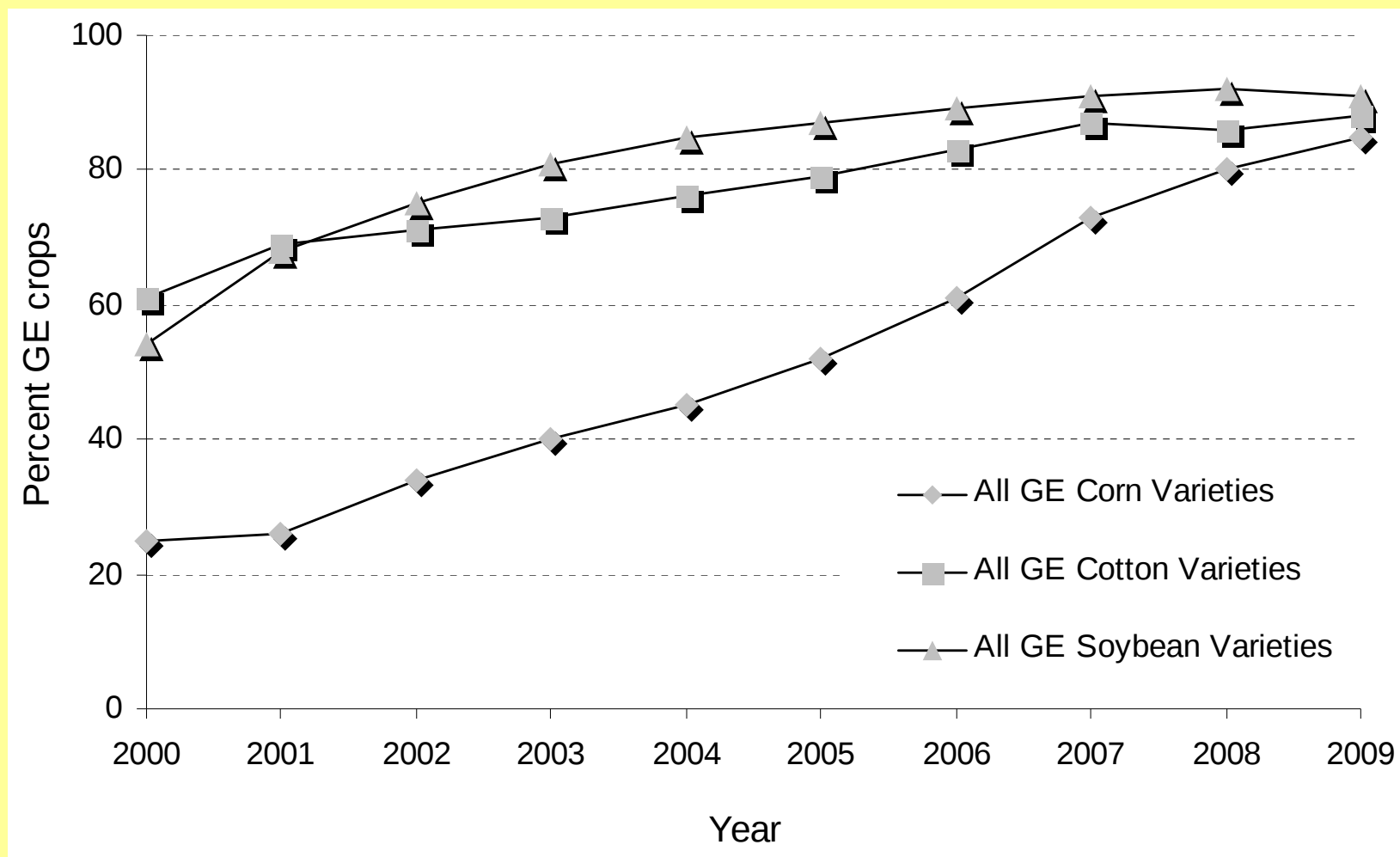
Glutamine Synthetase - Ignite



Acetolactate Synthase (ALS) Resistant *Palmer Amaranth*



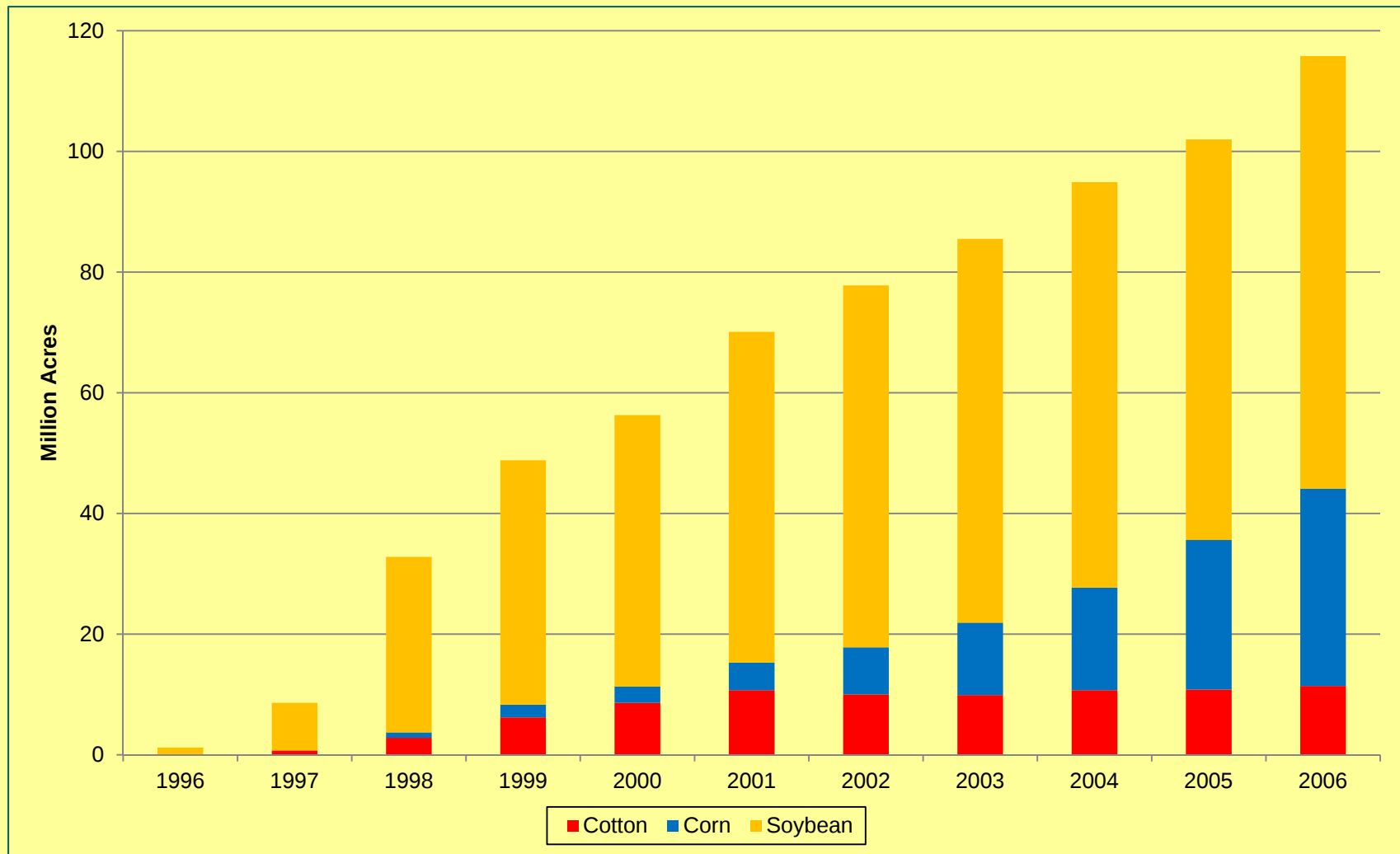
Nationwide acres of glyphosate-resistant soybean, cotton, and corn as a percent of all acres of the crops



