Effects of "Bollie" Lint on Cotton Quality

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Harvesting cotton with the mechanical stripper is a non-selective process. Bolls on the plant, regardless of their condition, are removed by the stripping rolls. Although some strippers have provisions for separating green bolls from the stripped material, most of the dry, immature bolls resulting from insect, disease, or weather damage remain in the harvested material.

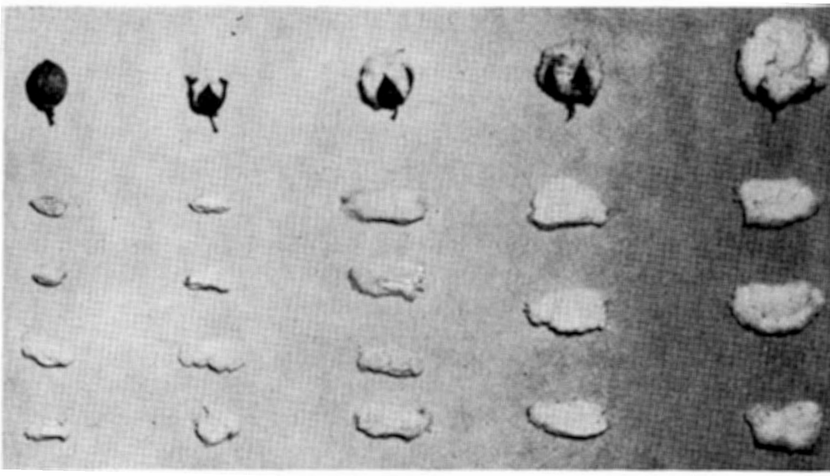
The presence of immature or damaged bolls in stripped material is frequently assumed to affect cotton quality adversely. Research reported herein was made to determine the effects of immature bolls on lint value factors, fiber properties and spinning performance of stripper-harvested cotton.

Nature of the Tests

These tests were conducted for three years from 1960 through 1962. While the exact details varied somewhat from year to year, the basic procedure was to gin and evaluate cotton which had various levels of mature lock content. In this study, mature lock content was defined as the difference between total locks and "bollie" lock content. Mature lock contents were determined on a weight basis and expressed as a percent of the total locks entering the gin stand. Mature locks were so classified only if they showed no evidence of discoloration, abnormal development, non-fluffiness, or damage due to insects, disease, or weather. (See illustration on page 4). During the three years, mature lock contents ranged from 13 to 98 percent. The lower figure typifies stripper-scrapping of cotton which had previously been hand snapped or machine picked leaving only the damaged or frost-opened bolls for the scrapping operation. The upper figure might exemplify a very careful and selective hand snapping of the most elite portion of the crop. Cotton harvested by normal hand snapping in a once-over operation averaged approximately 87 percent mature locks in these tests.

[1]Stationed at Oklahoma Cotton Research Station, Chickasha, operated jointly by the Oklahoma Agricultural Experiment Station and the U.S. Department of Agriculture, in cooperation with the Oklahoma Cotton Research Foundation.

Research reported herein was done under Oklahoma Station Project Number 753.



Typical range from "bollies" and bollie locks to mature bolls and locks, left to right.

Test Material and Procedures

Parrott variety cotton which yielded approximately one bale per acre was used for tests in 1960. Lankart 57 was used in 1961 and 1962. The nominal yields were respectively one-half and one bale per acre. All cotton used in these tests was grown without irrigation on the Oklahoma Cotton Research Station, Chickasha.

In 1960, cotton was harvested after frost by four methods: (1) Selective hand snapping in which only the obviously fully matured and developed bolls were harvested. Any boll which was only partially opened or which appeared to contain any damaged or immature locks was left on the plant: (2) Normal hand snapping in which all bolls were harvested except those having a high proportion of immature locks; (3) Machine stripping of the material remaining on the plants after selective hand snapping; and (4) Machine stripping of the material remaining on the plants after normal hand snapping.

Mature lock contents were determined for these four classes of material from samples taken while harvesting. From these four classes, seven treatments, each with a different mature lock content, were compounded for the ginning test. Four of these treatments consisted of ginning the four previously described classes without alternation of their mature lock content. The other three treatments were fabricated by manually mixing appropriate portions of the normally hand snapped material and machine stripped bollies (class 4) to yield intermediate mature lock contents.

The 1960 harvesting required several days to complete; therefore, a different harvesting procedure was used in 1961 to reduce the risk of weather changes. All cotton used in the test, including bollies, was hand snapped in a once-over, non-selective harvest operation during a two-day period after frost. In the laboratory, all mature locks or bolls were hand separated from a portion of the harvested material. These mature locks formed the elite category of test material. Another consisted of the remains of the material from which the mature locks were removed. The unaltered material as harvested provided a third category. A fourth category was obtained during ginning by processing a portion of the unaltered harvested material through the green boll trap to remove some of the bollies. The fifth category consisted of the bollies thus removed.

