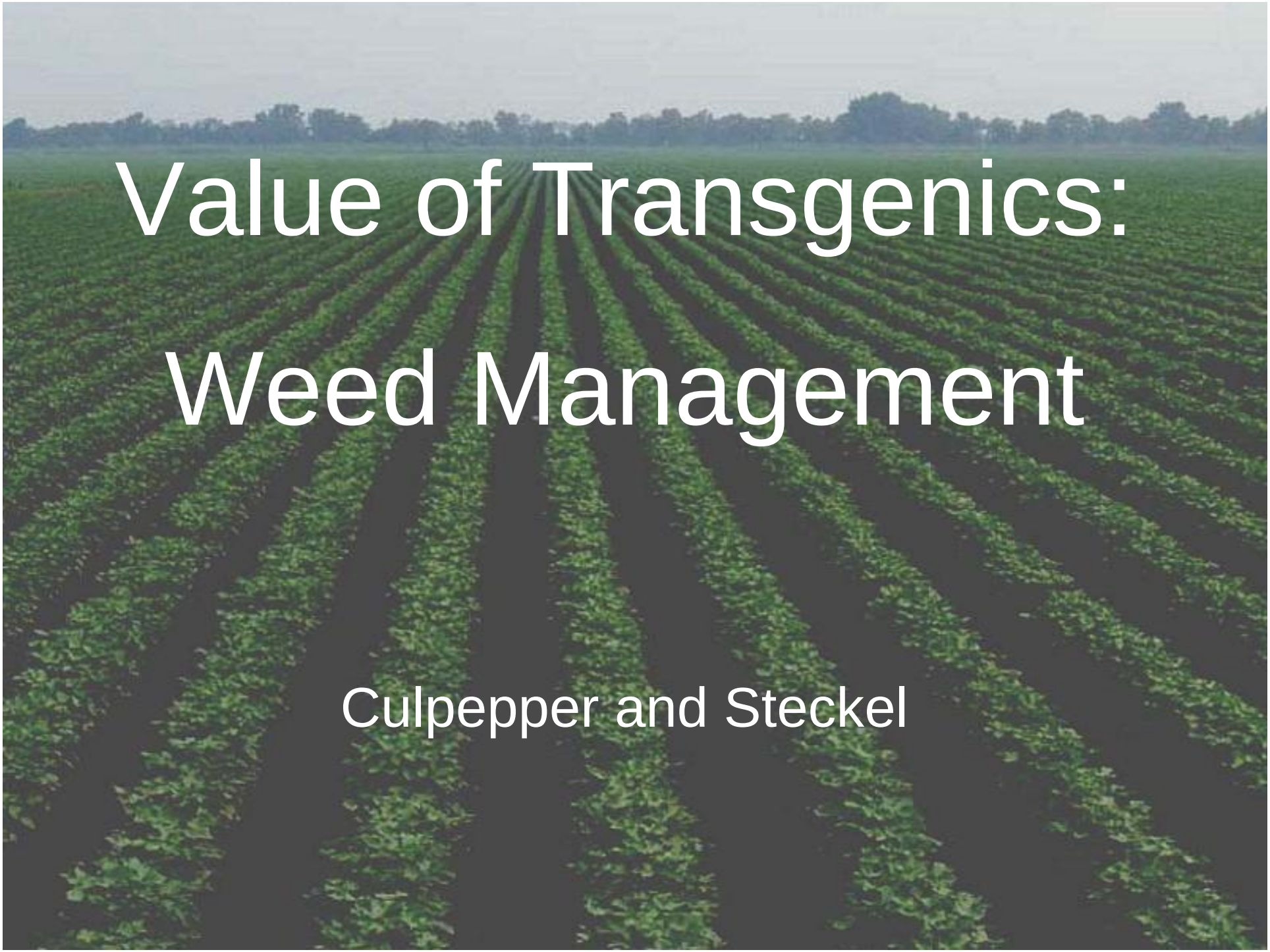


Value of Transgenics: Weed Management

Culpepper and Steckel

Survey Participants

Jamshid Asigh

Tom Barber

Tom Baughman

Jason Bond

Stanley Culpepper

Peter Dotray

Wayne Keeling

Mike Marshall

Donnie Miller

Mike Patterson

Ken Smith

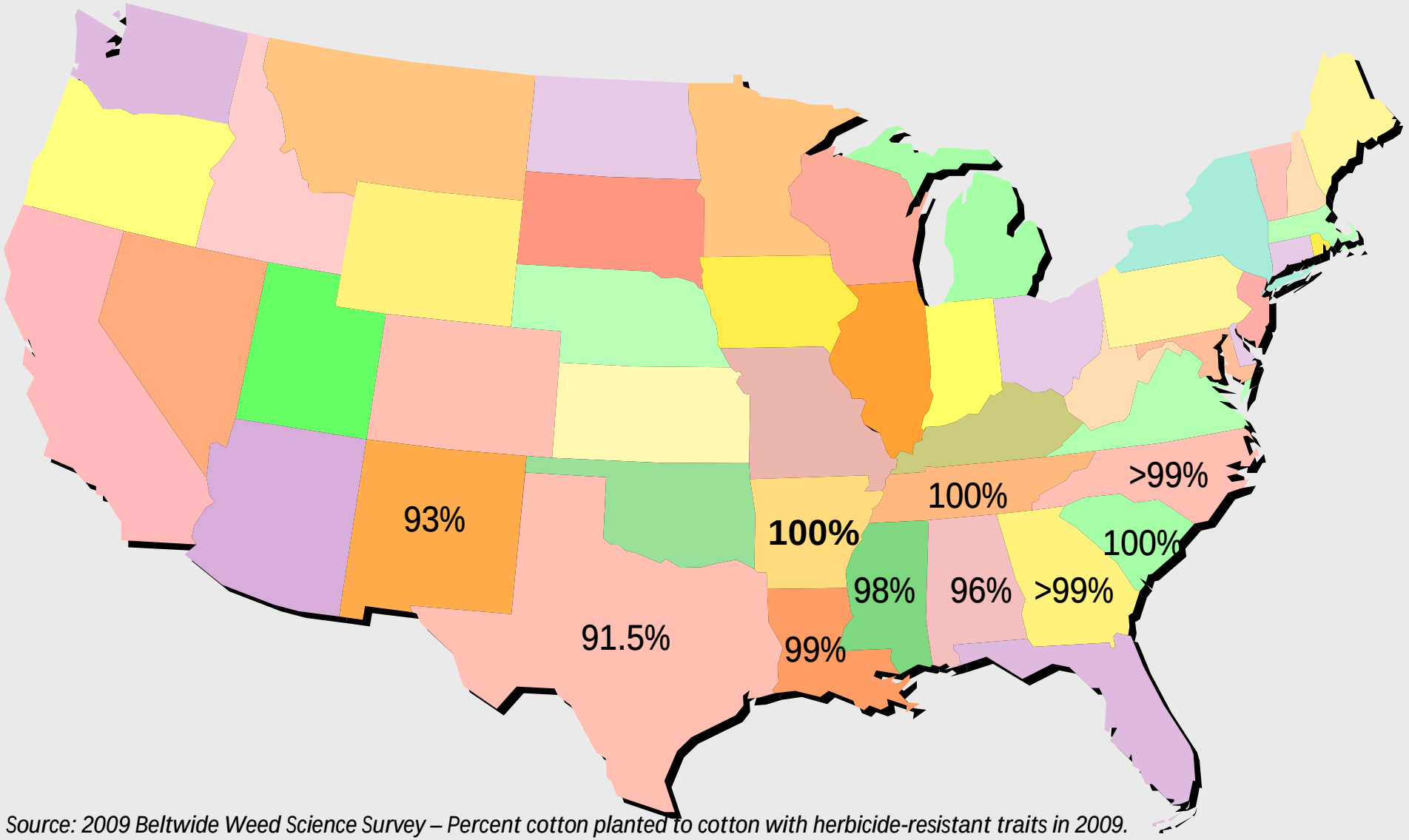
Larry Steckel

Daniel Stephenson

Alan York

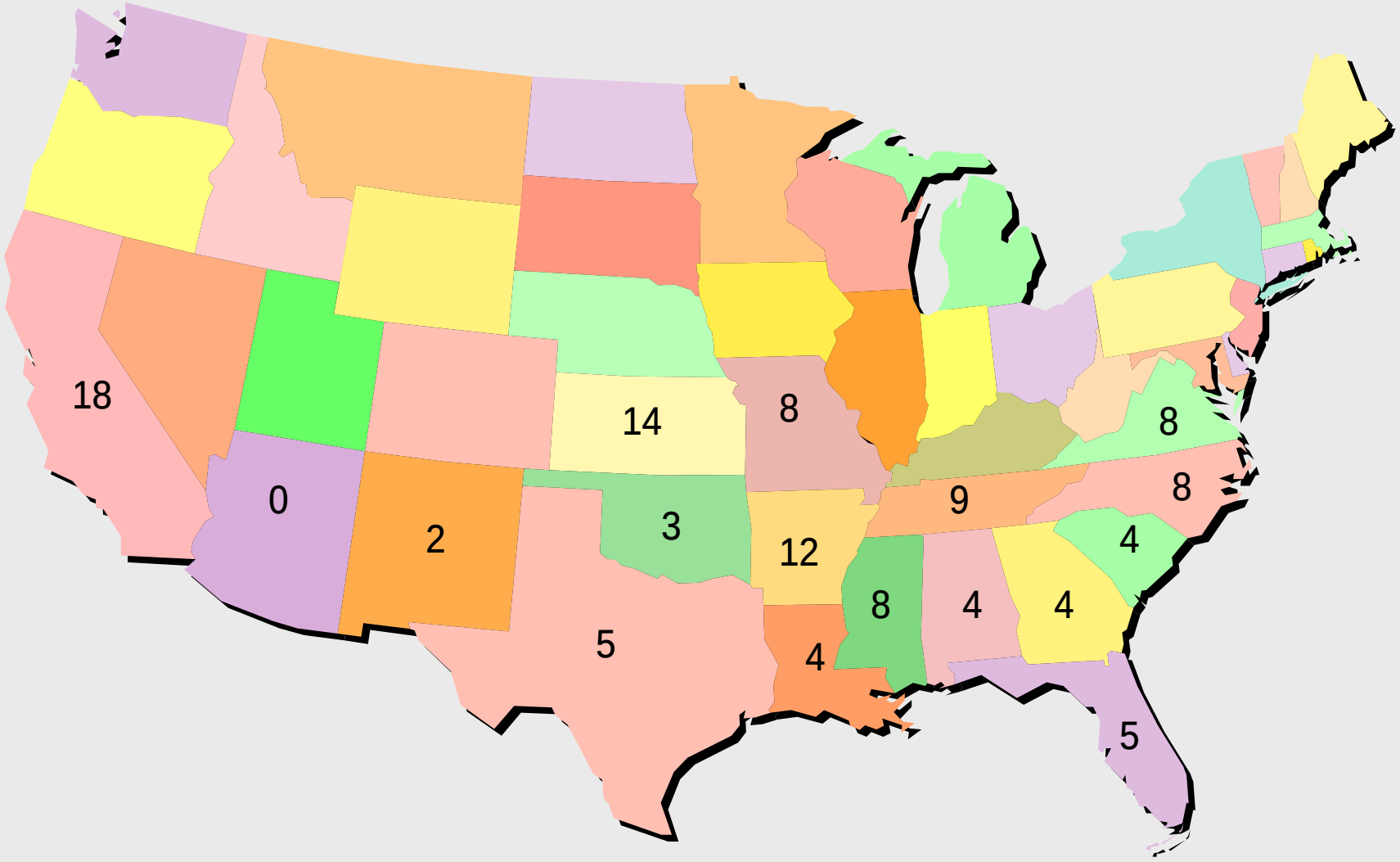
Individuals represent 96% of the 2009 US cotton crop!

