



Impacts of Herbicide Resistant Weeds - Southern States

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Acknowledgments

Dr. Joe Armstrong – Oklahoma State University

Dr. Nilda Burgos – University of Arkansas

Dr. Stanley Culpepper – University of Georgia

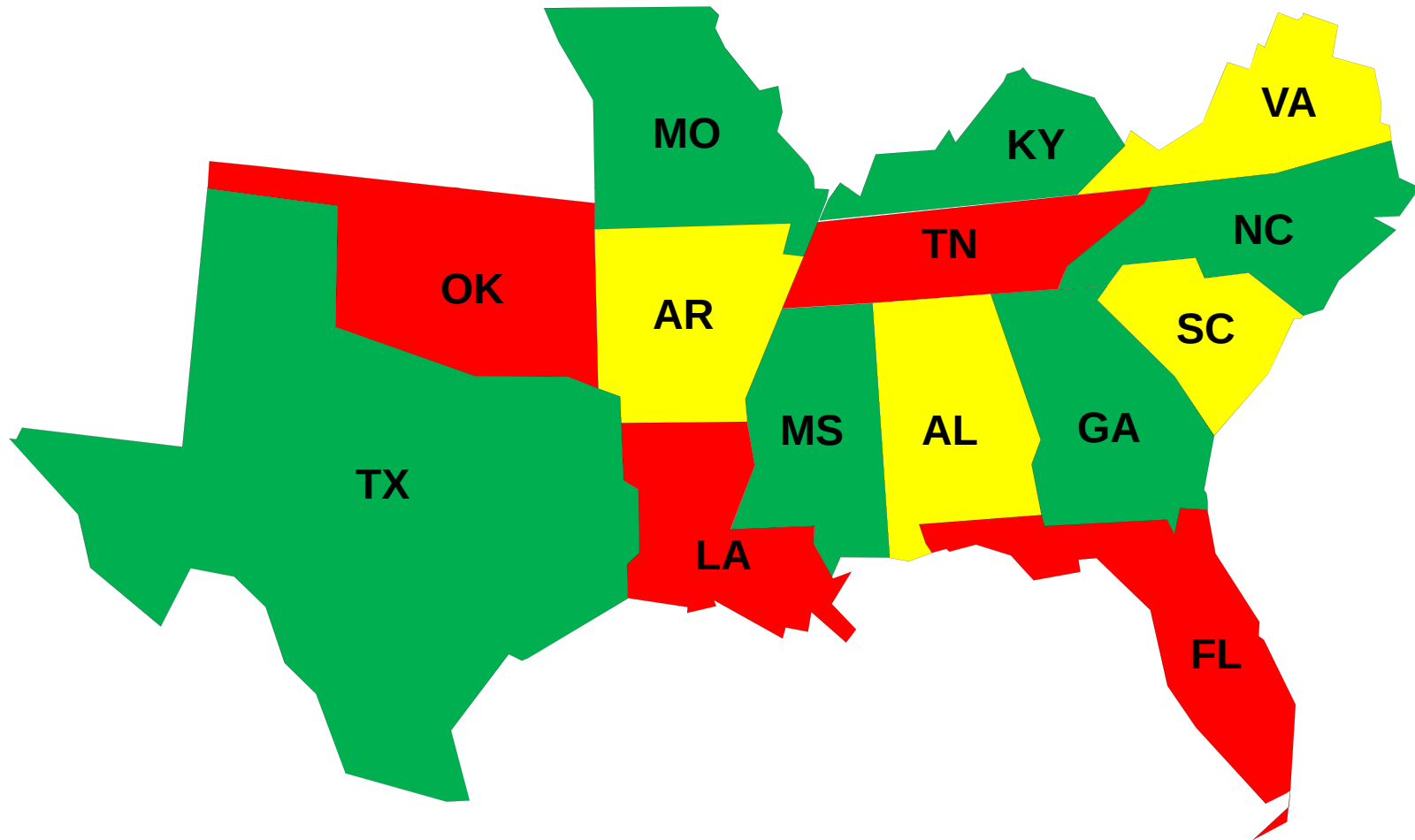
Dr. Steve Martin – Mississippi State University

Dr. Robert Scott – University of Arkansas

Dr. William Vencill – University of Georgia



Southeastern United States





Acres of Major Agronomic Crops in the Southern United States

Crop	U. S.	Southern Region	% Region
	Acres x 10 ⁶		%
Soybean	72.5	17.2	23
Winter Wheat	59.6	15.9	27
Maize	83.0	11.6	14
Cotton	12.3	11.4	91
Rice	2.9	2.4	84



Economic Losses to Resistance

The first year is usually worst, when the occurrence is not expected. In subsequent years, increased management costs continue. Resistance can force changes in production practices.



Outline of Presentation

- Overview of Agronomic Crops and Weeds in the Southern Region

Crop

Rice

Winter Wheat

Corn, Soybean & Cotton

Troublesome Weeds

Warm Season Grasses

Cool Season Grasses

Summer Annuals

- For Each Crop:

Most Troublesome Weeds, Resistant Weeds, Herbicides Used,
Impact of Resistance on Management

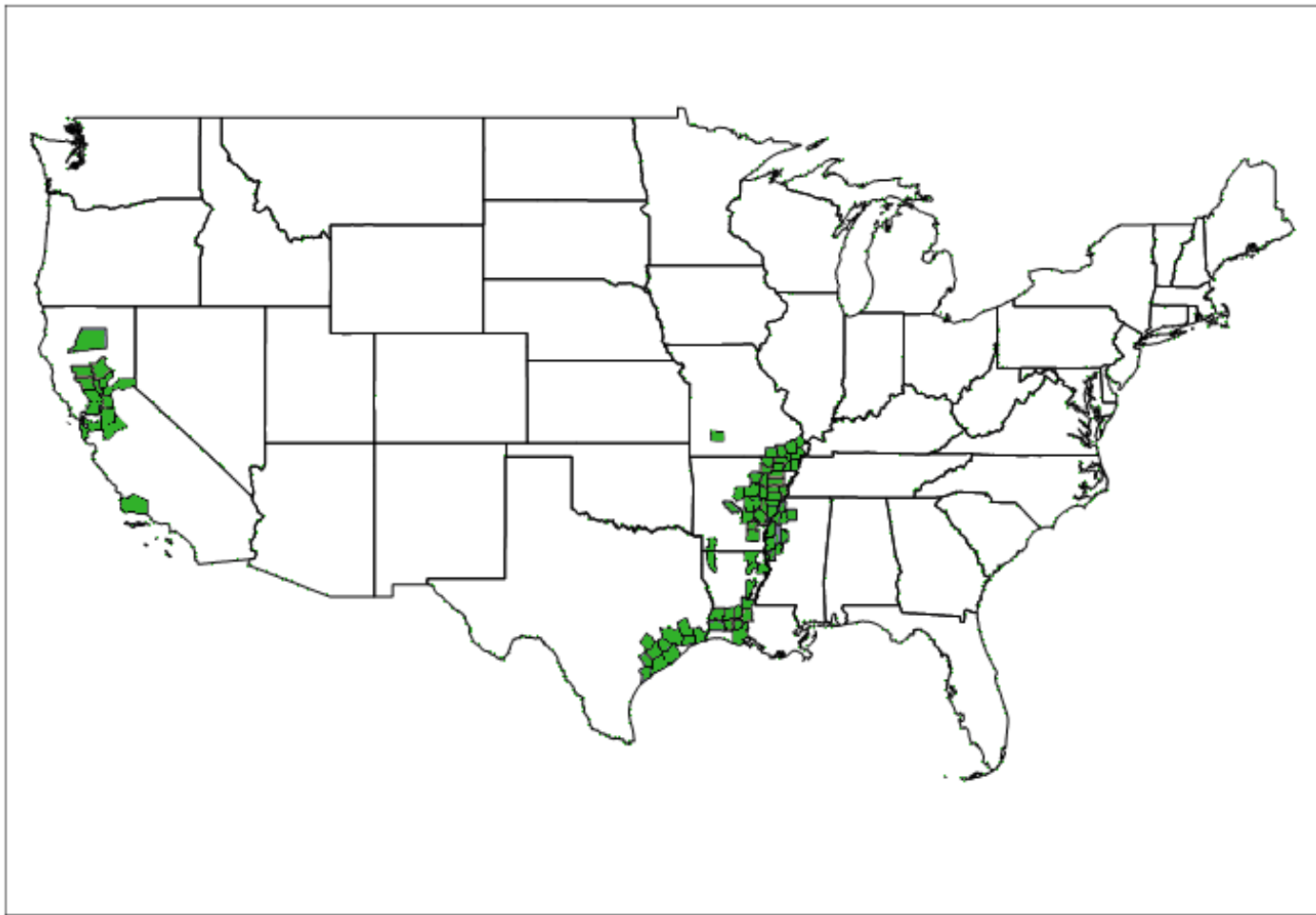
- Concerns for Sustainable Herbicide Use



Sources of Weed and Herbicide Data

Data	References
Major Weeds	Southern Weed Science Society Surveys
Resistant Weeds	Herbicide Resistance Action Committee
Herbicides Used	National Agricultural Statistics Service
Weed Management Programs	State Cooperative Extension Services

