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Preserving Quality from Seed to Harvest

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A frequent criticism of U.S. cotton, asserts that modern production practices such as high inputs, defoliation and machine harvesting reduce quality below that of foreign cotton grown under subsistence agriculture and hand picked without harvest aids. As the U.S. starts another harvest of bumper quality cotton, it is useful to look back at where that quality originates — modern technology in the hands of quality conscious producers.

Why preserve Quality

Cotton production is unique among all of the other field crops, in that quality plays a dominant role in producer decisions all season long. Corn, soybean or rice producers rarely discuss oil quality when selecting the variety to plant — it is yield that concerns them. And when decisions are made to fertilize or prepare the crop for harvest they don't consider the effects on grain quality — it is cost that concerns them. This is where cotton is unique, for at every step of the production system not only does the marketing system reward the enhancement and preservation of quality but also producers take the opportunity to build quality into their final product, the bale.

With the expansion of High Volume Instrumentation (HVI) testing to the entire U.S. crop in 1991 and the further refinements of HVI to encompass separate color and trash grades in 1993 has come the ability of textile companies to select premium qualities, letting the market reward these bales if in short supply, or to select lower grade cotton that still meets their needs for strength, length, uniformity and maturity. These premiums and discounts in the market place, now passed on through HVI, give producers strong incentive to focus on the production practices that enhance and preserve quality: variety selection, production inputs and harvest preparation.

Importance of the Variety

Of all the activities a producer performs during the year, the most critical for yield and quality is varietal selection. Since cost differences from one variety to another are minimal, most producers select the variety that will give them the greatest combination of yield and quality. Only recently have all of the major U.S. growing areas had access to varieties with both top yield and top quality.

Those quality factors most closely controlled by biochemistry or physiology of the plant and not by the growing conditions will be those traits most influenced by variety selection. For example: fiber strength appears to be controlled by the length and orientation of cellulose molecules in the fiber. If the cellulose molecules in a fiber are long, that fiber will be strong — similar to the way that long fibers increase yarn strength in ring spinning.

Other important traits controlled primarily by the variety include fiber length and fineness. Producers (and textile mill owners) are indeed fortunate that the most important fiber quality traits — strength, length and fineness — can be guaranteed just by the simple act of selecting the right variety. This guarantee holds up even under extreme adverse weather. Last year, the Texas High Plains crop suffered severe yield loss due to insects and rain, yet the strength continued its upward climb (25.6 average g/tex in 1989, 26.1 in 1990 and 26.5 g/tex in 1991).

So strong is the control of variety over these important quality parameters that even before HVI, variety restrictions were used by San Joaquin Valley cotton growers to insure that all the bales produced in that region contained high-strength, long-staple cotton. Marketing based on variety is catching on in other high quality producing areas, where producers plant and grow large lots of uniform, high-quality cotton for sale to textile mills that need that added guarantee that control over the variety gives them.

