SMALL TRASH PARTICLES IN SAMPLES OF GINNED COTTON

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Abstract

Small particles of foreign matter have historically created problems at the textile mill. They are very difficult to remove without considerable fiber damage and weight loss. Cotton standards approved in 1986 for classing cotton worldwide contain large trash and small trash, depending on the reference grade. As a result of the perceived need to reduce the amount of small trash in the reference sample, seed cotton was collected from Mississippi, New Mexico and Texas and ginned at Stoneville, MS, on a common ginning system. A variable number of saw-type lint cleaners were used to achieve different amounts and types of trash in the ginned and cleaned samples. Dust (less than 500 microns) and trash (larger than 500 microns) particles in the cleaned lint were reduced dramatically by lint cleaning. The trash-related characteristics of the samples are reported. The samples were used as references during establishing proposed cotton standards for possible consideration at the next Universal Standards Conference.

Introduction

The textile industry has long been concerned with the particle size distribution of trash in ginned lint samples. In general, the larger the trash particle the easier it is to remove with conventional mill (and gin) cleaning machinery. Reference cotton samples are used to establish various grades of cotton for standardization worldwide. The current cotton standards were adopted in 1986 and many textile leaders believe that the standards contain too much pepper trash. As a result of this concern, the American Textile Manufactures Institute and the National Cotton Ginners Association drafted a proposal to reduce the percentage of pepper trash in the universal standards for cotton and to increase the percentage of larger trash. Specifically they proposed that:

- Appropriate notice should be provided to the Secretary of Agriculture and/or AMS that a change in standard boxes may be requested when the Universal Standards Committee convenes in June of 2001;
- A special task force should be appointed to work with AMS to create standard boxes during the fall of 2000 that reflect an agreed-upon goal for leaf content and particle size;
- In order to provide timely notice of intent to change standard boxes, seek to determine, by January 2001, whether the leaf goal could be achieved with harvest of the 2001 crop and, therefore, whether a June 2001 change in the standard boxes is feasible;
- Meanwhile, with coordination through NCC's Quality Task Force, initiate, immediately, a thorough study to determine the causes of pepper trash in lint cotton and possible remedies, including the role of varieties, defoliation, harvest, ginning and other practices, and seek appropriate authority and funding to implement remedies;
- If and only if there is agreement among all segments that the goal is feasible and attainable with the 2001 harvest, the National Cotton Council should officially request that the standard boxes be changed in keeping with the agreed-upon mix of leaf content and particle size;

The Board of Directors of the National Cotton Council approved the resolution and placed additional responsibilities on the Cotton Quality Task Force of the National Cotton Council regarding the pepper trash in lint cotton. A subcommittee was subsequently charged with creating some of the proposed standards for review by the Task Force.

Previous research has focused primarily on grades, respirable dust, and processing efficiency. Some research has consider the impact of gin machinery on the trash currently of concern to the Task Force. Baker, Brashears and Lalor (1993) reported the results of a three-year study to investigate the effects of various seed cotton cleaners, saw gin stands, and saw-type lint cleaners on the amount of trash and the size distribution of trash in cotton. In their studies, trash sizes and quantities were determined with a video imaging system. They defined fine trash as particles having an area of less than 0.05 mm^2 and pepper trash as having an area lying between 0.05 and 0.79 mm^2. Particles between 0.79 and 3.14 mm^2 were called small leaf and those larger than 3.15 mm^2 were called large leaf. Generally, seed cotton cleaners and extractors reduce the quantity of fine trash and pepper trash in the cotton. Only the saw-type gin stand tended to generate fine trash and pepper trash especially if the seed cotton contained a significant quantity of plant leaf. Saw-type lint cleaners were very effective in removing the trash regardless of particle size. Overall, the gin process reduced fine trash and pepper trash by about 70%. Baker, Brashears, and Lalor (1991) did not find any evidence that lint cleaners increased the quantity of pepper trash in lint. In general, they concluded that only the saw gin stand increased the amount of fine trash and pepper trash in lint samples collected before lint cleaning.

