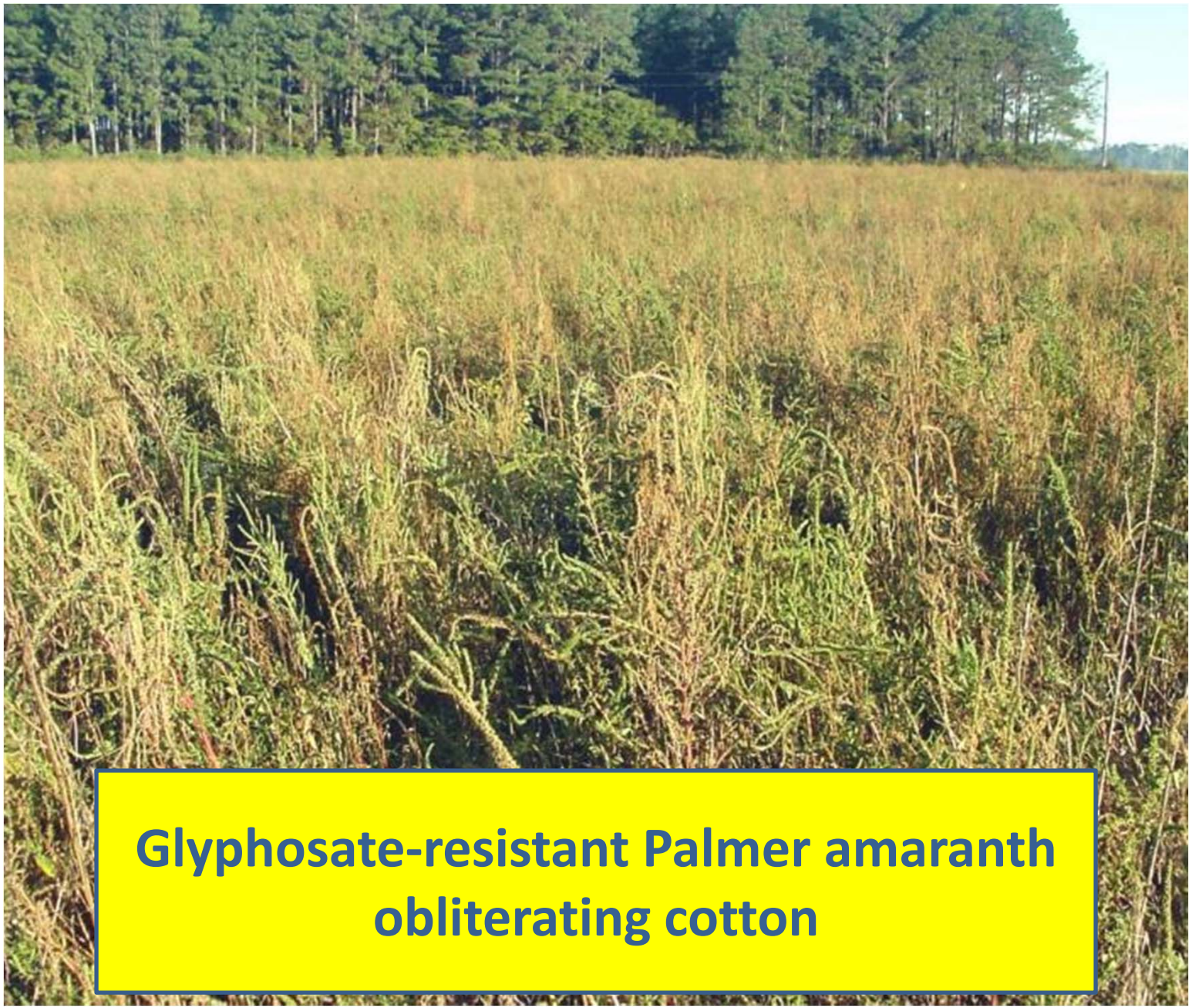
Biology and Management of Herbicide-Resistant Palmer amaranth in Cotton in the United States

