Cottonseed Quality – Public Breeders

Fred Bourland, University of Arkansas

Change in seed index (weight of 100 seed):

Size Categories, 1920 Duggar		Seed index 2018	Fuzzy seed/lb	2018 Ark Var Test	2018 Main	2018 1st yr	2018 Conv
Large	≥ 13 g		≤ 3492				
Medium	10 - 12.9 g	11.1-**12.1** g	3752-4090	13	3	9	1
		10.1-11.0 g	4127-4495	29	7	15	7
Small	< 10 g	9.1-10.0 g	4540-4989	29	8	16	5
		8.2-9.0 g	5044-5537	9	3	4	2
Duggar, J.F. 1920. Southern Field Crops. The Macmillan Co., NY		2018 range in seed index: 8.2 g (DG 3433 B2XF) to 12.1 g (ST 5020 GLT), 48% difference, low to high					

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Cottonseed Quality – Public Breeders
1967 Beltwide Joint Session

1967 Beltwide Proceedings – 6 papers on seed quality. pp. 177-206. References to seed index were scarce:

Niles. "Cotton seed quality (from the agronomist-geneticist viewpoint). pp. 177-188.

Defined seed quality:

1. Sound seed coat, free of cuts and physical damage
2. Freedom from internal infection by seed-borne disease pathogens.
3. Properly processed to remove immature seed, excess lint, foreign seeds and extraneous matter
4. High germinability and emergence over a range of temperature conditions

Only 2 references to seed size:

1. Porterfield and Smith, OK AES Tech Bull T-60. 1956. Graded seed of 3 varieties by size, and showed highest emergence occurred with medium sized seed.
2. "Practical aspects of seed size are recognized by many seedsmen when they cull largest and smallest seed during processing of planting seed"

Cottonseed Quality – Public Breeders
1978 Beltwide Joint Session

1978 Beltwide Proceedings – 7 papers on seed quality. pp. 210-225. –
References to seed index were scarce:
Bird et al. pp. 217-219. "Determining biological performances for cotton planting-seed"

- S-72 Regional Project – 5 cultivars, seed produced at 2 locations, seed separated by density into 3 sub-samples.
- Independent variables: 73 laboratory measurements in 1st year, 49 in 2nd year (35 both years).
- Dependent variables: Field performance at 7 multi-state sites over 2 years.

Indep. variables most closely rel to field perf.:	Damping-off	Stand	Earliness	Yield
% damaged seed, multi-cut	+ , -	- , -	+ , -	+ , -
Total germination, % of check	+ , -	+ , +	+ , +	+ , +
Velocity of germination, 18C	- , -	- , +	- , -	- , +
Total germination, % 18C	+ , +	+ , +	- , +	+ , +
Seed index, acid-delinted	- , -	- , -	+ , -	- , -
Leachate, resistance to conductivity	- , -	+ , +	- , -	+ , +

Cottonseed Quality – Public Breeders
Bourland Dissertation

F.M. Bourland. 1978. Inheritance and interrelationships of several seed and seedling characteristics of cotton. Diss. Texas A&M U.
Genetic evaluation of selected seed and seed-coat traits in cotton. J. of Heredity 74:118-120.

- High seed weight related to:
  - Higher seed volume (r = 0.97)
    - Thus, little variation in seed density
  - Lower lint % (r = -0.38)
  - Lower linters % (r = -0.28)
- High lint % related to lower linter % (r = -0.60)

- Heritability: Seed weight (48.8); lint % (40.3); linters % (32.2)

Cottonseed Quality – Public Breeders
1981 Beltwide "Treatise"

1981 Beltwide Proceedings – 12 papers "Cotton Physiology – A Treatise, Section III. Seed and Germination. pp. 266-321.

References to seed index were scarce:

Tupper and Kunze. pp.306-308. "Relation of seed density and weight to seed quality: Culling by liquid separation".

- Seed weight was best related to growth of seedlings in germinator
- Seed density had greater influence than volume & diameter on germination & root and hypocotyl growth.

Hopper. pp. 312-314. "Significance and evaluation of vigor"

- Seed density better indicator of vigor than seed index.

Bird. pp. 318-321. "Cottonseed and germination – stand establishment"

- S-72 regional project.

