

# Ginning technology: The next frontier

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Worldwide production of cotton was over 100 million bales in 2004 with the United States producing about 23 million. Today, only the United States, Australia and Israel are completely mechanised. Most of the cotton elsewhere in the world is hand harvested and processed with minimal equipment at the gin.

Vast improvements in cotton varieties, weed control, insect control and other production practices in recent years has focused attention squarely on ginning as the next frontier for the cotton industry.

## HARVESTING AND MODULING

Proper defoliation, harvesting and moduling are critical to good ginning. Seed cotton should not be harvested at moisture contents above 12 per cent.

Although accurate, hand-held moisture meters are not available as a tool in harvesting cotton, but the technology is available as a modification to a cotton harvester. Anthony and Byler have successfully developed and field-tested an electronic device mounted in the conveyance duct of a cotton harvester to measure moisture online.

The device continuously displays the moisture as green, yellow and red recommendations to the operator. They also developed and successfully field-tested an electronic device added to the tramper section of a module builder to measure moisture during moduling using similar advisory colours. These sensors are currently not used — primarily due to costs.

Once harvested, good, high quality coverings must be used on modules and they must be stored in a well-drained location that is accessible to module trucks during rainy weather. Recent research indicates that poorly built modules with defective covers reduce seed cotton value from \$30 to \$478 per 12 bale module, while well-built, properly covered modules increased seed cotton value about \$200 per module.

Temperatures should be monitored at five or six locations in a module at a depth of about three feet for five to six days beginning immediately after the module is made. If the temperature rises more than 8°C or reaches 49°C, the module should be ginned immediately.

FIGURE 1: Schematic of typical gin system in the United States

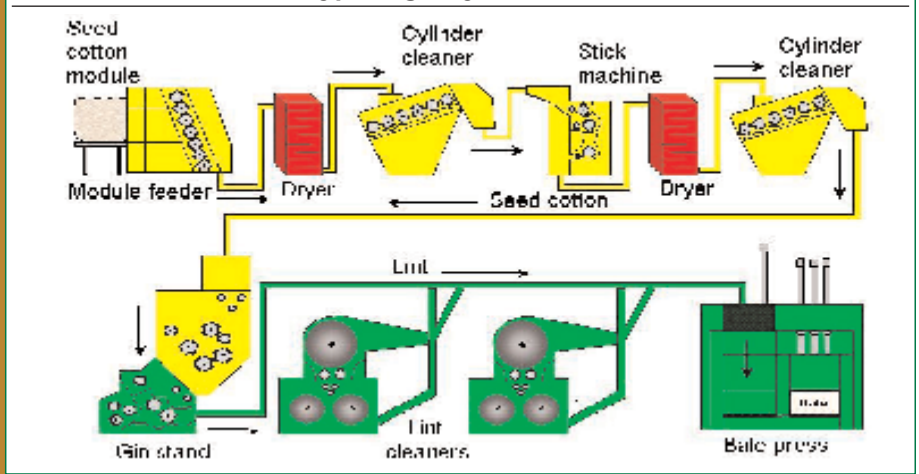
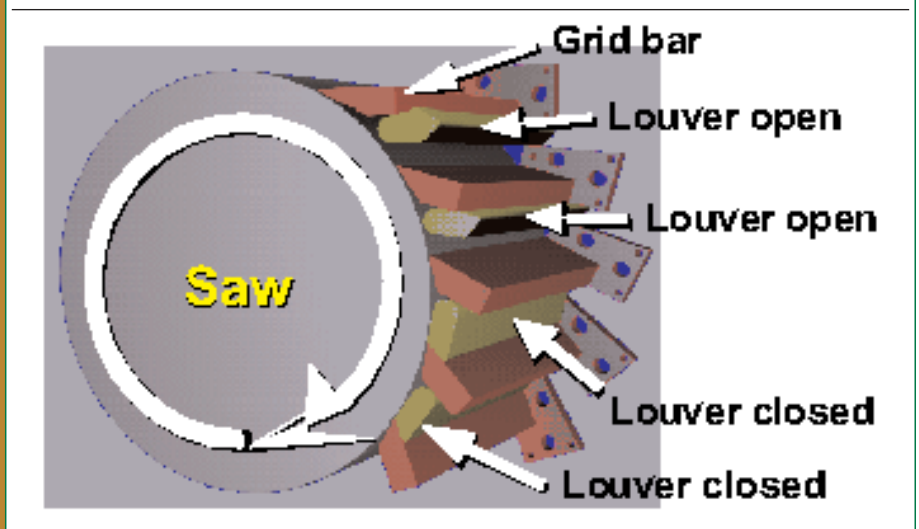