U. S. Counties Growing - Rice





Major and Resistant Weeds in Rice

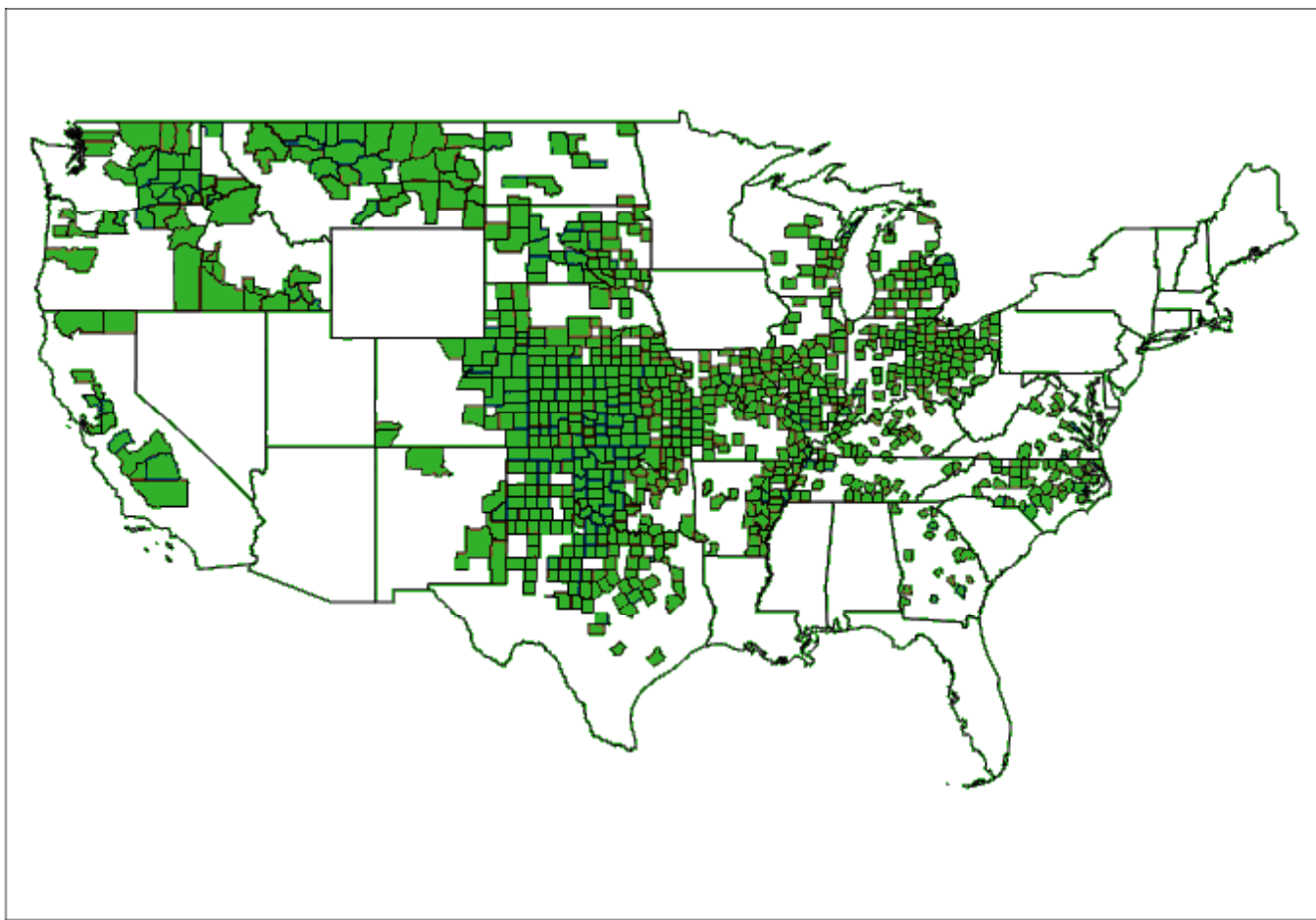
Rank	Weed Species	Resistant	Mode of Action
1 st	<i>Echinochola crus-galli</i>	Yes	PSII & Auxin
2 nd	<i>Oryza sativa</i> *	(Brazil)	ALS
3 rd	<i>Hemp sesbania</i>	No	
4 th	<i>Lemna minor</i>	No	
5 th	<i>Leptochloa spp.</i>	(Thailand)	ACCase
* red rice			



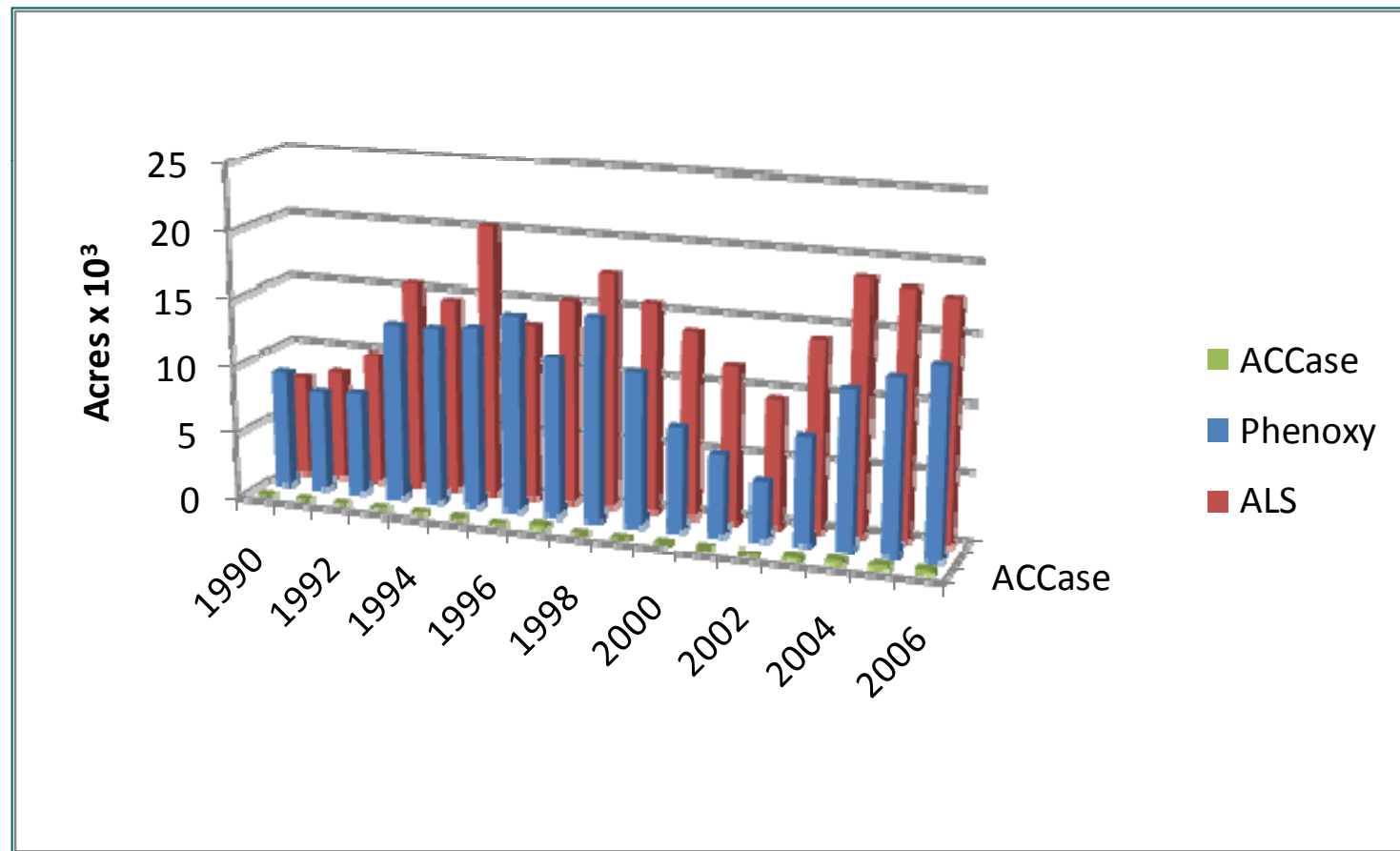
Herbicide Resistance in Rice

- The principal problems are with weedy grasses, especially *Echinochloa crus-galli*.
- *E. crus-gallis* is widely resistant to propanil (PSII) and often resistant to quinclorac (phenoxy).
- The standard treatment for grasses is clomazone (carotenoid biosynthesis inhibitors).
- Red rice is a continuing problem because it is con-specific with the crop.
- ‘Clearfield’ rice cultivars are ALS-resistant by means of conventional breeding. A resistance management program is recommended by the vender.

U. S. Counties Growing Wheat



Winter Wheat Acres Exposed to Herbicide Modes of Action





Major and Resistant Weeds in Winter Wheat

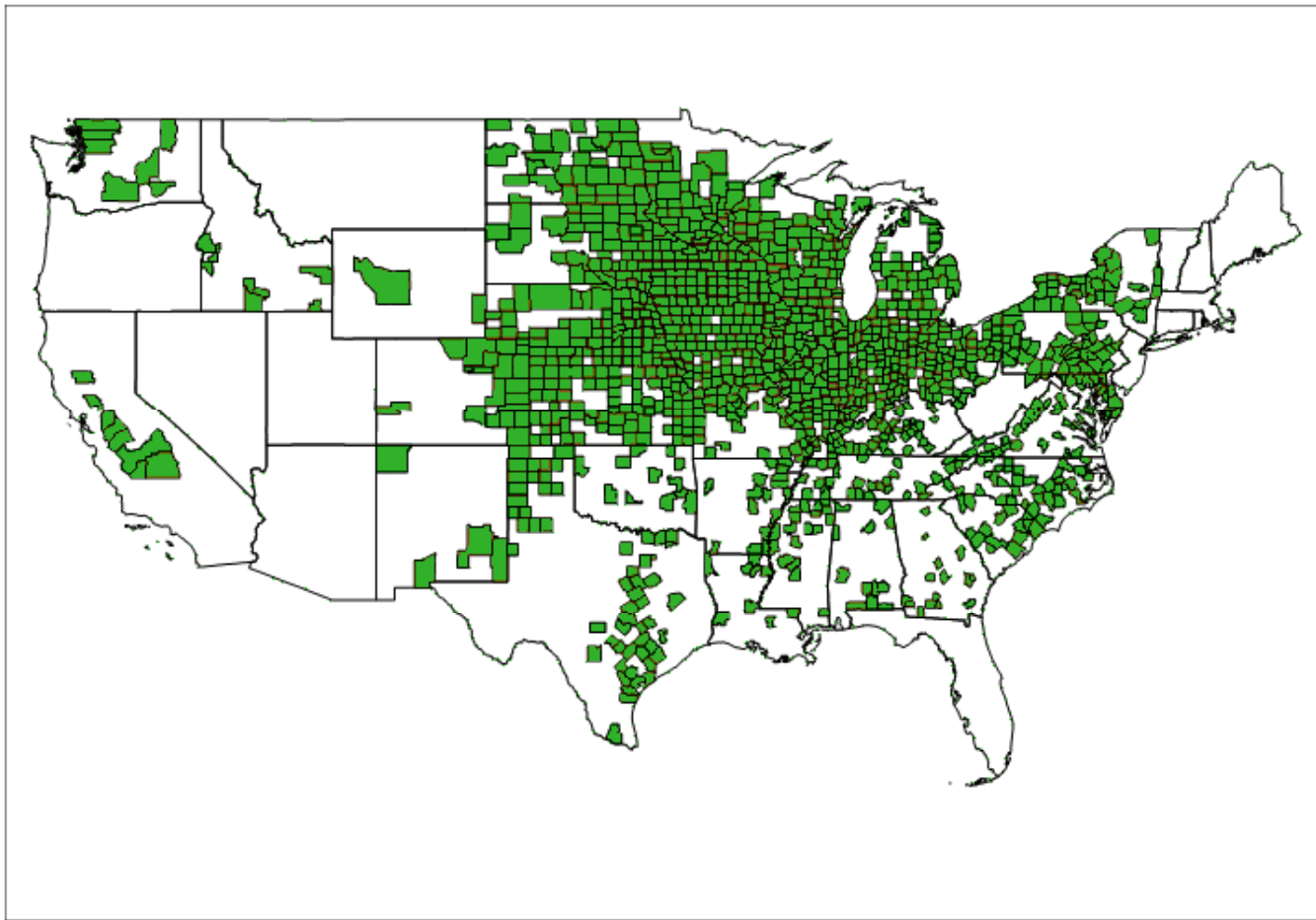
Rank	Weed Species	Resistant	Mode of Action
1 st	<i>Lolium multiflorum</i>	Yes	ACCCase & ALS
2 nd	<i>Bromus secalinus</i>	Yes (KS*)	ALS
3 rd	<i>Allium vineale</i>	No	
4 th	<i>Aegilops cylindrica</i>	No	
5 th	<i>Rumex crispus</i>	No	
* Just outside of southern region in an adjacent state			