A different procedure was used in 1962 in an attempt to secure a wider range and more uniform distribution of mature lock contents for ginning. Cotton was harvested in late October by hand snapping, but all green bolls and bollies were left on the plants. The material thus harvested was not used as a part of the test. This procedure established a supply of damaged or late-maturing bolls which could then be harvested after frost without contamination by the already mature bolls. The material remaining on these plants was hand snapped in mid-December; this formed one category of test material. A second category was formed by selectively hand snapping only the most elite portion of the crop in early December. The material remaining on the plants following the selective harvest of elite bolls was then hand snapped to form a third category. A fourth category was hand snapped in mid-December in a normal, once-over operation, leaving most of the severely damaged or grossly undeveloped bolls on the plant. A fifth category of test material was formed during ginning by processing a portion of the normally hand snapped material through the green boll trap to remove some of the bollies. The sixth category consisted of the bollies removed by the green boll trap from the material hand scrapped following the October harvest.

In each year of the test series, each category of material was processed through a 4-cylinder air-line screen cleaner, 14-foot burr machine, 7-cylinder inclined screen cleaner, extractor-cleaner-feeder, 80-saw gin stand, and two saw cylinder lint cleaners in series. The first cylinder of the air-line cleaner was operated at 1000 rpm to serve as a boll breaker; the other cylinders rotated at 400 rpm. The material passed through the green boll trap only when it was desired to alter the mature lock content of some test categories. No gin drying was used during any of the three years.

During the first year of this test series, each category of material was ginned in replicated 400-pound experimental units in a completely randomized test design. During the other two years, each category was ginned without replication in one-bale units. Each year, multiple samples of seed cotton, trash, seed, and lint were taken at various stations during the ginning process. Data from these samples were statistically analyzed to determine the significance of differences associated with mature lock contents.

Test Results

An analysis of variance was made each year of the data collected for each attribute. For some attributes, this type of analysis clearly indicated a response to variations in mature lock content. But for other attributes, the statisitcal significance of mean differences was inconsistent and the nature of the response was not readily evident. Consequently the linear regression of each attribute on mature lock contents was calculated and plotted for each year in figures 1 through 24. Simple correlation coefficients were also calculated each year for each attribute. Correlation and regression calculations are summarized in Appendix A.

Statistical tests for equality of regression slopes indicated the possibility of combining the three years of data for some attributes, and calculating a single regression equation and correlation coefficient to represent the combined relationship. For other attributes, however, pooling of the three years of data was not appropriate.

Ginning Characteristics

Immature bolls often contain several non-fluffed locks which are not readily engaged by the extractor saw teeth. Also, the burr segments frequently cling tightly to non-fluffed locks and are not separated even if the lock is engaged by the saw teeth. Consequently, increases in mature lock content consistently resulted in more effective performance of the burr machine both in more nearly complete recovery of seed cotton from the harvested material and in removal of burr segments from the extracted seed cotton (figs. 1 and 2). The more effective seed cotton recovery resulted in increased gin turnout associated with increasing mature lock contents (fig. 3).

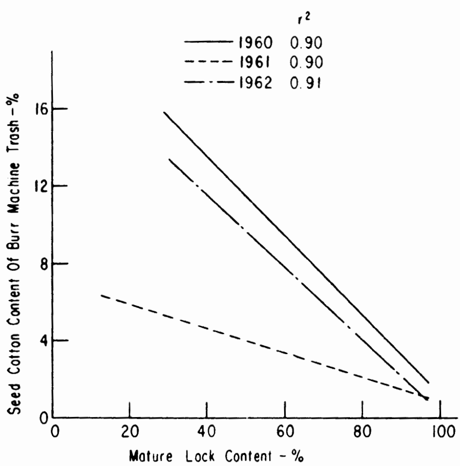


Fig. 1 Seed cotton in burr machine trash.

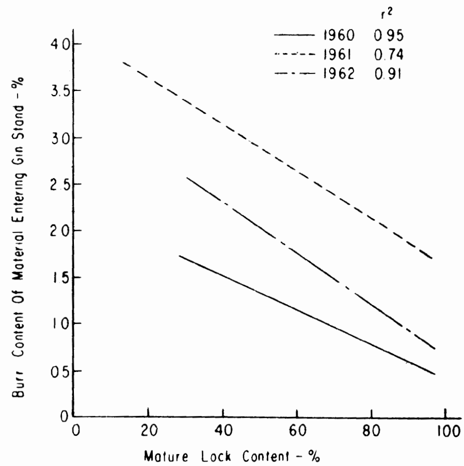


Fig. 2 Burr removal.

Increases in mature lock content reduced the amount of lint fly and nuisance dusts within the gin plant. These materials from immature bolls are particularly irritating to the respiratory passages and eyes.

Seed germination tests were made of samples from selected mature lock contents during two years. The seed germinating after four days ranged from 20 percent for the lowest mature lock content to 86 percent for the highest.

