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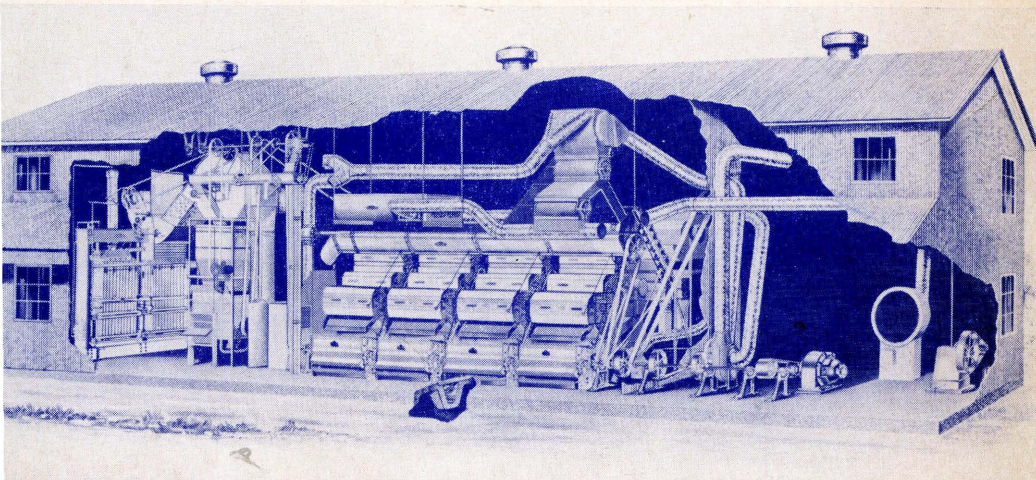
QUALITY AND COST OF GINNING UPLAND COTTON IN ARIZONA



UNIVERSITY OF ARIZONA
AGRICULTURAL EXPERIMENT STATION

IN COOPERATION WITH

U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING SERVICE

ACKNOWLEDGMENT

This study was planned and conducted cooperatively by the University of Arizona and the Agricultural Marketing Service of the U.S. Department of Agriculture. Most of the study was conducted under the general direction of Ralph S. Hawkins, Director of the Arizona Agricultural Experiment Station; George W. Barr, Head, Department of Agricultural Economics, University of Arizona; John W. Wright, Chief, Standards and Testing Branch, Cotton Division, AMS; W. H. Fortenberry, Assistant Chief of the Branch and formerly in charge, Mesilla Park Cotton Laboratory, Mesilla Park, New Mexico. The later stages of the project were supervised by Maurice R. Cooper, Head, Fibers Section, Market Organization and Costs Branch, Marketing Research Division, AMS.

This study would not have been possible without the cooperation of the owners and managers of Arizona cotton gins who permitted the use of their ginning facilities and financial records. Their help is gratefully acknowledged. The authors wish to express their thanks to Lloyd G. Crittendon and to Stanley C. Rademaker and J. L. King, of the El Paso cotton classing office, USDA, for classing the lint cotton.

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Summary and Conclusions

1. The gins included in this study with special overhead equipment (12 to 21 overhead cleaning cylinders plus large driers and a large bur machine) got the seed cotton slightly cleaner than those with standard overhead equipment. For example, hand-harvested seed cotton in 1951 contained 1.7 per cent trash after conditioning on special overhead equipment compared with 2.3 per cent after conditioning on standard equipment (consisting of less than 12 cleaning cylinders, a small bur machine and small driers).

   Gins with both special overhead equipment and lint cleaners produced the cleanest lint, with non-lint content averaging only four to five per cent of bale weight, compared to five to eight per cent for gins which had standard overhead equipment and no lint cleaners.
2. All gins except the standard gins without lint cleaners appeared to reduce the moisture of the lint cotton to a very low level, averaging only 3.5 to 4.5 per cent of bale weight in 1952. The specially equipped gins with lint cleaners tended to get the lint cotton slightly the driest, but the differences were not great. The spread was usually only about one-half of one per cent of the bale weight between the most elaborately equipped and the most simply equipped gins.
3. The specially equipped gins with lint cleaners produced the highest grades. In terms of the grade index, grades of cotton processed in the most elaborately equipped gins were the equivalent of one-third to two-thirds of a grade higher than grades of cotton processed in the standard gins without lint cleaners.
4. When weight loss and lint cleaning charges were considered, lint cleaning appeared unprofitable to farmers for cotton which without such cleaning would grade Strict Low Middling White or higher. However, lint cleaning of lower grades of White cotton appeared to bring producers a profit. Also, the possibilities of enhancing the bale value of all grades of Spotted cotton through lint cleaning appeared quite promising from the results of this study, although the greatest increases in bale value were usually noted in the lower grades. These findings indicate, therefore, that the use of lint cleaners should generally be delayed until that time in the season when the lower grades begin to appear in considerable numbers.
5. Moisture content of cottonseed was fairly uniform among the four gin groups, but seed from machine-harvested cotton tended to be slightly higher in moisture than seed from hand-harvested cotton. Seed from the 1952 crop contained an average of 2.5 to 4.5 percentage points less moisture than corresponding seed from the 1951 crop.

6. The spinning tests conducted in connection with this study indicated no appreciable damage to the fiber properties of the cotton resulting from the conditioning and cleaning equipment used in the gins. Out of 36 spinning lots tested during the 1951 season, 25 were "medium" with respect to nep count (16 to 25 neps), six were regarded as "high" and five were "low." During the 1952 season the nep count was "low" for all spinning lots tested for hand-harvested and machine-harvested cotton, and for saw type and pneumatic type lint cleaners. In fact, the highest nep count for either Middling or Strict Low Middling grade was 13. The increase in nep count after lint cleaning was so slight as to be immaterial — only one to three neps per 100 square inches of card web in most cases.

   The spinning tests conducted gave no evidence that ginning machinery was the deciding factor in either yarn appearance or yarn strength of Arizona cotton in the years studied. Most of the tests in both seasons gave either "fair" or "average" yarn appearance, while yarn strength ranged from slightly above to slightly below average with very little regard to gin machinery group.

7. In comparing the costs of providing ginning services, all specially equipped gins were treated as one group and all standard gins as another group, regardless of the presence or absence of lint cleaners. The total replacement cost per gin plant ranged from over $150,000 for specially equipped gins to about $100,000 for standard gins. Both groups operated at average volumes of 11 to 13 thousand bales per year during the years studied. In 1951, total costs of ginning per bale averaged $8.08 per bale for standard gins and $9.22 per bale for specially equipped gins. Costs for both groups were slightly higher in 1952, averaging $8.67 for standard gins and $9.47 for specially equipped gins. In general, it appeared that the special overhead cleaning equipment made more difference in costs than the presence or absence of lint cleaners. One thing that stood out in the comparison was the wide variation within groups. For example, at similar volumes of from 11 to 13 thousand bales, individual gins in the specially equipped group reported ginning costs ranging all the way from $7.83 to $11.91 per bale during the 1952 season.

8. Although at any given volume individual plants may have costs either higher or lower than average because of differences in management practices, size of labor crew, expenditures for repairs and modifications, and many other factors, nevertheless, volume of ginning per season is the most important single factor determining ginning costs. Differences in annual volume explained 72 per cent of the variations in total ginning costs per plant among the standard gins sampled and 44 per cent of such variations among the specially

equipped gins. Ginning costs, on a per bale basis, tend to decrease markedly with increases in volume. Increases in ginning volume from 8,000 to 15,000 bales in the specially equipped gins resulted in decreases in estimated ginning costs per bale from $10.13 to $9.05; comparable increases in volume in standard gins resulted in decreases in estimated ginning costs per bale from $9.50 to $7.74. These data seem to indicate that at volumes between 8,000 and 15,000 bales, the standard gins not only retained, but actually increased their cost advantage over specially equipped gins as volume increased.

9. During the 1952 season, ginning charges averaged 50 cents per hundredweight of seed cotton plus 10 cents per hundredweight for drying and 10 cents per hundredweight for lint cleaning; bagging and ties sold for $3.25 per pattern.

   These charges resulted in gross ginning revenues during the 1952-53 season averaging $13.25 per bale for the specially equipped gins compared with $12.70 per bale for the standard gins. This 55 cent per bale difference in revenue is in accord with the 80 cents per bale difference in costs, which during the same season averaged $9.47 per bale for specially equipped gins and $8.67 per bale for standard gins.

10. For a substantial proportion of Arizona cotton, the Group IV gins (standard gins without lint cleaners) contained all the equipment that is necessary to do a satisfactory job of ginning. In fact, using more equipment than this on clean, dry seed cotton may actually reduce returns to farmers when weight loss and extra ginning charges are considered. However, the specially equipped gins with lint cleaners have the advantage of greater flexibility, in that they can handle all types of seed cotton, from the cleanest to the most roughly harvested. Most specially equipped gins are so arranged that any piece of cleaning or drying equipment in the gin can be by-passed, and a careful ginner will use only that amount of cleaning or drying equipment that is necessary for the particular type of cotton he is ginning. Only when cotton contains a large proportion of foreign matter does it become necessary, or even advisable, to employ all the conditioning and cleaning equipment contained in Arizona's specially equipped gins.

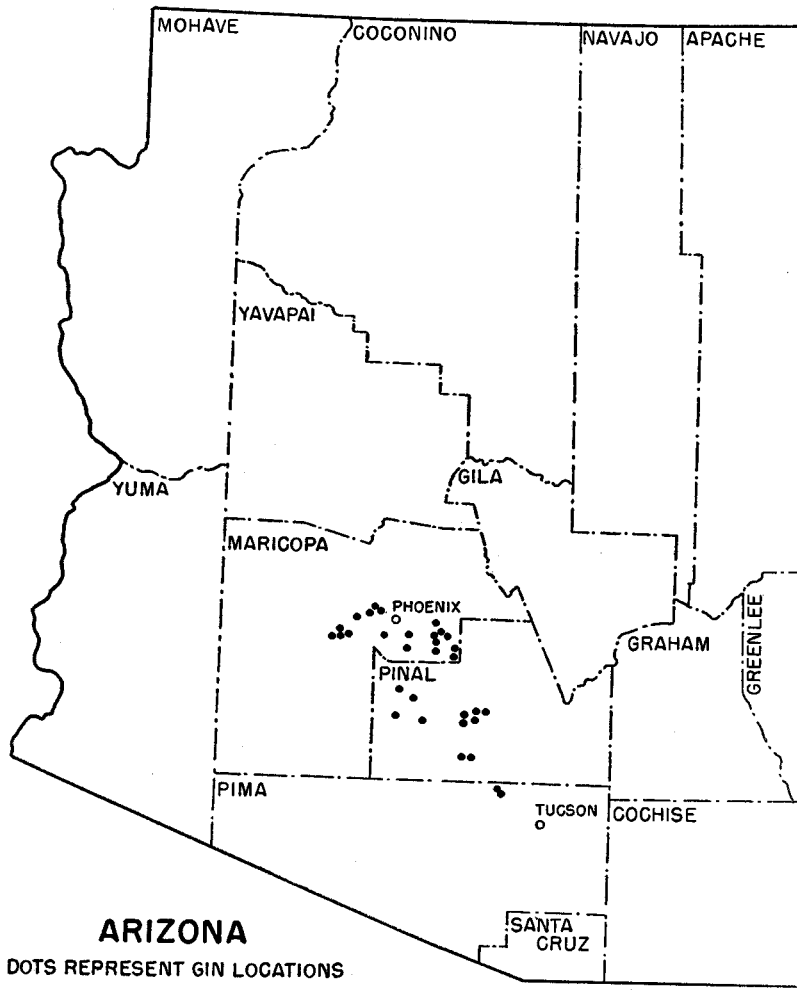

Figure 1. Location of gins included in quality and cost of ginning study, central Arizona, seasons of 1951-52 and 1952-53.

Quality and Cost of Ginning Upland Cotton in Arizona

By JAMES S. ST. CLAIR AND ARTHUR L. ROBERTS[1]

OBJECTIVES

This study was conducted to ascertain: (1) the quality of ginning services being performed by gins equipped with varying amounts of cleaning and conditioning equipment, (2) comparative costs of providing ginning services for gins employing varying amounts of equipment, (3) operating practices and conditions affecting the quality of ginning services performed, and (4) comparative returns to cotton producers from ginning cotton at various types of gin establishments.

SCOPE

This study was confined to saw gins located in the irrigated areas of central Arizona and included gins in Maricopa, Pinal, and Pima counties (Fig. 1). In 1952, these three counties accounted for 85 per cent of Arizona's total cotton production. Maricopa and Pinal counties are the two largest cotton producing counties in the state and, therefore, have the greatest concentration of gins. The area covered extends from Marinette on the north to Marana on the south and from Queen Creek on the east to Buckeye on the west.

METHOD

Classification and selection of gins.

Prior to the beginning of this study a gin machinery survey was made of all gin plants in central Arizona. As a result of this survey, the gins were divided for purposes of this study into four groups on the basis of machinery installed. These are:

Group I. *Specially equipped gins with lint cleaners:* These gins had huller fronts, extractor feeders, one or more driers, a large bur machine, 12 to 21 overhead cleaning cylinders and lint cleaners.

Group II. *Specially equipped gins without lint cleaners:* These gins were similar to group I except for the absence of lint cleaners.

Group III. *Standard gins with lint cleaners:* These gins had huller fronts, extractor feeders, usually had either one drier or heat on the feeders, usually had one small bur machine or its

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equivalent, always had less than 12 overhead cleaning cylinders, and always had lint cleaners.

Group IV. *Standard gins without lint cleaners:* These gins were similar to group III except for the absence of lint cleaners.

After the gins were classified as indicated above, a further subdivision was made between those gins equipped with saw-type lint cleaners and those equipped with pneumatic lint cleaners. A stratified sample was drawn which sought to give proportionate representation to each machinery group and subdivision and to randomize the effects of geographical differences. The result was a sample of 26 gins representing a population of approximately 77 gins in operation at the time the sample was drawn, and divided as follows:

Group I:	11 gins
Group II:	5 gins
Group III:	5 gins
Group IV:	5 gins

During the summer following the first year of sampling, additional machinery installations were made in some standard gins which placed them in a higher equipment group. As a result it was necessary to move some gins to a higher equipment category, drop some from the study, and make certain substitutions in the standard gins.

Two inherent characteristics of the population of gins in central Arizona made it somewhat difficult to select gins from each machinery group which would permit valid comparisons between groups. First, the standard gins were usually, but not always, the older gins. Since the large volume of cotton handled per gin necessitates a rather complete overhaul of the machinery following each ginning season, the relative age of the gins in each group probably does not seriously affect comparisons between groups. Second, most of the standard gins were and are located in the Salt River Valley, rather than being distributed uniformly throughout central Arizona. This fact probably weakens the grade comparisons between gin groups, because of the effect which differing environments have upon the quality of the cotton produced.

Field Procedure.

Gins selected for the purposes of the study were visited at regular intervals and samples were drawn from each of four bales of cotton as they were being processed. From each of these four bales, samples were drawn as follows:

Samples taken at gins without lint cleaners	*Samples taken at gins with lint cleaners*
1 qt. can wagon sample s/c	1 qt. can wagon sample s/c
½-lb. bag wagon sample s/c	½-lb. bag wagon sample s/c
1 qt. can feeder sample s/c	1 qt. can feeder sample s/c
½-lb. bag feeder sample s/c	½-lb. bag feeder sample s/c

1 qt. can lint
1 qt. can cottonseed
1 lb. lint sample

1 qt. can lint
1 qt. can cottonseed
1 lb. lint sample, before cleaning
1 lb. lint sample, after cleaning
1 lb. bag lint cleaner waste

In addition to the above, lint cleaner waste for each of four bales sampled was caught and weighed during each sampling tour at four gins employing pneumatic lint cleaners and at four gins using saw-type lint cleaners.

The one quart cans of wagon seed cotton and feeder seed cotton were tested for moisture content for the purpose of determining regularity of moisture in the seed cotton load and for the purpose of measuring gin performance on cotton of different moisture contents. It was also possible to determine the effectiveness of driers by establishing the moisture content of seed cotton as it arrived at the gin and after it had passed through driers and the pre-cleaning machinery.

The one-half pound bags of wagon and feeder seed cotton samples were tested for foreign matter content, thereby permitting a determination of the effectiveness of the overhead cleaning machinery in the various types of gins in removing foreign matter from seed cotton.

The one quart can of lint, taken at the press box, was used to determine the amount of moisture in the lint cotton after going through all the gin machinery.

The one quart can of cottonseed was used to determine the amount of seed moisture and also the percentage of lint on the seed after ginning.

The wrapped lint sample was used for classification and for Shirley Analyzer test. If the gins were equipped with lint cleaners, samples were taken before and after lint cleaning and Shirley Analyzer tests were made of both samples. These tests made possible a determination of the influences of lint cleaners on cotton quality. Spinning tests were performed upon composite lots made up of several wrapped lint samples to determine the influence of lint cleaners and other gin machinery upon spinning properties.

The one pound bag of lint cleaner waste was taken at all gins equipped with either pneumatic or saw-type lint cleaners. A Shirley Analyzer test was made of each sample of waste to determine the amount of lint and actual waste in the sample.

Sampling trips to gins selected for the study were made at about one week to ten day intervals. Twelve sampling trips were made during the 1951 season and nine trips were made during the 1952 season. These sampling trips were spread over a period beginning the latter part of September and ending about the middle or latter part of February of the following year during each season.