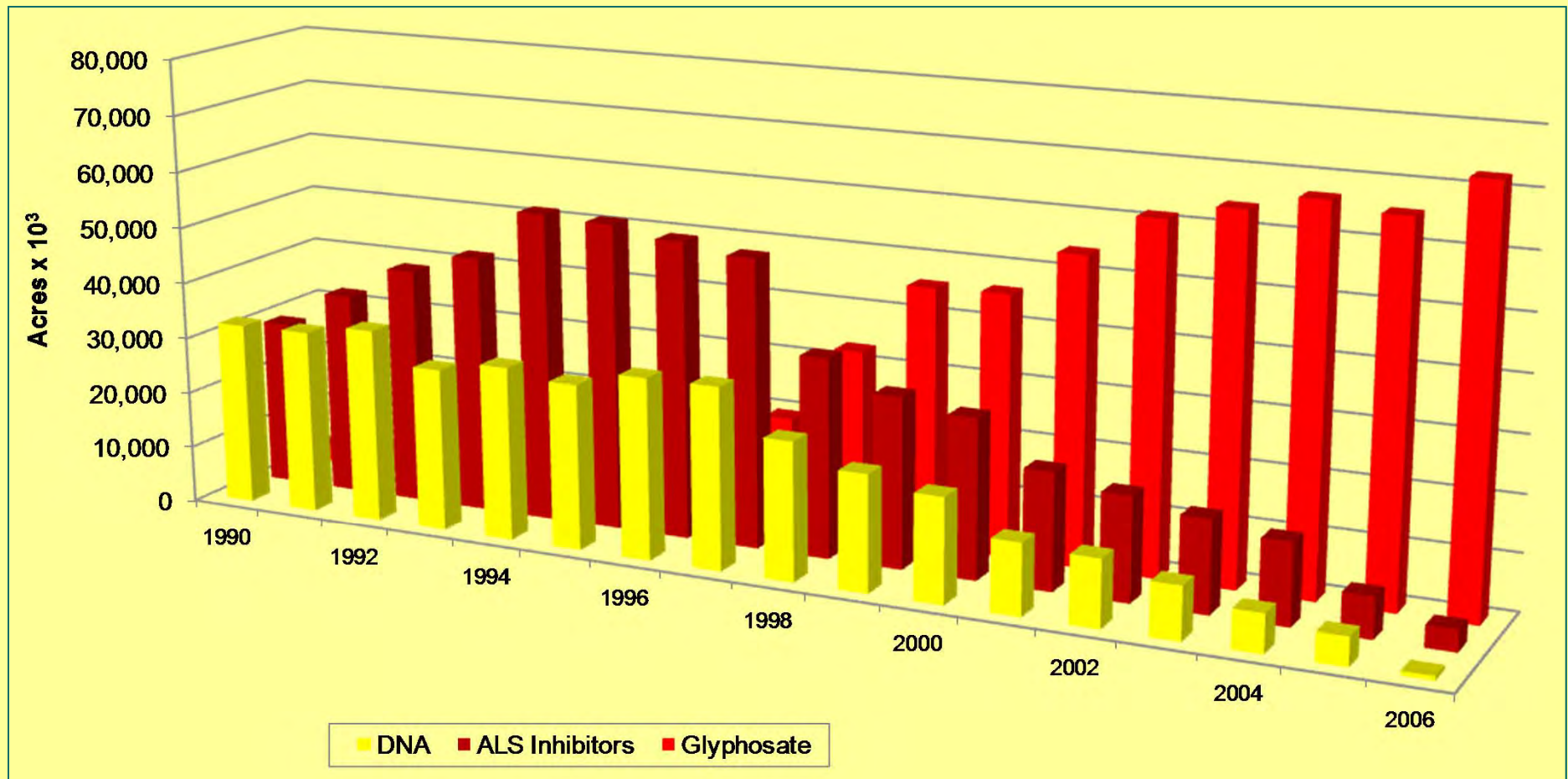
Source: USDA-NASS (2001, 2003, 2005, 2007, 2009b).



