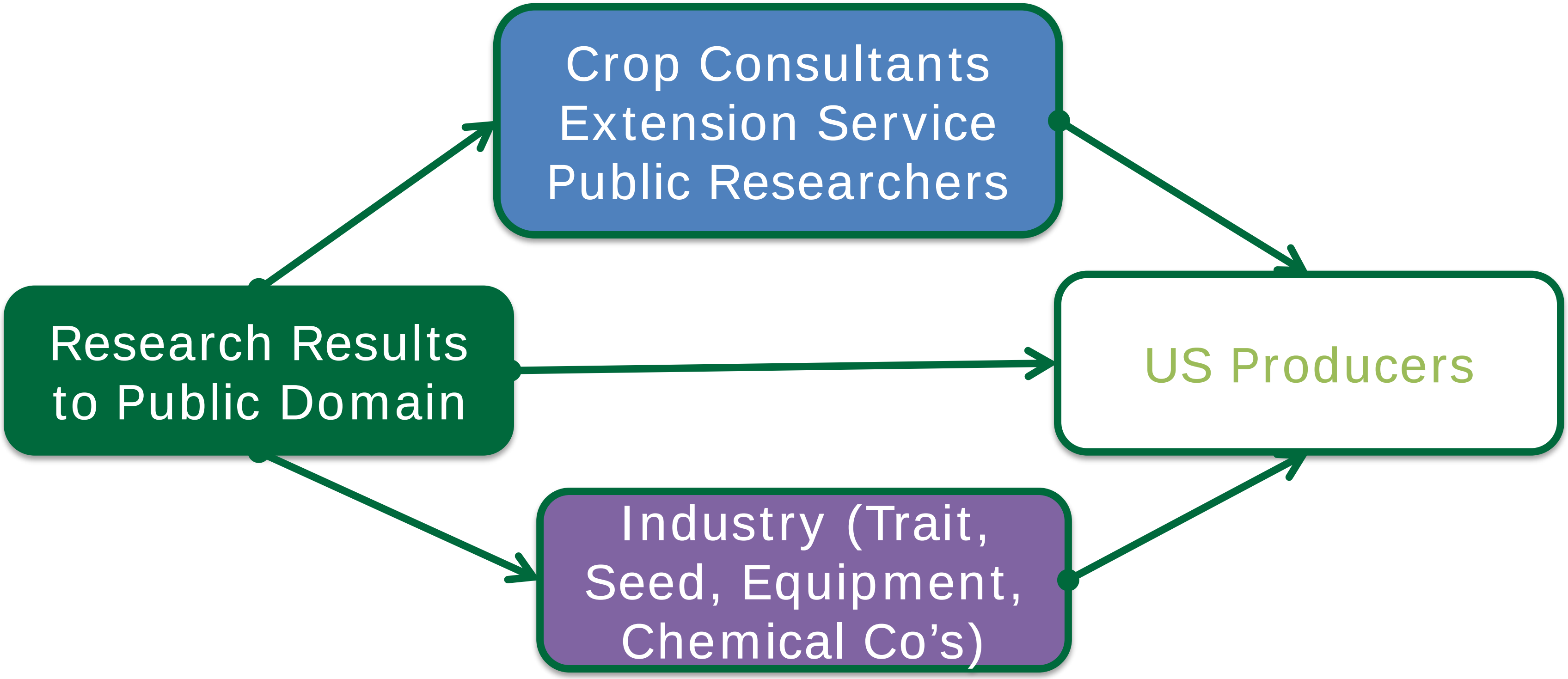
AGRICULTURAL RESEARCH

Cotton Incorporated's ICAC Tour May 11, 2010

Cotton Incorporated Ag. Research

- Mission: increase profitability of U.S. cotton and the consumption of cotton
- Ag. Research is 8 scientists supporting 350 Academic cooperators on dirt-to-gin innovations

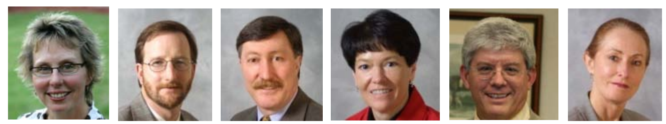


403 Cotton Production Research Projects

COTTONSEED VALUE

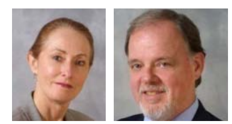
VARIETY IMPROVEMENT

SUSTAINABILITY

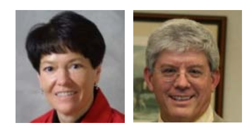


PRODUCTION EFFICIENCY

- Resistance Management

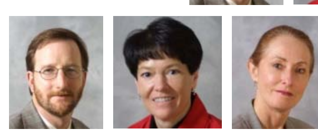


- Economics and Farm Profitability



- Innovative Machinery

- Precision Cotton



- Pest Management

Agriculture Research Network

ASU

USDA

LSU

CLEMSON UNIVERSITY

UNT UNIVERSITY OF NORTH TEXAS

1785

National Cotton Council OF AMERICA

NM STATE

OKLAHOMA STATE UNIVERSITY

TEXAS A&M UNIVERSITY

UNIVERSITY of ARKANSAS

FLORIDA STATE UNIVERSITY 1851

Mississippi State UNIVERSITY

Georgia Tech

TEXAS TECH UNIVERSITY SYSTEM

UC University of California

Cotton Council International

COTTON USA

1856 2006 AUBURN UNIVERSITY

THE UNIVERSITY OF TEXAS AT AUSTIN Research

NC STATE UNIVERSITY

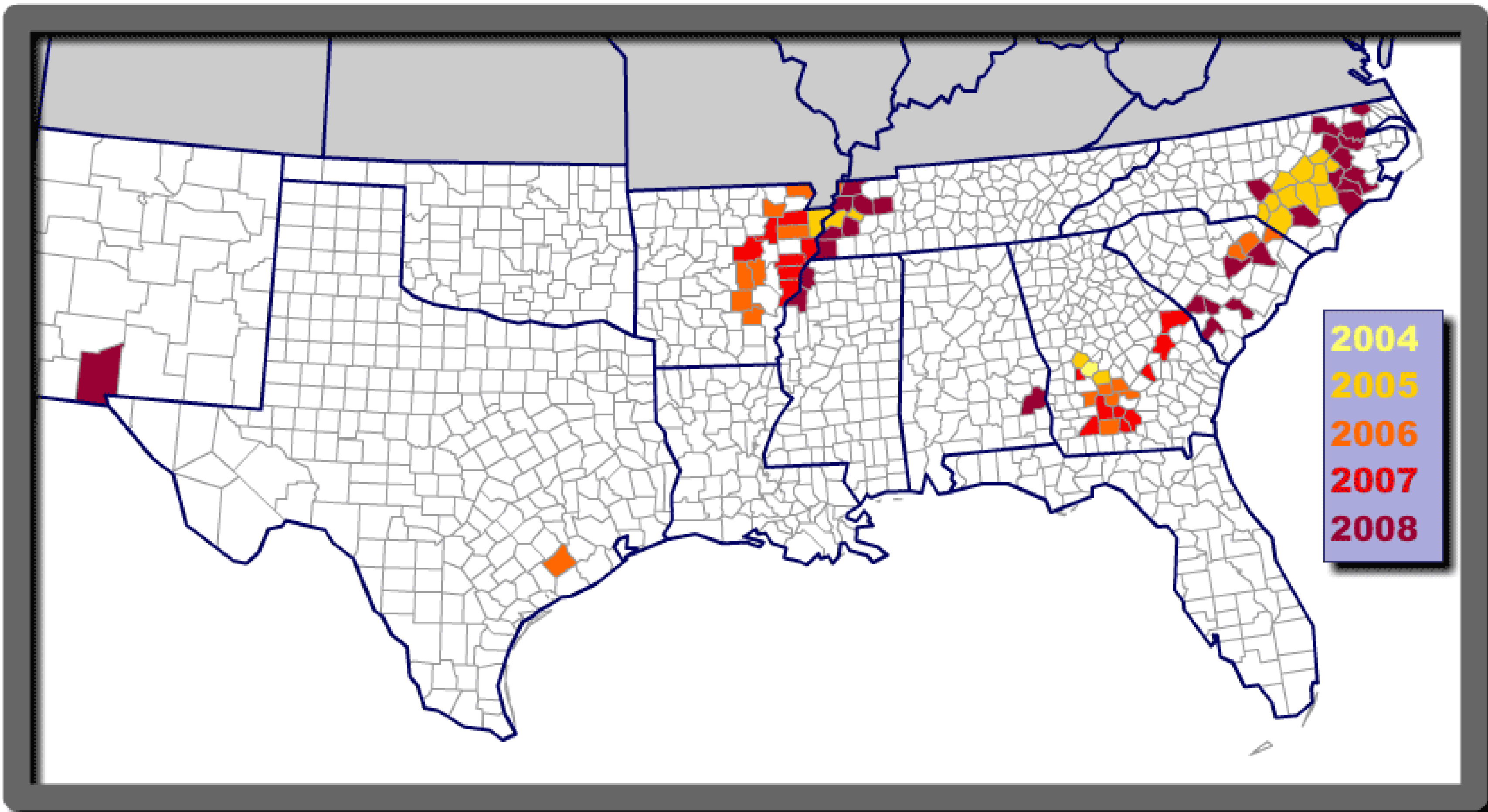
VirginiaTech Invent the Future

The U.S. is NOT a “Garden of Eden”