FIGURE 2: Lint cleaner equipped with louvers for selectively cleaning cotton



## GIN PROCESSING

### Drying

Seed cotton is usually exposed to drying before and during cleaning (Figure 1). Typically, two stages of drying are available at cotton gins. Temperatures of less than 104°C are recommended. Moderate fibre damage will occur above 121°C and heavy damage will occur at temperatures above 149°C.

Irreversible damage will occur at temperatures above 177°C. Damage occurs at these temperatures regardless of exposure time. For each one per cent reduction in fibre moisture content below five per cent, the number of short fibres is increased about one per cent. Ginning

cotton below five per cent moisture decreases yarn strength and yarn appearance, and increases short fibres.

### Seed cotton cleaners

Large foreign matter is removed with a sequence of machines called seed cotton cleaners. These may be cylinder-type or extractor-type, commonly called stick machines.

### Gin stands

Saw-type gin stands separate the fibre from the cottonseed although roller gin stands are also used.

### Lint cleaners

After the gin stand removes the fibre from the cottonseed, the fibre is transported pneumatically to an air-type lint cleaner

or a saw-type lint cleaner. Air-type lint cleaners remove about four pounds of material per 500-pound bale. The opening for trash removal is easily adjustable and must be monitored because modules of cotton differ. Adjustment of the opening may be required for each module. These cleaners increase neps slightly but in general do not damage the fibre.

The first saw-type lint cleaner removes about 20 pounds of material per bale and the second stage removes about 10 pounds. Unfortunately, over 50 per cent of the removed material is good fibre. If grid bars are worn, fibre wastage will increase dramatically but cleaning efficiency will not decrease.

Lint turnout will improve substantially when sharp grid bars are used and the number of bales required to produce a bale of motes will decrease noticeably.

Grid bars should be inspected annually and replaced or sharpened as necessary. The amount and type of lint cleaning required is a function of the initial foreign matter in the ginned lint as well as the market price for the various grades of cotton. Since many different marketing schedules exist, both foreign and domestic, the decision as to the number of lint cleaners required to optimise monetary returns to the farmer cannot be made manually.

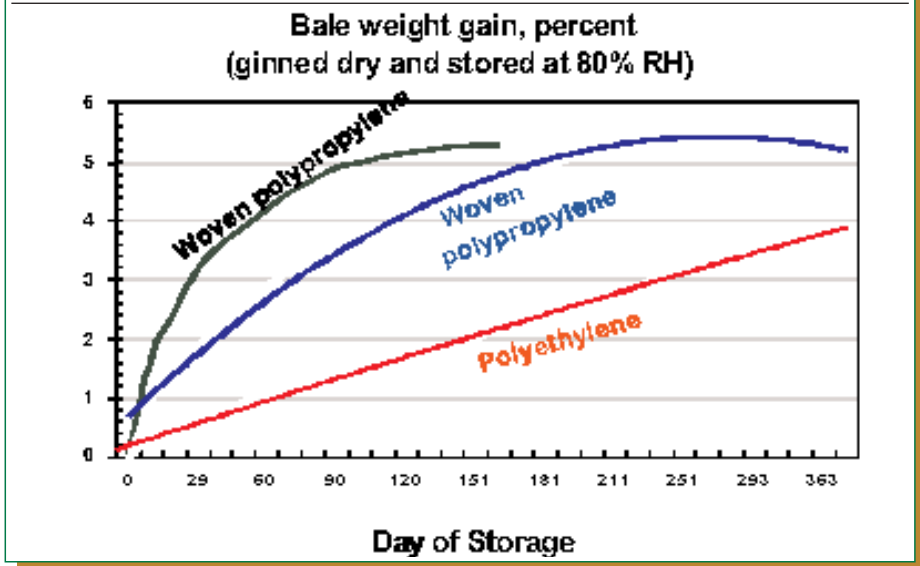
Increased drying can be used to increase lint cleaning efficiency but fibre quality is sacrificed. The decision can be made automatically using a computerised gin process control system developed by myself and licensed to Uster Technologies of Knoxville, Tennessee.