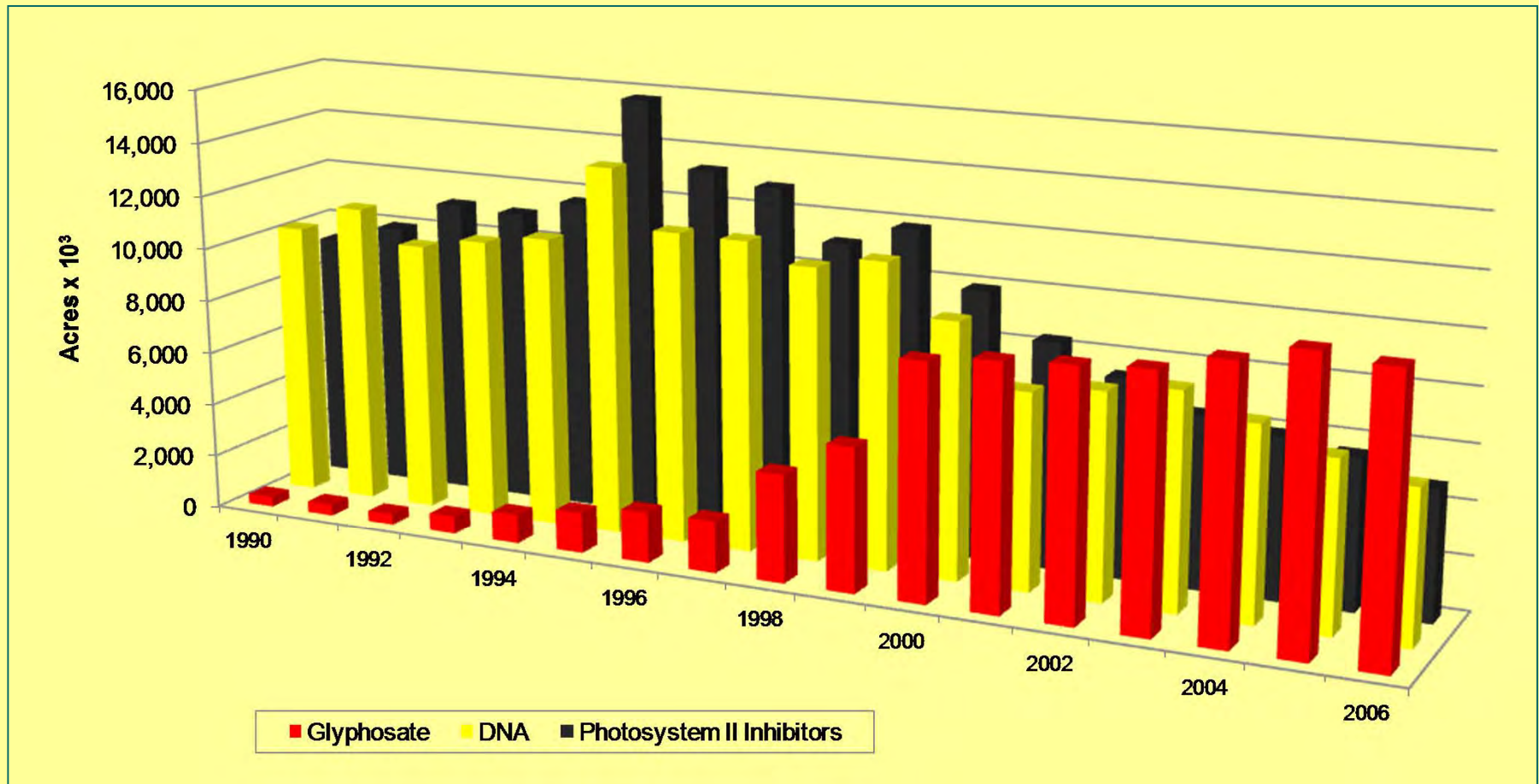
Acres of Glyphosate-Resistant Crop Cultivars



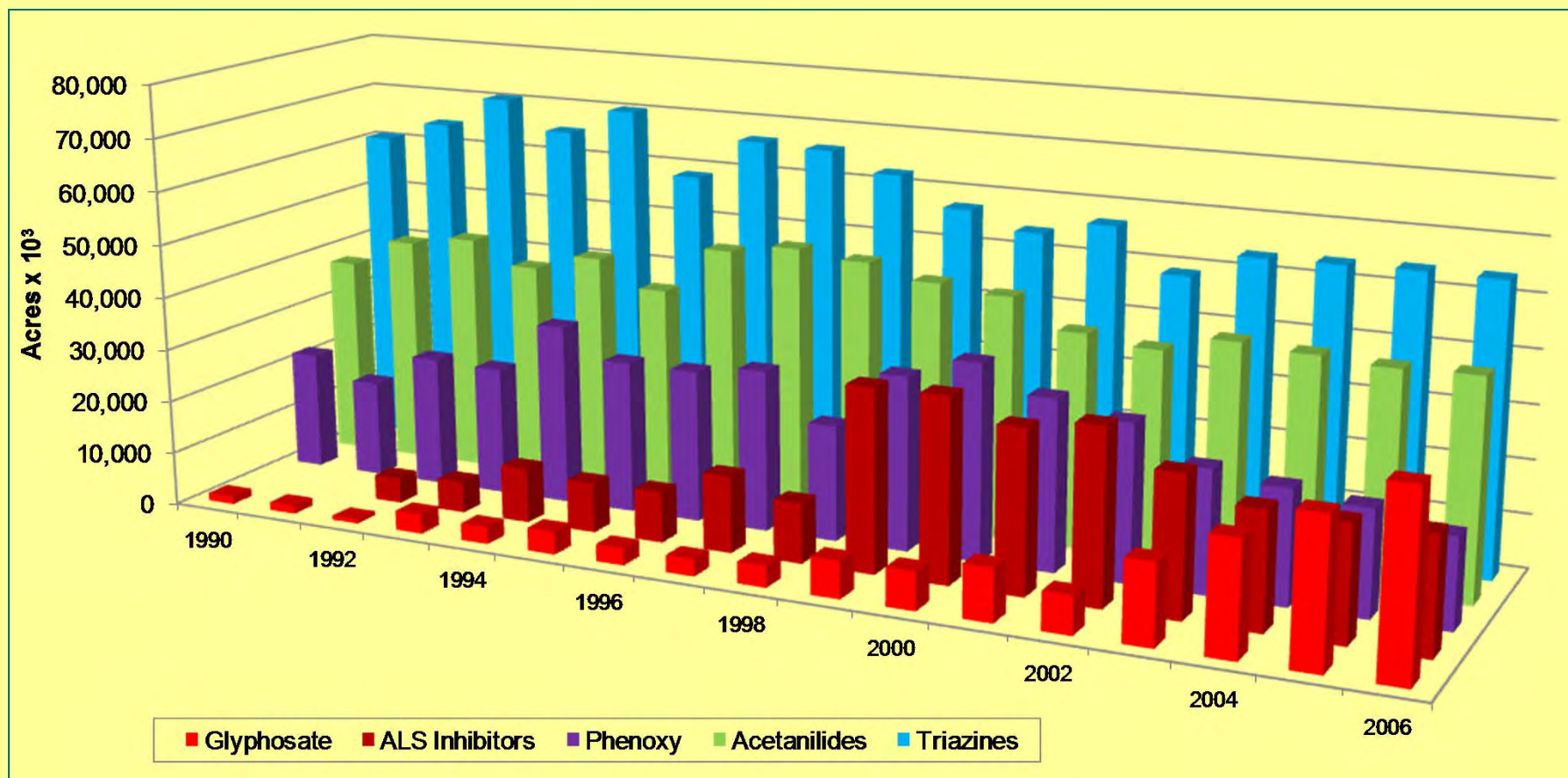
Soybean Acres Exposed to Herbicide Modes of Action