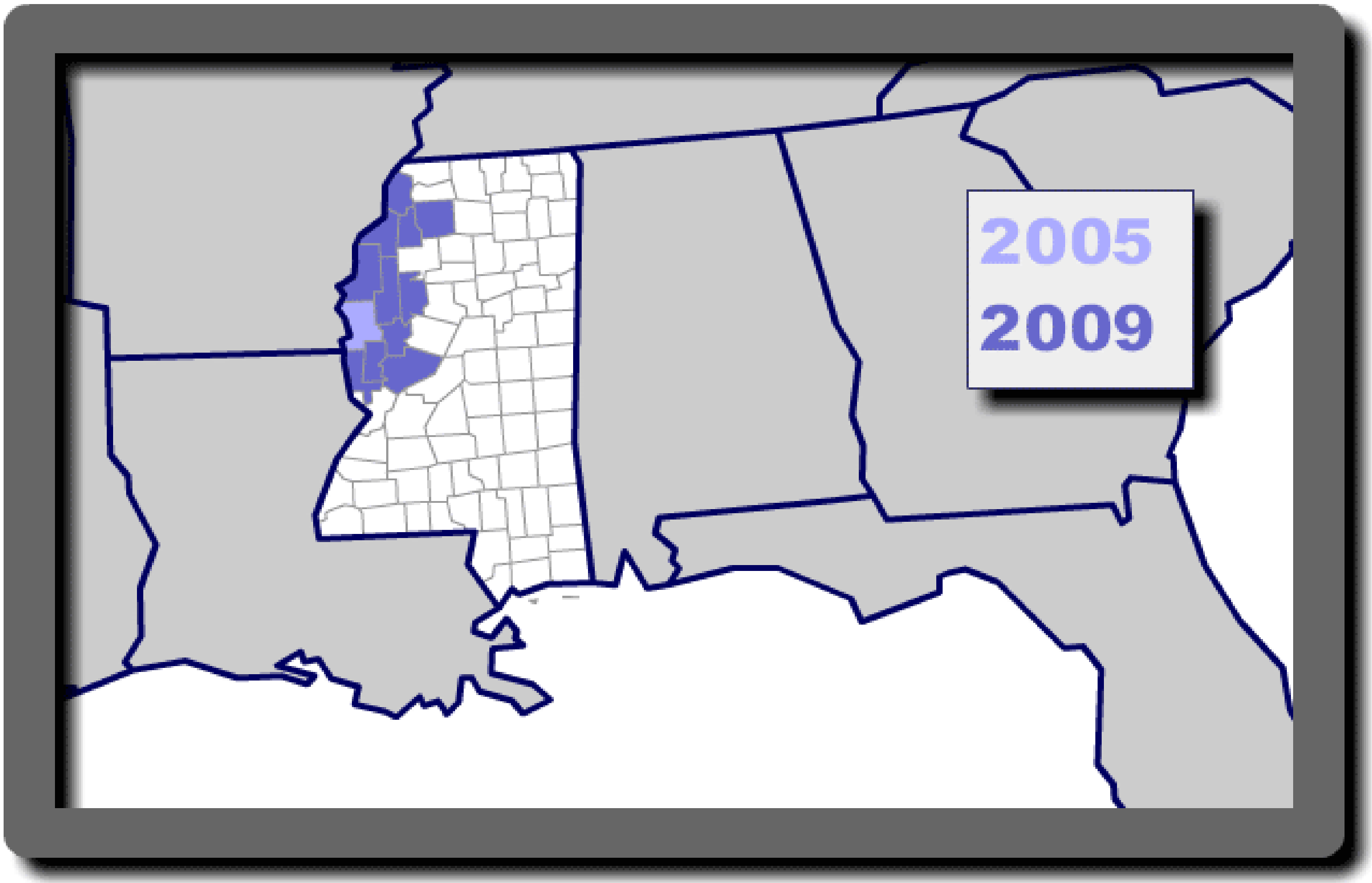
Input costs
Energy costs
Labor cost
Regulatory costs
Market Changes

Weather
Water
Soils
Insect Pests
Weeds

Documented Distribution of Glyphosate-Resistant Amaranths in the Southern U. S.

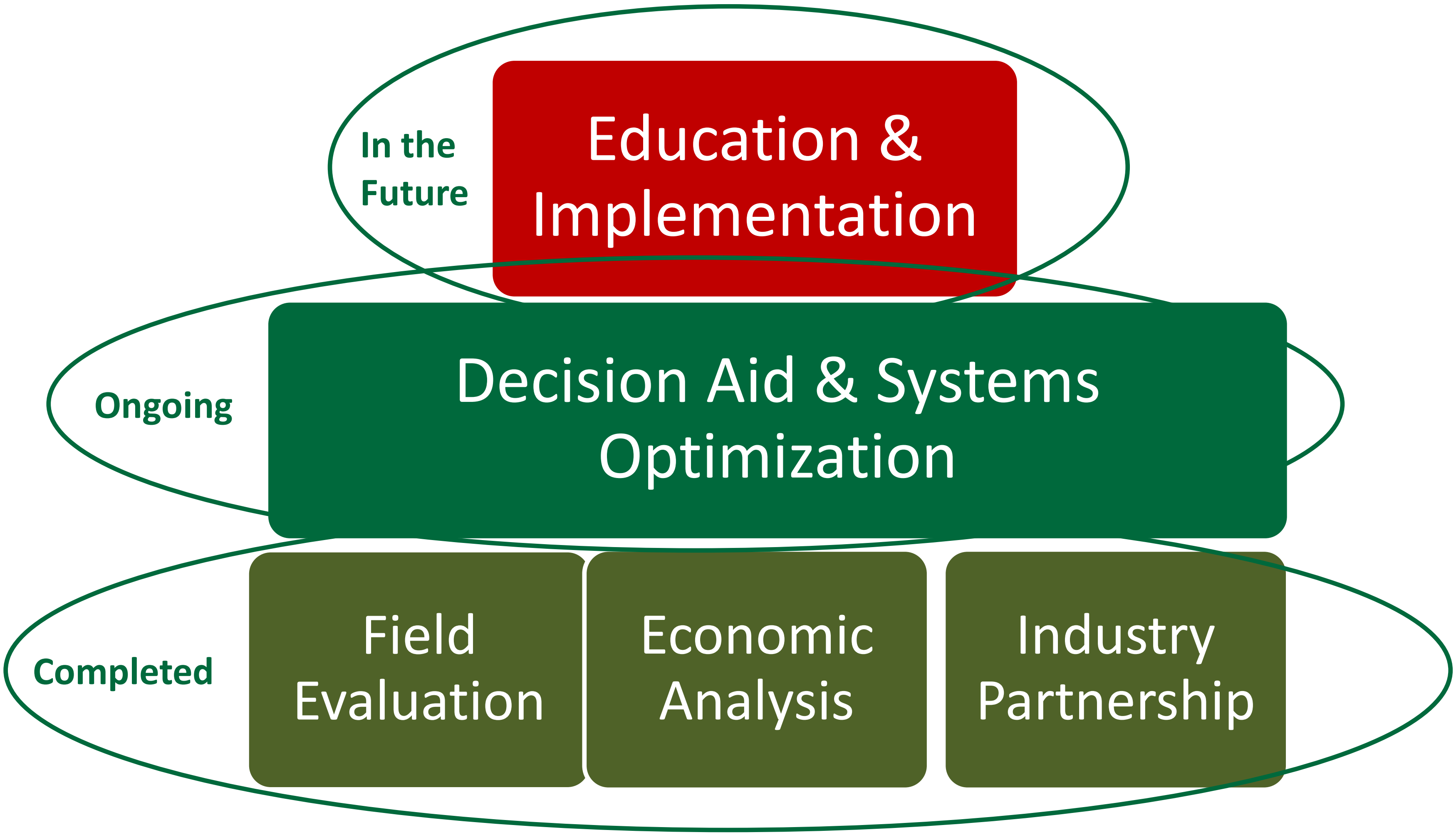


Bioassays Reveal Glyphosate-Resistant Ryegrass in Mississippi



Harvest Efficiency

Harvest Efficiency



Harvest Efficiency

2008 Field Evaluation on 28 fields (10 farms)
-average time to unload a conventional picker was 2.6 minutes
-average time spent turning during harvest ranged from 5% to 14%.