Although the video imaging method is suitable, it is not as readily available as other systems. An alternate method to determine the particle size distribution is with the Advanced Fiber Information System (AFIS) marketed by Zellweger Uster of Knoxville, TN. The AFIS does not measure trash particle sizes less than 50 microns but classifies particles in the 50 to 500 micron size as dust and particles greater than 500 microns as trash. The AFIS also provides a histogram of information giving the particle size distribution from 50 microns up to 2000 microns. The International Textile Manufacturers Federation (ITMF) defines dust and trash in the same manner as the AFIS.

Purpose

The purpose of this study was to provide samples of ginned lint representing a wide distribution of trash levels and sizes for use as a reference in creating representative physical standards for cotton classifications.

Methodology

At the request of the National Cotton Council batches of seed cotton were collected by the three USDA, ARS Cotton Ginning Research Laboratories in the United States to be used as reference samples in identifying the visual differences in the particle size distribution of cotton produced in different areas of the U.S. and ginned in a common ginning facility.

Four different "cottons" were used to create the samples as follows: 1) Western grown, spindle-harvested, irrigated, from Las Cruces, NM, 2) Mid South-grown, spindle-harvested, smooth leaf variety, (Stoneville, MS), 3) Mid South-grown, spindle-harvested, hairy-leaf variety, (Stoneville, MS), and 4) Texas grown, stripper-harvested. The cottons were subdivided into

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four batches. For each batch within a cotton, 4-inch thick layers were spread on the floor and the other batches were spread on top and blended manually for each cotton. The process was repeated twice. Then each cotton was subdivided into four batches and randomly assigned to a lint cleaner treatment. This procedure helped ensure the homogeneity between batches. The spindle-harvested cotton was processed through the following machine sequence in the microgin: dryer, cylinder cleaner, stick machine, dryer, cylinder cleaner, extractor-feeder/gin stand, and various lint cleaner treatments. For the stripper-harvested cotton, a second stick machine was added after the second stage of cylinder cleaning. The lint cleaner treatments were 0 lint cleaners, 1 lint cleaner equipped with 2 active grid bars, 1 lint cleaner equipped with 5 active grid bars, and 2 lint cleaners each equipped with 5 active grid bars. Samples were taken at the extractor-feeder apron before ginning for foreign matter determination based on the fractionation method reported by Shepherd (1972). The standard fractionation test divides raw seed cotton into several categories as follows: 1) bolls, 2) hulls, 3) sticks and stems, 4) grass, 5) seed, 6) motes, 7) small leaf and 8) pin trash. Categories 1-5 are removed manually and 6-8 are separated pneumatically and collected with three sieves in series. Motes (fibrous waste), small leaf and pin trash are collected in sieves with openings of 3360 microns (0.132 in.^{2}), 300 microns (0.0117 in.^{2}) and 75 microns (0.0029 in.^{2}), respectively. Samples were taken after ginning for lint moisture content, High Volume Instrument (HVI) classification, and analysis by the AFIS.

Sub-samples of the ginned lint and seed cotton were also delivered to the National Cotton Council for review by a study committee charged with developing new, proposed standards.

Results

The foreign matter in the seed cotton samples immediately before ginning averaged 3.8% and ranged from 2.5% for the Mid South smooth leaf cotton to 5.6% for the Texas stripped cotton. The small leaf content was 0.29% as compared to the pin trash at 0.02%. Small leaf ranged from 0.22% for NUC33B to 0.34% for the Western cotton. Pin trash ranged from 0.01% for the Mid South hairy cotton to 0.03% for the Texas stripped cotton. Visible foreign matter (Table 1), trash particles per gram (Table 2) and dust particles per gram (Table 3) averaged 2.25%, 132 particles per gram, and 527 particles per gram, respectively. Visible foreign matter ranged from 1.2% for the Mid South smooth leaf cotton to 3.0% for the Texas stripped cotton (Table 1). Trash particles per gram ranged from 63 per gram for the Mid South smooth leaf cotton to 179 for the Texas stripped cotton (Table 2). Dust particles per gram ranged from 276 per gram for the Mid South smooth-leaf cotton to 691 for the Texas stripped cotton (Table 3).