Samples collected at the various gins studied were designated

TABLE 1.—NUMBER OF BALES OF UPLAND COTTON SAMPLED, BY GIN GROUPS AND METHOD OF HARVESTING, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Crop year and method of harvesting	Specially equipped gins		Standard gins		Total
	With lint cleaners (Group I)	Without lint cleaners (Group II)	With lint cleaners (Group III)	Without lint cleaners (Group IV)	
	bales	bales	bales	bales	bales
1951:					
Hand harvested	252	191	58	203	704
Machine harvested	189	33	145	28	395
Total	441	224	203	231	1099
1952:					
Hand harvested	143	59	21	99	322
Machine harvested	178	50	57	23	308
Total	321	109	78	122	630

according to the method of harvesting as either hand harvested or machine harvested (Table 1). A majority of samples taken both in 1951 and in 1952 were from hand-harvested cotton, but the proportion of machine-harvested cotton in 1952 was considerably larger than that in 1951. These proportions relate to the number of samples actually taken and should not necessarily be applied to the method of harvesting for the whole cotton crop of Arizona. The Arizona State Employment Service reports that for the State as a whole, approximately one-third of the 1951 crop and 39 per cent of the 1952 crop were machine harvested.[2]

The sampling was random insofar as method of harvesting was concerned, since the enumerators consistently sampled the first four bales ginned after their arrival regardless of method of harvesting. Thus, some indication was obtained of the proportion of ginnings of each gin group which was machine harvested.

Of all the samples taken at group I gins (specially equipped gins with lint cleaners) during the two years of the study, 48.2 per cent were of machine-harvested cotton; of the samples taken at group II gins (specially equipped gins without lint cleaners), 24.9 per cent were of machine-harvested cotton; of the samples taken at group III gins (standard gins with lint cleaners), 71.9 per cent were of machine-harvested cotton; of the samples taken at group IV gins (standard gins without lint cleaners), only 14.4 per cent were of machine-harvested cotton. This would indicate that the selection of gins for the processing of machine-harvested cotton tends to be made more on the basis of whether

[2]Rork, J. A., and Salter, R. H., "Arizona Cotton Harvest, 1952: A Study of Utilization and Production of Cotton Picking Machines in Arizona," (Mimeo.) Arizona State Employment Service, 101 Heard Building, Phoenix, Arizona, April, 1953. Page 1.

the gins are equipped with lint cleaners than on the basis of the presence of special overhead equipment.

Cost Phase Procedure.

At the close of each ginning season, detailed cost schedules were completed on the year's operations at several of the cooperating gins for the purpose of determining the costs of providing ginning services for gins with varying amounts of cleaning and conditioning equipment. Usable cost data were obtained from 11 of the 26 gins in the 1951-52 season and from 15 of the 26 gins in the 1952-53 season.

EFFECT OF GIN MACHINERY UPON COTTON QUALITY

In appraising the quality of ginning services performed by the four groups of gins, the standard gins without lint cleaners (group IV) were used as a "control" group with which to compare each of the other groups of gins. A similar method might be used in a laboratory experiment in ginning except that each ginning setup would begin with an identical lot of seed cotton. Since it was impossible to control the quality of the seed cotton coming to the gin, the next best alternative was to measure the foreign matter and moisture content of the seed cotton as it came to the gin. If, then, cotton coming to the specially equipped gins contained as much foreign matter as that coming to the standard gins before conditioning, but significantly less than the standard gins after conditioning, it could be concluded that the overhead cleaning equipment in the specially equipped group had performed more effectively.

Foreign matter removal from hand-harvested cotton.

The foreign matter content of hand-harvested seed cotton as it came to the gins in 1951 was similar to the control group (standard gins without lint cleaners) for all gin groups except group III (standard gins with lint cleaners) which had a significantly higher percentage of foreign matter than the control group

TABLE 2.—FOREIGN MATTER CONTENT OF HAND-HARVESTED SEED COTTON AND LINT PROCESSED IN FOUR GROUPS OF GINS, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Season and stage of processing	Specially equipped gins		Standard gins	
	With lint cleaners (Group I)	Without lint cleaners (Group II)	With lint cleaners (Group III)	Without lint cleaners (Group IV) control
	Pct	Pct	Pct	Pct
1951:				
Seed cotton, before conditioning	9.4	12.6	13.7	10.8
Seed cotton, after conditioning	1.7	2.1	2.5	2.3
Lint (non-lint content)[1]	4.3	5.8	5.5	6.2
1952:				
Seed cotton, before conditioning	12.4	11.3	5.7	10.5
Seed cotton, after conditioning	1.4	1.6	1.6	1.4
Lint (non-lint content)[1]	4.2	5.7	4.3	5.2

[1]As determined by Shirley Analyzer test.

(Table 2). After passing through the overhead machinery, however, the cotton in group I (specially equipped group with lint cleaners) contained only 1.7 per cent foreign matter compared with 2.3 per cent for the control group, a highly significant difference. The differences between other gin groups and the control group were not judged to be significant in 1951.

In 1952, all gin groups succeeded in conditioning hand-harvested seed cotton to a lower level of foreign matter (1.4 to 1.6

TABLE 3.—FOREIGN MATTER CONTENT OF HAND-HARVESTED SEED COTTON WHICH PRODUCED LINT OF SPECIFIED GRADES, BY OVERHEAD EQUIPMENT GROUPS, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Grade[1]	Specially equipped gins (Groups I & II)			Standard gins (Groups III & IV)		
	Foreign matter content of seed cotton		Non-lint content of lint[2]	Foreign matter content of seed cotton		Non-lint content of lint[2]
	Before overhead cleaning	After overhead cleaning		Before overhead cleaning	After overhead cleaning	
	Pct	Pct	Pct	Pct	Pct	Pct
1951:						
White & EW						
GM				*	*	*
SM	4.5	1.1	4.26	3.6	1.0	4.27
M	7.8	1.5	5.92	6.7	1.5	5.06
SLM	14.6	2.3	6.49	14.6	2.9	7.03
LM	25.9	3.4	7.89	20.4	4.2	9.70
SGO				*	*	*
Spotted						
GM sp.	*	*	*			
SM sp.	14.3	1.5	4.30	*	*	*
M sp.	13.0	2.4	6.44	*	*	*
SLM sp.	*	*	*	*	*	*
Gray						
SM g.	*	*	*			
M g.	*	*	*	*	*	*
1952:						
White & EW						
GM	*	*	*			
SM	5.5	.7	4.16	6.2	.7	4.09
M	6.8	.9	4.63	5.7	1.0	4.58
SLM	23.0	2.4	6.40	14.7	2.2	6.36
Spotted						
GM sp.	*	*	*			
SM sp.	13.7	1.5	5.25	*	*	*
M sp.	35.0	3.1	6.83	*	*	*
SLM sp.	*	*	*	*	*	*

*Insufficient number of samples.

[1]In lint cleaner gins, groups I and III, grades used are grades prior to lint cleaning.

[2]Non-lint content as determined by Shirley Analyzer. In lint cleaner gins, groups I and III, the lint samples used are those taken prior to lint cleaning.

per cent) than in the previous year, but the specially equipped gins did not reduce foreign matter to a significantly lower level than the standard gins.

In both years, lint coming from gins equipped with lint cleaners had a significantly lower non-lint content as determined by Shirley Analyzer tests than lint coming from the control group (standard gins without lint cleaners). Non-lint content was lowest in both years for group I (specially equipped gins with lint cleaners) indicating the combined effect of the additional overhead cleaning equipment and the lint cleaners.

Another method of estimating the relative efficiency of the overhead cleaning equipment in different gin groups in removing trash from seed cotton is to determine the average trash content of the seed cotton before conditioning which produced each grade of lint for the specified gin groups (Table 3). For this calculation all specially equipped gins were combined and all standard gins were combined. In groups I and III, the lint cleaner gins, "before cleaning" grades were used to eliminate the effect of the lint cleaners.

The gins with special overhead equipment did not, in general, require quite as clean hand-harvested seed cotton as did the standard gins in order to produce lint of a given grade (Table 3). Exceptions are noted in the case of Strict Low Middling cotton in the 1951 season and Strict Middling in the 1952 season.

Foreign matter removal from machine-harvested cotton.

The average foreign matter content of machine-harvested seed cotton as it came to the gins in 1951 did not differ significantly from the control group for any group of gins (Table 4).

TABLE 4.—FOREIGN MATTER CONTENT OF MACHINE-HARVESTED SEED COTTON AND LINT PROCESSED IN FOUR GROUPS OF GINS, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Season and stage of processing	Specially equipped gins		Standard gins	
	With lint cleaners (Group I)	Without lint cleaners (Group II)	With lint cleaners (Group III)	Without lint cleaners (Group IV) control
	Pct	Pct	Pct	Pct
1951:				
Seed cotton, before conditioning	5.9	4.5	4.9	4.9
Seed cotton, after conditioning	1.5	1.5	1.8	1.8
Lint (non-lint content)[1]	4.6	6.2	5.5	6.8
1952:				
Seed cotton, before conditioning	8.8	7.0	10.0	10.3
Seed cotton, after conditioning	1.9	1.5	2.0	2.4
Lint (non-lint content)[1]	5.0	6.4	4.9	8.7

[1]As determined by Shirley Analyzer test.

The foreign matter content of seed cotton after conditioning averaged slightly lower for groups I and II which had special overhead cleaning equipment than for the control group (1.5 per cent as compared with 1.8 per cent) but a difference this large could be accounted for by random errors in sampling.

TABLE 5.—FOREIGN MATTER CONTENT OF MACHINE-HARVESTED SEED COTTON WHICH PRODUCED LINT OF SPECIFIED GRADES, BY OVERHEAD EQUIPMENT GROUPS, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Grade[1]	Specially equipped gins (Groups I & II)			Standard gins (Groups III & IV)		
	Foreign matter content of seed cotton		Non-lint content of lint[2]	Foreign matter content of seed cotton		Non-lint content of lint[2]
	Before overhead cleaning	After overhead cleaning		Before overhead cleaning	After cleaning overhead	
	Pct	Pct	Pct	Pct	Pct	Pct
1951:						
White & EW						
SM	3.9	.9	4.60	*	*	*
M	4.5	.9	4.68	4.2	1.2	5.97
SLM	5.3	1.4	5.75	5.2	1.8	7.73
LM	7.3	2.0	6.88	5.0	2.5	8.42
SGO	*	*	*	*	*	*
Spotted						
SM sp.	*	*	*			
M sp.	5.5	1.7	6.38			
SLM sp.	*	*	*	*	*	*
Gray						
SM g.	*	*	*	*	*	*
M g.	*	*	*	*	*	*
1952:						
White & EW						
M	5.9	.9	5.23	5.8	1.3	6.15
SLM	8.8	1.9	6.95	8.7	1.8	7.41
LM	12.9	2.6	8.48	13.7	3.3	8.91
SGO	*	*	*			
Spotted						
SM sp.	*	*	*			
M sp.	8.1	1.8	6.09	*	*	*
SLM sp.	*	*	*	*	*	*
LM sp.	*	*	*			
Gray						
SM g.	*	*	*			

*Insufficient number of samples.

[1]In lint cleaner gins, groups I and III, grades used are grades prior to lint cleaning.

[2]Non-lint content as determined by Shirley Analyzer. In lint cleaner gins, groups I and III, the lint samples used are those taken prior to lint cleaning.

In 1952, both specially equipped groups received machine-harvested seed cotton containing significantly less foreign matter than that received by the control group, thus making any inferences regarding performance of the overhead equipment in that year more difficult. In spite of the fact that both specially equipped groups received significantly cleaner cotton than the control group, only group II (specially equipped gins without

lint cleaners) showed significantly cleaner seed cotton than the control group after passing through the overhead equipment.

With respect to the foreign matter content of the lint, results for machine-harvested cotton tended to parallel those reported for hand-harvested cotton. Lint coming from gins equipped with lint cleaners had a significantly lower non-lint content as determined by Shirley Analyzer tests than lint coming from the control group. However, for each gin group in each year, lint from machine-harvested cotton tended to have a slightly higher non-lint content than lint from hand-harvested cotton.

In the 1951 season the gins with special overhead equipment appeared to be able to produce a given grade of lint from machine-harvested seed cotton containing slightly more trash than did the gins with standard overhead equipment (Table 5). In the 1952 season, the advantages of the specially equipped gins in this respect were much less evident. What was more evident in both years was that if a given grade of machine-harvested lint cotton had been processed on a gin with special overhead equipment it had slightly less non-lint content in the lint than if it had been processed in a gin with only standard overhead equipment. (This observation is based upon samples which have not had the benefit of lint cleaning).

Moisture removal from hand-harvested cotton.

The average moisture content of hand-harvested seed cotton as it came to the gins in 1951 was similar to that in the control group (standard gins without lint cleaners) for all gin groups, ranging between 8.6 and 9.0 per cent (Table 6). After conditioning, however, the seed cotton in group I (the specially equipped gins with lint cleaners) was somewhat drier than that in the control group. This difference between groups was accentuated in the ginned lint stage, with group I (the specially equipped gins with lint cleaners) testing an average of only 4.0 per cent lint moisture as compared with an average of 4.6 per cent lint moisture in the control group. The differences between other

TABLE 6.—MOISTURE CONTENT OF HAND-HARVESTED SEED COTTON AND LINT PROCESSED IN FOUR GROUPS OF GINS, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Season and stage of processing	Specially equipped gins		Standard gins	
	With lint cleaners (Group I)	Without lint cleaners (Group II)	With lint cleaners (Group III)	Without lint cleaners (Group IV) control
	Pct	Pct	Pct	Pct
1951:				
Seed cotton, before conditioning	8.7	8.6	9.0	8.9
Seed cotton, after conditioning	7.6	7.7	8.3	7.9
Lint	4.0	4.6	4.3	4.6
1952:				
Seed cotton, before conditioning	7.8	8.2	7.9	8.5
Seed cotton, after conditioning	6.8	7.4	6.5	7.4
Lint	3.7	4.3	3.5	4.2

gin groups and the control group were not judged to be significant in 1951.

In 1952, the hand-harvested cotton sampled averaged significantly drier than the control group at each stage of the ginning process for groups I and III (the specially equipped gins with lint cleaners and the standard gins with lint cleaners), but no inferences may be safely drawn from these differences because the seed cotton received by these two gin groups was drier than that received by the control group. The most striking fact is the relatively low moisture content of lint resulting from hand-harvested cotton for all gin groups during the 1952 season, averaging from 3.5 to 4.3 per cent. This compares with the six to seven per cent moisture which is considered normal for bales opened at cotton textile mills.[3] It should be stated, however, that lint cotton in Arizona would not normally approach the moisture content of cotton in humid areas, because of the differences in atmospheric conditions.

Moisture removal from machine-harvested cotton.

The average moisture content of machine-harvested cotton for group I, II, and III gins did not differ significantly from that in the control group (group IV, standard gins without lint cleaners) at any stage of the ginning process in 1951 (Table 7). That is, the samples taken did not indicate any marked differences in performance between gin groups in the drying of machine-harvested cotton.

However, in 1952, although groups I, II, and III all received machine-harvested seed cotton of about the same moisture content as the control group, these groups all reduced moisture content to a significantly lower level after conditioning than the control group (7.2 to 7.5 per cent for the other groups as

TABLE 7.—MOISTURE CONTENT OF MACHINE-HARVESTED SEED COTTON AND LINT PROCESSED IN FOUR GROUPS OF GINS, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Season and stage of processing	Specially equipped gins		Standard gins	
	With lint cleaners (Group I)	Without lint cleaners (Group II)	With lint cleaners (Group III)	Without lint cleaners (Group IV) control
	Pct	Pct	Pct	Pct
1951:				
Seed cotton, before conditioning	10.2	10.0	10.1	9.5
Seed cotton, after conditioning	8.3	7.7	8.5	8.1
Lint	4.3	4.9	4.7	4.4
1952:				
Seed cotton, before conditioning	9.3	9.8	9.7	9.6
Seed cotton, after conditioning	7.2	7.4	7.5	8.5
Lint	3.9	4.5	4.3	5.4

[3]Martin, William J., and McClure, Joe H., "Market Outlets for Cotton in Some of the Principal Cotton Fabrics." Production and Marketing Administration, U. S. Department of Agriculture, February 1950, table 57, page 102.

compared with 8.5 per cent for the control group). This difference is emphasized in the lint stage when group I tests only 3.9 per cent lint moisture as compared with 5.4 per cent for the control group.

There was a tendency for machine-harvested seed cotton to have higher average moisture content than hand-harvested cotton received in the same gin during the same season. This difference amounted to slightly over one per cent for the years studied. Also, there was observed more moisture variation within machine-picked loads than within hand-picked loads. Machine-picked loads were frequently characterized by "wet spots".

Optimum seed cotton moisture contents have not been established for western irrigated cotton either for cleaning or ginning. Further study is needed before reliable recommendations can be made in this regard.

A recent study of drying rain-grown cottons shows that increased drying produces almost continuous increases in the effectiveness of cleaners and in grade, if reduced staple length, bale weight losses, and possible damage to fibers are ignored. This study also states that "excessive drying causes reductions in fiber length and increases nep count, which results are reflected in reduced yarn strength and appearance grade".[4]

Classification of hand-harvested cotton.

Another measure of the performance of the four groups of gins is the grade index of lint produced. Ranking the gins in order of the grade index of lint produced from hand-harvested seed cotton during the 1951 season gives the following results: Gin group I highest, followed by groups II, III, and IV in that order (Table 8). The highest group had a grade index of 100.1 (equivalent to Middling), approximately two-thirds of a grade above the lowest group, which had a grade index of 96.6 (equivalent to Strict Low Middling plus). This difference must be credited, at least in part, to the additional machinery in the group I gins (specially equipped with lint cleaners) since there was but

TABLE 8.—GRADE INDEX[1] OF HAND-HARVESTED COTTON BY SPECIFIED GIN GROUPS, CROPS OF 1951 AND 1952

Crop Year	Specially equipped gins		Standard gins	
	With lint cleaners (Group I)	Without lint cleaners (Group II)	With lint cleaners (Group III)	Without lint cleaners (Group IV) control
	Index	Index	Index	Index
1951	100.1	97.6	96.8	96.6
1952	100.4	98.4	100.4	98.1

[1]104 = SM, 100 = M, 94 = SLM, 85 = LM.

