Breeding Peanuts: The Story of a Lowly Groundnut

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Arachis hypogaea L.

- Annual legume
- Self pollinated
- Indeterminate
- Genetics
  - Cultivated = allotetraploid
    - 2n = 4x = 40
    - A and B genomes
  - Wild = diploid
    - 2n = 2x = 20 (66 species)
    - 2n = 4x = 40 (1 specie)
- Botanically - Fabaceae
- Culinary- nut family
- Oil crop

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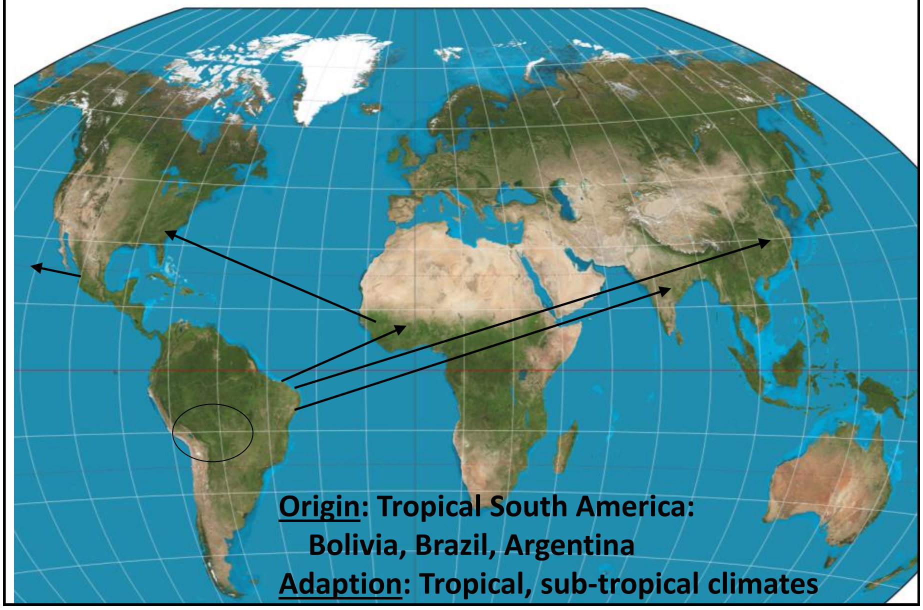
Origin and Dispersion



Peanut plants produce flowers above ground and seeds below ground

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Digging Peanuts

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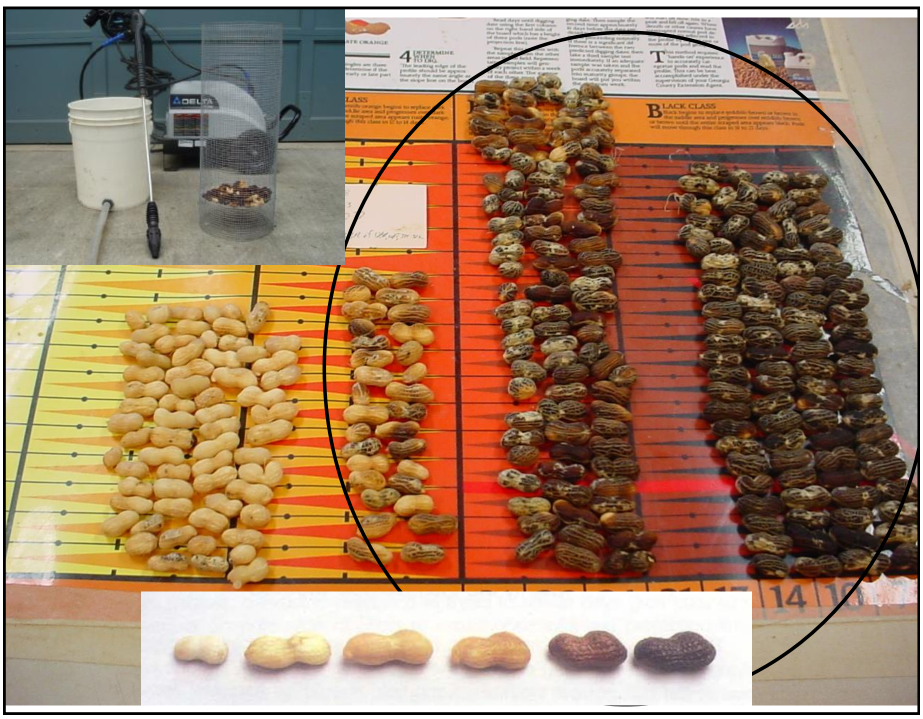
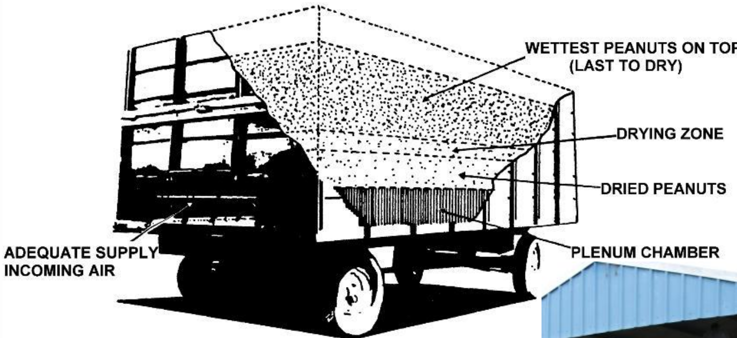