From a lint cleaner perspective, visible foreign matter ranged from 1.0% for two lint cleaners to 3.4% for 0 lint cleaners. The number of trash particles per gram ranged from 66 for two lint cleaners to 189 for 0 lint cleaners. Dust particles per gram ranged from 290 for two lint cleaners up to 789 for 0 lint cleaners. Figures 1, 2, 3, and 4 illustrate the change in particle size distribution as a function of increasing lint cleaner treatments for the Western cotton. Figures 5-16 present similar data for the other cottons. The figures show that saw-type lint cleaners reduced the number of particles of all sizes dramatically. There was no evidence that lint cleaners increased the smaller sized trash. The AFIS data for all 16 samples (4 cottons and 4 lint cleaner treatments) are given in Table 4.

Summary

The particle size distribution of trash in ginned lint from the Western irrigated area, Texas stripper-harvested area and Mid South spindle-harvested area with smooth and hairy-leaf cottons was investigated on standard ginning equipment at the USDA Cotton Ginning Research Laboratory, Stoneville, MS. Results indicated that trash particles per gram of cotton were decreased dramatically by saw-type lint cleaners.

Disclaimer

References

Baker, R.V., A.D. Brashears and W.F. Lalor. 1991. Influence of lint cleaning on fine trash levels. ASAE Paper No. 911504. 12 pp.

Baker, R.V., A.D. Brashears and W.F. Lalor. 1993. Effects of ginning on pepper trash. Proceedings of the 1993 Beltwide Cotton Conference. National Cotton Council, Memphis, TN. pp. 1428-1430.

Shepherd, J.V. 1972. Standard procedures for foreign matter and moisture analytical tests used in cotton ginning research. Agricultural Handbook No. 422. 13 pp.

Table 1. Visible foreign matter (VFM), based on AFIS, as a function of cotton and lint cleaners.

	VFM, %, for level of lint cleaning				
Cotton	**0**	**0.4**	**1.0**	**2.0**	**Mean**
Midsouth-Smooth	1.8	1.3	1.0	0.6	1.2
Midsouth-Hairy	5.2	2.4	2.3	0.9	2.7
Southwest	3.1	2.2	2.0	1.0	2.1
Stripped	3.4	3.8	3.4	1.5	3.0
Mean	3.4	2.4	2.2	1.0	2.3

Table 2. Trash count per gram (based on AFIS) as a function of cotton and lint cleaners.

	Trash count/gm for level of lint cleaning				
Cotton	**0**	**0.4**	**1.0**	**2.0**	**Mean**
Midsouth-Smooth	94	70	56	33	63
Midsouth-Hairy	290	152	141	68	163
Southwest	170	130	128	63	123
Stripped	201	225	190	99	199
Mean	189	144	129	66	136

Table 3. Dust count per gram (based on AFIS) as a function of cotton and lint cleaners.

	Dust count/gm for level of lint cleaning				
Cotton	**0**	**0.4**	**1.0**	**2.0**	**Mean**
Midsouth-Smooth	464	261	224	152	276
Midsouth-Hairy	892	505	440	259	524
Southwest	974	593	600	300	617
Stripped	827	730	762	446	691
Mean	789	522	507	290	527

Table 4. Advanced Fiber Information System (AFIS) data for four cottons processed with four lint cleaner treatments.

Lint cleaner	Cotton[1]	SFC (w) %[2]	Neps per gram	SCN size [µm][3]	SCN[3] per gram	Mean size [µm][3]	Dust count per gram	Trash count per gram	VFM[4] [%]
0.0	NM	6.9	204	969	26	293	974	70	3.12
0.4	NM	7.8	234	1140	24	318	593	130	2.22
1.0	NM	8.2	254	1040	42	310	600	128	2.04
2.0	NM	7.9	298	1118	30	304	300	63	1.00
0.0	MS-S	8.3	163	1129	10	326	464	95	1.78
0.4	MS-S	8.8	221	1158	6	360	261	70	1.26
1.0	MS-S	7.4	236	1152	8	348	224	56	0.98
2.0	MS-S	8.2	314	1214	12	332	152	33	0.61
0.0	MS-H	6.8	184	1040	20	388	892	290	5.19
0.4	MS-H	7.4	175	1152	14	376	505	152	2.42
1.0	MS-H	6.9	217	1165	18	380	440	142	2.28
2.0	MS-H	7.6	230	1080	15	342	259	68	0.94
0.0	TX	9.8	266	996	18	333	827	201	3.44
0.4	TX	9.7	317	932	23	371	730	225	3.83
1.0	TX	9.2	310	952	19	348	762	190	3.38
2.0	TX	9.0	354	901	19	328	446	99	1.54