[4]Griffin, A. C., Jr., and Merkel, C. M., "Moisture Content of Seed Cotton in Relation to Cleaning and Ginning Efficiency and Lint Quality," U.S.D.A., P.M.A., Cotton Branch, Washington, D. C., September 1953.

little average difference in the amount of foreign matter and moisture content of seed cotton arriving at the gins.

The 1952 ranking of the gins in order of grade index of lint produced from hand-harvested seed cotton corresponded to that in 1951, with the exception of gin group III (standard gins with lint cleaners). Group III gins received significantly cleaner seed cotton in 1952 than any other group and quite understandably

TABLE 9.—GRADE DISTRIBUTION OF HAND-HARVESTED COTTON BY SPECIFIED GIN GROUPS, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Grade	Specially equipped gins		Standard gins		Total hand harvested
	With lint cleaners (Group I)	Without lint cleaners (Group II)	With lint cleaners (Group III)	Without lint cleaners (Group IV)	
	Pct	Pct	Pct	Pct	Pct
1951:					
White & EW					
SM & above	36.9	19.4	10.3	8.4	21.7
M	38.1	40.3	41.4	36.0	38.3
SLM	13.9	25.1	27.6	45.8	27.3
LM	2.0	12.0	3.4	5.4	5.8
SGO & below	0	0	0	.9	.3
Total White & EW	90.9	96.8	82.7	96.5	93.4
Spotted					
SM & above	5.1	1.1	5.2	0	2.6
M	2.8	2.1	5.2	2.0	2.6
SLM & below	1.2	0	5.2	1.5	1.3
Total Spotted	9.1	3.2	15.6	3.5	6.5
Gray (all)	0	0	1.7	0	.1
TOTAL	100.0	100.0	100.0	100.0	100.0
1952:					
White & EW					
SM & above	37.2	28.8	33.3	19.2	29.9
M	33.1	44.1	52.4	52.5	42.3
SLM	9.7	11.8	14.3	15.2	12.0
LM	.7	0	0	0	.3
SGO & below	0	0	0	0	0
Total White & EW	80.7	84.7	100.0	86.9	84.5
Spotted					
SM & above	10.3	6.8	0	2.0	6.5
M	8.3	0	0	8.1	6.2
SLM & below	.7	8.5	0	3.0	2.8
Total Spotted	19.3	15.3	0	13.1	15.5
Gray (all)	0	0	0	0	0
TOTAL	100.0	100.0	100.0	100.0	100.0

equalled the grade index of 100.4 (equivalent to Middling) achieved by group I. The difference between the highest groups (I & III) and the lowest group (IV) in 1952 was only the equivalent of one-third of a grade in terms of the grade index.

A more precise comparison between gin groups may be made by examining the grade distributions for hand-harvested cotton (Table 9). Grades of Middling and above constituted 75 per cent of the hand-harvested ginnings during the 1951 season for group I (specially equipped gins with lint cleaners) compared with 60 per cent, 52 per cent, and 44 per cent for gin groups II, III, and IV, respectively.

During the 1952 season all gin groups obtained exceptionally good grade distributions from their hand-harvested cotton, but the differences between groups were much less striking than during the previous year. The highest proportion of grades Middling and above, 86 per cent, was produced by gin group III, which received the cleanest seed cotton and had no Spots or Grays. The other three gin groups all produced nearly the same proportions of Middling and higher grades, ranging between 70 and 73 per cent. Gin group I continued to distinguish itself, however, by producing the highest proportion of Strict Middling cotton of any of the groups — 37.2 per cent.

Classification of machine-harvested cotton.

A comparison of the average grade indexes resulting from machine-harvested cotton ginned in the four groups of gins during the 1951 season does not reveal any great differences between groups (Table 10). The grade indexes for all groups except group III translated to the equivalent of Strict Low Middling plus; group III rated the equivalent of a high Strict Low Middling in terms of the index, just short of being a plus.

TABLE 10.—GRADE INDEX[1] OF MACHINE-HARVESTED COTTON BY SPECIFIED GIN GROUPS, CROPS OF 1951 AND 1952

Crop year	Specially equipped gins		Standard gins	
	With lint cleaners (Group I)	Without lint cleaners (Group II)	With lint cleaners (Group III)	Without lint cleaners (Group IV) control
	Index	Index	Index	Index
1951	96.3	95.5	94.9	95.1
1952	96.4	95.3	92.9	89.7

[1]104 = SM, 100 = M, 94 = SLM, 85 = LM

Since there were no significant differences between groups in the foreign matter or moisture contents of the cotton received by the gins, one is tempted to conclude that all groups performed about equally well in processing machine-harvested cotton in 1951. Examination of the grade distributions (Table 7) reveals some variations between groups, however. Gin group I (specially

equipped gins with lint cleaners) obtained the highest proportions of Middling and above from its machine-harvested ginnings, 58 per cent, followed by groups III, II, and IV with 39 per cent, 30 per cent, and 18 per cent, respectively. The higher proportion of better grades obtained by gin group I tends to be offset

TABLE 11.—GRADE DISTRIBUTION OF MACHINE-HARVESTED COTTON BY SPECIFIED GIN GROUPS, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Grade	Specially equipped gins		Standard gins		Total machine harvested
	With lint cleaners (Group I)	Without lint cleaners (Group II)	With lint cleaners (Group III)	Without lint cleaners (Group IV)	
	Pct	Pct	Pct	Pct	Pct
1951:					
White & EW					
SM & above	6.9	3.0	8.3	0	6.6
M	50.8	27.3	31.0	17.8	39.2
SLM	15.3	45.5	33.1	78.6	28.9
LM	11.1	9.1	10.3	3.6	10.1
SGO & below	0	0	.7	0	.3
Total White & EW	84.1	84.9	83.4	100.0	85.1
Spotted					
SM & above	4.8	0	0	0	2.3
M	2.7	15.1	1.4	0	3.0
SLM & below	2.1	0	1.4	0	1.5
Total Spotted	9.6	15.1	2.8	0	6.8
Gray (all)	6.3	0	13.8	0	8.1
TOTAL	100.0	100.0	100.0	100.0	100.0
1952:					
White & EW					
SM & above	2.2	0	0	0	1.3
M	50.6	36.0	22.8	30.4	41.6
SLM	26.4	52.0	35.1	26.1	32.1
LM	3.4	4.0	17.5	34.8	8.4
SGO & below	.6	0	0	0	.3
Total White & EW	83.2	92.0	75.4	91.3	83.7
Spotted					
SM & above	6.7	0	3.5	0	4.6
M	3.9	8.0	15.8	0	6.5
SLM & below	4.5	0	5.3	0	3.6
Total Spotted	15.1	8.0	24.6	0	14.7
Gray (all)	1.7	0	0	8.7	1.6
TOTAL	100.0	100.0	100.0	100.0	100.0

by a considerable proportion of extremely low grades, so that the average grade index for all groups is nearly the same.

Comparison of grades for the 1952 season is hampered by the fact that both gin groups I and II received machine-harvested seed cotton which had significantly lower foreign matter content than that received by the control group. The grade indexes progress in ascending order of the amount of machinery in the gin from gin group IV which has a grade index of 89.7 to gin group I which has a grade index of 96.4. Statistical significance may only be attributed to the comparison between the control group which produced the equivalent of Strict Low Middling minus, in terms of the grade index, and gin group III (standard gins with lint cleaners) which produced the equivalent of Strict Low Middling, in terms of the index. This difference of one-third of a grade may presumably be attributed to the use of lint cleaners, and is consistent with other findings of the study regarding the use of lint cleaners on machine-harvested cotton. Statistical inferences regarding groups I and II are prevented by the fact that these groups received significantly cleaner cotton than the control group.

Consulting the grade distributions (Table 11) for machine-harvested cotton reveals that gin group III actually had a lower proportion of its machine-harvested cotton grading Middling and above in 1952 than the control group — 23 per cent as compared with 30 per cent. The higher grade index for gin group III results from the fact that gin group III had a smaller proportion of very low grade cotton than the control group.

Grade differences between gin groups were not as great for machine-harvested as for hand-harvested cotton. This was undoubtedly caused by the differences in the nature of foreign matter present in seed cotton harvested by the two methods.

The trash in machine-harvested cotton tends to be finer than that in hand-harvested cotton and is, therefore, more difficult

TABLE 12.—AVERAGE STAPLE LENGTHS OF UPLAND COTTON, BY SPECIFIED GIN GROUPS, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Method of harvest and season	Specially equipped gins		Standard gins	
	With lint cleaners (Group I)	Without lint cleaners (Group II)	With lint cleaners (Group III)	Without lint cleaners (Group IV) control
	1/32 inch	1/32 inch	1/32 inch	1/32 inch
Hand harvested:				
1951	33.2	33.2	32.9	33.0
1952	33.8	33.9	33.4	33.4
Machine harvested:				
1951	33.2	33.2	33.0	33.4
1952	33.7	33.7	33.4	33.7

to remove with conventional cleaning machinery. The grade indexes for machine-harvested cotton were one-third grade to one whole grade lower than for hand-harvested cotton processed in the same gins.

Staple length.

Although differences in staple length among gins were in several cases large enough to denote statistical significance, these differences followed no consistent pattern (Table 12). It has been assumed that staple differences are more closely associated with varietal differences than with differences in ginning equipment. Since it was impossible to completely randomize the sample of gins on a varietal basis, it has been assumed that varietal differences between gin groups constituted the principal source of differences in staple length.

General observations regarding performance of the four gin groups.

Differences in performance were relatively small among the four gin groups — considerably smaller, in fact, than had been anticipated. Performance of the groups was measured for cotton harvested in two seasons and by two methods of harvest, making a total of four cases studied. Processing hand-harvested cotton in standard gins without lint cleaners resulted in grades equivalent in terms of the grade index to Strict Low Middling plus in 1951 and to a "shy" Middling in 1952; processing machine-harvested cotton in the same gins resulted in grades equivalent to Strict Low Middling plus in 1951 and to a "shy" Strict Low Middling in 1952.

With these as starting points, the addition of special overhead equipment without addition of lint cleaners, resulted in appreciable grade benefits (equivalent to one-third of a grade or more in terms of the grade index) in only two of the four cases studied. Other effects were noted in the lowered trash content of the lint.

The addition of lint cleaners alone had much the same effect on grades as the addition of special overhead equipment alone; namely, grades tended to be raised appreciably (the equivalent of one-third of a grade in terms of the grade index) over the control group in two of the four cases studied. Other effects were noted in the lowered trash content of the lint.

With these same starting points, the addition of both special overhead equipment and lint cleaners apparently resulted in grade benefits equivalent to two-thirds of a grade in terms of the grade index in two out of four cases observed, one-third of a grade in one case, and less than one-third of a grade in the other case. However, the removal of approximately two per cent of the weight of the lint in foreign matter and perhaps one-half per cent in moisture (additional to amounts removed by the control group) may partially or completely offset the additional value of the higher grades.

The law of diminishing physical returns operates with gin cleaning machinery as with most other physical phenomena. The

first cleaning unit used removes a relatively great amount of trash. Additional installations remove successively less and less trash until finally the point is reached where no measurable improvement in quality can be noted.

Compounding the effect of the additional costs of operating additional units of cleaning machinery is the fact that additional cleaning units cause slight but measurable reductions in lint turnout. There is, then, a quantity problem involved as well as a quality problem. This suggests that from an economic standpoint it may actually pay to halt cleaning and conditioning operations prior to the point where maximum grade benefits are attained.

EFFECTS OF LINT CLEANING UPON QUALITY OF LINT AND RETURNS TO FARMERS

The purpose of lint cleaners is to improve the grade of ginned lint. Lint cleaners in operation in Arizona gins are of two types: The saw type, which cleans by passing the lint over a second set of saws and grid bars, and the pneumatic type, which cleans by the principle of centrifugal force operating in a specially designed air chamber. Findings of this study indicate that, if adjusted and operated according to manufacturers' recommendations, both types of lint cleaners will remove enough finely ground trash and short fibers from the ginned lint to produce measurable grade improvements on a substantial proportion of the bales. It does not necessarily follow that the value of the grade improvements is sufficient to defray all expenses involved in the lint cleaning process.

In conducting this portion of the study, paired samples were taken from slightly over 1,000 bales. One sample was taken before, and one sample after the cotton passed through the lint cleaning machinery.

One of the most consistent results of lint cleaning observed

TABLE 13.—NON-LINT CONTENT OF LINT[1] BEFORE AND AFTER LINT CLEANING, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Method of harvest and season	Saw type cleaners			Pneumatic type cleaners		
	Before lint cleaning	After lint cleaning	Change	Before lint cleaning	After lint cleaning	Change
	Pct	Pct	Pct	Pct	Pct	Pct
Hand harvested:						
1951	5.9	4.6	—1.3	5.1	4.6	— .5
1952	5.1	4.0	—1.1	5.0	4.1	— .9
Machine harvested:						
1951	6.9	5.0	—1.9	5.7	5.0	— .7
1952	6.8	5.1	—1.7	6.7	5.2	—1.5

[1]As measured on the Shirley Analyzer

TABLE 14.—ANALYSIS OF LINT CLEANER WASTE REMOVED FROM HAND-HARVESTED UPLAND COTTON, BY GRADE AND TYPE OF LINT CLEANER, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Grade before lint cleaning	Saw type cleaners					Pneumatic type cleaners				
	Total pounds of lint cleaner waste removed[1]	Waste analysis[2]				Total pounds of lint cleaner waste removed[1]	Waste analysis[2]			
		Lint content		Trash content			Lint content		Trash content	
		Lbs	Pct	Lbs	Pct		Lbs	Pct	Lbs	Pct
1951:										
White & EW										
SM	8.1	4.6	56.4	3.5	43.6	5.7	.8	13.3	4.9	86.7
M	9.7	4.5	46.8	5.2	53.2	4.7	.8	17.0	3.9	83.0
SLM	15.1	4.9	32.5	10.2	67.5	7.5	1.0	12.9	6.5	87.1
LM	17.5	5.6	32.2	11.9	67.8	4.8	.4	7.6	4.4	92.4
SGO						9.8	.8	8.1	9.0	91.9
Spotted										
SM sp.	11.3	5.9	52.0	5.4	48.0	3.1	.3	8.9	2.8	91.1
M sp.	9.6	2.9	30.4	6.7	69.6	5.4	.4	8.1	5.0	91.9
SLM sp.	12.0	3.7	30.6	8.3	69.4			7.5		92.5
Gray										
SM g.	8.2	2.6	31.9	5.6	68.1					
M g.	13.7	4.8	34.8	8.9	65.2					
1952:										
White & EW										
SM	7.5	3.7	49.7	3.8	50.3	2.7	.4	14.6	2.3	85.4
M	7.8	3.7	48.0	4.1	52.0	5.9	1.0	17.1	4.9	82.9
SLM	10.8	3.6	33.1	7.2	66.9	8.4	1.0	11.5	7.4	88.5
Spotted										
SM sp.	5.6	2.8	50.8	2.8	49.2	1.9	.1	6.3	1.8	93.7
M sp.						2.9	.2	7.6	2.7	92.4
SLM sp.	10.8	2.5	22.9	8.3	77.1					

[1]Per 500 lb. gross weight bale.
[2]As determined by Shirley Analyzer test.

was the reduction in the non-lint content of lint cotton. The average reduction in non-lint content of lint cotton ranged from .5 per cent to 1.9 per cent of net bale weight (Table 13) and for

TABLE 15.—ANALYSIS OF LINT CLEANER WASTE REMOVED FROM MACHINE-HARVESTED UPLAND COTTON, BY GRADE AND TYPE OF LINT CLEANER, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Grade before lint cleaning	Saw type cleaners					Pneumatic type cleaners				
	Total pounds of lint cleaner waste removed[1]	Waste analysis[2]				Total pounds of lint cleaner waste removed[1]	Waste analysis[2]			
		Lint content		Trash content			Lint content		Trash content	
		Lbs	Pct	Lbs	Pct		Lbs	Pct	Lbs	Pct
1951:										
White & EW										
SM	10.9	5.2	48.1	5.7	51.9	4.1	.8	19.3	3.3	80.7
M	12.8	5.9	46.0	6.9	54.0	5.2	.9	17.6	4.3	82.4
SLM	15.3	4.7	30.4	10.6	69.6	6.3	.9	14.3	5.4	85.7
LM	14.2	3.6	25.7	10.6	74.3	7.5	.8	11.0	6.7	89.0
Spotted										
SM sp.						4.4	.7	15.2	3.7	84.8
M sp.	8.6	2.8	32.6	5.8	67.4	5.2	.6	11.0	4.6	89.0
SLM sp.	15.5	5.4	34.8	10.1	65.2	13.9	1.1	7.6	12.8	92.4
LM sp.	14.8	4.1	28.0	10.7	72.0					
Gray										
SM g.	12.3	6.2	50.2	6.1	49.8					
M g.	16.9	5.9	35.0	11.0	65.0	5.9	.5	8.8	5.4	91.2
1952:										
White & EW										
M	10.9	5.2	47.5	5.7	52.5	6.6	.9	13.6	5.7	86.4
SLM	16.3	5.2	32.0	11.1	68.0	8.7	1.1	12.8	7.6	87.2
LM	19.7	6.5	33.0	13.2	67.0	8.3	.9	11.4	7.4	88.6
Spotted										
M sp.	11.5	4.5	39.1	7.0	60.9	3.9	.3	8.4	3.6	91.6
SLM sp.	13.6	4.0	26.8	9.6	73.2	12.1	1.7	14.3	10.4	85.7
LM sp.	31.9	3.8	12.0	28.1	88.0					

[1]Per 500 lb. gross weight bale.
[2]As determined by Shirley Analyzer test.

each of the groups considered was highly significant. In general, the reduction in non-lint content averaged greater for cotton processed on saw type cleaners than for cotton processed on

pneumatic type cleaners, and greater for machine-harvested than for hand-harvested cotton.

Analysis of lint cleaner waste.