Case IH 625	**4.0 mph**	**76%**
John Deere 7760	**4.2 mph**	**82%**
conventional picker	**4.0 mph**	**76%**

Field Evaluation

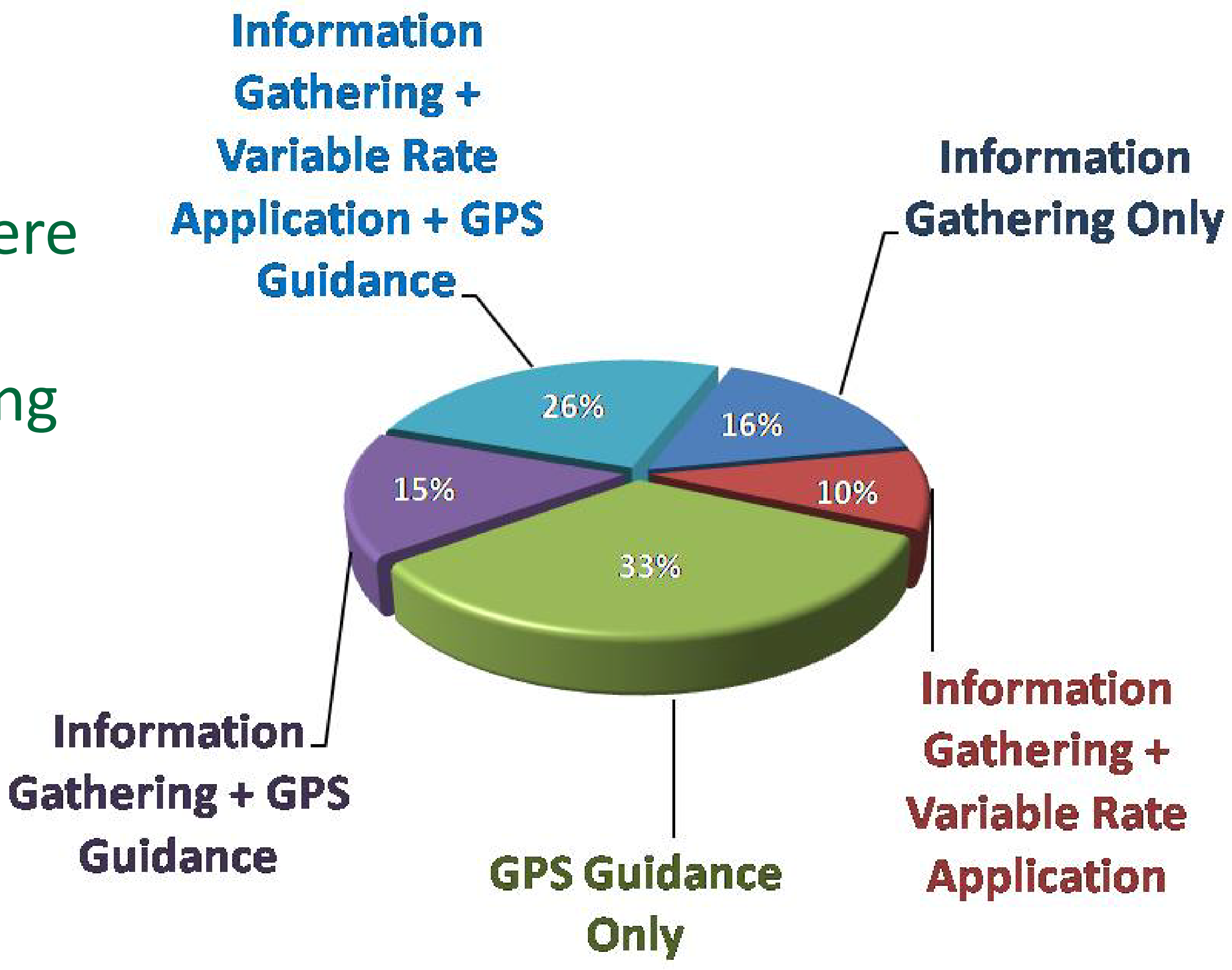
Economic Analysis

Industry Partnership


GreenSeekers mounted on Deere 6700 sprayer
University of Georgia - Tifton

2009 Precision Farming Survey

Overall, 63% of respondents were defined as precision farming adopters (n=1,089)

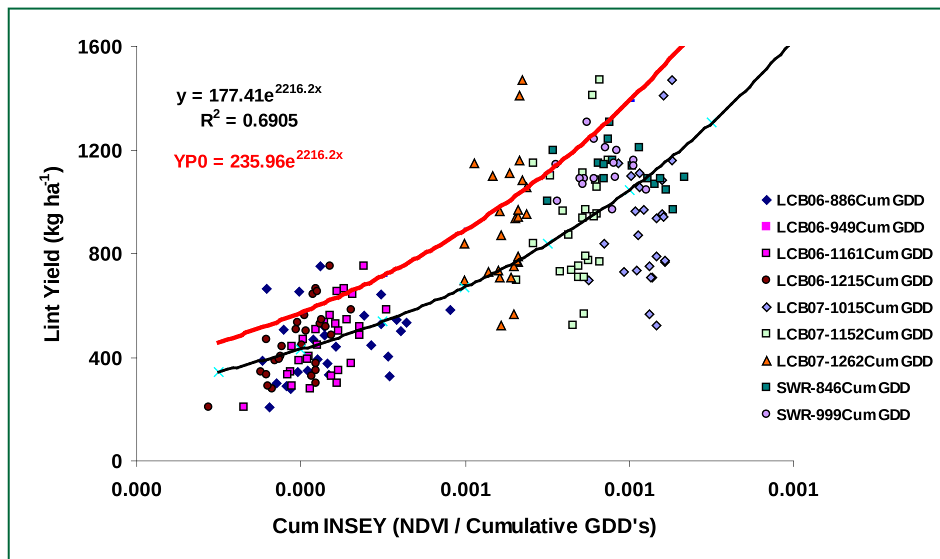


2009 Precision Application Study Sites

		Inputs managed based on Modulated Active Light Sensors					
State	**Investigators**	**PGR**	**Defoliant**	**Nitrogen**	**Insecticide**	**Plant Map**	**Irrigation**
California	Whiting, Ustin, et la.			GS			
Arizona	Tom Clarke, Doug Hunsaker			CC			CC
New Mexico	Tracy Carrillo, Joe Ellington	GS	GS	GS	GS	GS	GS
Texas (Lubbock)	Kevin Bronson			GS CC+			
Texas (USDA)	Dan Martin	GS	GS				
Texas (College St.)	Alex Thomasson, Ruixiu Sui			MSU			
Oklahoma	Randy Taylor, Tim Sharp, Shane Osborne, J.C. Banks, Bill Raun	GS	GS	GS			
Arkansas	Morteza Mozaffari			GS?			
Louisiana	Roger Leonard, Barbara T.			GS	GS		
Missouri	Gene Stevens, Peter Scarf, Earl Vories			GS CC+			
Tennessee	John Wilkerson			GS CC+			
Tennessee	Owen Gwathmey					GS	
Tennessee	James Larson - **Economics**						
Mississippi	Jack Varco			GS CC+			
Alabama	Shannon Norwood, Amy Winstead, John Fulton	GS	GS	GS			
Alabama	Kip Balkcom et al.			GS			
Georgia	George Vellidis, Calvin Perry	GS CC	GS CC				
Georgia - USDA	Harry Schomberg	CC					
North Carolina	Gary Robinson			GS			
South Carolina	Mike Jones, Phil Bauer	CC	CC				
South Carolina	Ahmad Khalilian, Will Henderson	GS	GS	GS			

OSU Algorithm – Arnall et al.

- N Rate = (YPo * RI – YPo) * %N / NUE
- Where:
  - YPo - potential cotton lint yield, kg/ha = $235.96\ e^{2216.2 * INSEY}$
  - Response Index: RI = 1.8579 * RINDVI – 0.932
  - %N = 0.09
  - Nitrogen Use Efficiency: NUE = 0.50



2010 Version 1.0

- “Yield Potential” based
- For high yield variability (2 bale/acre)
- Ideal for someone NOT using GIS or soil mapping
- A proto-type version is already implemented in the current GreenSeeker
- Will have the option for a min and/or max N rate.

Profitability Squeeze

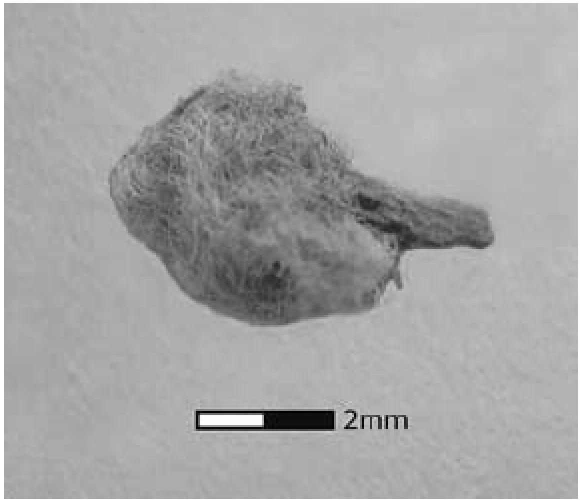


Fig. 5. Close-up of cotton boll recovered from a buried house floor at CA-09-71.