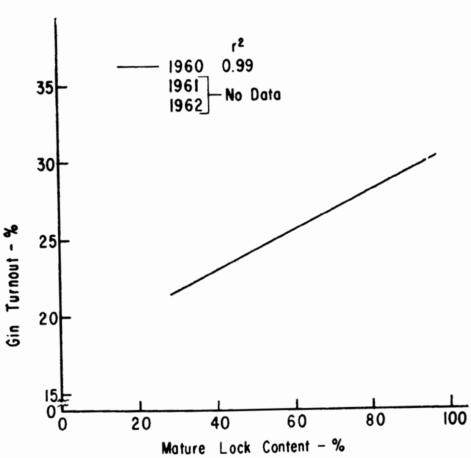


Fig. 3 Turnout.

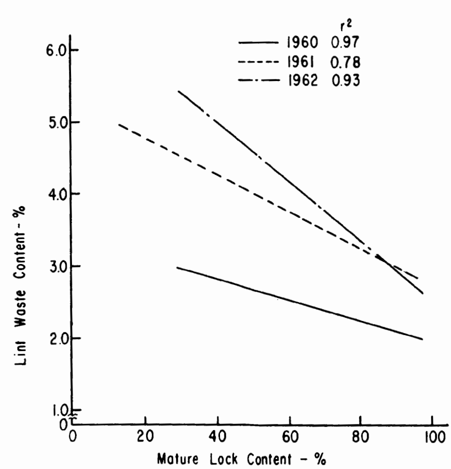


Fig. 4 Lint waste.

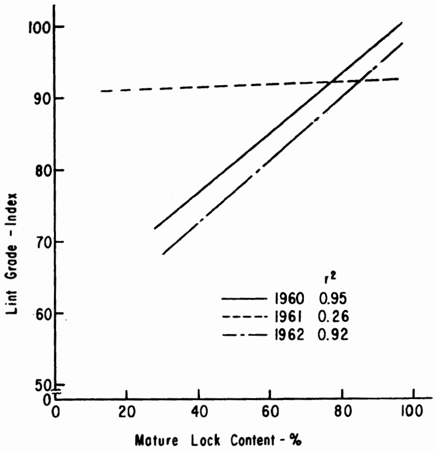


Fig. 5 Grade.

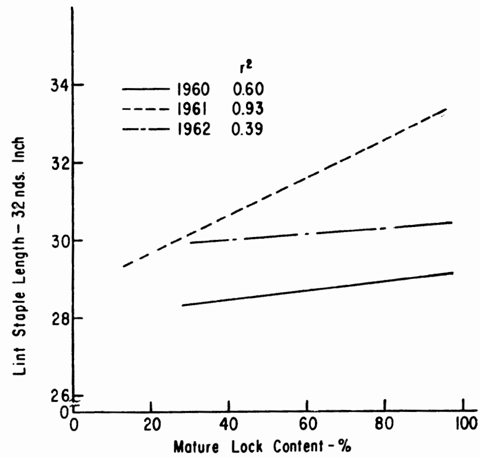


Fig. 6 Staple length.

Lint Characteristics

In all three years lint waste contents were reduced and in two years grade indices were substantially increased by increases in mature lock content. (figs. 4 and 5). More than 90 percent of the variation in these two attributes was associated with variations in mature lock content in two years. Grades ranged from Low Middling to Middling and carried color designations ranging from Tinge to White. In the third year, very little correlation between grade index and mature lock content was evident.

A noteworthy relationship between mature lock content and the classer's staple length designation was established in only one of the three years (fig. 6). In that year, all samples from the lowest mature lock content were reduced in staple length because of wastiness.

Lint values, based on government loan schedules, were highly correlated with mature lock contents (fig. 7). Lint from individual samples of selectively harvested elite cotton was valued at 30 to 33 cents per pound each year, while that from the lowest mature lock contents had a value of 18 to 23 cents per pound.

Lint yellowness decreased and lint reflectance increased with increasing mature lock contents. Variations in mature lock content explained from 93 to 99.7 percent of the variation in yellowness and reflectance (figs. 8 and 9).

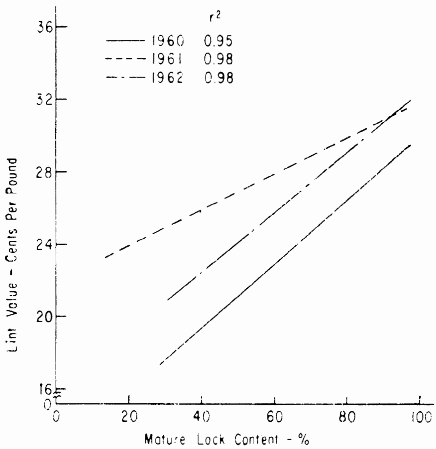


Fig. 7 Unit lint value.

