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Effects of Saw Ginning, Roller Ginning, and Lint Cleaning on Fiber Length Uniformity Index

Carlos B. Armijo
Southwestern Cotton Ginning Research Laboratory, Agricultural Research Service, USDA, Mesilla Park, NM, USA

ABSTRACT

The objective of this project is to develop ginning methods that improve fiber length uniformity index to levels that are compatible with the newer and more efficient spinning technologies. Providing the textile industry with a longer and more uniform fiber to manufacture yarns more efficiently would expand market share and increase the demand for cotton products. A literature search of harvesting and ginning studies within the past fifteen years that included HVI uniformity found that cultivar was an important determining factor and some production practices, such as early defoliation and stripper harvesting, could also reduce uniformity. Uniformity was not adversely affected by seed cotton cleaning machinery (cylinder cleaners and stick machines). Saw ginning reduced uniformity more than did roller ginning. Uniformity was negatively affected by the saw-type lint cleaner used in saw gins. Moisture restoration before lint cleaning partially mitigated lint cleaning's decrease in uniformity. Although uniformity was not affected by lint cleaner grid bars, faster lint cleaner saw cylinder speeds did reduce uniformity. Lint cleaners used in roller gins reduced uniformity, but to a lesser degree than saw-type lint cleaners. These studies suggested that most of the decrease in uniformity occurs at the saw-type lint cleaner feed bar. Based on these results, a project was started to determine how conventional and experimental lint cleaning machines affect uniformity. The project includes 1) older conventional saw-type lint cleaners that retain the harmful feed bar (this is the most widely used lint cleaner), 2) newer commercially-available saw-type lint cleaners that alter the configuration of the damaging feed mechanism, and 3) experimental saw and roller gin coupled lint cleaners that eliminate the feed mechanism altogether. What follows are detailed results of how harvesting and ginning practices affect uniformity, and a description of the project that will determine how experimental lint cleaning machines affect uniformity.

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Carlos B. Armijo, Christopher D. Delhom, Derek P. Whitelock, Paul A. Funk, John D. Wanjura, Gregory A. Holt, Sui Ruixiu, Vikki B. Martin

USDA United States Department Of Agriculture Agricultural Research Service

Southwestern Cotton Ginning Research Laboratory, Mesilla Park, NM

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Problem Statement

- **There is a need to develop ginning methods that reduce fiber damage and improve fiber length properties, HVI length uniformity index in particular.**

Problem Statement

- Improving length uniformity is important for international mills that use ring spinning equipment.
- It may also lead to more use of newer and more efficient spinning technologies such as air-jet spinning.