Cotton has supported man for at least 5,500 years. Originally hand spun for fishing & hunting nets, storage bags and food

Modern cotton is an industrial material processed by high speed, expensive machinery with diverse quality needs

Conventional Variety Program

Facilitating grower access to more seed options:

- **increasing Breeder Class seed for field testing and to hand off to seed companies**
- **rouging off-types and testing for commercial Biotech traits**
- **licensing conventional varieties**
- **demonstrating that spinning performance of new varieties can be determined before large scale introduction**

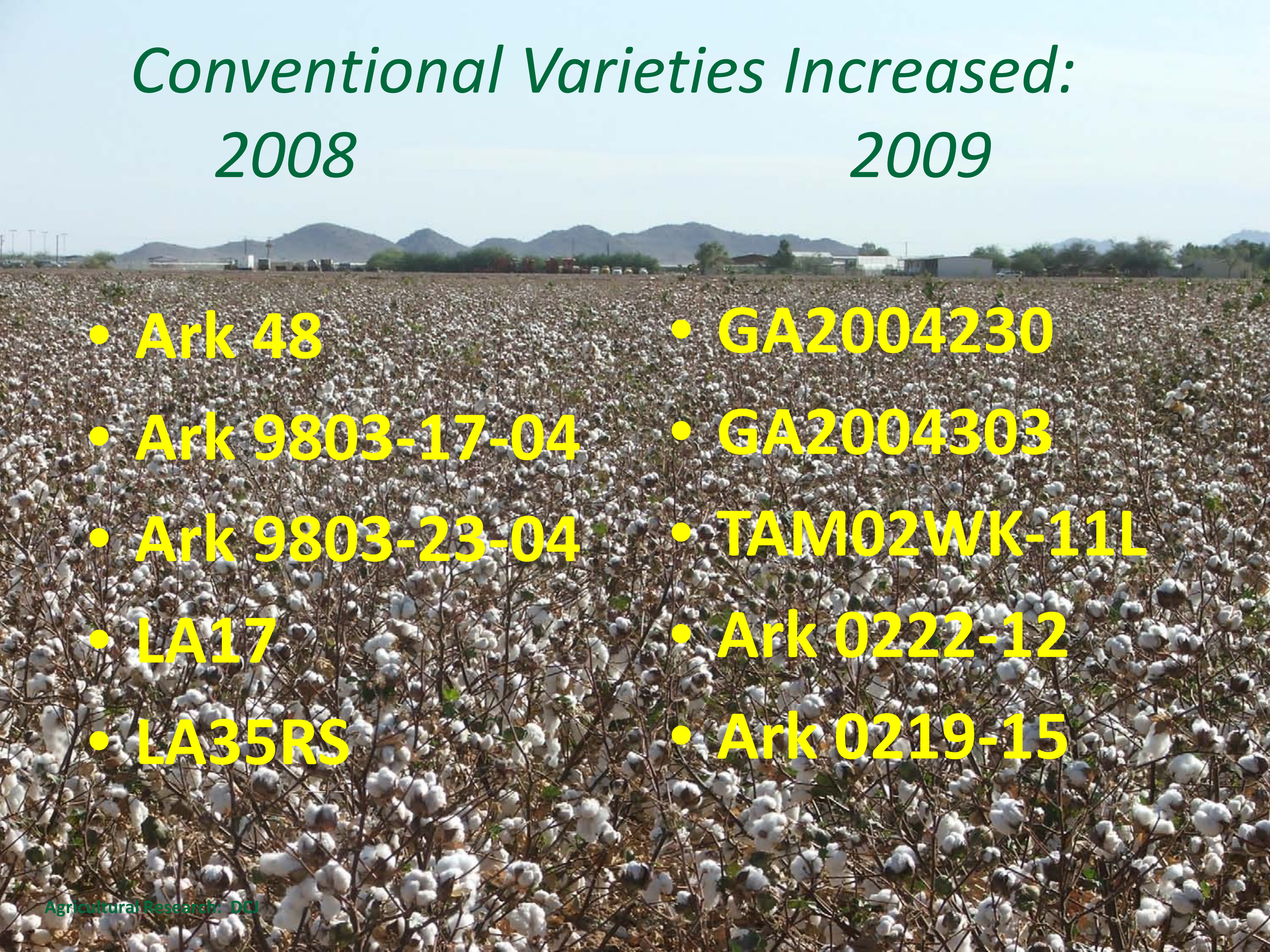
2008 RBTN least square means for lint yield, boll traits, and fiber quality traits over 9 locations†.

Cultivar	Lint Yield	Lint‡ Percent	Lint§ Index	Boll Size	Seed§ per Boll	Seed§ Index	MIC	UHM	UI	STRN	ELO	Q SCORE
	lbs/a	%	grams	grams	#	grams	mic	%	%	g/tex	%	
DP 393	1350	42.59	7.60	5.45	30.17	10.09	4.89	1.15	84.68	30.58	7.26	55.40
Ark0008-22-10	1311	40.91	6.92	5.40	31.13	9.82	4.88	1.15	84.39	29.96	6.25	53.84
GA2004303	1308	43.17	7.48	5.33	30.52	9.64	4.90	1.15	83.98	30.33	6.16	51.08
GA2004230	1307	42.74	6.89	5.25	32.01	9.05	4.68	1.24	84.36	30.85	5.68	81.31
Ark0015-06-11	1298	43.45	8.31	5.83	30.16	10.68	4.75	1.17	84.37	28.19	7.39	59.54
04PST-275	1296	42.45	7.56	5.51	30.82	10.03	5.02	1.14	84.00	28.70	6.98	45.87
Ark0001-01-03	1294	42.93	7.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.01
Ark0002-03-02	1290	41.90	7.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.80
04PST-250	1280	41.25	8.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.26
Ark0012-03-08	1274	42.56	8.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.31
SG 105	1270	41.72	7.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.74
AU-6103	1264	40.89	7.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.32
FM 958	1253	42.16	7.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.81
GA2004089	828	45.09	7.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.82
Mean	1186	41.09	7.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.14
LSD (.05)	73	0.43	0.21	[illegible]	[illegible]	[illegible]	[illegible]	0.01	0.40	0.79	0.15	5.07
CV(%)	13.06	2.09	5.64	7.40	8.31	5.07	4.75	2.58	0.97	5.17	4.83	17.52
R-Square	0.81	0.93	0.75	0.72	0.60	0.86	0.83	0.86	0.71	0.77	0.96	0.70
Reps	35	31	29	32	29	29	32	32	32	32	32	32

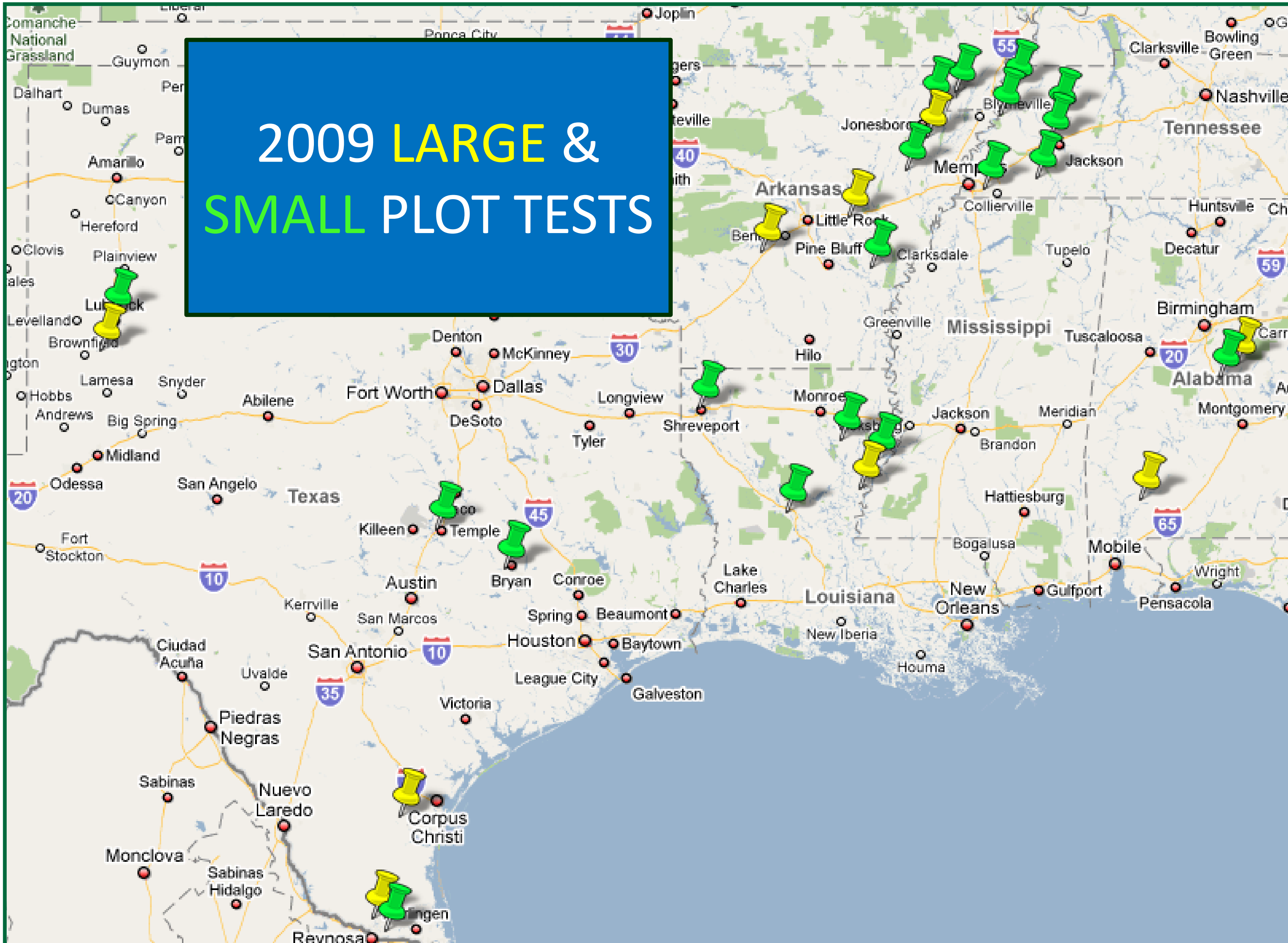
2008
Regional
Breeder
Testing
Network

	Len	Str	Mic
DP	1.15	30.58	4.89
GA	1.24*	30.85	4.68*
LS	0.01	0.79	0.11

Agricultural Research: DCJ


Conventional Varieties Increased:
2008
2009
• Ark 48
• Ark 9803-17-04
• Ark 9803-23-04
• LA17
• LA35RS
• GA2004230
• GA2004303
• TAM02WK-11L
• Ark 0222-12
• Ark 0219-15
Agricultural Research: DCJ