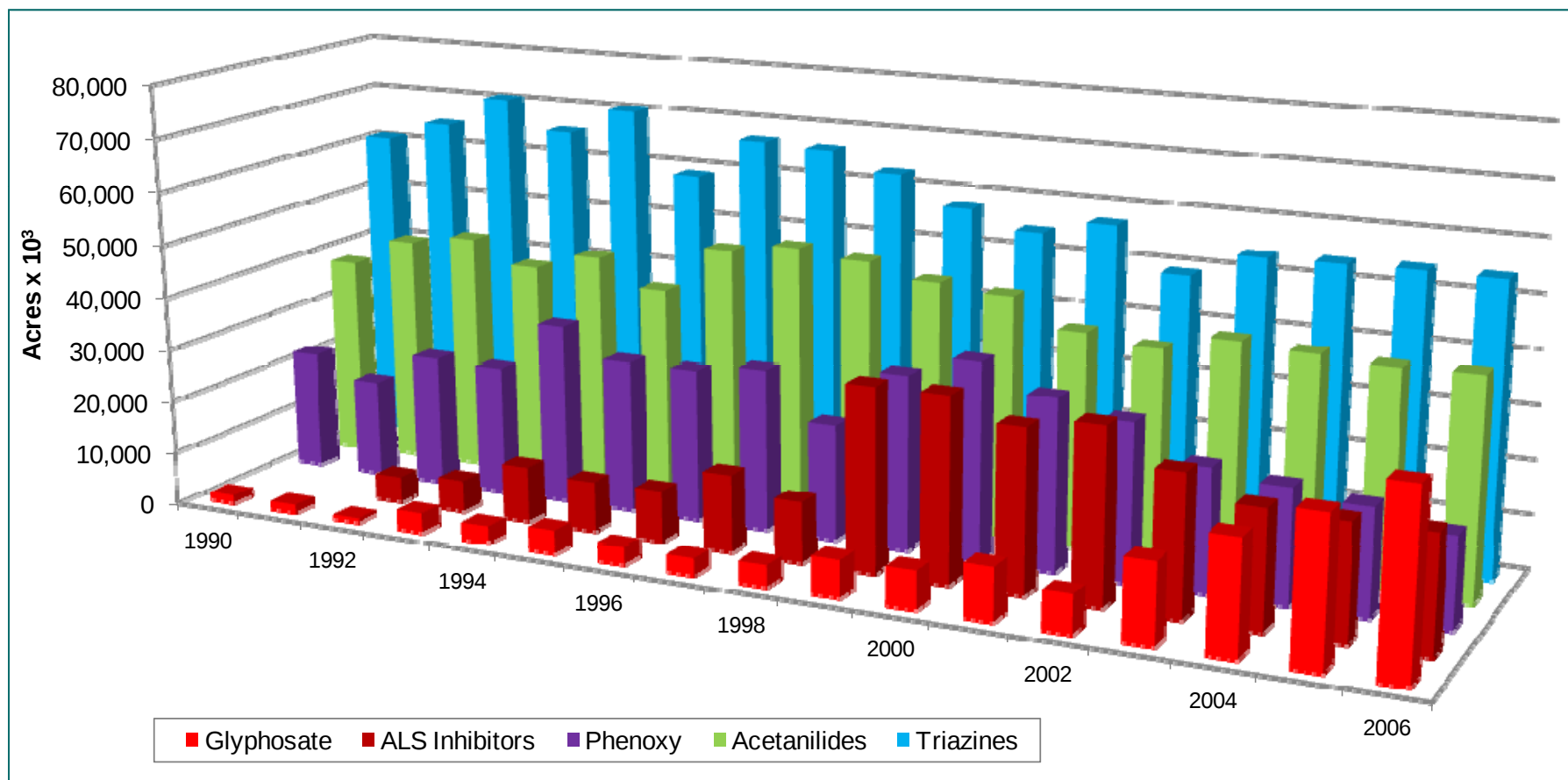
Herbicide Resistance - Winter Wheat

- Broadleaf weeds are managed with inexpensive phenoxy herbicides.
- Problem weeds are grasses, broadleaf biennials, and certain monocots such as wild garlic.
- ALS resistance is wide-spread in the western states; ACCase resistance also occurs in several southern states.
- ACCase resistance frequently changes a one-application program to a two-application program.
- Where both ALS and ACCase resistances occur, pre-emergence herbicides are applied between wheat emergence and the emergence of weedy grasses, a difficult timing.

U. S. Counties Growing - Corn



Corn Acres Exposed to Herbicide Modes of Action





Major and Resistant Weeds in Corn

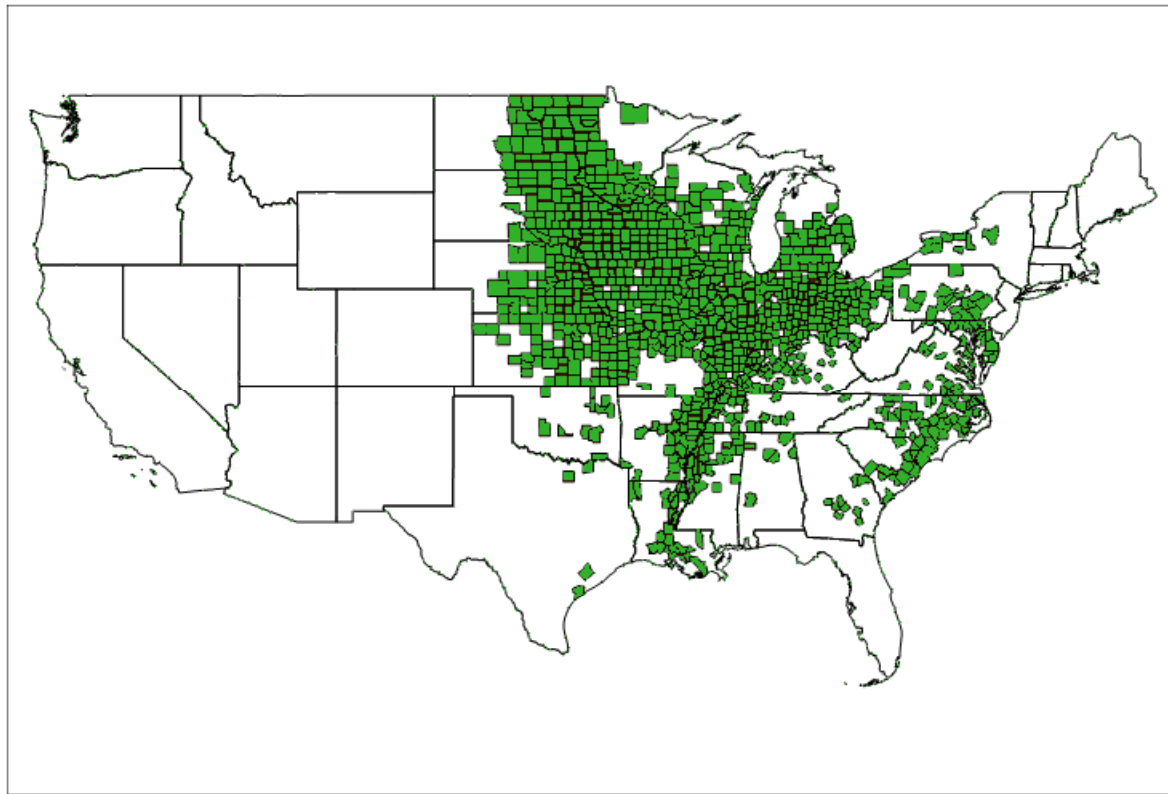
Rank	Troublesome Weeds	Resistant	Mode of Action
1 st	<i>Ipomea spp.</i>	No	None
2 nd	<i>Panicum texanum</i>	No	None
3 rd	<i>Sorghum halepense</i>	Yes	ACCase, ALS, glycine
4 th	<i>Amaranthus spp.</i>	Yes	Many & Multiple
5 th	<i>Brachiaria platyphylla</i>	No	None