Saw type cleaners removed considerably more waste per bale than did pneumatic type cleaners (Tables 14 and 15). Total weights of waste removed per bale by saw type cleaners averaged from 7.5 to 17.5 pounds for hand-harvested cotton and from 8.6 to 31.9 pounds for machine-harvested cotton; comparable figures for pneumatic type cleaners were 2.7 to 9.8 pounds for hand-harvested cotton and 4.1 to 13.9 pounds for machine-harvested cotton. (The lower weights of waste pertain to the higher grades of cotton). The waste removed by saw type cleaners contained a somewhat higher proportion of lint than that removed by pneumatic type cleaners. Per cent of lint in the waste removed by saw type cleaners averaged from 22.9 to 56.4 per cent for hand-harvested cotton and from 12.0 to 48.1 per cent for machine-harvested cotton; comparable figures for pneumatic type cleaners were 6.3 to 17.0 per cent for hand-harvested cotton and 7.6 to 19.3 per cent for machine-harvested cotton. The higher percentages of lint content in lint cleaner waste are associated with the higher grades of cotton. It should not be assumed that all the lint in lint cleaner waste is of spinnable quality, as this is not the case. Even considering the relatively higher lint content of the lint cleaner waste removed by the saw type cleaners, the saw type cleaners succeeded in removing more actual net trash than the pneumatic type cleaners in most of the cases studied.

Effect of lint cleaners upon staple length.

Changes produced in staple length by lint cleaning were small, and not entirely consistent even as to direction (Table 16). Differences in staple length were so slight as to be unimportant from a market standpoint.

TABLE 16.—STAPLE LENGTH OF UPLAND COTTON BEFORE AND AFTER LINT CLEANING, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Method of harvest and season	Saw type cleaners			Pneumatic type cleaners		
	Before lint cleaning	After lint cleaning	Change	Before lint cleaning	After lint cleaning	Change
	1/32"	1/32"	1/32"	1/32"	1/32"	1/32"
Hand harvested:						
1951	33.1	33.2	+ .1	33.0	33.1	+ .1
1952	33.8	34.0	+ .2	34.1	33.7	− .4
Machine harvested:						
1951	32.9	33.1	+ .2	32.9	33.0	+ .1
1952	33.9	34.0	+ .1	33.6	33.6	0

Effect of lint cleaners upon grade.

Lint cleaners raised the grade index of hand-harvested cotton 1.1 and 1.9 grade points, or just under one-third of a grade, during

TABLE 17.—GRADE INDEX[1] OF UPLAND COTTON BEFORE AND AFTER LINT CLEANING, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Method of harvest and season	Saw type cleaners			Pneumatic type cleaners		
	Before lint cleaning	After lint cleaning	Change	Before lint cleaning	After lint cleaning	Change
	Index	Index	Index	Index	Index	Index
Hand harvested:						
1951	97.7	99.6	+1.9	98.1	99.4	+1.3
1952	99.0	100.1	+1.1	98.5	100.0	+1.5
Machine harvested:						
1951	95.0	96.5	+1.5	93.8	94.6	+ .8
1952	93.8	96.2	+2.4	93.1	95.0	+1.9

[1]LM = 85, SLM = 94, M = 100, SM = 104.

the two years studied (Table 17). All grade improvements on hand-harvested cotton were regarded as statistically significant except the 1.1 grade points produced by the saw type cleaners during the 1952 season. Significant improvements in grade indexes of machine-harvested cotton were noted in both years for both types of lint cleaners, ranging from an average improvement of .8 grade points for pneumatic type cleaners in the 1951 season to 2.4 grade points for the saw type cleaners in the 1952 season.

The amount of improvement in grade depends, in part, upon the position of the "before cleaning" grade with respect to the dividing line for the next higher grade. Hand-harvested cotton was apparently raised from the equivalent of a "shy" Middling to the equivalent of Middling, in terms of the grade index, by both types of cleaners in both years studied. Machine-harvested cotton was apparently raised from a grade equivalent of Strict Low Middling to an index of Strict Low Middling plus by the saw type cleaners in both seasons. The improvement in grade index of machine-harvested cotton resulting from the use of pneumatic type cleaners, while significant in both seasons, was insufficient to result in a change in average grade designation, remaining Strict Low Middling both before and after lint cleaning.

A more detailed examination may be made of the effect of lint cleaners upon grades of cotton by comparing the grade distributions before and after lint cleaning (Tables 18 and 19). Saw type cleaners increased the proportion of hand-harvested cotton grading Strict Middling and above from 22 to 34 per cent during the 1951 season and from 32 to 39 per cent during the 1952 season. Pneumatic type cleaners increased the proportion of hand-harvested cotton grading Strict Middling and above from 15 to 29 per cent during the 1951 season and from 5 to 31 per cent during the 1952 season (Table 18).

The over-all grade distribution was lower for machine-harvested than for hand-harvested cotton in both years studied, and the proportion grading Strict Middling and higher remained relatively small even after lint cleaning. However, considerable increases were observed after lint cleaning in the proportions grading Middling and higher (Table 19). Saw type lint cleaners increased the proportion of machine-harvested cotton grading Middling and above from 34 to 54 per cent during the 1951 season

TABLE 18.—GRADE DISTRIBUTION OF HAND-HARVESTED COTTON BEFORE AND AFTER LINT CLEANING, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Grade	Saw type cleaners		Pneumatic cleaners	
	Before lint cleaning	After lint cleaning	Before lint cleaning	After lint cleaning
	Pct	Pct	Pct	Pct
1951:				
White & EW				
SM & above	22.2	33.9	15.1	29.5
M	30.4	35.7	47.5	42.5
SLM	26.9	21.6	20.2	10.1
LM	7.0	3.5	.7	.7
SGO & below	0	0	1.5	0
Total White & EW	86.5	94.7	85.0	82.8
Spotted				
SM & above	4.7	4.1	5.0	5.0
M	5.2	0	4.3	7.9
SLM & below	1.8	.6	5.0	4.3
Total Spotted	11.7	4.7	14.3	17.2
Gray (all)	1.8	.6	.7	0
TOTAL	100.0	100.0	100.0	100.0
1952:				
White & EW				
SM & above	32.1	38.7	5.2	31.0
M	30.2	32.1	58.6	39.7
SLM	14.2	6.6	25.9	19.0
LM	0	.9	0	0
SGO & below	.9	0	0	0
Total White & EW	77.4	78.3	89.7	89.7
Spotted				
SM & above	11.3	10.4	3.4	6.9
M	9.5	10.4	6.9	3.4
SLM & below	.9	.9	0	0
Total Spotted	21.7	21.7	10.3	10.3
Gray (all)	.9	0	0	0
TOTAL	100.0	100.0	100.0	100.0

and from 38 to 48 per cent during the 1952 season. Pneumatic type cleaners increased the proportion grading Middling and above from 31 to 44 per cent during the 1951 season and from 32 to 40 per cent during the 1952 season.

Effect of lint cleaners upon returns to farmers.

The net gain or loss in bale value which resulted from the use of saw type lint cleaners on cotton of specified grades is shown in the last columns of tables 20 and 21 for hand and machine-harvested cotton, respectively. Similar results for pneu-

TABLE 19.—GRADE DISTRIBUTION OF MACHINE-HARVESTED COTTON BEFORE AND AFTER LINT CLEANING, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Grade	Saw type cleaners		Pneumatic cleaners	
	Before lint cleaning	After lint cleaning	Before lint cleaning	After lint cleaning
	Pct	Pct	Pct	Pct
1951:				
White & EW				
SM & above	6.8	12.1	1.4	.7
M	26.8	41.6	29.2	43.0
SLM	38.9	22.6	36.1	24.3
LM	13.7	8.9	18.7	13.2
SGO & below	1.1	.5	.7	0
Total White & EW	87.3	85.7	86.1	81.2
Spotted				
SM & above	1.1	1.1	2.8	5.6
M	4.2	1.1	2.8	5.6
SLM & below	3.7	1.6	3.5	2.0
Total Spotted	9.0	3.8	9.1	13.2
Gray (all)	3.7	10.5	4.8	5.6
TOTAL	100.0	100.0	100.0	100.0
1952:				
White & EW				
SM & above	.6	2.3	0	0
M	37.2	45.4	31.7	39.7
SLM	34.9	28.5	34.9	28.6
LM	8.2	5.2	17.5	11.1
SGO & below	1.7	.6	0	0
Total White & EW	82.6	82.0	84.1	79.4
Spotted				
SM & above	4.1	5.2	0	7.9
M	5.8	6.4	4.8	7.9
SLM & below	5.8	4.7	11.1	4.8
Total Spotted	15.7	16.3	15.9	20.6
Gray (all)	1.7	1.7	0	0
TOTAL	100.0	100.0	100.0	100.0

TABLE 20.—EFFECT OF SAW TYPE LINT CLEANERS UPON GRADES, BALE WEIGHTS AND MARKET VALUES OF HAND HARVESTED UPLAND COTTON, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Grade before lint cleaning	Total	Grade after lint cleaning															Phoenix Price		Bale Weight		Bale Value		Gain or loss in bale value
		White & EW						Spotted					Gray										
		GM	SM	M	SLM	LM	SGO	GM	SM	M	SLM	LM	GM	SM	M	SLM	BC[2]	AC[2]	BC[2]	AC[2]	BC[2]	AC[2]	
	bales			bales						bales				bales			cents		lbs.		dollars		dollars
1951:																							
White & EW																							
GM	1		1														39.48	39.38	500.0	491.1	197.40	193.40	— 4.00
SM	37	8	27	2													39.38	39.37	500.0	491.9	196.90	193.66	— 3.24
M	52		19	32	1												38.86	39.01	500.0	490.3	194.30	191.27	— 3.03
SLM	46			21	24	1											37.01	37.77	500.0	484.9	185.05	183.15	— 1.90
LM	12			1	9	1					1						33.33	36.34	500.0	482.5	166.65	175.34	+ 8.69
Spotted																							
GM sp.	2		1					1									37.07	38.22					
SM sp	6		2		1				3								36.89	37.74	500.0	488.7	184.45	184.44	— .01
M sp	9			2	1	3			3								34.42	36.15	500.0	490.4	172.10	177.28	+ 5.18
SLM sp	3			1	1	1											30.74	36.40	500.0	488.0	153.70	177.63	+23.93
Gray																							
SM g.	1			1													35.64	38.86	500.0	491.8	178.20	191.11	+12.91
M g.	2			1											1		33.67	36.26	500.0	486.3	168.35	176.33	+ 7.98
1951 Phoenix quotation[1]		39.48	39.38	38.86	37.01	33.33	30.16	37.07	36.89	34.42	30.74	28.15	(36.47)	(35.64)	(33.67)	(29.94)							
1952:																							
White & EW																							
GM	3	3															35.51	35.51					
SM	31		30	1													35.41	35.39	500.0	492.5	177.05	174.30	— 2.75
M	32		8	24													34.87	35.00	500.0	492.2	174.35	172.27	— 2.08
SLM	16			9	6					1							33.49	34.10	500.0	489.2	167.45	166.82	— .63
LM																							
SGO	1		—									1					27.85	25.80					
Spotted																							
GM sp.	1							1									33.09	33.09					
SM sp.	10			1				2	7								32.99	33.20	500.0	494.4	164.95	164.14	— .81
M sp.	10									10							30.85	30.85	500.0	489.2	154.25	150.92	— 3.33
SLM sp.	1					1											28.00	30.99					
1952 Phoenix quotation[1]		35.51	35.41	34.87	33.49	30.99	27.85	33.09	32.99	30.85	28.00	25.80	(32.69)	(32.29)	(30.65)	(28.35)							

[1]Source: "Cotton Price Statistics", USDA, PMA, Market Info. Section, Cotton Branch, Memphis, Tenn.: Vol. XXXIII, No. 13, Season 1951-52, p. 19; and Vol. XXXIV, No. 13, Season 1952-53, p. 20. Prices used are season average market quotations at Phoenix for cotton of the modal staple length, which was 1-1/32" in 1951 and 1-1/16" in 1952. Gov't. loan differences between Spotted and Gray grades were used in arriving at prices of Grays, which were not included in Phoenix market quotations.

[2]BC=Before Cleaning; AC=After Cleaning.

TABLE 21.—EFFECT OF SAW TYPE LINT CLEANERS UPON GRADES, BALE WEIGHTS AND MARKET VALUES OF MACHINE HARVESTED UPLAND COTTON, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Grade before lint cleaning	Total	Grade after lint cleaning															Phoenix Price		Bale Weight		Bale Value		Gain or loss in bale value
		White & EW						Spotted					Gray										
		GM	SM	M	SLM	LM	SGO	GM	SM	M	SLM	LM	GM	SM	M	SLM	BC[2]	AC[2]	BC[2]	AC[2]	BC[2]	AC[2]	
	bales	bales								bales			bales				cents		lbs.		dollars		dollars
1951:																							
White & EW																							
SM	13		9	4													39.38	39.22	500.0	489.1	196.90	191.83	— 5.07
M	51		14	29	2								2	4			38.86	38.58	500.0	487.2	194.30	187.96	— 6.34
SLM	74		1	35	23	3				2				5	5		37.01	37.38	500.0	484.7	185.05	181.18	— 3.87
LM	25			2	12	11											33.33	35.54	500.0	485.8	166.65	172.65	+ 6.00
SGO	3				1	1	1										30.16	33.50					
Spotted																							
SM sp.	2			2													36.89	38.86					
M sp.	8			4	3						1						34.42	37.15	500.0	491.4	172.10	182.56	+10.46
SLM sp.	6			2		2					1				1		30.74	34.80	500.0	484.5	153.70	168.61	+14.91
LM sp.	1										1						28.15	30.74	500.0	485.2	140.75	149.15	+ 8.40
Gray																							
SM g.	4			1				1						2			35.64	36.80	500.0	487.7	178.20	179.47	+ 1.27
M g.	3				1									1	1		33.67	35.44	500.0	483.1	168.35	171.21	+ 2.86
1951 Phoenix quotation[1]		39.48	39.38	38.86	37.01	33.33	30.16	37.07	36.89	34.42	30.74	28.15	(36.47)	(35.64)	(33.67)	(29.94)							
1952:																							
White & EW																							
SM	1		1														35.41	35.41					
M	63		3	55	3				2								34.87	34.77	500.0	489.1	174.35	170.06	— 4.29
SLM	60			19	36	1			2					2			33.49	33.83	500.0	483.7	167.45	163.64	— 3.81
LM	14			1	5	8											30.99	32.16	500.0	480.3	154.95	154.46	— .49
SGO	2											2					27.85	25.80					
Spotted																							
SM sp.	7								7								32.99	32.99					
M sp.	10				2					8							30.85	31.38	500.0	488.5	154.25	153.29	— .96
SLM sp.	4				2						2						28.00	30.74	500.0	486.4	140.00	149.52	+ 9.52
LM sp.	6									2	3	1					25.80	28.58	500.0	468.1	129.00	133.78	+ 4.78
Gray																							
SM g.	3													3			32.29	32.29					
1952 Phoenix quotation[1]		35.51	35.41	34.87	33.49	30.99	27.85	33.09	32.99	30.85	28.00	25.80	(32.69)	(32.29)	(30.65)	(28.35)							

[1]Source: "Cotton Price Statistics", USDA, PMA, Market Info. Section, Cotton Branch, Memphis, Tenn.: Vol. XXXIII, No. 13, Season 1951-52, p. 19; and Vol. XXXIV, No. 13, Season 1952-53, p. 20. Prices used are season average market quotations at Phoenix for cotton of the modal staple length, which was 1-1/32" in 1951 and 1-1/16" in 1952. Gov't. loan differences between Spotted and Gray grades were used in arriving at prices of Grays, which were not included in Phoenix market quotations.

[2]BC=Before Cleaning; AC=After Cleaning.

TABLE 22.—EFFECT OF PNEUMATIC TYPE LINT CLEANERS UPON GRADES, BALE WEIGHTS AND MARKET VALUES OF HAND HARVESTED UPLAND COTTON, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Grade before lint cleaning	Total	Grade after lint cleaning														Phoenix Price		Bale Weight		Bale Value		Gain or loss in bale value
		White & EW						Spotted					Gray									
		GM	SM	M	SLM	LM	SGO	GM	SM	M	SLM	LM	GM	SM	M	SLM						
	bales	bales								bales			bales				cents		lbs.		dollars		dollars
																	BC[2]	AC[2]	BC[2]	AC[2]	BC[2]	AC[2]	
1951:																							
White & EW																							
SM	20		17	3													39.38	39.30	500.0	494.3	196.90	194.27	— 2.63
M	64	1	20	37	3	1			1	1							38.86	38.76	500.0	495.3	194.30	191.98	— 2.32
SLM	27			11	9				2	5							37.01	37.28	500.0	492.5	185.05	183.60	— 1.45
LM	1				1												33.33	37.01	500.0	495.2	166.65	183.27	+16.62
SGO	2										1	1					30.16	29.44	500.0	490.2	150.80	144.31	— 6.39
Spotted																							
GM sp.	1			1													37.07	38.86					
SM sp.	6		2	1					3								36.89	38.05	500.0	496.9	184.45	189.07	+ 4.62
M sp.	5			1	1					3							34.42	35.83	500.0	494.6	172.10	177.22	+ 5.12
SLM sp.	6									2	4						30.74	31.97					
Gray																							
M g.	1			1													33.67	38.86					
1951 Phoenix quotation[1]		39.48	39.38	38.86	37.01	33.33	30.16	37.07	36.89	34.42	30.74	28.15	(36.47)	(35.64)	(33.67)	(29.94)							
1952:																							
White & EW																							
SM	3		3														35.41	35.41	500.0	497.3	177.05	176.09	— .96
M	35		15	19					1								34.87	35.05	500.0	494.1	174.35	173.18	— 1.17
SLM	14			3	11												33.48	33.79	500.0	491.6	167.45	166.11	— 1.34
Spotted																							
SM sp.	2								2								32.99	32.99	500.0	498.1	164.95	164.32	— .63
M sp.	4			1					1	2							30.88	32.39	500.0	497.1	154.25	161.01	+ 6.76
1952 Phoenix quotation[1]		35.51	35.41	34.87	33.49	30.99	27.85	33.09	32.99	30.85	28.00	25.80	(32.69)	(32.29)	(30.65)	(28.35)							

[1]Source: "Cotton Price Statistics", USDA, PMA, Market Info. Section, Cotton Branch, Memphis, Tenn.: Vol. XXXIII, No. 13, Season 1951-52, p. 19; and Vol. XXXIV, No. 13, Season 1952-53, p. 20. Prices used are season average market quotations at Phoenix for cotton of the modal staple length, which was 1-1/32" in 1951 and 1-1/16" in 1952. Gov't. loan differences between Spotted and Gray grades were used in arriving at prices of Grays, which were not included in Phoenix market quotations.