Adoption of Herbicide-Resistant Cotton



Source: 2009 Beltwide Weed Science Survey – Percent cotton planted to cotton with herbicide-resistant traits in 2009.
USDA AMS 2009 crop estimates 94.75% transgenic.

Confirmed Number of Herbicide-Resistant Weed Species in the Cotton Belt



Source: International Survey of Herbicide Resistant Weeds (12/28/09)

Herbicide-Resistant Weeds Challenging Cotton Growers

Palmer amaranth

Common waterhemp

Horseweed

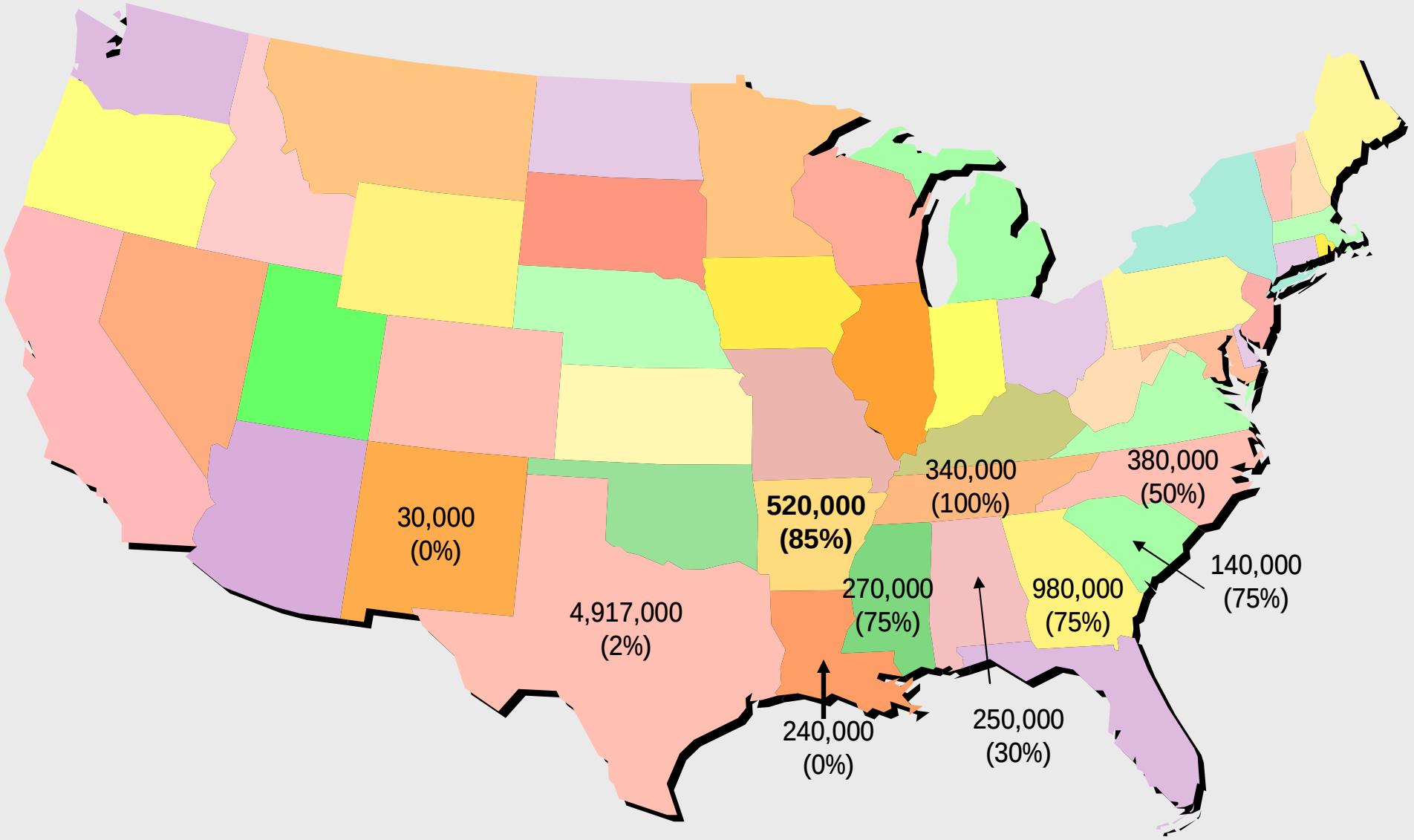
Johnsongrass

Ryegrass

Ragweed – common and giant

Resistance to glyphosate in all of the listed weeds is the primary issue as well as ALS resistance in several of the species.

2009 Cotton Acreage and Percent Acreage Infested with Herbicide-Resistant Weeds



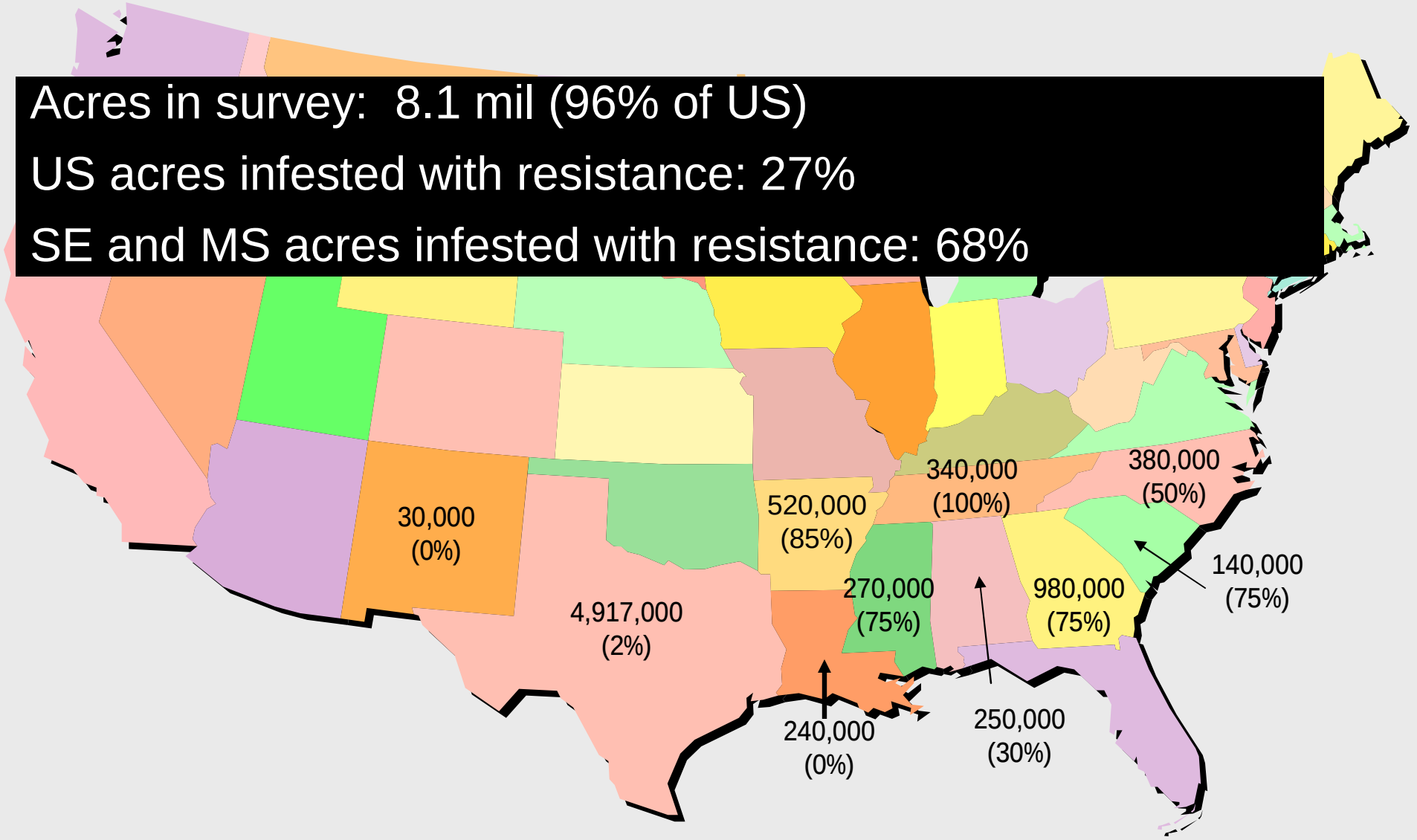
Source: National Cotton Council and Beltwide Weed Science Survey