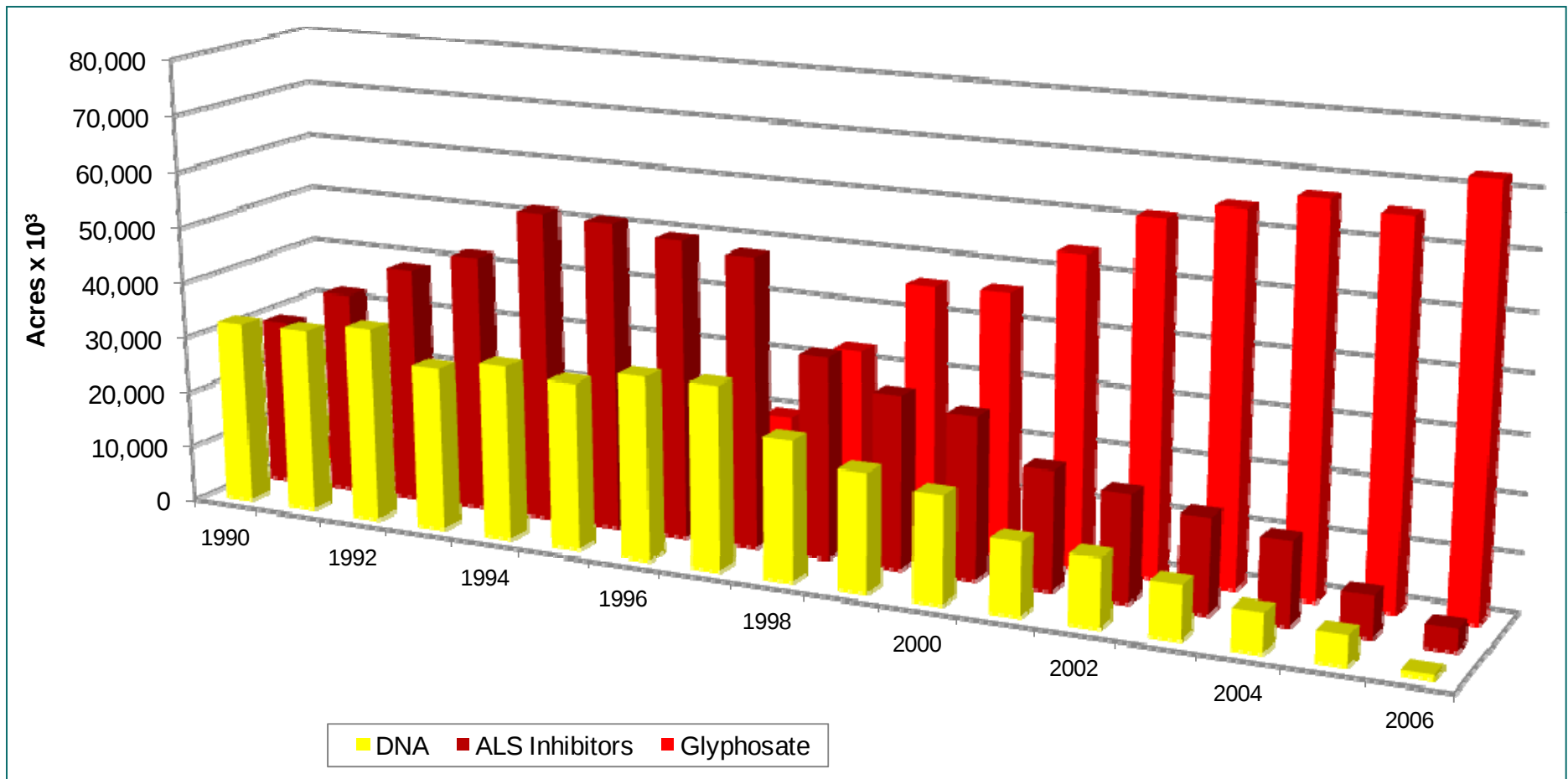
Herbicide Resistance in Corn

- Corn, the largest U.S. crop, is grown in all regions, and is tolerant to many herbicides.
- Triazine and acetanilide herbicides still mainstays of U.S. corn production.
- Transgenic-glyphosate and glufosinate-resistant corn cultivars are increasing in popularity.
- There is concern that the increasing use of glyphosate in corn precludes the positive effect of corn in crop rotations, because it reduces herbicide rotation.

U. S. Counties Growing Soybeans



Soybean Acres Exposed to Herbicide Modes of Action





Major and Resistant Weeds in Soybeans

Rank	Troublesome Weed	Resistant	Mode of Action
1 st	<i>Ipomea spp.</i>	No	None
2 nd	<i>Amaranthus spp.</i>	Yes	Many & Multiple
3 rd	Regional*		

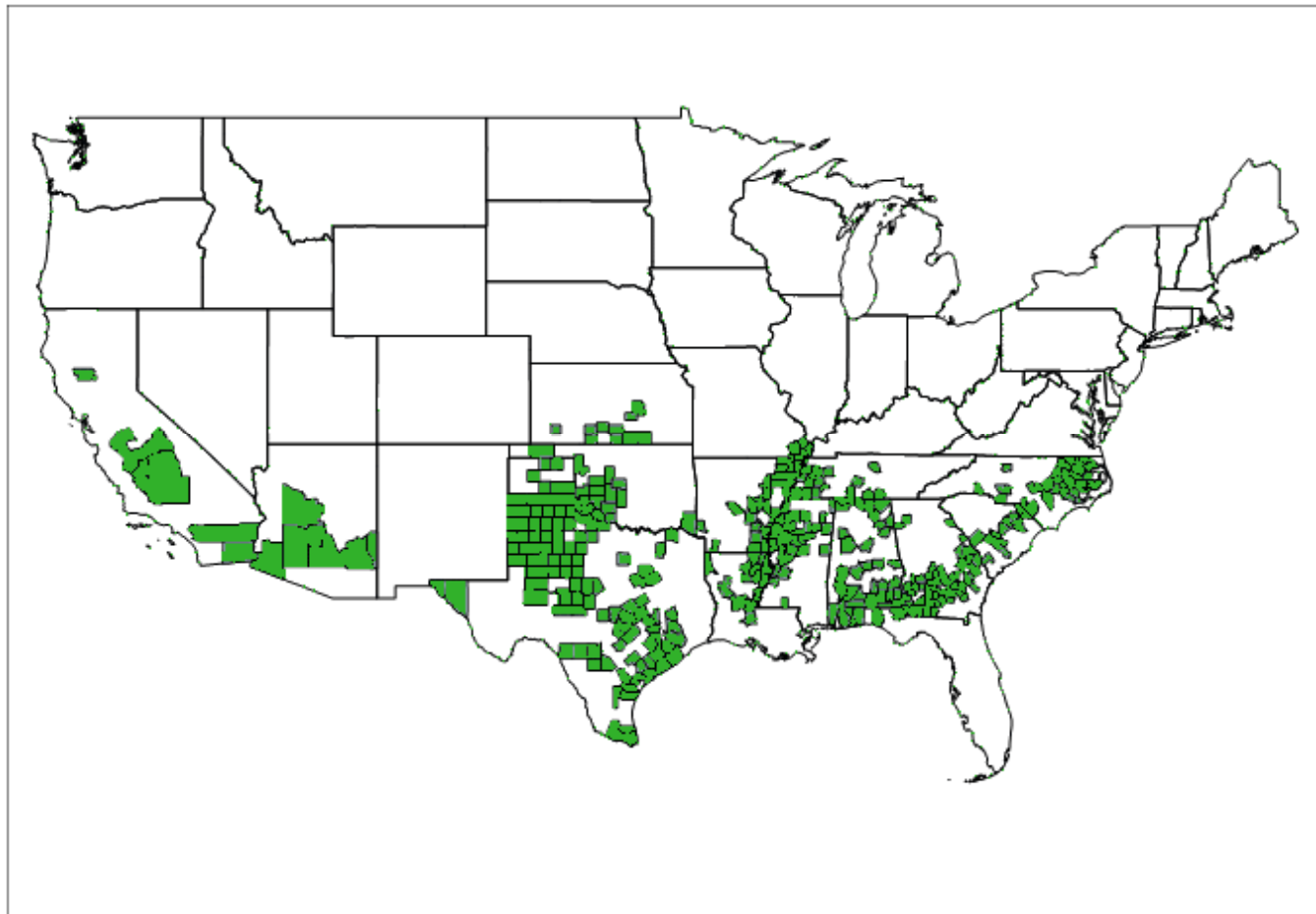
* *Amaranthus* and *Ipomea spp.* are ranked highly as troublesome weeds throughout the South. Other weeds are important locally, but not rated highly across region.



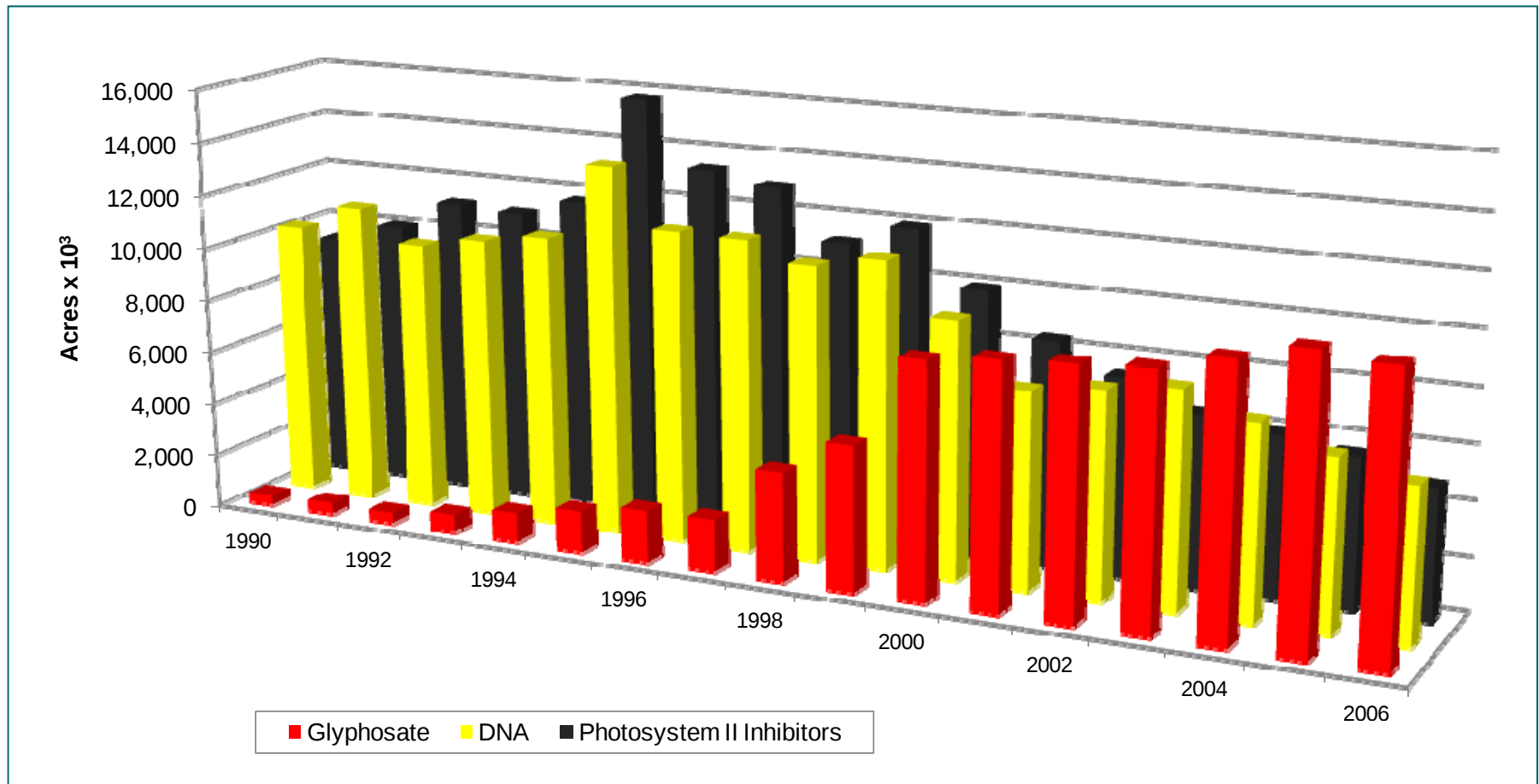
Herbicide Resistance in Soybeans

- Dinitroaniline, and to a lesser extent, acetanilide herbicides were widely used in soybeans.
- In the late 1980s and early 1990s, ALS herbicides were widely used in soybeans as a post-emergence complement to pre-emergence herbicides.
- Transgenic glyphosate-resistant cultivars now dominate U.S. soybean culture.
- There is concern that extensive and multiple applications of glyphosate in soybean, often as a solo product has led to serious incidence of glyphosate-resistance.