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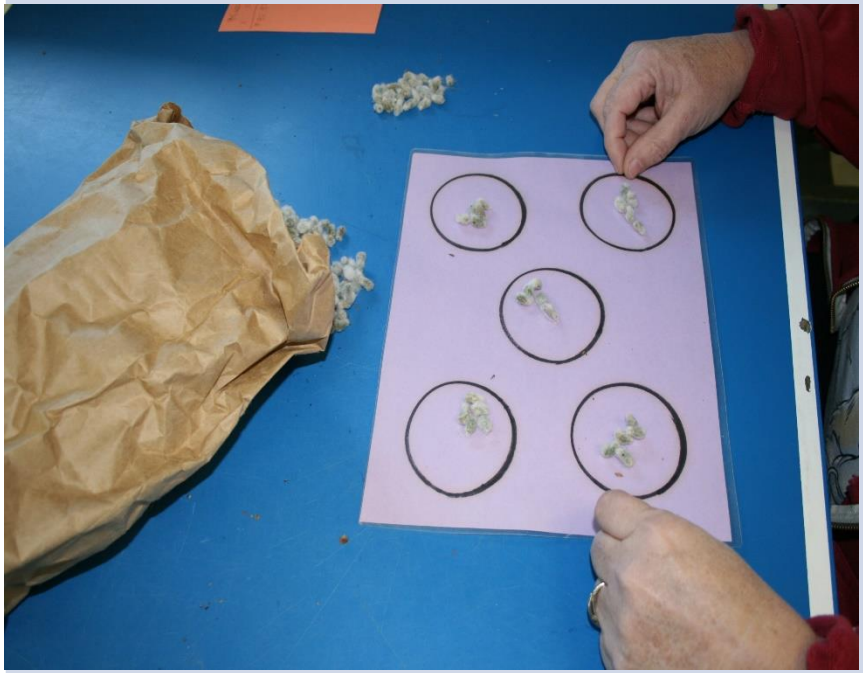
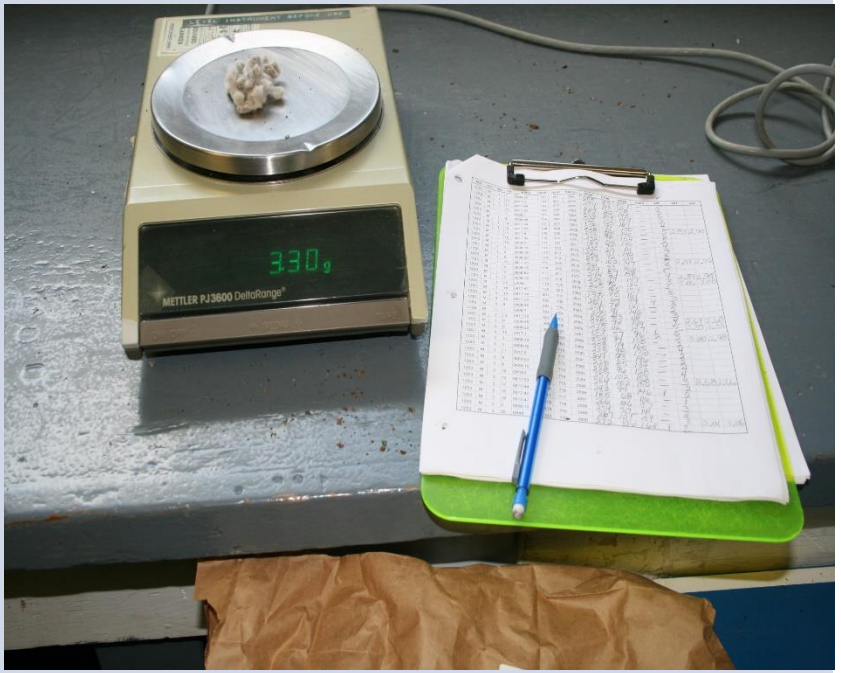
Cottonseed Quality – Public Breeders
Seed Index Measurement

Seed index/size is often overlooked because:

1. Difficult to measure - must count fuzzy seed or delint seed prior to counting. (Count 2 sets of 25, weights within 0.2 g tolerance)





2. Seed index varies greatly between and within seed lots.

Cottonseed Quality – Public Breeders
Sources of Seed Size Variation

1. **Processing (processing damage, grading)**
2. **Within a variety - different environments: Temperature, water, soil type, nutrition, pests, drainage, harvest timing – anything that affects growth and maturity of a plant and/or boll.**