[1]NM = New Mexico; MS-S = MidSouth smooth-leaf; MS-H = MidSouth hairy leaf; TX = Texas stripped.
[2]Short fiber content by weight based on AFIS.
[3]Seed coat neps based on AFIS.
[4]Visible foreign matter based on AFIS.

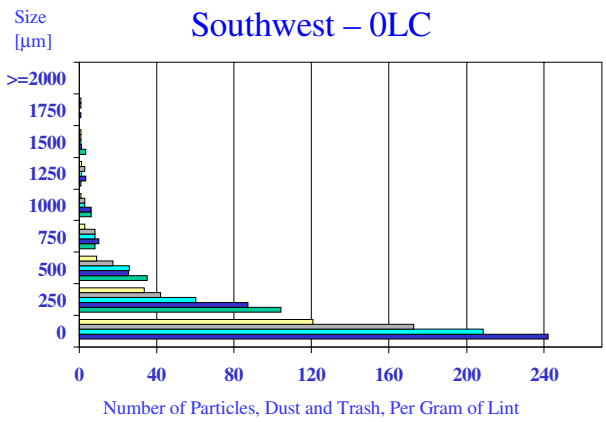

Figure 1. Southwest-grown, spindle-harvested cotton without lint cleaning. The lowest bar is 100 microns (242 particles) and the remainder increase in increments of 50 microns.

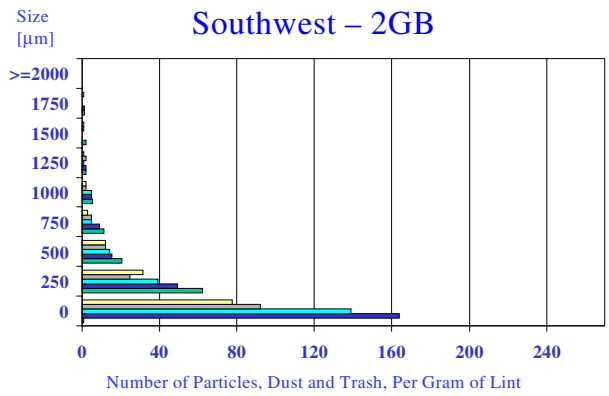

Figure 2. Southwest-grown, spindle-harvested cotton with one saw-type lint cleaner with two active grid bars. The lowest bar is 50 microns (0.7 particles) and the remainder increase in increments of 50 microns.

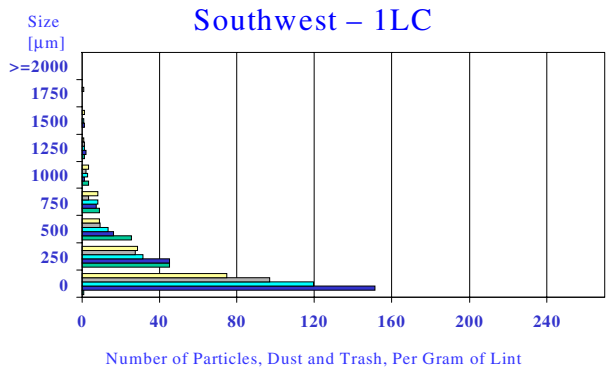

Figure 3. Southwest-grown, spindle-harvested cotton with one saw-type lint cleaner with five active grid bars. The lowest bar is 50 microns (0.7 particles) and the remainder increase in increments of 50 microns.