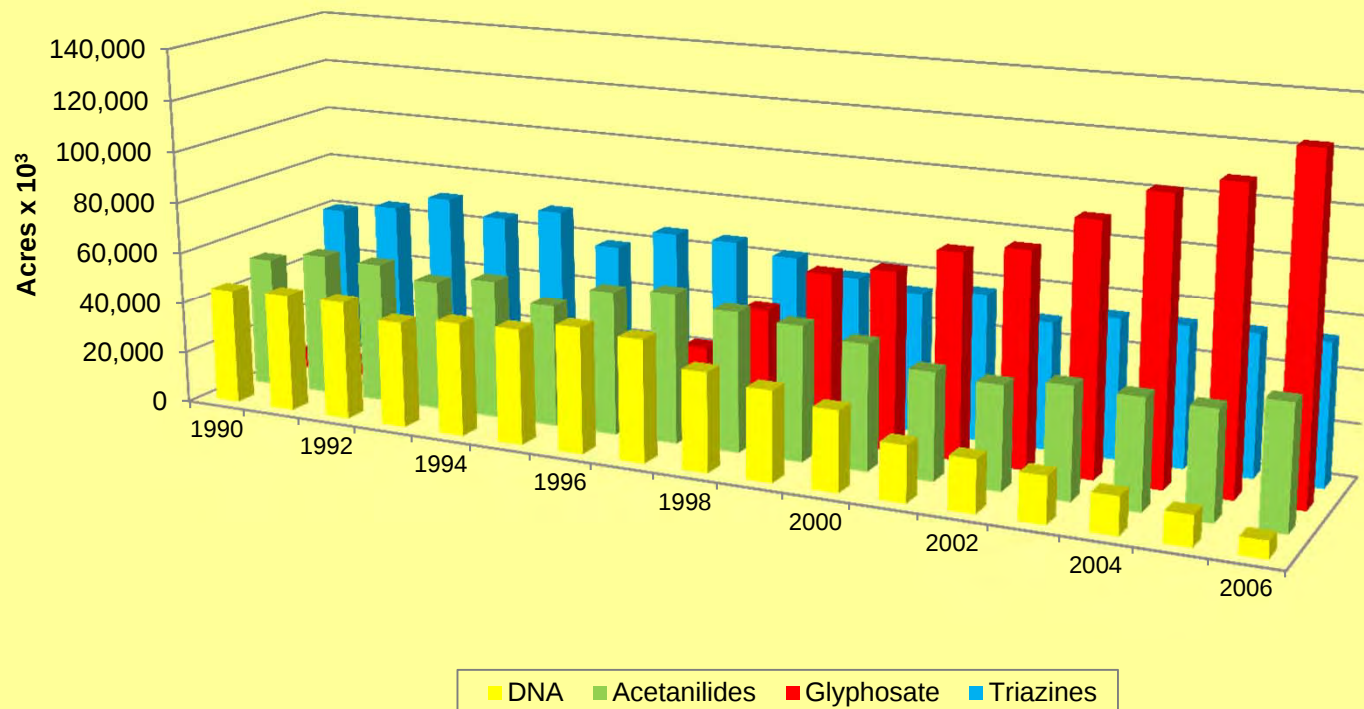
Cotton Acres Exposed to Herbicide Modes of Action



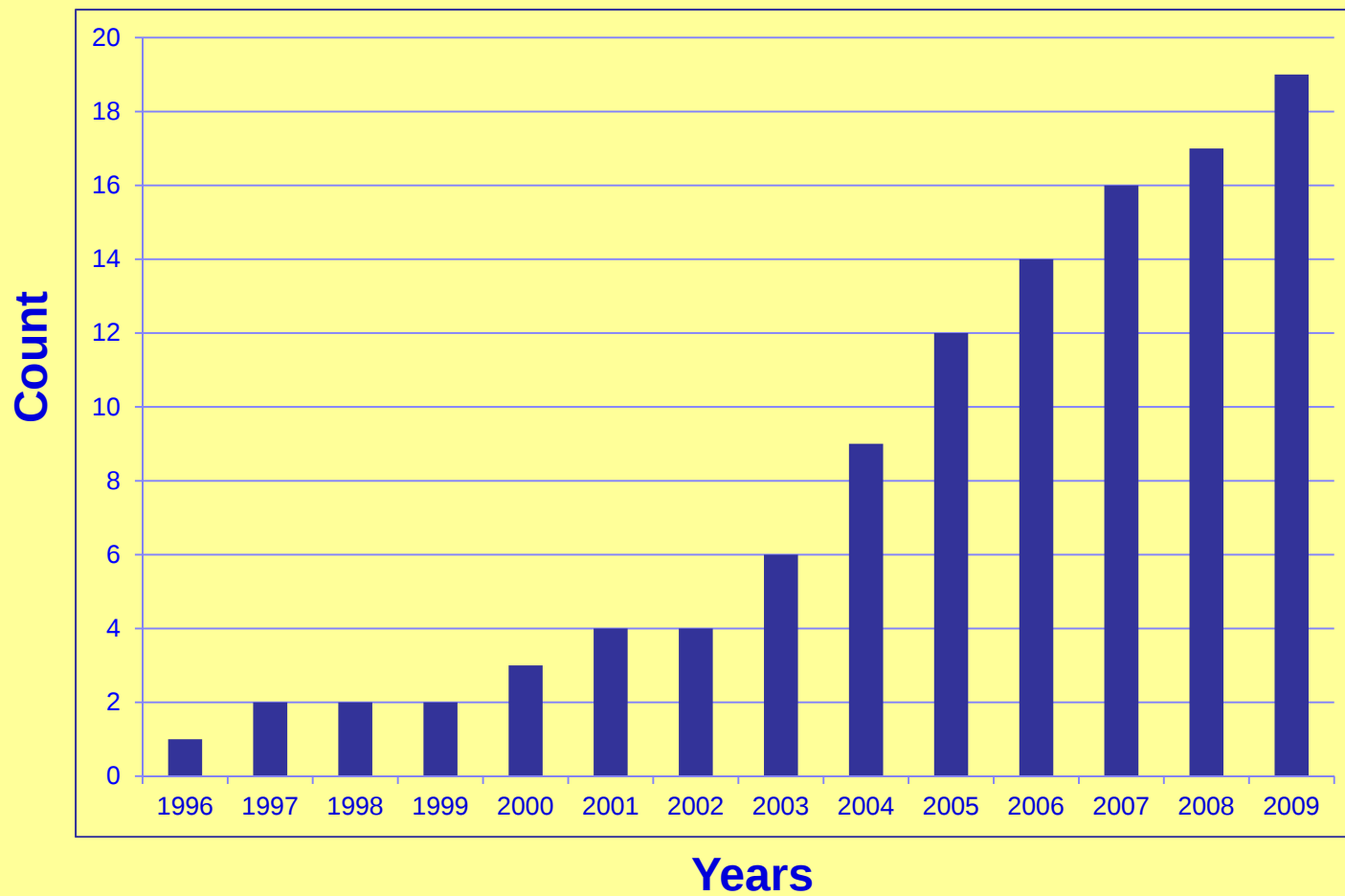
Corn Acres Exposed to Herbicide Modes of Action