[2]BC=Before Cleaning; AC=After Cleaning.

TABLE 23.—EFFECT OF PNEUMATIC-TYPE LINT CLEANERS UPON GRADES, BALE WEIGHTS AND MARKET VALUES OF MACHINE-HARVESTED UPLAND COTTON, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Grade before lint cleaning	Total	Grade after lint cleaning															Phoenix Price		Bale Weight		Bale Value		Gain or loss in bale value
		White & EW						Spotted					Gray										
		GM	SM	M	SLM	LM	SGO	GM	SM	M	SLM	LM	GM	SM	M	SLM	BC^2	AC^2	BC^2	AC^2	BC^2	AC^2	
	bales	bales								bales			bales				cents		lbs.		dollars		dollars
1951:																							
White & EW																							
SM	2			1					1								39.38	37.88	500.0	495.9	196.90	187.85	— 9.05
M	44		1	34	4				4						1		38.86	38.41	500.0	494.8	194.30	190.05	— 4.25
SLM	55			27	24	3				1							37.01	37.67	500.0	493.7	185.05	185.98	+ .93
LM	24			2	6	14				1	1						33.33	34.65	500.0	492.5	166.65	170.65	+ 4.00
SGO	1															1	30.16	29.94					
Spotted																							
SM sp.	4			1	1				2								36.89	37.41	500.0	495.6	184.45	185.40	+ .95
M sp.	4			1					1	2							34.42	36.15	500.0	494.8	172.10	178.87	+ 6.77
SLM sp.	5									1	2					2	30.74	31.16	500.0	486.1	153.70	151.47	— 2.23
Gray																							
M g.	7														7		33.67	33.67	500.0	494.1	168.35	166.36	— 1.99
1951 Phoenix quotation[1]		39.48	39.38	38.86	37.01	33.33	30.16	37.07	36.89	34.42	30.74	28.15	(36.47)	(35.64)	(33.67)	(29.94)							
1952:																							
White & EW																							
M	20			18	1				1								34.87	34.71	500.0	493.4	174.35	171.26	— 3.09
SLM	22			6	13	1			2								33.49	33.71	500.0	491.3	167.45	165.62	— 1.83
LM	11			1	3	6					1						30.99	31.75	500.0	491.7	154.95	156.11	+ 1.16
Spotted																							
M sp.	3								1	2							30.85	31.56	500.0	496.1	154.25	156.57	+ 2.32
SLM sp.	7				1				1	3	2						28.00	30.72	500.0	487.9	140.00	149.88	+ 9.88
1952 Phoenix quotation[1]		35.51	35.41	34.87	33.49	30.99	27.85	33.09	32.99	30.85	28.00	25.80	(32.69)	(32.29)	(30.65)	(28.35)							

[1]Source: "Cotton Price Statistics", USDA, PMA, Market Info. Section, Cotton Branch, Memphis, Tenn.: Vol. XXXIII, No. 13, Season 1951-52, p. 19; and Vol. XXXIV, No. 13, Season 1952-53, p. 20. Prices used are season average market quotations at Phoenix for cotton of the modal staple length, which was 1-1/32" in 1951 and 1-1/16" in 1952. Gov't. loan differences between Spotted and Gray grades were used in arriving at prices of Grays, which were not included in Phoenix market quotations.

[2]BC=Before Cleaning; AC=After Cleaning.

matic type cleaners are shown in tables 22 and 23, respectively. Taking several bales of cotton of a given grade and passing them through the lint cleaners will usually result in a new grade distribution in which some bales are raised in grade, and some remain the same. Occasionally, also, a few of the bales may have a lower grade after cleaning. Cotton may also change in color class as a result of lint cleaning. For most grades of cotton, the effect of lint cleaning will be an increased selling price per pound of lint. However, in the lint cleaning process, a certain number of pounds of waste is removed from each bale, which would have been sold in the baled cotton, had it not been lint cleaned. If the cotton is assumed to average 500 pounds gross weight per bale before lint cleaning, after lint cleaning it would weigh an amount equal to 500 pounds less the weight of waste removed in the lint cleaning process. The bale value before cleaning (BC) then is estimated by multiplying the "BC" bale weight (500 pounds) times the "BC" price per pound. In the same way, bale value after cleaning (AC) is estimated by multiplying the "AC" price per pound times the "AC" bale weight. As an example, let us take from Table 20 the 52 bales of 1951 season hand-harvested cotton which graded Middling prior to lint cleaning. It may be noted that after passing through the saw type lint cleaners 19 of the 52 Middling bales were raised in grade to Strict Middling, 32 bales remained Middling after lint cleaning, and one bale was reduced to Strict Low Middling. Applying 1951 season average Phoenix market prices for the specified grades to the "AC" grade distribution shows that the selling price per pound had been raised from 38.86 cents (the price for Middling) to 39.01, which was the weighted average price per pound for a distribution consisting of 19 bales of Strict Middling, 32 bales of Middling and one bale of Strict Low Middling. However, in the lint cleaning process, an average weight of waste material of 9.7 pounds per bale was removed. Thus the effect was to reduce the average bale weight from an average of 500 pounds before cleaning (BC) to an average of 490.3 pounds after cleaning (AC). Multiplying the "BC" (before cleaning) bale weight (500 pounds) times the "BC" price per pound (38.86 cents) gives a "BC" bale value of $194.30; similarly multiplying the "AC" (after cleaning) bale weight (490.3 pounds) times the "AC" price per pound (39.01 cents) gives an "AC" bale value of $191.27. The difference between $194.30 and $191.27 represents a loss in bale value on Middling cotton of $3.03 per bale. This figure does not take into consideration any charge made by the gin for the lint cleaning service. Where separate charges are made, they are usually 10 cents per hundredweight of seed cotton or in the neighborhood of $1.50 per bale. In the example above, this $1.50 per bale lint cleaning charge would have to be added to the $3.03 loss in bale value in order to obtain the total economic effect on the farmer. In the case of gains in bale value

from lint cleaning, this $1.50 per bale lint cleaning charge should be subtracted in order to obtain the net gain to the farmer.

The particular grade (Middling) included in the above example suffered a loss in bale value as a result of lint cleaning. A glance at Tables 20 through 23 reveals that for certain grades and in certain cases gains in bale value resulted from lint cleaning—and sometimes these gains were quite spectacular.

Because the number of bales included is so small in some of the cases, results are not as consistent as might be desired. Viewing all the evidence together, however, brings certain facts into focus:

1. The lint cleaning of White grades Strict Low Middling or higher almost always resulted in a loss in bale value. The only exception noted was in the case of hand-harvested cotton of Strict Low Middling White grade cleaned by pneumatic type cleaners in the 1951 season. In this case an increase in bale value of 93 cents per bale resulted from the lint cleaning process, but this was insufficient to cover the $1.50 charge customarily made for lint cleaning. The loss was generally greatest for cotton grading Strict Middling prior to lint cleaning because the proportion of bales which were increased in grade was small, and the spread to the next higher grade (Good Middling) was only 10 points or 50 cents a bale. For this grade, losses in bale value of $4 to $5 a bale were not uncommon. The picture was only a little brighter for Middling where a higher proportion of bales were improved in grade, but the spread of 52-54 points to the next grade was insufficient, on the average, to offset the loss in bale weight which resulted from the lint cleaning process. Even Strict Low Middling cotton which had spreads to the next grade of 185 points and 138 points for 1951 and 1952, respectively, and sometimes had nearly half of the bales raised in grade, generally suffered a loss from lint cleaning when weight loss was taken into consideration. The amount of such losses on Strict Low Middling was frequently less than $1.00 per bale, however.

2. The lint cleaning of Low Middling White cotton usually resulted in gains in bale value, and not infrequently the gains were substantial—$4 to $6 per bale. An exception was noted in the case of machine-harvested cotton processed on saw type cleaners in the 1952 season. Despite the fact that 5 of the 14 bales were raised from Low Middling to Strict Low Middling and one bale to Middling, the increase in price per pound was insufficient to offset the nearly 20 pounds loss in bale weight resulting from the lint cleaning process.

3. The possibilities of enhancing the value of Spotted cotton appear quite promising from the results of this study, although the number of bales available for study was too small to lead to consistent and conclusive results. Whether gains in bale value can be achieved and the size of such benefits seems to depend in large measure upon the ability to raise a considerable proportion

of the "Spotted" bales to white designation, which in turn seems to depend upon the nature of the "spots". For this reason, the cleaning of Spotted cotton is something of a gamble. However, it seems to be a gamble with favorable odds, since out of 20 different combinations of grade, method of harvest, season and type of lint cleaner studied, 14 resulted in an improvement in bale value and in 10 cases the improvement was over $5 per bale. As in the case of the White grades, the greatest increases in bale value were generally to be noted in the lower grades.

Undoubtedly there are some types of spots which may be removed or "blended" more easily than others. Further study would be needed to learn why, for example, during the 1951 season, more than one-half of the total bales which were designated as Spotted before lint cleaning were changed to White grades following cleaning; while during the 1952 season less than one-eighth of such bales were changed to White. With Spotted cotton, however, there are two ways in which the bale value may be enhanced. First there is a chance of raising the cotton to a White designation; that failing, there is a chance of improving the grade within the "Spotted" class sufficiently to outweigh the costs of the weight loss and the lint cleaner charge.

4. Only a few bales of cotton designated as "Gray" prior to lint cleaning were available for study—20 to be exact. Results from lint cleaning these Gray bales ranged from a loss of $2 in bale value to a gain of over $12.00, so it is not possible to draw any firm conclusions. It is probably not as easy to improve the color class of cotton with a background color of Gray as to raise a Spotted bale to White; however, five of the 20 bales with "BC" designations of Gray were raised to White grades following lint cleaning. When a Gray bale can be moved into a White classification following lint cleaning, the potential gain in bale value is great. This again is a "gamble", and perhaps not quite as sound a proposition as in the case of Spotted cotton.

5. Shifts between color classes produced by lint cleaning were not always in the direction of improvement; but the proportion of Spotted or Gray bales which was moved into the White color class following lint cleaning was much greater than the proportion of White bales which became Spotted or Gray. For example, out of a total of 133 bales which graded Spotted prior to lint cleaning 43 were changed to White grades following lint cleaning, in each case with a resulting increase in the selling price per pound of lint. On the other hand, out of a total of 882 bales which graded White before lint cleaning, 35 were changed to Spotted designations following lint cleaning; and in all but 2 of the 35 cases, the result was a decrease in selling price per pound of lint. The proportion of Spotted bales changed to White was about 32 per cent, while the proportion of White changed to Spotted was only 4 per cent. But there are many more White bales in the average Arizona crop than Spotted bales, with the

TABLE 24.—COMPARATIVE EFFECTS OF SAW AND PNEUMATIC TYPE LINT CLEANERS UPON SELLING PRICE PER POUND, BALE WEIGHT, AND BALE VALUE OF HAND-HARVESTED COTTON, CENTRAL ARIZONA, CROPS OF 1951 AND 1952[1]

Grade before lint cleaning	Phoenix price after cleaning		Bale weight after cleaning		Gain or loss in bale value	
	Type of cleaner		Type of cleaner		Type of cleaner	
	Saw	Pneumatic	Saw	Pneumatic	Saw	Pneumatic
	cents	cents	lbs.	lbs.	dols.	dols.
1951:						
White & EW						
GM	39.38	.....	491.1	.....	— 4.00	.....
SM	39.37	39.30	491.9	494.3	— 3.24	— 2.63
M	39.01	38.76	490.3	495.3	— 3.03	— 2.32
SLM	37.77	37.28	484.9	492.5	— 1.90	— 1.45
LM	36.34	37.01	482.5	495.2	+ 8.69	+16.62
SGO	.....	29.44	.....	490.2	.....	— 6.39
Spotted						
GM sp.	38.22	38.86	.....	.....	.....	.....
SM sp.	37.74	38.05	488.7	496.9	— .01	+ 4.62
M sp.	36.15	35.83	490.4	494.6	+ 5.18	+ 5.12
SLM sp.	36.40	31.97	488.0	.....	+23.93	.....
Gray						
SM g.	38.86	.....	491.8	.....	+12.91	.....
M g.	36.26	38.86	486.3	.....	+ 7.98	.....
1952:						
White & EW						
GM	35.51	.....	.....	.....	.....	.....
SM	35.39	35.41	492.5	497.3	— 2.75	— .96
M	35.00	35.05	492.2	494.1	— 2.08	— 1.17
SLM	34.10	33.79	489.2	491.6	— .63	— 1.34
LM	.....	.....	.....	.....	.....	.....
SGO	25.80	.....	.....	.....	.....	.....
Spotted						
GM sp.	33.09	.....	.....	.....	.....	.....
SM sp.	33.20	32.99	494.4	498.1	— .81	— .63
M sp.	30.85	32.39	489.2	497.1	— 3.33	+ 6.76
SLM sp.	30.99	.....	.....	.....	.....	.....

[1]Source: Tables 20 and 22.

result that if the lint cleaners were used on the whole crop, the number of bales moved from White to Spotted designations might almost equal the number of bales changed from Spotted to White. This might serve as one argument for exercising judgment in the matter of when to use (and when not to use) lint cleaners.

6. There are differences between the performance of saw and pneumatic type lint cleaners which may be demonstrated by examining Tables 24 and 25. Table 24 compares the effects which saw and pneumatic type cleaners had upon (1) selling price per pound, (2) bale weight, and (3) bale value, of specified grades of hand-harvested cotton in central Arizona during the 1951 and 1952 seasons. Table 25 makes the same comparisons for machine-

TABLE 25.—COMPARATIVE EFFECTS OF SAW AND PNEUMATIC TYPE LINT CLEANERS UPON SELLING PRICE PER POUND, BALE WEIGHT, AND BALE VALUE OF MACHINE-HARVESTED COTTON, CENTRAL ARIZONA, CROPS OF 1951 AND 1952[1]

Grade before lint cleaning	Phoenix price after cleaning		Bale weight after cleaning		Gain or loss in bale value	
	Type of cleaner		Type of cleaner		Type of cleaner	
	Saw	Pneumatic	Saw	Pneumatic	Saw	Pneumatic
	cents	cents	lbs.	lbs.	dols.	dols.
1951:						
White & EW						
SM	39.22	37.88	489.1	495.9	— 5.07	—9.05
M	38.58	38.41	487.2	494.8	— 6.34	—4.25
SLM	37.38	37.67	484.7	493.7	— 3.87	+ .93
LM	35.54	34.65	485.8	492.5	+ 6.00	+4.00
SGO	33.50	29.94	.....	.....	.....	.....
Spotted						
SM	38.86	37.41	.....	495.6	.....	+ .95
M	37.15	36.15	491.4	494.8	+10.46	+6.77
SLM	34.80	31.16	484.5	486.1	+14.91	—2.23
LM	30.74	.....	485.2	.....	+ 8.40	.....
Gray						
SM	36.80	.....	487.7	.....	+ 1.27	.....
M	35.44	33.67	483.1	494.1	+ 2.86	—1.99
1952:						
White & EW						
SM	35.41	.....	.....	.....	.....	.....
M	34.77	34.71	489.1	493.4	— 4.29	—3.09
SLM	33.83	33.71	483.7	491.3	— 3.81	—1.83
LM	32.16	31.75	480.3	491.7	— .49	+1.16
SGO	25.80	.....	.....	.....	.....	.....
Spotted						
SM	32.99	.....	.....	.....	.....	.....
M	31.38	31.56	488.5	496.1	— .96	+2.32
SLM	30.74	30.72	486.4	487.9	+ 9.52	+9.88
LM	28.58	.....	468.1	.....	+ 4.78	.....
Gray						
SM	32.29	.....	.....	.....	.....	.....

[1]Source: Tables 21 and 23.

harvested cotton. Each "BC" (before cleaning) grade for which data are available constitutes a separate comparison. Thus for hand-harvested cotton there were a total of 14 price comparisons available. Since "BC" (before cleaning) prices for each grade are the same for saw and pneumatic types, a comparison of "AC" selling prices gives a comparison of the extent of grade improvement by saw and pneumatic type cleaners, respectively. For hand-harvested cotton, out of a total of 14 cases, saw type cleaners had the higher "AC" price 7 times and pneumatic type had the higher "AC" price 7 times. Because of gaps in the data only 11 comparisons were possible for bale weights and bale values. In respect to bale weight, pneumatic type cleaners had

the greatest "AC" weight (least weight loss) in *all 11* cases. The result was, that in 9 out of 11 cases pneumatic type cleaners had the higher "AC" bale value.

For machine-harvested cotton (Table 25) 14 price comparisons were available, and saw type cleaners had the higher "AC" price 12 times. This indicates that saw type cleaners raised grades of machine-harvested cotton with more frequency (or to a greater extent) than did pneumatic type cleaners. However, in respect to bale weight, pneumatic type cleaners again had the greatest "AC" bale weight (least weight loss) in *all cases studied.* Twelve comparisons of bale value were available for machine-harvested cotton. Despite the superior showing made by the saw type cleaners in the matter of grade improvement, pneumatic type cleaners resulted in higher average "AC" bale value in 7 of the 12 combinations available for study. This was, of course, because of the relatively smaller loss in bale weight resulting from the use of pneumatic type cleaners, as compared with saw type cleaners.

Recommendations regarding the use of lint cleaners.