Objectives of Study

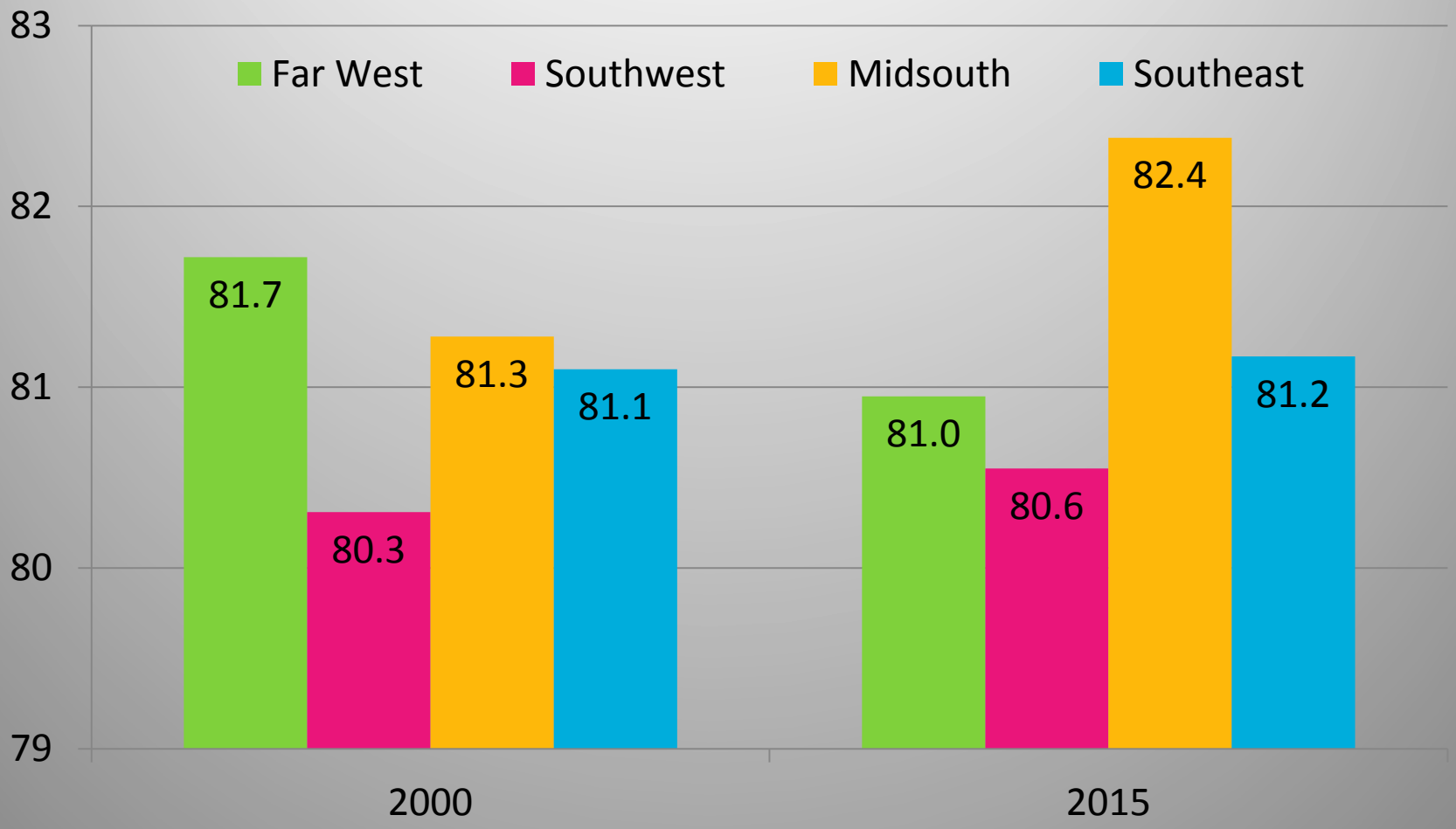
1. Document (literature search) how fiber length uniformity is effected by current saw ginning, roller ginning, and lint cleaning processes.
2. Determine how fiber length uniformity is effected by experimental lint cleaning processes.

Fiber Length Uniformity

LUI = (mean length / upper half mean length) x 100

• Very High	above 85
• High	83-85
• Intermediate	80-82
• Low	77-79
• Very Low	below 77

Length Uniformity (%) in the U.S.



Length Uniformity Effects at the Saw Gin Stand

Saw Gin Stand Study - 2006

- **Examined different types of seed roll boxes and seed roll densities**
  - **Traditional = low density**
  - **Conveyor tube and paddle roll = high density**

Seed Roll Box	Uniformity (%)
Traditional (seed roll turned by gin saws)	83.7 a
Conveyor tube (assists turning seed roll)	83.6 a
Conveyor tube, slow speed	83.6 a
Power Roll (assists turning seed roll)	83.3 a

Power Roll Gin Stand - 2008

- **Upland Cotton, Before Lint Cleaning**
- **No seed tube or agitator, paddle roll turns seed roll**
- **A seed finger roll returns “not fully ginned seed” to saw**

McClendon, Mann and Felton Gins	Uniformity (%)
Power Roll 161 saw	83.9 a
Continental Golden Eagle 161 saw	83.4 a

Miniturn Coop	Uniformity (%)
Power Roll 158 saw	84.4 a
Lummus 158 saw	84.3 a
Lummus 158 saw	84.0 a

Saw Gin Tooth Design - 2015

- Upland cotton
- Gin Saws Varied the Number of Teeth
- Gin Stand Motor Load was Kept Constant

Treatment (teeth/saw)	Gin Rate (lb/min)	Uniformity (%)	
		Before Lint Cleaning	After Lint Cleaning
328	89.8 a	81.2 a	80.3 a
352 (conventional)	81.0 b	81.1 a	79.6 b
352 (conventional)	80.2 b	81.0 a	80.3 a
330	71.5 c	81.1 a	80.1 ab
352	67.0 d	81.6 a	80.0 ab