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



Number of Glyphosate-Resistant Species



Glyphosate Resistant Weeds in United States

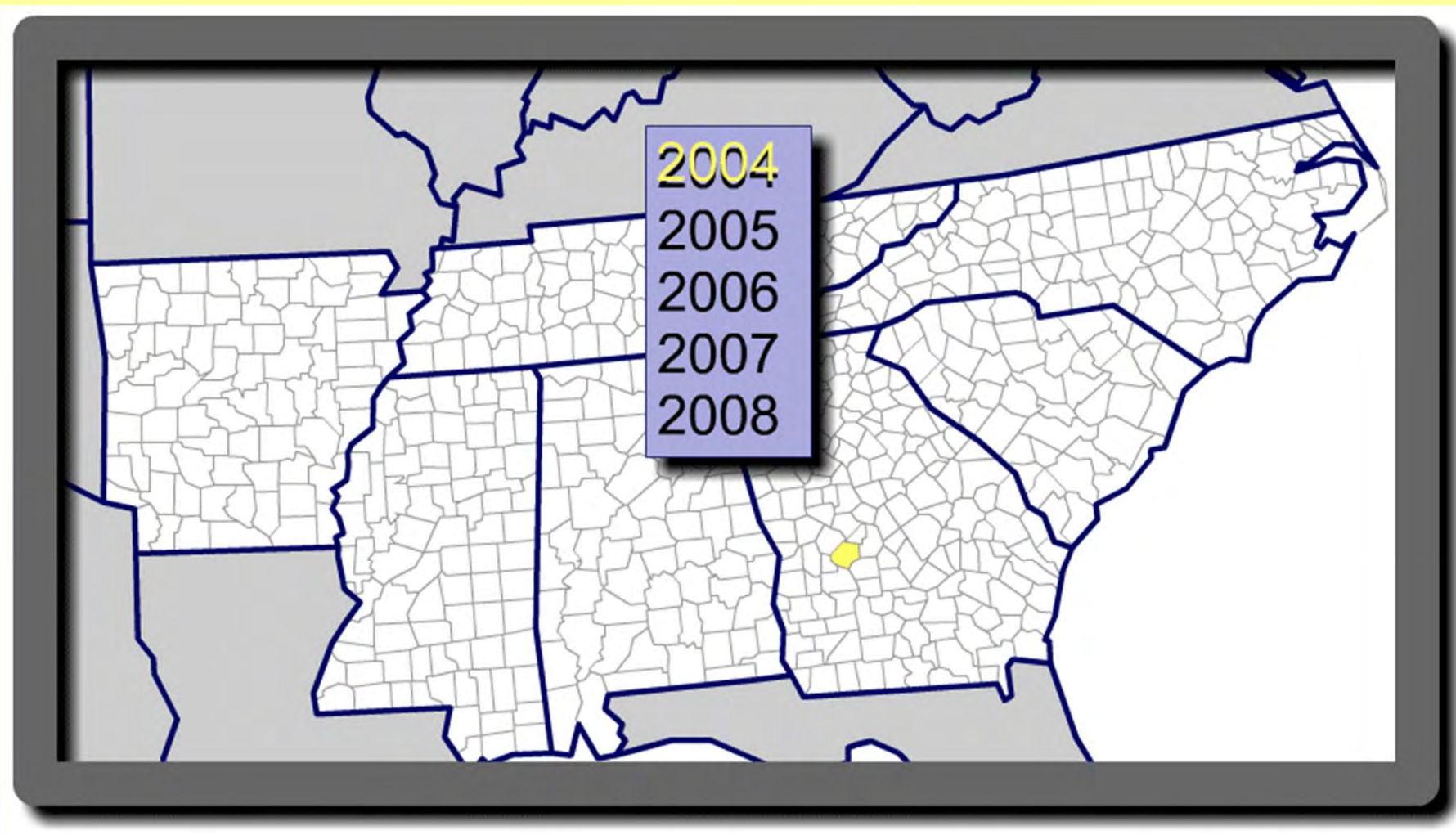
- **Horseweed – 2000 (DE)**
- **Palmer amaranth – 2004 (GA)**
- **Giant Ragweed – 2005 (AR)**
- **Waterhemp – 2005 (MO)**
- **Ryegrass – 2005 (MS)**
- **Johnsongrass – 2007 (AR)**