Peanut pods are dried after harvest in wagons



Peanut pods are stored in large warehouses

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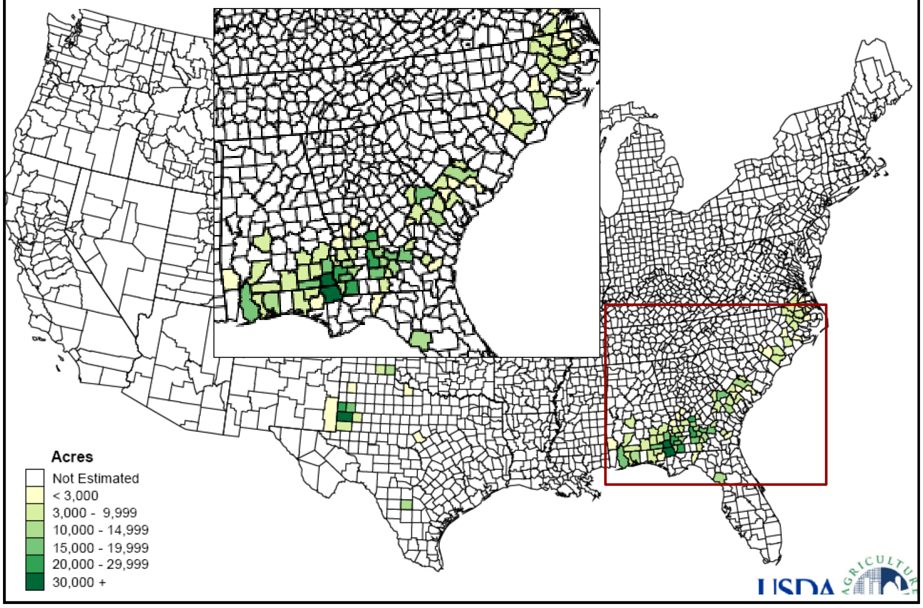
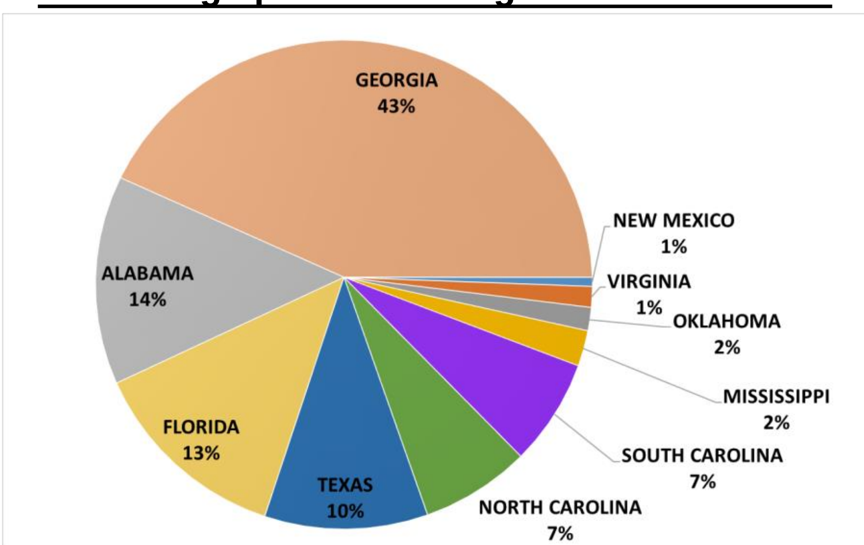
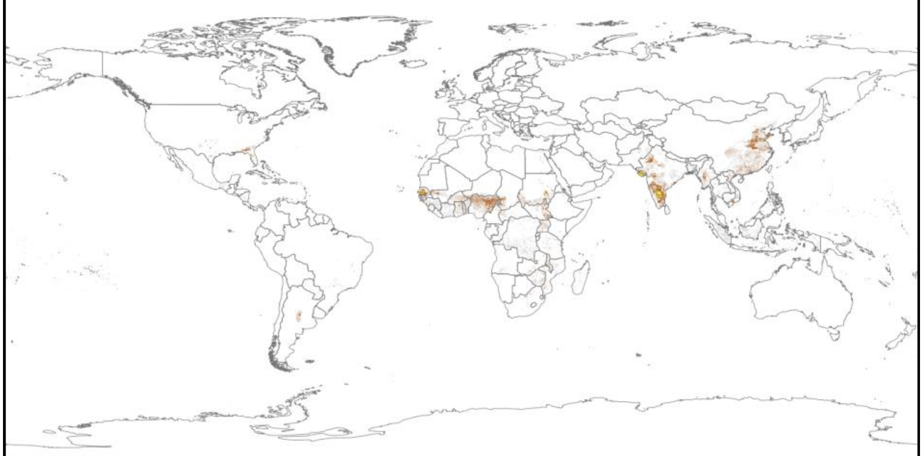
USA – about 500,000 HA



Four states produce 80% of US peanuts
…. Average planted acreage 2010-2014



World - about 24,000,000 HA



Source: http://gaez.fao.org/Main.html

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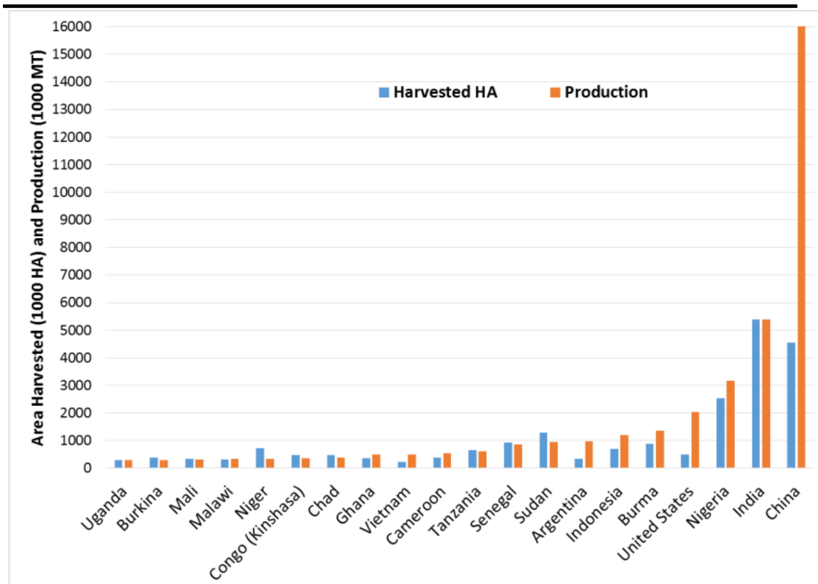
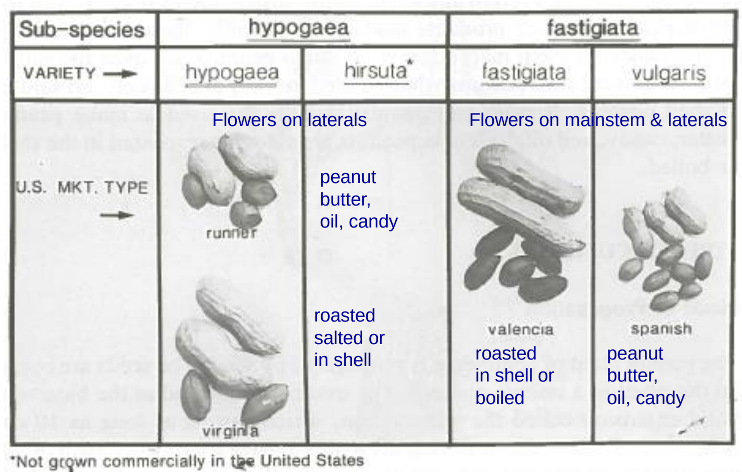
World - around 24,000,000 HA