World Cotton Research Conference
Goiania, Brazil
May 2, 2016

- R. L. Nichols
- N. Burgos
- P. Dotray
- A. Lawton-Rauh
- L. Steckel

J. Burton
S. Culpepper
T. Gaines
J. Norsworthy
A. York


Glyphosate-Resistant Palmer amaranth
impeding cotton harvest


Glyphosate-resistant Palmer amaranth obliterating cotton

Dioecious Amaranth *Species;* aka Pigweeds

Palmer Amaranth

Waterhemp

Two Dioecious amaranths in North America

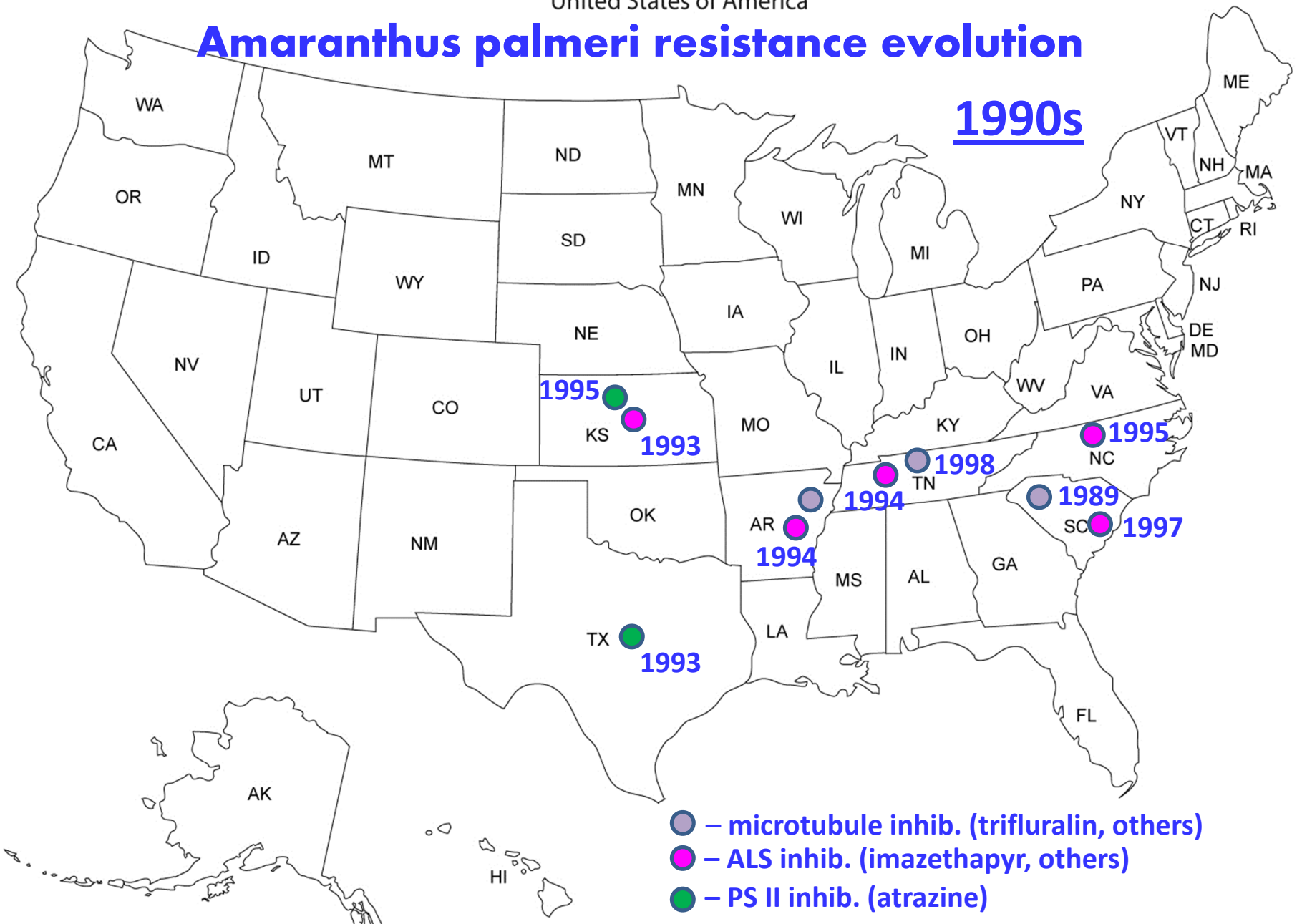
- *Amaranthus tuberculatus* – Tall Waterhemp
  - Midwest; heavy soils - South Central
- *Amaranthus palmeri* – Palmer amaranth, Palmer pigweed
  - light soils - South & many soils Southwest

- The two dicots resistant to the most herbicide modes of action (6 each)
  - *A. palmeri* is invading the Midwest