3. **Within a variety - same environment:**
   a. **Plant-to-plant variation (emergence speed, spacing, segregation, off-types)**
   b. **Boll position on plant (indeterminate fruiting habit)**
   c. **Seed position in locule (medial > basal > apical)**
4. **Between varieties (genetic)**

Relative importance of sources of variation?

4 > 3 (c>b>a) > 2 > 1?

Changes in Seed Index

Two Questions:

I. **From a variety (genetic) perspective, have detectable shifts in seed index occurred in the Mississippi River Delta Region?**

II. **How does seed index relate to yield, yield components, and fiber quality traits?**

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Changes in Seed Index

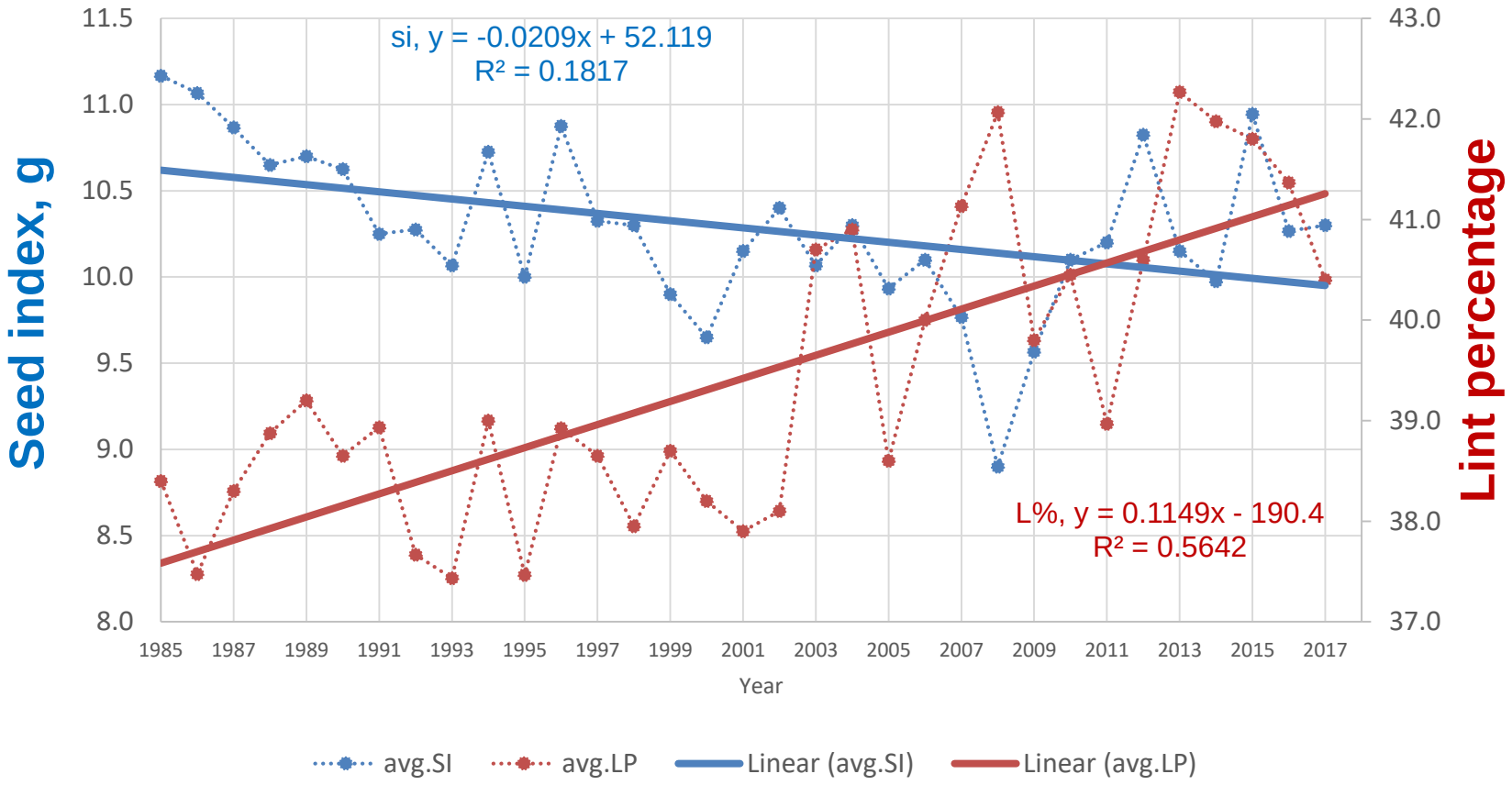
Data Set 1: 1985-2017 NCVT (32 years)