The findings of this study make it appear that it would not generally be wise to use the lint cleaners indiscriminately on the entire crop. Management should bear in mind that lint cleaners enjoy their greatest potential benefits when used on White cotton of Low Middling or poorer grade, or on "off-color" cotton, particularly Spotted cotton.

If green leaf spots on early machine-picked cotton become a problem, it might be well to experiment with the use of the cleaners on particularly dirty individual loads to see if the proportion of Spotted bales can be reduced by lint cleaning. However, it would seem that from the farmer's standpoint, and from the ginner's also in the long run, it would be better to delay the general use of lint cleaners (under existing price spreads) until that time in the season when Low Middling Whites, Spotted, and/or Gray

TABLE 26.—AVERAGE MOISTURE CONTENT OF COTTONSEED, BY SPECIFIED GIN GROUPS, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Method of harvest and season	Specially equipped gins		Standard gins	
	With lint cleaners (Group I)	Without lint cleaners (Group II)	With lint cleaners (Group III)	Without lint cleaners (Group IV) control
	Pct	Pct	Pct	Pct
Hand harvested:				
1951	10.3	10.3	10.9	10.4
1952	7.5	7.8	6.9	7.7
Machine harvested:				
1951	10.8	12.2	11.2	11.5
1952	7.8	7.7	8.2	8.6

bales begin to appear in the ginnings in considerable numbers. By this time of the season, a major portion of the crop will probably be grading Strict Low Middling without the use of lint cleaners and slight losses to farmers generally result from lint cleaning this grade. However, if there is considerable lower grade cotton in the grade distribution, the chances are quite favorable of offsetting the losses on Strict Low Middling with gains on lower grades of White and on Spotted and Gray cottons.

ANALYSIS OF COTTONSEED RESULTING FROM THE GINNING PROCESS

Moisture content of cottonseed.

The average moisture content of cottonseed resulting from the ginning of hand-harvested cotton was similar for all four gin groups during the 1951 season ranging from 10.3 to 10.9 per cent. Machine-harvested cotton showed a little wider variation among gin groups in seed moisture content, ranging from 10.8 to 12.2 per cent. However, only gin group I (specially equipped gins with lint cleaners), had a significantly different moisture content than the control group: 10.8 per cent compared with 11.5 per cent (Table 26).

In a few instances, particular loads of seed cotton had considerably more than the average seed moisture, but due to the extremely dry weather and uniform environmental conditions in the Central Arizona Valley, the seed moisture content was, on the whole, very uniform.

The moisture content of seed obtained from machine-harvested cotton, however, was higher in every case than of seed produced from hand-harvested cotton by the corresponding gin group during the 1951 season. These slightly higher percentages of moisture in seed produced from machine-harvested cotton were believed to be the result of moisture added to the spindles of mechanical pickers during the harvesting process.

The moisture content of cottonseed is, to some extent, a relative measure of the amount of moisture in the seed cotton that has passed through all the gin driers and is ready to fall from the feeder apron to the gin saws. This is not always true, however, due to the nature and source of moisture in the seed cotton. In one case, the moisture of seed may be high due to early harvesting when seeds are relatively high in moisture and lint is dry. On the other hand, seed may be dry and lint damp because of recent rain.

Moisture content of cottonseed is very important since it is closely related to the development of free fatty acid and the value of seed in oil milling.[5] There seemed to be very little, if any indication that gins in this study were selected by cotton growers because the gin was more efficient in drying than an-

[5]Whitten, M. E., and Stevenson, J. H., *The Grading of Cottonseed*, 1951, U. S. Department of Agriculture, P.M.A., Cotton Branch, Washington, D. C.

other gin in the same group or in other groups. In fact, cottonseed produced under central Arizona weather conditions does not usually contain sufficient moisture to prevent it from being premium seed.

Again in 1952, the differences between gin groups in average moisture content of cottonseed from hand-harvested cotton tended to be relatively small, average moisture contents ranging from 6.9 to 7.8 per cent. Only gin group III (standard gins with lint cleaners) had a moisture content significantly different from the control group: 6.9 per cent as compared with 7.7 per cent in the control group.

Again in 1952, the seed from mechanically harvested cotton was of a little higher moisture content than the seed from hand-harvested cotton, ranging from 7.7 to 8.6 per cent. Both gin groups I and II had machine-harvested cottonseed which was significantly drier than that in the control group: 7.8 and 7.7 per cent respectively, compared with 8.6 per cent in the control group.

Taking gin group for gin group, the proportions of seed moisture averaged from 2.5 to 4.5 percentage points lower in the 1952 season than in the 1951 season. This drier condition of seed during the 1952 season was perhaps due to the drier weather conditions and to more careful use of mechanical harvesters.

Linters content of cottonseed.

Several reasons are advanced as a cause of high or low linters content of cottonseed. The most persistent explanation is that nearly closed seed boards and tight seed rolls will lead to more complete removal of linters from the seed. Others claim that dull saws will leave more lint on the seed than freshly sharpened saws and that cotton which is too damp to gin properly will invariably result in an excessive amount of lint on the seed.

As the result of a study, including the seasons 1942-43 through 1946-47, Whitten and Stevenson concluded that linters

TABLE 27.—AVERAGE LINTERS CONTENT OF COTTONSEED, BY SPECIFIED GIN GROUPS, CENTRAL ARIZONA, CROPS OF 1951 AND 1952

Method of harvest and season	Specially equipped gins		Standard gins	
	With lint cleaners (Group I)	Without lint cleaners (Group II)	With lint cleaners (Group III)	Without lint cleaners (Group IV) control
	Pct	Pct	Pct	Pct
Hand harvested:				
1951	13.0	13.0	12.6	11.8
1952	13.0	12.7	12.6	12.5
Machine harvested:				
1951	13.2	13.1	12.9	11.9
1952	13.2	12.9	13.0	12.7

content of cottonseed was due to variety and growing environment more than to method of ginning.[6]

It has been found that there was considerable difference in linters content of seed grown in the same locality, from one variety, and ginned at the same gin when one season is compared with another. There is little doubt but that environmental and growing conditions have considerable influence on linters content of cottonseed. However, some fairly consistent differences between gin groups were observed in the present study. The linters content of cottonseed from hand-harvested cotton was highest at the specially equipped gins during both seasons studied. During the 1951 season, the linters contents at gin groups I, II, and III all averaged significantly higher than in the control group (group IV, standard gins without lint cleaners); the averages were 13.0 per cent in both specially equipped groups, and 12.6 per cent in the standard gins with lint cleaners, compared with 11.8 per cent in the control group (Table 27).

The 1952 results for hand-harvested cottonseed were similar except that in that year only gin group I (the specially equipped gins with lint cleaners) was judged to have a significantly higher linters content than the control group; the averages for gin groups I, II, III, and IV were 13.0, 12.7, 12.6, and 12.5 per cent, respectively.

As in the case of the hand-harvested cottonseed, the machine-harvested cottonseed during the 1951 season showed a significantly higher linters content at gin groups I, II, and III than at the control group. Or, stating it the other way around, group IV (the standard gins without lint cleaners) produced a significantly *lower* linters content than any of the other groups. The averages for gin groups I, II, III, and IV were 13.2, 13.1, 12.9 and 11.9 per cent, respectively.

The same trend in linters contents was indicated for machine-harvested cottonseed during the 1952 season, but in this case none of the groups differed from the control group by a statistically significant amount. The averages for gin groups I, II, III, and IV were 13.2, 12.9, 13.0, and 12.7 per cent, respectively.

A majority of the individual gins produced seed bearing from 11.0 to 13.0 per cent linters from hand-harvested or machine-harvested cotton during both the 1951 and the 1952 seasons. At least one specially equipped gin produced seed bearing 15.0 per cent linters from both methods of harvesting, and one specially equipped and one standard gin produced seed bearing more than 14.0 per cent linters. Only one of the group I gins produced less than 11.0 per cent linters during the two seasons. These gins were in widely scattered areas of the study territory. The 11.0 per cent to 13.0 per cent linters content for seed appar-

[6]Whitten, M. E., and Stevenson, J. H., *The Grading of Cottonseed*, p. 25, 1951, U. S. Department of Agriculture, P.M.A., Cotton Branch, Washington, D. C.

ently was about normal for central Arizona under 1951 and 1952 conditions.

PROCESSING RESULTS

Introduction.

In order to further explore ginning quality and also to determine manufacturing performance of central Arizona cotton, 36 spinning tests (five pounds of lint were used in each test) were made of lint samples from the 1951 crop. The following items were considered in selecting spinning lots used in the 1951 tests:

Item	*Explanation*
Time of harvest	(early season, midseason, late season)
Grades used	(Strict Middling, Middling, and Strict Low Middling)
B.C. and A.C. samples	(B.C., before lint cleaning; and A.C., after lint cleaning)
Gin group	(specially equipped gins, with and without lint cleaners; and standard gins with and without lint cleaners) (Groups I, II, III, and IV, respectively)
Variety	(Arizona 44 only was used)

The following items were considered in selecting the spinning test lots for the 1952 season:

Item	*Explanation*
Method of harvest	(hand-harvested and machine-harvested)
Grades used	(Middling and Strict Low Middling)
B.C. and A.C. samples	(B.C., before lint cleaning; and A.C., after lint cleaning)
Type of lint cleaner	(saw type and pneumatic type lint cleaners)

The "B.C." and "A.C." samples were not paired during the 1951 season because of an effort to obtain a maximum number of spinning tests from the field samples available. Only three grades were used for the 1951 season spinning tests because there was insufficient cotton in other grades for making tests. For the same reason, two grades (Middling and Strict Low Middling) were used for spinning tests during the 1952 season.

A somewhat different procedure was followed in selecting the 1952 spinning lots as compared with the 1951 season. During the 1952 season, "before lint cleaning" and "after lint cleaning" samples were paired. In other words, both the B.C. and A.C. samples were taken from the same bale of cotton in each instance. Also, in selecting the 1952 spinning lots, method of harvest and type of lint cleaner were indicated.

All spinning test results given are based upon a carding rate of 9½ pounds per hour for both the 1951 and the 1952 seasons. This is the normal laboratory spinning test made of short and medium staple upland cottons and compares with actual commercial operations.

Picker and card waste.

Percentage of picker and card waste is a measure of the waste removed by the cleaning machinery at cotton mills. Based on repeated tests made of samples of cotton used in the white grade standards for upland cotton, a scale has been established to represent the average picker and card waste of various grades.

During the 1951 season, the lint from gins equipped with lint cleaners consistently exhibited lower percentages of picker and card waste than the averages for corresponding grades of cotton used in the grade standards (Table 28). On the other hand, the lint from gins without lint cleaners (especially in those with only standard overhead cleaning equipment) frequently exhibited somewhat higher percentages of non-lint content than averages for corresponding grades of cotton used in the grade standards.

TABLE 28.—PICKER AND CARD WASTE[2] OF 36 LOTS OF COMMERCIALLY GINNED ARIZONA 44 UPLAND COTTON, CENTRAL ARIZONA, CROP OF 1951

Season	Grade	Specially equipped gins			Standard gins		
		With lint cleaners		Without lint cleaners	With lint cleaners		Without lint cleaners
		B.C.[1]	A.C.[1]		B.C.[1]	A.C.[1]	
		Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Early-season samples	SM	7.23	6.87	7.05	*	*	9.75
	M	8.16	7.55	8.07	8.36	7.78	8.92
	SLM	*	*	*	*	*	*
Midseason samples	SM	6.66	6.27	8.36	*	*	*
	M	7.75	7.14	7.69	8.78	7.97	9.12
	SLM	8.40	7.60	10.36	9.88	8.44	10.51
Late-season samples	SM	*	*	*	*	*	*
	M	7.50	7.72	8.38	8.56	7.55	*
	SLM	8.54	8.81	10.25	10.12	9.28	10.98

*Inadequate sample for spinning test.

[1]B.C. and A.C. spinning lots were not paired. (B.C. = before lint cleaning; A.C. = after lint cleaning).

[2]Average Picker and Card Waste

Grade (Upland cotton)	Short & Medium staple
	Pct.
GM	6.3
SM	7.2
M	8.1
SLM	9.3
LM	12.5
SGO	15.6
GO	18.3

TABLE 29.—PICKER AND CARD WASTE[2] OF 16 LOTS OF UPLAND COTTON GINNED AT COMMERCIAL GINS EQUIPPED WITH LINT CLEANERS, CENTRAL ARIZONA, CROP OF 1952

Method of harvest and grade	Picker and card waste[2]			
	Saw type cleaners		Pneumatic type cleaners	
	B.C.[1]	A.C.[1]	B.C.[1]	A.C.[1]
	Pct.	Pct.	Pct.	Pct.
Hand harvested:				
M	8.23	7.29	7.40	8.57
SLM	9.10	8.65	10.55	9.35
Machine harvested:				
M	9.30	8.67	9.50	8.79
SLM	10.79	10.22	10.16	9.08

[1]B.C. and A.C. spinning lots paired in each instance. (B.C. = before lint cleaning; A.C. = after lint cleaning).

[2]Average picker and card waste

Grade (Upland cotton)	Short & Medium staple
	Pct.
GM	6.3
SM	7.2
M	8.1
SLM	9.3
LM	12.5
SGO	15.6
GO	18.3

During the 1952 season, picker and card waste was reduced in almost every test from the "before lint cleaning" to the "after lint cleaning" sample. While three out of the four "after lint cleaning" samples of hand-harvested cotton showed less than the average picker and card waste for cotton of their grade, three out of the four samples of machine-harvested cotton continued to have slightly greater than average picker and card waste even following lint cleaning (Table 29).

Neps in card web

The number of neps appearing in card web are of considerable concern to textile manufacturers because of the difficulties which neps cause in dyeing and in producing cloth of consistent color and appearance. Neps in cotton lint are believed to be primarily associated with variety, extensive machining, and growing conditions peculiar to certain years of growth. Extensive machining is sometimes necessary in order to obtain satisfactory grades of lint from seed cotton of high foreign matter content.

Under controlled laboratory ginning, extensive machining has definitely demonstrated a tendency to produce a higher nep count than is produced by a moderate use of cleaning machinery. However, even in controlled laboratory ginning, the increased use of cleaning machinery usually produces only

a moderate accumulation in the number of neps within the range of machinery setups found in central Arizona. The amount

TABLE 30.—NEPS IN THE CARD WEB (PER 100 SQUARE INCHES)[2] OF 36 LOTS OF COMMERCIALLY GINNED ARIZONA 44 UPLAND COTTON, CENTRAL ARIZONA, CROP OF 1951

Season	Grade	Specially equipped gins			Standard gins		
		With lint cleaners		Without lint cleaners	With lint cleaners		Without lint cleaners
		B.C.[1]	A.C.[1]		B.C.[1]	A.C.[1]	
		Neps	Neps	Neps	Neps	Neps	Neps
Early-season samples	SM	18	21	10	*	*	12
	M	18	20	18	16	19	13
	SLM	*	*	*	*	*	*
Midseason samples	SM	23	14	15	*	*	*
	M	18	22	17	20	21	16
	SLM	20	17	26	26	20	16
Late-season samples	SM	*	*	*	*	*	*
	M	17	23	20	19	23	*
	SLM	22	24	26	36	32	27

*Inadequate sample for spinning test.
[1]B.C. and A.C. spinning lots were not paired. (B.C. = before lint cleaning; A.C. = after lint cleaning).
[2]No. of neps per 100 sq. in. of card web

Description	Medium staple upland cottons
Low	Below 16
Medium	16-25
High	26-40
Very high	Above 40

TABLE 31.—NEPS IN THE CARD WEB (PER 100 SQUARE INCHES)[2] OF 16 LOTS OF UPLAND COTTON GINNED AT COMMERCIAL GINS EQUIPPED WITH LINT CLEANERS, CENTRAL ARIZONA, CROP OF 1952

Method of harvest and grade	Neps per 100 sq. in. of card web[2]			
	Saw type cleaners		Pneumatic type cleaners	
	B.C.[1]	A.C.[1]	B.C.[1]	A.C.[1]
	Neps	Neps	Neps	Neps
Hand harvested:				
M	7	10	7	8
SLM	13	11	6	9
Machine harvested:				
M	7	8	10	7
SLM	10	13	11	12

[1]B.C. and A.C. spinning lots paired in each instance. (B.C. = before lint cleaning; A.C. = after lint cleaning).
[2]No. of neps per 100 sq. in. of card web

Description	Medium staple upland
Low	Below 16
Medium	16-25
High	26-40
Very high	Above 40

of foreign matter in the seed cotton is important because it naturally influences the amount of machinery which will be used.

In commercial ginning, nep count comparisons between specially equipped gins and standard gins do not always lead to consistent results because the standard gin usually employs all machinery in the gin while machinery is by-passed in the specially equipped gin according to the condition of seed cotton to be ginned. There appeared to be a tendency during the 1951 season for the nep count of cotton to be lowest at those gins with the least cleaning equipment, but this tendency was reversed to some extent during the late season and on the lower grades of cotton (Table 30). This apparent reversal may be accounted for by the fact that standard gins had considerable overflow which was usually passed back through all overhead cleaning machinery. The specially equipped gins used all overhead cleaning machinery on roughly harvested cotton, but had very little overflow and did not pass this seed cotton back through the overhead cleaning machinery.

In eight out of 12 cases studied at lint cleaner gins during the 1951 season, samples taken prior to lint cleaning had a lower nep count than of the corresponding grade of cotton taken following lint cleaning. However, the greatest increase in nep count after lint cleaning was only six, and most of the increases were only one to three neps per 100 square inches of card web. Out of the total of 36 spinning lots tested during the 1951 season, 25 were "medium" with respect to nep count (16 to 25 neps), six were regarded as "high" and five were "low".

During the 1952 season the nep count was "low" for all spinning lots tested for hand-harvested and for machine-harvested cotton, and for saw type and pneumatic type lint cleaners. The highest nep count for either Middling or Strict Low Middling grade was 13. All nep counts below 16 are considered low (Table 31). Of the eight paired samples taken before and after lint cleaning in the 1952 season, six showed an increase in nep count after lint cleaning, but the increase was so slight as to be immaterial—only one to three neps per 100 square inches of card web.