Length Uniformity Effects at the Saw-Type Lint Cleaner

Beltwide Lint Cleaning Study - 2011

- **Upland Cotton**
- **Tracked quality changes all through the gin/season**

Gins using 1 lint cleaner	Uniformity (%)
Before Lint Cleaning	81.9 a
After One Lint Cleaning	81.1 b

Gins using 2 lint cleaners	Uniformity (%)
Before Lint Cleaning	82.3 a
After One Lint Cleaner	81.7 b
After Two Lint Cleaners	81.3 c

Saw-Type Lint Cleaner Damage - 2008

- **Mid South Cottons**

Treatment	Uniformity (%)
By-Pass Lint Cleaning	82.2 a
No grid bars	81.5 b
1 Grid Bar	81.5 b
2 Grid Bars	81.6 b
5 Grid Bars	81.6 b

L.C. Saw Speed (rpm)	Uniformity (%)
605	82.0 a
870	81.8 ab
1135	81.6 b
1400	81.3 cc

Lummus Sentinel Lint Cleaner - 2004

- **Upland Cotton**
- **Eliminates condenser batt, but retains feed plate**
- **Feeds individual fiber tufts**

Gin A	Uniformity (%)
Before Sentinel	83.4
After Sentinel	82.9
Percentage point change	-0.60%

Gin A	Uniformity (%)
Before Model 108	84.0
After Model 108	82.8
Percentage point change	-1.43%

Length Uniformity Effects from Roller Ginning

High Speed Roller Ginning Studies - 2012

- **Mid-South Upland cotton**

Gin Treatment	Uniformity (%)
Roller Gin, High Speed	82.3 a
Saw Gin	80.9 b

- **Texas A&M ELS Upland strains**

Gin Treatment	Uniformity (%)
Roller Gin, High Speed	84.2 a
Saw Gin	82.8 b

High Speed Roller Ginning Studies

- **2013, 3 cottons (1 stripper harvested)**

Gin Treatment	Uniformity (%)
Roller Gin, High Speed	83.9 a
Roller Gin, Conventional	83.5 a
Saw Gin	81.7 b

- **2017, Mid-South Upland cotton**

Gin Treatment	Uniformity (%)
Roller Gin, Pin Cylinder Cleaner	84.3 a
Roller Gin, Experimental Cleaner	83.9 ab
Roller Gin, Saw-Type Cleaner	83.6 b
Saw Gin, Saw-Type Cleaner	82.8 c

Roller Gin Lint Cleaning Study - 2013

- **3 cottons (1 stripper harvested)**
- **No interactions with cultivar**

Gin and Lint Cleaner Treatment	Uniformity (%)
Roller Gin, High Speed, No Lint Cleaning	84.2 a
" , Beater Lint Cleaner	84.0 ab
" , Pin Cylinder Cleaner	83.4 bc
Roller Gin, Conventional, No Lint Cleaning	83.7 abc
" , Beater Lint Cleaner	83.9 ab
" , Pin Cylinder Cleaner	83.1 c
Saw Gin, No Lint Cleaning	82.4 d
" , One Saw-Type Cleaner	81.7 e
" , Two Saw-Type Cleaners	81.1 e

Literature search confirmed that the feed bar on the saw-type lint cleaner was one of the causes for reduced uniformity.