United States of America

Amaranthus palmeri resistance evolution

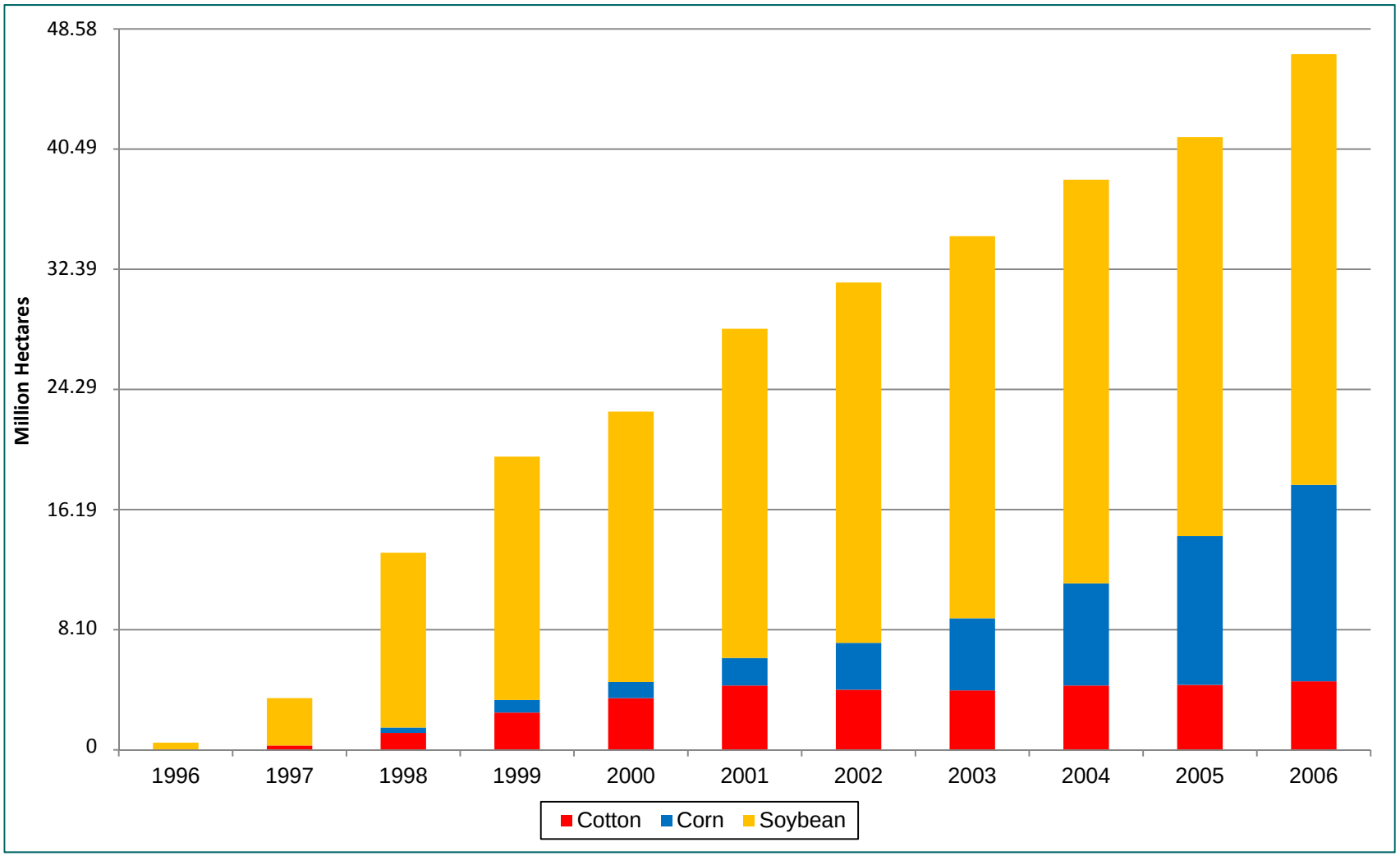
1990s



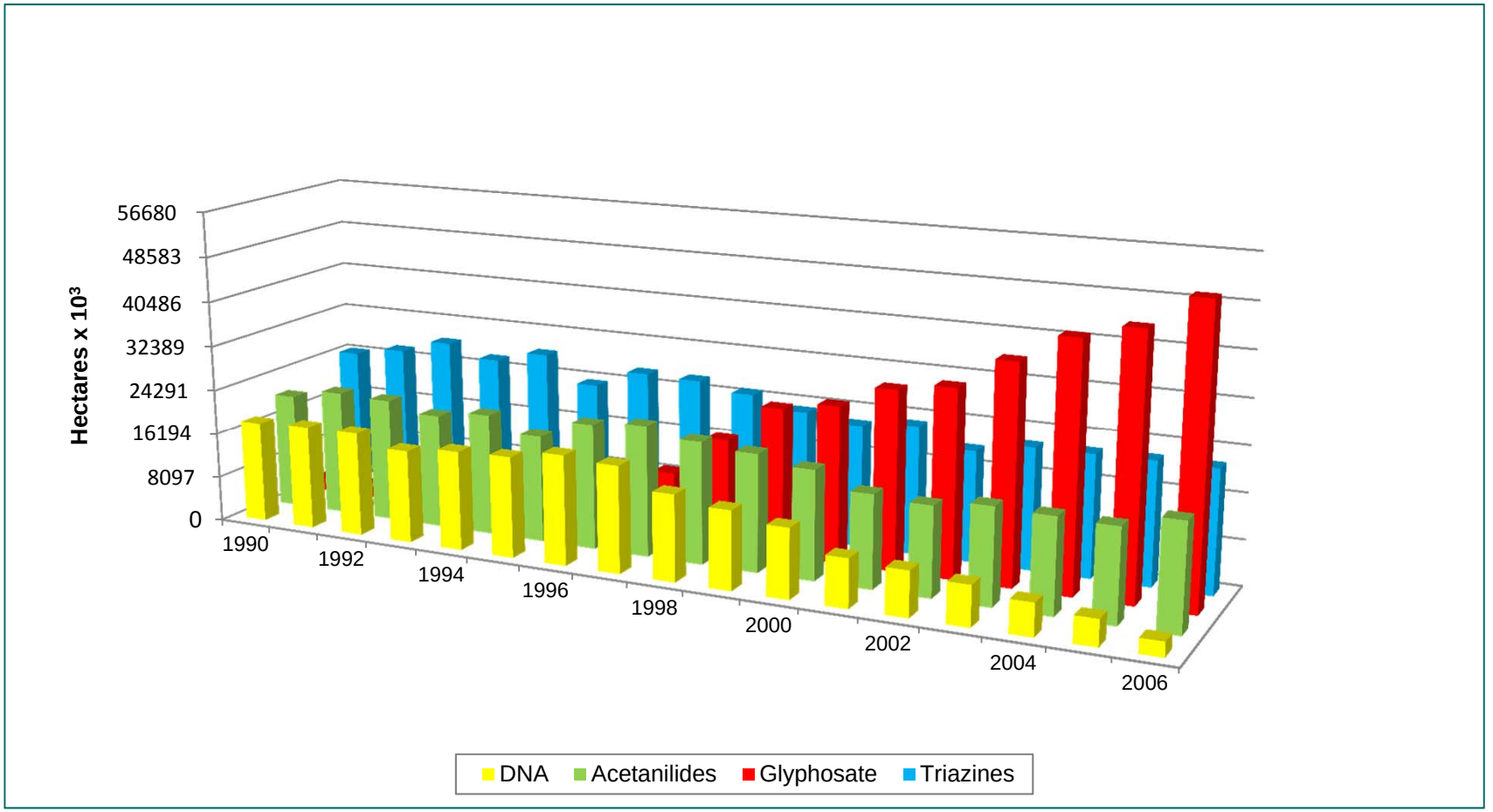
● – microtubule inhib. (trifluralin, others)
● – ALS inhib. (imazethapyr, others)
● – PS II inhib. (atrazine)

Heap (2016) The International Survey of Herbicide Resistant Weeds. Available www.weedscience.org

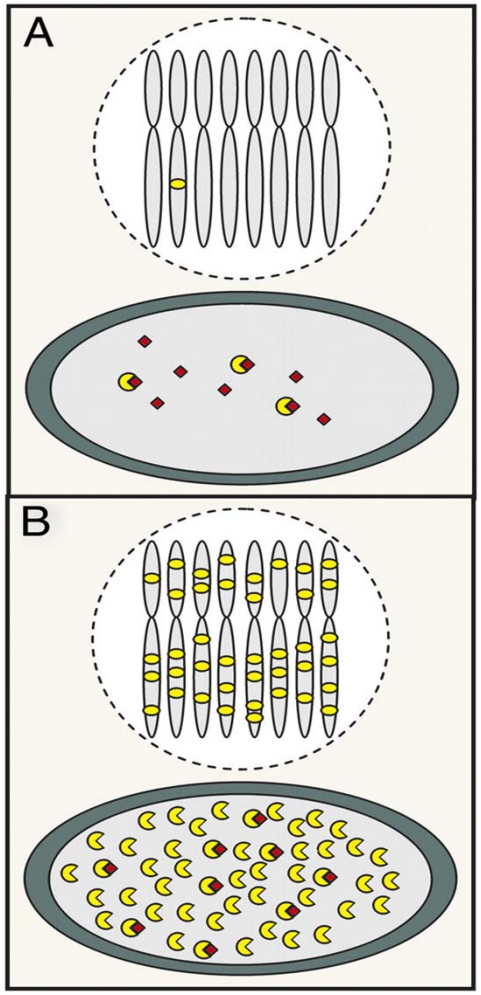
Hectares of Glyphosate-Resistant Crop Cultivars