It should also be noted that the nep count for machine-harvested cotton compared favorably with that for hand-harvested cotton during the 1952 season, being low in both cases.

In justice to the lint cleaners, it should be said that while they may not always produce the grade improvements claimed for them, the data of this study do not support the indictment of either type of lint cleaner on grounds of excessive nep formation.

There is no apparent reason for the lower nep count during the 1952 season as compared with the 1951 season unless it is the fact that many gins were overhauled during the summer

TABLE 32.—AVERAGE BREAK FACTORS[2] FOR SKEIN STRENGTH OF CARDED 22'S AND 50'S YARN OF 36 LOTS OF COMMERCIALLY GINNED ARIZONA 44 UPLAND COTTON, CENTRAL ARIZONA, CROP OF 1951

Season	Grade	Staple length	Break factors[2] for carded 22's and 50's					
			Specially equipped gins			Standard gins		
			With lint cleaners		Without lint cleaners	With lint cleaners		Without lint cleaners
			B.C.[1]	A.C.[1]		B.C.[1]	A.C.[1]	
		inches	lbs. x No.	lbs. x No.	lbs. x No.	lbs. x No.	lbs. x No.	lbs. x No.
Early-season samples	SM	1-1/32	2322	2381	2337	*	*	2358
	M	1-1/32	2267	2328	2254	2254	2245	2178
	SLM	1-1/32	*	*	*	*	*	*
Midseason samples	SM	1-1/32	2340	2344	2379	*	*	*
	M	1-1/32	2237	2262	2274	2279	2322	2269
	SLM	1-1/32	2220	2270	2158	2283	2283	2196
Late-season samples	SM	1-1/32	*	*	*	*	*	*
	M	1-1/32	2309	2206	2227	2241	2242	*
	SLM	1-1/32	2255	2219	2178	2276	2304	2203

*Inadequate sample for spinning test.

[1]B.C. and A.C. spinning lots were not paired. (B.C. = before lint cleaning; A.C. = after lint cleaning).

[2]Break factor values listed above are the average of the skein strengths in pounds times the yarn numbers for the 2 yarn numbers specified. Standard break factor for carded 22's and 50's spun from 1-1/32" staple is 2251. A higher figure than this indicates above average strength.

TABLE 33.—AVERAGE BREAK FACTORS[2] FOR SKEIN STRENGTH OF CARDED 22'S AND 50'S YARN OF 16 LOTS OF UPLAND COTTON GINNED AT COMMERCIAL GINS EQUIPPED WITH LINT CLEANERS, CENTRAL ARIZONA, CROP OF 1952

Method of harvest	Grade	Staple length	Break factors[2] for carded 22's and 50's			
			Saw type cleaners		Pneumatic type cleaners	
			B.C.[1]	A.C.[1]	B.C.[1]	A.C.[1]
		inches	lbs. x No.	lbs. x No.	lbs. x No.	lbs. x No.
Hand harvested	M	1-1/16	2271	2282	2341	2202
	SLM	1-1/16	2366	2310	2144	2197
Machine harvested	M	1-1/16	2355	2331	2356	2387
	SLM	1-1/16	2350	2290	2338	2272

[1]B.C. and A.C. spinning lots paired in each instance. (B.C. = before lint cleaning; A.C. = after lint cleaning).

[2]Break factor values listed are the average of the skein strengths in pounds times the yarn numbers for the 2 yarn numbers specified. Standard break factor for carded 22's and 50's spun from 1-1/16" staple is 2387. A higher figure than this indicates above average strength.

of 1952, or that possibly the 1952 growth year was favorable to cotton of superior quality from the standpoint of nep count.

Yarn strength.

When compared with average or standard break factors for yarns spun from cotton of the same (1 1/32 inch) staple length, 24 of the 36 spinning lots tested in the 1951 season had greater than average yarn strength (Table 32). There appeared to be no consistent relationship between gin equipment group and yarn strength. Strict Middling cotton consistently exhibited greater yarn strength than Middling cotton processed at the same group of gins, but Middling cotton did not always show a greater yarn strength than Strict Low Middling cotton. There also appeared to be a tendency for the strength of the cotton to deteriorate toward the end of the 1951 season.

Only one spinning lot of the 16 lots tested during the 1952 season equaled the standard break factor for yarns spun from cotton of the same (1 1/16 inch) staple length, while the remaining 15 lots fell slightly below average (Table 33). Actually, the break factors for cotton tested from the 1952 crop were about equal to those tested from the previous crop. However, since samples from the 1952 crop had a 1/32 inch longer staple, their performance was compared with a higher standard for yarn strength, with relatively less favorable results. From the 1952 test data, there is little, if any, evidence that different types of lint cleaners or methods of harvest had a decided influence upon yarn strength.

Yarn appearance.

The average yarn appearance during the 1951 season ranged from D to C+, but most of the lots graded either C (fair) or

TABLE 34.—AVERAGE YARN APPEARANCE INDEX[2] OF 36 LOTS OF COMMERCIALLY GINNED ARIZONA 44 UPLAND COTTON, CENTRAL ARIZONA, CROP OF 1951

Season	Grade	Specially equipped gins			Standard gins		
		With lint cleaners		Without lint cleaners	With lint cleaners		Without lint cleaners
		B.C.[1]	A.C.[1]		B.C.[1]	A.C.[1]	
		Index	Index	Index	Index	Index	Index
Early-season samples	SM	100	95	95	*	*	100
	M	90	90	100	95	100	95
	SLM	*	*	*	*	*	*
Midseason samples	SM	95	95	100	*	*	*
	M	95	95	95	95	100	90
	SLM	95	95	90	90	90	90
Late-season samples	SM	*	*	*	*	*	*
	M	95	90	95	90	95	*
	SLM	90	85	90	80	90	85

*Inadequate sample for spinning test.
[1]B.C. and A.C. spinning lots were not paired. (B.C. = before lint cleaning; A.C. = after lint cleaning).
[2]Yarn appearances

Description	Grade	Index
Excellent	A	130
Very good	B+	120
Good	B	110
Average	C+	100
Fair	C	90
Poor	D+	80
Very poor	D	70

TABLE 35.—AVERAGE YARN APPEARANCE INDEX[2] OF 16 LOTS OF UPLAND COTTON GINNED AT COMMERCIAL GINS EQUIPPED WITH LINT CLEANERS, CENTRAL ARIZONA, CROP OF 1952

Method of harvest and grade	Average yarn appearance index[2]			
	Saw type cleaners		Pneumatic type cleaners	
	B.C.[1]	A.C.[1]	B.C.[1]	A.C.[1]
	Index	Index	Index	Index
Hand harvested:				
M	90	90	95	100
SLM	90	90	95	100
Machine harvested:				
M	90	95	100	100
SLM	90	90	90	95

[1]B.C. and A.C. spinning lots paired in each instance. (B.C. = before lint cleaning; A.C. = after lint cleaning).
[2]Yarn appearance

Description	Grade	Index
Excellent	A	130
Very good	B+	120
Good	B	110
Average	C+	100
Fair	C	90
Poor	D+	80
Very poor	D	70

C+ (average). Average and fair yarn appearance resulted for all lots tested for early and midseason ginnings. Poor yarn appearance was observed only for Strict Low Middling grade ginned during late season 1951 (Table 34).

All the 1952 spinning lots were in the fair to average yarn appearance groups even though only Middling and Strict Low Middling grades were tested (Table 35). Four of the 16 lots were judged average in yarn appearance.

Neither the 1951 nor the 1952 spinning tests gave convincing evidence that yarn appearance was being injured by any particular gin machinery setup. With respect to lint cleaners, these data would indicate that yarn appearance was actually improved by lint cleaning more often than it was impaired, although most frequently there was no change whatsoever.

In 1952, when separate spinning tests were conducted for hand- and machine-harvested cotton, the yarn appearance indexes were practically the same for both methods of harvest.

COST OF GINNING SERVICES IN ARIZONA

In order to compare the costs of providing ginning services for gins with varying amounts of cleaning and conditioning equipment, detailed cost records were obtained from several of the sampled gins at the close of the ginning season each summer. Usable cost data were not available from all 26 gins included in the quality phase of the study each year, but only from 11 of the 26 gins in the 1951-52 season and 15 of the 26 gins in the 1952-53 season. For this reason, the same degree of detail cannot be given for the cost data as for the quality data. It has been necessary to treat all specially equipped gins as one group and all standard gins as another group, regardless of the presence or absence of lint cleaners. Nevertheless, certain useful comparisons can be made.

Investment in gin plant and equipment.

The total replacement cost per gin plant ranged from over $150,000 for specially equipped gins, to about $100,000 for standard gins (Table 36). The largest investment was in gin machinery and power plant, accounting for about 58 per cent of total replacement cost in specially equipped plants, and 53 to 55 per cent of replacement cost in standard plants. The higher investment in plant and equipment was reflected in annual depreciation being 35 to 39 per cent greater in the specially equipped gins than in the standard gins (Table 37). Since the average gin in the specially equipped group was less than four years old, compared with over eight years for the standard gins, the difference in present value is even more striking—a present value of 127 to 137 thousand dollars for the specially equipped gins compared with a present value of 62 to 69 thousand for standard gins, only about half as much.

The number of gins in Arizona has more than doubled since 1948. Most of the gins built in Arizona in recent years fall into

TABLE 36.—BREAKDOWN OF REPLACEMENT COSTS PER GIN PLANT, SPECIALLY EQUIPPED AND STANDARD GINS, CENTRAL ARIZONA, SEASONS 1951-52 AND 1952-53

Replacement Cost	Specially equipped gins	Standard gins
	Dollars	Dollars
1951-52:		
Buildings	32,026	28,592
Machines in buildings	75,291	48,731
Power plant	11,884	4,541
Other equipment	17,868	12,372
Real estate	13,530	5,874
Total replacement cost	150,599	100,110
1952-53:		
Buildings	34,910	28,775
Machines in buildings	77,505	48,994
Power plant	11,636	5,807
Other equipment	17,252	11,354
Real estate	11,659	5,600
Total replacement cost	152,962	100,530

TABLE 37.—AVERAGE REPLACEMENT COST, PRESENT VALUE, AND ESTIMATED ANNUAL DEPRECIATION FOR SPECIALLY EQUIPPED AND STANDARD GINS, CENTRAL ARIZONA, SEASONS 1951-52 AND 1952-53

Cotton season and item	Specially equipped gins	Standard gins
	Dollars	Dollars
1951-52:		
Replacement cost	150,599	100,110
Present value	127,120	62,416
Estimated annual depreciation[1]	6,369	4,712
1952-53:		
Replacement cost	152,962	100,530
Present value	137,418	68,655
Estimated annual depreciation[1]	6,429	4,629

[1]Buildings were depreciated at 3-5 per cent, depending upon construction; machinery and equipment at 5 per cent. Eight years was the maximum length of depreciation charged.

years studied (Table 38). In 1951, total costs of ginning per the specially equipped group, and most have lint cleaners. Hence, the large plant with lint cleaners and representing an investment of upward of $150,000 can be thought of as the one typical of Arizona conditions.

Comparison of costs by gin groups.

Cost comparison between gin groups was made easier by the fact that both standard and specially equipped groups operated at average volumes of 11 to 13 thousand bales during the

TABLE 38.—DISTRIBUTION OF GINNING COSTS PER BALE FOR SPECIALLY EQUIPPED AND STANDARD GINS, CENTRAL ARIZONA, SEASONS 1951-52 AND 1952-53

Items of cost	1951-52 season		1952-53 season	
	Specially equipped gins	Standard gins	Specially equipped gins	Standard gins
	Dols	Dols	Dols	Dols
Fixed costs:				
Management	.33	.25	.38	.32
Office salaries	.34	.29	.23	.32
Night watchman	.13	.08	.14	.07
Depreciation	.55	.36	.55	.41
Interest on investment	.43	.20	.46	.24
Insurance (general)	.17	.09	.18	.11
Taxes	.10	.06	.10	.06
Total fixed costs	2.05	1.33	2.04	1.53
Variable costs:				
Bagging & ties	2.93	2.95	2.80	2.71
Labor	1.98	1.91	2.22	2.28
Repairs	.62	.41	.62	.68
Power	.59	.36	.58	.46
Yard insurance	.42	.42	.37	.37
Compensation insurance	.16	.15	.18	.18
Ginning supplies	.21	.11	.10	.13
Travel & auto expense	.06	.12	.08	.02
Drier fuel	.06	.05	.12	.06
Office supplies	.03	.12	.05	.10
Telephone & telegraph	.05	.03	.08	.04
Legal & audit	.01	.05	.06	.01
Miscellaneous	.05	.07	.17	.08
Total variable costs	7.17	6.75	7.43	7.14
TOTAL ALL COSTS	9.22	8.08	9.47	8.67
Bales per gin	11,719	13,176	11,781	11,246

bale averaged $8.08 per bale for standard gins and $9.22 per bale for specially equipped gins. Costs for both groups were slightly higher in 1952, averaging $8.67 for standard gins and $9.47 for specially equipped gins. In general, it appeared that the special overhead cleaning equipment made more difference in costs than the presence or absence of lint cleaners. One thing that stood out in the comparison was the wide variation within groups. For example, at similar volumes of from 11 to 13 thousand bales, individual gins in the specially equipped group reported ginning costs ranging all the way from $7.83 to $11.91 per bale during the 1952 season.

Fixed costs.

The standard gins enjoyed their greatest cost advantage

in some of the fixed costs. These costs, totaling around $2.05 per bale for specially equipped gins, ran 50 to 75 cents less for the standard gins (Table 38).

Managerial and office salaries were not related in any very definite way to the type of equipment in the plant. Managers' salaries ranging from less than $4,000 to more than $8,000 were reported, but frequently multiple plants on a single location made it possible to spread this management cost over more than one plant.

Depreciation, interest on investment, insurance and taxes totaled higher for the specially equipped than the standard gins, both because these gins represented higher initial investments and because they were newer than the standard plants. Depreciation was figured at five per cent of replacement cost for machinery, power plant and equipment, and at three to five per cent for buildings, depending upon their construction. This results in average depreciation costs of 36 - 41 cents per bale for the standard gins and 55 cents per bale for the specially equipped gins, reflecting the much higher replacement cost of the specially equipped plants. Differences in interest on investment were still more striking, because interest was figured at four per cent on the *present value,* and the standard gins in the sample tended to be older than the gins in the specially equipped group. As a result, interest on investment, which amounted to 43 - 46 cents per bale on the specially equipped gins, was only about half this much on the standard gins.

Insurance on the buildings and machinery costs $2.50 to $3.00 per $100 of coverage, but insurance was usually carried on only a portion of replacement value. County, state and local tax rates vary among counties and among school districts within counties, but averaged from $5 to $6 per $100 in most areas during 1951 and 1952. In general, gin equipment is appraised at about one-third of original cost. Since the prices of gin equipment have approximately doubled from pre-World War II prices, the older gins in the standard group obviously enjoyed a considerable tax advantage.

Variable costs.

Variable costs are those costs which change as output changes. They include bagging and ties, wages of the gin labor, power, fuel, etc. Average variable costs ranged from $6.75 per bale for standard gins in the 1951 season to $7.43 per bale for specially equipped gins in the 1952 season (Table 38). The range among individual plants was even wider, actually from as little as $6 to more than $9 per bale.

The largest single item of ginning cost, *bagging and ties,* cost the gins from $2.93 to $2.95 per pattern during the 1951 season and from $2.71 to $2.80 during the 1952 season (Table 38).

TABLE 39.—GIN LABOR REQUIREMENTS AND COSTS FOR SPECIALLY EQUIPPED AND STANDARD GINS, CENTRAL ARIZONA, SEASONS 1951-52 AND 1952-53

Cotton season and item	Specially equipped gins	Standard gins
1951-52:		
Average man hours of gin labor, per gin[1]	21,779	22,180
Average man hours per bale[2]	1.86	1.68
Average cost of gin labor, per gin (dols)	23,179	25,134
Average cost of gin labor per bale (dols)	1.98	1.91
Average cost of gin labor per man hour (dols)	1.06	1.13
Average volume per gin (bales)	11,719	13,176
1952-53:		
Average man hours of gin labor, per gin[1]	22,454	21,642
Average man hours per bale[2]	1.91	1.92
Average cost of gin labor, per gin (dols)	26,165	25,682
Average cost of gin labor per bale (dols)	2.22	2.28
Average cost of gin labor per man hour (dols)	1.17	1.19
Average volume per gin (bales)	11,781	11,246

[1]Includes gin labor only. Does not include office salaries, management, or the night watchman.
[2]The average number of man hours required to gin a bale including all stoppages resulting from normal commercial ginning operations.

Retail prices during these years ranged among gins from $3.25 to $3.45.

Labor costs, following bagging and ties as a source of expense, featured moderate variations between groups, and sizeable variations among individual gins within the groups. Typically, Arizona gins require about six men for their operation: a ginner and assistant ginner, a pressman and assistant pressman, a suction man, and a yardman. An additional man is required to maintain proper operation of some types of lint cleaners. Frequently, an extra man is carried on the night crew for relief on the suction. Individual gins, however, had crews ranging in size all the way from five to nine men, with labor costs ranging from less than $1.50 to more than $2.50 per bale at volumes over 11 thousand bales. There was no consistent relationship among gin groups, either as to labor costs or man-hour requirements per bale (Table 39). The standard gins appeared to have some advantage over the specially equipped gins in average man-hour requirements per bale during the 1951 season, when they required 1.68 man-hours per bale as compared to 1.86 for the specially equipped gins. During the 1952 season, slightly reduced volumes for standard gins took away this advantage and actually gave the standard gins slightly higher labor requirements and costs per bale than the specially equipped plants. Average labor costs per bale during the 1951

season were $1.98 and $1.91 per bale for specially equipped and standard gins, respectively; during the 1952 season comparable costs were $2.22 and $2.28 per bale.