The first and second stages of saw-type lint cleaning can improve the leaf grade about one unit and one-half unit, respectively. They can reduce fibre length by over 0.02 inches (1/64), especially at moistures below five per cent. Lint cleaners can change light-spotted cotton grades to white over 50 per cent of the time. They can also cut bark discounts over 50 per cent of the time but have only limited impact (25 per cent) on grass discounts.

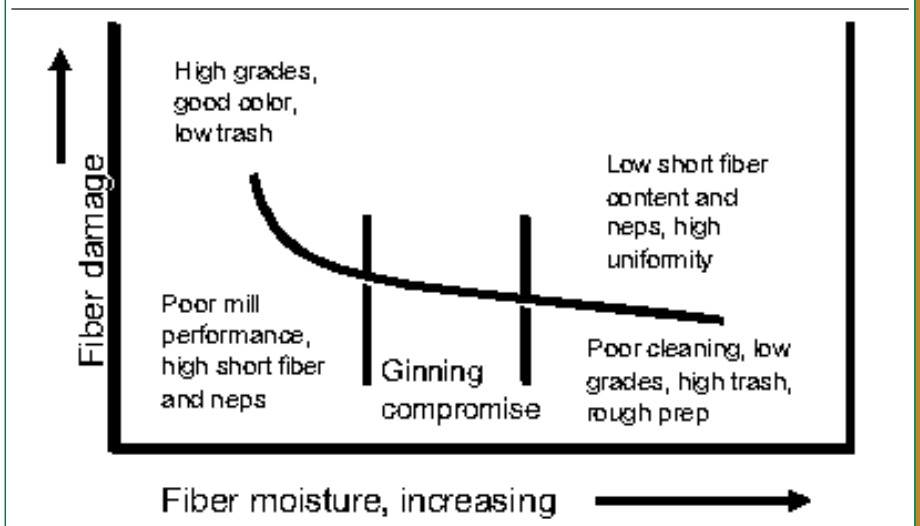
So farmers should be especially careful to avoid harvesting grass with the cotton. As cotton is exposed to extreme weather conditions, the bark tends to separate from the stalks and becomes entangled with the cotton during harvesting, seed cotton cleaning and fibre-seed separation.

Typically, one or two stages of saw-type lint cleaners are used in series to produce bales with leaf grades of two to four. As the number of lint cleaners increase, the

**FIGURE 3:** Several months are required for universal density bales to reach equilibrium with the storage climate — the permeability of the bale bagging has a strong influence on the equilibration time



**FIGURE 4:** Processing cotton is a compromise between high moisture and low moisture



trash content and bale weight decrease. Studies to establish the impact of saw-type lint cleaners on fibre quality found that bale weight changed from 525 to 507 and then 500 pounds as lint cleaners changed from 0 to 1 to 2 (Table 1).

As the number of lint cleaners increased, length, uniformity, strength, HVI per cent area and leaf decreased. But short fibre content, reflectance (Rd), plus b and neps increased. Bale value was highest with zero lint cleaners!

Since some cottons do not require a full stage of saw-type lint cleaning, we have developed a system to select a variable number of cleaning points (grid bars) in a lint cleaner (Figure 2). The concept is commercially available as the LouverMax lint cleaner from Continental Eagle.

The LouverMax was introduced in 2002 and over 80 units are now in use in seven countries. The LouverMax reduces the amount of good fibre lost by the lint cleaner and increases bale weight by eight to 10 pounds. In addition, the fibre is exposed to fewer aggressive cleaning points that might damage the fibre.

#### Packaging

In the US, bales are packaged at universal density (28 lbs per cubic foot), and weigh about 500 pounds. They have outside dimensions of about 21 by 55 by 32 inches. In order to reduce bale tie failures, the bale should be compressed to at least 40 lbs per cubic foot density. For a 500-pound bale, this is typically a platen separation of 20 inches. Compression forces

in excess of 750,000 pounds are often required to compress the bale.