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



EPSPS Gene Duplication: Glyphosate Resistance Mechanism



Susceptible

Resistant

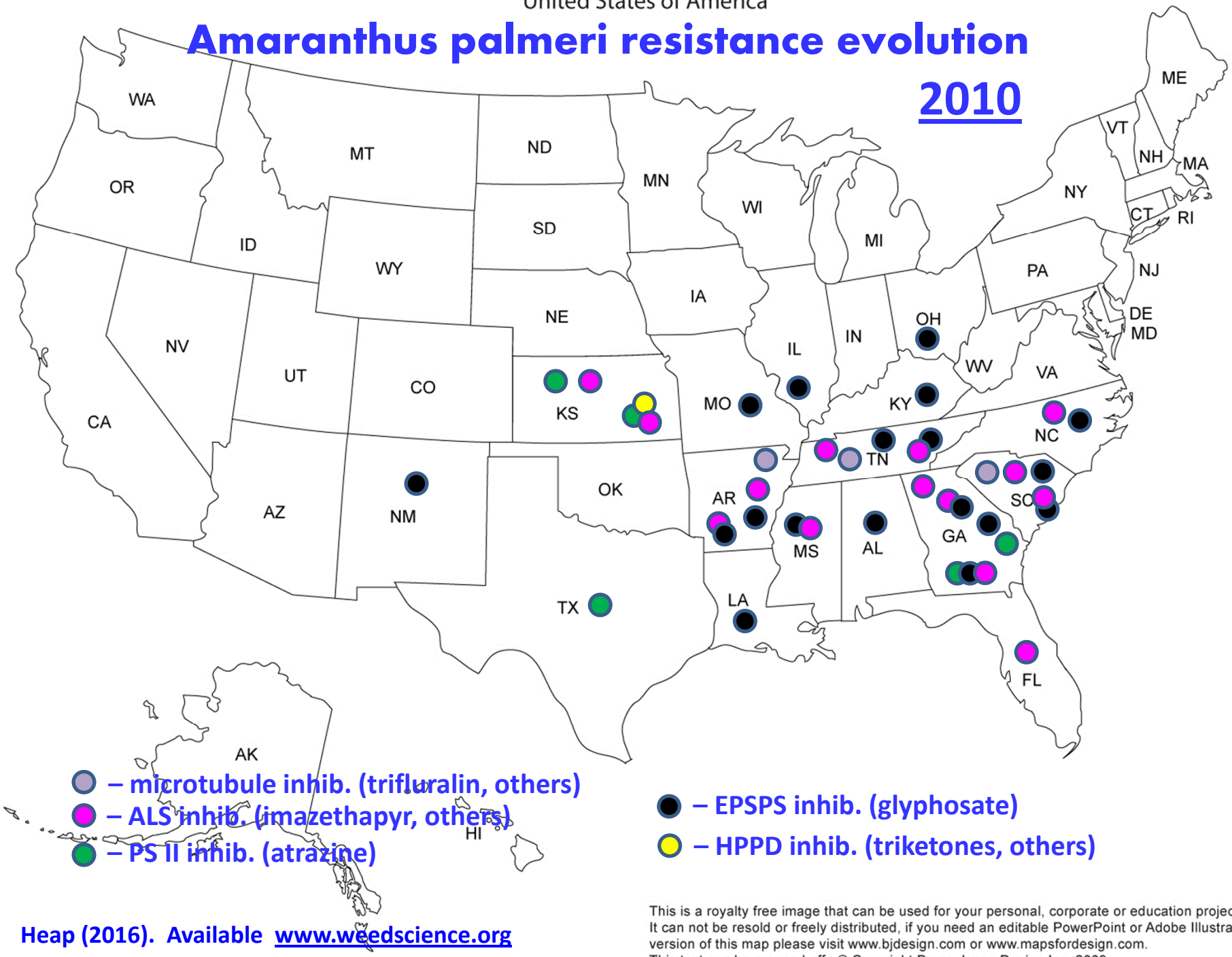
Powles, PNAS 2010;107:955-956

- Resistant plants have much more EPSPS
- Extra gene copies are located on multiple chromosomes
- Gaines et al. 2010. Gene amplification confers glyphosate resistance in *Amaranthus palmeri. Proc. Natl. Acad. Sci. USA* 107:1029-1034.

United States of America

Amaranthus palmeri resistance evolution

2010



– microtubule inhib. (trifluralin, others)

– ALS inhib. (imazethapyr, others)