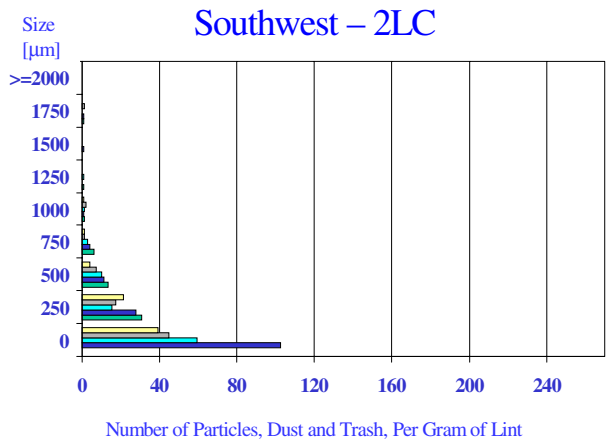

Figure 4. Southwest-grown, spindle-harvested cotton with two lint cleaners with five active grid bars each. The lowest bar is 100 microns (102.7 particles) and the remainder increase in increments of 50 microns.

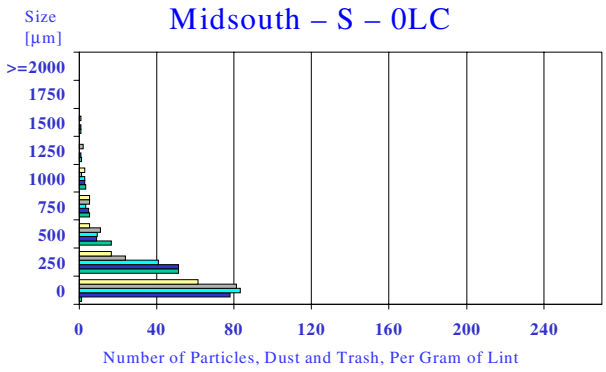

Figure 5. Midsouth grown, smooth-leaf cotton without lint cleaning. The lowest bar is 50 microns (1.3 particles) and the remainder increase in increments of 50 microns.

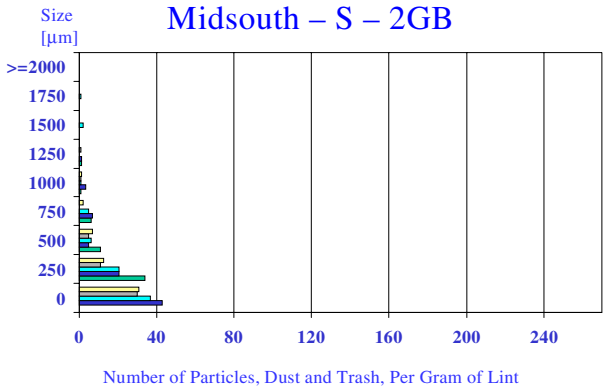

Figure 6. Midsouth grown, smooth-leaf cotton with one saw-type lint cleaner with two active grid bars. The lowest bar is 100 microns (42.7 particles) and the remainder increase in increments of 50 microns.

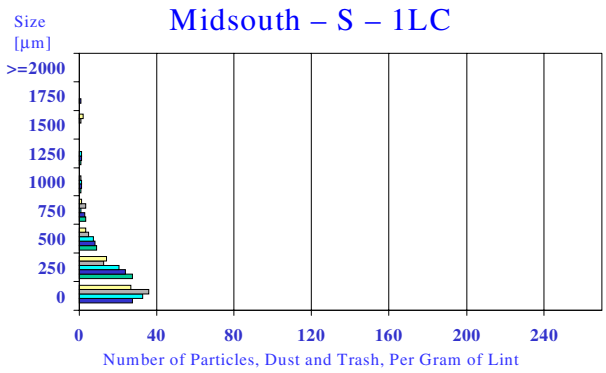

Figure 7. Midsouth grown, smooth leaf cotton with one saw type lint cleaner with five active grid bars. The lowest bar is 100 microns (27.3 particles) and the remainder increase in increments of 50 microns.