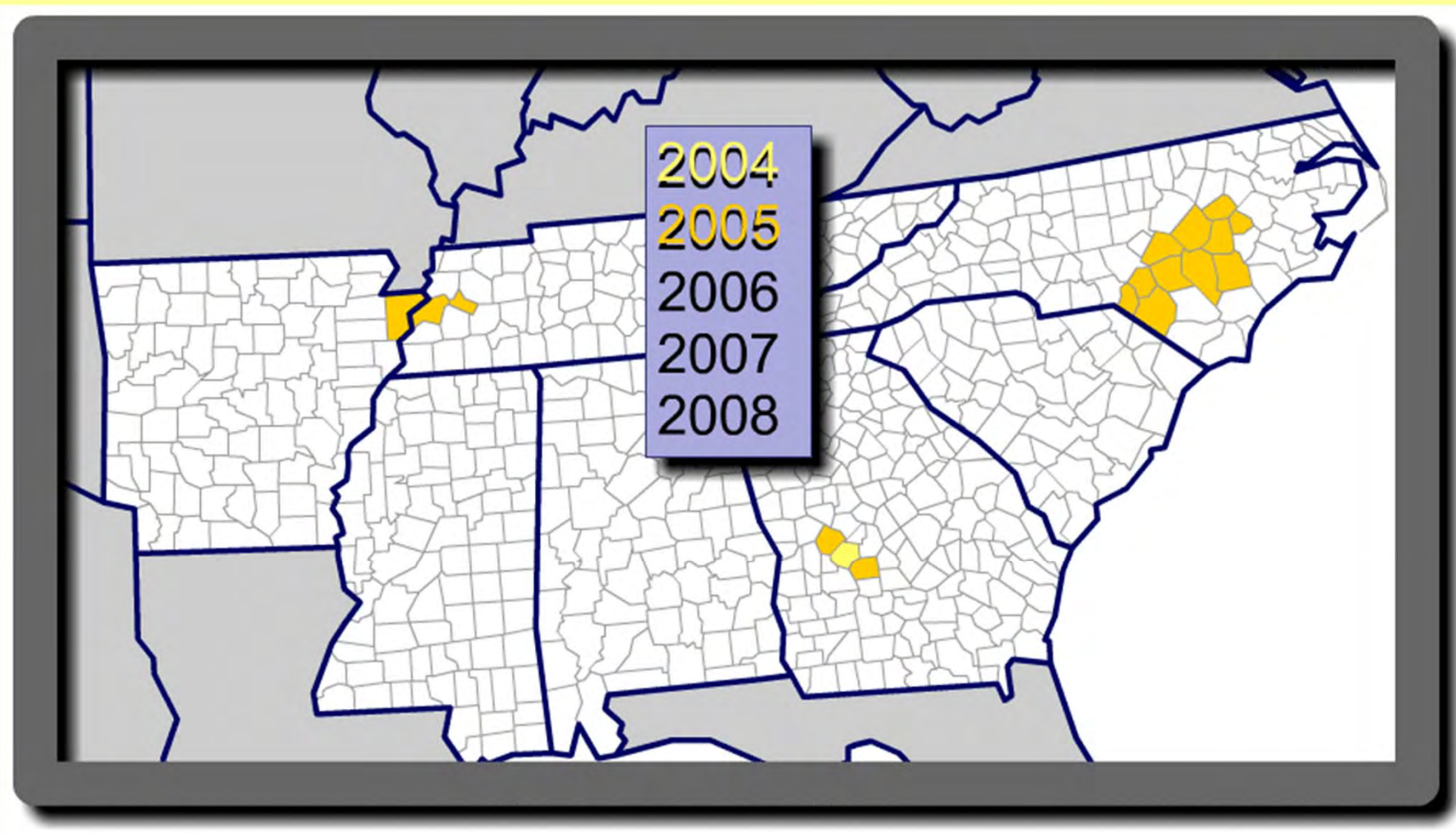


Macon County, Georgia - 2005

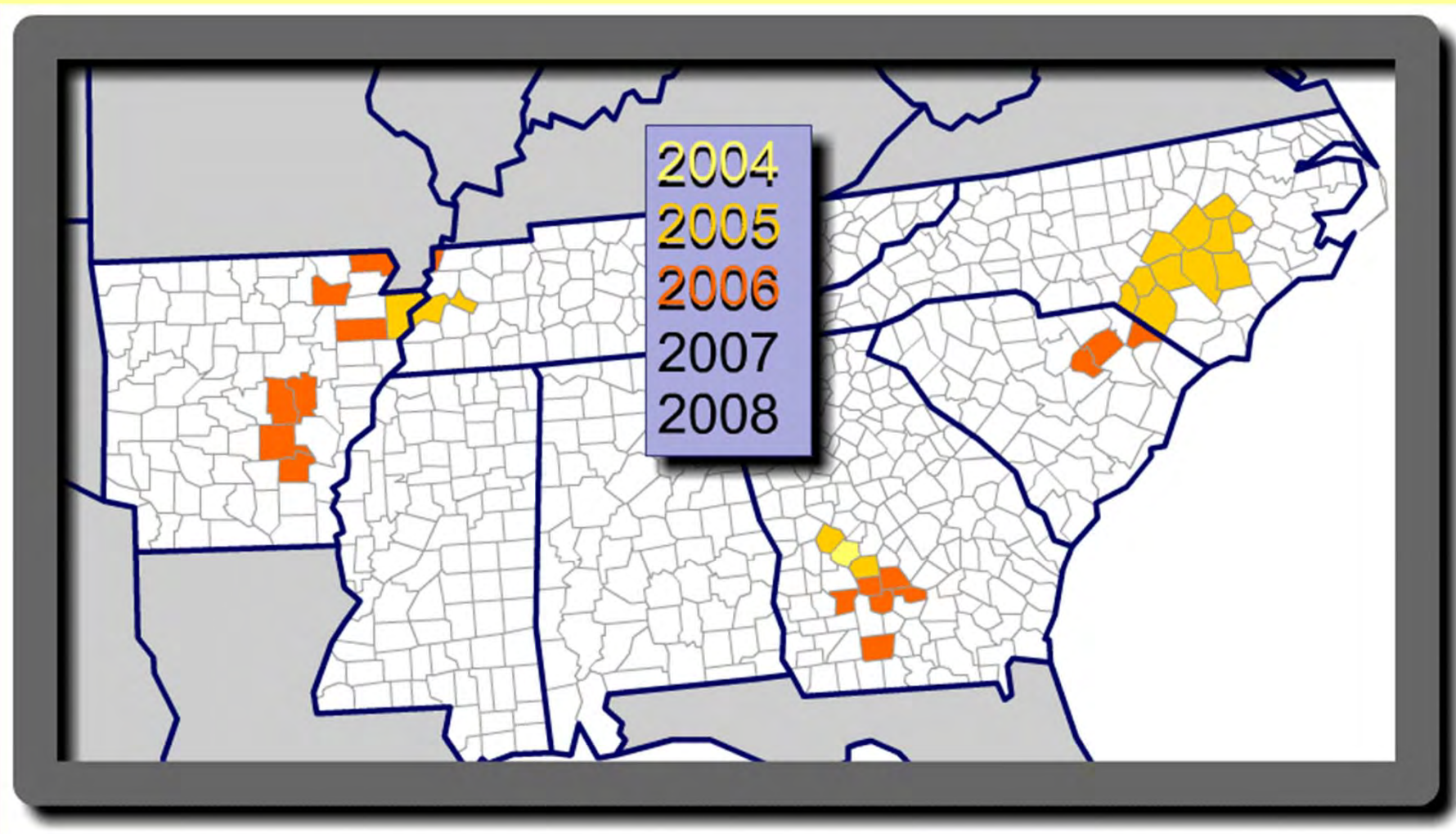
Counties with Confirmed Populations of Glyphosate-Resistant Palmer Amaranth 2004



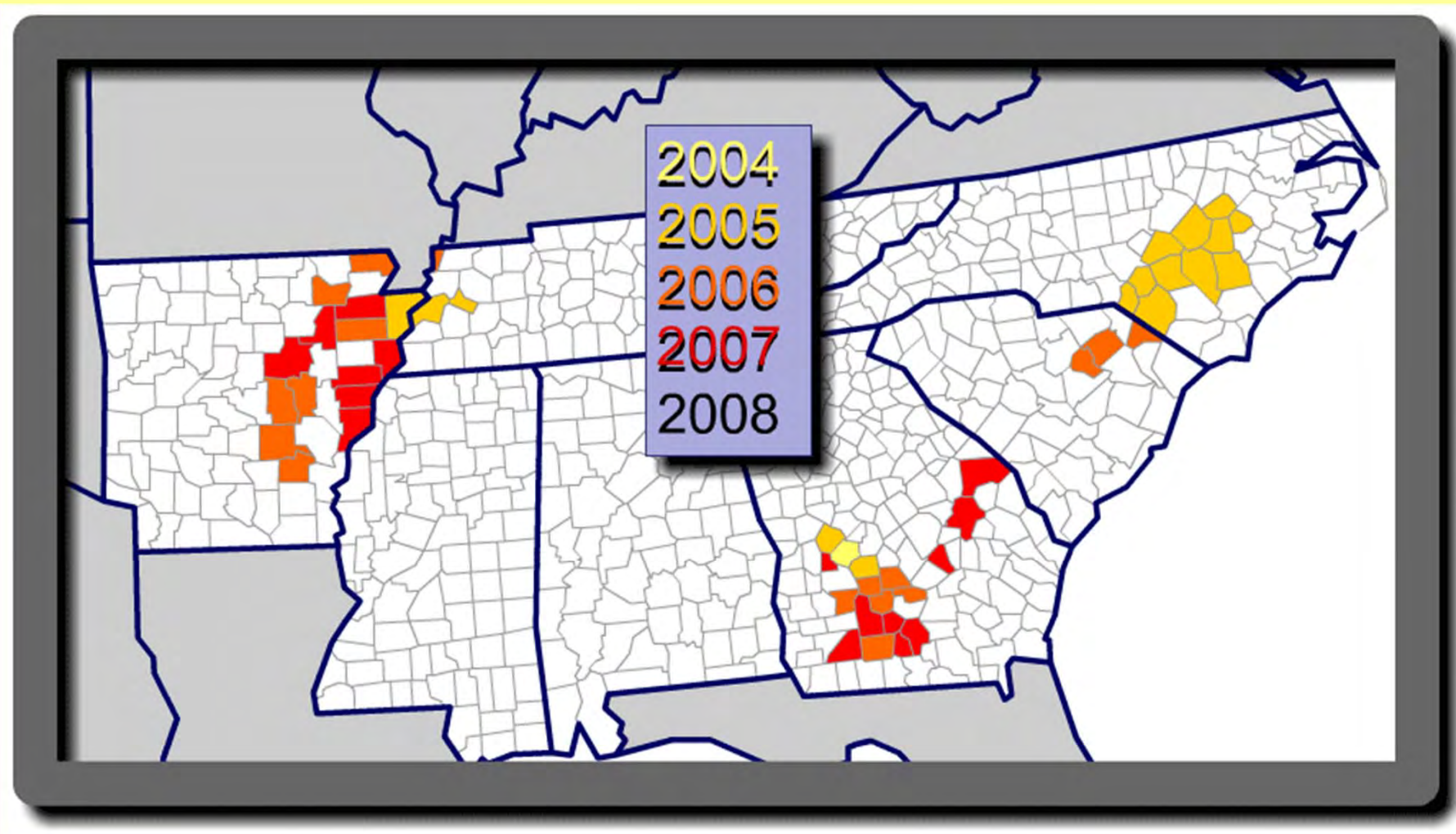
Counties with Confirmed Populations of Glyphosate-Resistant Palmer Amaranth 2005