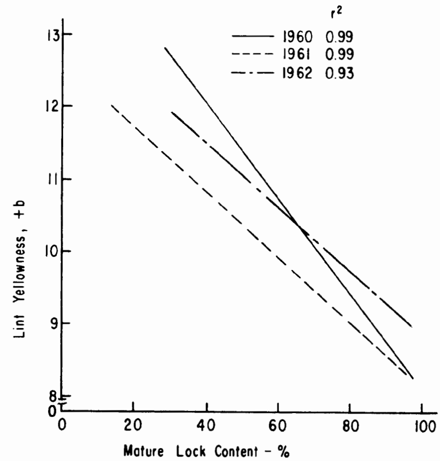


Fig. 8 Lint yellowness.

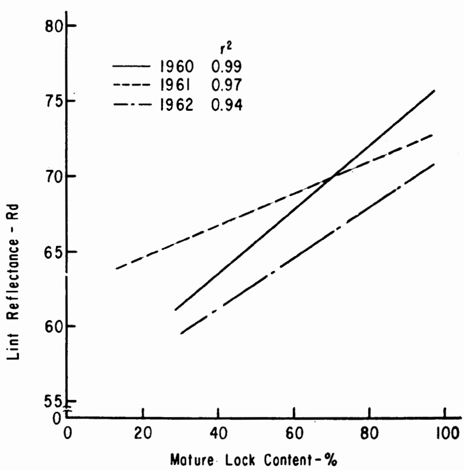


Fig. 9 Lint reflectance.

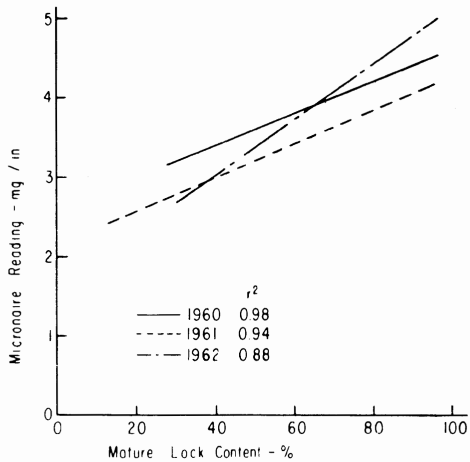


Fig. 10 Micronaire.

Fiber Properties

Micronaire readings, which are considered an indicator of fiber maturity, were also highly correlated with mature lock contents (fig. 10). With only rare exceptions, each increase in mature lock content each year was associated with a statistically significant increase in micronaire reading. The highest mature lock contents had micronaire readings 45 to 87 percent higher than the lowest mature lock contents.

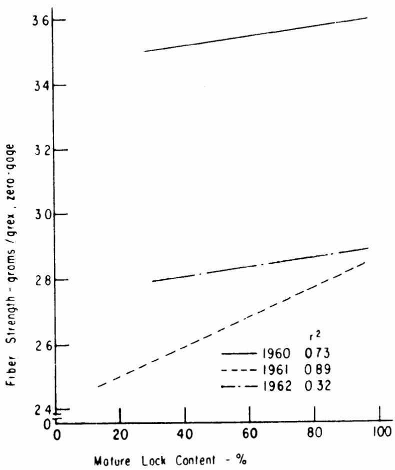


Fig. 11 Fiber strength.

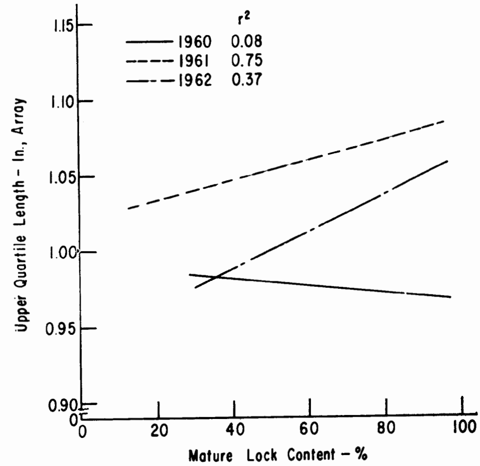


Fig. 12 Upper quartile length.

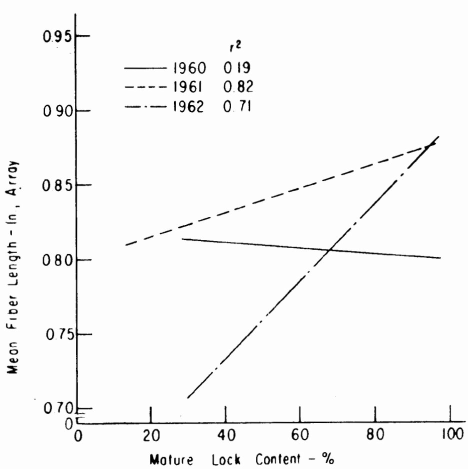


Fig. 13 Mean length.