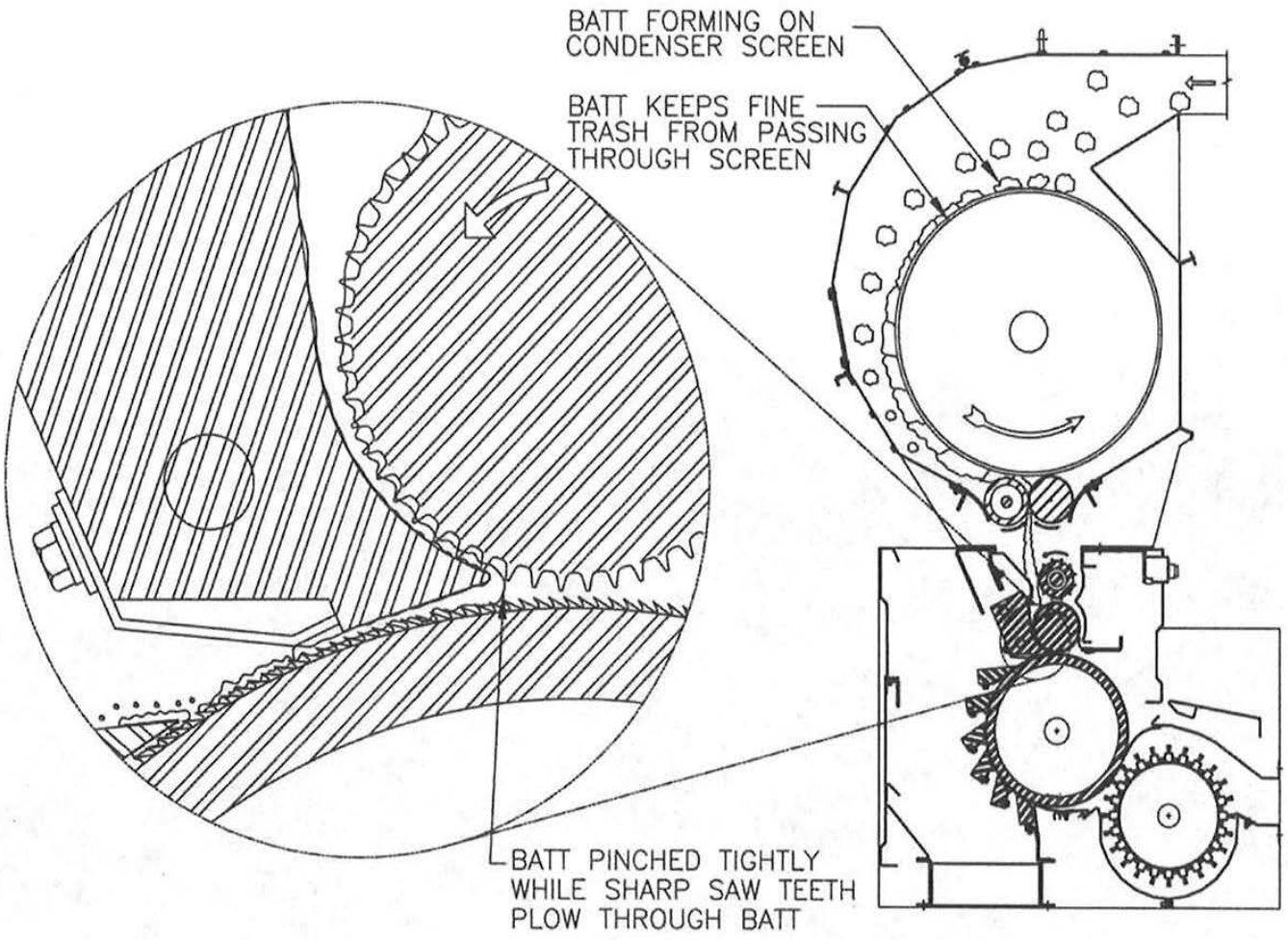


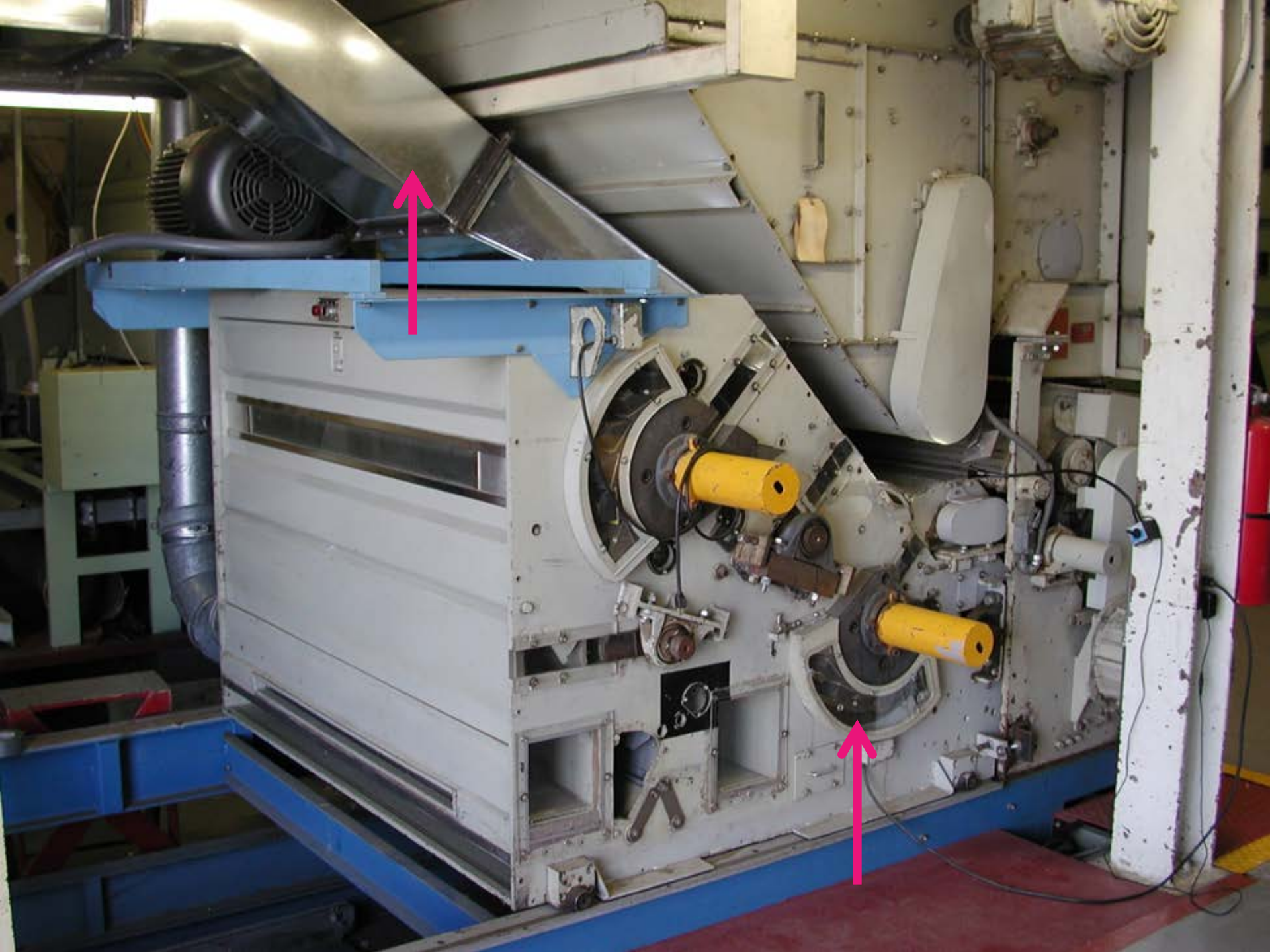
Figure 2. A typical conventional controlled-batt, saw-type lint cleaner (the Lummus Model 108 Lint Cleaner).

Part 2 of Study: Lint Cleaner Test

- To determine how fiber length uniformity is effected by:
  - Conventional saw and roller ginning (controls)
  - Saw gin coupled lint cleaner (experimental)
  - Lummus Sentinel II lint cleaner
  - Cherokee Regal lint cleaner
  - Roller gin coupled lint cleaner (experimental)

