Cotton Stripper Conveyors

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Contents

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By J. G. Porterfield, D. G. Batchelder and W. E. Taylor*

More cotton is harvested in Oklahoma with the cotton stripper than with any other machine. Research workers in both private industry and public institutions are finding ways of adapting the stripper to areas where it is not now used. It is reasonable to expect that in the near future the cotton stripper will be working successfully in all cotton producing sections of the United States.

The cotton stripper performs two essential, but distinct, functions; remove cotton from the plant and, convey the stripped material to a trailer or basket. The first function is performed by a stripping mechanism[1]. The second function is performed by mechanical and/or pneumatic conveyors. These conveyors normally have some provision for cleaning stripped material as it is being conveyed. Different types of conveyors vary widely in the amount of cleaning performed.

Research reported herein was made to determine the influence of feed rate, operating speed, type of screen surface, and type of conveyor on the amount of cleaning and the quality of lint. Results were obtained over a five-year period.

Nature of the Tests

Stripper conveying systems were evaluated in laboratory tests and ginning tests. Laboratory tests were made in each of three years to determine the kinds and amounts of foreign matter removed by successive increments of conveyor length, as affected by the type of conveyor and cleaning surface, conveyor operating speed, and feed rate. Ginning tests were made to determine the ginning characteristics and lint quality of harvested material as influenced by both cleaning and boll breaking which occur in stripper conveying systems. The influence of cleaning was evaluated four years and the influence of boll breaking, two years.

Research reported herein was done under Oklahoma Station Project 753 and 578.

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*Professor, Assistant Professor and Assistant Professor, respectively, Agricultural Engineering Department.

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[1] Batchelder, D. G., Taylor, W. E., and Porterfield, Jay G. "Stripper Rolls for Cotton Harvesters". Okla. Agri. Exp. Sta. Bul. B-589, 1961.

In the laboratory tests, detailed measures were made of the various components of foreign matter removed by successive increments of conveyor length as each test lot was processed. In the ginning tests, fewer measures were made of foreign matter removed in the conveyors. But within the gin, seed cotton was sampled at various stations and lint was sampled from the lint slide or bale to determine the effects of conveyor types on the performance of gin machines, on lint value factors, and on fiber properties.

In the laboratory, the experimental unit size was 20 pounds of harvested material, while in the ginning evaluations, 200 to 400-pound units were used for some tests, and one-bale units were used for others.

Laboratory Tests

Equipment

Two types of conveyors were used in the laboratory tests. One conveyor consisted of a series of six rotating spike-tooth cylinders that moved the cotton over successive screen concaves. The cylinders were placed on one-foot centers and had a horizontal axis of rotation perpendicular to the direction of cotton flow. All cylinders rotated at the same speed with their axes in a common horizontal plane.

Each cylinder consisted of 14 spike teeth mounted on a hub of 2 3/8 inches diameter and 12 inches long. The ½-inch round spike teeth

Fig. 1: Relative position of spike-tooth cylinders and screening surfaces in the cylinder conveyor.

were welded 3 inches apart in alternate rows of 3 and 4 teeth each, with the row axis parallel to the longitudinal axis of the hub. There were 4 rows per cylinder equally spaced 90° apart around the hub. In rows having 4 teeth, the end teeth were placed 1½ inches from the ends of the hub; the outside teeth of the 3-tooth rows were spaced 3 inches from the hub ends. Adjacent cylinders were timed to avoid possible tooth interference during operation. Figure 1 shows the cylinder and concave arrangement.

The other conveyor was a single-pitch screw conveyor, 12 inches in diameter and 96 inches long. The longitudinal axis of the auger was positioned horizontally; the flow of cotton over the screen concave was parallel to the auger axis. At the end of the 8-foot conveyor, the cotton was discharged at a right angle to the screw axis. The last foot of auger flighting was replaced by two radially opposed flat steel plates to assist in discharging the cotton. These plates affected the trash removal characteristics for the last two feet of the auger conveyor; therefore, only the data from the first six feet of this conveyor were used in the analysis.

Four kinds of screens were used in both the cylinder and auger conveyors. The screen concaves used in the cylinder conveyor had a 6½ inch radius of curvature. The clearance between the concaves and spike teeth was ½ inch. The cotton was scrubbed over the first concave by the first cylinder and passed to the next cylinder. This procedure was repeated by successive cylinders until the cotton was discharged at the end of the conveyor. The length of the cylinder conveyor was six feet, but the total length of screen surface was 81 3/8 inches. The 12-inch width of this screen provided 976.5 square inches of screen surface. The trash passed through the screen openings into trash pans provided for each one-foot increment of conveyor length.

Screens used in the auger conveyor had a 6½-inch radius of curvature. There was a one-half inch clearance between the screen and auger. The effective width of these screens was 20 inches which provided a total of 1,440 square inches of screen surface.

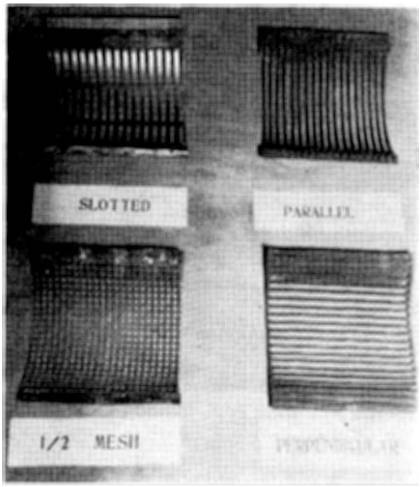

Fig. 2: Screening surfaces for the cylinder conveyor.

Figure 2 shows the screen types used in the cylinder conveyor. The slotted metal screen consisted of openings 3/8 by 3-1/8 inches. The distance between ends and sides of adjacent slots was 1/2 and 3/8 inches respectively. The parallel and perpendicular grid bar screens differed only in the orientation of the grid bars in relation to the path of the conveyed material. The grid bars were 1/4-inch in diameter and spaced on 5/8-inch centers. This provided a clearance of 3/8 inch between grid bars through which trash could pass. The 1/2-inch square mesh screen was made of galvanized woven wire approximately 1/8-inch in diameter; this provided a 3/8-inch opening.

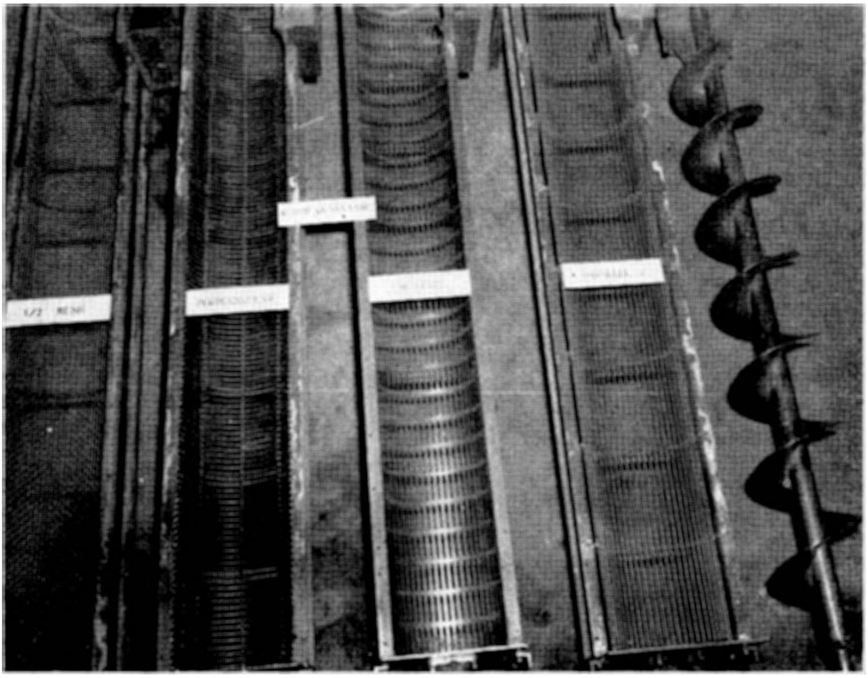

Fig. 3: Screening surfaces for the auger conveyor.

The same four screen types were used in the auger conveyor and are shown in Figure 3. A curved top was placed over the auger during operation to prevent loss of material.

Three shaft speeds were used in each of the two conveyors: 200, 350, and 500 rpm. The rate of input for each conveyor was approximately 20 pounds per minute.

A separate series of tests was designed to evaluate the effects of feed rates. In these tests, the auger and cylinder conveyors were operated only at 500 rpm and used only parallel grid bar concaves. The rates of input were 20, 40, 60, and 80 pounds per minute.

Test Cotton

Parrott variety cotton grown on dryland, was used in these tests. All cottons were harvested in a once-over operation after frost with an experimental stripper. This stripper had no provision for trash removal; the cotton was conveyed without cleaning into a wagon. This procedure provided a supply of material in essentially the same condition as when it left the stripper rolls. Processing this material through the laboratory conveyors simulated the cleaning which normally occurs in the stripper conveying system.

The test cotton was uniform in trash content in any one year, but varied from one year to another, depending upon the condition of the plants at harvest time.

Procedure

The laboratory tests were of randomized block design with six replications for each treatment. The handling of all lots in the laboratory tests was characterized by the following procedure:

Weigh 20-pound test lot of harvested material for processing through conveyor.

Weigh 1-pound sample of harvested material for separation into four components: Clean seed cotton, burrs, sticks, and leaf trash. The sum of burrs, sticks, and leaves was called total trash.

Place 20-pound test lot in feed control unit and process through auger or cylinder conveyor with appropriate combination of shaft speed and concave type.

Separate contents of each trash pan into three classes: Burr, stick, and leaf trash.

Determine weights of each foreign matter component in 20-pound test lot, using information obtained from the 1-pound sample of harvested material.

Determine the percent of each foreign matter component removed from the 20-pound lot by each increment of conveyor length.

An analysis of variance of the trash removed by each length increment was made each year. The analysis of variance showed that real differences existed among the treatment combinations. Therefore, a multiple curvilinear regression analysis of the data was made.

This provided equations of the general form $Y=A+BX_1+CX_1^2+DX_1X_2+EX_2+FX_2^2$ where Y=the component of trash removed in percent, X_1=conveyor speed in hundreds of rpm, and X_2=conveyor length in feet. (See appendix A). Upon solution of the equation that best fit the data, values were substituted into the equation to solve for intermediate points. From these data values of equal quantities of trash removed were determined by interpolation.

Results

The results are presented as graphs with each line on the graph representing a particular percent of trash removed for the system under consideration.[1] The results from the use of each screen are shown in terms of each trash component. The abscissa of each graph is conveyor shaft speed, and the ordinate is conveyor length.

Table 1 shows maximum plotted values of trash removal and the conveyor speeds at which they occurred.

The following two paragraphs illustrate the interpretations which can be made from the graphs.

The auger conveyor was less effective in removing burrs than the cylinder conveyor when both were equipped with the slotted screen (Figure 4). More than 10 percent burr removal was achieved with the cylinder conveyor, but only one percent with the auger conveyor.

Burr removal effectiveness was influenced by conveyor speed for both the auger and cylinder conveyors. For a given length of conveyer, the cylinder conveyor generally removed more burrs and the auger conveyor removed fewer burrs as shaft speed increased. For example, the first 3 feet of cylinder conveyor removed approximately 3.5 percent of the burrs at 200 rpm, and 8 percent at 500 rpm. The first 3 feet of auger conveyor removed approximately 0.7 percent of the burrs at 200 rpm, but only 0.3 percent at 500 rpm.

Please turn to Page 22.

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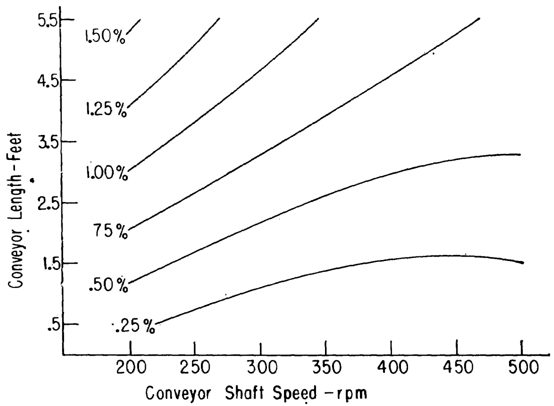
[1] The percents range from .025% to 50.0%.

TABLE I

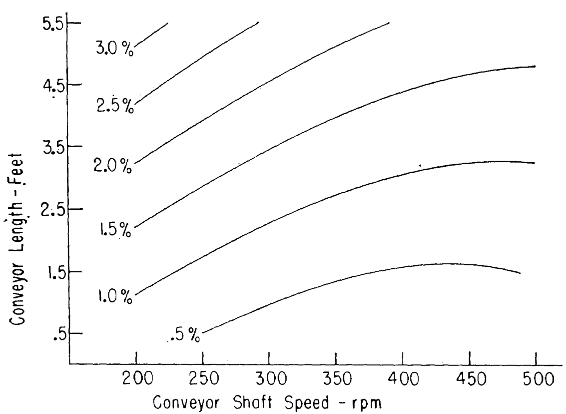
Percent trash removal at the relative speed where trash removal per unit of conveyor length was a maximum.