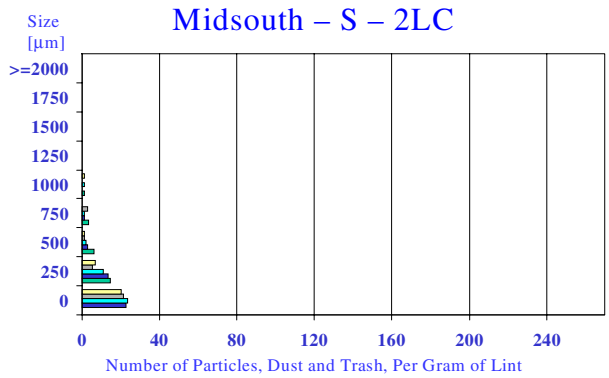

Figure 8. Midsouth grown, smooth-leaf cotton with two lint cleaners with five active grid bars each. The lowest bar is 100 microns (22.7 particles) and the remainder increase in increments of 50 microns.

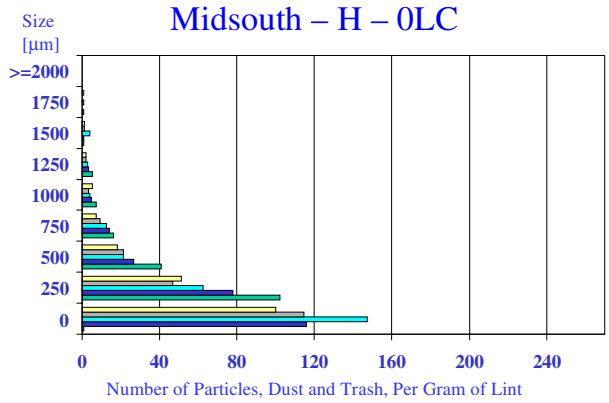

Figure 9. Midsouth grown, hairy-leaf cotton without lint cleaning. The lowest bar is 50 microns (0.7 particles) and the remainder increase in increments of 50 microns.

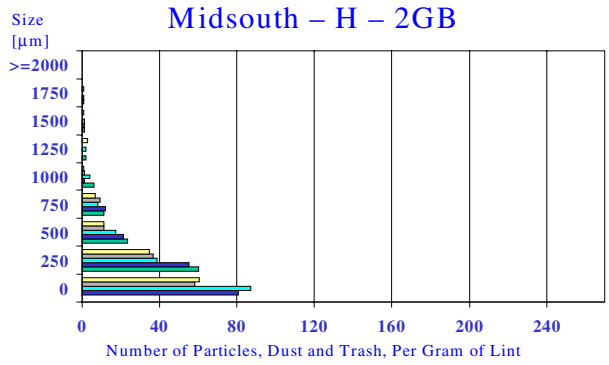

Figure 10. Midsouth grown, hairy-leaf cotton with one saw-type lint cleaner with two active grid bars. The lowest bar is 100 microns (80.7 particles) and the remainder increase in increments of 50 microns.

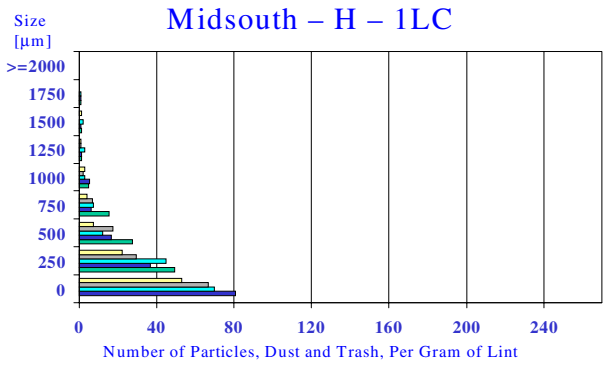

Figure 11. Midsouth grown, hairy-leaf cotton with one saw-type lint cleaner with five active grid bars. The lowest bar is 100 microns (80.7 particles) and the remainder increase in increments of 50 microns.

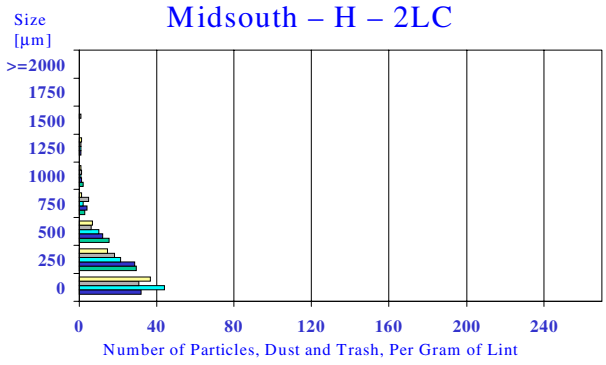

Figure 12. Midsouth grown, hairy-leaf cotton with two lint cleaners with five active grid bars each. The lowest bar is 100 microns (32 particles) and the remainder increase in increments of 50 microns.