2009 LARGE & SMALL PLOT TESTS



Agricultural Research: DCJ

Foundation Seed Program

Two excellent LSU varieties advanced to second year seed increase

	Lint	Seed	Len	Str	Mic
DP393	1164	1411	1.11	29.8	5.1
LA 35	1115	1636	1.18	33.7	4.8
PSC355	1090	1478	1.11	32.3	5.1
FM958	1013	1373	1.12	30.1	4.8
LA 17	1001	1513	1.19	34.7	4.6

Foundation Seed Program

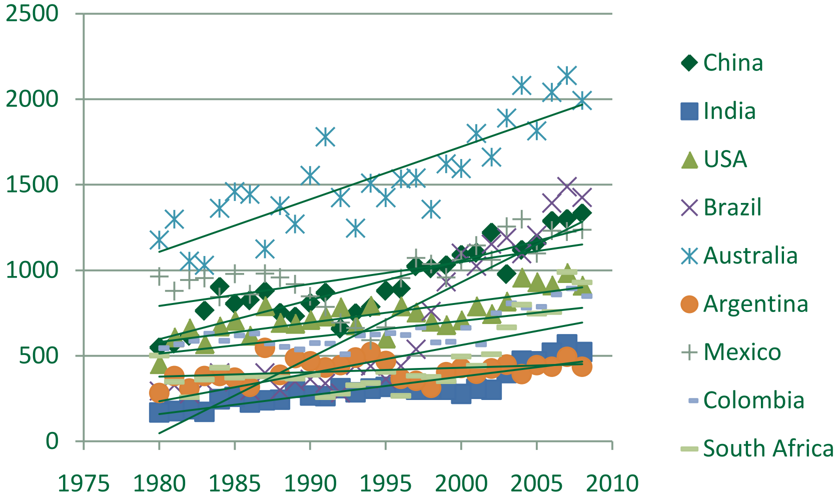
One Arkansas variety yielded exceptionally well for fiber, seed and quality and advanced to second year seed increase

	Lint	Seed	Len	Str	Mic
AR 48	1276	2053	1.29	35.6	4.8
SG105	1261	1839	1.17	30.1	5.0
DP393	1197	1655	1.18	31.7	4.7

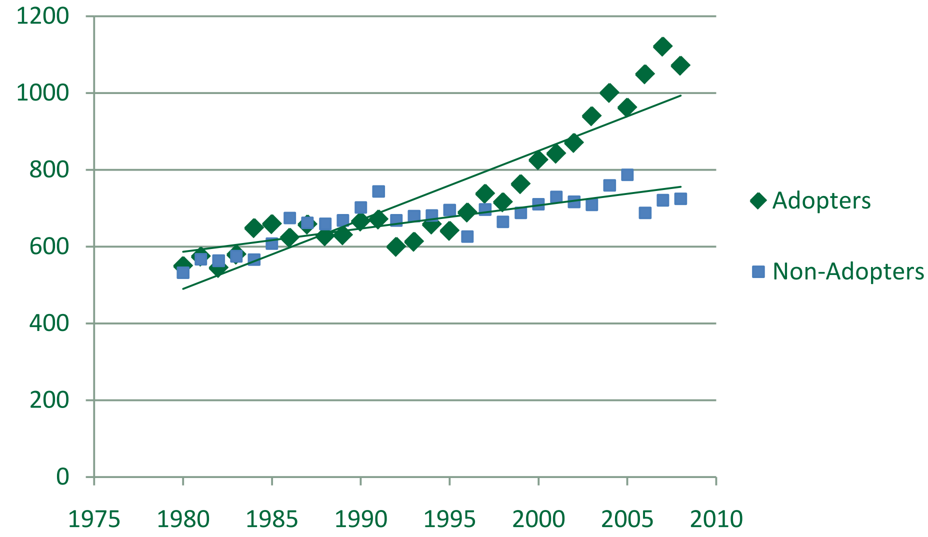
Spinning Performance of AZ Grown Seed (22 Ne count yarn)

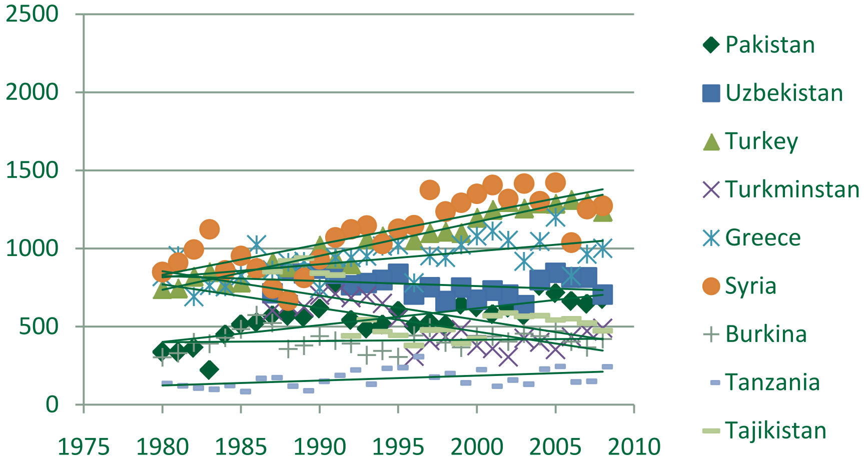
Variety	Yarn Strength (skein g/f)	Thins 50%	Thicks 50%	Neps 200%
DP 393	2398	10	265	128
Ark 48	3030	5	290	218
LA 17	3129	6	176	154
LA 35	2715	7	311	207