National Cotton Variety Test (NCVT)

- **https://www.ars.usda.gov/southeast-area/stoneville-ms/crop-genetics-research/docs/national-cotton-variety-test/ (1993-)**
- **Annual test conducted at >20 locations each year**
- **Delta Regional Test (1 of 8 Beltwide Regions) – Most years:**
  4 locations (same varieties at each location within a year):
  Portageville, MO
  Clarkedale or Keiser, AR
  Stoneville, MS
  Saint Joseph, LA
  10 entries = 4 national and 6 regional checks
- **Boll samples from 2 reps → Seed index (weight of 100 fuzzy seed) and lint percentage (100* lint weight / sample weight) plus seed and fiber samples for analyses.**
- **Lint yield from 4 reps**

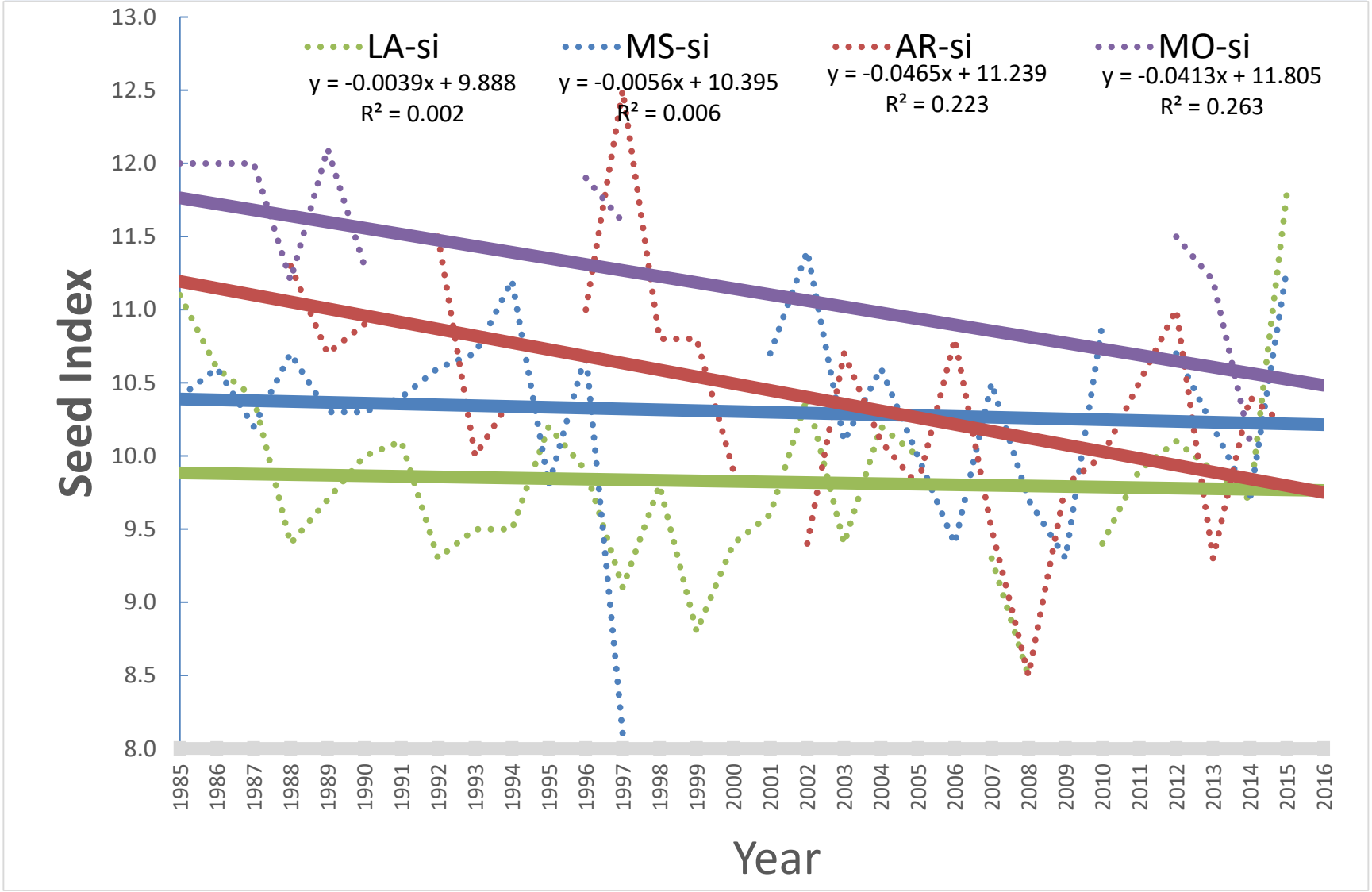
Changes in Seed Index

Data Set 1: 1985-2017 NCVT (32 years)



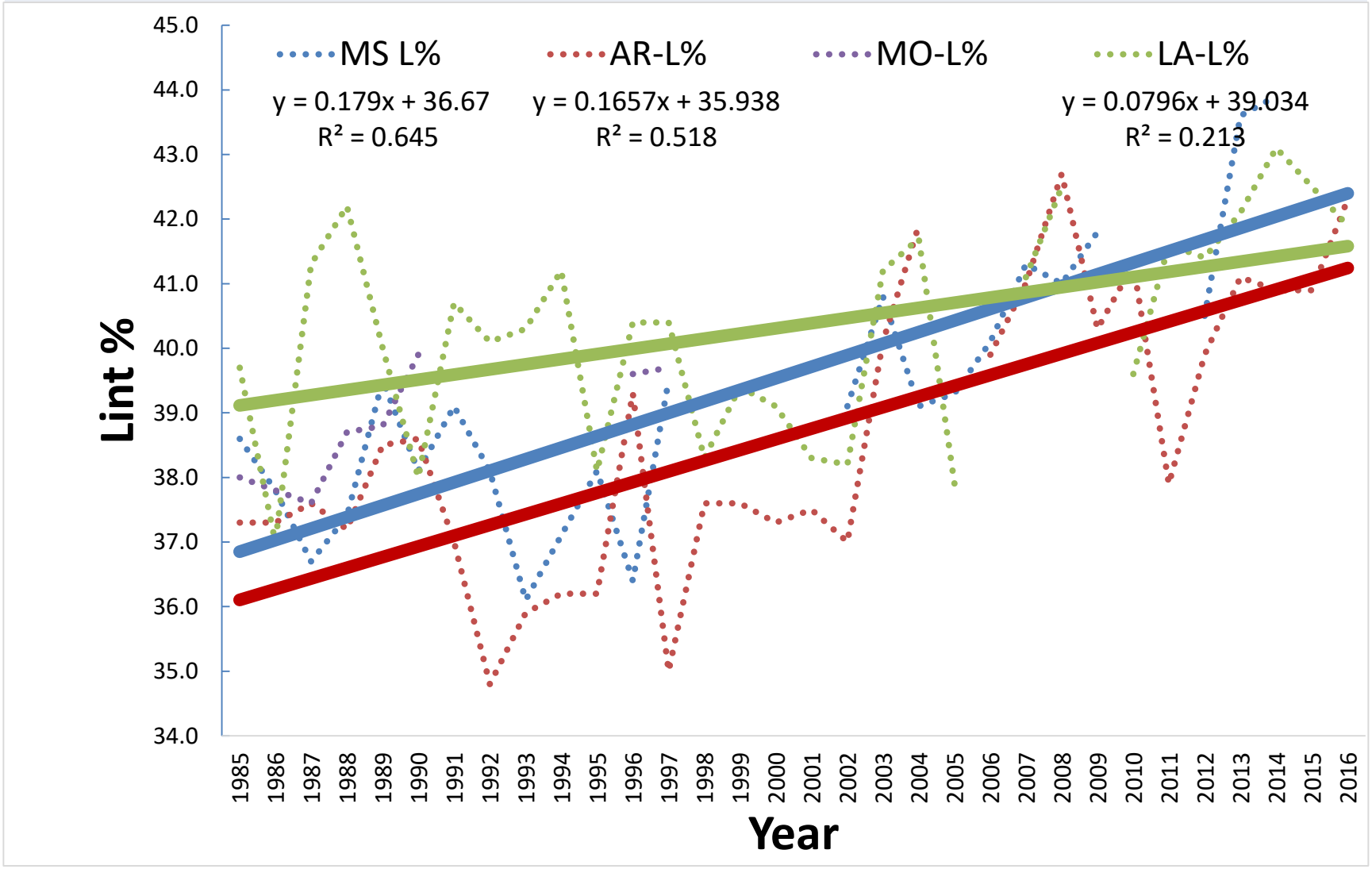
Changes in Seed Index

Data Set 1: 1985-2016 NCVT (31 years)