Screen Type	Conveyor Type	Burrs			Sticks			Leaves			Total Trash		
		Relative Conveyor Speed											
		Slow	Med.	Fast	Slow	Med.	Fast	Slow	Med.	Fast	Slow	Med.	Fast
		Percent Trash Removal											
Slotted	Auger	1.0			18.0					12.0	8.0		
	Cylinder			10.0			45.0			50.0			35.0
Parallel Grid Bar	Auger	1.5				16.0	16.0			12.0			8.0
	Cylinder			12.0			45.0			50.0			35.0
Perpendicular Grid Bar	Auger	3.0			25.0				20.0			12.0	
	Cylinder	5.0		5.0			40.0			50.0			30.0
½ Inch Square Mesh	Auger	.18			12.0			12.0			7.0		
	Cylinder			7.0		25.0				40.0			25.0

AUGER

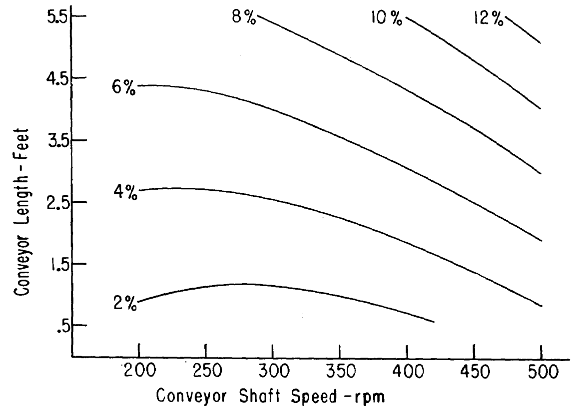


Parallel

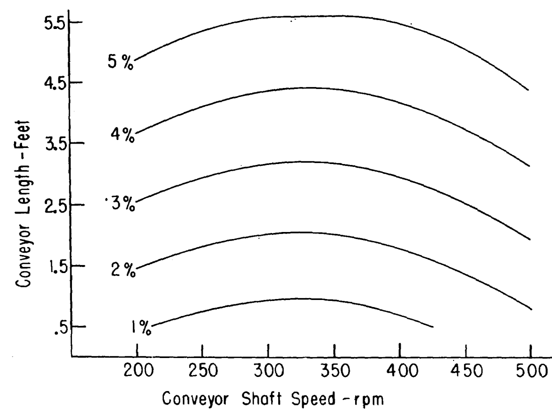


Perpendicular

CYLINDER



Parallel



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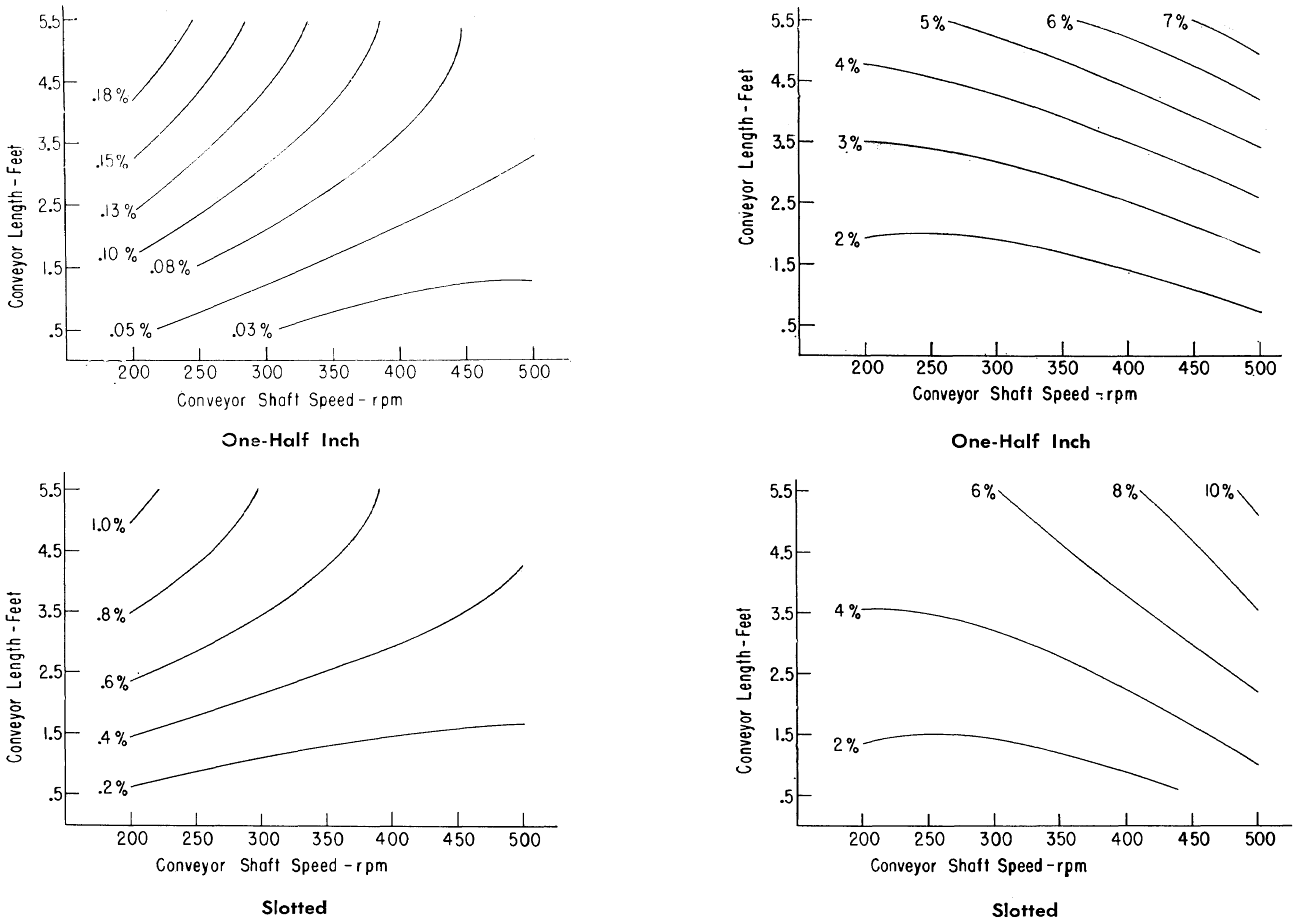
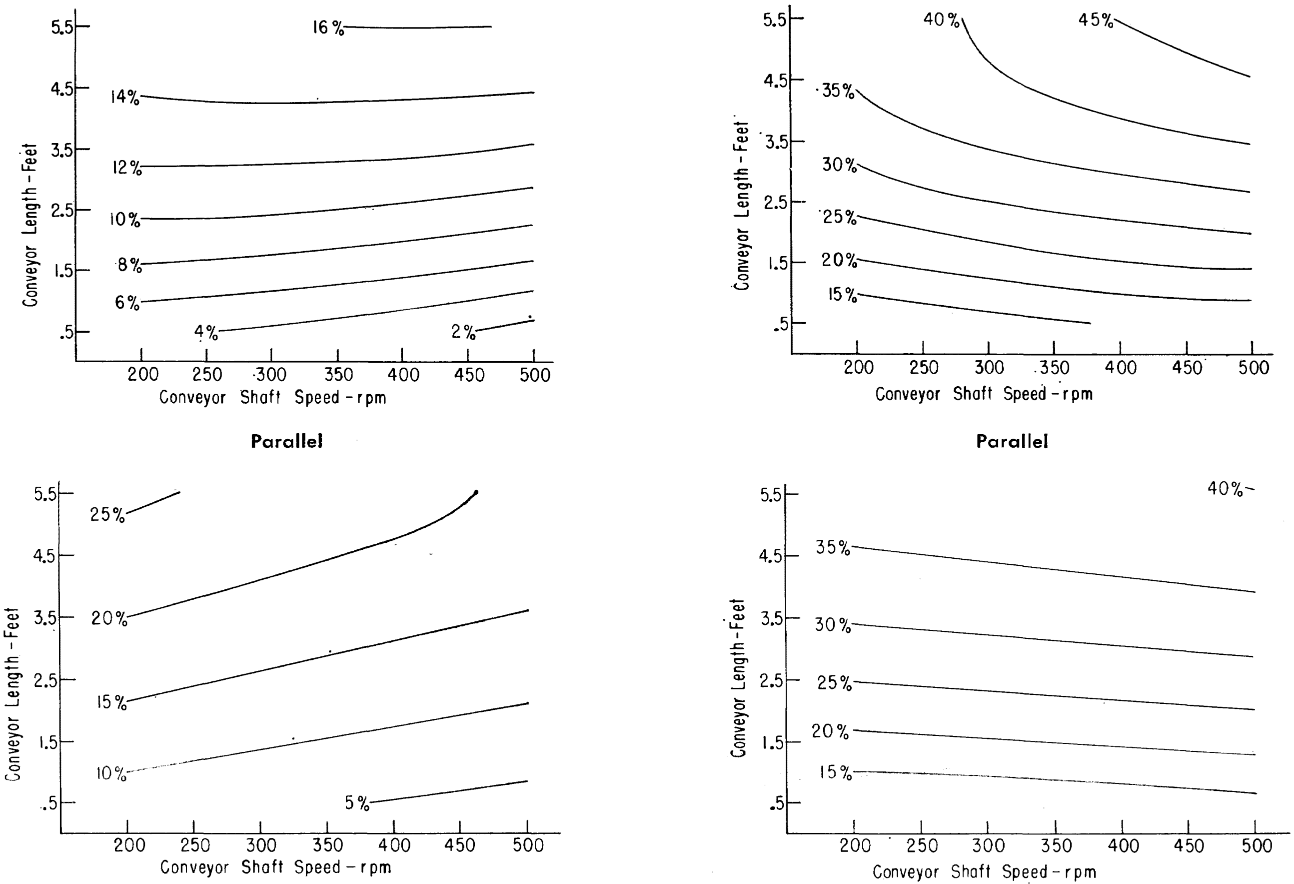


Fig. 4: Percent burrs removed for different conveyor types, lengths, speed, and screening surfaces.

AUGER **CYLINDER**



Perpendicular **Perpendicular**

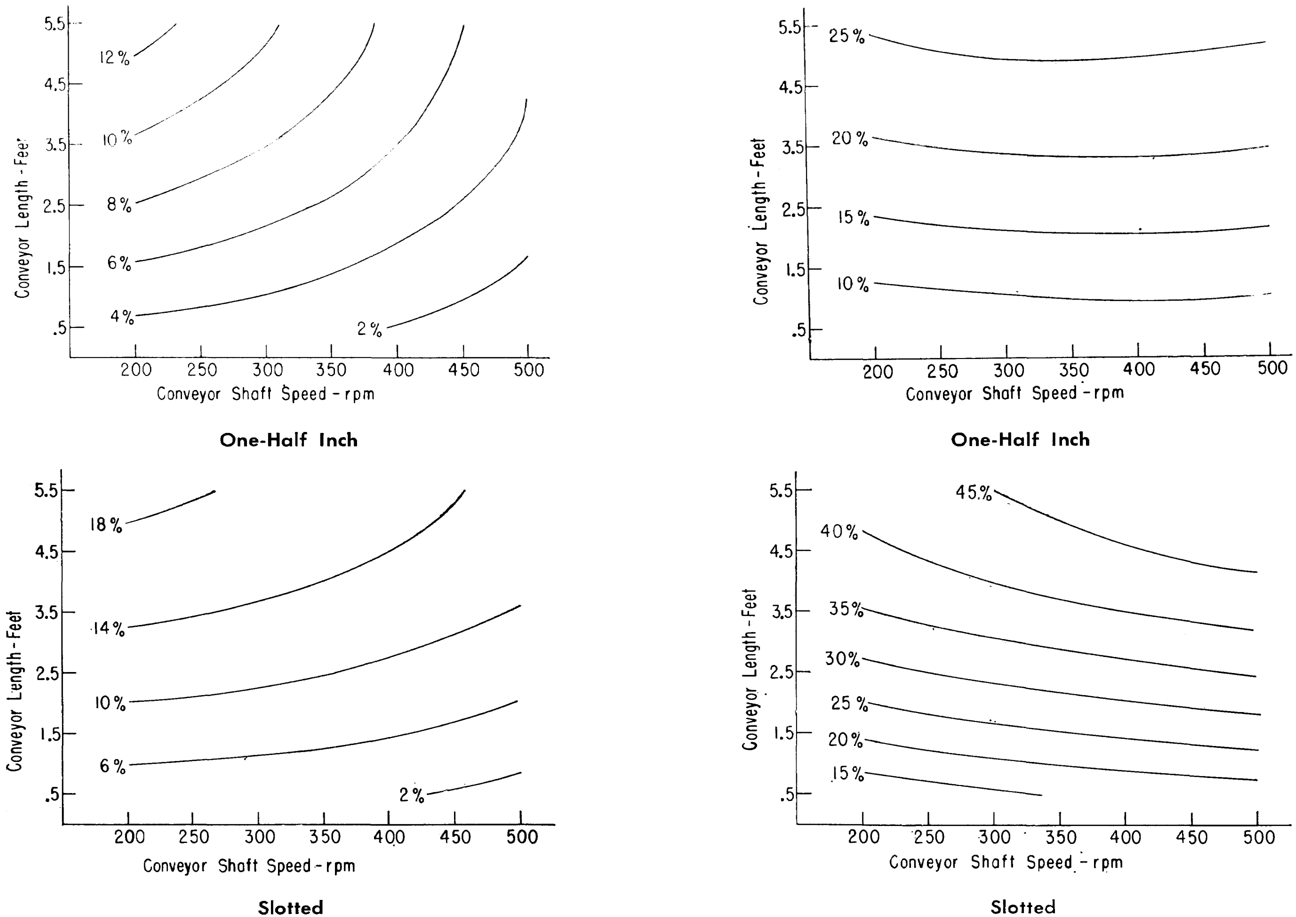


Fig. 5: Percent sticks removed for different conveyor types, lengths, speeds, and screening surfaces.

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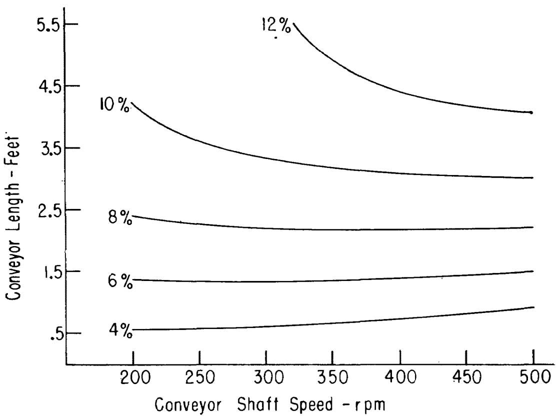
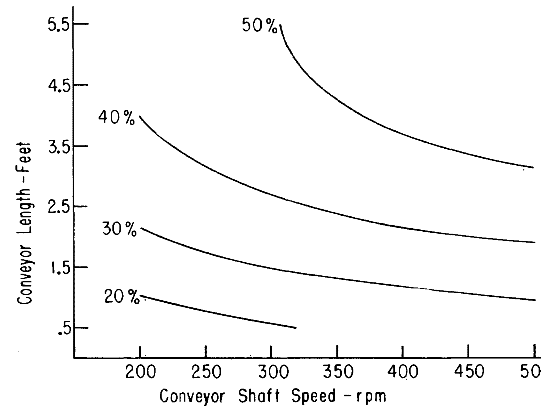
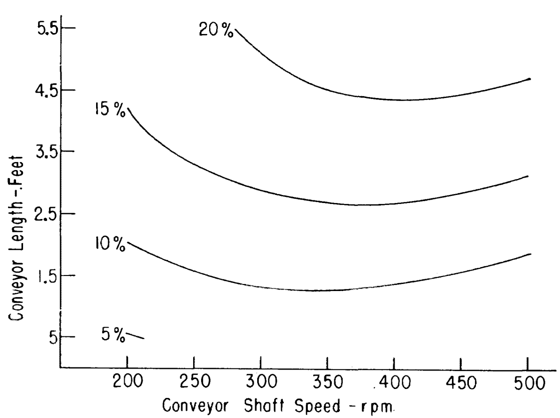
CYLINDER