Agricultural Research: DCJ



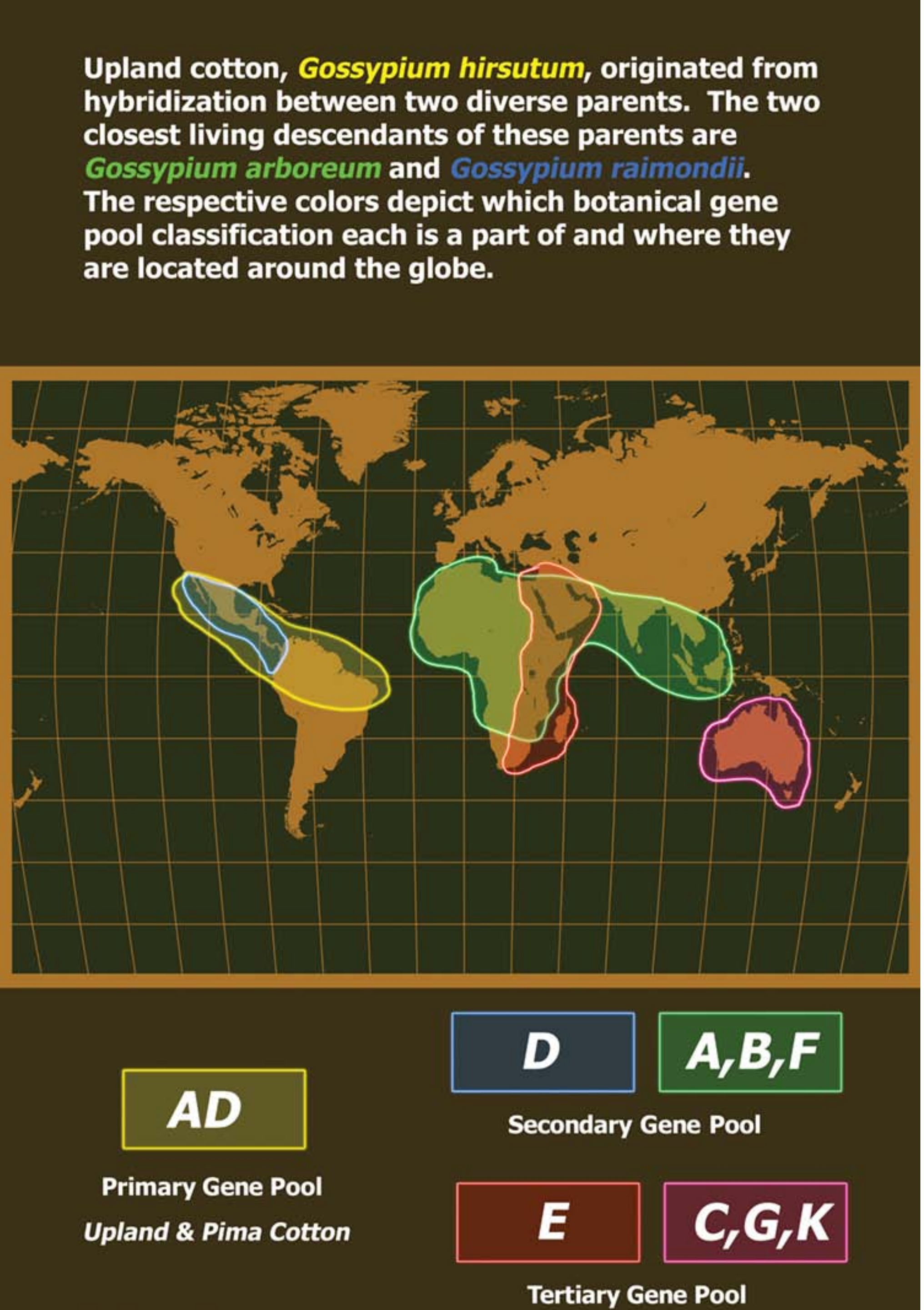
Adopters Yield Gain was 17 lbs/acre-yr



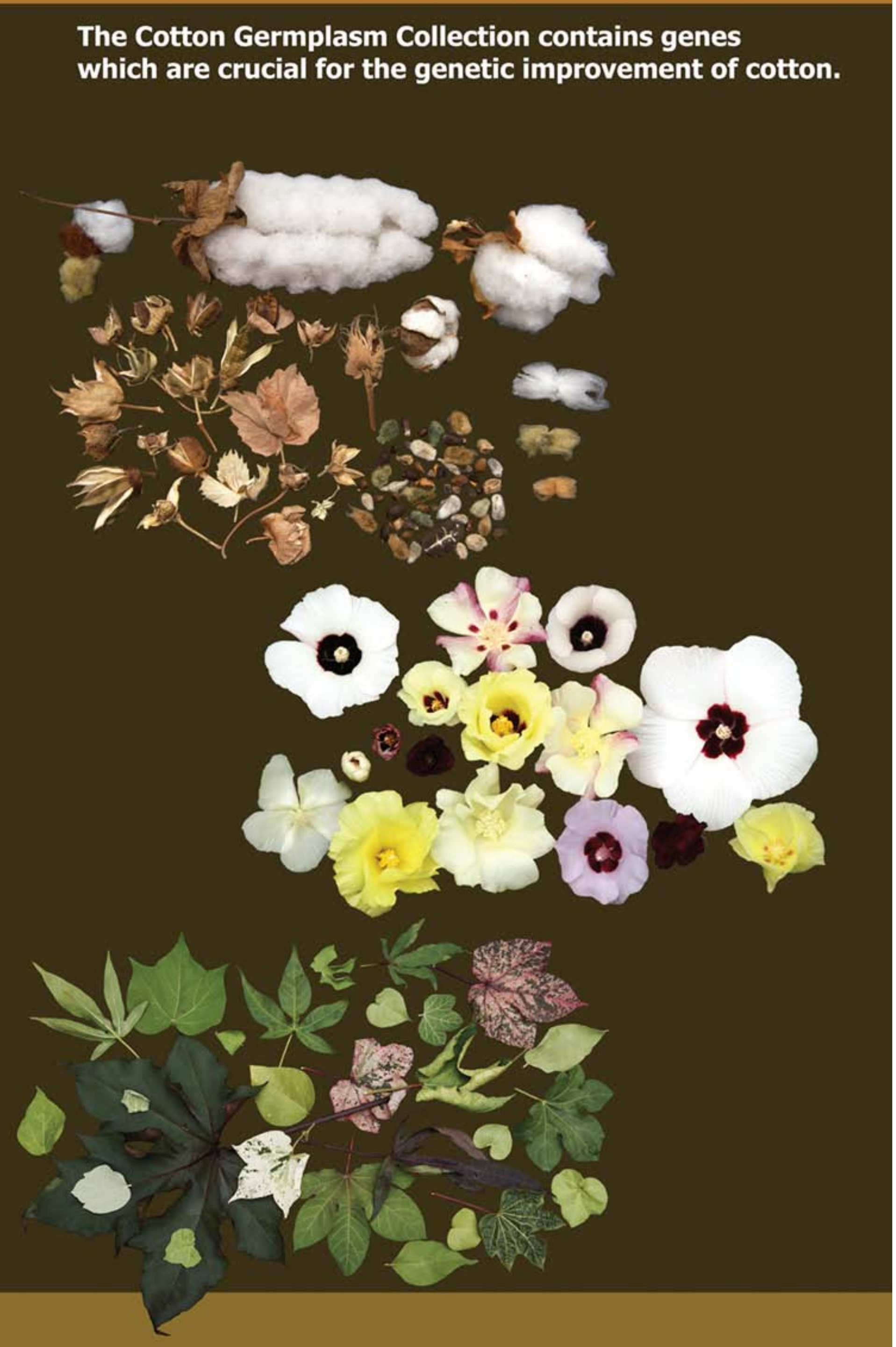


Non-Adopters Yield Gain was 6.5 lbs/acre-yr and currently 200 lbs/acre less

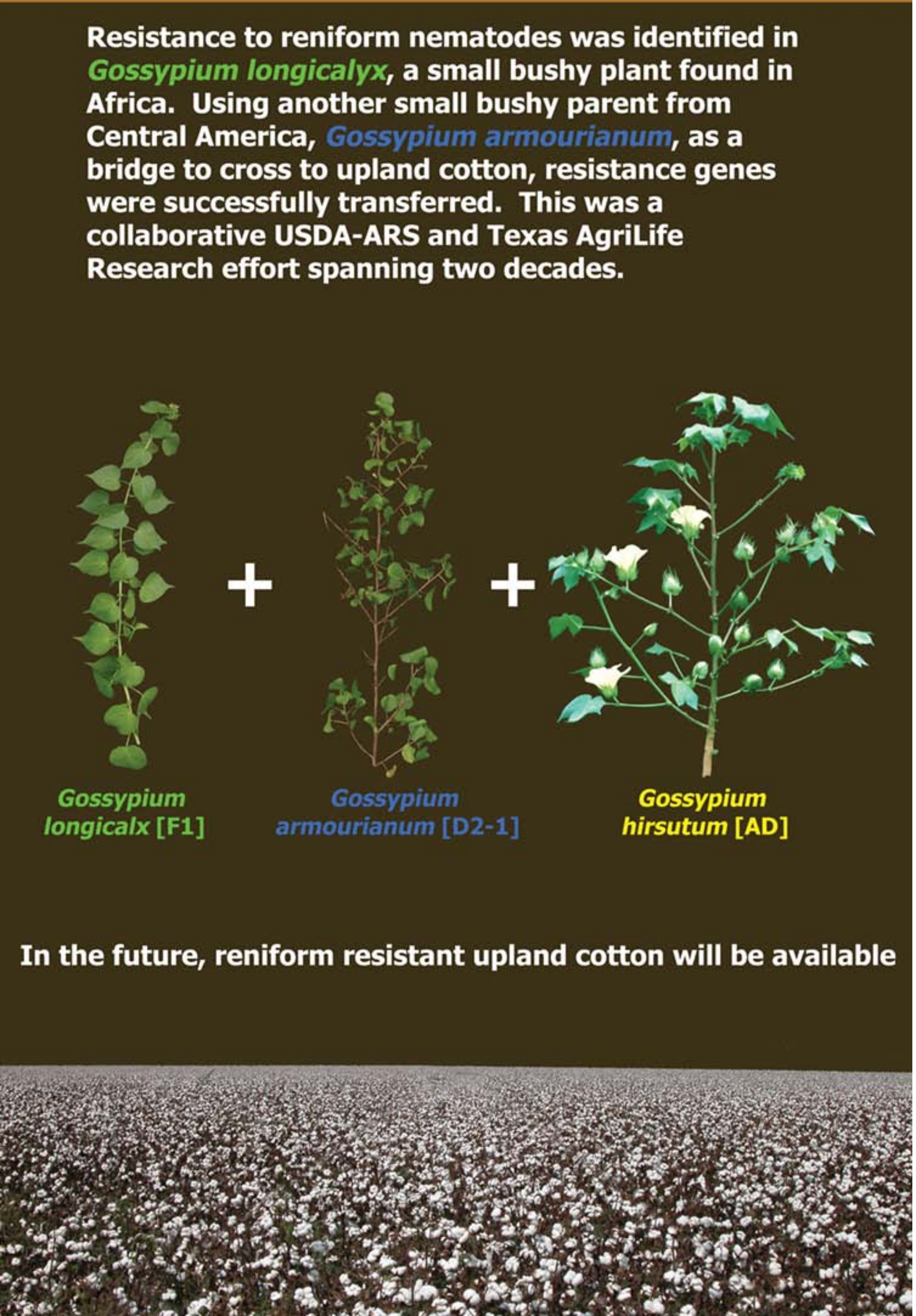
Cotton's Future is with Biotechnology



Origin of modern cotton was part from the new world and part from the old world creating a plant with twice as many chromosomes that could evolve rapidly but was difficult to breed