The required compression force can be reduced about 30 per cent by using redesigned bale platens that I patented in 1998 and licensed to C&M Baling and LP Brown. Bale tie lengths should be 87 to 89 inches. Since bale compression force increases at low moisture levels, moisture contents below five per cent should be avoided.

When bales with low initial moisture content are stored in higher humidities, they gain weight as shown in Figure 3.

**Moisture**

Moisture content is the key to harvesting, moduling, ginning, packaging and bale storage. The cleaning efficiency during ginning is inversely related to moisture content. Cotton fibre must be relatively dry (five per cent wet basis) to achieve good trash removal efficiency but it should be six to seven per cent for fibre length preservation (Figure 4).

For instance, fibre ginned at seven per cent moisture content might be 1.11 inches long but that same fibre ginned at four per cent moisture content would only be 1.07 inches long.

In addition to weight loss (15 pounds) and increased short fibre content (five per cent to 11 per cent) at those two moisture contents, the market value is also decreased by \$8.75 a bale. In addition, many textile mills remove the short fibre content as waste. For the above example (five per cent versus 11 per cent short fibre content), the textile mill will lose an additional 30 pounds of fibre per bale.

Uniformity is also reduced by ginning at low moisture contents. Ginning at 6.6 per cent moisture might yield a uniformity of

83.5 compared to 82.5 at 3.4 per cent moisture.

Neps are also increased by processing at low moistures. For example, at moisture contents of 3.4, 5.0 and 6.6 per cent, neps might be 154, 181 and 217 per gram of lint, respectively.

One of the best methods to control drying was developed by Anthony and Byler and is marketed by Uster Technologies as a part of its computerised gin process control system under the trade name IntelliGin. The computerised process control system is based on several patents licensed from the US Department of Agriculture. Sensing stations (Figure 5) are used to grade the cotton online.

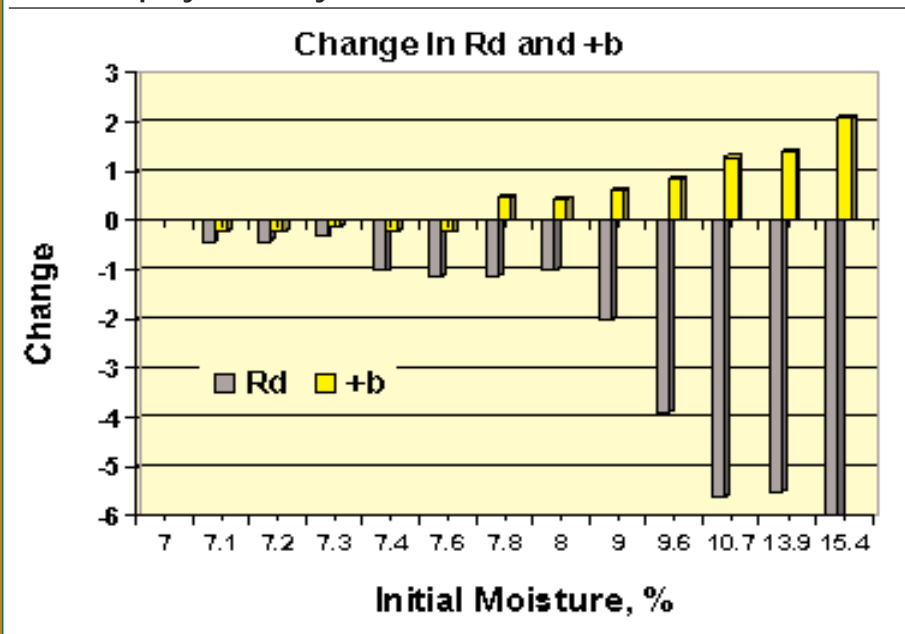
About 80 systems worldwide process

about two million bales of cotton annually and manage the drying process to optimise processing. The IntelliGin also controls the amount of seed cotton cleaning and lint cleaning to optimise monetary returns to the farmers. Studies by a university agricultural economist reported an increase in net value of about \$8 per bale at IntelliGin sites.