Market and botanical types of peanut



UF Program: Runner types (85%), Virginia types (10%)
Valencia types (5%)

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Peanut in the USA is a food

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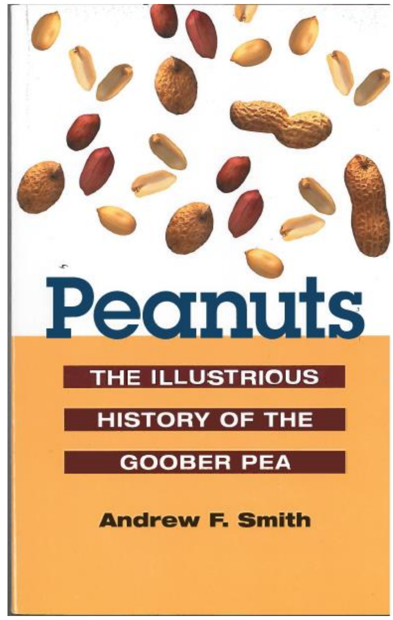
Peanuts have a cultural bias

- George Washington Carver
- Mr. Peanut- Planters
- Many names
  - Peanut, Groundnut, Goober
  - Mani (Spanish), Pindar
- Various cultural preparations
  - USA
    - ✓ Peanut butter, Candies, Whole nuts, in-shell
  - Asia (China, India)
    - ✓ Cooking oil, whole nuts
  - South America
    - ✓ Roasted whole, beverage
    - ✓ Large amounts exported



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Breeding programs in USA

- Over 99% of cultivars publicly bred
  - New Mexico State Univ.
  - Texas A&M Univ.
  - USDA- Oklahoma State Univ.
  - Auburn Univ.
  - University of Florida
  - University of Georgia
  - USDA- University of Georgia
  - Clemson Univ.
  - North Carolina State Univ.

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Breeding Goals: A peanut variety must satisfy several major customers

Consumer
Healthiness and flavor are keys to peanut consumption

Farmer
Seed vigor, Yield, Grade, Disease res.

Target Traits in Peanut Breeding

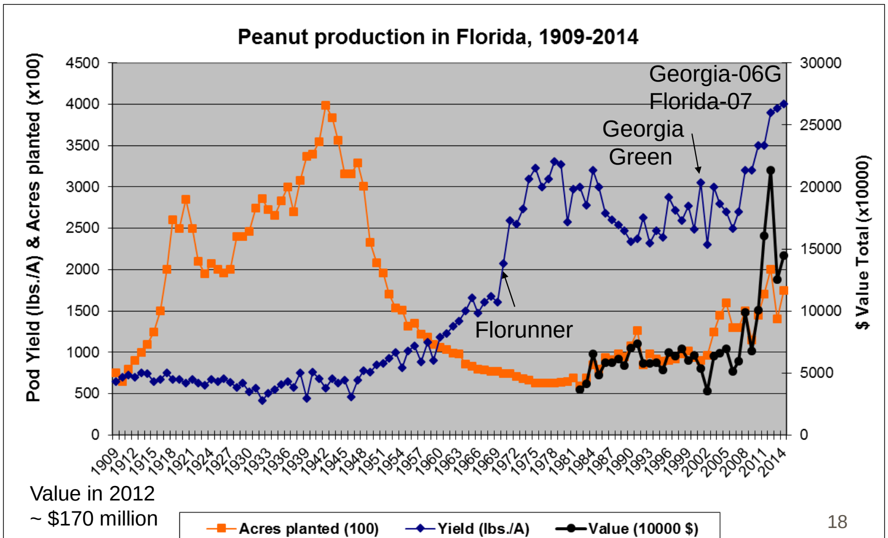
Sheller
Uniform size, easy to shell and process

Manufacturer
Uniformity, blanching, Roasted FLAVOR, Oil Chemistry, Low Aflatoxin

Traits we measure
Yield, grade, pod/seed size, disease resistance, oil quality

Traits needing better measures
Germination, oil concentration, flavor, antioxidants, protein, reaction to drought, Virginia- pod color

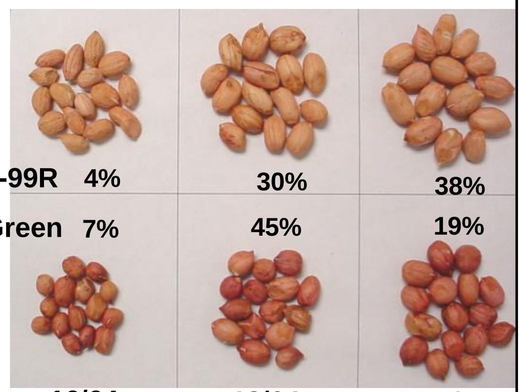
Peanut yields in Florida have increased over the past 5 years (2010-14). One ton= $400-600



Value in 2012
~ $170 million

Partial output from the grading process

USDA value of peanut determined by the "grade" or percentage of Total Sound Mature Kernels (TSMK %)