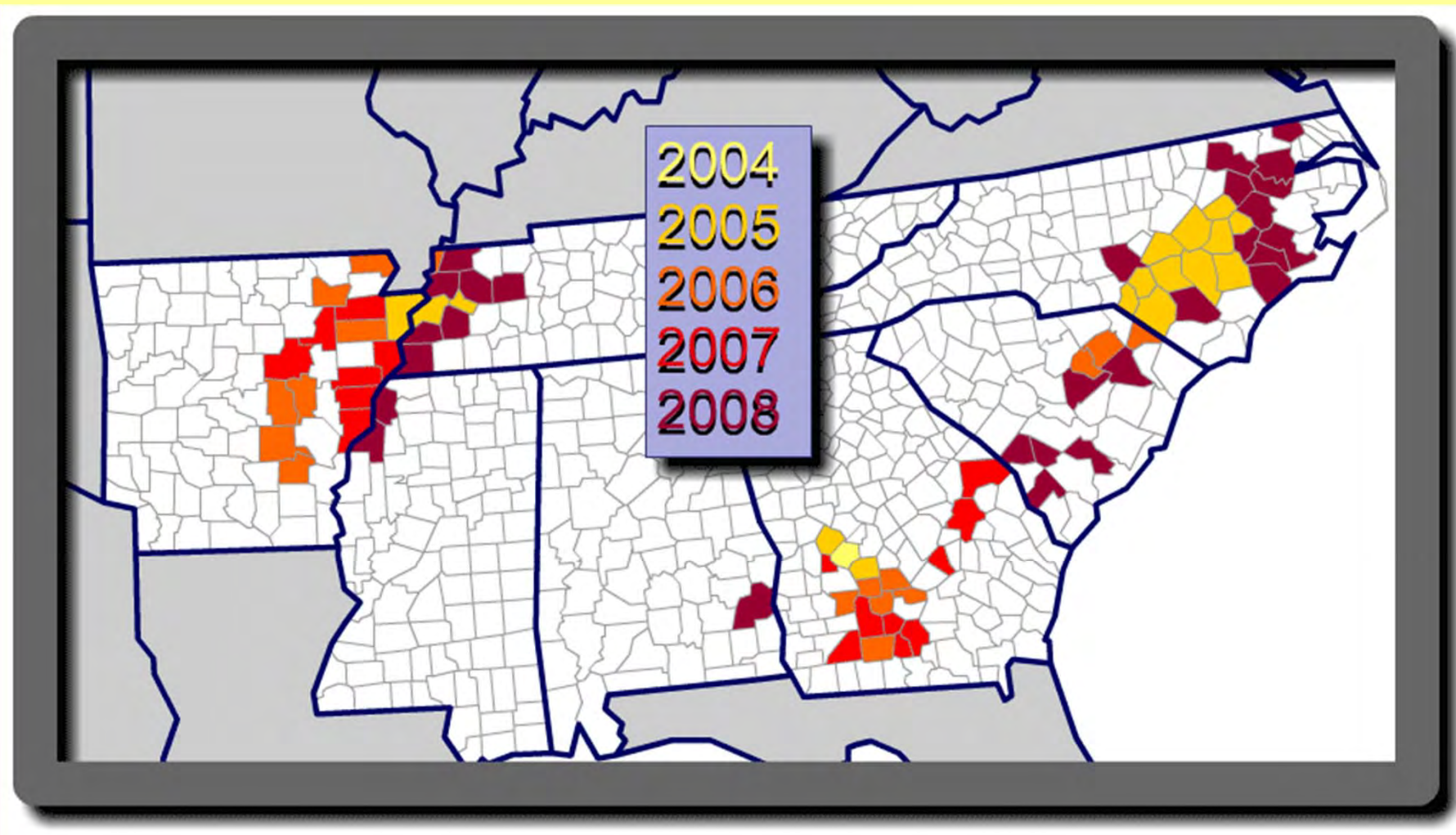
Counties with Confirmed Populations of Glyphosate-Resistant Palmer Amaranth 2006