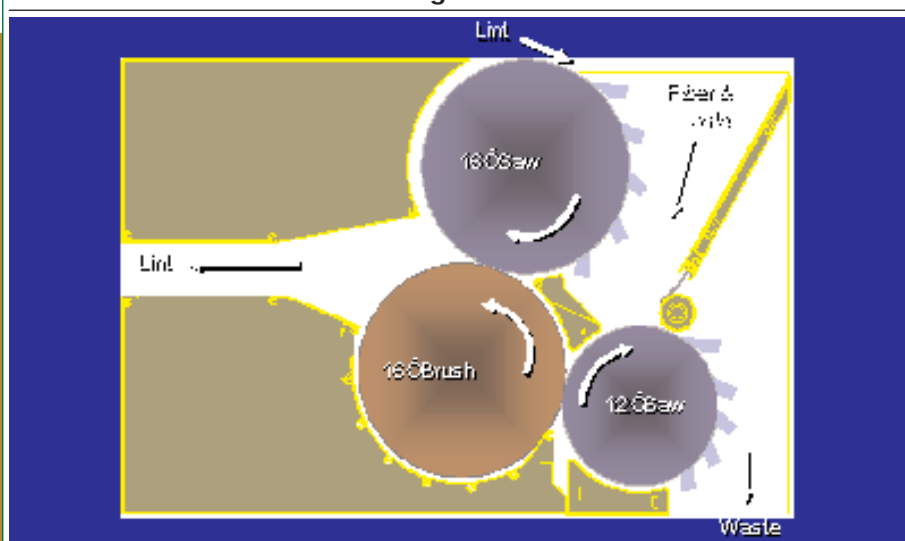
Most portable moisture sensors are relatively inaccurate ( $\pm 1$  per cent); but Byler and Anthony developed a new version that used the same technology as IntelliGin. It worked well with an accuracy of  $\pm 0.25$  per cent in the range of 4.3 to 10.2 per cent moisture content.

Systems are available to restore small amounts (one per cent or five pounds) of

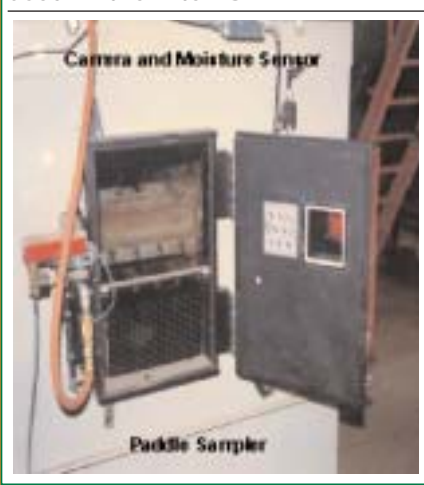
**FIGURE 6: Reflectance and yellowness are adversely impacted by moisture sprayed directly on cotton fibre**



**FIGURE 7: New lint cleaner developed at Stoneville to reduce fibre loss was field tested at a commercial gin from 2002-2004**



**FIGURE 5: Typical sensing station used in the IntelliGin**



moisture to fibre before the gin stand. These systems generally prevent fibre length reduction and increase bale weight slightly.

Ginning at low humidity will cause much of the added moisture to be removed before the fibre reaches the bale press but the advantages received at the gin stand in terms of fibre length preservation will remain. All gins should be equipped with methods to add moisture before the gin stand.

The addition of moisture after the ginning and lint cleaning operations are completed is usually accomplished at the battery condenser or lint slide. These systems use humidified air, direct water spray or a combination of these two techniques.

Regardless of the method of adding moisture in the bale press area, bales should never be packaged above 7.5 per cent moisture to avoid significant fibre degradation (primarily colour) during storage. Numerous research reports clearly demonstrate that colour degradation occurs in bales packaged with excessive moisture.