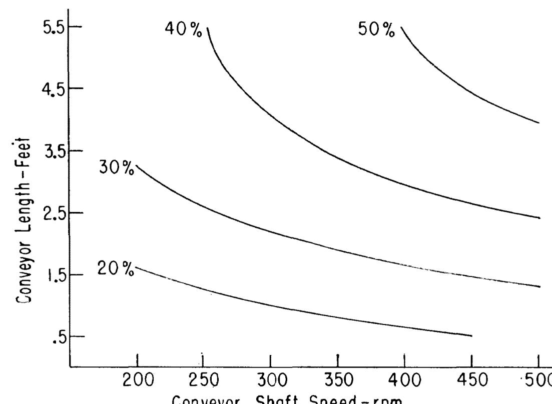




Parallel

Parallel





Perpendicular

Perpendicular

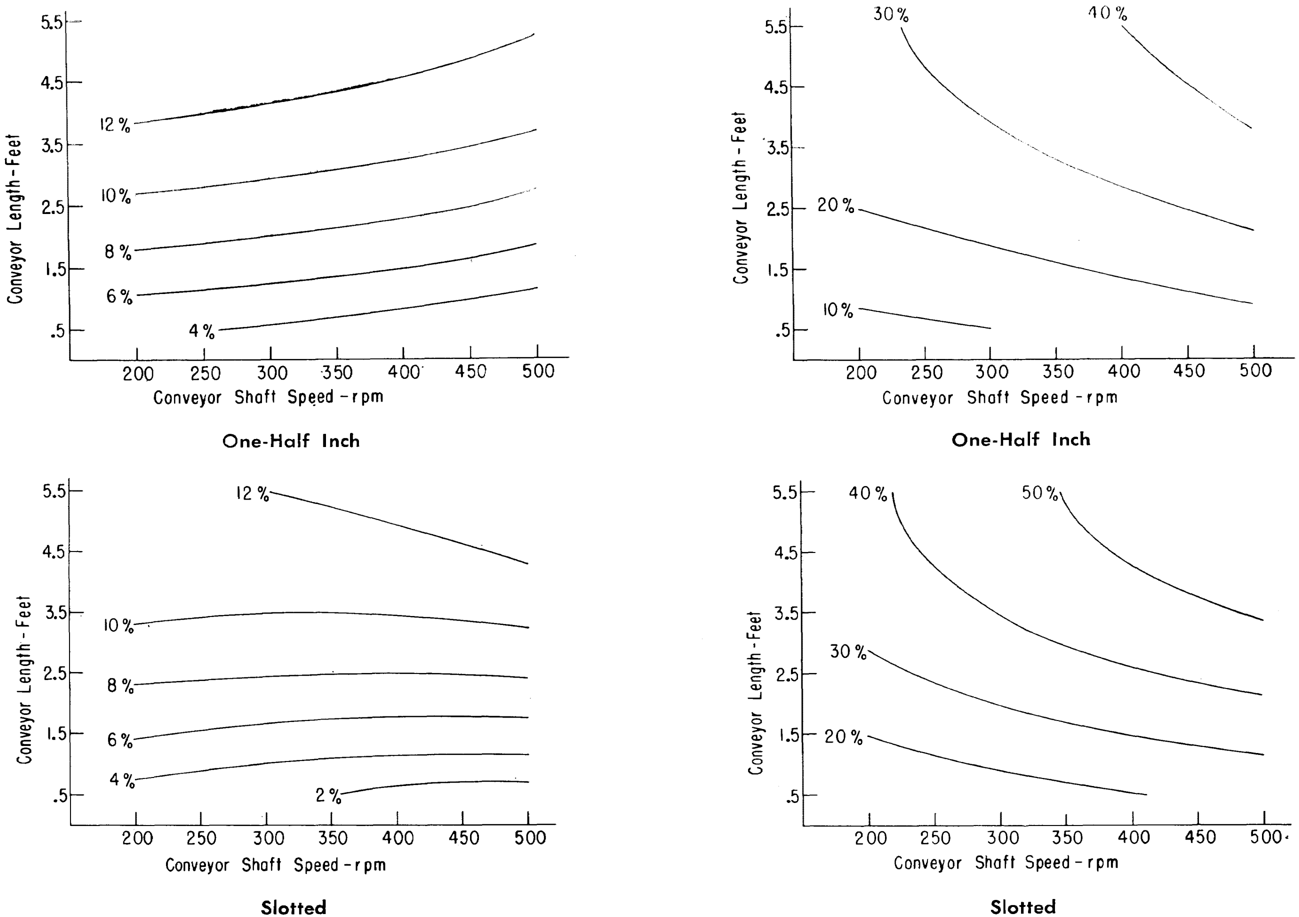
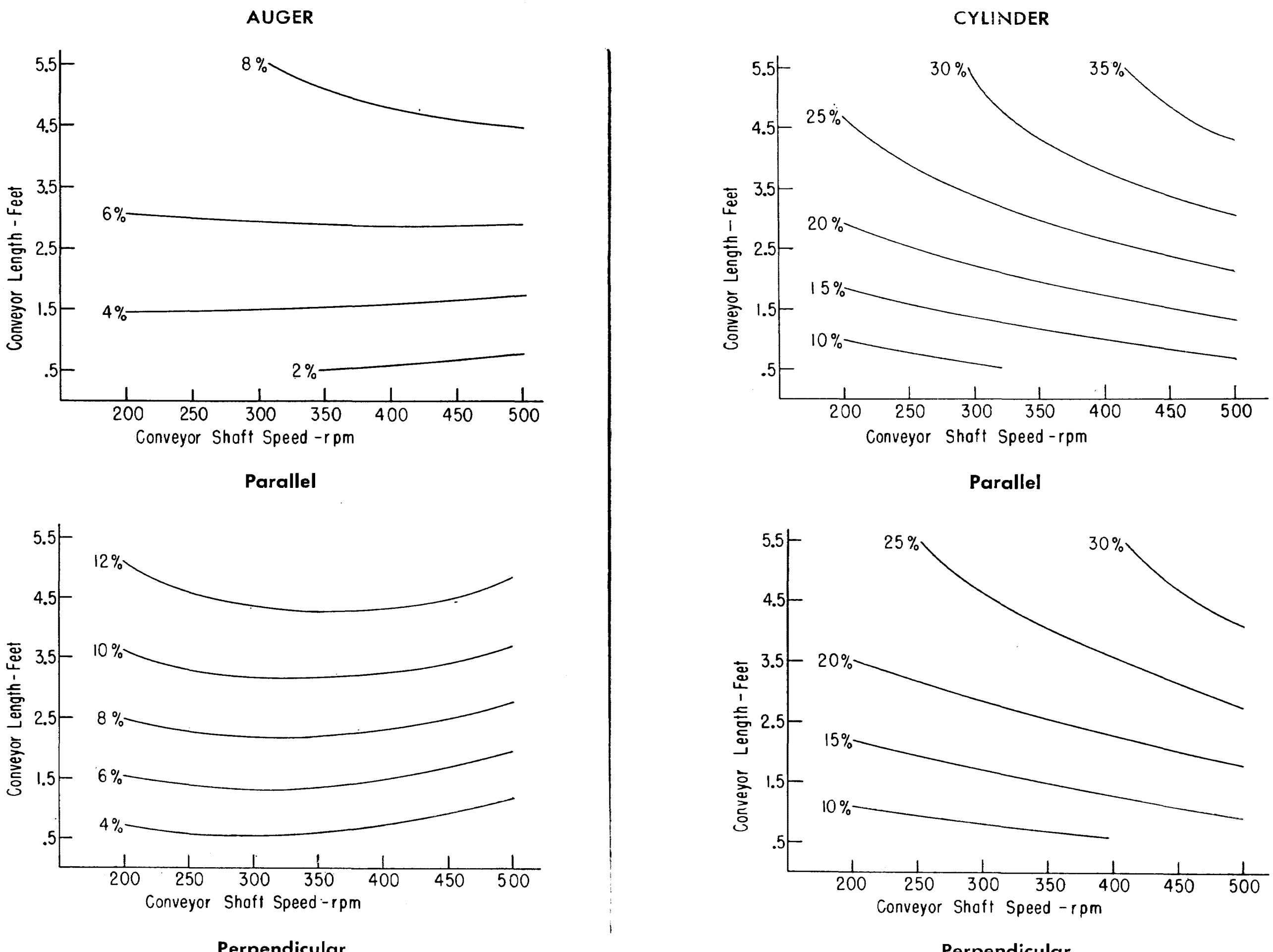


Fig. 6: Percent leaf trash removed for different conveyor types, lengths, speeds, and screening surfaces.


AUGER
CYLINDER
5.5
4.5
3.5
2.5
1.5
.5
Conveyor Length - Feet
8 %
6 %
4 %
2 %
200
250
300
350
400
450
500
Conveyor Shaft Speed - rpm
Parallel
30 %
35 %
25 %
20 %
15 %
10 %
12 %
Perpendicular

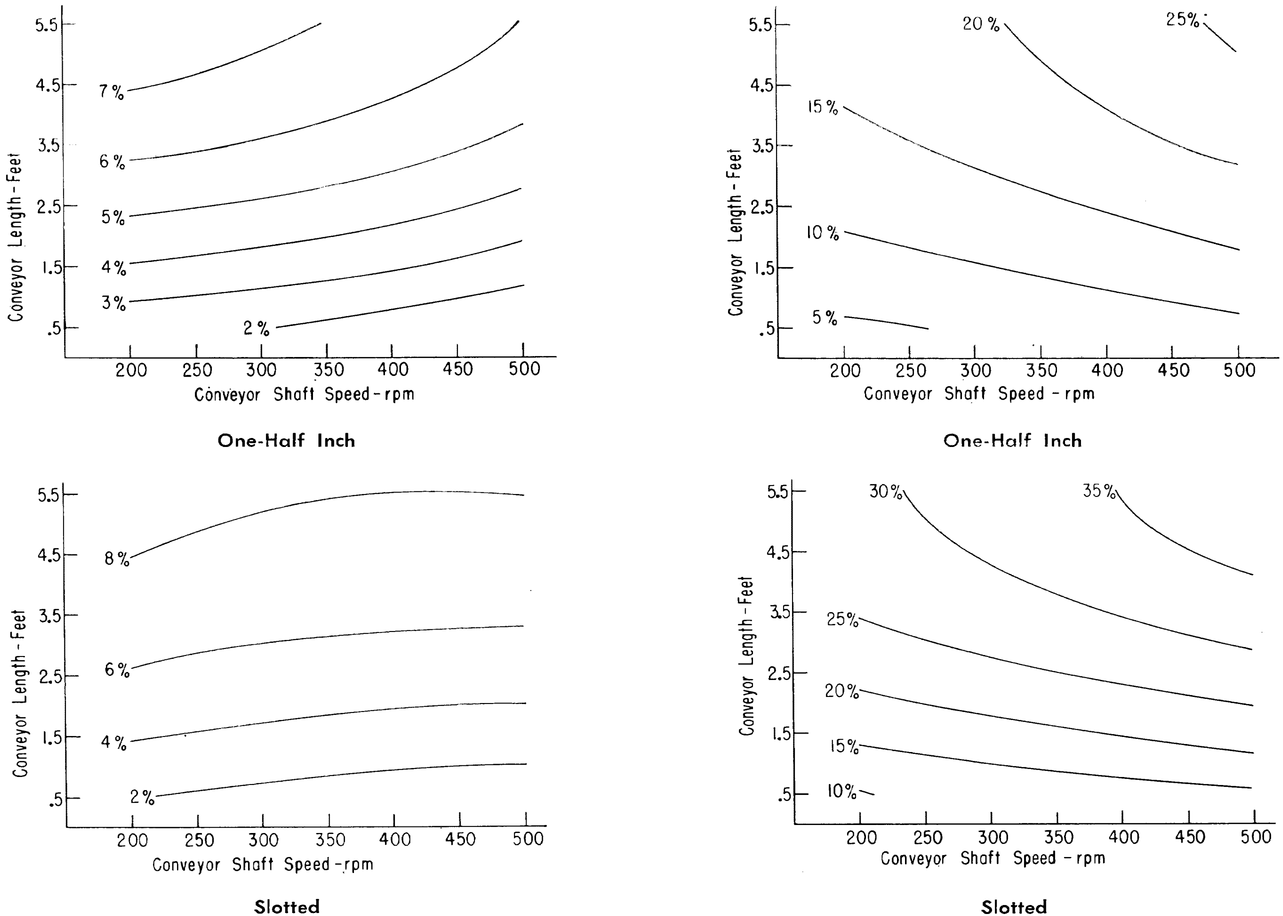


Fig. 7: Percent total trash removed for different conveyor types, lengths, speeds, and screening surfaces.

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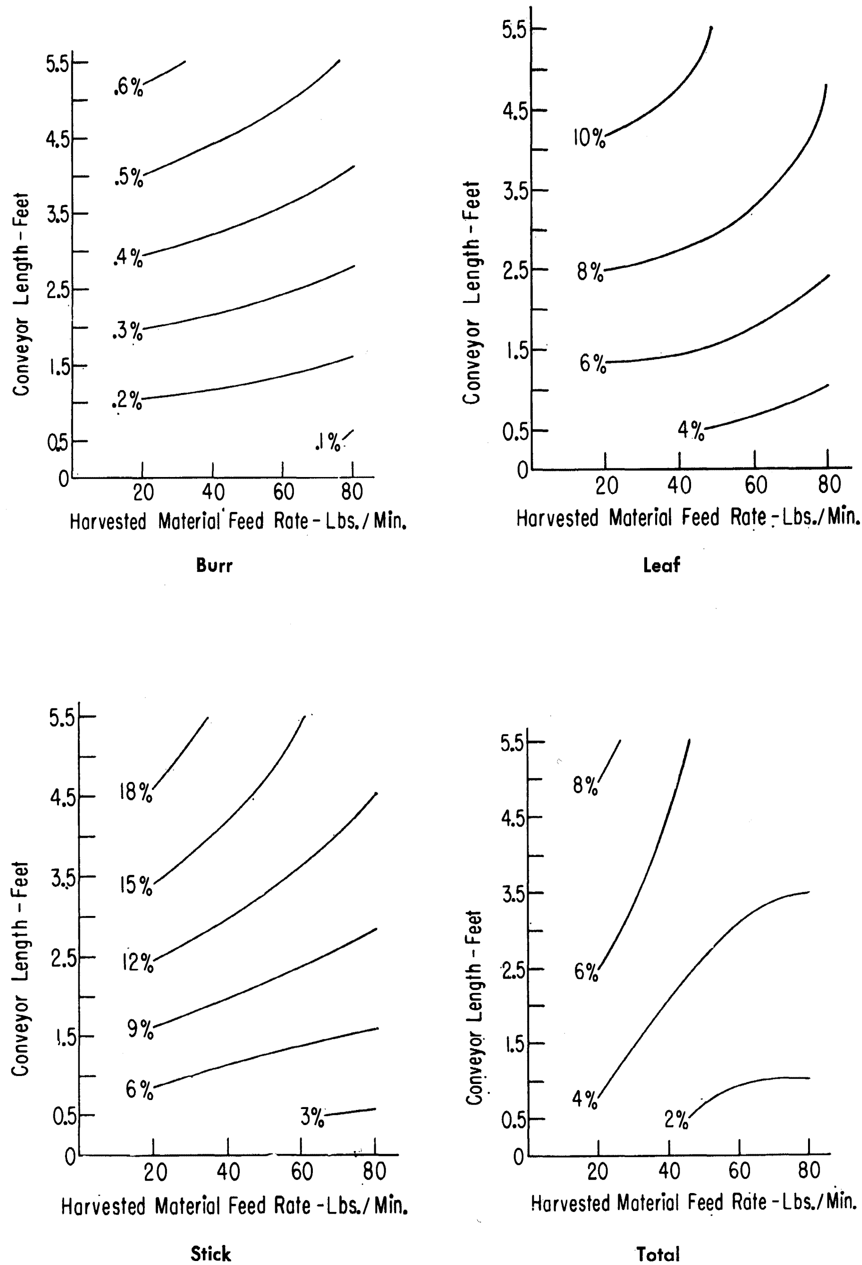

Fig. 8: Percent burrs, sticks, leaf, and total trash removed for different conveyor types, lengths, and feed rates.