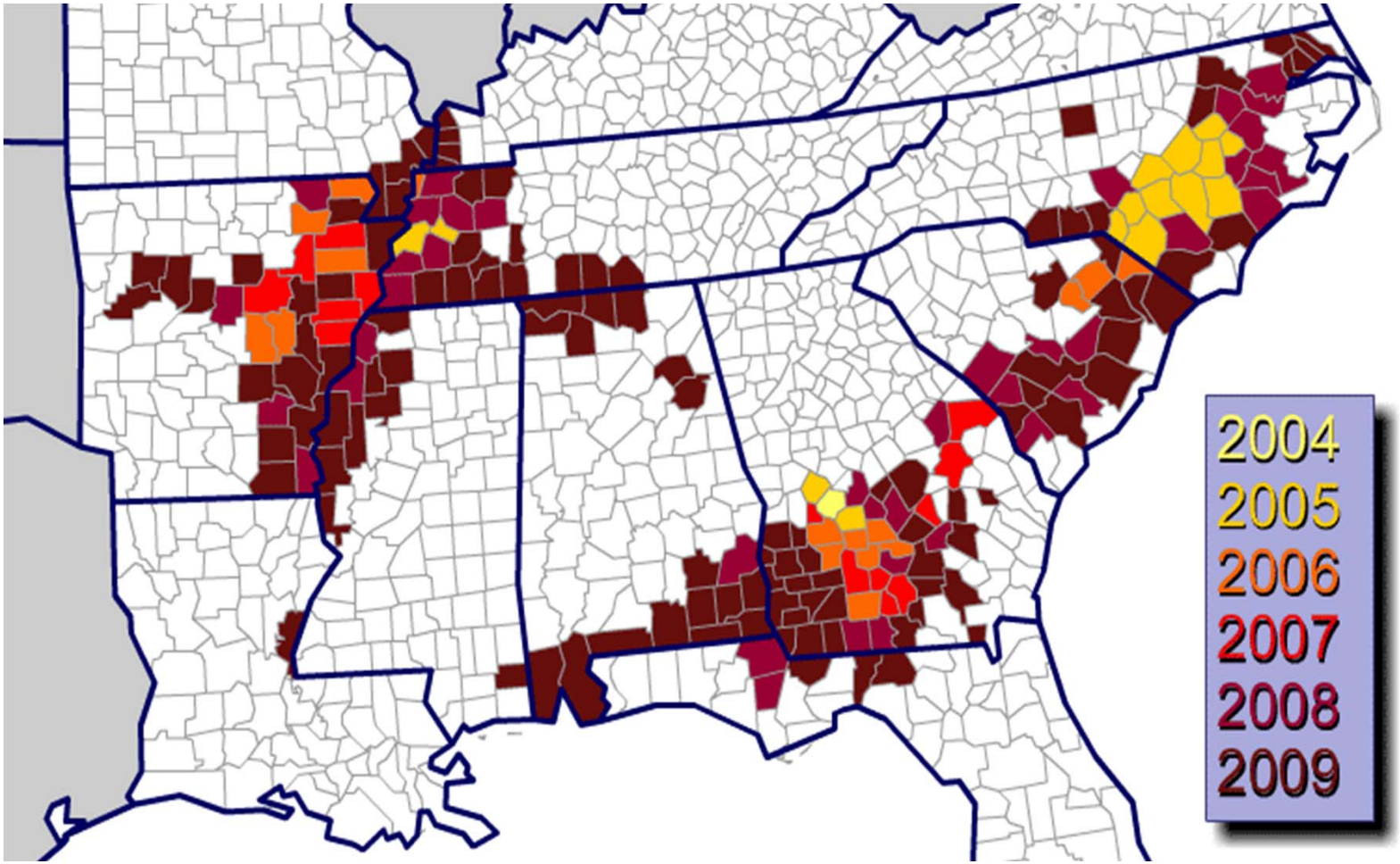
– PS II inhib. (atrazine)

– EPSPS inhib. (glyphosate)

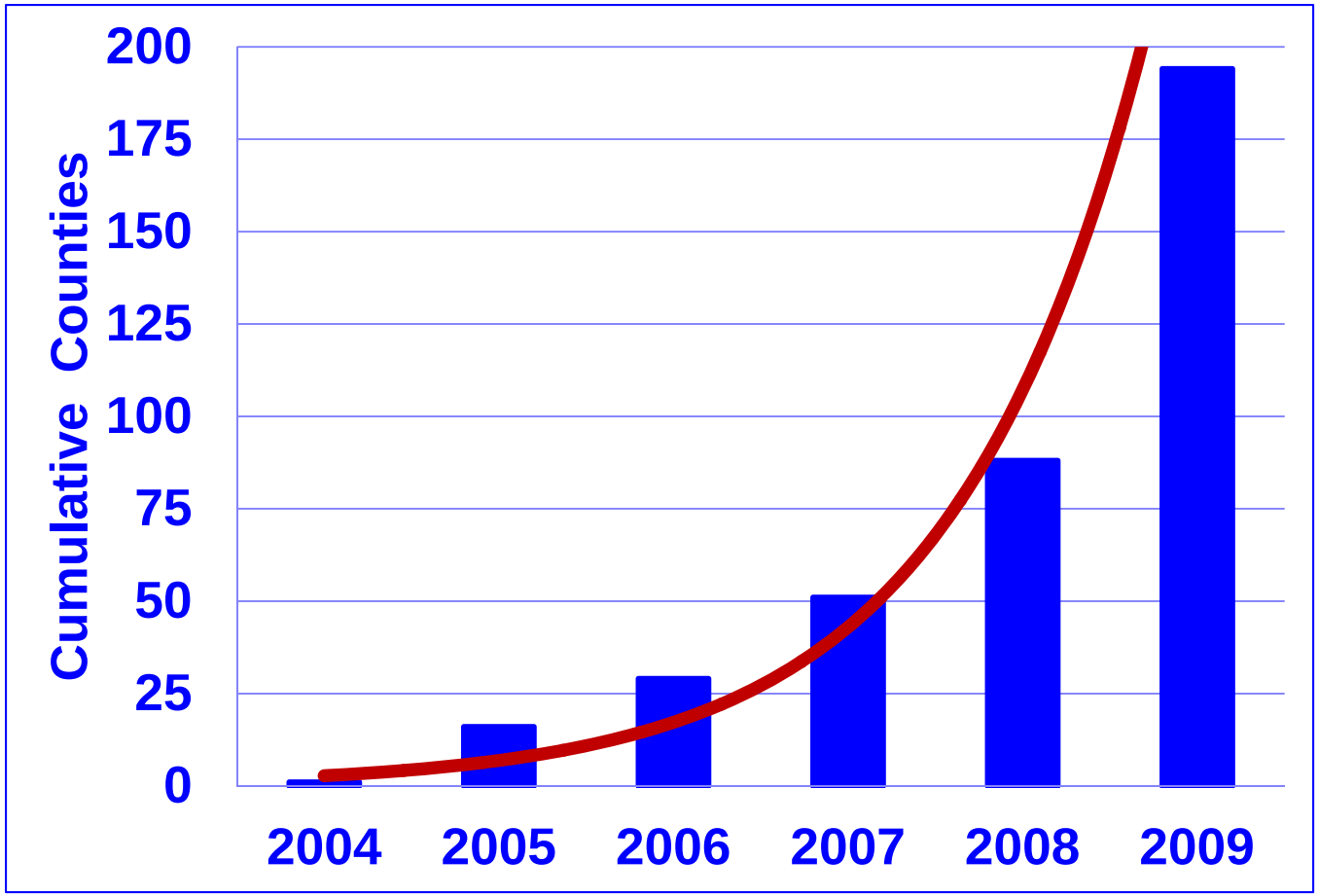
– HPPD inhib. (triketones, others)