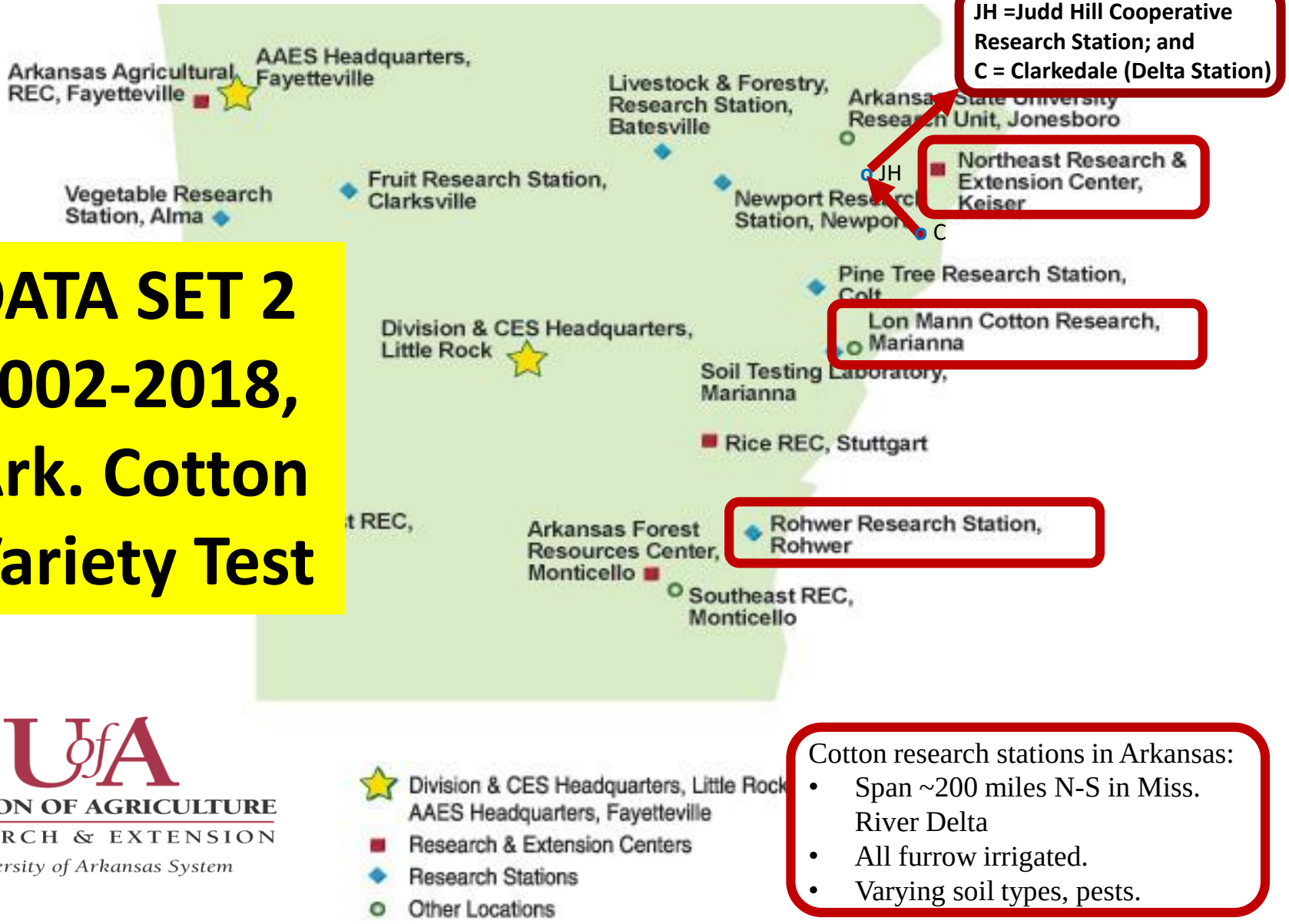


Changes in Lint Percentage

Data Set 1: 1985-2016 NCVT (31 years)



Arkansas Agricultural Experiment Station Locations



DATA SET 2 2002-2018, Ark. Cotton Variety Test

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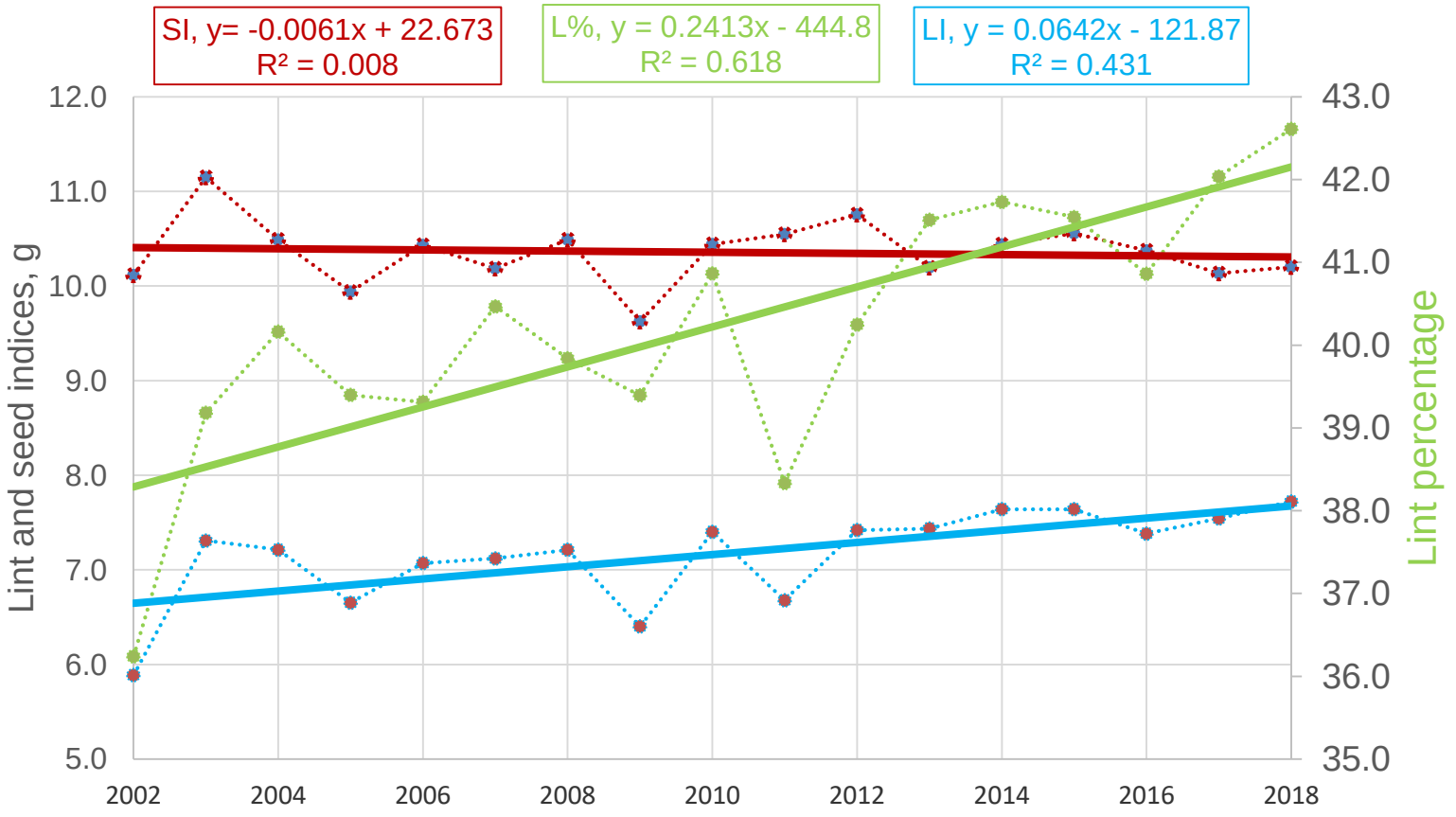
Cotton research stations in Arkansas:

- Span ~200 miles N-S in Miss. River Delta
- All furrow irrigated.
- Varying soil types, pests.

Changes in Seed Index

Data Set 2: 2002-2018 Ark Cotton Variety Test

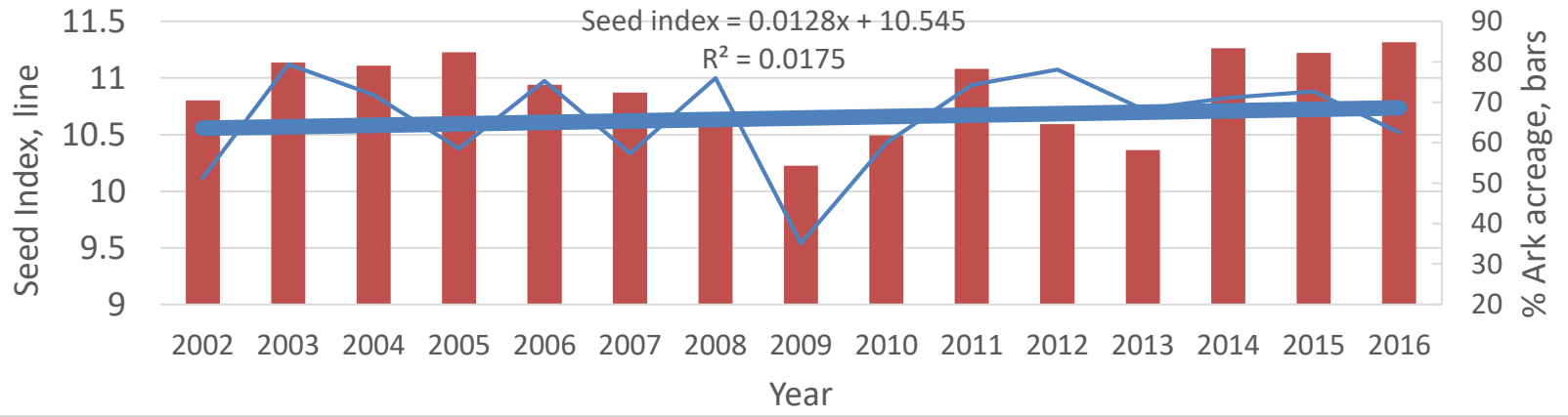
Average over all locations (Kei, C-JH, Mar, Roh)