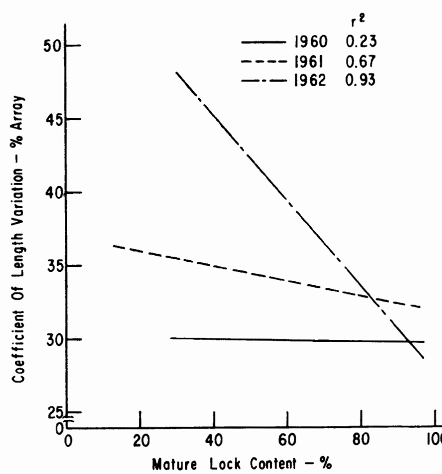


Fig. 14 Length variability.

Although zero-gage fiber strength was significantly correlated two years with mature lock content, the increase in strength from the lowest to highest mature lock contents averaged only 7 percent (fig. 11).

Upper quartile length, mean fiber length, coefficient of length variation, and short fiber content, as determined from fiber array measurements, were significantly correlated in most instances with mature lock content in 1961 and 1962, but not in 1960. (figs. 12, 13, 14, 15).

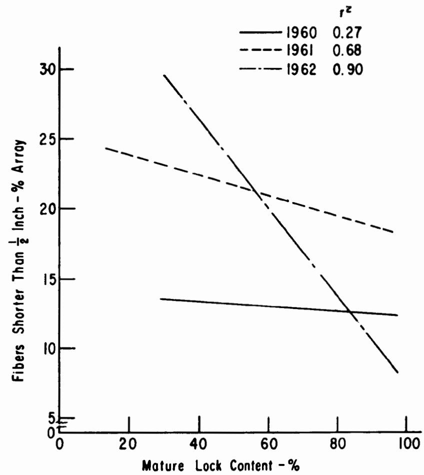


Fig. 15 Short fibers.

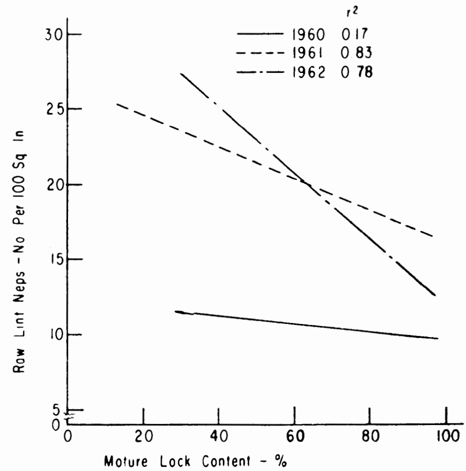


Fig. 16 Raw lint neps.

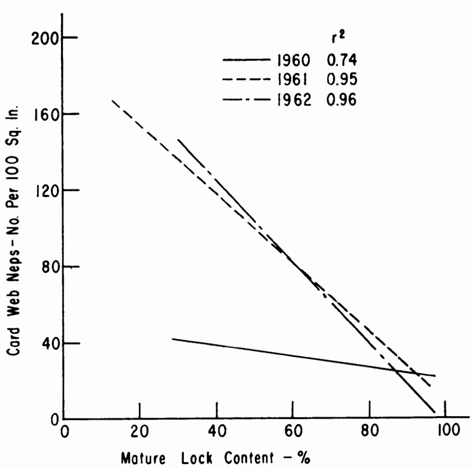


Fig. 17 Card web neps.

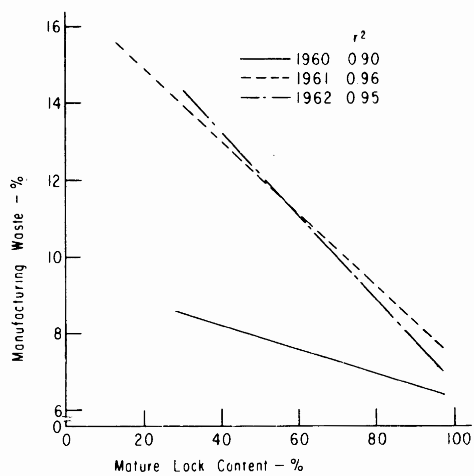


Fig. 18 Manufacturing waste.

Where significant correlations were found, all the foregoing attributes were favorably influenced by increases in mature lock content, although the amount of improvement was relatively slight in some instances.

Processing Performance

Raw lint neps, card web neps, and manufacturing waste were negatively, and usually significantly, correlated with mature lock contents

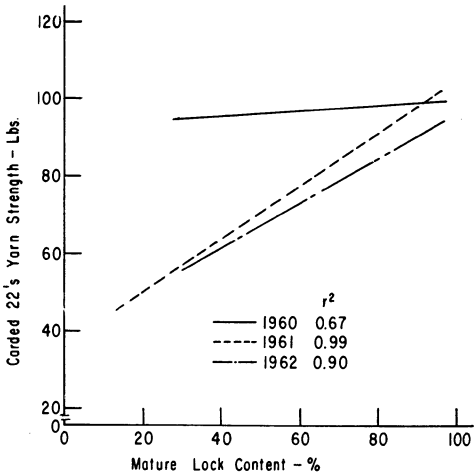


Fig. 19 22's yarn strength.