Saw Gin Coupled Lint Cleaner

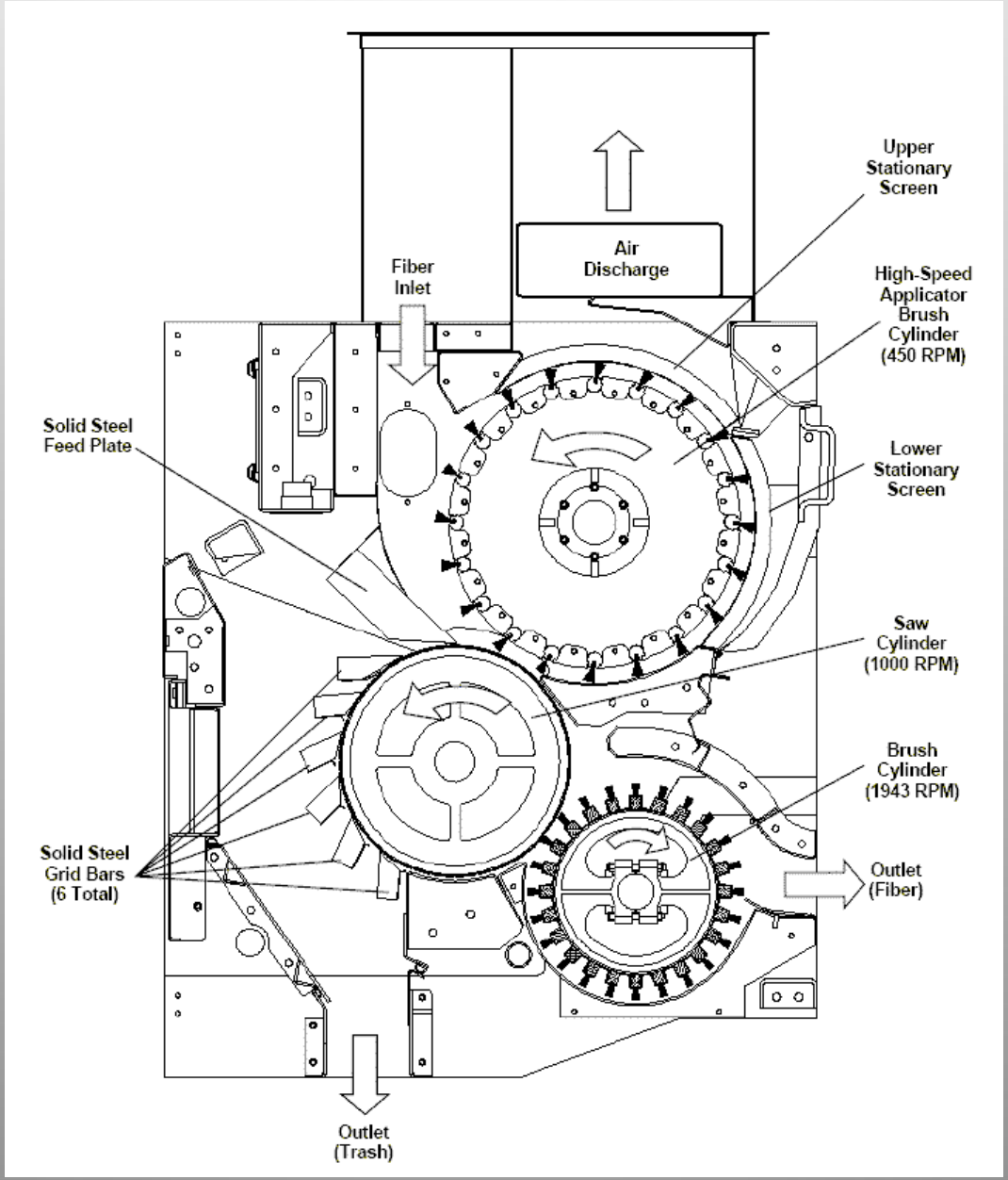
- Developed 30 years ago.
- Main objective was to eliminate the pneumatic transport system to reduce energy costs (35% saving) and particulate emissions.
- Lesser objective was to reduce fiber damage.
- Coupled lint cleaner eliminates the condenser batt, feed works, and feed plate.
- Past research showed that fiber processed through the coupled lint cleaner was significantly longer and had fewer short fibers.



Lummus Sentinel II Lint Cleaner

- Individual tufts of fiber are applied directly to the saw, thus eliminating the condenser batt.
- The feed works assembly is eliminated, but the feed plate is retained.
- The Sentinel was developed based on the concept of the coupled lint cleaner.
- Field tests showed improvement in uniformity, but no formal test has been published.