2009 Cotton Acreage and Percent Acreage Infested with Herbicide-Resistant Weeds

Acres in survey: 8.1 mil (96% of US)

US acres infested with resistance: 27%

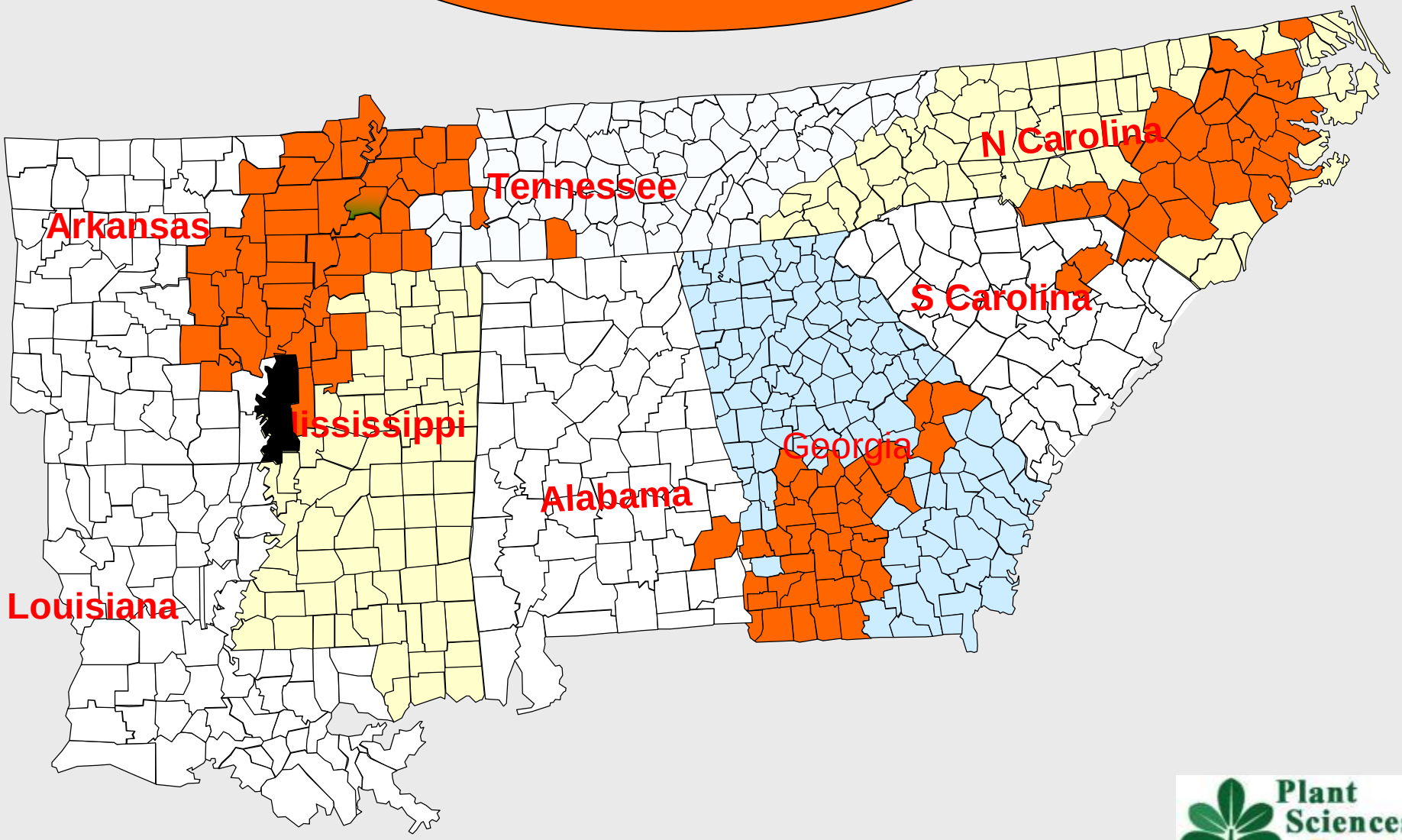
SE and MS acres infested with resistance: 68%



Source: National Cotton Council and beltwide weed survey (12/28/09)