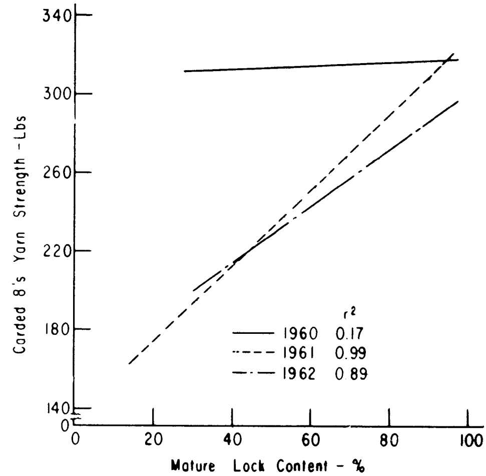


Fig. 20 8's yarn strength.

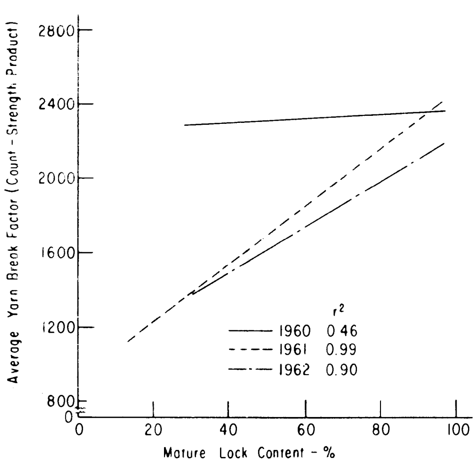


Fig. 21 Yarn break factor.

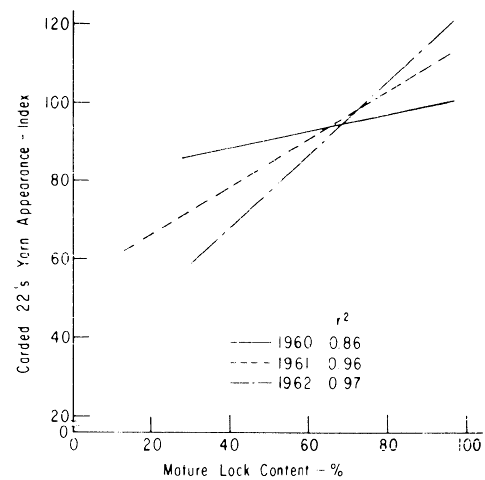


Fig. 22 22's yarn appearance.

(fig. 16, 17, 18). All measures of yarn strength and yarn appearance were in most instances significantly correlated with mature lock content (figs. 19-24). In every instance, the attributes in this group responded favorably to increases in mature lock content. In general, the measures of processing performance showed greater response to mature lock content than did those of lint and fiber properties. The 1960 data showed less correlation and less response to mature lock content than did 1961 and 1962 data for all measures of fiber length, length distribution, neps,

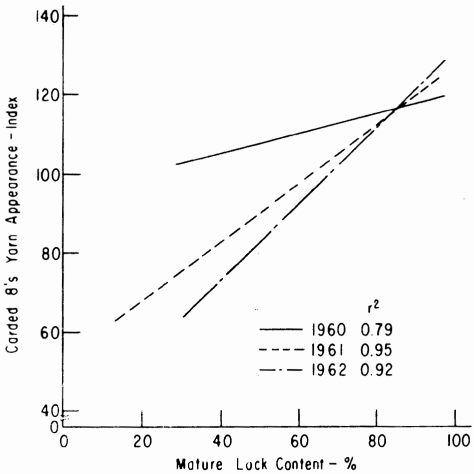


Fig. 23 8's yarn appearance.

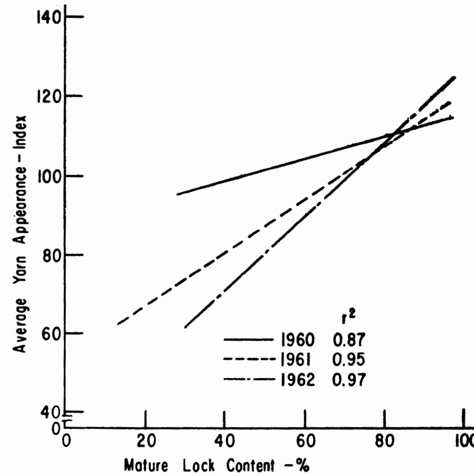


Fig. 24 Average yarn appearance.

manufacturing waste, yarn strength, and yarn appearance. Whether or not this is an indication that Parrott cotton in less sensitive than Lankart to variations in mature lock content could not be ascertained from the data.