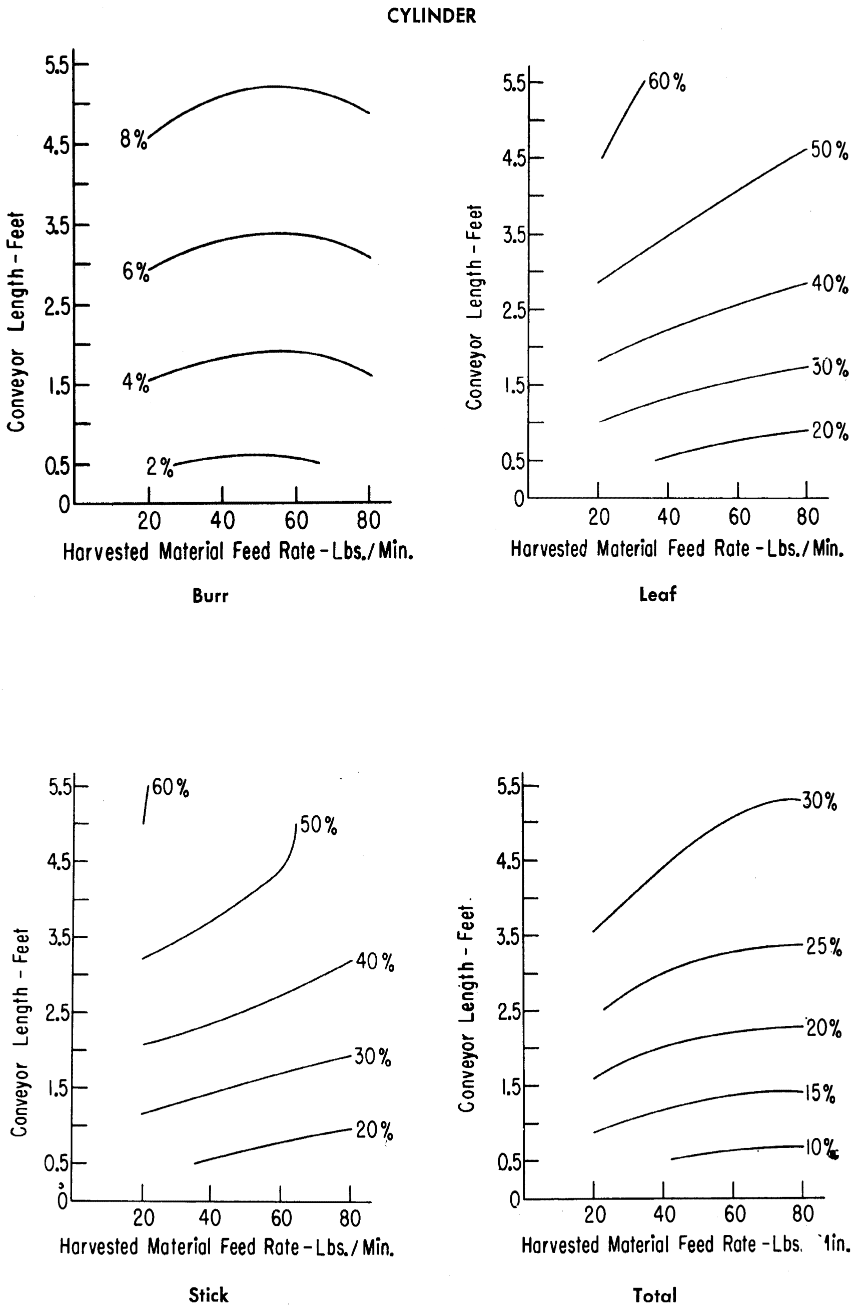

Fig. 8 Continued.

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The cylinder conveyor, in all cases, removed more of each trash component than the auger conveyor (Table I). The parallel grid bar screen consistently removed as much or more of each trash component than any other screen on the cylinder conveyor. The perpendicular grid bar screen removed as much or more of each of the trash components than any other screen on the auger conveyor.

With one exception, the cylinder conveyor was most efficient in trash removal when operated at the highest shaft speed. The exception was the removal of sticks when the conveyor was equipped with the ½ inch square mesh screen. In this instance, the greatest stick removal efficiency occurred at approximately 350 rpm. (Figure 5).

The auger conveyor was most efficient at the slowest shaft speed, except when: (1) equipped with the slotted screen and operated at 500 rpm for leaf removal (Figure 6); (2) equipped with the parallel grid bar screen and operated at 350 to 500 rpm for stick removal, 500 rpm for leaf removal and 500 rpm for total trash removal (Figure 7); (3) equipped with the perpendicular grid bar screen and operated at 425 rpm for leaf removal, and 350 rpm for total trash removal.

More of each trash component was removed as conveyor length increased. However, each additional increment of conveyor length generally removed less than the preceding increment.

Several factors were thought to be important in trash removal: namely amount of agitation; effective use of available screen surface: orientation of screen openings relative to the direction of flow of the conveyed material; and percent open area of screen surface.

The configuration of the cylinder conveyor's screen surface is nearly that of a continuous curtate cycloid. This configuration and the tossing of the conveyed material by the spike teeth resulted in greater agitation by the cylinder conveyor.

The entire width of the cylinder conveyor screens was used in trash removal. Whereas, in the auger conveyor, the screw tended to convey the material along one side of the screen. Unless the material was carried over the auger shaft, the other side of the conveyor screen was not effectively used.

For all trash components, particularly sticks, it was necessary that they be properly oriented and small enough to go through the concave openings. With the ½-inch square mesh screen, the opportunity for proper orientation is less than with those having elongated openings. Because of this, trash components must be relatively small for removal through this screen. This may explain the relatively poor performance of the square mesh screen.

The percent open area of the screen surface was not a test variable. This area differed among the screens tested. For given dimensions and configurations of the individual openings, trash removal would be closely related to the percent open area.

The trash removed per unit of conveyor length for any specified length was a maximum at the lowest feed rate (Figure 8). For each increase in the feed rate, a longer conveyor length was required to remove the same amount of trash, with one exception, which was the removal of burrs by the cylinder conveyor. In this case, the burr removal rate was relatively insensitive to the feed rate.

The feed rate into the conveying system is a function of forward speed of the harvester and the amount of material to be handled per unit of row length. The results indicate that the feed rate is a factor in cleaning efficiency and to accomplish maximum cleaning it is necessary to have adequate conveyor length.

The results further suggest that to maintain a given level of cleaning, as forward speed (hence feed rate) increases, conveyor length must be increased.

Ginning Tests

Equipment (Cleaning)

Ginning evaluations were made of the cleaning performed in four types of conveyors. These conveyors were:

A. A spike-tooth cylinder conveyor similar to that previously described, and shown in Figure 1, except that it had 8 cylinders and used only ½ inch-mesh screen concaves. This provided approximately 1300 square inches of screen surface. The cylinders were operated at approximately 500 rpm.

B. The auger conveyor previously described, and shown in Figure 3. This conveyor was equipped with a ½-inch mesh screen which provided a screen surface of approximately 1900 square inches. The auger was operated at approximately 200 rpm.

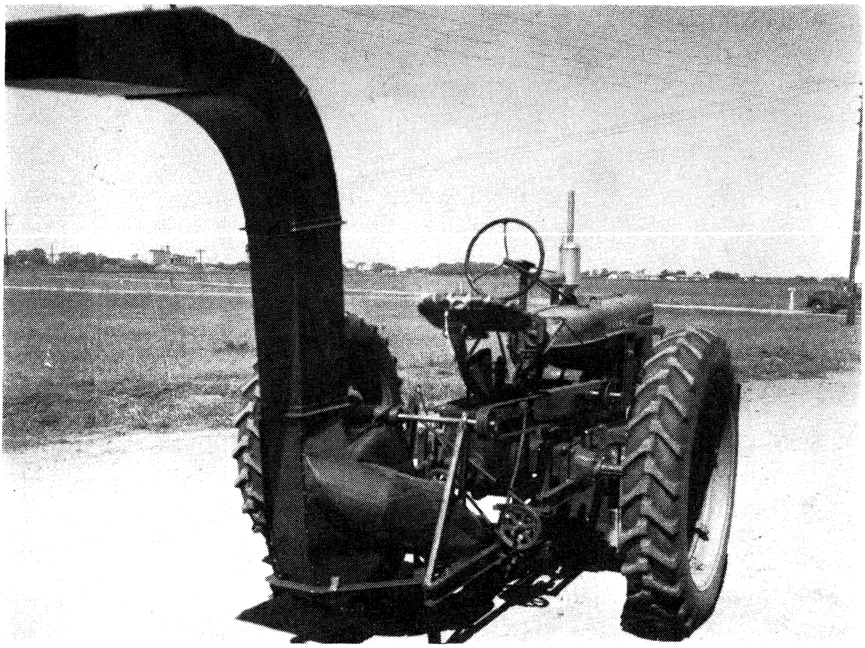

Fig. 9: Pneumatic conveyor.

C. A pneumatic conveyor consisting of a straight-blade centrifugal fan and the necessary pipe for conveying cotton (Figure 9). The fan wheel was 22 inches in diameter, 6½ inches wide, and rotated in a 30-inch housing. Cotton entered the fan housing off-center from the wheel axis to minimize seed damage. The fan speed was approximately 1900 rpm. The only opportunity for foreign matter removal was through a slotted section in the outer wall of the curved discharge pipe. The slots were 3/16 of an inch wide, spaced on 15/16-inch centers, and oriented parallel to the direction of cotton flow. The screen area thus formed was approximately 459 square inches.

D. A conveyor consisting of one horizontal and one inclined belt. The horizontal belt was 12 inches wide and conveyed the cotton some 42 inches before depositing it on the inclined belt. The inclined belt was 10 inches wide and conveyed the cotton upward at an angle of approximately 45 degrees for a distance of 11 feet. Both belts had lugs attached at intervals to insure movement of cotton along the conveyor. These two belts were a part of the conveying system in the one-row experimental stripper used to harvest the cotton for this series of experiments (Figure 10). The horizontal belt conveyed cotton from

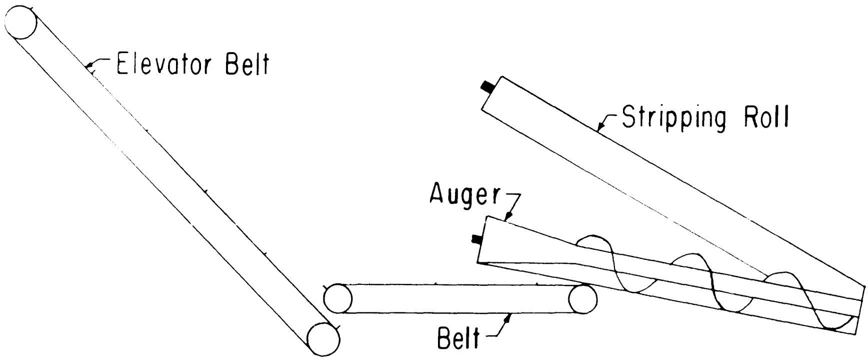

Fig.10: Schematic diagram of stripping and conveying components in the cotton stripper.

the stripping rolls to the inclined belt, which in turn conveyed the cotton to the wagon. This conveyor had no provision for trash removal.

Test Cotton

The cotton varieties used in these evaluations were Lankart 57 and Parrott. These were grown on dryland, with yields ranging from approximately 1/4 to 4/5 bales per acre. They were machine stripped in a once-over operation after frost.

Procedure

The harvested material was processed through the cylinder, auger, or pneumatic conveyor at approximately 1½ bales per hour. After passing through the conveyor, the cotton was ginned in 200 to 400-pound replicated units with 11 cylinders of screen cleaning, and burr extraction. Single-stage lint cleaning was used the first year of these tests. Double lint cleaning then became available and was used thereafter. Drying was used as necessary to maintain lint moisture content in the 5 to 7 percent range. Cotton representing the belt conveying system was ginned directly from the wagon since it had already been subjected to this type of conveyor within the stripper.

Samples were taken from the material entering and exiting the conveyors to determine the amount and kinds of trash removed. While ginning each test lot, seed cotton samples were taken at various stations in the ginning process and lint samples were taken from the lint slide or bale. An analysis of variance was made of the foreign material and quality data obtained from these samples. An analysis was also made of the weight of foreign matter removed by each machine in the gin.

Results

The average results of ginning evaluation of cleaning which occurred within the conveyors tested are presented in bar graphs. In general, the following discussion will be based on average values.

One attribute measured was the number of whole bolls which passed unbroken through the test conveyors. The material conveyed by the belt had the greatest number of whole bolls; that from the cylinder conveyor had the least (Figure 11).

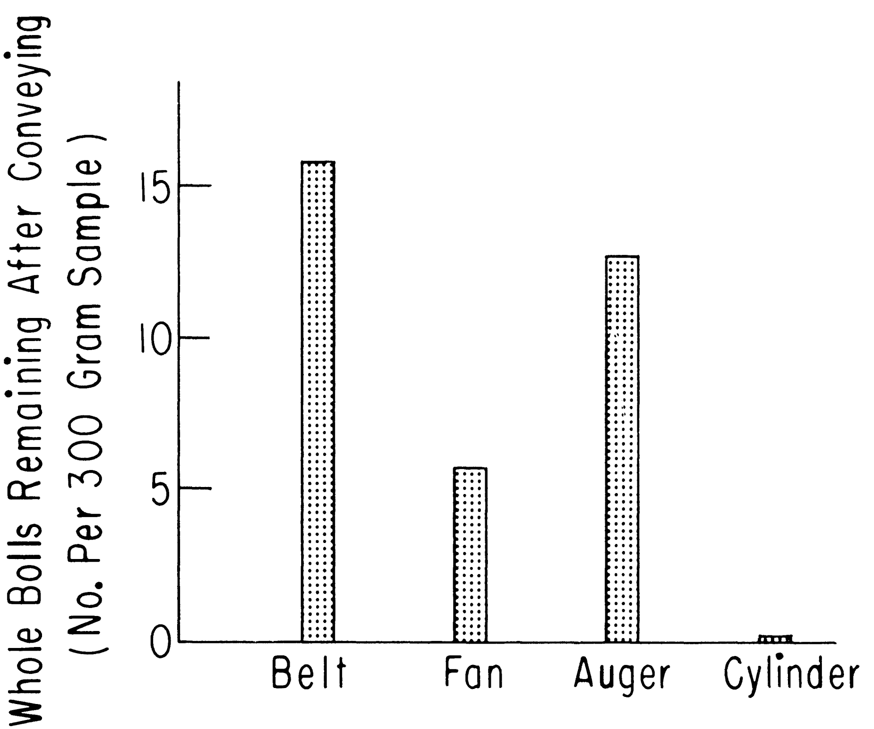

Fig. 11: Boll breakage for different conveyors.