All Weeds Are Not Created Equal

Amaranthus palmeri 2009

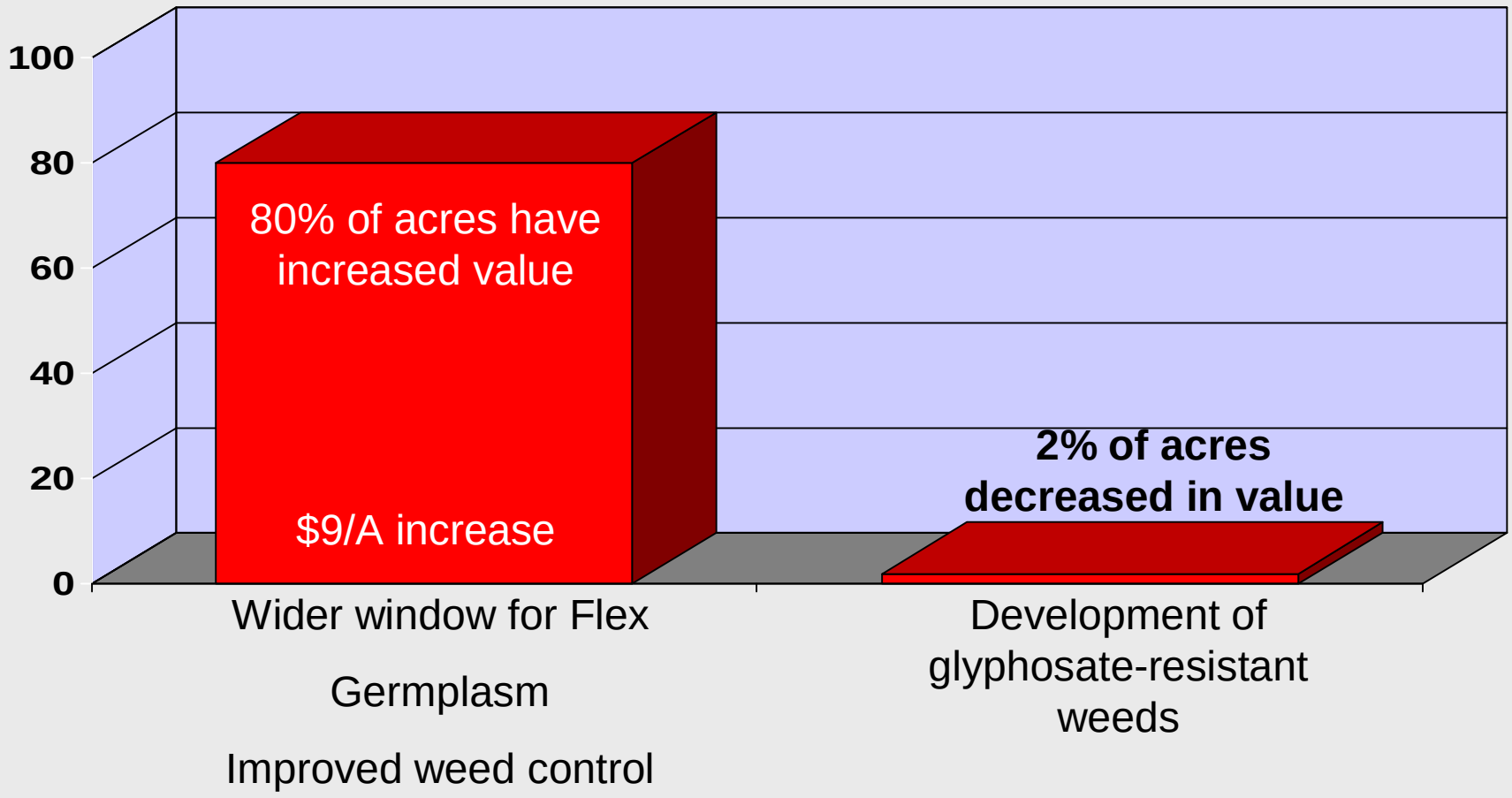


Plant Sciences

Palmer amaranth Infestation Levels

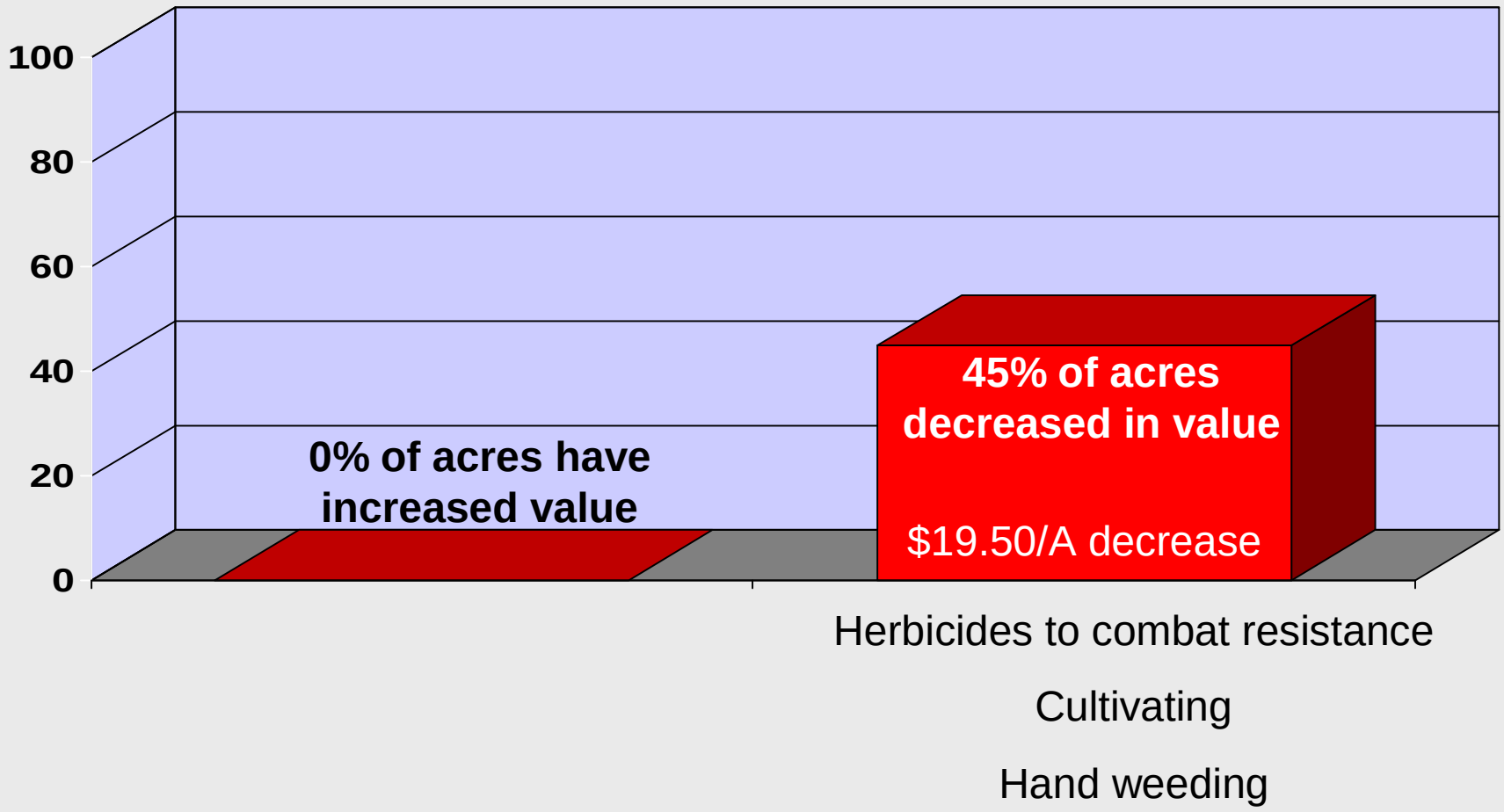
Little to No Infestations	Significant
Alabama	Arkansas
Louisiana	Georgia
Mississippi	North Carolina
New Mexico	South Carolina
Texas	Tennessee
{5,707,000 acres}	{2,360,000}

Has The Value of Glyphosate-Resistant Technology Changed for Areas With Minimal Impact by GR Palmer?



**Results are weighted on cotton acreage in states participating in the survey.*

Has The Value of Glyphosate-Resistant Technology Changed for Areas Impacted by GR Palmer?



**Results are weighted on cotton acreage in states participating in the survey.*

Value of Transgenics Are Changing Where GR Palmer is Present.

Glyphosate 3 times

2006

Glyphosate 3 times

2009

University of Georgia Ponder Farm

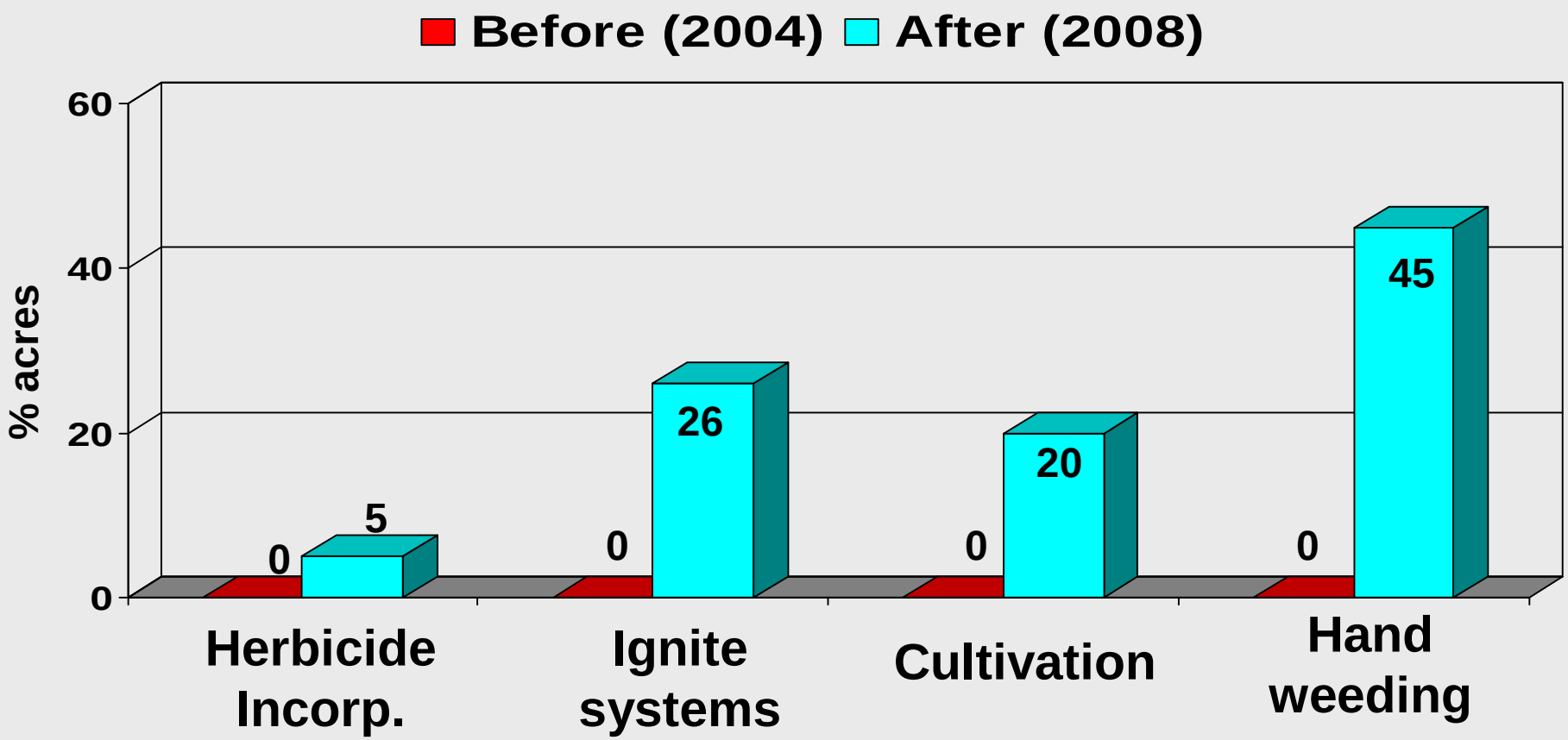
Managing Severe GR Palmer Amaranth Populations in Dryland Cotton Production.