Lummus Sentinel II Lint Cleaner



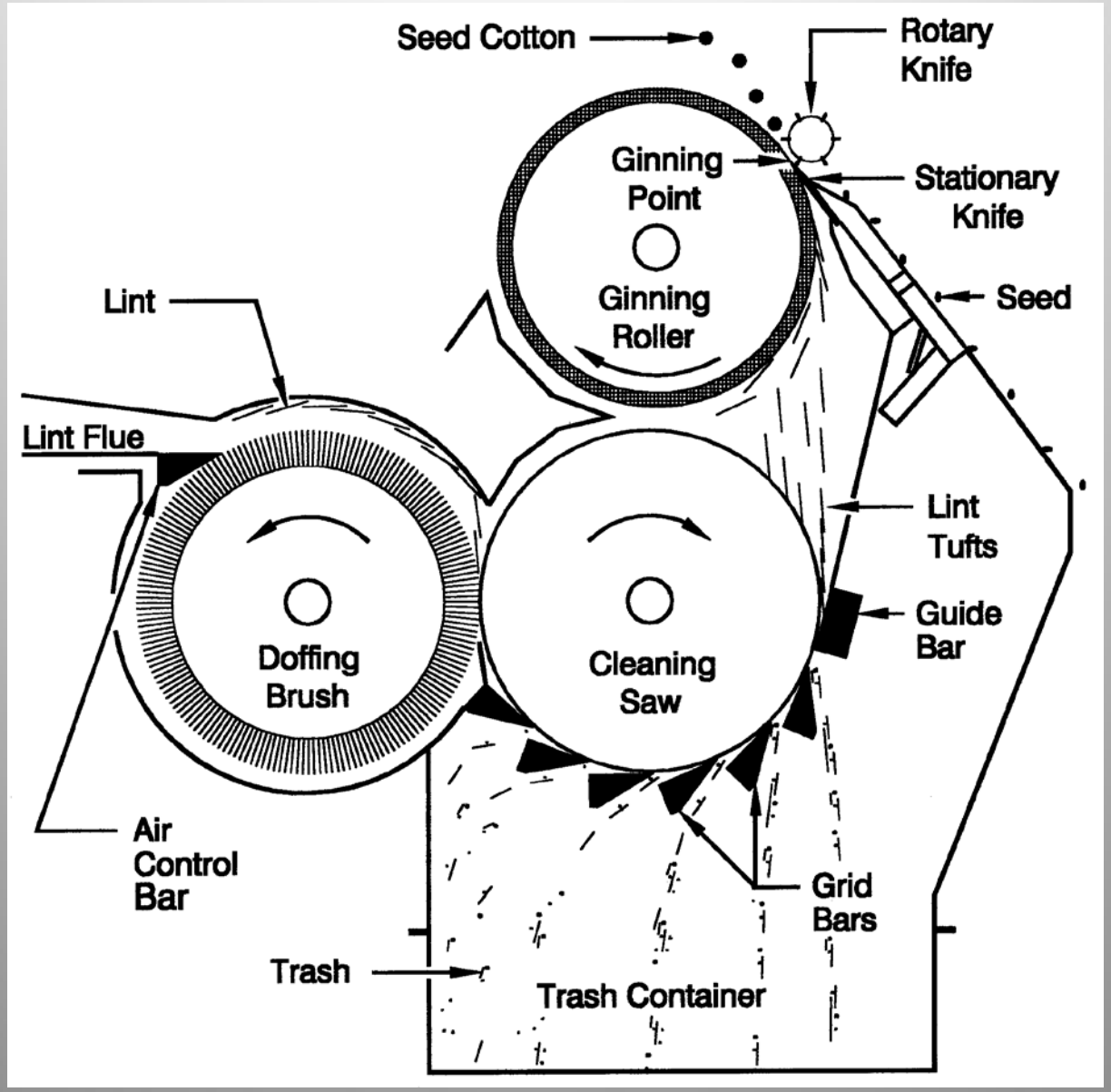
Cherokee Regal Lint Cleaner

- A rolling feed bar and splined roller removes the batt from the condenser drum.
- The batt feeds directly onto the saw without changing direction.
- An applicator bar ensures that the saw holds the lint.
- No formal test has been published.