Returns to Producer

A generalized analysis of the economic opportunity for removing immature bolls in the gin or stripper was not possible from the test data. However, a more restricted analysis was made using test data and certain assumptive procedures. Results indicated that removing, handling, ginning, and selling the lint from immature bolls separately from that of mature bolls would not be profitable for the cotton producer. The price premium commanded by lint from mature bolls was not adequate to offset the price penalty attached to lint from immature bolls. Even less attractive to the producer would be the practice of separating and discarding bollies. This suggests that the present system of evaluating and pricing lint cotton is not sufficiently sensitive to fiber properties and processing performance to encourage selective harvesting or differential ginning as possible methods of raising cotton quality.

Summary

The role of immature locks of seed cotton in lint and fiber quality, and in mill processing performance was studied for three years with stripper-type cottons grown without irrigation. Several levels of mature lock content were secured by hand fractionation and by differential harvesting and ginning procedures. Over the three-year period, 15 different mature lock contents were obtained; these ranged from 13 to 98 percent of the total seed cotton locks entering the gin stand. All cotton was ginned with machinery arrangements and amounts typical for stripper-harvested material.

Linear regression and correlation coefficients were calculated for most measured attributes to determine and define their relationship with mature lock contents. One group of attributes found to be consistently and significantly correlated with mature lock content included lint waste content, value, reflectance, and yellowness; micronaire; card web neps; manufacturing waste; and yarn appearance. Another group of attributes less consistently correlated with mature lock content included the classer's grade and staple designations, raw lint neps, and measures of fiber and carded yarn strength. Fiber length measures determined by the array method were generally less consistently and significantly correlated with mature lock content than any other group.

The influence of immature locks was **detrimental** in **every** instance where a **statistically significant correlation** was found. In only a few instances was this influence so slight that it might be considered inconsequential.

For many attributes there was no indication of a mature lock content above which no further improvement in lint and fiber properties and processing performance would occur. This suggests that removal of immature locks in any degree within the stripper or gin would likely contribute to improvements in the attributes measured. However, until the lint evaluation and pricing system adequately rewards such improvements, the cotton producer will likely realize greater net returns if no attempt is made to exclude immature locks.

APPENDIX A

Summary of regression equations and statistical values showing relation of mature lock contents to various criteria of cotton quality.

Attributes		Linear Regressions on Mature Lock Content[1] (a) Constant	(b) Coefficient	(Sy) Standard Error of Estimate[2]	Simple Correlations (r) Coefficient of Correlation[3]
1. Seed Cotton Content of Burr Mach. Trash (pct.)	1960	21.59	—0.2044	± 1.54	—0.947**
	1961	7.14	—0.0630	± 0.62	—0.950**
	1962	18.86	—0.1849	± 1.28	—0.953**
2. Burr Content of Material Entering Gin Stand (pct.)	1960	2.27	—0.0184	± .097	—0.973**
	1961	4.18	—0.0253	± .445	—0.861*
	1962	3.41	—0.0274	± .190	—0.953**
3. Gin Turnout (pct.)	1960	17.85	0.1298	± .186	0.998**
4. Lint Waste Content (pct.)	1960	3.40	—0.0145	± .056	—0.986**
	1961	5.30	—0.0258	± .411	—0.881*
	1962	6.68	—0.0418	± .249	—0.965**

[1] a and b are respectively the constant and regression coefficient in the regression equation, $Y = a + bX$, where Y is the attribute or dependent variable, and X is the mature lock content of the total locks entering the gin stand, expressed in percent.

[2] Units of standard error are those of corresponding attributes.

[3] Two asterisks indicate a degree of correlation significant at no less than the 99% level of statistical probability. One asterisk indicates a probability level of no less than 95%.

APPENDIX A (continued)

Attributes		Linear Regressions on Mature Lock Content[1]			Simple Correlations
		(a) Constant	(b) Coefficient	(Sy) Standard Error of Estimate[2]	(r) Coefficient of Correlation[3]
5. Lint Grade Index	1960	60.00	0.4171	± 2.12	0.975**
	1961	90.70	0.0174	± 3.14	0.162
	1962	55.00	0.4366	± 2.87	0.957**
6. Lint Staple Length (32nds. in.)	1960	28.00	0.0113	± .208	0.772*
	1961	28.70	0.0476	± .398	0.963**
	1962	29.70	0.0073	± .199	0.627
7. Lint Value (cents per lb., CCC)	1960	12.90	0.1734	± .868	0.977**
	1961	21.90	0.1087	± .469	0.990**
	1962	15.80	0.1654	± .500	0.991**
8. Lint Yellowness (+b)	1960	14.68	—0.0655	± .160	—0.994**
	1961	12.61	—0.0445	± .077	—0.998**
	1962	13.28	—0.0444	± .265	—0.964**
9. Lint Reflectance (Rd)	1960	55.00	0.2144	± .454	0.996**
	1961	62.50	0.1056	± .527	0.986**
	1962	54.65	0.1684	± .902	0.971**
10. Fiber Coarseness (mcg. per in.)	1960	2.63	0.0195	± .066	0.992**
	1961	2.14	0.0211	± .161	0.968**
	1962	1.59	0.0351	± .276	0.940**