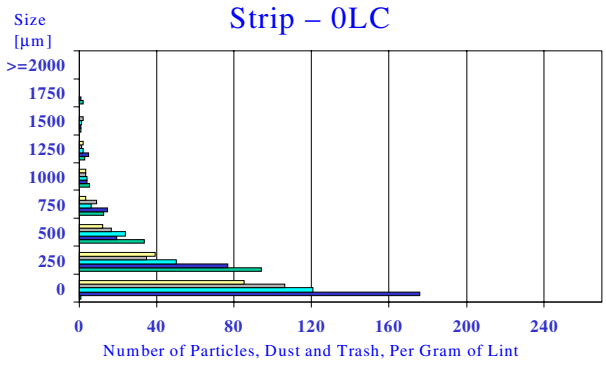

Figure 13. Stripper-harvested cotton without lint cleaning. The lowest bar is 50 microns (0.7 particles) and the remainder increase in increments of 50 microns.

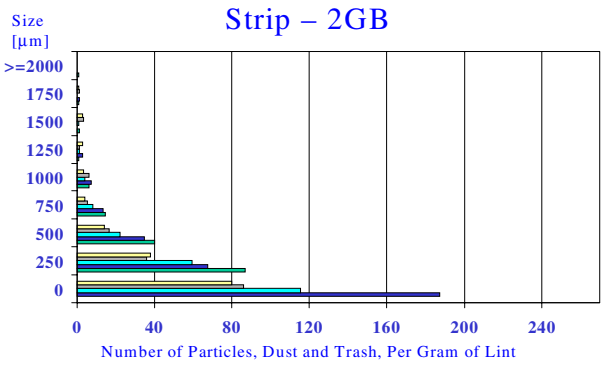

Figure 14. Stripper-harvested cotton with one saw-type lint cleaner with two active grid bars. The lowest bar is 100 microns (187.3 particles) and the remainder increase in increments of 50 microns.

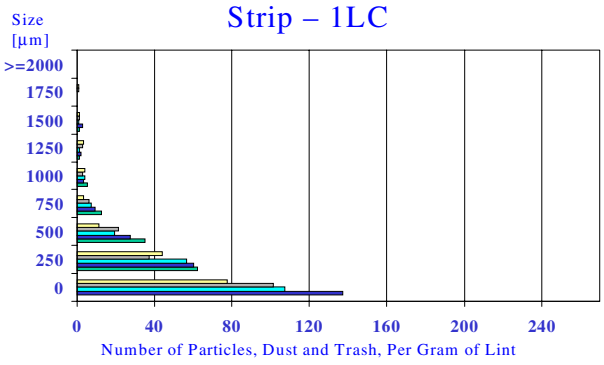

Figure 15. Stripper-harvested cotton with one saw-type lint cleaner with five active grid bars. The lowest bar is 100 microns (137.3 particles) and the remainder increase in increments of 50 microns.

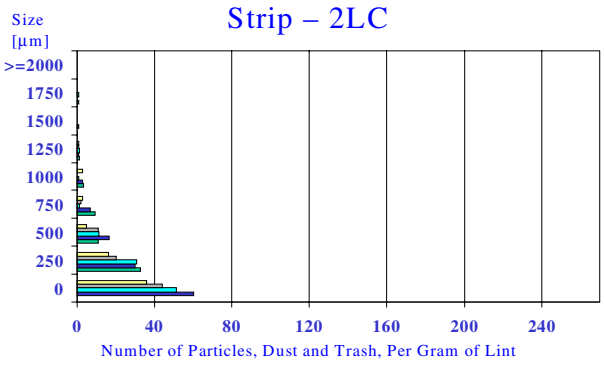

Figure 16. Stripper-harvested cotton with two lint cleaners with five active grid bars each. The lowest bar is 100 microns (60 particles) and the remainder increase in increments of 50 microns.