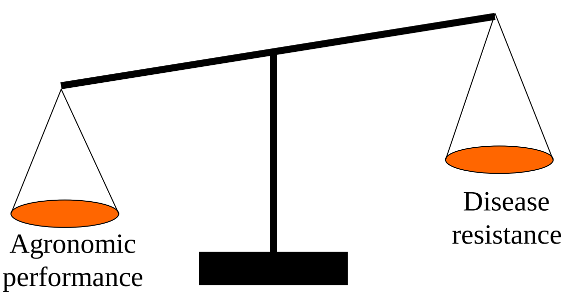


	Number 1	Medium	Jumbo
C-99R	4%	30%	38%
GA Green	7%	45%	19%
Screen size (inches)	16/64	18/64	21.5/64

TSMK% ranges from 74-80%

Every point in TSMK = about $5 in value

Breeding for disease resistance



Make sure the variety is not extremely susceptible to a prevalent disease

"if a new disease-resistant variety is to be acceptable to farmers, it must yield fully as well as the old, susceptible variety in all features that influence the net value of the crop even when disease is absent". (ANDRUS, 1953)

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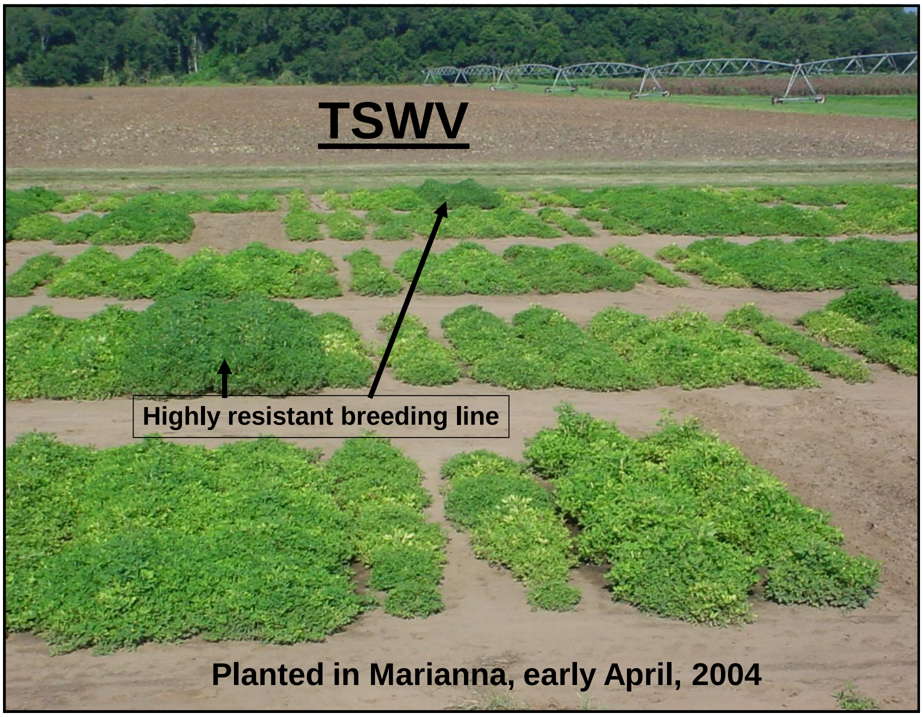
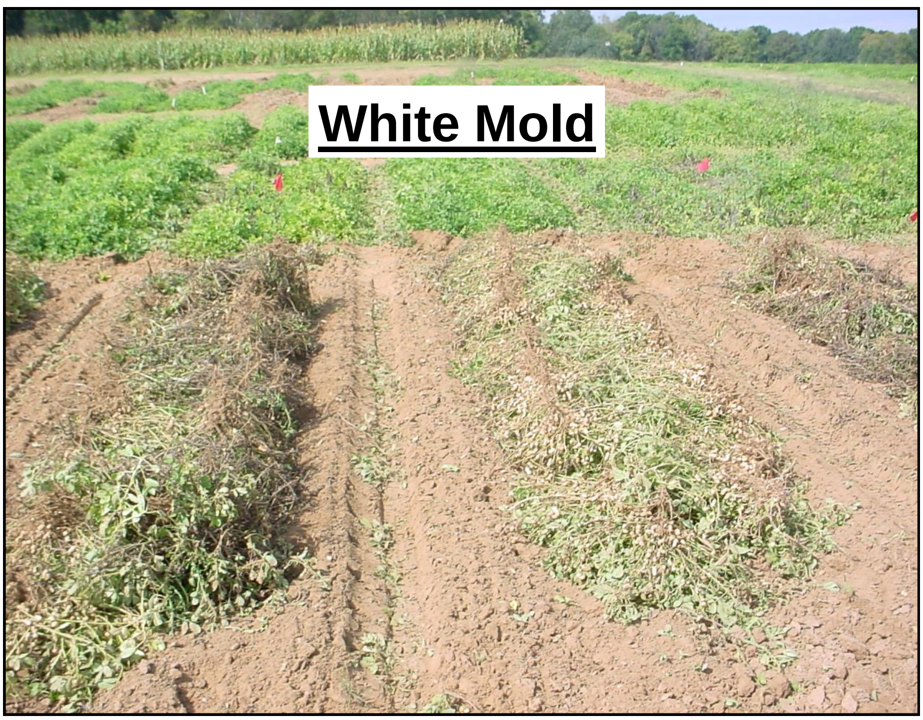
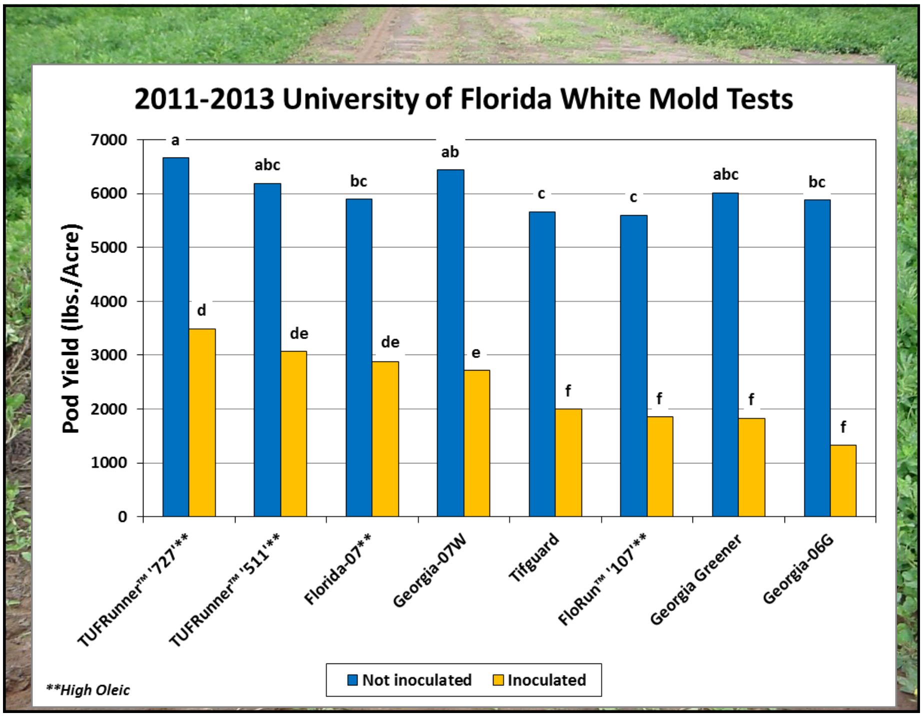
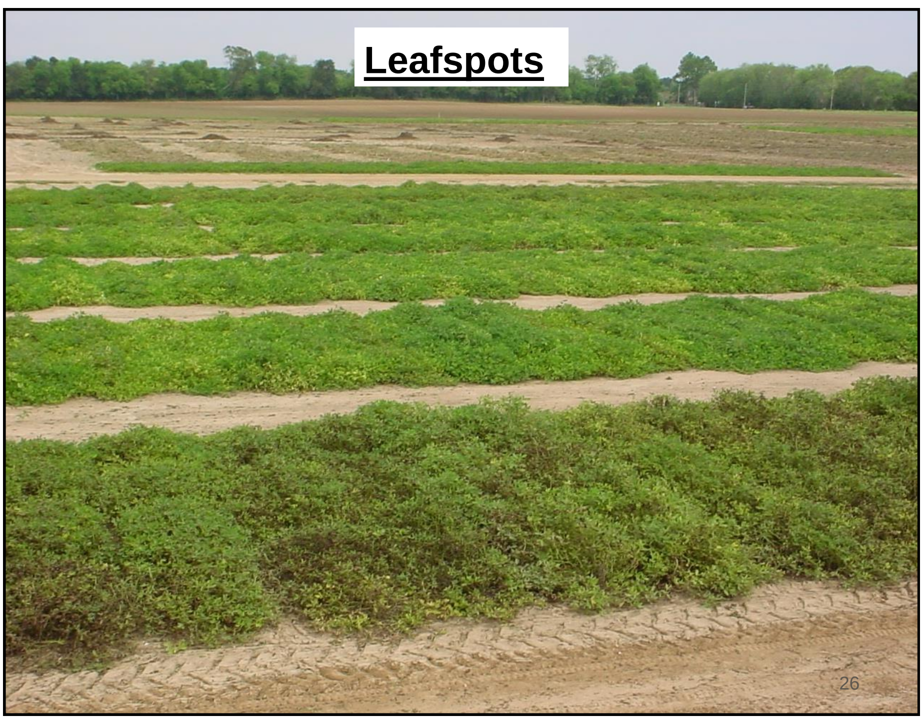