Heap (2016). Available www.weedscience.org

Expansion of Glyphosate-Resistant Palmer amaranth – counties infested

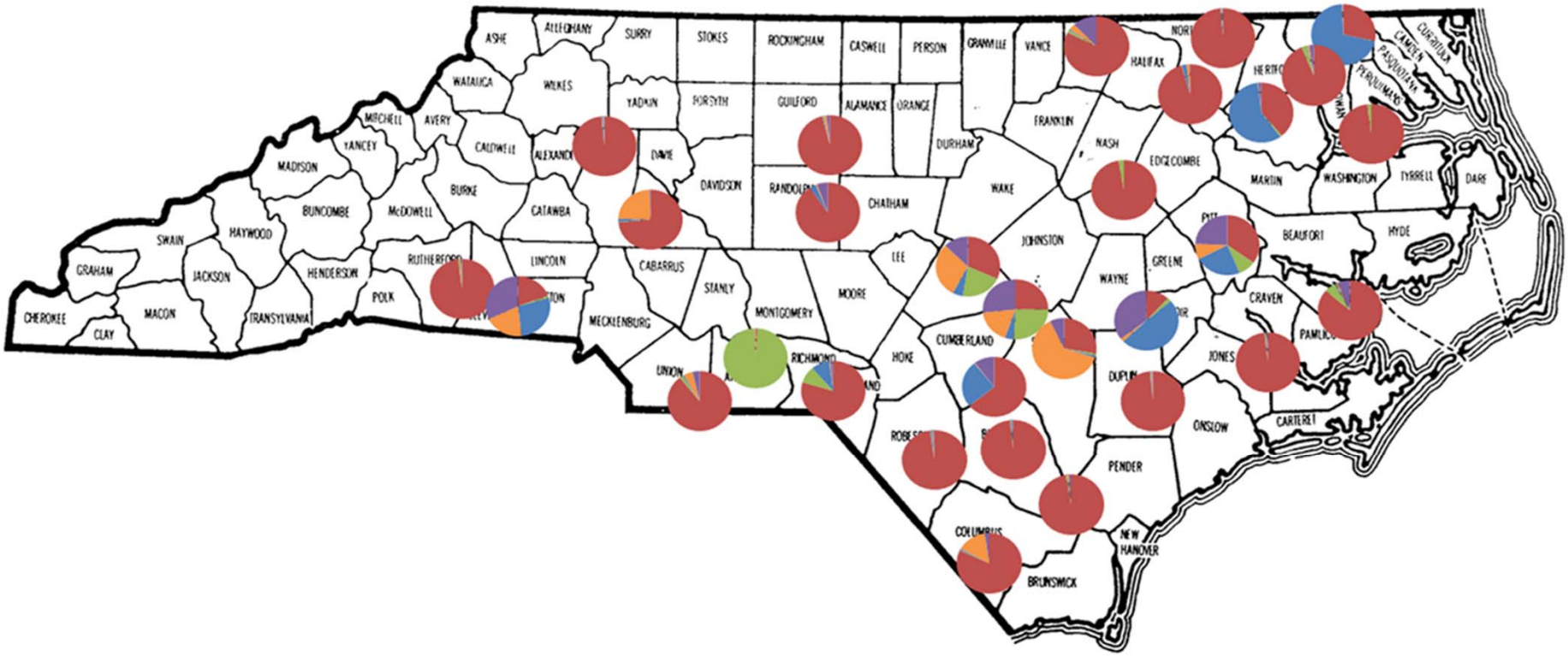


Counties with Glyphosate-Resistant Palmer Amaranth



Population Genetics of Glyphosate Resistance in Palmer amaranth

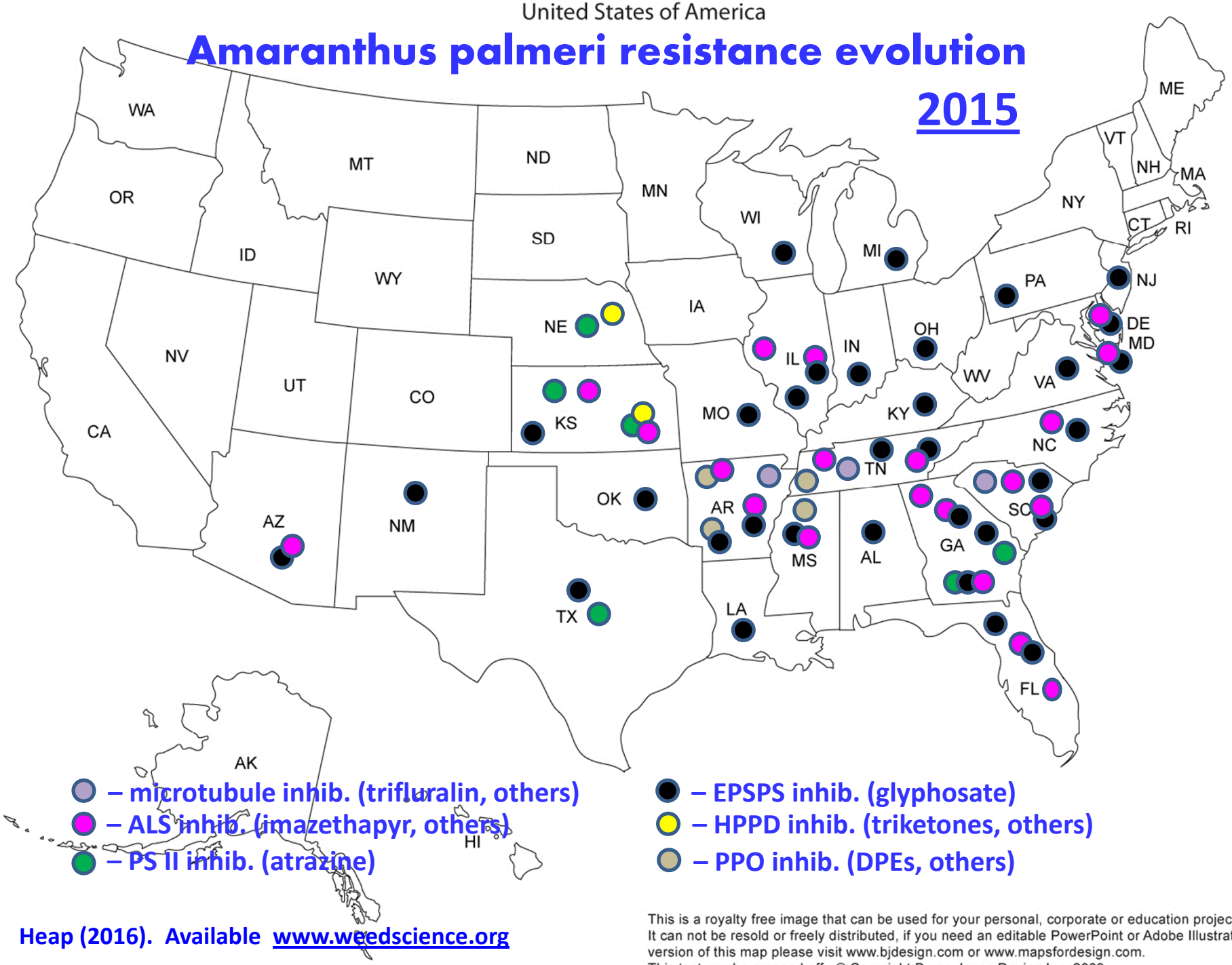
- **Distribution of Genotypes in North Carolina - 2009**