APPENDIX A (continued)

Attributes		Linear Regressions on Mature Lock Content[1] (a) Constant	(b) Coefficient	(Sy) Standard Error of Estimate[2]	Simple Correlations (r) Coefficient of Correlation[3]
11. Fiber Strength (grams per grex Stel. O-gage)	1960	3.46	0.0014	± .018	0.856**
	1961	2.41	0.0045	± .047	0.942**
	1962	2.75	0.0014	± .045	0.565*
12. Upper Quartile Length (in., Array)	1960	0.99	—0.0003	± .020	—0.279
	1961	1.02	0.0007	± .011	0.866*
	1962	0.94	0.0012	± .035	0.610
13. Mean Fiber Length (in., Array)	1960	0.82	—0.0002	± .029	—0.138
	1961	0.80	0.0008	± .011	0.904*
	1962	0.64	0.0025	± .035	0.843*
14. Coefficient of Length Variation (pct., Array)	1960	30.29	—0.0044	± 2.07	—0.478
	1961	37.09	—0.0509	± 1.06	—0.820*
	1962	57.47	—0.2960	± 1.78	—0.964**
15. Fibers Shorter than ½ in. (pct., Array)	1960	14.03	—0.0169	± 2.28	—0.164
	1961	25.31	—0.0730	± 1.50	—0.823*
	1962	39.13	—0.3168	± 2.33	—0.948**
16. Raw Lint Neps (no. per 100 sq. in.)	1960	12.29	—0.0259	± 1.27	—0.414
	1961	26.84	—0.1076	± 1.44	—0.912*
	1962	33.88	—0.2182	± 2.54	—0.882**

APPENDIX A (continued)

Attributes		Linear Regressions on Mature Lock Content[1] (a) Constant	(b) Coefficient	(Sy) Standard Error of Estimate[2]	Simple Correlations (r) Coefficient of Correlation[3]
17. Card Web Neps (no. per 100 sq. in.)	1960	51.01	—0.2896	± 3.81	—0.862**
	1961	192.90	—1.8270	± 4.08	—0.973**
	1962	212.90	—2.1464	± 9.42	—0.980**
18. Manufacturing Waste (pct.)	1960	9.57	—0.0323	± .240	—0.950**
	1961	16.81	—0.0947	± .587	—0.979**
	1962	17.69	—0.1100	± .524	—0.977**
19. Carded 22's Yarn Strength (lbs.)	1960	92.38	0.0709	± 1.11	0.820*
	1961	36.01	0.6921	± 2.49	0.993**
	1962	38.12	0.5816	± 4.20	0.949**
20. Carded 8's Yarn Strength (lbs.)	1960	308.73	0.0824	± 4.00	0.418
	1961	134.53	1.9342	± 3.55	0.998**
	1962	153.71	1.4963	±11.47	0.944**
21. Average Yarn Break Factor	1960	2250.20	1.1242	±26.98	0.682
	1961	934.50	15.3483	±40.74	0.996**
	1962	1034.20	12.3829	±91.69	0.947**
22. Carded 22's Yarn Appearance Index	1960	79.63	0.3125	± 2.88	0.925**
	1961	54.06	0.6113	± 3.85	0.978**
	1962	31.32	0.9184	± 3.58	0.984**

APPENDIX A (continued)

Attributes		Linear Regressions on Mature Lock Content[1]			Simple Correlations
		(a) Constant	(b) Coefficient	(Sy) Standard Error of Estimate[2]	(r) Coefficient of Correlation[3]
23. Carded 8's Yarn Appearance Index	1960	94.89	0.2537	± 2.95	0.888**
	1961	53.39	0.7378	± 4.94	0.975**
	1962	34.56	0.9630	± 6.30	0.958**
24. Average Yarn Appearance Index	1960	87.30	0.2831	± 2.39	0.935**
	1961	53.72	0.6746	± 4.38	0.977**
	1962	32.94	0.9407	± 3.54	0.985**

Oklahoma's Wealth in Agriculture

Agriculture is Oklahoma's number one industry. It has more capital invested and employs more people than any other industry in the state. Farms and ranches alone represent a capital investment of four billion dollars—three billion in land and buildings, one-half billion in machinery and one-half billion in livestock.

Farm income currently amounts to more than $700,000,000 annually. The value added by manufacture of farm products adds another $130,000,000 annually.

Some 175,000 Oklahomans manage and operate its nearly 100,000 farms and ranches. Another 14,000 workers are required to keep farmers supplied with production items. Approximately 300,000 full-time employees are engaged by the firms that market and process Oklahoma farm products.

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