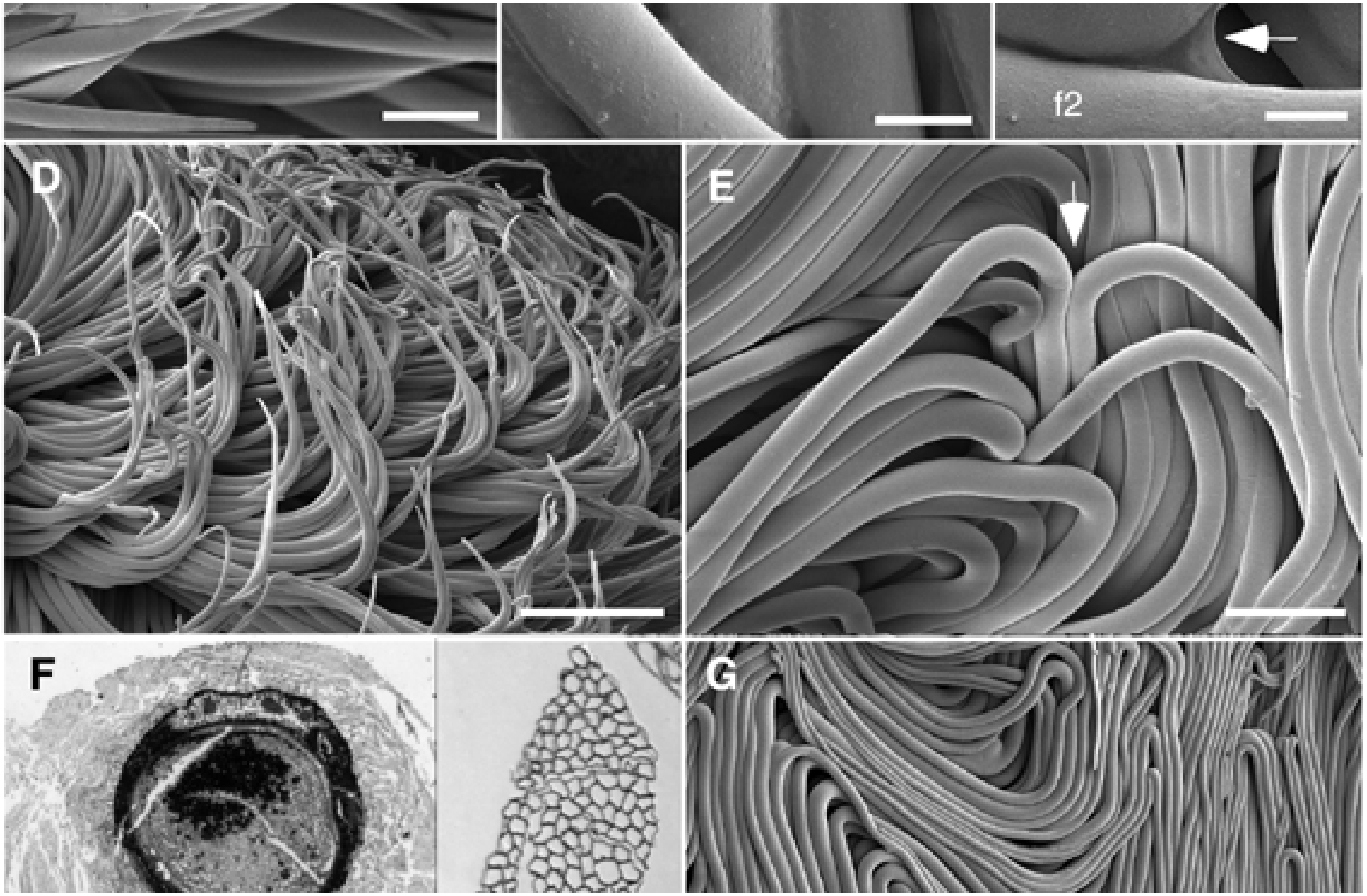
Although the original parents of cotton have not been found a highly diverse resource is maintained by the USDA in Texas and Tecoman, Mexico



Related cotton species have been used for many years but unrelated species, such as those used in LonRen, is a novel tool to find pest tolerance for modern cotton.

Novel Breeding Tools

Novel Breeding Tools



Breeding for Stress Tolerance

Seed set is limited by pollen viability

- **17 day pre-bloom (pollen development)**
- **day of bloom (pollen hydration or desiccation and pollen tube growth)**

STILES FARM STEM DRENCH EXPERIMENT OCTOBER 8, 2009

RED: 0.25 lb a.i./A (rep 4); BLACK: CONTROL (rep 4)

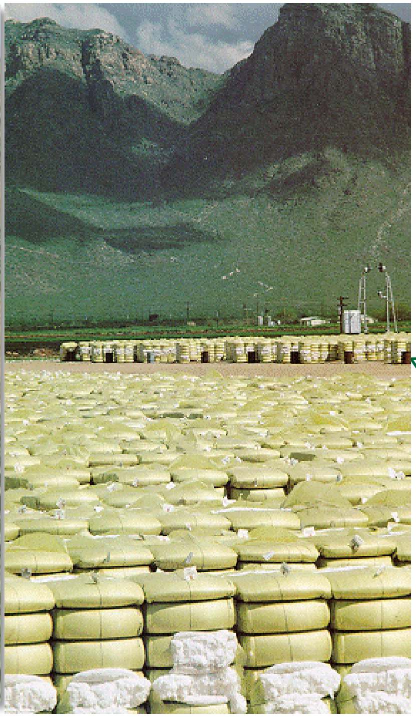
STILES FARM STEM DRENCH EXPERIMENT OCTOBER 8, 2009

RED: 0.25 lb a.i./A (rep 4); BLACK: CONTROL (rep 4)

YIELD AND COTTON ROOT ROT (%) WITH FLUTRIAFOL APPLIED VIA DRIP IRRIGATION DURING THIRD SET SQUARE

Treatment (lb. a.i./A)	% CRR (at cut out)	Yield (lb./A)*
Check	52 a	5016 c
0.0625 lb, applied twice	33 ab	6519 b
0.125	18 bc	7405 ab
0.5	9 bcd	7809 a
4 (applied 2008 only)	2 d	7614 ab

*Letters indicate significant differences (*P*>0.05) using LSD.



FIBER

fuzzy seed → dairy products

field → gin

Ginning creates valuable byproducts

Whole cottonseed and cottonseed meal are fed to cattle.

No additional inputs (land, water, energy etc.) are required to produce cottonseed.

They accumulate at the gin for “free”.