TSWV
Highly resistant breeding line
Planted in Marianna, early April, 2004

White Mold





2011-2013 University of Florida White Mold Tests
Pod Yield (lbs./Acre)
7000
6000
5000
4000
3000
2000
1000
0
a
abc
bc
ab
c
c
abc
bc
d
de
de
e
f
f
f
f
TUFRunner™ '727'**
TUFRunner™ '511'**
Florida-07**
Georgia-07W
Tifguard
FloRun™ '107'**
Georgia Greener
Georgia-06G
Not inculated
Inoculated
**High Oleic



Leafspots
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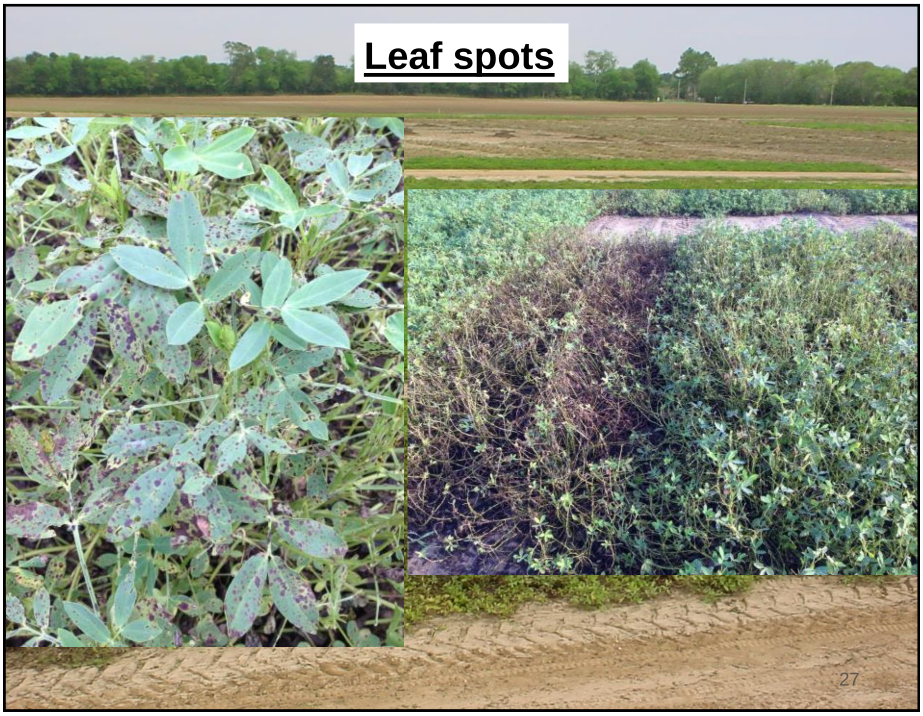
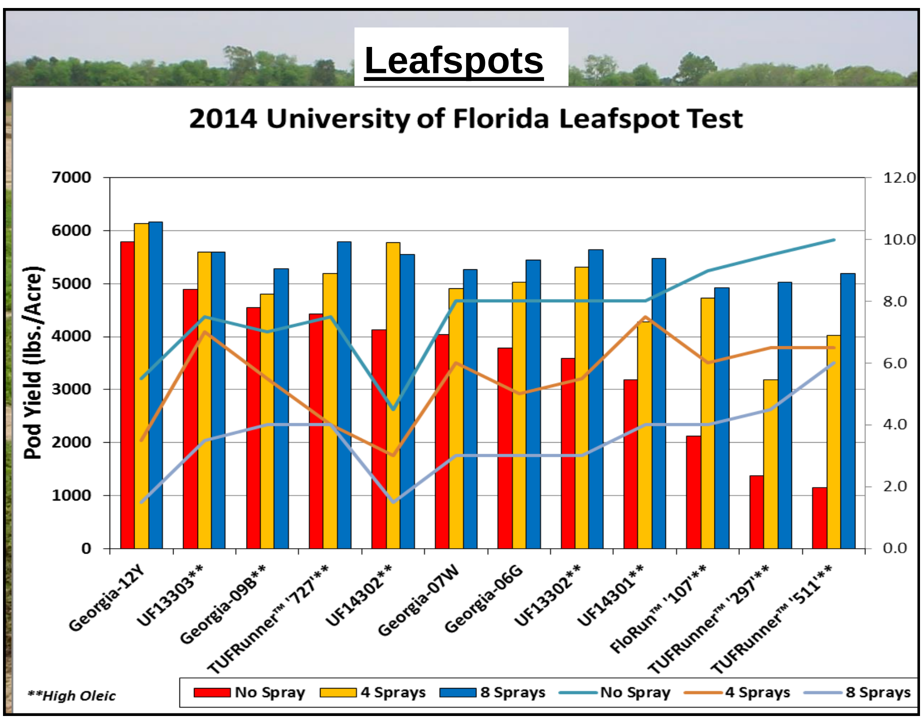