Cotton conveyed by the cylinder conveyor contained 26 percent foreign material, while that from the auger conveyor contained 34 percent (Figure 12). This is believed due primarily to the difference in aggressiveness of the two conveyors.

Notwithstanding the aggressiveness of the fan conveyor, cotton conveyed by it contained 34 percent foreign material because of the limited area of screen surface. Seed breakage by the fan conveyor was apparent in

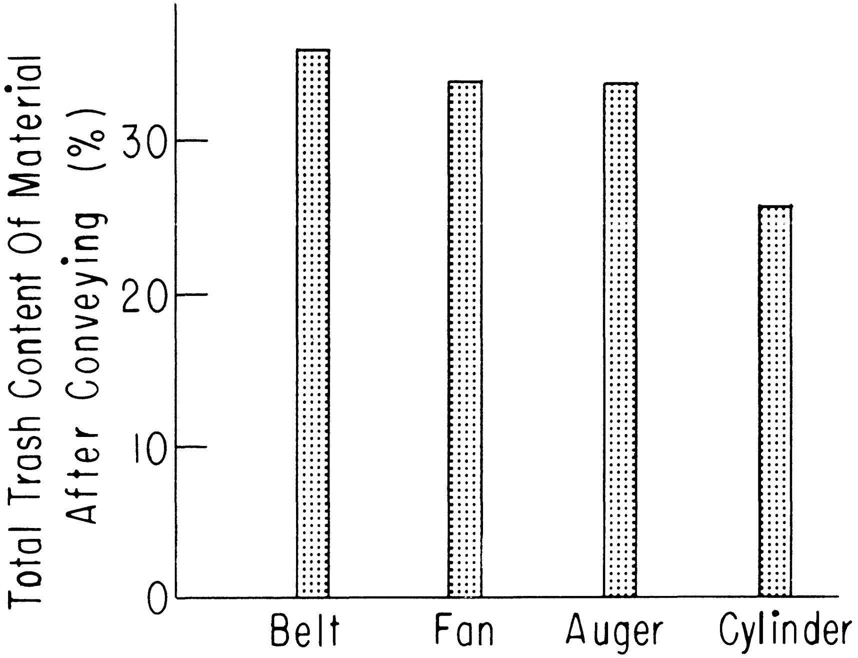

Fig. 12: Foreign material removal for different conveyors.

years when the seed coats were not well filled. Broken seed was classed as foreign material; thus in some instances, foreign material in the test lot was greater after passing through the fan conveyor than in the original lot

The foreign material removed in the conveyors was primarily leaf trash. Lesser amounts of sticks and burrs were removed. In general, leaf trash removal in seed cotton cleaning machinery in the gin was inversely related to the differences in prior leaf removal in the conveyors (Figure 13) ; and little difference in leaf content was evident in the cotton entering the gin stand. Burr trash removal in the burr machine was inversely related to the aggressiveness of the conveyors (Figure 14) ; less burr trash was removed from the cylinder and fan-conveyed cottons than from the auger or belt-conveyed cottons. The resulting differences in seed cotton burr contents were still apparent when the cotton entered the gin stand, even though they were somewhat minimized by the gin stand feeder (Figures 15, 16, 17) . However, these differences were usually nullified by the huller-front on the gin stand.

Because of the foregoing equalizing effects of the gin machinery,

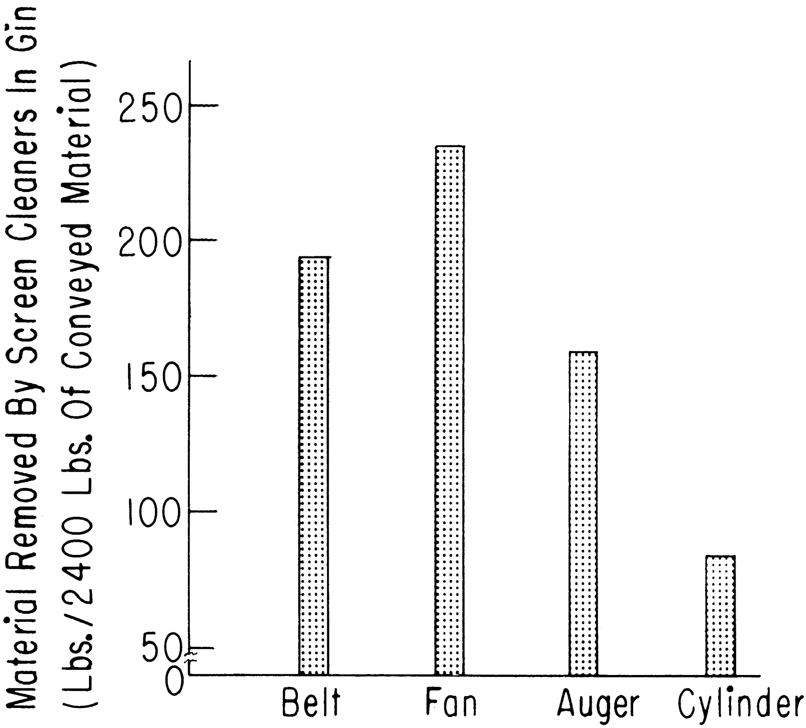

Fig. 13: Leaf trash removal in the gin for different conveyors.

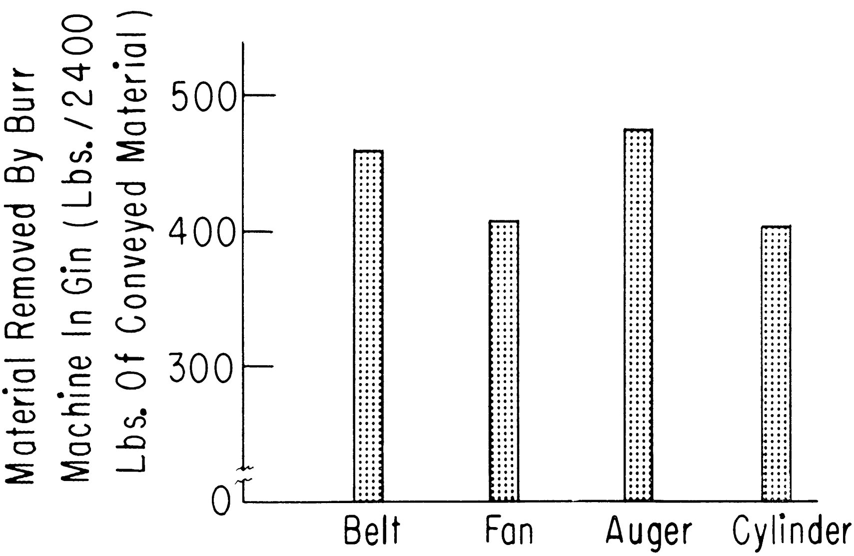

Fig. 14: Burr removal in the extractor for different conveyors.

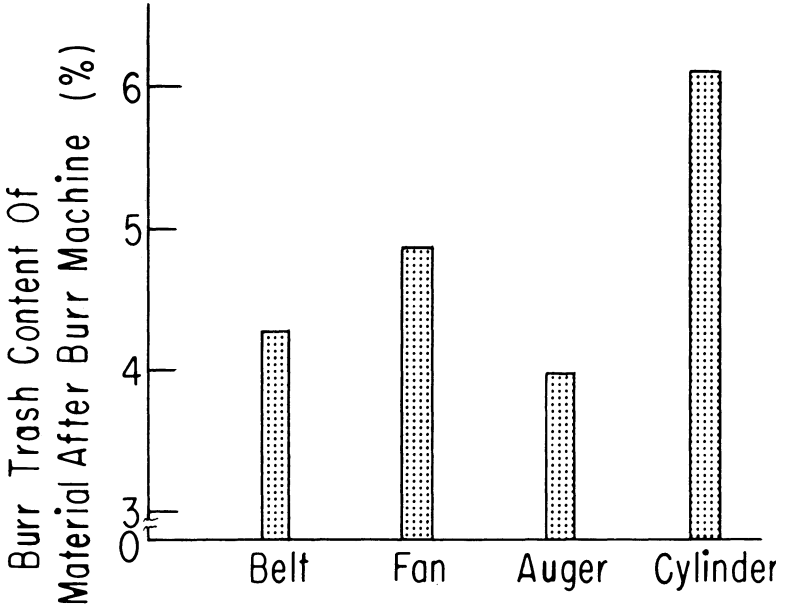

Fig. 15: Burrs in extracted cotton for different conveyors.

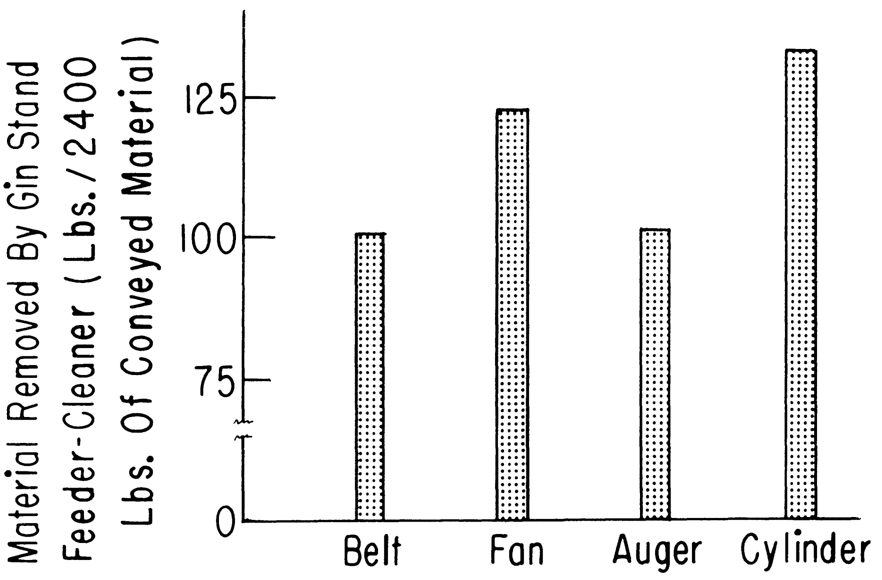

Fig. 16: Burr removal in the feeder for different conveyors.

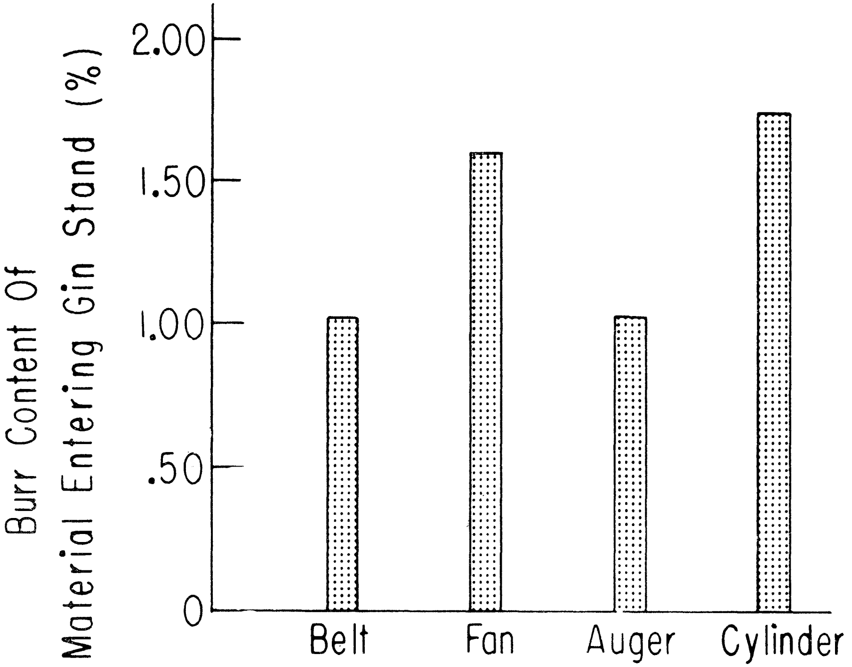

Fig. 17: Burrs entering gin stand for different conveyors.

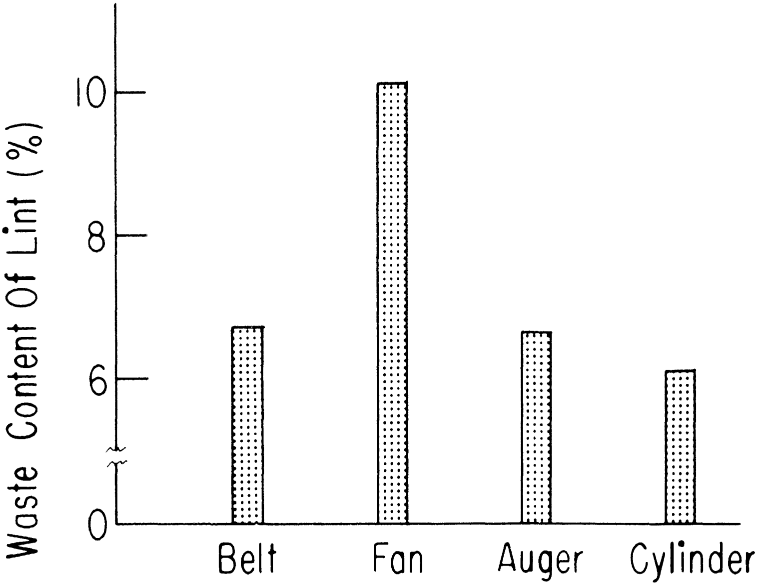

Fig. 18: Lint waste content for different conveyors.

ginned lint waste contents displayed little reaction to the degree of aggressiveness or cleaning performed in the conveyors. The exception to this was lint from the fan conveyor; in one year, this lint contained large quantities of seed coats, and therefore averaged highest in waste content (Figure 18).

Lint grades in these tests ranged from Strict Good Ordinary to Strict Low Middling, and usually carried some color designation. Except for the presence of seed coats one year in the fan-conveyed lint, grade indices and unit lint values displayed little reaction to the conveying systems. Lint reflectance and yellowness were not influenced to an important degree by conveyors.

Fiber length and strength measurements were obtained in only one year. Fiber coarseness data were obtained two years. None of these attributes were significantly affected by conveyors. Raw lint neps were inconsistently and inconclusively affected by conveyors; in all instances, nep counts were in the "average" category.