field → gin

gin → FIBER, fuzzy seed

fuzzy seed → dairy products, crusher

crusher → linters, black seed

linters → manufacturing, food

black seed → oil, meal & hulls

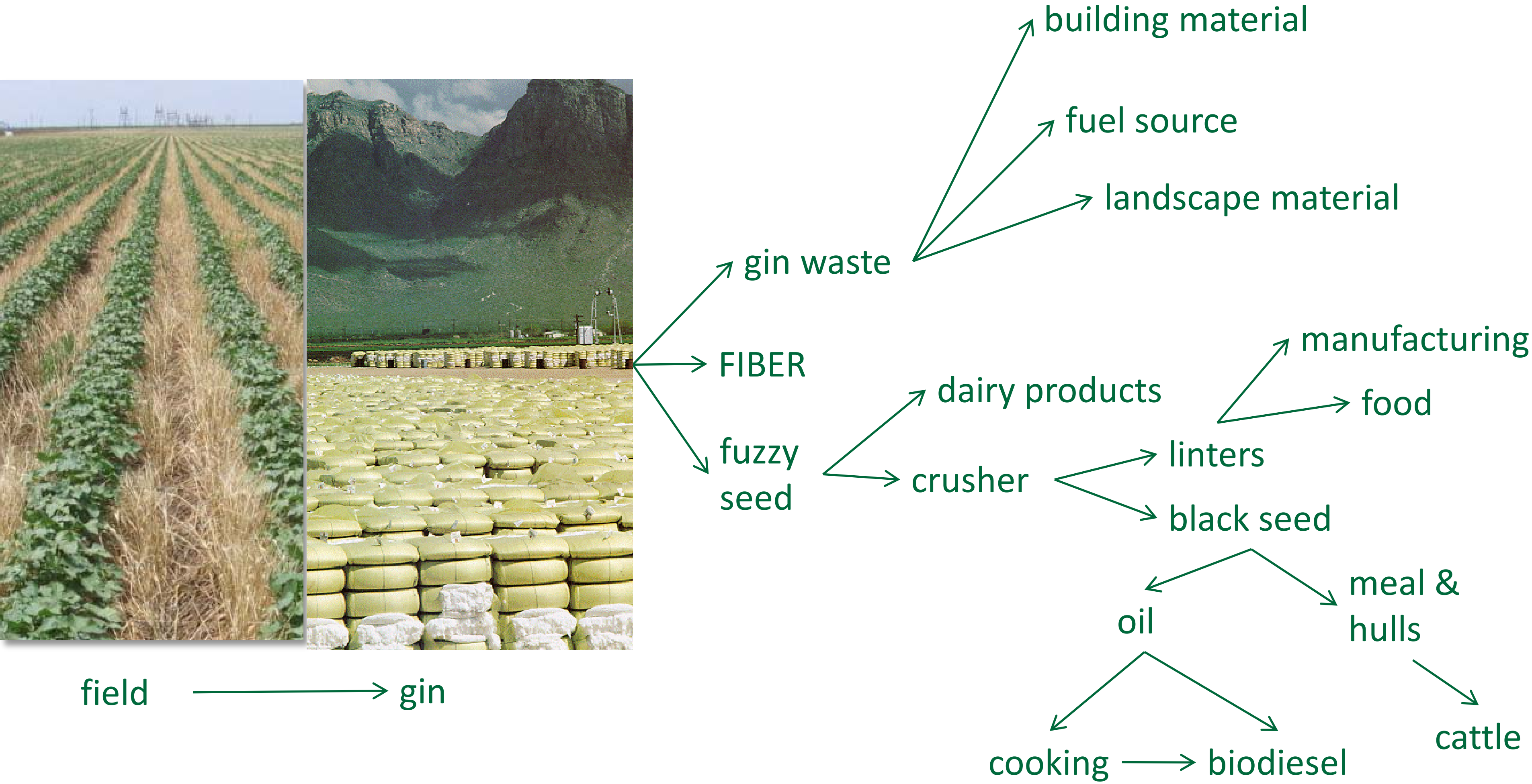
oil → cooking, biodiesel

cooking → biodiesel

meal & hulls → cattle

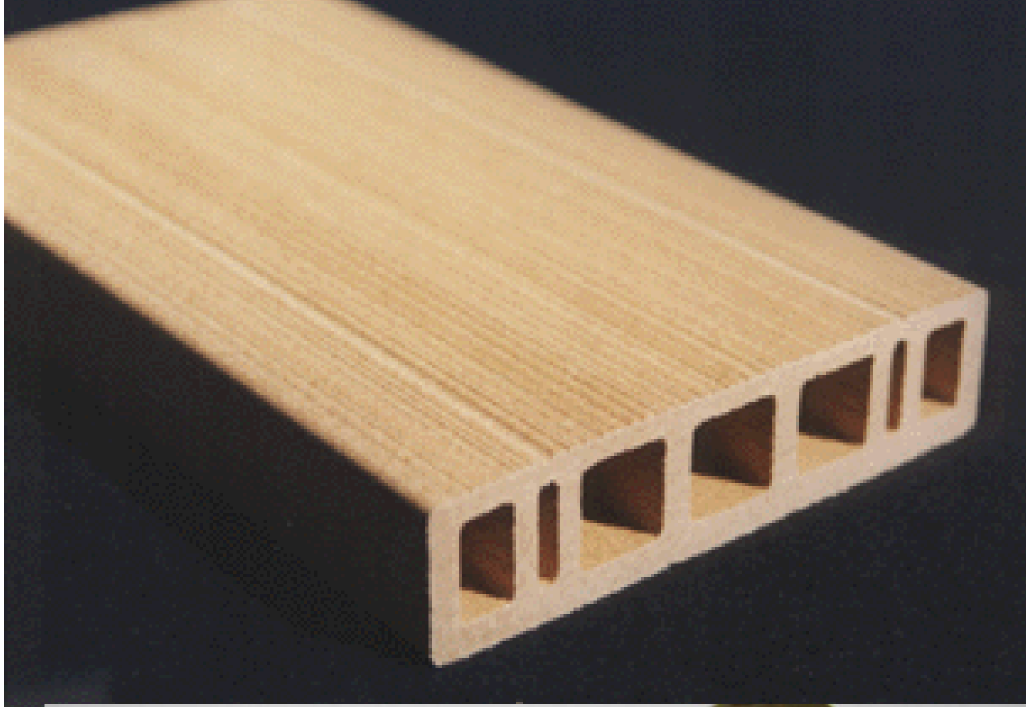
Ginning creates valuable byproducts

Cottonseed oil is in demand for trans-free cooking , baking and frying for its heat stability and lack of odor transfer from food to food.



Ginning creates valuable byproducts

Gin Waste → Wood Replacement in composite construction materials offers superior strength from cellulose fibers and lignin burs. Fuel as well.



Gin Waste → Erosion Control Products containing grass seed, fiber and leaf provide easier and lower cost alternative to sod

field → gin

gin waste → building material, fuel source, landscape material

FIBER

fuzzy seed → dairy products

fuzzy seed → crusher

fuzzy seed → food, aquaculture & high value feed

crusher → linters → manufacturing, food

crusher → black seed → oil, meal & hulls

oil → cooking → biodiesel

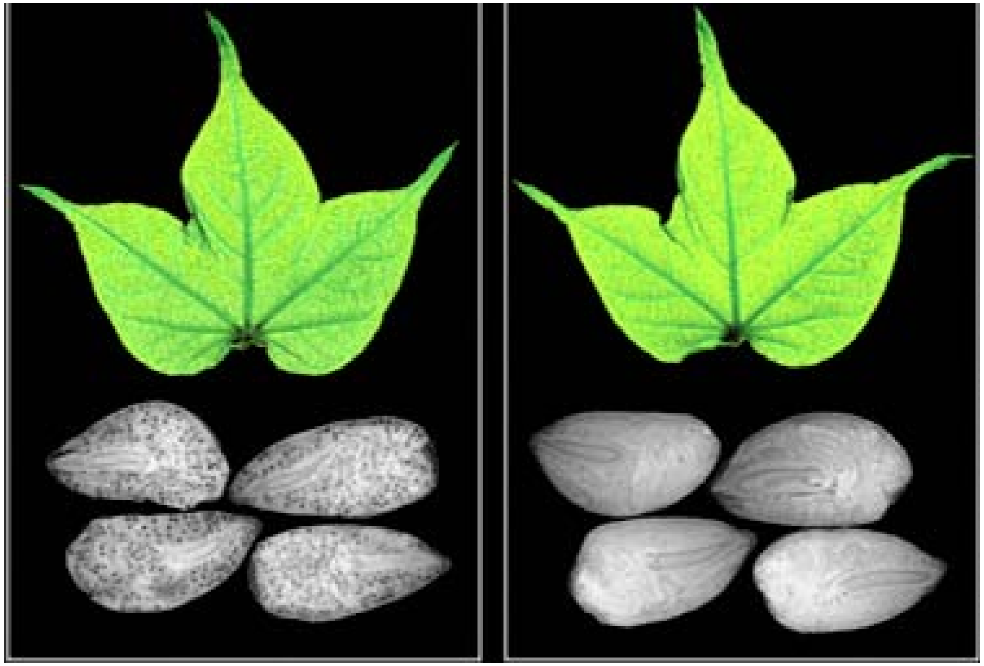
oil → biodiesel

meal & hulls → cattle

Ginning creates valuable byproducts

Gossypols Elimination Opens Doors

- **Keep gossypol in the leaves to suppress insect pests, but remove from the seed to feed the more efficient pigs, chickens & fish**
- **1st field trial of low-gossypol trait in 2009**
- **Increases value of cottonseed to US farmers (oil quality, aquaculture & better dairy feed) and to developing country farmers (broadens feed usage & provides emergency food opportunity)**



PNAS 2006 vol. 103: 18054-18059

HEALTH

Edible Cotton. Genetic engineers have removed a powerful toxin from cottonseed, which is rich in protein

1. Genetically modified cotton in a field trial in Texas 2. A new lab technique keeps toxin from forming in protein-laden seeds 3. Leaves still contain the toxin to protect against bugs

BY BRYAN WALSH

IT'S AS TRUE IN TODAY'S WORLD as it was in the antebellum South: cotton is king. The plant has been cultivated for its fiber for over 7,000 years, and today it's grown by more than 20 million farmers in some 80 countries. But while cotton accounts for nearly 40% of the fiber used worldwide to make clothing, there's one thing the plant has never been able to do well: feed people. Cottonseeds are a rich source of protein—the current cotton crop produces enough seeds to meet the daily requirements of half a billion people a year. But the seeds can be consumed only after an extensive refining process removes the gossypol, a toxic chemical that helps protect the plant from insect and microbe infestation. "People, pigs, chickens—none of us can stomach gossypol," says Kater Hake, vice president of agricultural research for the industry group Cotton Inc. Only cows and other ruminants can handle it.

Remove the gossypol, however, and you'll have a cheap and abundant form of protein for everyone. But get rid of all the gossypol, as plant breeders did in the 1950s, and insects will devour the defenseless cotton. Enter Keerti Rathore, a professor at Texas A&M University, who found a way around the problem through genetic engineering. In new field-trial data, Rathore's team demonstrated that it can turn off the genes that stimulate the production of gossypol in the cottonseeds while the rest of the plant keeps its natural defenses. "This research potentially opens the door to utilizing safely the more than 40 million tons of cottonseed produced annually as a large, valuable protein source," says Norman Borlaug, an American agronomist who won the Nobel Peace Prize in 1970 for developing high-yield wheat varieties that have helped increase the world's food supply.

Rathore used a new technique, called RNA interference, to construct a genetic sequence that blocked the gossypol-producing enzyme in the seeds only. After succeeding in the lab, he began a test in a greenhouse to see if the genetically modified cotton plant would survive and pass on its new trait. Rathore's just-compiled data show that the modified cotton appears to be normal in every way other than the fact that it has instantly edible seeds. "What works in the greenhouse should hold true in the fields," he says.

Genetically modified cottonseeds will need government approval before they hit grocery shelves, and they're more likely to be used first to supplement fish or animal feed. But with the global population still on the rise and farmland limited, the planet can use free protein. And you might even like it. "It's not bad," says Rathore, who has popped a few seeds. "Tastes like chickpeas." ■

NULLELUART

44 MILLION
Number of metric tons of cottonseed produced annually; a toxic compound keeps humans from eating it

23%
Percentage of cottonseed that is protein

500 MILLION
Number of people whose protein needs could be met with detoxified cottonseed at current cotton production levels

54 TIME September 14, 2009

"Edible Cotton" is the poster child for agricultural innovation