Staple + Reflex + Direx PRE

Roundup WMax + Parrlay POST

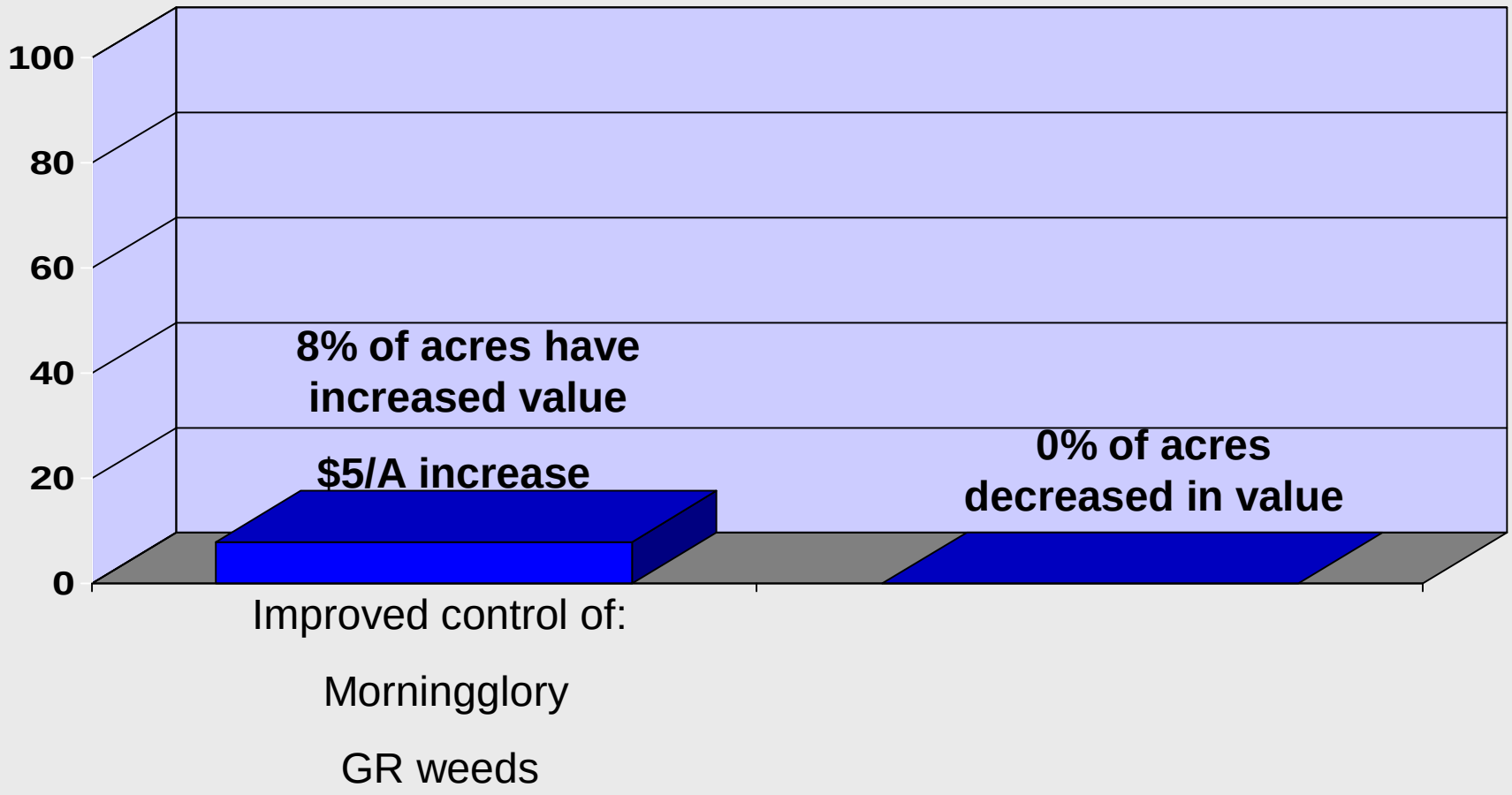
Direx + MSMA Layby

Impact of GR Palmer amaranth in Georgia counties with severe infestations.*



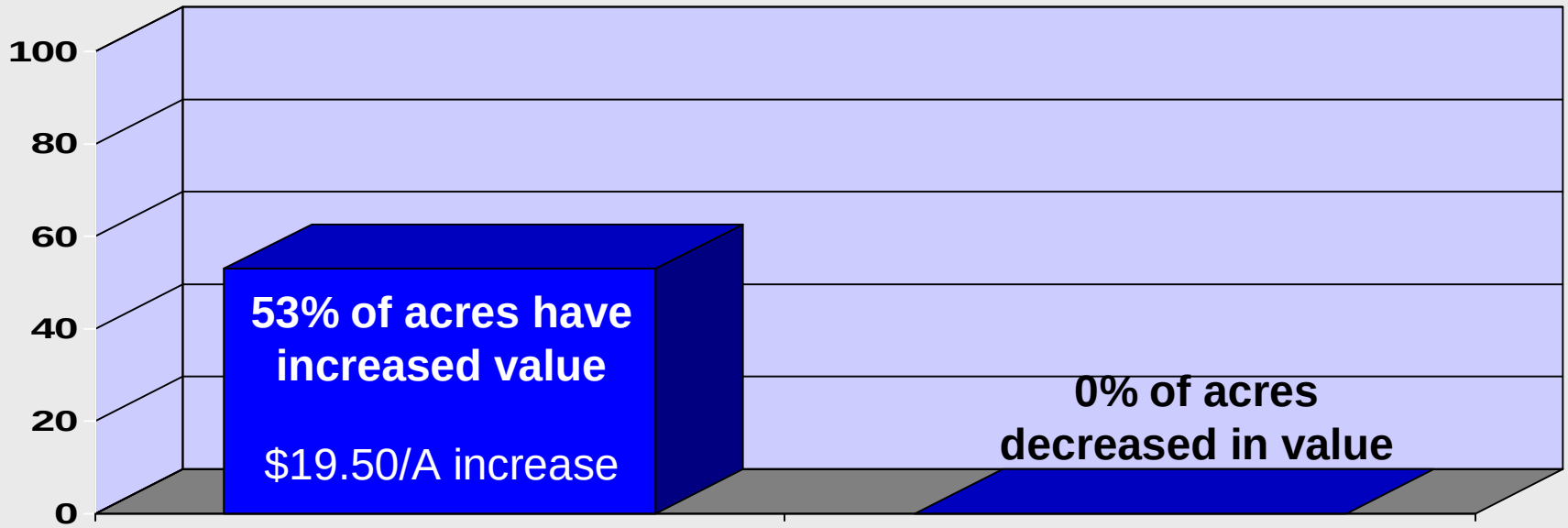
*Average of Macon, Taylor, Sumpter, Schley, and Dooly counties

Has The Value of Ignite-Based Programs Changed for Areas With Minimal Impact by GR Palmer?



**Results are weighted on cotton acreage in states participating in the survey.*

Has The Value of the Ignite-Based Programs Changed for Areas Impacted by GR Palmer?



Best option for GR Palmer POST

Only option for ALS+GR Palmer POST

POST option for GR horseweed and ragweed

Less cultivating and handweeding

**Results are weighted on cotton acreage in states participating in the survey.*


Weathermax 88 oz
Staple LX 10 oz

GR Palmer Control in Dryland Conservation Tillage

Prowl + Reflex PRE

Roundup + Dual POST

Diuron + MSMA PD

Prowl + Reflex PRE

Ignite + Dual POST

Diuron + MSMA PD

Giant Ragweed Control with Ignite or Roundup. TN, 2009.

PowerMax 22 oz 2 leaf

PowerMax 22 oz 5 leaf

Ignite 29 oz 2 leaf

Ignite 29 oz 5 leaf

Is There More Value with Flex Cotton Compared to Traditional RR cotton?

Focus is just on weed control and not germplasm!!

No herbicide resistance: 10 of 10 states say there is increased value **($8 to 20/A):**

- Topical applications easier, quicker, less expensive
- One sprayer to maintain
- Improved weed control
- Overtop options without crop damage

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- Topical applications easier, quicker, less expensive
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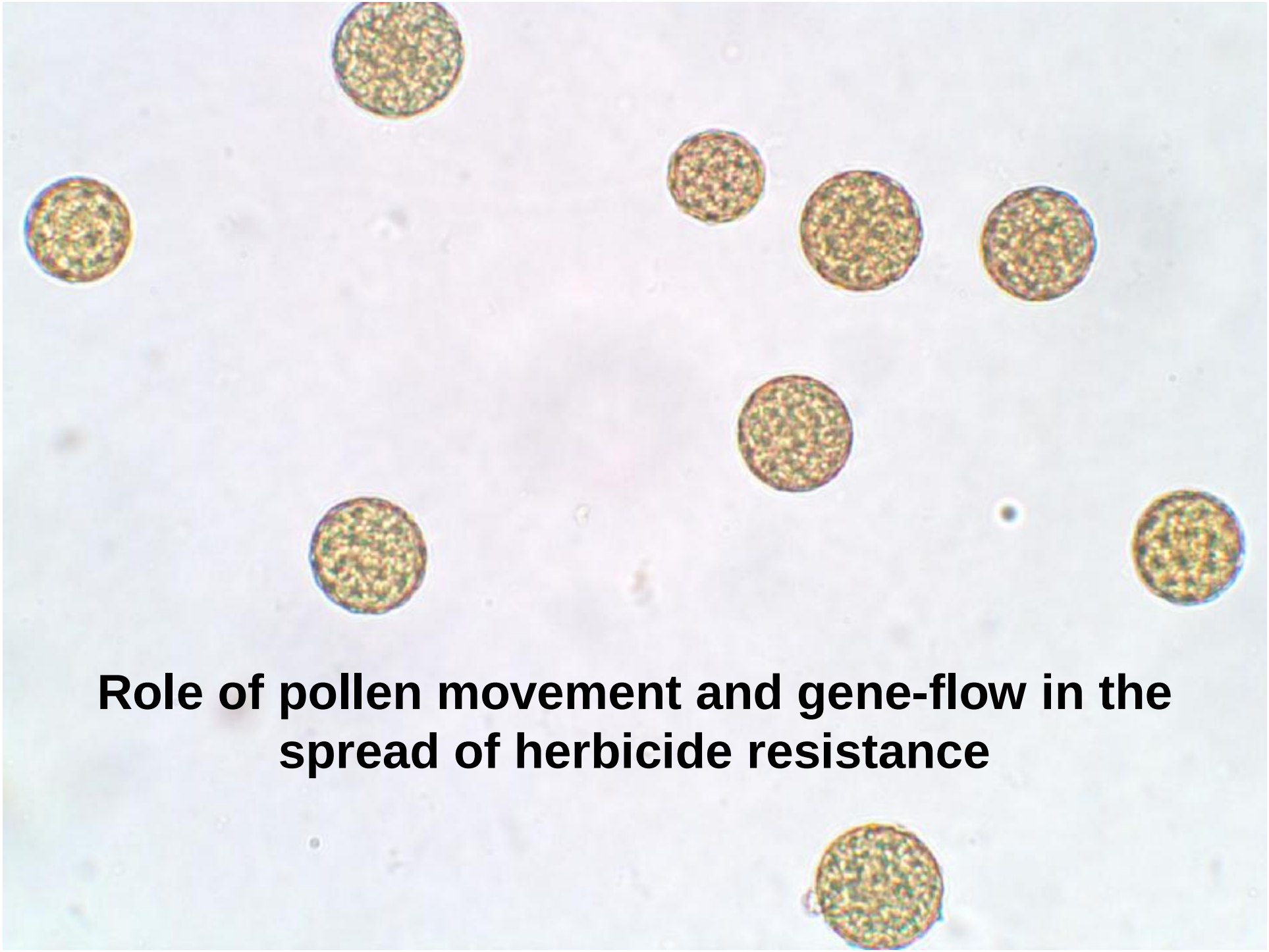
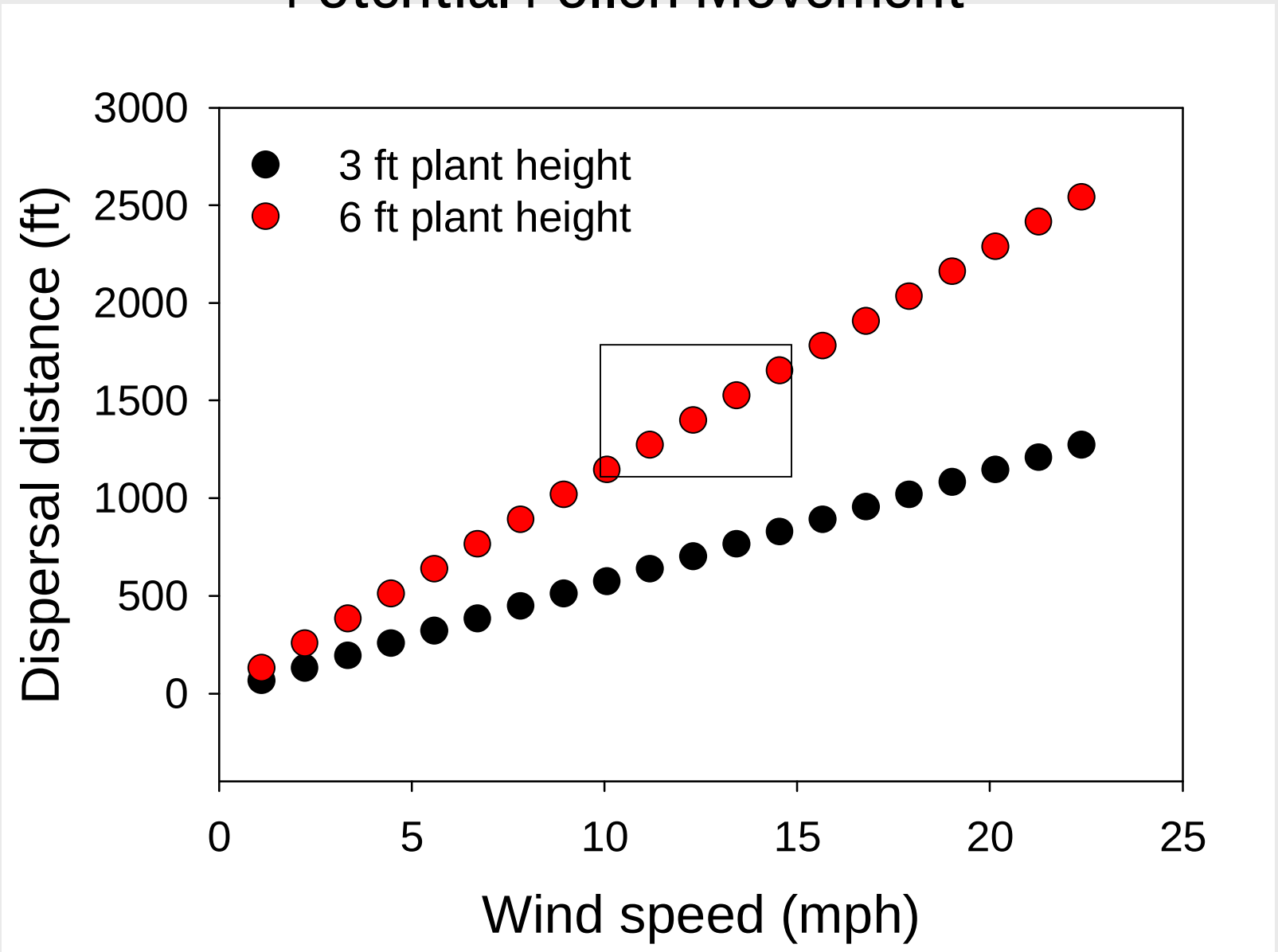
- Improved weed control
- Overtop options without crop damage