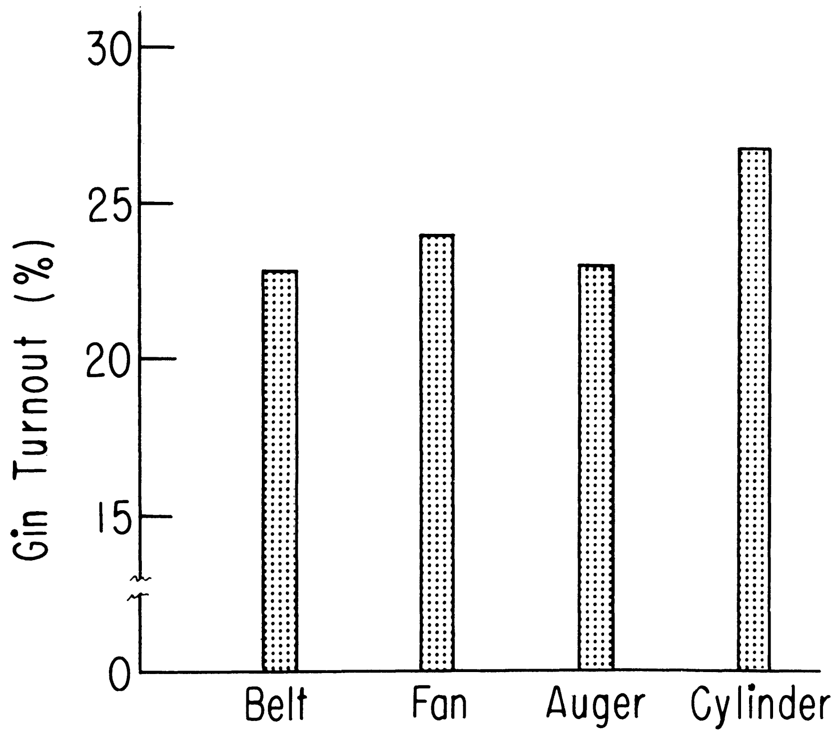

Fig. 19: Gin turnout for different conveyors.

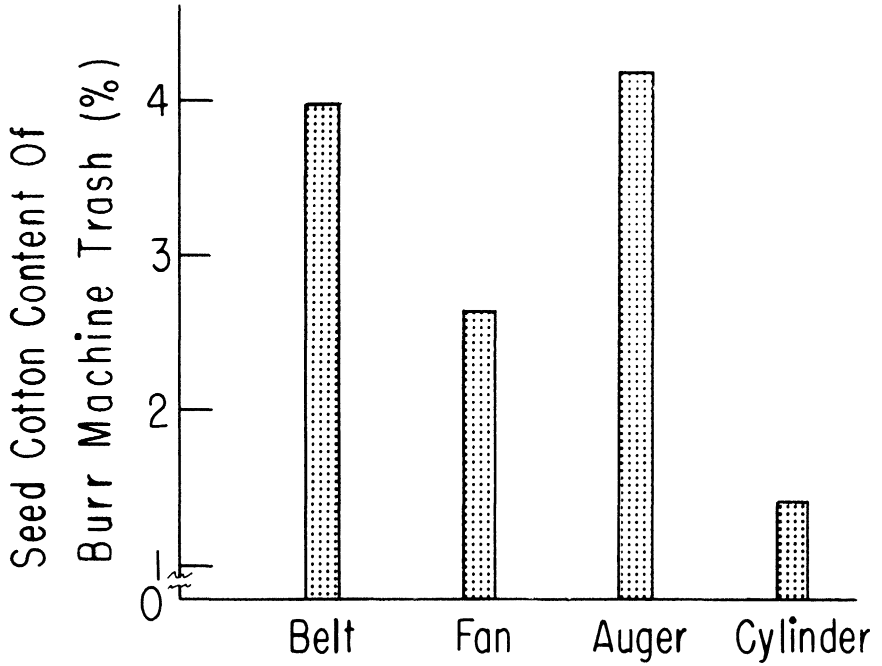

Fig. 20: Seed cotton loss in the extractor for different conveyors.

Gin turnouts were greater from the cylinder and fan-conveyed cottons than from the other two cottons (Figure 19). This was due to the greater foreign material removal by the cylinder conveyor, and to a lower loss of seed cotton in the burr machine trash (Figure 20). Compared to the belt and auger conveyors, cotton conveyed by the cylinder produced almost 100 additional pounds of lint from each 2400 pounds of material delivered to the gin.

Disregarding the slight differences in loss of cotton during cleaning within the conveying system, the same amount of seed cotton would be harvested and delivered to the gin from each acre regardless of the conveying system used. Only the amount of foreign material delivered to the gin from each acre would vary substantially. And since ginning fees are based on the weight of material processed, any cleaning performed in the stripper conveying system would be directly reflected in reducing ginning fees. Computations, based on the foregoing premises and on the foreign material contents of the conveyed cotton, indicate that cleaning accomplished within the cylinder conveyor would reduce ginning fees by an average of approximately $1.65 per acre. Reductions in ginning fees associated with the auger and fan conveyors were 40 to 50 cents per acre.

Equipment (Boll Breaking)

Ginning evaluations were made of the boll breaking which occurred in two types of conveyors; the 8 foot cylinder conveyor previously described, and the conveying system in a Southern Harvester cotton stripper. The Southern Harvester stripper (Figure 21) had a cleaning and conveying system of augers with parallel grid bar screens. Lugs could be attached to the periphery of the auger flights to provide additional cleaning and agitation of the cotton as it was being conveyed. Different degrees of boll breaking were obtained by using or not using the lugs. The screen surface area in this conveyor was approximately 2500 square inches.

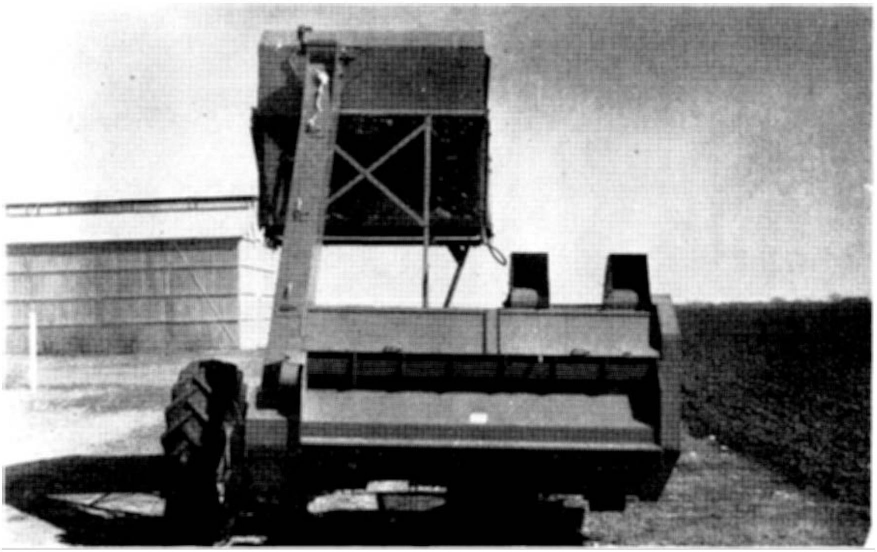

Fig. 21: Auger conveying system of Southern Harvester stripper.

The effects of cleaning in conjunction with boll breaking were also evaluated with these two conveyors. This was accomplished by using removable sheet metal covers installed on the grid bar or screen surfaces to prevent the removal of trash. These covers were removed when cleaning was desired.

Test Cotton

Parrott variety cotton grown on dryland and machine stripped after frost, was used in the boll breaking evaluations. Cotton yields were approximately ½ bale per acre one year, and 4/5 bale the other. The one-row experimental stripper using smooth steel rolls was used to harvest cotton for processing through the cylinder conveyor. This harvester performed no cleaning and left a relatively high percentage of the bolls in the whole form.

Procedure

With the cylinder conveyor, a factorial test design was used which had four levels of boll breaking and two levels of seed cotton cleaning. The different levels of boll breaking were accomplished by operating the cylinders at speeds of 125, 250, 375, and 500 rpm. Approximately 1,200 pounds of stripped material were processed through the conveyor at each of these speeds, both with and without the screen surfaces exposed. After passing through the conveyor, the material was ginned with 11 cylinders of screen cleaning, burr extraction, and double battery lint cleaning. A check treatment was ginned from the harvested cotton.

With the Southern Harvester stripper, a factorial test design was used which had two levels of boll breaking and two levels of cleaning. The resulting treatments were obtained by harvesting approximately one bale of cotton both with and without agitating lugs attached to the conveying augers, and with and without the sheet metal shields over the grid-bar screen surfaces. The four bales of cotton were ginned with the machinery arrangement described previously.

Samples were taken from the cotton prior to ginning to determine the number of whole bolls left in the cotton. Samples were also taken at various stations in the ginning process to determine foreign material components. Lint samples were taken from the lint slide for value and quality determinations. Data from the samples were analyzed by appropriate statistical procedures.

Results

Each increase in cylinder speed reduced the number of whole bolls left in the conveyed material. A speed of 375 rpm was sufficient to break almost all bolls (Figure 22).

The leaf content of the seed cotton decreased at all sampling locations within the gin when cleaning was done in the cylinder conveyor. However, this effect became less pronounced as the cotton proceeded through the gin machines and was not evident in lint waste content.

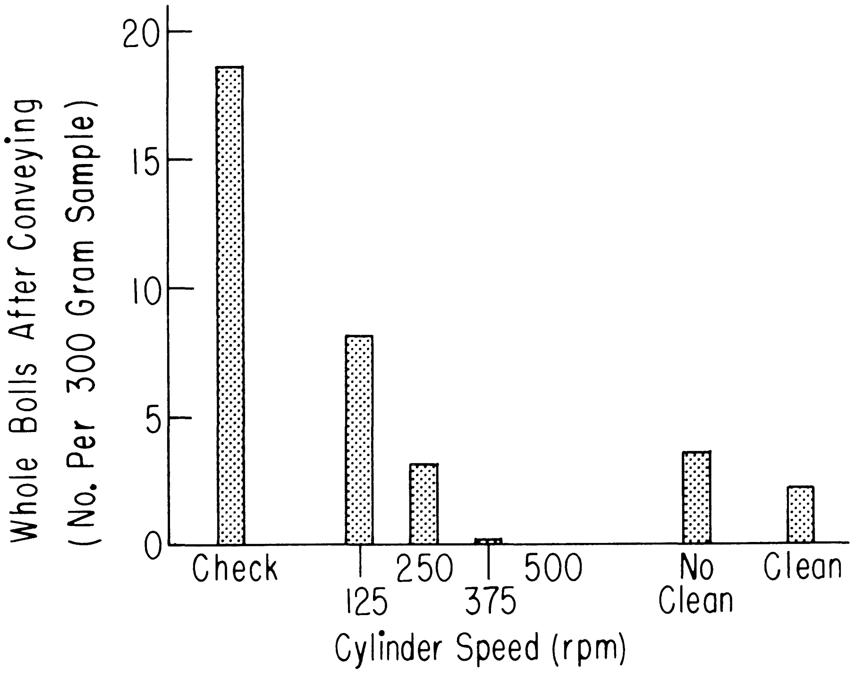

Fig. 22: Boll breakage for cleaning and different conveyor speeds.

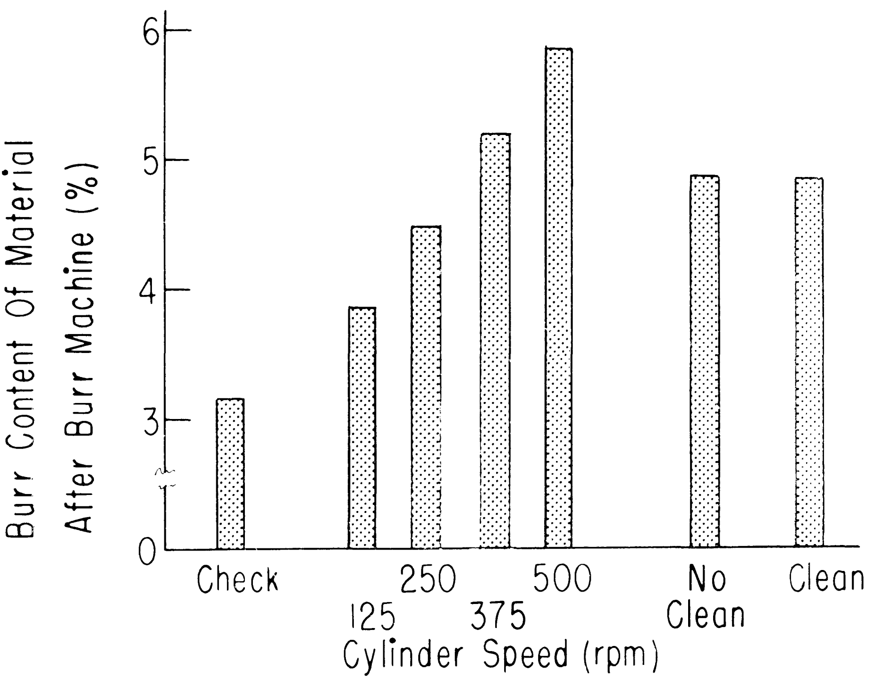

Fig. 23: Burrs in extracted cotton for cleaning and different conveyor speeds.

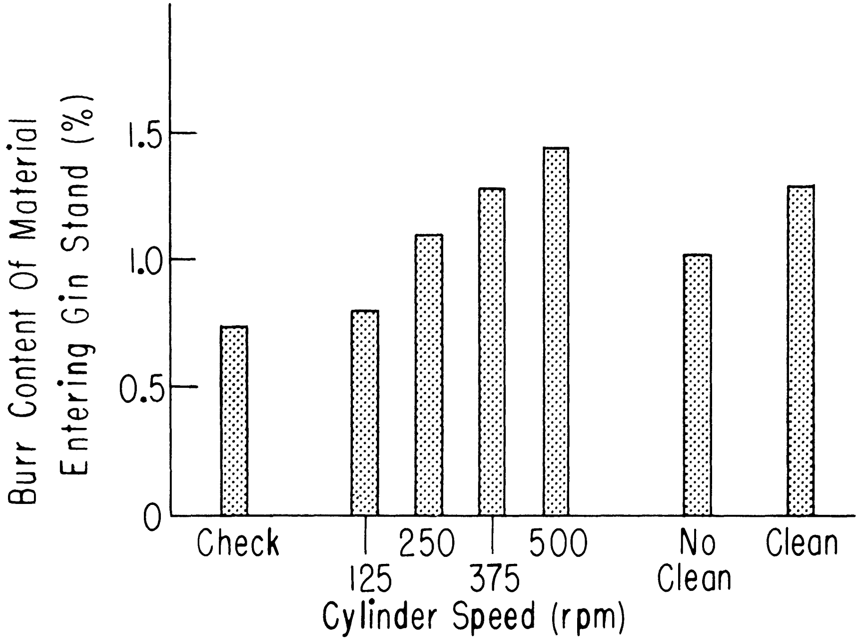

Fig. 24: Burrs entering gin stand for cleaning and different conveyor speeds.