U. S. Counties Growing Cotton



Cotton Acres Exposed to Herbicide Modes of Action





Major and Resistant Weeds in Cotton

Rank	Troublesome Weeds	Resistant	Mode of Action
1 st	<i>Ipomea spp.</i>	No	None
2 nd	<i>Amaranthus spp.</i>	Yes	Many & Multiple
3 rd	<i>Cyperus spp.*</i>	(CA)	N/A
4 th	<i>Cynodon dactylon</i>	No	None

* *Cyperus difformis* is not a major weed in U.S. row crops, but *C. esculentus* and *C. rotundus* are major weeds.

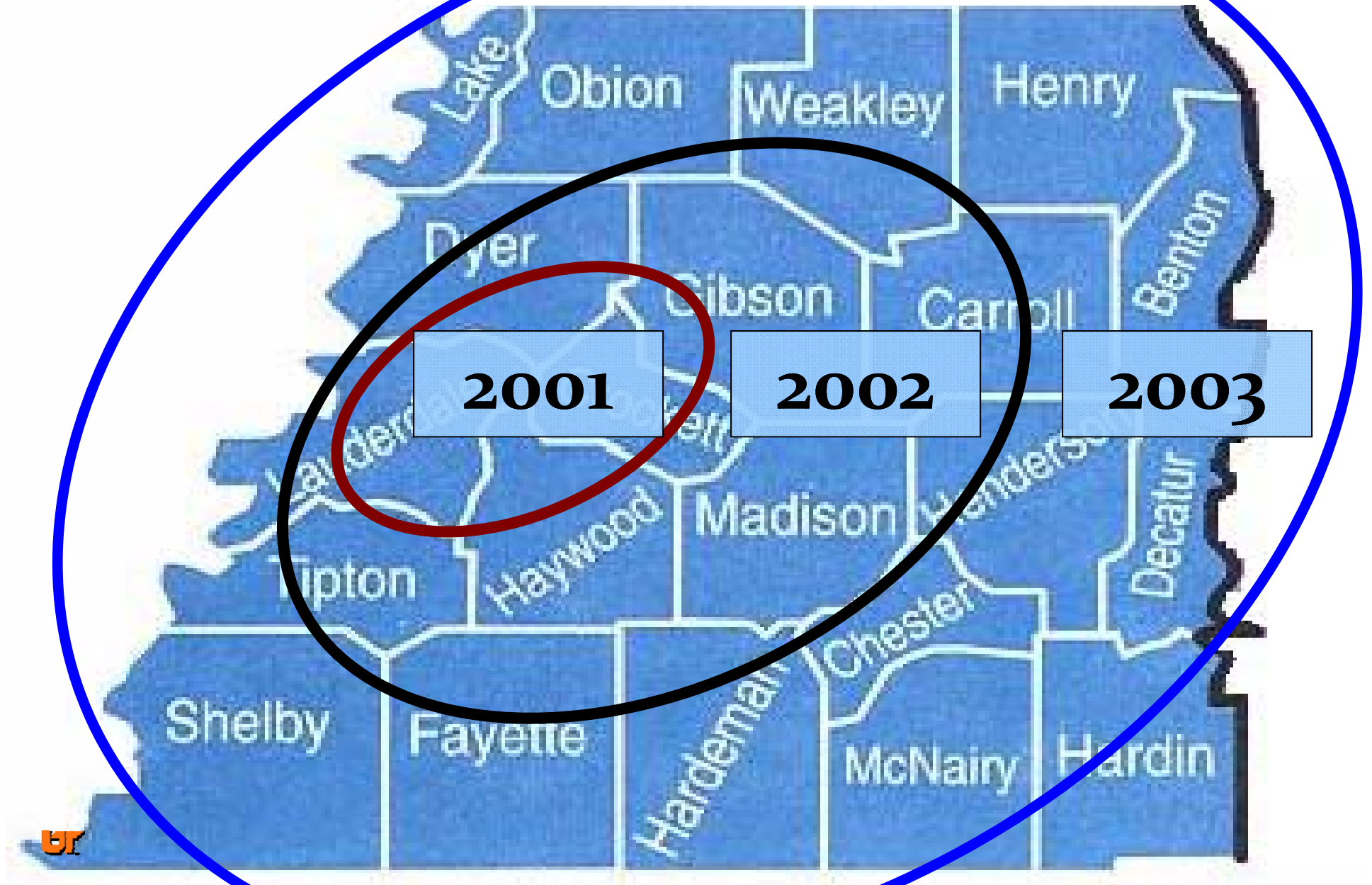


Herbicide Resistance in Cotton

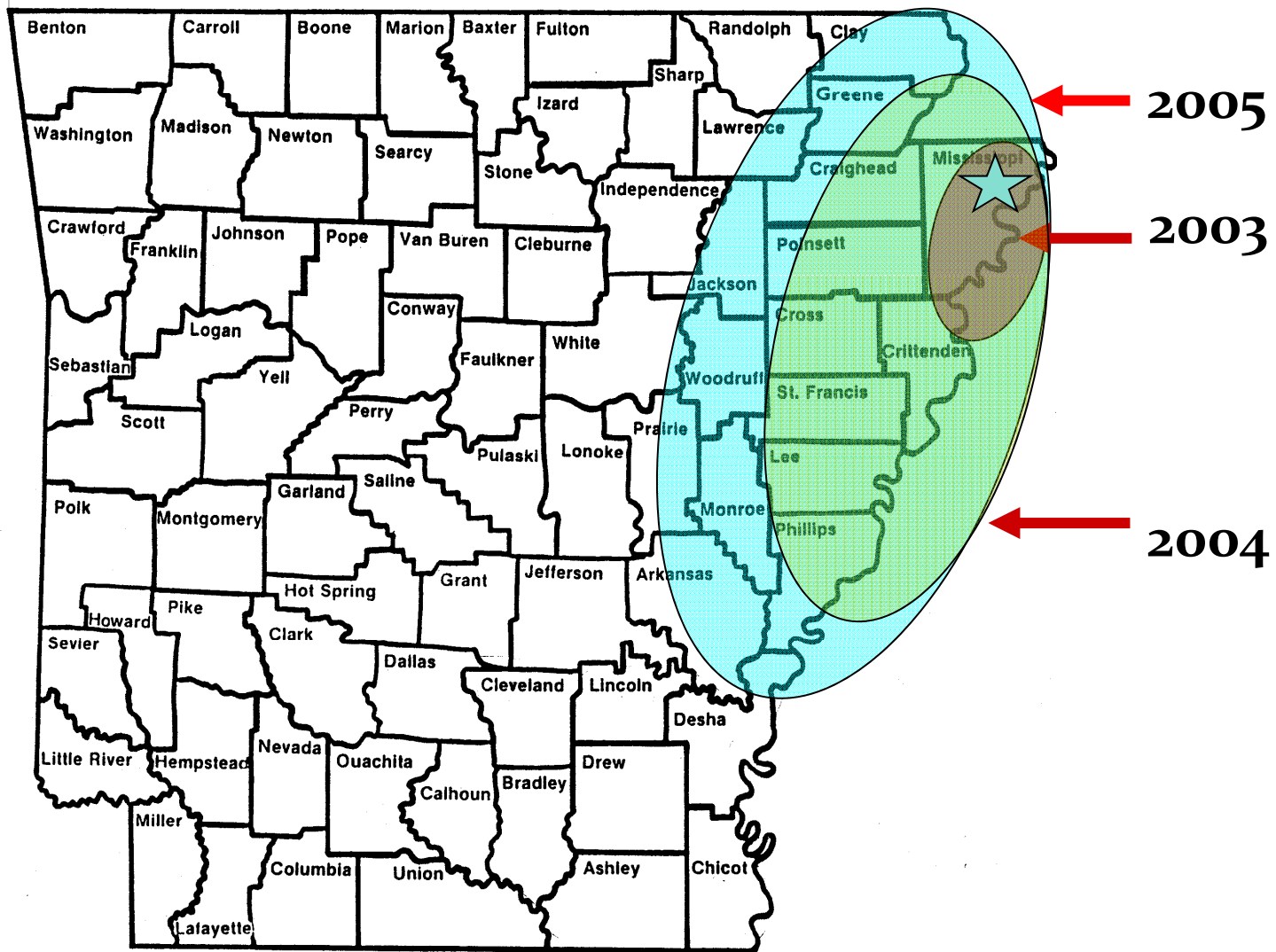
- Cotton is the least competitive of the top three U.S. summer row crops, because the cotton seedling grows slowly.
- Relatively fewer herbicides are tolerated by cotton than by crops with more vigorous seedlings.
- Cotton weed management has generally required three (or more) treatments, whereas corn and soybean usually require two. $\{n \text{ vs. } n-1\}$
- Cotton is heavily impacted by ALS and glycine resistance in the Southeast and increasingly in the Mid-South area.
- Conservation tillage is potentially at risk.