Leaf spots
27


Leafspots
2014 University of Florida Leafspot Test
Pod Yield (lbs./Acre)
7000
6000
5000
4000
3000
2000
1000
0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Georgia-12Y
UF13303**
Georgia-09B**
TUFRunner™ '727'**
UF14302**
Georgia-07W
Georgia-06G
UF13302**
UF14301**
FloRun™ '107'**
TUFRunner™ '297'**
TUFRunner™ '511'**
**High Oleic
No Spray
4 Sprays
8 Sprays
No Spray
4 Sprays
8 Sprays

Chemical composition of peanut seeds

Component	*Percentage*	
Moisture	5-8	6
Oil	44-56	50
Protein	25-34	27
Carbohydrates	6-25	13
Fiber	1.6-1.9	2
Ash	1.8-2.9	2

Interested in oil quality, not quantity

Fatty Acids		Normal Oleic	High Oleic
Oleic	37 - 80%	50-60%	75-80%
Linoleic	2 - 43%	15-25%	2 - 5%

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High oleic peanuts delayed rancidity by 28 weeks
(PV of 20 is considered unacceptable)

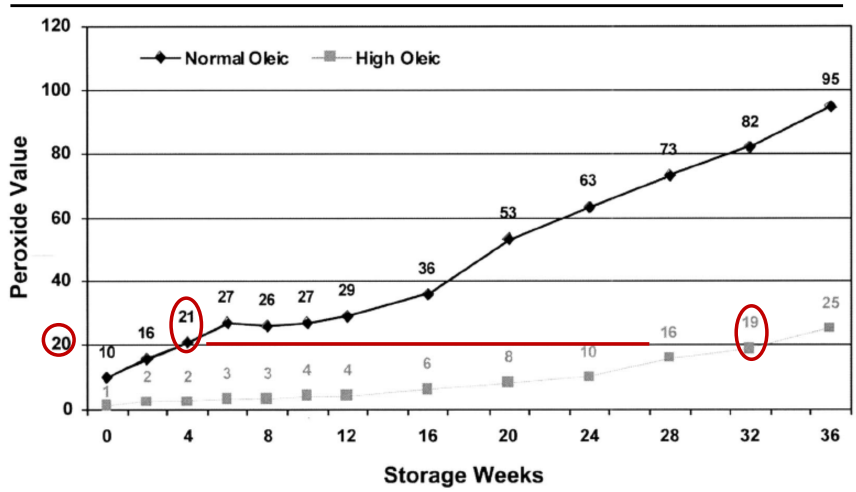


Fig. 1. Shelf life of roasted inshell normal vs. high oleic peanut.

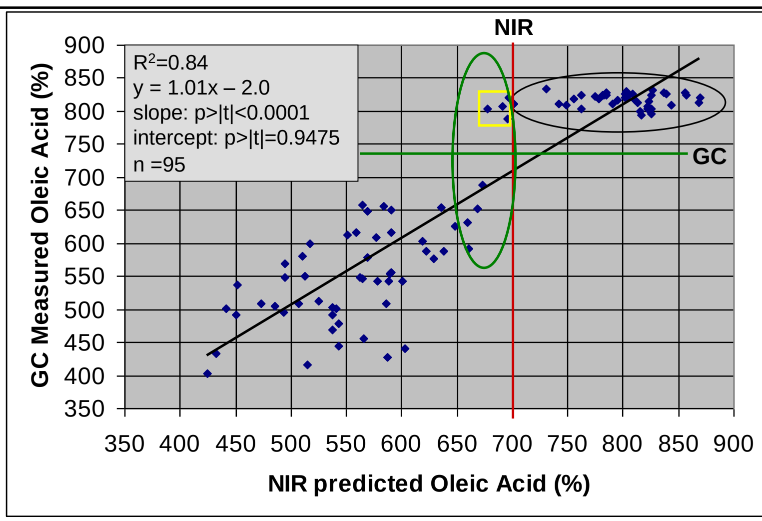
Source: R.W. Mozingo, et. al. Peanut Science (2004) 31:45-50

Measuring oil and fatty acids

- Gas chromatography (GC)
  - Accurate
  - Always destructive/injurious
  - Time consuming (15-20 min./sample)

- Near infrared reflectance (NIR)
  - Less accurate
  - non-destructive
  - Fast (3-5 min./sample)