The burr content of the seed cotton leaving the burr machine increased with each increase in cylinder speed used to convey the harvested material (Figure 23). This suggests that boll breaking reduced the effectiveness of burr removal by the burr machine. When the burrs are broken into segments, they apparently become more difficult to remove. By the time the material had passed through all the seed cotton cleaning machinery, burr contents still reflected the adverse effects of boll breaking on burr removal (Figure 24).

Conversely, the seed cotton content of the burr machine trash decreased with each increase in cylinder speed used to convey the harvested material (Figure 25). This indicates greater recovery of seed cotton from the partially open bolls due to boll breaking. Such bolls do not otherwise have sufficient lint exposed to engage the extractor saws. Because of this, each increase in boll breaking resulted in an increase in gin turnout (Figure 26). At the same time, cleaning within the conveyor increased turnout by reducing the foreign material content of the harvested material.

A trend toward increased lint yellowness and decreased reflectance was noted with each increase in boll breaking. Lint grades were predom-

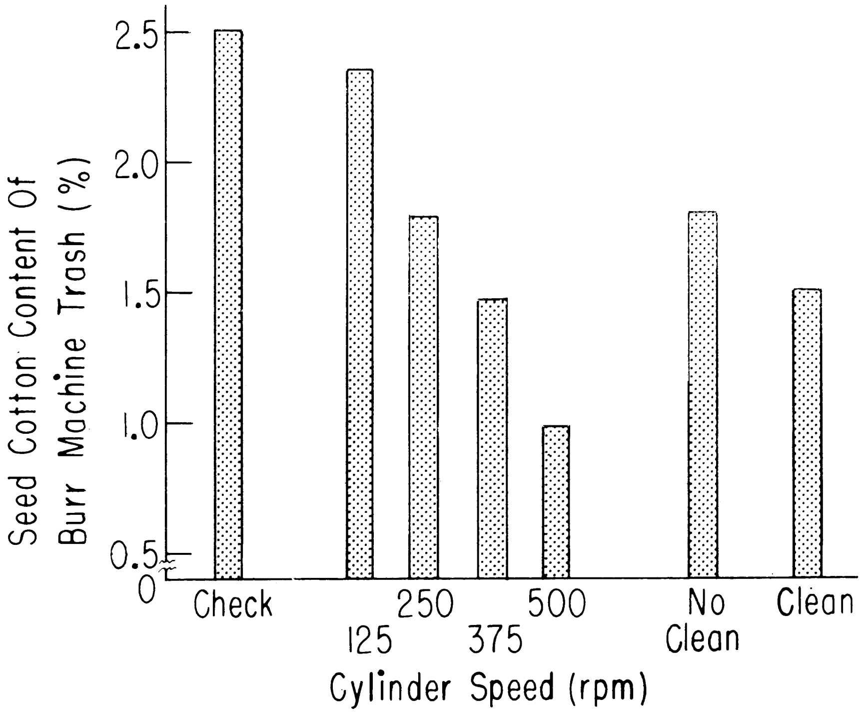

Fig. 25: Seed cotton loss in the extractor for cleaning and different conveyor speeds.

inately Strict Low Middling with an occasional Light Spot designation. Grade indices were not improved by cleaning and were not conclusively affected by boll breaking. Lint which had received cleaning in the conveyor was slightly shorter in staple than that which had not. Unit lint value, micronaire reading, neps, and fiber strength showed no definite response to either boll breaking or cleaning.

The foregoing effects of boll breaking and cleaning were essentially independent of each other. For this reason, the information presented in Figures 22 through 26 for boll breaking was averaged over the two levels of cleaning, and that for cleaning was averaged over all levels of boll breaking. However, the monetary benefits of boll breaking accrue on an entirely different basis than do those of cleaning. Therefore, the following economic evaluation of boll breaking was made at the zero level of cleaning in order to isolate the influence of cleaning.

Since the same amount of foreign material and seed cotton would be delivered to the gin from each acre regardless of the degree of boll breaking, the net effect of increased turnouts through boll breaking

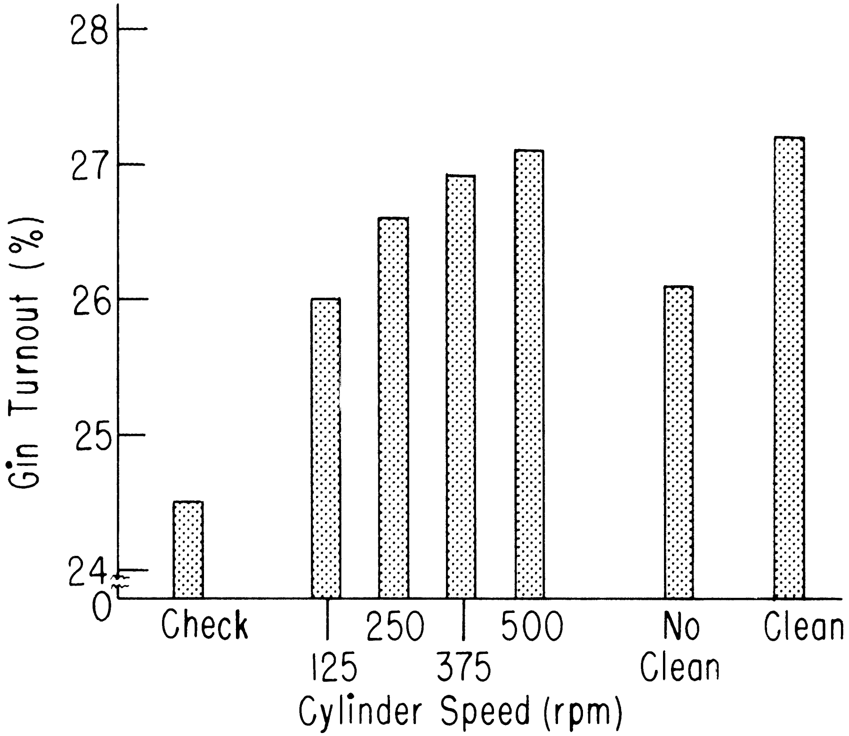

Fig. 26: Gin turnout for cleaning and different conveyor speeds.

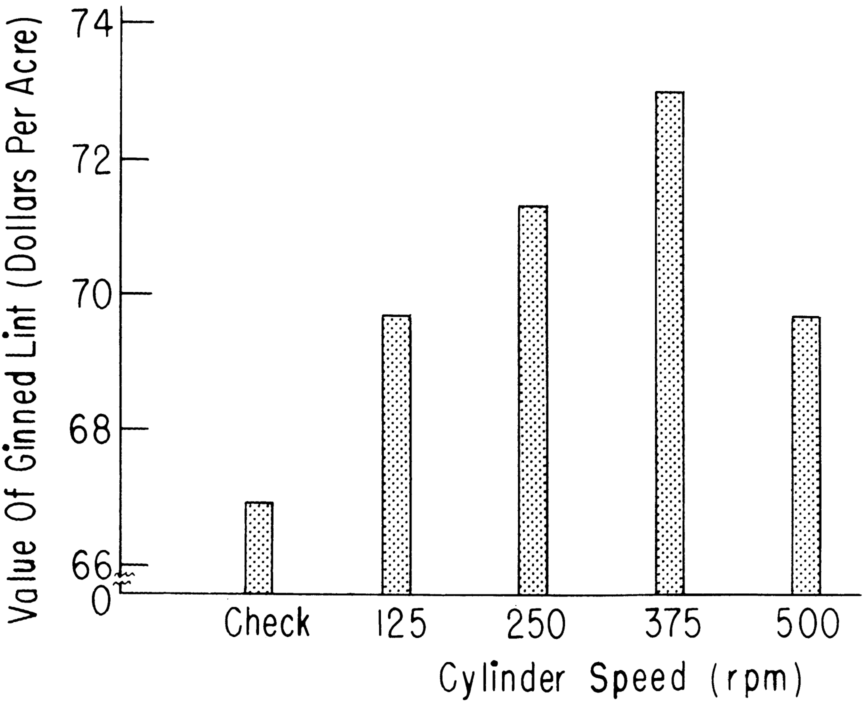

Fig. 27: Acre value of lint for different conveyor speeds.

alone would be an increase in acre yield of ginned lint. The maximum increase in acre yield due to boll breaking was 20 pounds of lint, and was obtained at the highest conveyor cylinder speed, 500 rpm. However, because of slightly lower lint grade associated with that speed, the maximum increase in acre lint value was $6.08, obtained at 375 rmp (Figure 27).

Since a lesser amount of foreign material would be delivered to the gin from each acre because of cleaning within the conveyor, the net effect of increased turnouts due to cleaning would be a reduction in ginning fees, inasmuch as ginning fees are based on the weight of material processed. This reduction in ginning fee due to cleaning averaged 24 cents per acre over all levels of boll breaking.

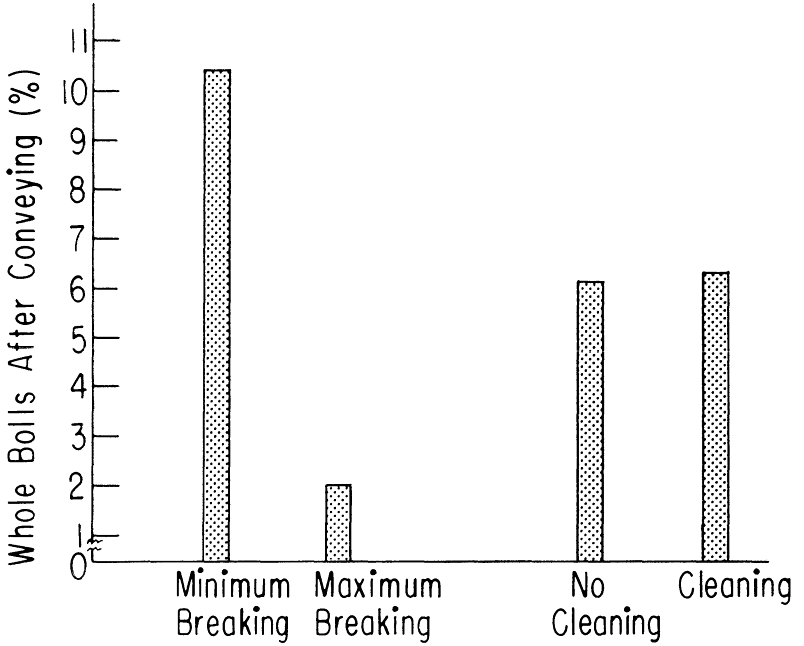

Fig. 28: Boll breakage for two levels of breaking and cleaning.

With the Southern Harvester, the number of whole bolls remaining in the conveyed material was substantially reduced by adding lugs to the auger flights (Figure 28). The subsequent effects of this additional boll breaking were similar in many respects to those reported for the cylinder conveyor (Figures 29-30). Exceptions were a slight increase in fiber neps due to breaking; and when no cleaning was used breaking reduced micronaire readings.

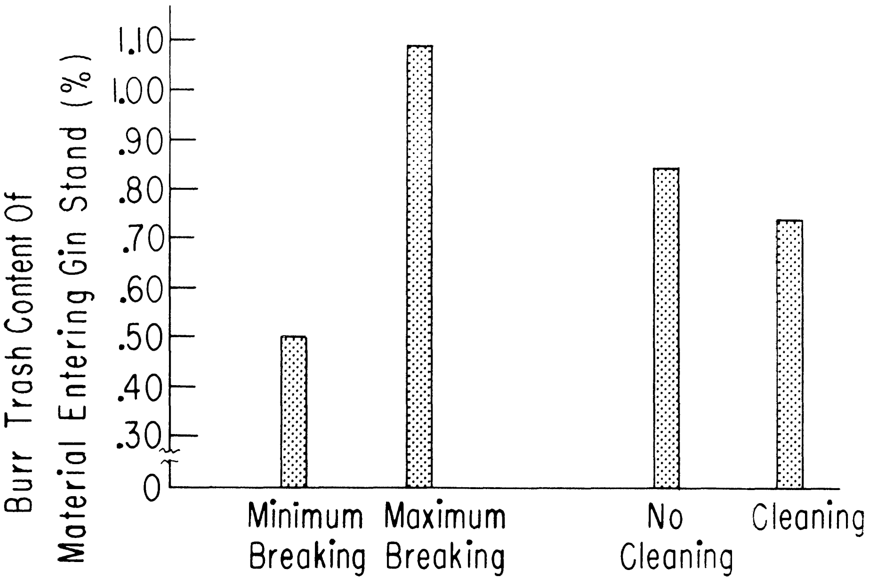

Fig. 29: Burrs entering gin stand for two levels of breaking and cleaning.

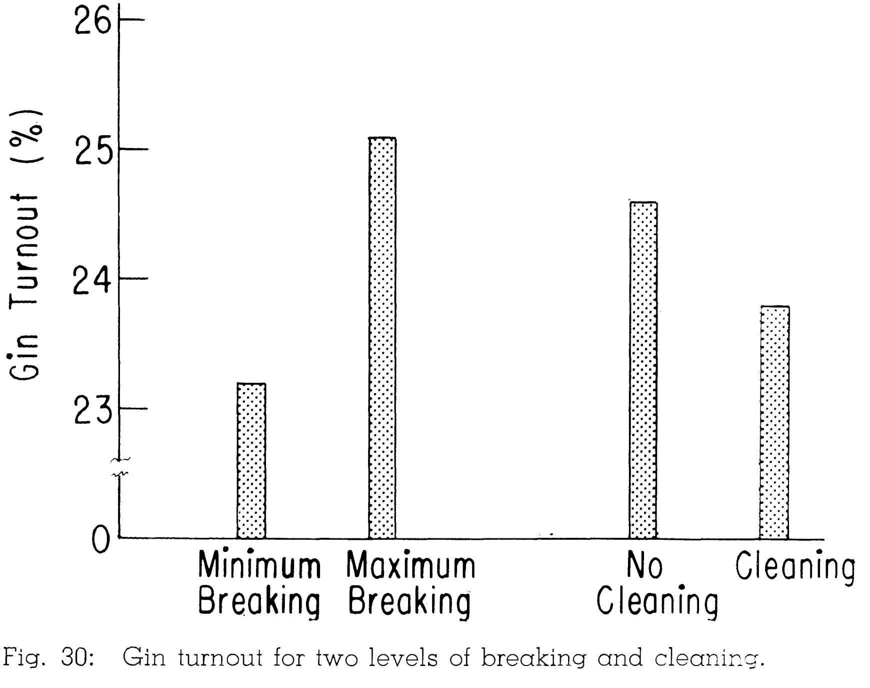

Fig. 30: Gin turnout for two levels of breaking and cleaning.