West Tennessee



Glyphosate Resistant Horseweed





Pre-Plant Herbicide Programs for Conservation Tillage - Cotton

No Glyphosate-Resistant Conzya canadense

Glyphosate – \$12.70/acre

Total = \$12.70

Glyphosate-Resistant Conzya canadense

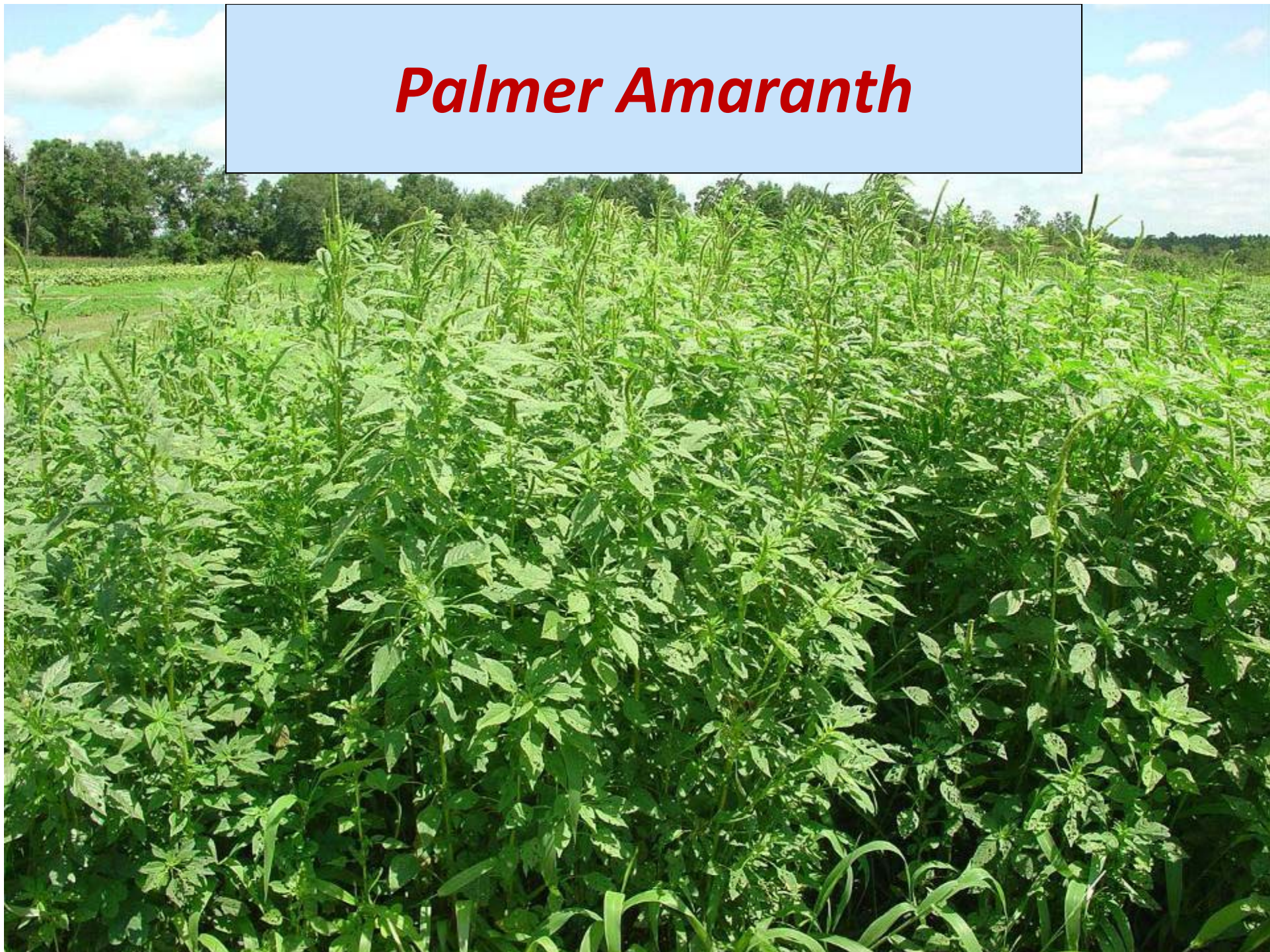
Glyphosate + Dicamba –
\$18.77/acre

Flumeturon – \$8.60/acre

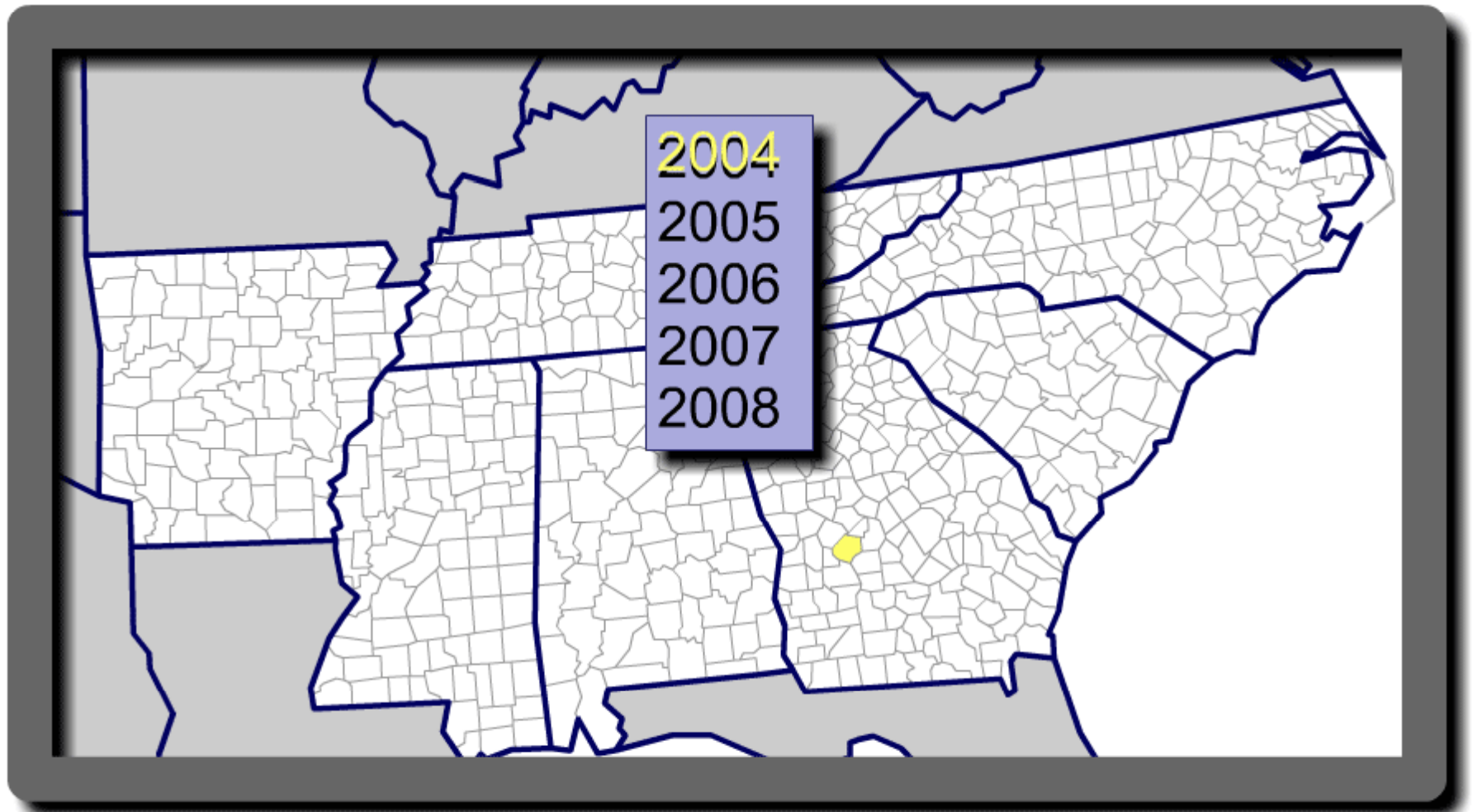
Total = \$27.38/acre

Described in