Iteration 1 *validation*- Oleic Acid
4 out of 43 HO kernels were misclassified by NIR



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Breeding Process & Program Philosophy

Research to Improve Processes

Ultimate Goal

NIR to predict chemistry

Predict seed quality

Improve efficiency of basic tasks

Peanut Breeding Process

Improved Cultivars

Identify new germplasm with advantageous traits

New germplasm with disease resistance

Transgenics, Molecular markers

Peanut flowers are self-pollinating

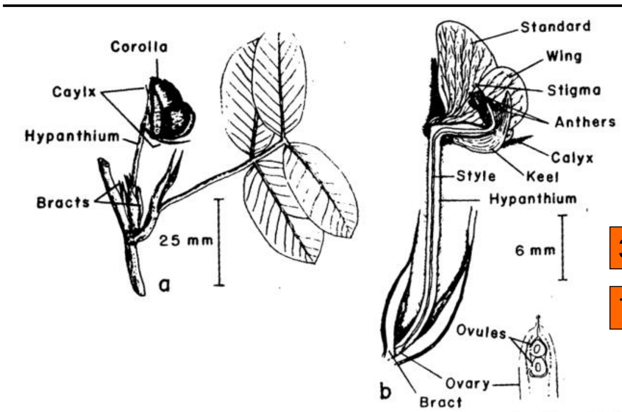
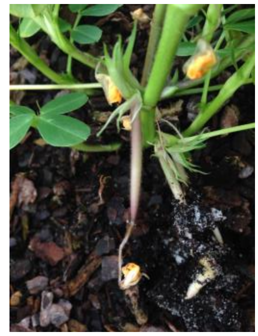


Figure 10-2 (a) Peanut inflorescence with flower in leaf axil, and (b) longitudinal schematic drawing of the flower. From *Hybridization in Crop Plants*, p. 447, by permission of the Crop Science Society of America and American Society of Agronomy. (After Smith, 1950)

3-4 pm emasculate

7-8 am pollinate

Crossing is tedious



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Cultivar Development Process:

pedigree method, early generation testing, one generation per year

Visual Selection

80-90 crosses per year

F_1 in Citra, FL, NIR for oleic

F_2 & F_3 in Marianna
Selected for pod, TSWV, FA

$F_{3:4}$ in Marianna- generation adv.
$F_{3:4}$ in Ctira- yield and grade

Data driven selection

$F_{4:5}$ in Marianna, Citra
Yield and grade, FA

$F_{4:6}$ Yield/Grade-optimal
TSWV, leafspot, CBR, nematode

6000 YT plots **2400 BN iplots**

$F_{4:7}$
2-3 location YT: MR, GV, JY
Optimal & disease conditions

$F_{4:8}$
2-3 location YT: MR, GV, JY
Optimal & disease conditions

$F_{4:9}$
1) 3 loc. YT: MR, GV, JY optimal conditions
2) YT: TSWV, White Mold, CBR, nematode, leafspot
3) Three best lines in the UPPT

Release decision: 8-9 years
Seed Production: 3 years

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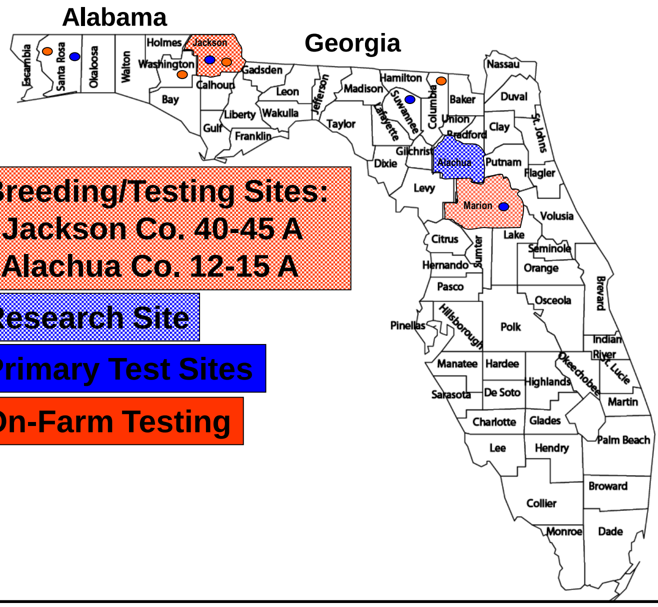
Research and testing sites



Breeding/Testing Sites:
- Jackson Co. 40-45 A
- Alachua Co. 12-15 A

Research Site

Primary Test Sites

On-Farm Testing

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An example of Cultivar Development: Timelines leading up to TSWV epidemic