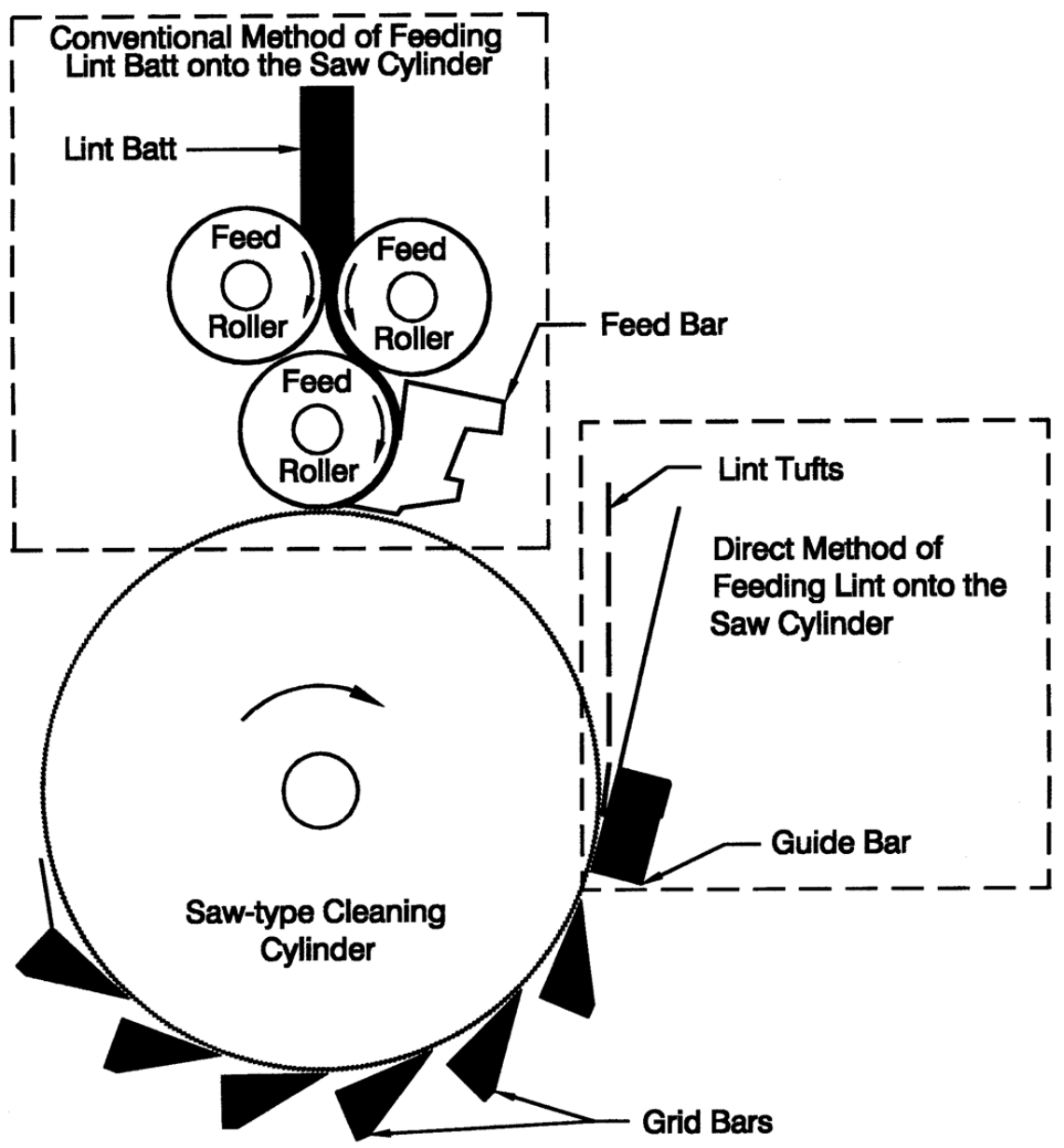
Roller Gin Coupled Lint Cleaner

- Developed 20 years ago for Pima cotton.
- A conventional roller gin lint cleaner is a bulk system that has high loading rates and requires pneumatic transfer, but low cost.
- The coupled lint cleaner uses a unit system that decreases loading rate and increases cleaning efficiency, eliminates pneumatic transfer of lint, but increases cost.
- High speed roller ginning, with possibly a wider stand, may reduce unit system cost.

Roller Gin Coupled Lint Cleaner



Roller Gin Coupled Lint Cleaner




FEEDER

Formal Gin Test

- 7 Ginning Treatments
- 4 Diverse Cultivars
- Evaluate:
  - Fiber properties and length distributions
  - Lint cleaning efficiency and lint loss
  - Turnout
  - Bale value
  - Spinning properties

Acknowledgment

Cotton Incorporated


The End