Mueller et al. 2005
Weed Tech. 19. 924-933

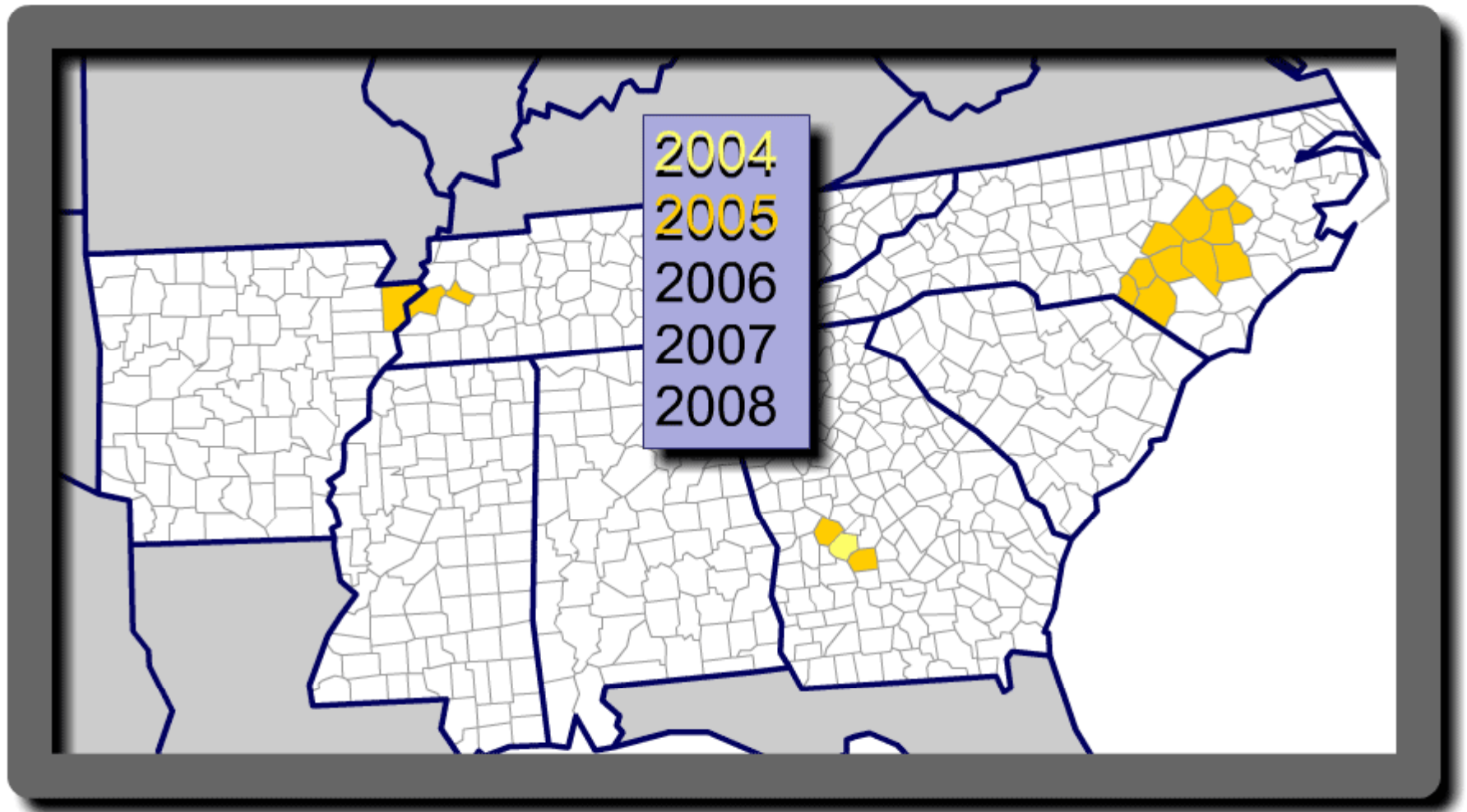
Palmer Amaranth



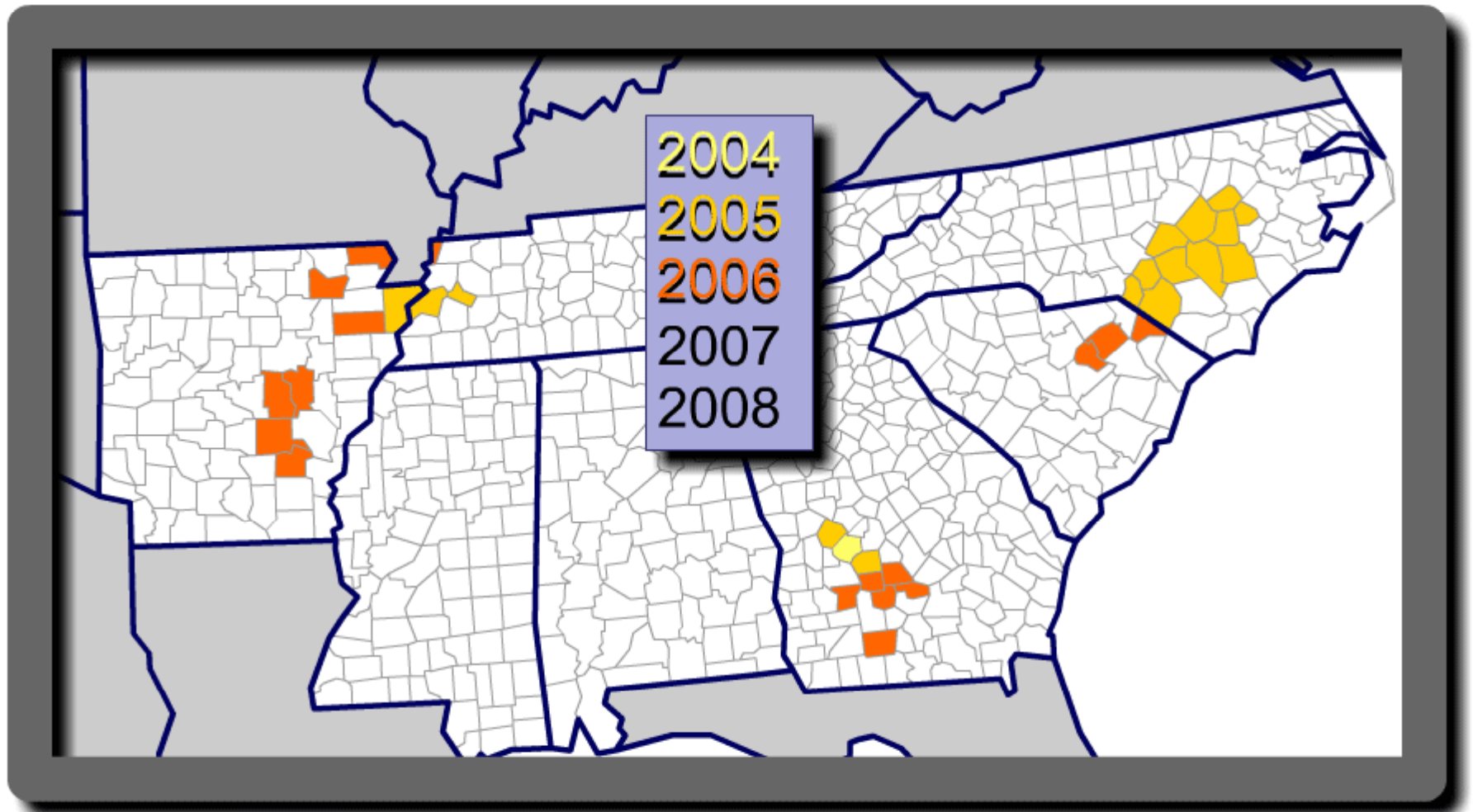
Counties Affected by Glyphosate-Resistant Palmer Amaranth – 2004



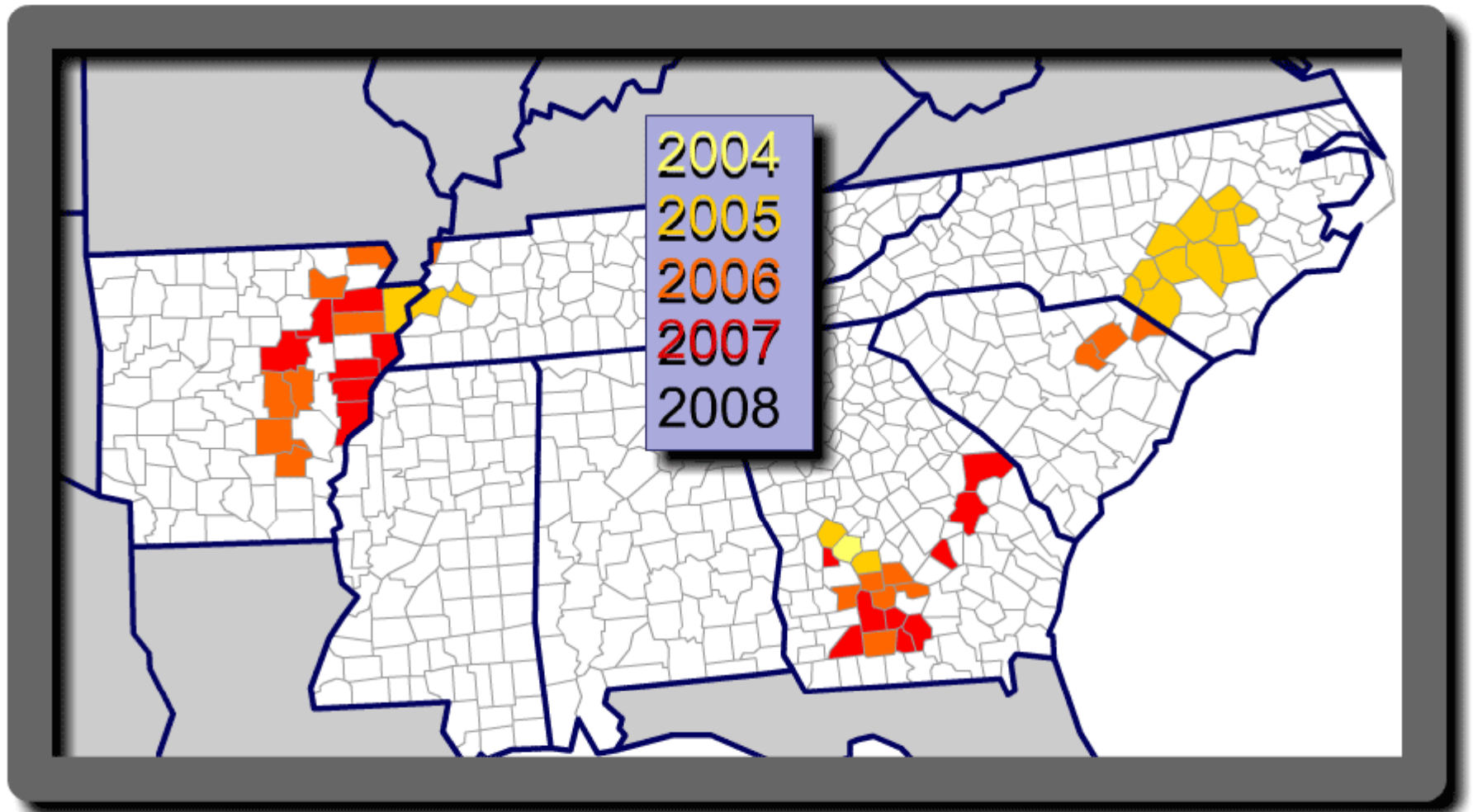
Counties Affected by Glyphosate-Resistant Palmer Amaranth – 2005



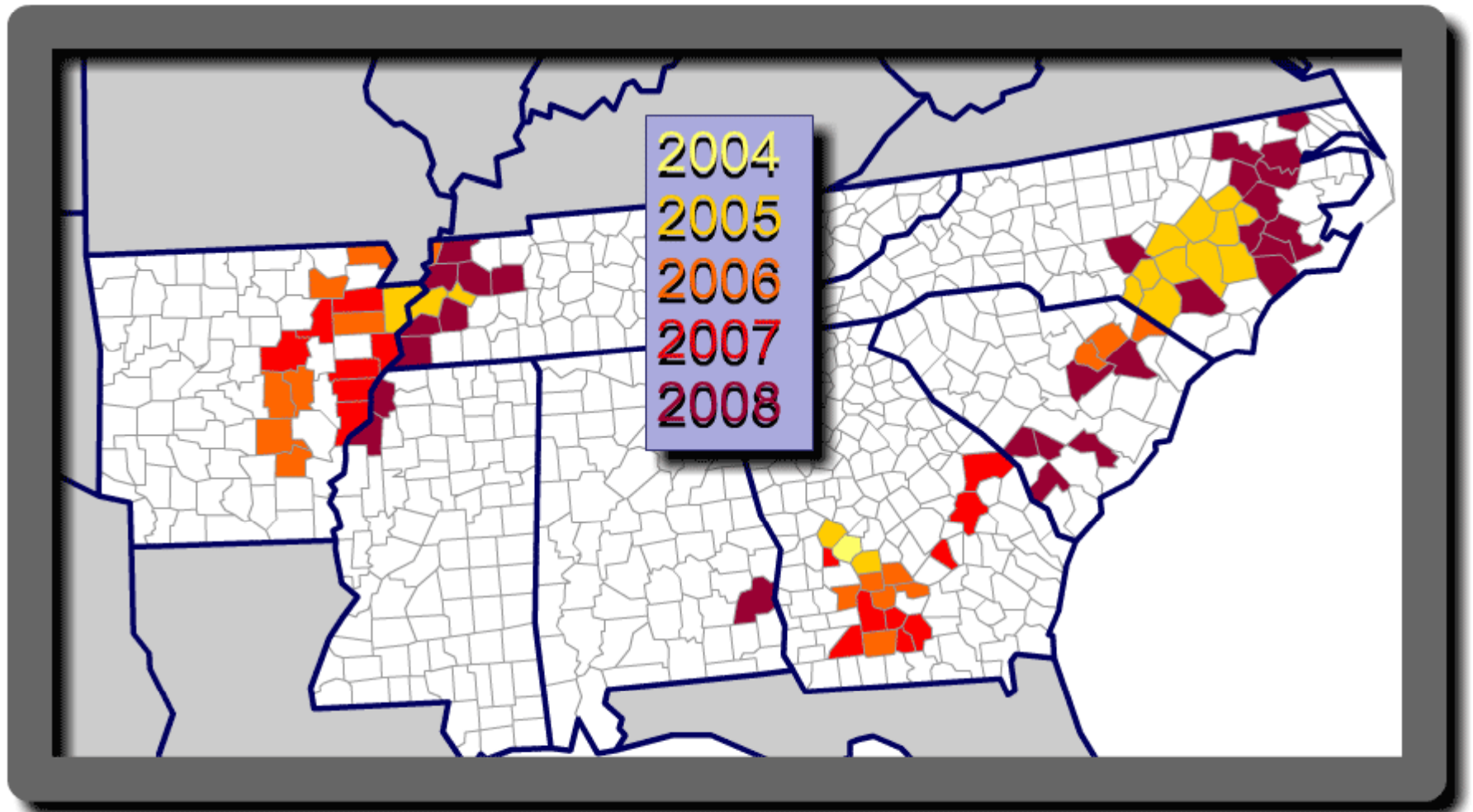
Counties Affected by Glyphosate-Resistant Palmer Amaranth – 2006