1971
PI203396- leafspot resistant

1972
PI203396 crossed with Florunner

1984
Southern Runner released

1985+/-
Southern Runner crossed with Sunbelt Runner

1995
Georgia Green released

1997-Tomato Spotted Wilt Virus causes severe losses

1972-96
Florunner, GK-7, etc.
Most very susceptible to TSWV

Southern Runner discovered to have resistance to TSWV derived from PI203396

1997-04
Georgia Green, C-99R
Both have PI203396 in parentage

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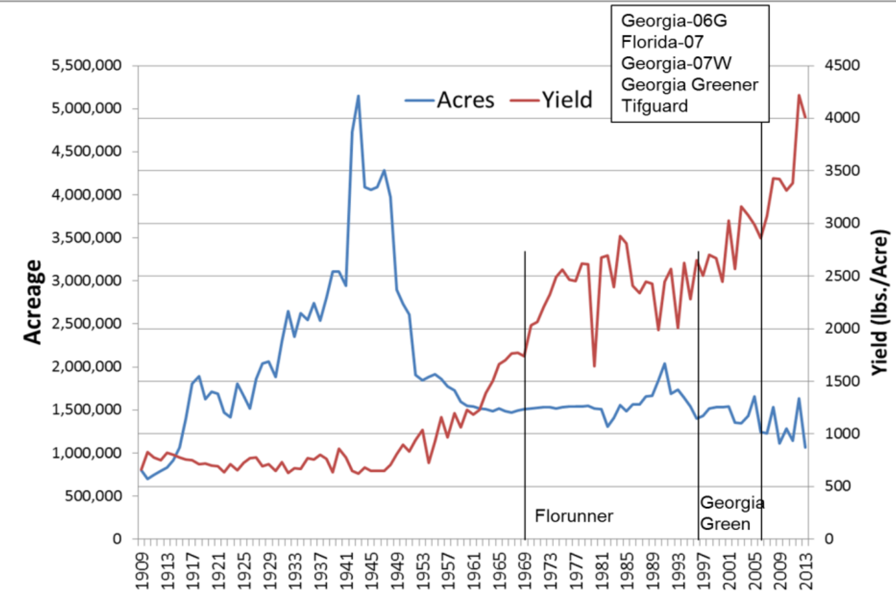
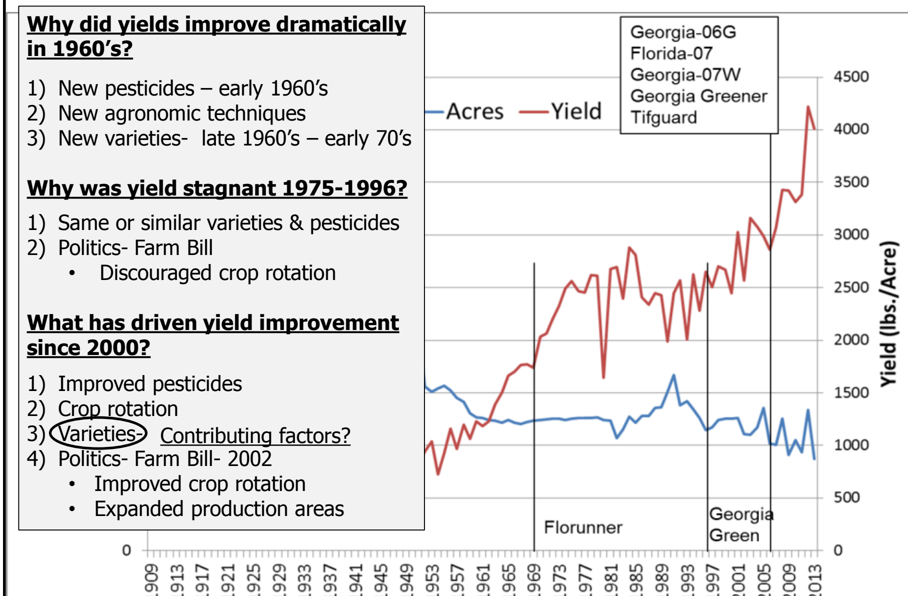
Peanut yields in USA have increased over time



Peanut yields in USA have increased over time



Why did yields improve dramatically in 1960's?

1) New pesticides – early 1960's
2) New agronomic techniques
3) New varieties- late 1960's – early 70's

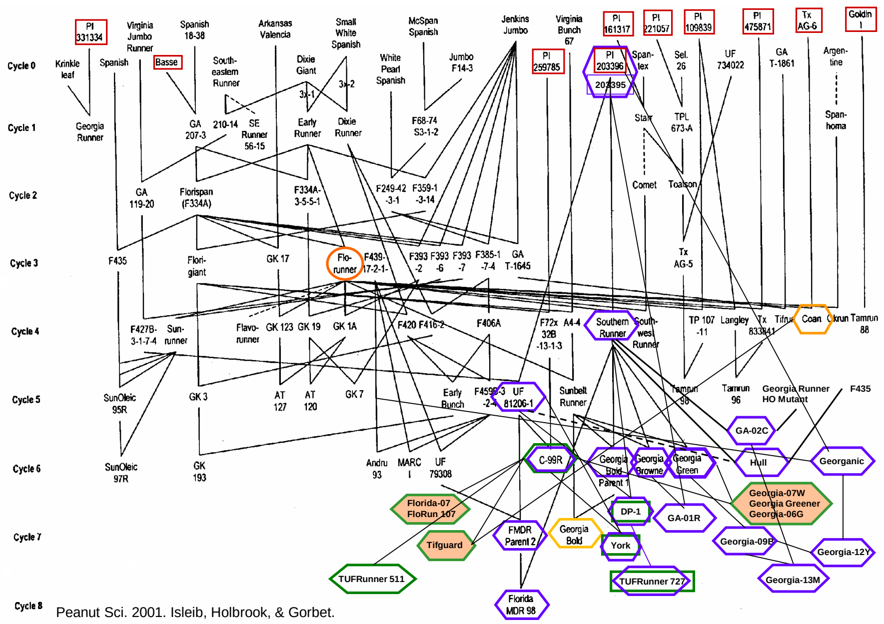
Why was yield stagnant 1975-1996?

1) Same or similar varieties & pesticides
2) Politics- Farm Bill
   - Discouraged crop rotation

What has driven yield improvement since 2000?

1) Improved pesticides
2) Crop rotation
3) Varieties- Contributing factors?
4) Politics- Farm Bill- 2002
   - Improved crop rotation
   - Expanded production areas

Plant introductions used in peanut breeding



Peanut Sci. 2001. Isleib, Holbrook, & Gorbet.

	PI203396	Southern Runner	C-99R
Parent	Southern Runner Georganic Georgia-01R Tifrunner	Georgia Green Georgia-09B DP-1	***Florida-07*** ***FloRun 107*** ***Georgia-06G*** ***Georgia-07W*** ***Georgia Greener*** ***Tifguard*** **TUFRunner 511** York
Grandparent	**Georgia-12Y** C-99R DP-1 York	Georgia-01R **TUFRunner 727** **Georgia-13M**	**TUFRunner 297**
Great grandparent	**Georgia-13M** Georiga-01R **TUFRunner 727** ***Florida-07*** ***FloRun 107*** ***Georgia-06G*** ***Georgia-07W*** ***Georgia Greener*** ***Tifguard***		

Over 90% of SE acreage

Implications: 1) better disease resistance and yield potential
2) more variation in seed size and seed vigor
3) more variation in maturity

NAPB Annual Meeting

"Identifying and utilizing genetic diversity"

27-30 July 2015, WSU Pullman, WA

https://www.plantbreeding.org/annual-meeting-2015

Registration Deadline- June 1st

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