BUT this will promote more use and dependence on glyphosate and ALS herbicide chemistry which will exasperate the impact of herbicide resistant weeds.



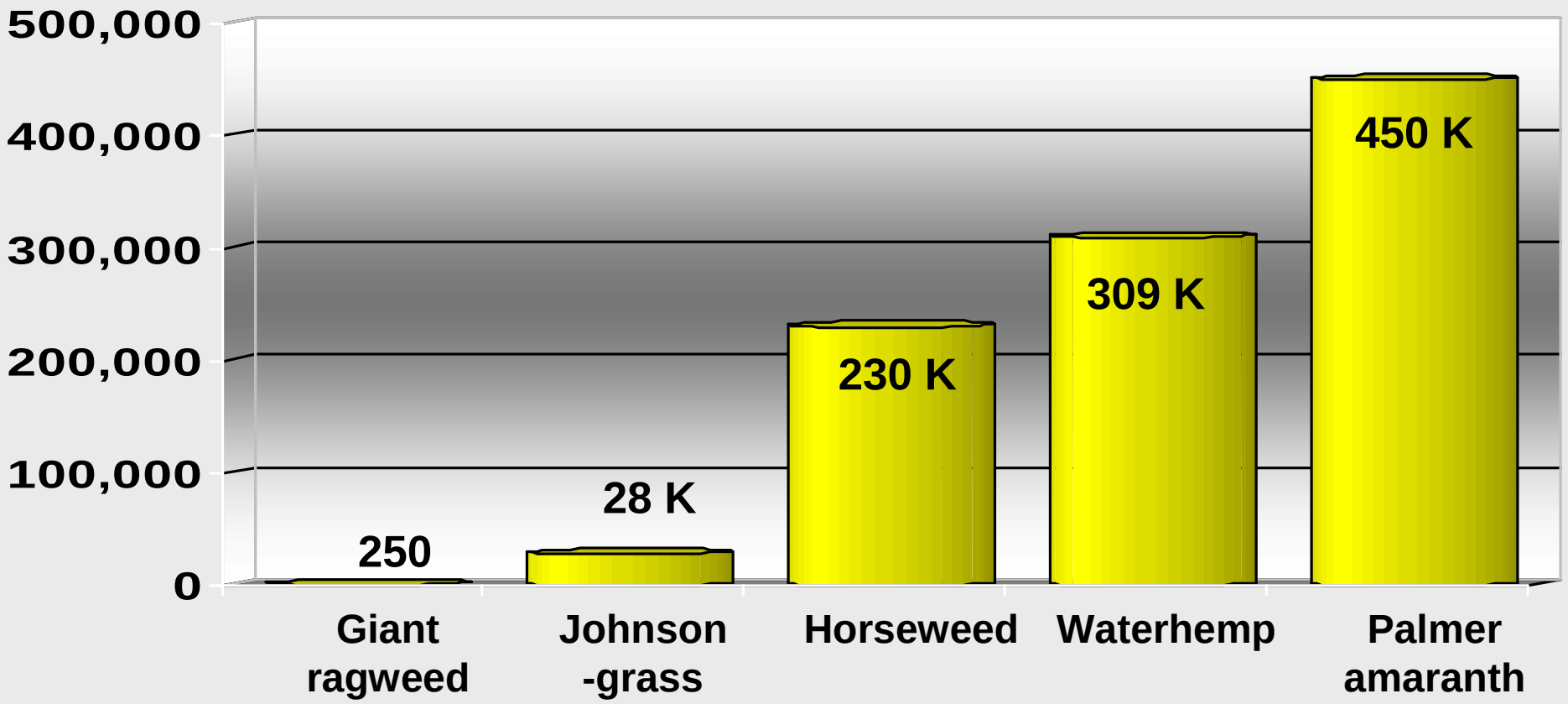
Role of pollen movement and gene-flow in the spread of herbicide resistance

Potential Pollen Movement



Sosnoskie, 2009

Number of Seed Produced per Plant. Glyphosate-Resistant Weeds in US.



Ragweed = Harrison et al. 2001; johnsongrass = Warwick and Black (1983); horseweed = Regehr and Bazzaz (1979); waterhemp = Nordby and Hartzler (2004); Palmer amaranth = Macrae et al (2009).

Is There More Value with Flex Cotton Compared to Traditional RR cotton?

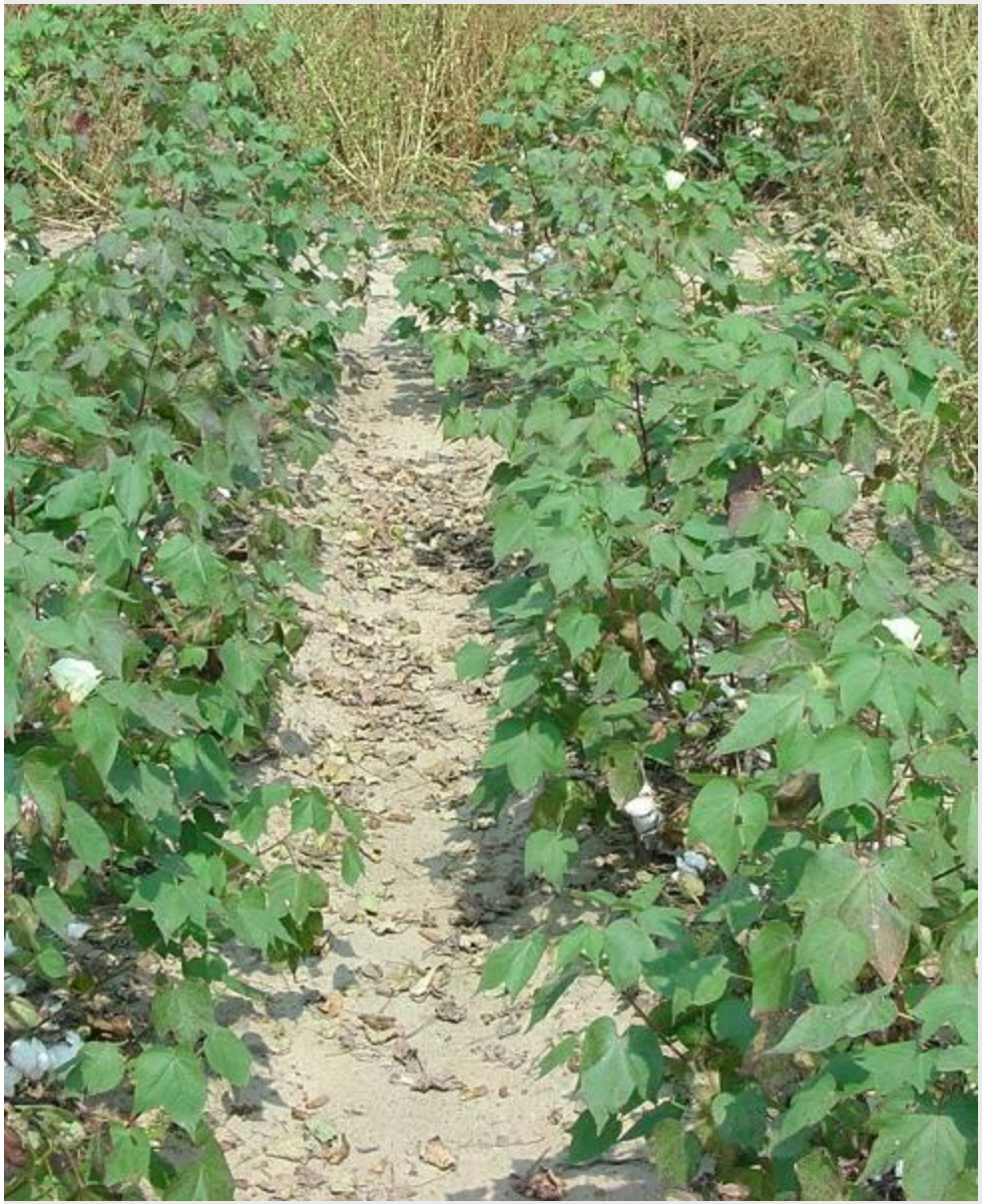
Focus is just on weed control and not germplasm!!