Counties Affected by Glyphosate-Resistant Palmer Amaranth – 2007



Counties Affected by Glyphosate-Resistant Palmer Amaranth – 2008





Herbicide Programs for Cotton - Arkansas

No Glyphosate-Resistant *Amaranthus palmeri*

Technology Fee - \$34.80/acre

Pendimethalin - \$4.48/acre

Glyphosate (2x) - \$9.60/acre

Total = \$48.88/acre

Glyphosate-Resistant *Amaranthus palmeri*

Technology Fee - \$34.80/acre

Pyrithiobac + Pendimethalin -
\$20.49/acre

Metolachlor + Glyphosate -
\$18.02/acre

Diuron + MSMA - \$3.46/acre

Total = \$76.77/acre



Herbicide Programs for Cotton - Georgia

No Glyphosate-Resistant *Amaranthus palmeri*

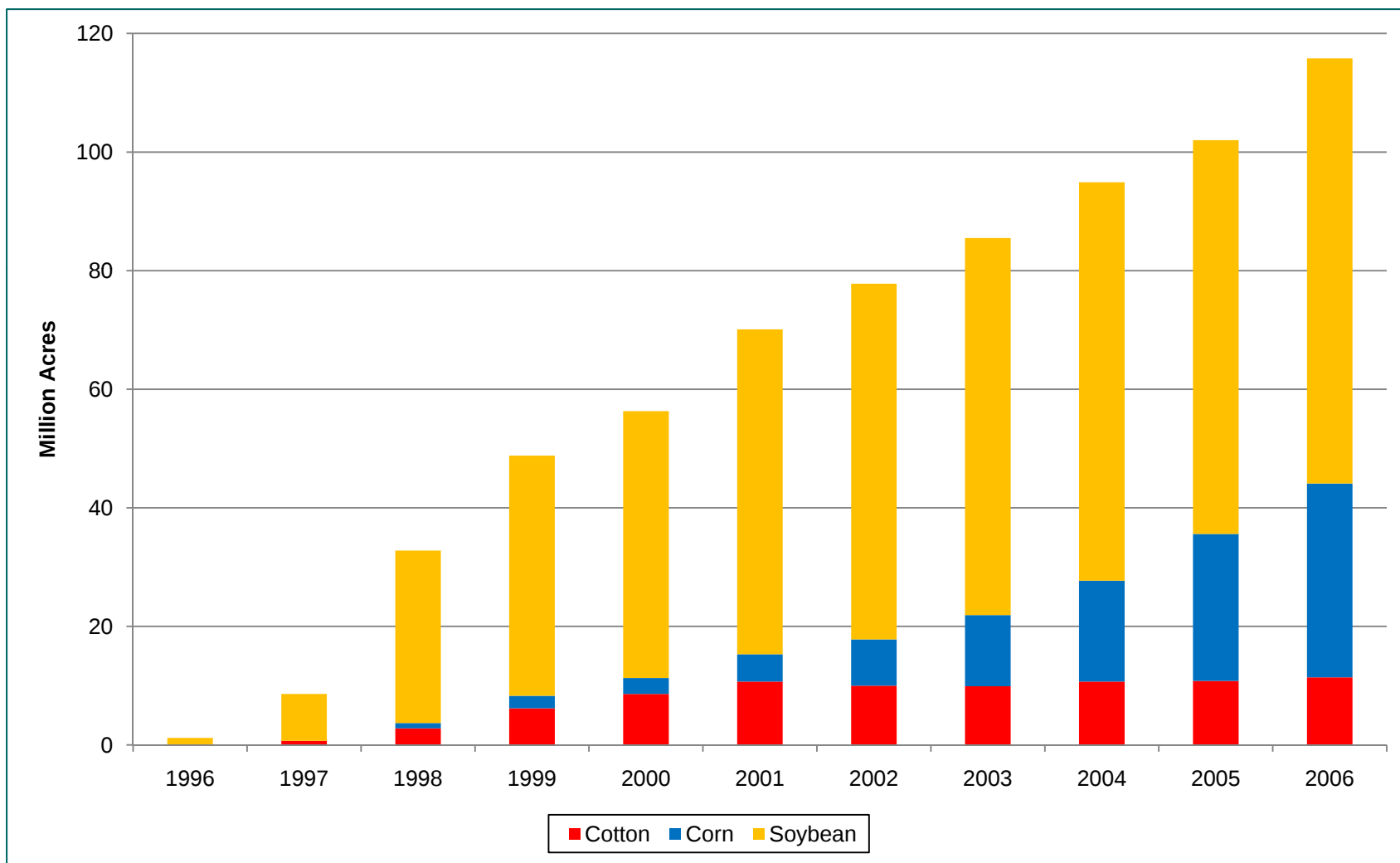
Technology Fee - \$42.18/acre
Pendimethalin - \$4.48/acre
Glyphosate (2x) - \$9.60/acre

Total = \$56.26/acre

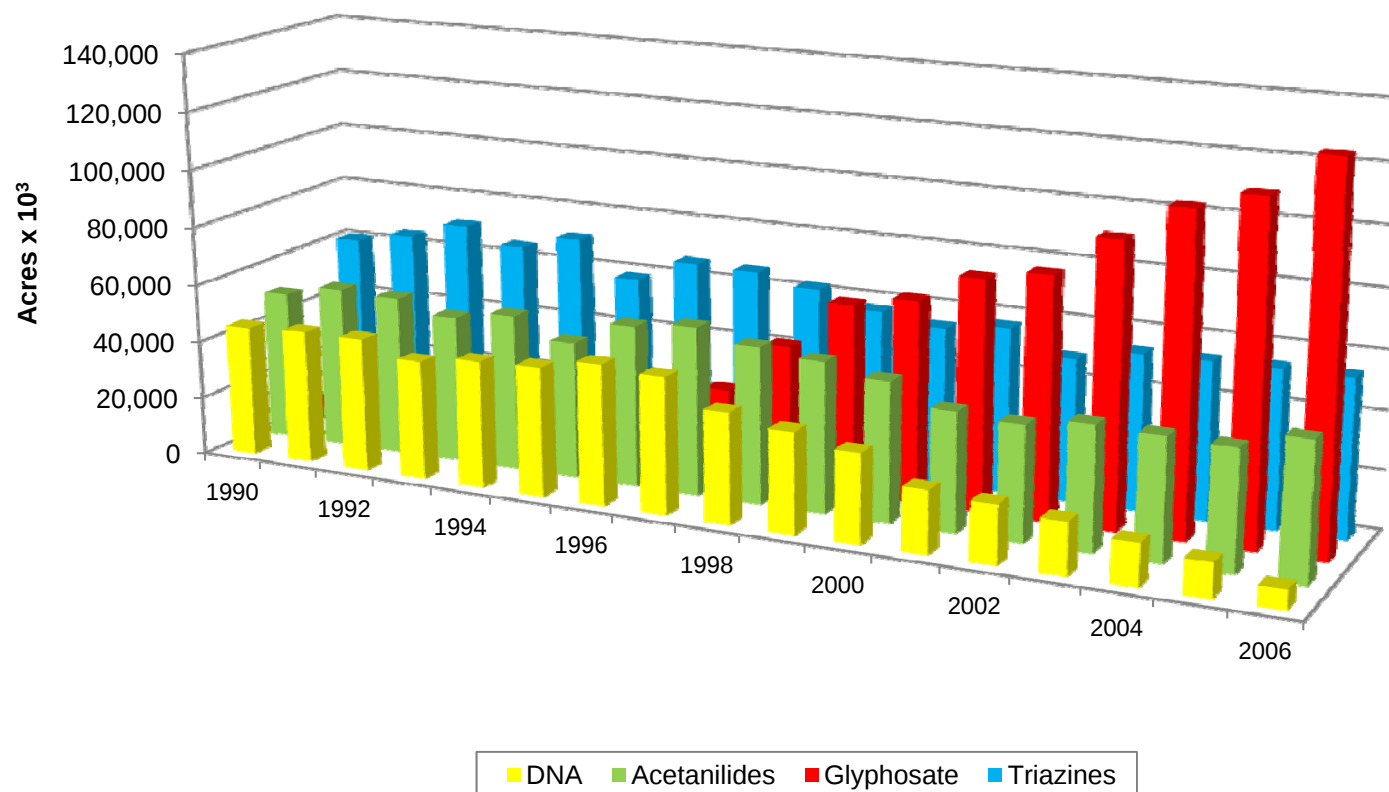
Glyphosate-Resistant *Amaranthus palmeri*

Technology Fee - \$42.18/acre
Fomesafen + Pendimethalin
- \$18.62/acre
Metolachlor + Glyphosate -
\$18.02/acre
Diuron + MSMA - \$3.46/acre
Total = \$82.28/acre

Glyphosate-Resistant Crop Acres (millions)



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





Distribution of Glyphosate Resistant Weeds in U.S. Cotton

Conzya canadensis – Widespread, AR, TN, NC

Amaranthus palmeri – Southeast & Mid-South

Amaranthus rudis – North Central & East TX

Ambrosia trifida – North Central & West TN

Sorghum halapense – North Delta

Lolium multiflorum – suspected Delta & NC



Summary of Resistance Issues

Crop	Principal Resistant Weed(s)	Impacts
Rice	<i>Echinochloa crus-galli</i>	Sequential Replacement of Modes of Action
Winter Wheat	<i>Lolium multiflorum</i>	Emerging Issues with ACCase, ALS, and Glycine Resistance
Corn, Soybean & Cotton	Annual Broadleaves	Emerging Issues with Resistance



Sustainable Use of Herbicide Modes of Action

- Sustaining the Efficacy of Herbicide Modes of Action (MOAs) is a Critical Issue for U.S. Agriculture.
- Broadleaf weed control in soybean and cotton depends on the continued efficacy of the acetolactate synthase (ALS), glycine, glutamine synthetase, and protophyrinogen oxidase (PPO) modes of herbicide action.
- All these MOAs are compromised to some extent, except the glutamine synthetase MOA.
- Cotton is particularly vulnerable because the PPO mode of action cannot be used over-the-top.
- Technical development and practical implementation of resistance management principles and practices are urgently needed.