Deterioration begins at moistures slightly above 7.0 per cent and increases dramatically as moisture exceeds 8.0 per cent (Figure 6). Note that the samples submit-

**TABLE 1: Impact of saw-type lint cleaners on fibre quality (Study 1, Anthony 1996)**

Fibre quality	Number of lint cleaners		
	0	1	2
Monetary returns, US\$	377	375	372
Turnout, %	36.5	35.2	34.7
Bale weight, lbs.	525	507	500
Percent area	0.92	0.45	0.32
Leaf	4.0	3.0	2.5
Length, in.	1.13	1.12	1.11
Uniformity	83.8	83.0	82.5
Strength, g/tex	29.4	28.8	28.8
Short fibre content, %	6.6	8.0	9.9
Rd	72.0	74.3	75.2
Plus b	8.3	8.4	8.6
Micronaire	4.80	4.78	4.83
Neps	147	185	226

ted for classification are not impacted by the addition of moisture at the lint slide area but the colour of the cotton in the bale after storage for several months changes.

Recent surveys of 20 cotton gins in the US that added moisture at the lint slide area indicated that gins that used the direct spray of water droplets produced bales over 7.5 per cent moisture over 25 per cent of the time. When excess moisture is applied at the gin, bales lose weight

during storage. Merchants have recently reported losses of 10 pounds or more per bale between the gin and the textile mill.

The resistance-based moisture sensors do not work well when water droplets are sprayed directly on the surface of the fibre. So we developed a hydraulic-based system that estimates bale moisture nearly as well as the oven-based system for bales without moisture added or for bales with humidified air added.

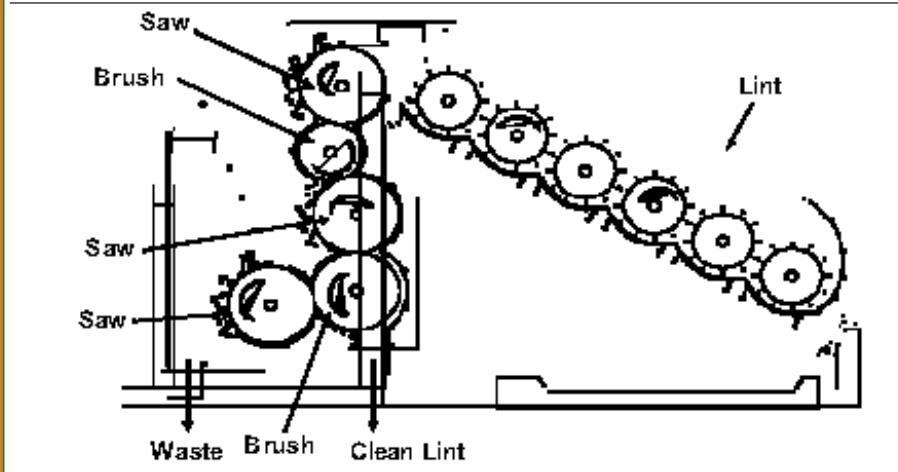
And it performs much better than the oven-based system for bales with water droplets sprayed directly on the fibre.

**The future**

The recent increase in cotton exported by the United States from six to 14 million bales also presents a problem for cotton gins. Foreign markets generally require a higher quality of cotton than domestic markets. In order to meet demands of the foreign market, farmers must carefully select cotton varieties capable of meeting those demands, and gins must use all available technology as well as emerging technologies to ensure that market demands are met. Cotton fibre should be ginned with minimal drying and temperatures controlled at below 121°C.

The minimum lint cleaning machinery required to achieve the desired leaf grade must be used. Bales should be stored at less than 7.5 per cent moisture to avoid fibre degradation. Computerised gin process control systems such as IntelliGin and prescription lint cleaning available as LouverMax are critical components for meeting both foreign and domestic requirements while ensuring adequate monetary returns for the farmer. In addition, other

**FIGURE 8: New lint cleaner consisting of a modified cylinder cleaner coupled with a lint cleaner saw and a secondary saw to prevent excessive fibre loss as well as a final cleaning saw was developed at Stoneville to reduce fibre loss**



new ginning technologies are required.

New lint cleaning technologies (Figures 7 and 8) that may prove helpful were recently developed at Stoneville. Most have been field tested and will be available to industry soon. These new lint cleaners reduce fibre loss dramatically (50 to 80 per cent). Some of the new machines are very effective in processing waste from lint cleaners and gin stands to recover good fibre.

The article is based on a presentation at the 2005 Australian Cotton Shippers conference. The presentation is available on the ASCA website [www.australiancottonshippers.com.au](http://www.australiancottonshippers.com.au)

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