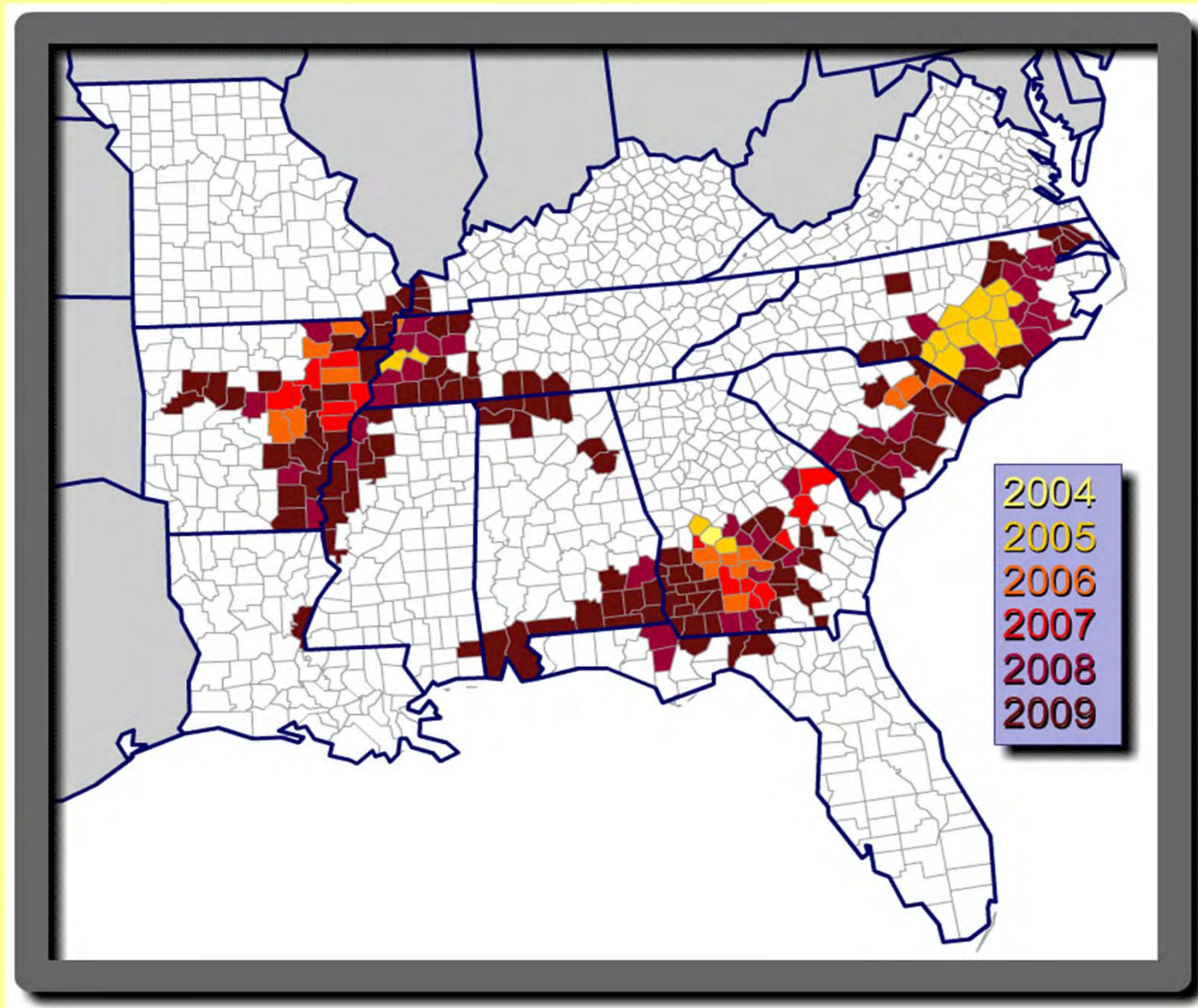
Counties with Confirmed Populations of Glyphosate-Resistant Palmer Amaranth 2007



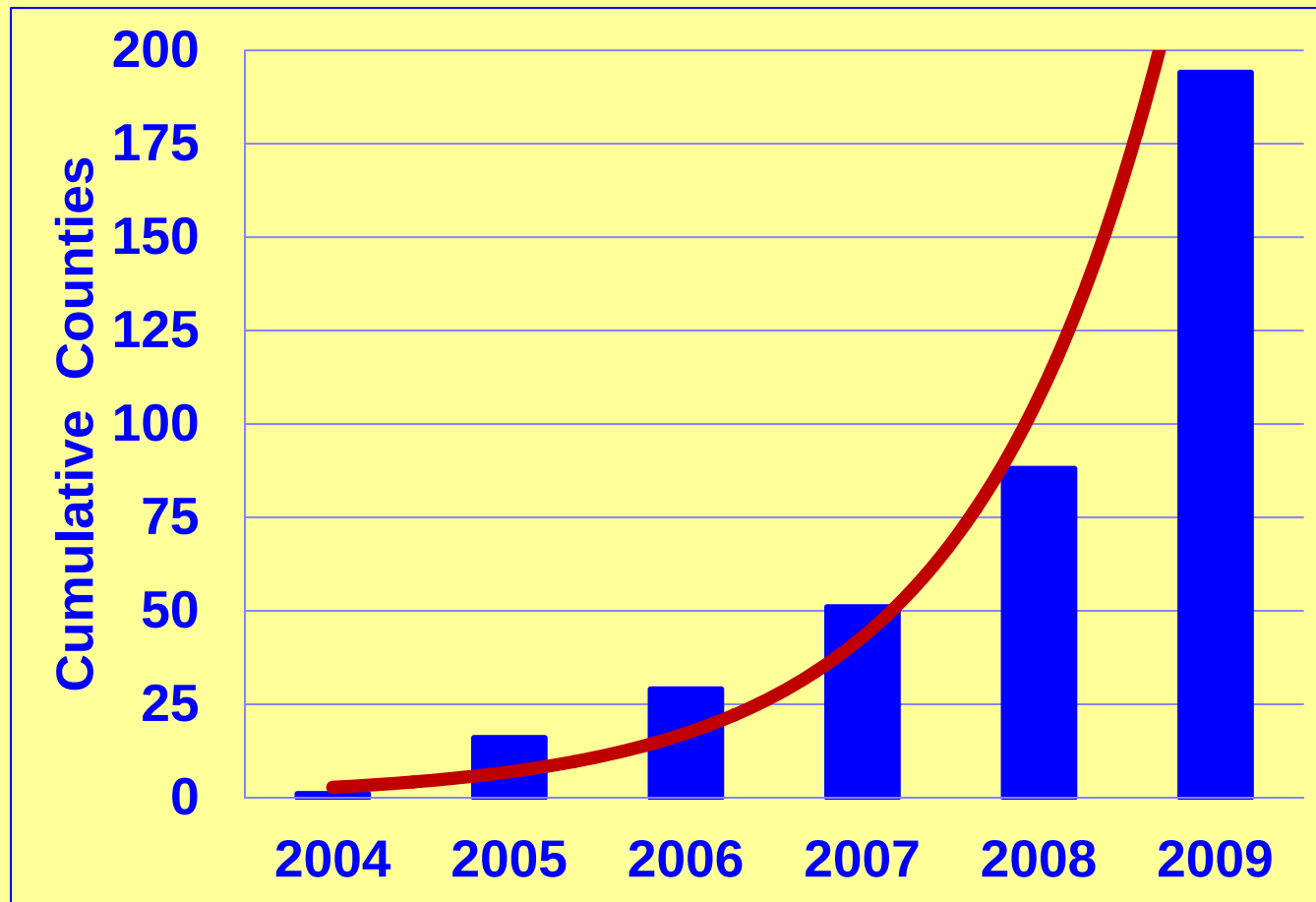
Counties with Confirmed Populations of Glyphosate-Resistant Palmer Amaranth 2008



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?**