United States of America

Amaranthus palmeri resistance evolution

2015



– microtubule inhib. (trifluralin, others)

– ALS inhib. (imazethapyr, others)

– PS II inhib. (atrazine)

– EPSPS inhib. (glyphosate)

– HPPD inhib. (triketones, others)

– PPO inhib. (DPEs, others)

Heap (2016). Available www.weedscience.org

Impacts of Glyphosate-Resistant Palmer amaranth

- Increase complexity and costs of weed management in cotton and soybean
- Compromise conservation tillage

  in the short-term
- May precipitate a cascade of resistance in post emergence broadleaf herbicides

Glyphosate Resistant Palmer amaranth

Economic Threat to Soybeans

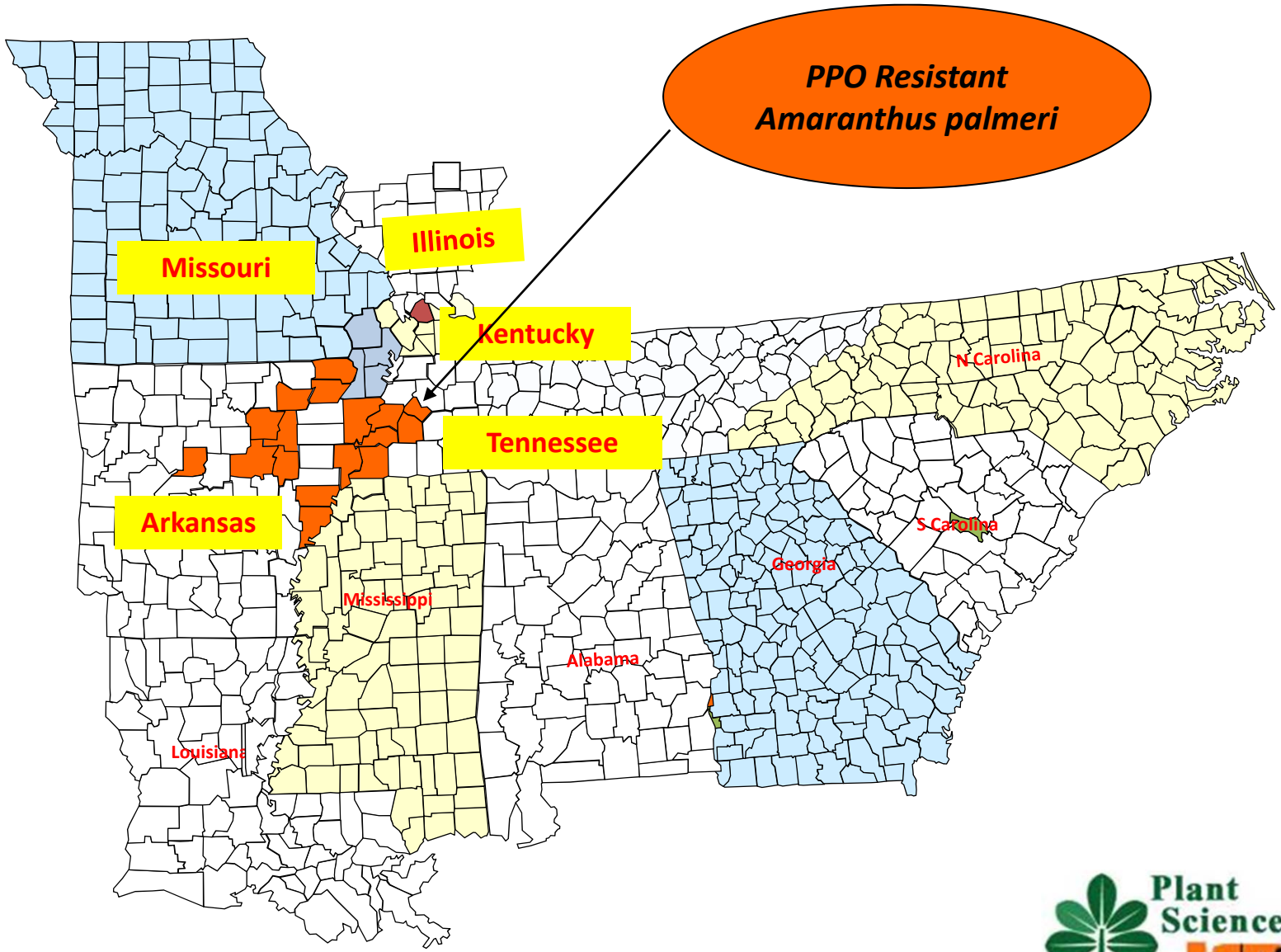
If ALS and glyphosate are compromised, PPO herbicides are the only post emergence option except glufosinate