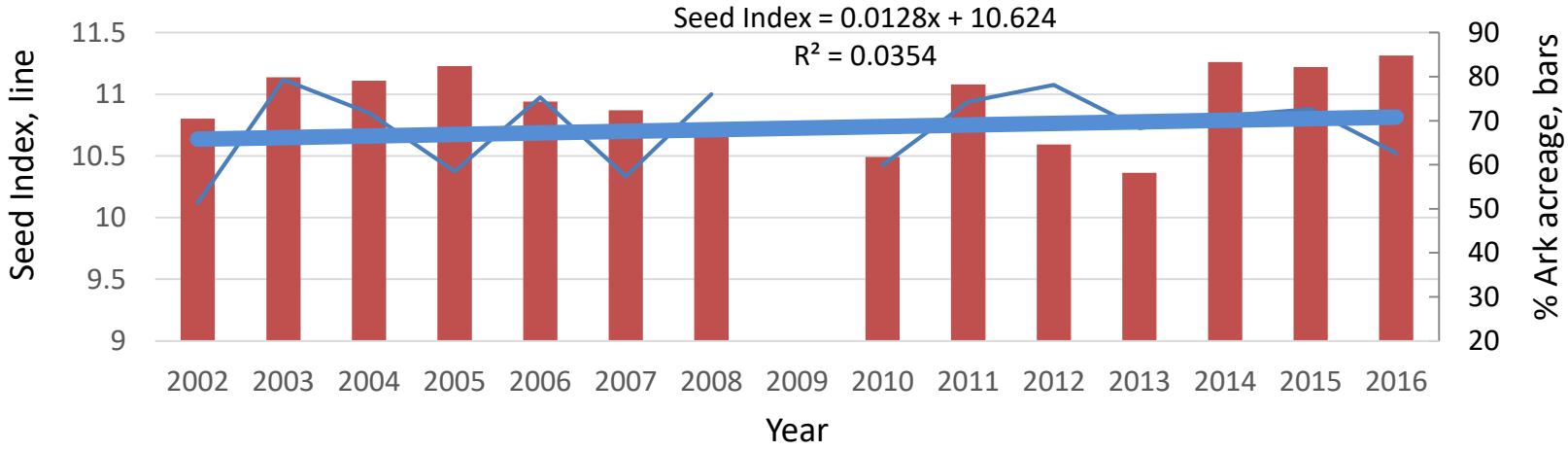


Changes in Seed Index

Data Set 2: 2002-2016 Ark Cotton Variety Test

Seed Index of 5 Most-planted Cotton Varieties in Arkansas

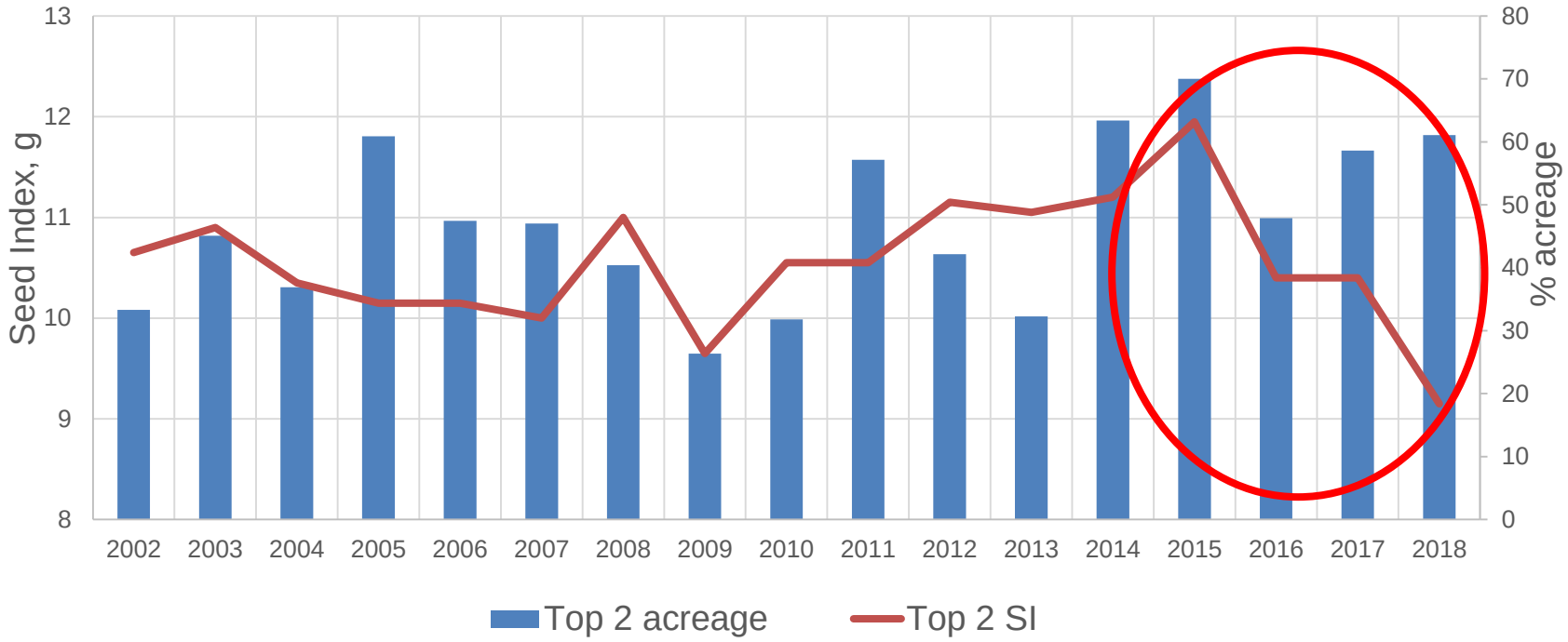




Changes in Seed Index

Data Set 2: 2002-2018 Ark Cotton Variety Test

Seed Index of 2 Most-planted Cotton Varieties in Arkansas



Seed Index Relationships

Data Set 2: 2002-2018 Ark Cotton Variety Test

Correlations with Seed Index by Years (17)

Variable group	Variable	Years positive	Years negative	Years non-sign.
Yield	Lint yield	5 (+0.337)	6 (-0.225)	6
	Lint percentage	0	**15 (-0.404)**	2
Yield Components	Seed per acre	2 (+0.326)	**12 (-0.370)**	3
	Lint index	**17 (+0.579)**	0	0
	Fibers per seed	**14 (+0.340)**	0	3
	Fiber density	2 (+0.366)	**15 (-0.301)**	0
Fiber Quality	Quality score	9 (+0.226)	0	8
	Micronaire	**11 (+0.290)**	2 (-0.250)	4
	Length	13 (+0.302)	0	4
	Strength	10 (+0.249)	1 (-0.257)	6

Lint Yield Relationships

Data Set 2: 2002-2018 Ark Cotton Variety Test

Correlations with Lint Yield by Years (17)

Variable group	Variable	Years positive	Years negative	Years non-sign.
Yield	Lint percentage	**14 (+0.401)**	0	3
Yield Components	Seed per acre	**17 (+0.876)**	0	0
	Seed index	5 (+0.337)	6 (-0.225)	6
	Lint index	**13 (+0.400)**	0	4
	Fibers per seed	**10 (+0.370)**	2 (-0.272	5
	Fiber density	**11 (+0.300)**	1 (-0.597)	5
Fiber Quality	Quality score	0	5 (-0.192)	12
	Micronaire	9 (+0.326)	3 (-0.188)	5
	Length	3 (+0.226)	9 (-0.298	5
	Strength	1 (+0.199)	9 (-0.303)	7