Herbicide resistance present: 8 of 9 say no

Paying more for technology fee with no benefits
Herbicide programs extremely costly
Residual herbicides at planting, during the season, and at layby

Wider window for early POST application?????

Prowl + Reflex PRE, WeatherMax + Dual POST, Direx + MSMA Layby



POST 18 DAP

POST 24 DAP

Will Growers Continue to Rely on the Glyphosate-Resistant Cotton Technology?

Areas without resistance:

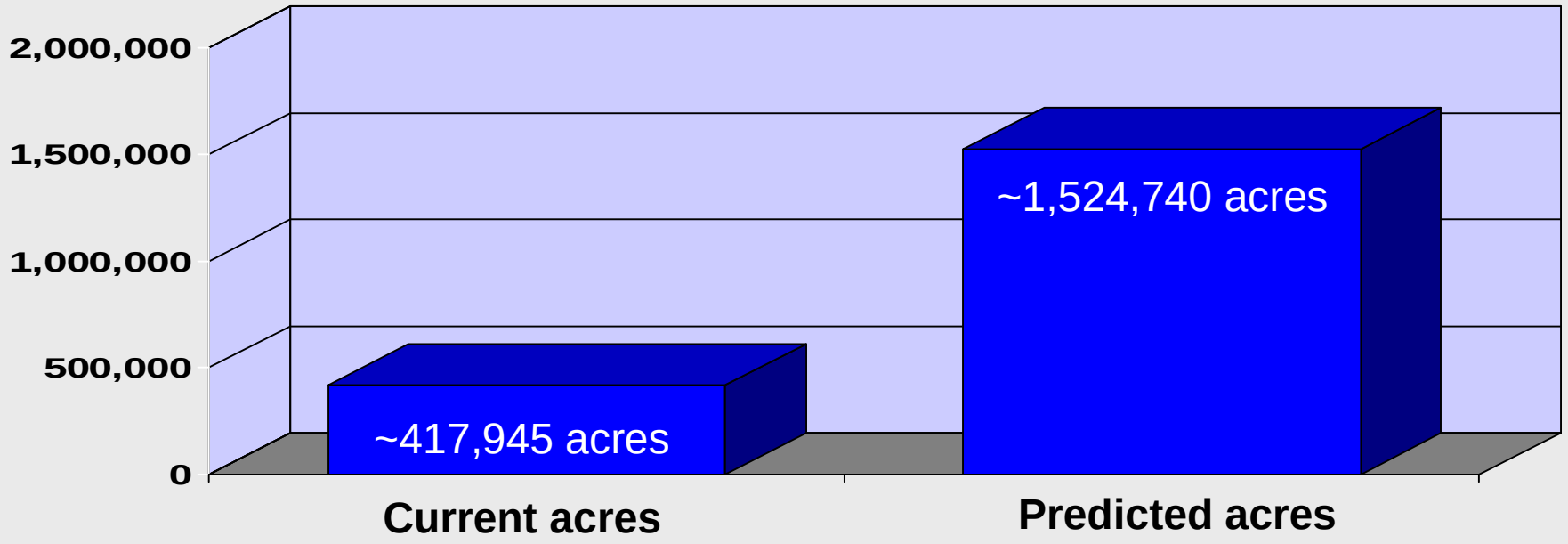
Yes, as long as the technology performs
Yes, but very interested in alternatives
Yes, but will use other modes of action to combat resistance development

Areas WITH resistance:

No better options. As options become available, they will be evaluated.
Yes, but interest building in conventional and Liberty Link systems.
Moving toward Ignite-based systems.
If yields were equal, growers would adopt Ignite based programs rapidly!!

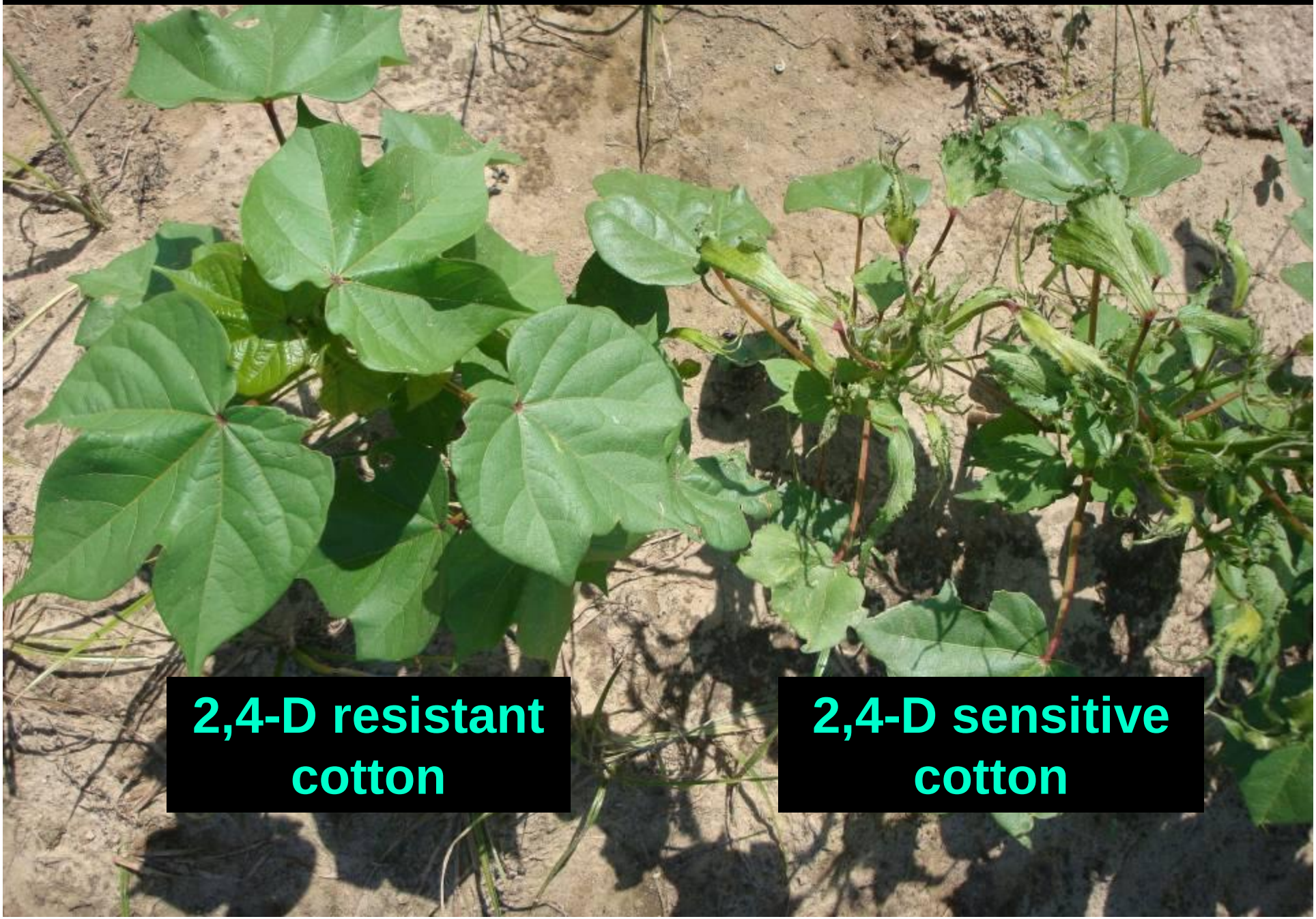
YIELD IS STILL THE KEY DECIDING FACTOR

With Yield and Quality Equal, How Many Acres Would Be Planted to Conventional Cultivars?