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

Nichols, R. L. 2010 – "Pigposium",
Forest City, Arkansas

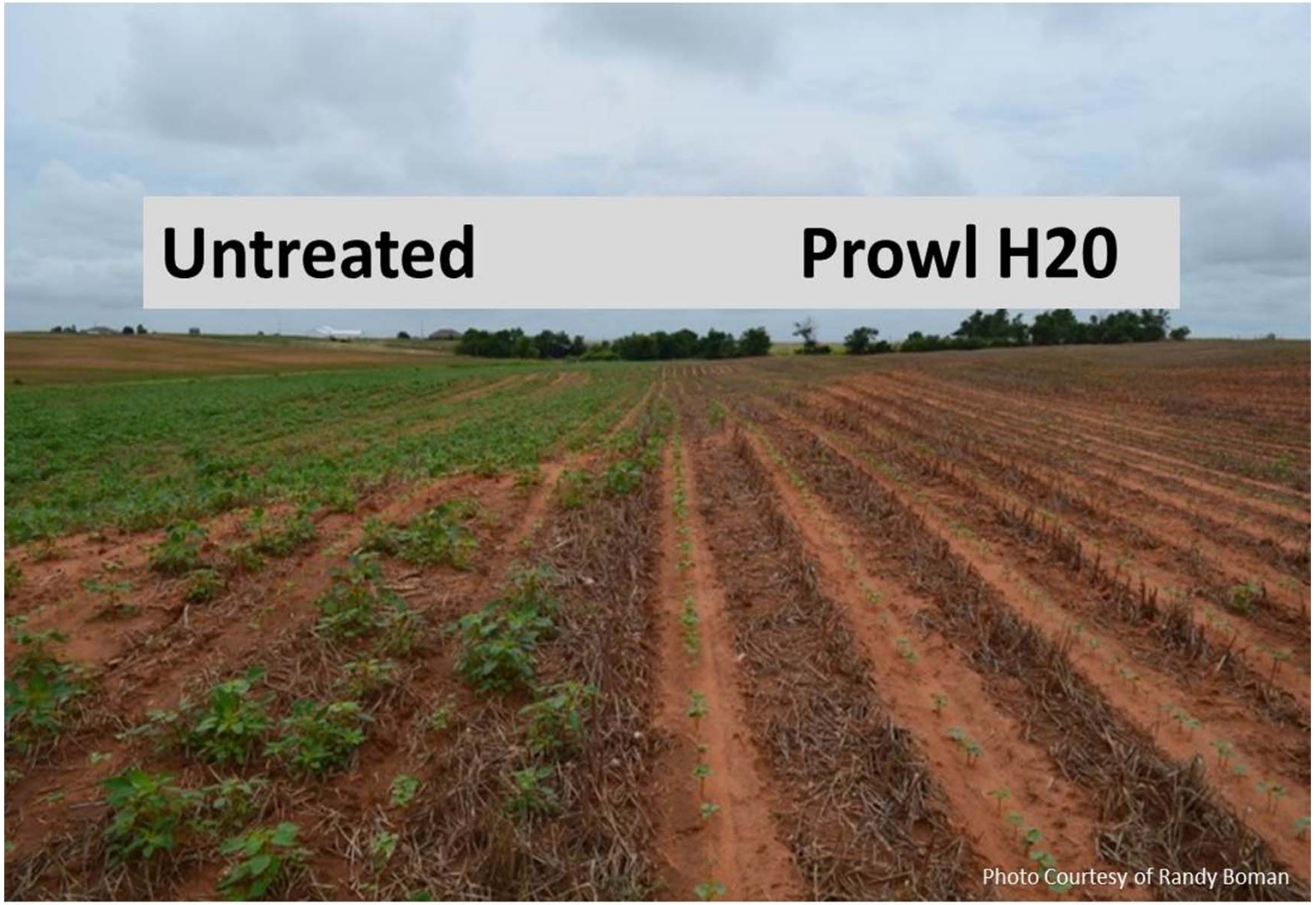
Glyphosate and PPO - Resistant Palmer amaranth



Plant Sciences


Palmer amaranth Resistant to Glyphosate
and PPO Inhibiting Herbicides

Soil-Active Herbicides are a Must



Greater Selection Pressure on Glufosinate

- Glyphosate is still a very useful herbicide, but
- Palmer amaranth is the 'driver' weed in the system.

- When glyphosate, ALS, and PPO herbicides fail, the only post option is glufosinate.

- Traits that will be used:
- Gytol Liberty Link, Wide Strike, and Xtend Flex.

2015 – Demonstration

No-till Drip Field

(Confirmed glyphosate resistant pigweed in 2014)

Total costs to control resistant pigweed in cotton this year

Conservation Tillage

- Most Economical; Saves Money, Soil, and Water
- Herbicides Replace Tillage
- Have Depended on Glyphosate
- Replace with Cover Crops and Alternative Herbicides

Using Heavy Rye Covers For Sustainability

Managing the Weed Seed Bank
- The New Paradigm -

- Not sufficient to control emerged weeds
- Unless the number of emerged weeds is decreasing every year, then it's increasing
- At some point 99% control will fail
- Rogue escapes in the crop
- Control emerged weeds following harvest


Zero
Tolerance
Destroy Escapes
Post Emergence
Herbicides/Scout
Pre-Emergence
Herbicides/Scout
Crop Rotation/Select Traits, Cultivar
& Seeding Rate
Select Tillage System/Start Clean
Scout Fall Escapes/Manage Winter Cover
Seed Bank Management

Community-Based Programs

"Zero"

UofA UNIVERSITY OF ARKANSAS DIVISION OF AGRICULTURE

No Escapes Allowed

No Seed Produced

Soil Weed Seedbank Reduction Program

"Tolerance"


Enlist
Weed Control System
™


BOLLGARD II®
XTENDFLEX™
COTTON


Enlist
Weed Control System
™


BOLLGARD II®
XTENDFLEX™
COTTON

Control with Trait-Based Auxin Herbicide Weed Management Program

Alan York, NCSU


Control with Trait-Based Auxin Herbicide Weed Management Program

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?

Weed Management Theme

Herbicide Stewardship

Protecting
Crops
Environment
Technology