Since it is difficult to replace skilled crews, labor usually becomes more or less a fixed cost during a given season. Thus, labor costs per bale are determined mainly by the sustained rate of production per hour or per day that the plant can maintain during the entire season (Table 41). A few large plants, however, in order to handle volumes in excess of 13,000 bales, employed such large crews that their labor costs were high ($2.50 per bale) even at these volumes.

Labor cost per bale is, of course, dependent also upon the wage rates being paid per hour (Table 39). Hourly wage rates, which averaged $1.06 and $1.13 per hour for specially equipped and standard gins, respectively, during the 1951 season, were increased to $1.17 and $1.19 for the corresponding groups in the 1952 season. (These figures include the ginner, who is frequently paid a monthly salary plus bonus, so would average somewhat higher than the prevailing rates for ordinary gin labor.) These increases in wage rates tended to increase labor costs per bale in the second year of the study even when there was no appreciable increase in man-hour requirements.

With the high volumes that are characteristic of Arizona gins, rather extensive overhauls are necessary at the close of each season. On the average, these *repairs* cost from 41 to 68 cents per bale for the gin groups studied, (Table 38) or on the order of $5,000 to nearly $8,000 per plant for parts and labor. Ordinarily one would expect the more elaborately equipped plants to show the higher repair costs because of the greater amount of machinery involved, but the greater age of the simpler gins tends to counteract this tendency. Most of the gins studied put in new saws at the start of each season, replaced worn belts, and gave the entire plant a thorough cleaning and oiling, while the older gins required more extensive repairs from time to time, such as new bearings, replacement of cleaning cylinders in feeders or overhead cleaners, new ribs or even new huller fronts. Such major repairs are reflected in the 68 cents per bale repair cost on the standard gins following two years of peak ginning volumes (Table 38). Such a complete maintenance policy keeps even the older and simpler plants in Arizona in excellent condition, and explains in part why the standard gins compared so favorably with the newer and more elaborately equipped plants, both in annual volume of production, and quality of ginning services performed.

At comparable volumes, the standard gins appeared to enjoy considerably lower *power* costs per bale than the specially equipped gins (Tables 38 and 40). For example, in 1951, standard gins had power costs of about 36 cents per bale compared to 58 cents per bale for specially equipped gins. Power consump-

tion per bale was also somewhat lower (29 compared with 33 kilowatt hours per bale) but not proportionately so. Most of the difference was in the power rate which averaged 1.22 cents per kilowatt hour for standard gins in 1951 compared with 1.75 cents per kilowatt hour for specially equipped gins (Table 40). Specially equipped gins averaged about 375 horsepower per gin, compared with around 200 for standard gins. Power rate schedules tend to give lower rates to smaller plants (in terms of demand readings) which maintain a high and reasonably uniform power demand during the season. A large gin with high demand readings (325 kilowatts or more) obtains fairly low rates if it operates at high volume, but its rates per kilowatt hour will climb steeply with reductions in baleage. Large gins are also assessed more heavily in terms of minimum charges during their slack months. These minimum service charges (frequently assessed at the rate of 65 cents per kilowatt of demand) may amount to more than $200 per month for a large gin. Some rate schedules contain special dispensations for seasonal types of service which allow cotton gins to escape these minimum monthly charges, but most do not.

Minimum rates for *insurance on baled cotton* on the gin yard were approximately 15 cents per month per $100 of valuation. This amounted to approximately 28 cents per bale per month in the 1951 season and 25 cents per bale per month in the 1952 season, when cotton prices were somewhat lower. For these

TABLE 40.—HORSEPOWER AND KILOWATT HOUR REQUIREMENTS AND COSTS FOR SPECIALLY EQUIPPED AND STANDARD GINS, CENTRAL ARIZONA, SEASONS 1951-52 AND 1952-53

Cotton season and item	Specially equipped gins	Standard gins
1951-52:		
Average horsepower installed per gin	376	196
Average KWH consumption per gin	392,114	386,817
Average KWH consumption per bale	33.5	29.4
Average power cost per gin (dols)	6,859	4,737
Average power cost per bale (dols)	.585	.360
Average power cost per KWH (dols)	.0175	.0122
Average volume per gin (bales)	11,719	13,176
1952-53:		
Average horsepower installed per gin	369	205
Average KWH consumption per gin	390,058	317,750
Average KWH consumption per bale	33.1	28.3
Average power cost per gin (dols)	6,878	5,180
Average power cost per bale (dols)	.584	.461
Average power cost per KWH (dols)	.0176	.0163
Average volume per gin (bales)	11,781	11,246

cost estimates it was figured that the average bale remained on the yard approximately 1½ months, making total cost of yard insurance about 42 cents per bale in 1951 and 37 cents per bale in 1952 (Table 38). Some individual gins reported yard insurance costs per bale of twice these amounts or more, reflecting longer storage periods and, in some instances, less favorable premium rates.

Premiums on *workman's compensation* insurance, which averaged from 14 to 20 cents per bale of cotton ginned, were assessed at a rate of $8.28 per $100 of payroll for gin labor, and 11 cents per $100 of payroll for the office help.

Ginning supplies included small tools, oil, belt dressing and innumerable other small items. In individual gins, amounts reported for this item ranged all the way from a few hundred dollars to over $5,000 per season. This resulted in group average costs for ginning supplies ranging from 10 to 21 cents per bale, with no consistent pattern of relationship apparent among the groups (Table 38).

Travel and auto expense consisted primarily of the costs of operating the manager's car and whatever use of public transportation was necessary to the conduct of the gin business. Reports on this expense were highly variable among gins, resulting in group averages ranging from 2 to 12 cents per bale. Since proration is difficult, a part of this expense may be travel in connection with the financing and cotton merchandising aspects of the business rather than for the ginning itself.

Drier fuel, usually natural gas, cost specially equipped gins an average of 6 cents per bale and standard gins an average of 5 cents a bale during the 1951 season. The standard gins had smaller driers, and, in one case, no drier at all. During the 1952 season, the cost of drier fuel rose to an average of 12 cents per bale for the specially equipped gins, showing the effect of the installation of "chain drying" equipment in these larger gins (Table 38). Some of the gins which already had a "big reel" drier installed a tower drier and provision for heat in the feeders in the 1952 season. The standard gins also showed a slight rise in drier fuel cost in the 1952 season, mostly as the result of the installation of additional drying equipment. (A frequent installation in these smaller gins was a thermo-cleaner with one or two stub tower driers).

Office supplies cost an average of 3 cents per bale for specially equipped gins and 12 cents per bale for standard gins during the 1951 season; comparable figures for the 1952 season were 5 cents per bale for specially equipped gins and 10 cents per bale for standard gins (Table 38). The lower costs of office supplies for the specially equipped gins may be attributed to the fact that most of these gins were owned by cotton finance companies who do a large part of the necessary paper work in a central office.

Telephone and telegraph charges averaged from three to eight cents per bale with no consistent pattern of relationship between gin groups (Table 38).

Legal and audit expenses usually consisted mainly of the cost of having an accountant close the books at the end of the season, plus such routine legal aid as is necessary to the conduct of a business. Such expenses seldom ran over six cents a bale except in the cases of certain newly established gin firms which incurred considerably higher legal and accounting costs during their initial season. Much of this expense was organizational in nature and would not be incurred in subsequent years of operation.

Miscellaneous expenses covered a multitude of minor costs such as advertising, publications and dues and donations, usually amounting to only 5 - 8 cents per bale in aggregate. An exception is noted in the case of the specially equipped group in 1952: Certain gins in this group made rather heavy expenditures for "equipment rental" during this season, raising the group average to 17 cents per bale (Table 38).

Factors affecting costs of ginning.

1. Production rates. The average gin in Arizona opens in September and operates about five months, four months of which it employs a night crew as well as a day crew. This makes perhaps 3,200 hours of operation. Costs per hour of operation range from about $29 for the simplest plant to $36 for the most elaborate (Table 41).

TABLE 41.—RELATIONSHIPS BETWEEN PRODUCTION RATES AND COSTS OF GINNING FOR SPECIALLY EQUIPPED AND STANDARD GINS, CENTRAL ARIZONA, SEASONS OF 1951-52 AND 1952-53

Cotton season and item	Specially equipped gins		Standard gins	
1951-52:				
Costs per plant (dols)	108,066.00		106,470.00	
Hours of plant operation[1]	3,287		3,690	
Bales ginned	11,719		13,176	
Bales per plant hour[1]		3.57		3.57
Costs per plant hour (dols)		32.88		28.85
Costs per bale (dols)		9.22		8.08
1952-53:				
Costs per plant (dols)	111,528.00		97,472.00	
Hours of plant operation[1]	3,128		3,235	
Bales ginned	11,781		11,246	
Bales per plant hour[1]		3.77		3.48
Costs per plant hour (dols)		35.65		30.13
Costs per bale (dols)		9.47		8.67

[1]Includes all stoppages resulting from normal commercial ginning operation.

Many of these costs continue unabated from the time the plant opens in the fall until it closes in the spring. Thus, the largest single factor determining the cost of ginning per bale is how steadily cotton can be kept going through the plant—not necessarily how fast but rather how steadily. For example, the large 5 - 90 stand gins are technically capable of ginning a bale of cotton in 6 - 8 minutes or at a ginning rate of 7 - 10 bales per hour, but it is the exceptional gin which sustains a rate of production of four bales per plant-hour for the entire season.

There are many delays connected with the ginning operation, some of them unavoidable. It may be lack of cotton, or rain, or clogging in the machinery, or breakage of a part which causes the shutdown. Seldom is it feasible to send the crew home when such a delay occurs, so most of the expenses go on. Thus, reducing delays due to breakdowns and stoppages is one important way of reducing per bale costs.

Actually, the specially equipped gins in this study, despite higher capacity from a technical standpoint, processed only slightly more cotton per hour than the standard gins. Since the specially equipped gins had higher costs per plant-hour than the standard gins in this study, they also had higher costs per bale.

Possibly gins with a great amount of cleaning equipment, which gin rapidly and thus move the cotton through the machinery in a fairly thick bat, may be more subject to stoppages from clogging than standard gins which gin more slowly. If this is the case, the automatic feed control should be a useful device in reducing this type of delay.

2. Annual volume of ginning. The relationship between annual volume of ginning and ginning costs per season is shown in Figure 2 for specially equipped and standard gins, respectively. The lines on this chart represent the average relationship for the group and the dots represent the annual costs and volumes of the individual plants. The rather wide scatter of the dots about the line indicates that, at any given volume individual plants have costs either higher or lower than average, because of differences in management practices, size of labor crew, expenditures for repairs and modifications, and many other factors. Nevertheless, volume of ginning per season is the most important single factor determining ginning costs. Differences in annual volume explained 72 per cent of the variations in total ginning costs per plant among the standard gins sampled and 44 per cent of such variations among the specially equipped gins, according to correlation analyses completed in connection with this study.

Obviously the total cost of operating a gin for a season increases as the volume goes up, because with each increase in volume, additional expenditures must be made for bagging and ties and other items of variable expense. On the other hand,

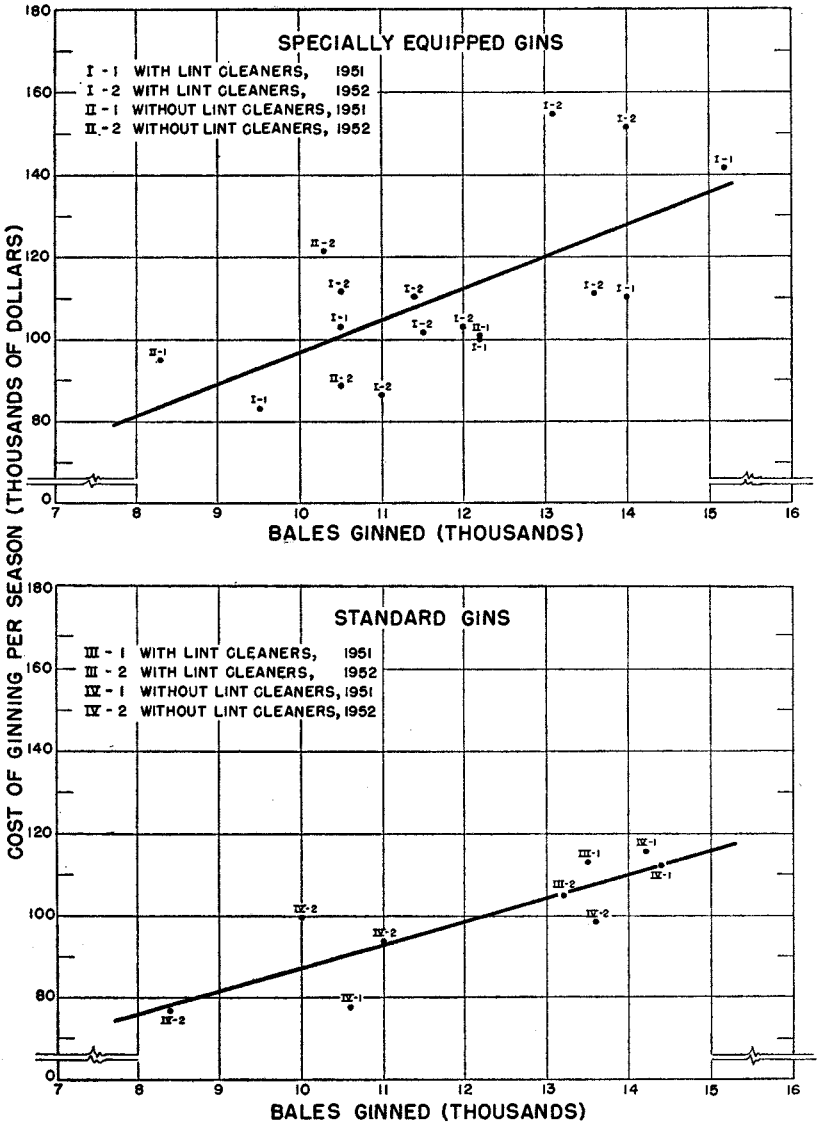

FIGURE 2.- RELATIONSHIP BETWEEN VOLUME AND COST OF GINNING, CENTRAL ARIZONA, SEASONS OF 1951-52 AND 1952-53

ginning *costs per bale* decrease markedly with increases in volume because the fixed costs for management, office salaries, insurance, taxes, etc., are spread over a larger number of bales. (The same thing applies to a lesser extent to labor, repairs, power, and other costs which are usually classified as "variable").

Estimated costs of ginning a bale of cotton at different levels of annual volume are shown for both standard and specially equipped gins in Table 42. Increases in ginning volume from 8,000 to 15,000 bales in the specially equipped gins resulted in decreases in estimated ginning costs per bale from $10.13 to $9.05; comparable increases in volume in standard gins resulted in decreases in estimated ginning costs from $9.50 to $7.74 per bale. It may be observed that while estimated ginning costs per bale were $9.50 for the standard gins at a volume of 8,000 bales, the specially equipped group needed volumes of 11,000 to achieve the same cost. These data also seem to indicate that at volumes between 8,000 and 15,000 bales, the standard gins not only retained, but actually increased their cost advantage with increased volumes. Thus, while standard gins show a cost advantage of 63 cents per bale at volumes of 8,000 bales, this advantage increases to $1.31 per bale at volumes of 15,000 bales.

Ginning revenue.

Ginning charges varied somewhat from company to company but the following are typical of rates charged in the two seasons studied:

	1951	1952
Ginning (per cwt. seed cotton)	$ .424*	$ .50
Drying (per cwt. seed cotton)	.10	.10
Lint cleaning (per cwt. seed cotton)	.10	.10
Bagging & ties (per pattern)	3.45	3.25
Ins. and storage, 1st 20 days (per bale)	1.00	1.00
" " " thereafter per day (per bale)	.04	.04
Sampling (per bale)	.10	.10

*At turnouts 33⅓ per cent and above. $.477 per cwt. for turnouts below 33⅓ per cent.

A few gins adopted in 1952 a flat rate charge per hundredweight of seed cotton for ginning which included bagging and ties, transportation insurance, baleyard insurance and storage and sampling. Without drying or lint cleaning the rate was $.85 per hundredweight; including drying it was $.95 per hundredweight; including both lint cleaning and drying it was $1.10. This has the effect of a steep scaling up of charges on the lower turnouts, being advantageous to those who have high turnout, and quite disadvantageous to those with low turnout.

Reports on gross ginning revenue were not available from both groups during the 1951-52 season, but during the 1952-53 season the specially equipped gins reported gross ginning revenues averaging $13.25 per bale compared with an average of $12.70 per bale for the standard gins (Table 43). This 55-cent-

per-bale difference in revenue is in accord with the 80 cents per bale difference in costs, which during the same season averaged $9.47 per bale for specially equipped gins and $8.67 per bale for standard gins (Table 38).

TABLE 42.—ESTIMATED GINNING COSTS AT DIFFERENT VOLUMES, CENTRAL ARIZONA[1]

Annual volume per gin	All specially equipped gins		All standard gins	
	Costs per gin	Costs per bale	Costs per gin	Costs per bale
	dollars	dollars	dollars	dollars
8,000	81,033	10.13	75,964	9.50
9,000	88,844	9.87	81,697	9.08
10,000	96,655	9.66	87,429	8.74
11,000	104,466	9.50	93,161	8.47
12,000	112,277	9.36	98,893	8.24
13,000	120,088	9.24	104,626	8.05
14,000	127,899	9.13	110,358	7.88
15,000	135,710	9.05	116,090	7.74

[1]Estimated from regression lines in Fig. 2.

TABLE 43.—GROSS GINNING REVENUE BY GIN GROUPS, CENTRAL ARIZONA[1]

Cotton season	Specially equipped gins	Standard gins
	dollars	dollars
1951-52	12.70	——
1952-53	13.25	12.70

[1]These include charges for bagging and ties, and also charges for lint cleaning and drying where these services were performed. Charges for storage and insurance of baled cotton not included.

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