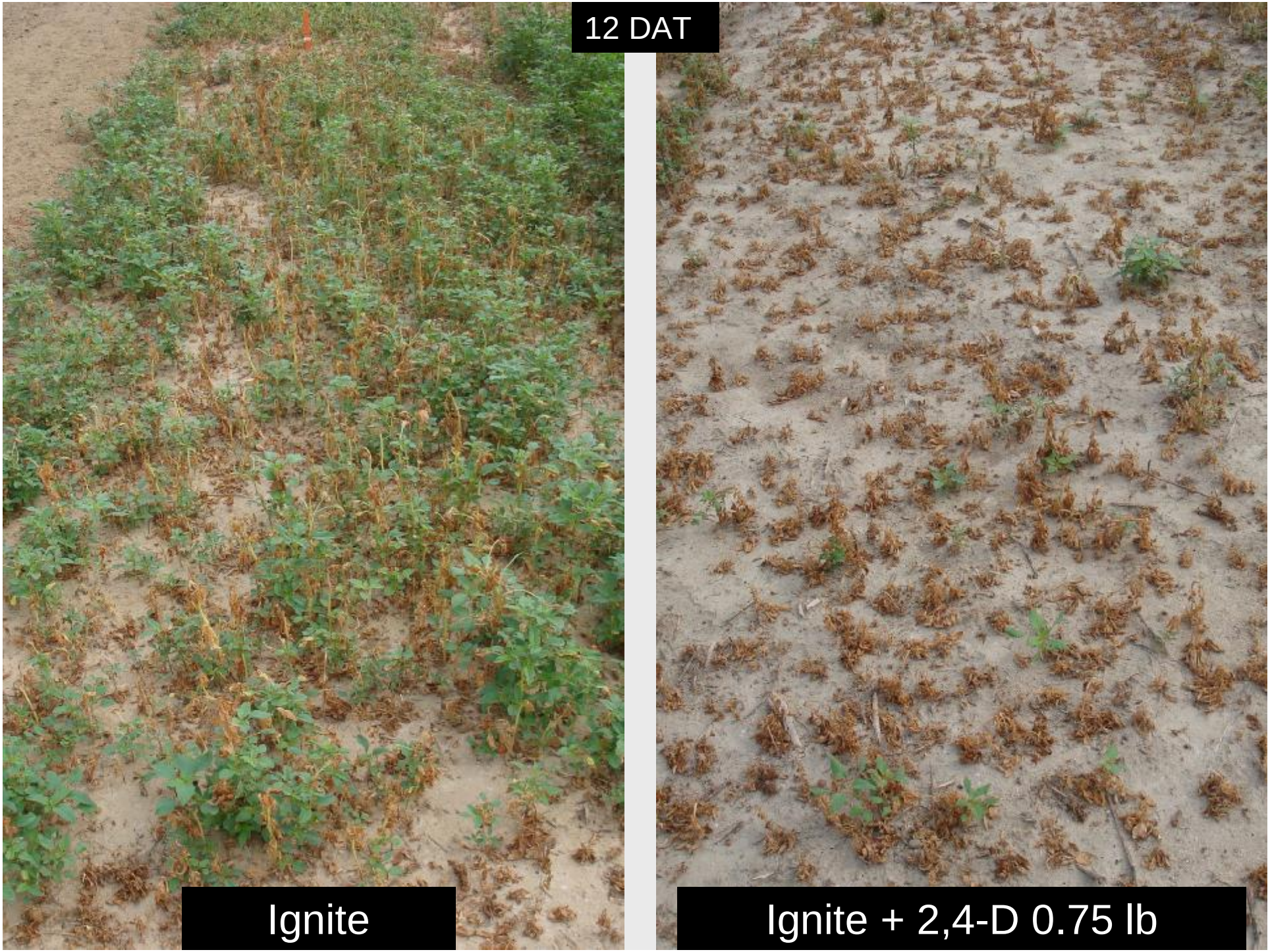
What would happen the second year after planting all the conventional acres???

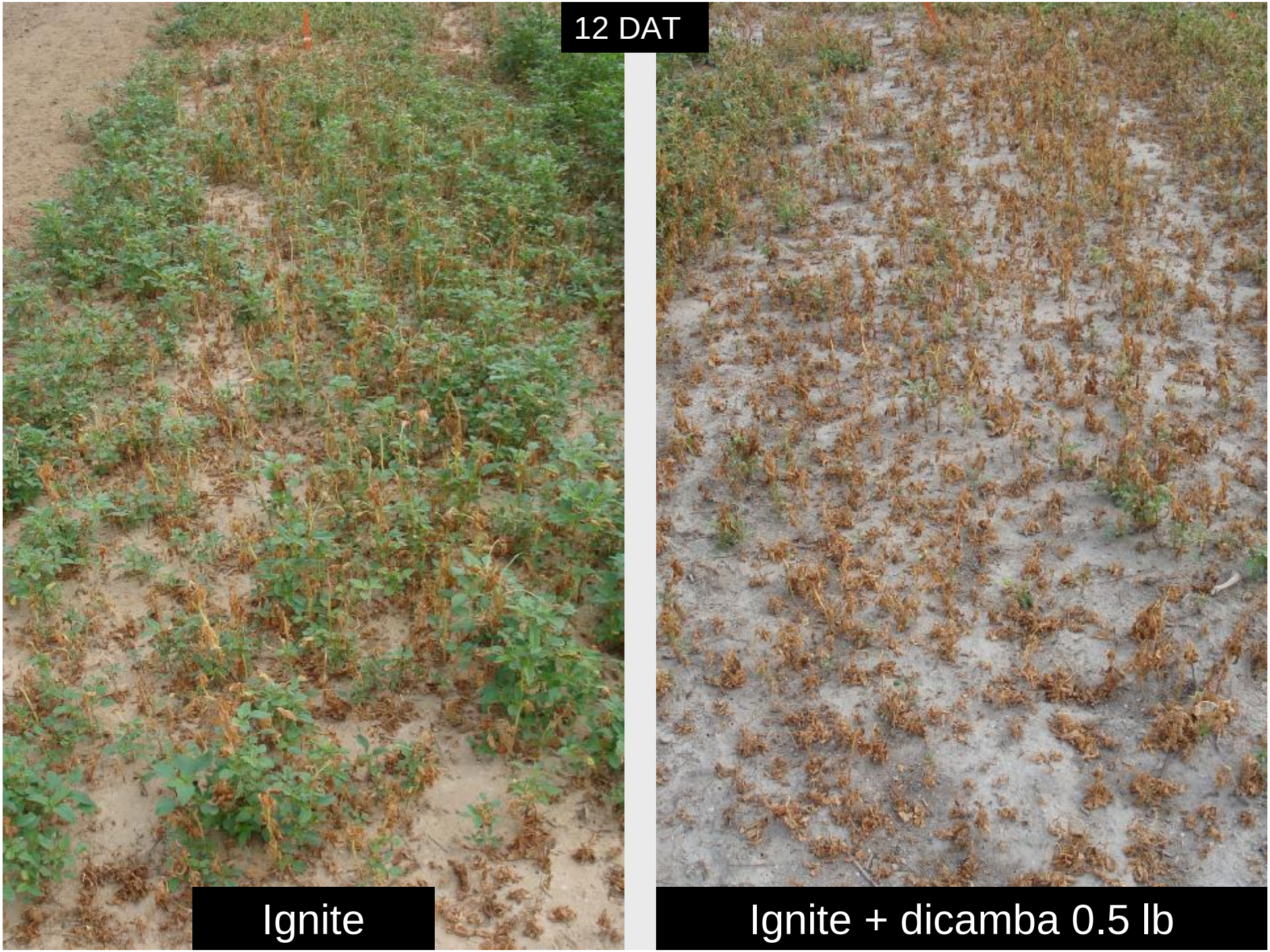
Future Technology: 2,4-D or Dicamba Resistant Cotton



Will There Be Value in 2,4-D or Dicamba Resistant Traits for Cotton Growers?

1. Tool for managing GR ragweed, horseweed, Palmer, morningglory, perennial weeds, winter annual weeds
2. No preplant interval for burndown
3. A new mode of action for in-crop control
4. Applications overtop of cotton
5. Price of herbicides are currently economical
6. Option to rotate with Roundup for resistance mgmt


12 DAT
Ignite
Ignite + 2,4-D 0.75 lb


12 DAT
Ignite
Ignite + dicamba 0.5 lb

Are You Comfortable Making 2,4-D or Dicamba In-Crop Weed Management Recommendations TODAY?

1. Fair
2. No
3. No
4. No
5. Comfortable with dicamba, not with 2,4-D
6. No
7. Absolutely not
8. No
9. Yes, but only in some locations
10. No way, not today

Why Are Weed Scientists So Uncomfortable?

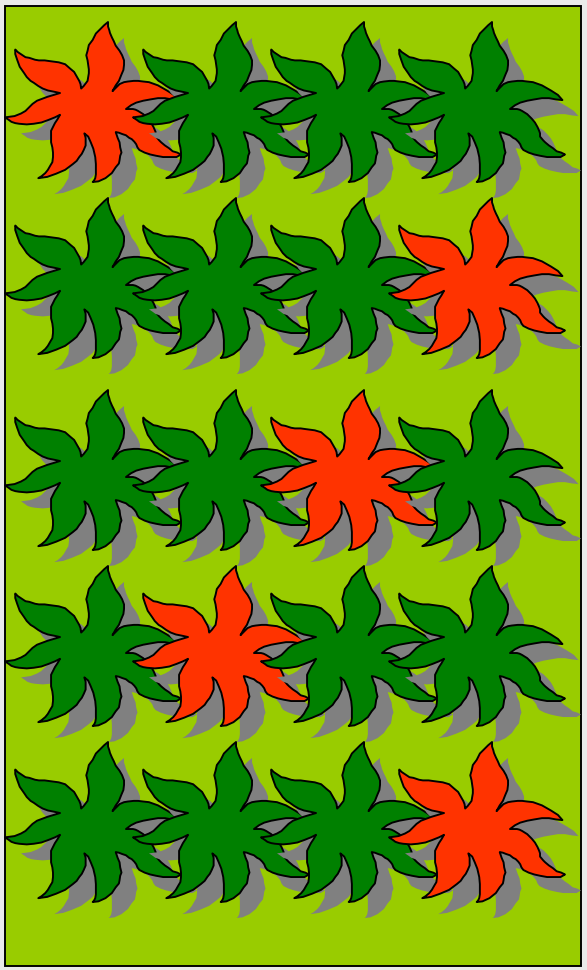
1. Physical drift, drift, drift (10 of 10 are concerned)

Why Are Weed Scientists So Uncomfortable?

1. Physical drift, drift, drift (10 of 10 are concerned)
2. Tank contamination
3. Volatility
4. Don’t provide complete pigweed control
5. Concern over cost of technology
6. Potential development of resistance
7. Accidental application to non-resistant cultivars
8. Attempting to control weeds too large

Palmer amaranth is a game changer!

Palmer amaranth seedbank – it is the key!



YEAR 1: 5 Palmer females escape

Produce 2,000,000 seeds in cotton (50% germ)

YEAR 2:

Weed program = 99.9% control

1,000 plants per acre left at harvest

400 female plants/A

160,000,000 seeds produced in cotton (50% germ)

YEAR 3:

Weed program 99.9% control

80,000 plants per acre left at harvest

32,000 female plants/A = 1.28×10^{10} seed/A

Value of Current Transgenics: Weeds

- **GR Palmer amaranth not present or very light:**
  - Value of RR technology increased avg. of $9/A on over 4.6 million acres
  - Value of Ignite-based programs increased avg. of $5 on 0.46 million acres.

- **GR Palmer amaranth present:**
  - Value of RR technology decreased avg. of $19.50/A on over 1.1 million acres
  - Value of Ignite-based programs increased avg. of $19.50/A on 1.2 million acres

Controlling GR Palmer amaranth by Developing Integrated Programs