Although cleaning performed in the conveying system of the Southern Harvester resulted in measurable reductions in stick, leaf, and mote contents of the harvested material, this was not reflected in reduced lint waste content or greater gin turnout. Lint grades were mostly Strict Low Middling Light Spot, and were not affected by cleaning or breaking. However, unit lint value was increased slightly by cleaning when performed without boll breaking.

Ginned lint yield was increased an average of 31 pounds per acre by adding agitating lugs to the conveyor augers to increase boll breaking. The value of this increase was $7.50 per acre (Figure 31).

Ginned lint yield per acre was slightly lowered by cleaning within the Southern Harvester. This may have been due to the loss of non-fluffed locks of cotton through the relatively wide-spaced grid bars of the conveyor. Lint value was reduced an average of 50 cents per acre by cleaning.

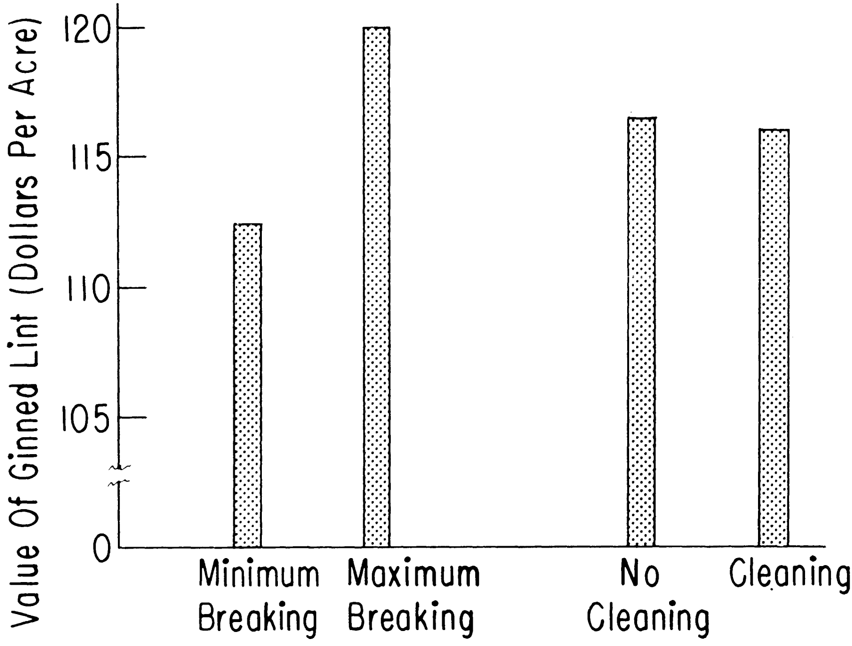

Fig. 31: Acre value of lint for two levels of breaking and cleaning.

Summary

Two classes of tests were made with cotton stripper conveyors over a five-year period. Laboratory tests furnished data for evaluating some of the factors important in removing trash from burr cotton during conveying. Ginning tests were performed to evaluate the effects of both cleaning and boll breaking accomplishments during conveying on the ginning characteristics of burr cotton and on the properties of the ginned lint.

Laboratory results showed that the cylinder conveyor removed more of all trash components than the auger conveyor at any given set of operating conditions.

Increasing shaft speed enhanced the effectiveness of trash removal in the cylinder conveyor, but decreased the effectiveness of the auger conveyor.

Increasing feed rates reduced the effectiveness of removal of all trash components except burrs by the cylinder conveyor.

In the auger conveyor, the perpendicular grid bar screen was most effective for removing all trash components.

In the cylinder conveyor, the parallel grid bar screen was most effective for removing all trash components.

The conveyors tested were less effective in removing burrs than they were in removing either sticks or leaf trash from the burr cotton.

Ginning results showed that after passing through the test conveyors, the total trash content of the burr cotton varied depending on which conveyor was used, but the differences were nearly eliminated after passing through the gin machinery.

The ginned lint waste content exhibited no casual relationship to the amount of trash in the burr cotton after conveying, except for the presence of seed coats in the cotton conveyed by the fan.

Grade indices, unit lint values, lint reflectance and yellowness, fiber length, strength, coarseness, and nep counts were influenced to no important degree by any of the conveyors. And only coarseness and neps showed an important response to boll breaking. Gin turnout was greatest for cottons conveyed by the cylinder and fan conveyors because the cylinder removed the greatest amount of trash and both performed an extensive amount of boll breaking.

There were no important inconsistencies between laboratory and ginning tests. The results of one test supported and confirmed the results of the other test insofar as both tests were used to measure the some conveyor characteristics.

Trash removal appears to be a desirable characteristic of burr cotton conveyors, particularly if it can be accomplished without rejecting lint with the trash. Greatest trash removal was obtained from the cylinder conveyor equipped with the parallel grid bar screen surface, operated at 500 rpm and at a feed rate of 20 pounds per minute.

Boll breaking appears to be a desirable function of burr cotton conveyors insofar as the effects of increased lint recovery exceed the effects of reduced unit lint values.

The cylinder conveyor was superior to all others in boll breaking. Boll breaking was three times more influential than cleaning in increasing net returns per acre.

APPENDIX A

Concave Type: Slotted Screen

Conveyor Type	Trash Component	Equation[1]	r[2]	r^2
Auger	Sticks	$Y = 1.090 + 0.847\,X_1 - 0.261\,X_1^2 - 0.185\,X_1X_2 + 5.085\,X_2 - 0.288\,X_2^2$	0.9980	0.9960
Cylinder	Sticks	$Y = -0.340 + 3.912\,X_1 - 0.281\,X_1^2 + 0.129\,X_1X_2 + 10.762\,X_2 - 0.833\,X_2^2$	0.9991	0.9981
Auger	Burrs	$Y = 0.357 - 0.209\,X_1 + 0.026\,X_1^2 - 0.034\,X_1X_2 + 0.342\,X_2 - 0.016\,X_2^2$	0.9970	0.9944
Cylinder	Burrs	$Y = 4.290 - 2.917\,X_1 + 0.498\,X_1^2 + 0.218\,X_1X_2 + 0.818\,X_2 - 0.072\,X_2^2$	0.9968	0.9936
Auger	Leaves	$Y = 4.704 - 1.989\,X_1 + 0.194\,X_1^2 + 0.204\,X_1X_2 + 3.247\,X_2 - 0.322\,X_2^2$	0.9991	0.9981
Cylinder	Leaves	$Y = -7.892 + 7.467\,X_1 - 0.535\,X_1^2 + 0.608\,X_1X_2 + 10.503\,X_2 - 1.023\,X_2^2$	0.9991	0.9981
Auger	Total Trash	$Y = 2.892 - 1.187\,X_1 + 0.109\,X_1^2 + 0.045\,X_1X_2 + 2.345\,X_2 - 0.191\,X_2^2$	0.9992	0.9984
Cylinder	Total Trash	$Y = -1.699 + 2.734\,X_1 - 0.087\,X_1^2 + 0.346\,X_1X_2 + 6.837\,X_2 - 0.619\,X_2^2$	0.9992	0.9984

Concave Type: Parallel Grid Bar

Conveyor Type	Trash Component	Equation[1]	r[2]	r^2
Auger	Sticks	$Y = 3.509 - 0.186\,X_1 - 0.140\,X_1^2 + 0.256\,X_1X_2 + 3.338\,X_2 - 0.281\,X_2^2$	0.9969	0.9939
Cylinder	Sticks	$Y = -1.719 + 4.561\,X_1 - 0.401\,X_1^2 + 0.296\,X_1X_2 + 9.813\,X_2 - 0.842\,X_2^2$	0.9980	0.9961
Auger	Burrs	$Y = 0.893 - 0.507\,X_1 + 0.065\,X_1^2 - 0.041\,X_1X_2 + 0.399\,X_2 - 0.011\,X_2^2$	0.9960	0.9920
Cylinder	Burrs	$Y = 4.897 - 3.033\,X_1 + 0.508\,X_1^2 + 0.238\,X_1X_2 + 0.681\,X_2 + 0.003\,X_2^2$	0.9957	0.9914
Auger	Leaves	$Y = 2.261 + 0.318\,X_1 - 0.125\,X_1^2 + 0.313\,X_1X_2 + 2.422\,X_2 - 0.292\,X_2^2$	0.9979	0.9958
Cylinder	Leaves	$Y = -5.357 + 8.282\,X_1 - 0.724\,X_1^2 + 0.404\,X_1X_2 + 12.027\,X_2 - 1.199\,X_2^2$	0.9970	0.9940
Auger	Total Trash	$Y = 1.844 - 0.122\,X_1 - 0.042\,X_1^2 + 0.166\,X_1X_2 + 1.702\,X_2 - 0.173\,X_2^2$	0.9982	0.9964
Cylinder	Total Trash	$Y = 2.270 + 1.799\,X_1 - 0.013\,X_1^2 + 0.247\,X_1X_2 + 7.508\,X_2 - 0.689\,X_2^2$	0.9974	0.9949

[1] Y = Amount of trash removed—%.
X_1 = Conveyor Speed. rpm/100 X_2 = Conveyor length—feet.

[2] r = Coefficient of Correlation.
r^2 = Coefficient of Determination.

APPENDIX A (Contd.)

Concave Type: Perpendicular Grid Bar

Conveyor Type	Trash Component	Equation[1]	r_2	r^2
Auger	Sticks	$Y = 8.552 - 1.805 X_1 + 0.067 X_1^2 - 0.125 X_1X_2 + 5.321 X_2 - 0.239 X_2^2$	1.9992	0.9984
Cylinder	Sticks	$Y = 4.338 + 1.046 X_1 - 0.001 X_1^2 - 0.021 X_1X_2 + 9.159 X_2 - 0.638 X_2^2$	0.9995	0.9990
Auger	Burrs	$Y = 2.075 - 1.040 X_1 + 0.132 X_1^2 - 0.067 X_1X_2 + 0.550 X_2 + 0.013 X_2^2$	0.9969	0.9938
Cylinder	Burrs	$Y = 3.669 - 2.260 X_1 + 0.357 X_1^2 - 0.025 X_1X_2 + 1.058 X_2 - 0.020 X_2^2$	0.9957	0.9915
Auger	Leaves	$Y = -6.993 + 7.055 X_1 - 1.104 X_1^2 + 0.439 X_1X_2 + 3.327 X_2 - 0.302 X_2^2$	0.9980	0.9959
Cylinder	Leaves	$Y = -6.506 + 6.809 X_1 - 0.499 X_1^2 + 0.623 X_1X_2 + 9.558 X_2 - 0.956 X_2^2$	0.9980	0.9960
Auger	Total Trash	$Y = -1.291 + 2.608 X_1 - 0.450 X_1^2 + 0.137 X_1X_2 + 2.504 X_2 - 0.164 X_2^2$	0.9990	0.9980
Cylinder	Total Trash	$Y = 2.606 + 0.044 X_1 + 0.243 X_1^2 + 0.282 X_1X_2 + 5.927 X_2 - 0.523 X_2^2$	0.9988	0.9976

Concave Type: 1/2 Inch Square Mesh

Conveyor Type	Trash Component	Equation[1]	r_2	r^2
Auger	Sticks	$Y = 2.196 + 0.382 X_1 - 0.167 X_1^2 - 0.359 X_1X_2 + 3.247 X_2 - 0.114 X_2^2$	0.9975	0.9950
Cylinder	Sticks	$Y = -1.396 + 3.151 X_1 - 0.382 X_1^2 - 0.062 X_1X_2 + 5.768 X_2 - 0.299 X_2^2$	0.9994	0.9987
Auger	Burrs	$Y = 0.127 - 0.060 X_1 + 0.007 X_1^2 - 0.007 X_1X_2 + 0.056 X_2 - 0.002 X_2^2$	0.9977	0.9953
Cylinder	Burrs	$Y = 0.292 - 0.133 X_1 + 0.020 X_1^2 + 0.018 X_1X_2 + 0.001 X_2 + 0.005 X_2^2$	0.9942	0.9884
Auger	Leaves	$Y = 3.631 - 0.298 X_1 - 0.073 X_1^2 + 0.057 X_1X_2 + 3.292 X_2 - 0.255 X_2^2$	0.9971	0.9941
Cylinder	Leaves	$Y = 0.409 + 0.977 X_1 + 0.248 X_1^2 + 0.605 X_1X_2 + 7.310 X_2 - 0.727 X_2^2$	0.9984	0.9968
Auger	Total Trash	$Y = 1.580 + 0.100 X_1 - 0.078 X_1^2 - 0.019 X_1X_2 + 1.854 X_2 - 0.126 X_2^2$	0.9971	0.9942
Cylinder	Total Trash	$Y = 0.988 + 0.163 X_1 + 0.179 X_1^2 + 0.315 X_1X_2 + 4.035 X_2 - 0.370 X_2^2$	0.9986	0.9972

APPENDIX A (Contd.)

RATE OF FEED TEST

	Equation	r	r²
Burrs:*			
Cylinder Conveyor:	$Y = 2.304 - 2.128X_1 + 0.850X_1^2 - 0.040X_1X_2 + 1.780X_2 - 0.076X_2^2$	0.9984	0.9968
Auger Conveyor:	$Y = 0.086 - 0.012X_1 + 0.004X_1^2 - 0.012X_1X_2 + 0.127X_2 - 0.004X_2^2$	0.9862	0.9726
Sticks:			
Cylinder Conveyor:	$Y = 17.629 - 5.256X_1 + 0.332X_1^2 - 0.703X_1X_2 + 14.725X_2 - 1.069X_2^2$	0.9980	0.9960
Auger Conveyor:	$Y = 3.428 - 2.277X_1 + 0.555X_1^2 - 0.668X_1X_2 + 4.824X_2 - 0.238X_2^2$	0.9914	0.9829
Leaves:			
Cylinder Conveyor:	$Y = 21.173 - 12.062X_1 + 2.615X_1^2 - 0.401X_1X_2 + 15.989X_2 - 1.295X_2^2$	0.9985	0.9970
Auger Conveyor:	$Y = 2.808 - 0.904X_1 + 0.669X_1^2 - 0.189X_1X_2 + 2.505X_2 - 0.178X_2^2$	0.9960	0.9921
Total Trash:			
Cylinder Conveyor:	$Y = 11.712 - 7.882X_1 + 2.250X_1^2 - 0.158X_1X_2 + 8.389X_2 - 0.637X_2^2$	0.9986	0.9973
Auger Conveyor:	$Y = 4.951 - 4.763X_1 + 1.360X_1^2 - 0.172X_1X_2 + 1.572X_2 - 0.094X_2^2$	0.9989	0.9979

Y = Trash Component Burrs, Sticks, Leaves, or Total Trash
X_1 = Feed rate into conveyor — bales per hour (one bale = 2,400 lbs. of harvested material)
X_2 = Conveyor length in feet
r = Coefficient of correlation
r^2 = Coefficient of determination

Oklahoma's Wealth in Agriculture

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

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

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

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