Changes in Seed Index

- **Current cotton varieties vary greatly in seed size.**
- **This variation is mostly coincidental, i.e., little or no direct selection for seed size.**
- **Seed size and lint percentage are linked.**
- **Issue with small seed size likely associated with a few widely planted varieties.**
- **Seed size is intrinsically related to yield components.**

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Yield and Yield Components

TOP TEN Varieties in 2018 – Arkansas: Lint yield

Rk, yld	Variety	Lint yield, All loc	Man., Sandy	Kei., Clay	J. H., Vert.	Mar., mid.	Roh., s.Ark.,
		lb/a	Rank by location				
1	DP 1725 B2XF	1606	1	16	1	2	3
2	DP 1646 B2XF	1580	2	9	11	1	1
3	ST 4949 GLT	1529	4	10	3	3	4
4	PHY 312 WRF	1512	8	1	2	6	15
5	DP 1518 B2XF	1491	15	2	7	8	6
6	PHY 444 WRF	1481	6	11	5	11	5
7	CROPLAN 9608	1477	7	14	12	4	2
8	DG 3385 B2XF	1473	3	3	10	9	18
9	PHY 430 W3FE	1438	5	7	6	20	8
10	DP 1614 B2XF	1431	11	17	8	5	7
	Variety x Location	***					

Yield and Yield Components

TOP TEN Varieties in 2018 – Ark.: Yield Components

Rk, yld	Variety	Lint yield, All loc	Lint %	Seed index	Lint index	Seed/ acre	Fibers /seed	Fiber den.
		lb/a	Rank, out of 21 varieties					
1	DP 1725 B2XF	1606	1	19	12	3	14	3
2	DP 1646 B2XF	1580	8	20	20	1	21	15
3	ST 4949 GLT	1529	3	12	3	9	5	4
4	PHY 312 WRF	1512	16	4	7	8	7	14
5	DP 1518 B2XF	1491	19	16	21	2	18	17
6	PHY 444 WRF	1481	11	2	1	16	1	5
7	CROPLAN 9608	1477	2	21	18	4	11	1
8	DG 3385 B2XF	1473	16	8	11	6	16	18
9	PHY 430 W3FE	1438	6	9	4	14	2	2
10	DP 1614 B2XF	1431	4	18	14	7	19	19
	Variety x Location	***						

Yield and Yield Components

TOP TEN Varieties in 2018 – Ark.: Yield Components

Rk, yld	Variety	Lint yield, All loc	Lint %	Seed index	Lint index	Seed/ acre	Fibers /seed	Fiber den.
		lb/a	Ranks over locations					
1	DP 1725 B2XF	1606	1	19	12	3	14	3
2	DP 1646 B2XF	1580	8	20	20	1	21	15
3	ST 4949 GLT	1529	3	12	3	9	5	4
4	PHY 312 WRF	1512	16	4	7	8	7	14
5	DP 1518 B2XF	1491	19	16	21	2	18	17
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8	DG 3385 B2XF	1473	16	8	11	6	16	18
9	PHY 430 W3FE	1438	6	9	4	14	2	2
10	DP 1614 B2XF	1431	4	18	14	7	19	19
	Variety x Location	***						

Lint yield (lb/a) of UA212ne
2014-2017 Strain Tests, 4 Ark. loc, 4 years
(UA212ne, patent pending)

Variety	All	Keiser	Judd Hill	Marianna	Rohwer
UA212ne	1110	895	1155	1335	1030
DP 393	1015	936	1095	1066	965
UA48	968	851	1054	1032	927
LSD0.10	45	87	88	65	77

Adaptation

- Lowest relative yield at Keiser, northeast Ark. site on clay soil.
- Judd Hill, Marianna, & Rohwer (all silt loam) span ~200 miles N-S in Delta of Ark.
- 2016 RBTN (http://rbtn.cottoninc.com/files/), 13 loc from VA to CA.
  - ✓ 2nd highest yielding entry of 28 entries (1 lb/a < highest one)
  - ✓ Significantly higher yield than 4 checks and equal to 5th (UA222)
  - ✓ Yield equal to highest yielding lines at each of 13 sites.

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Yield components of UA212ne
2014-2017 Strain Tests, 4 Ark. loc, 4 years
(UA212ne, patent pending)

Variety	Lint fraction	Seed per acre	Lint index	Seed index	Fibers per seed	Fiber density
UA 212ne	42.2	6.243	8.0	10.7	17177	162
DP 393	39.5	6.098	7.6	11.3	15646	141
UA48	37.8	5.735	7.7	12.3	13840	117
LSD0.10	0.7	0.323	0.2	0.4	573	6

Morphological characteristics

- Leaf pubescence (“semi-smooth-leaf”) and stem pubescence, equal to DP 393.
- Bract trichomes lower (smoother) than DP 393 and UA48.
- Nectariless = Absence of nectaries on leaves and fruit.

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Changes in Seed Index

Conclusions

- **Average seed size produced by varieties in NCVT (32 years) and in the Arkansas Cotton Variety Test (17 years) have trended downward, BUT seed index of most frequently planted varieties in Arkansas has declined drastically since 2015.**

- **Lint percentage and lint index (lint per 100 seed) have increased in both tests. These trends have led to lower weight of seed per bale of lint produced.**

- **Within years, lower seed index (weight per 100 seed) was consistently related to:**
  - **Higher: Lint percentage, seed per acre, and fiber density**
  - **Lower: Lint index, fibers per seed, length, micronaire, strength, and quality score.**
  - **Inconsistently related to yield.**

- **Using available genetic variation, trends toward smaller seed can be broken by judicious selection without negatively impacting yield.**