Maximum Yield

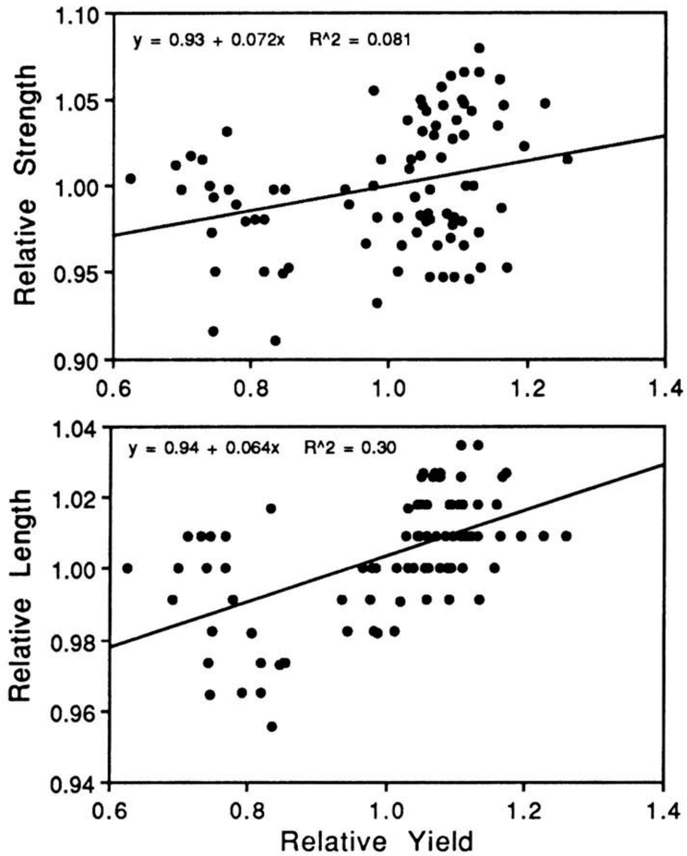
Even after the variety is selected and planted, cotton's unique production pattern continues. Most of the important production decisions with corn, beans, rice, wheat and other field crops are over by the time seed is placed in the ground. This is not so with cotton. Production decisions are predominately made during the growing season which allow producers to match inputs to the developing crop and weather. Producers use this in-season control over the plant to farm cotton in the new system of "non-stress production".

Historically, cotton throughout the world has been produced under a system of season-long stress: planting seeds early when it is too cold, letting the plant suffer from nutrient deficiency and water stress and finally attempting to mature bolls late in the cold wet fall. This system of cotton production was adopted because the tough nature of the cotton plant allowed some production under continual stress and producers did not have the tools necessary to produce cotton under a non-stress production system. These tools are available in the U.S. and include:

- Fast fruiting varieties to allow delayed planting until the weather is warmer.
- Soil and tissue monitoring to match fertilizer to crop needs.
- Irrigation systems to relieve drought stress during bloom.
- Harvest aids to prepare the crop for picking, instead of waiting until the frost opens the bolls and drops the leaves.
- Plant growth regulators to control plant height of healthy, rapidly growing, non-stress cotton.

As expected, with this system of non-stress production came increased yields due to the healthier plants. But not expected, was the increase in quality, that came with non-stress production. Bolls developing on healthy plants produce longer, stronger and more mature fiber. Fortunately for the entire cotton industry, when producers strive for maximum yield they also are striving for maximum quality. This is demonstrated in the figure below that displays the strength and length for San Joaquin Valley fields compared with their yield. As the farmer lessens the stress on the plant, yield and quality respond to everyone's benefit.

Yield vs. Strength or Length of Acala Varieties grown in the San Joaquin Valley (Bassett 1988).



Invariably, the top producing areas of the U.S. also produce the highest quality fiber. The role of production tools to simultaneously increase yield and quality is displayed in the adjacent diagram.

Harvest aids and harvest preparation are the final component of the production program that simultaneously increases yield and quality.

Harvest Preparation

Nowhere are the differences between cotton and other field crops more apparent than in the yields produced in relation to the length of season and the role that harvest preparation plays in maintaining quality. U.S. cotton returns on average less than 1 ton per acre (seed and lint) from a growing season which covers the 5 warmest months of the year. Over that same time period, corn produces 3 tons on average and rice 2½ tons. Wheat produces 15 percent more than cotton even though wheat is grown in the coldest months of the year.

Enhances Yield	Enhances Quality
Irrigation:	
maintains leaf health	late-set bolls fully develop
promotes boll retention	keeps micronaire moderate
increases cell and plant size	creates longer fibers
Potassium Fertilization:	
supplies developing bolls	promotes long and strong fiber
maintains leaf health	allows top bolls to mature
Nitrogen Fertilization:	
increases boll retention	keeps micronaire moderate
regulates plant size	brings micronaire into the premium range
Plant Growth Regulators:	
minimizes boll rot	lessens weak and deteriorated fiber
promotes early boll set	reduces field weathering
Pest Control:	
prevents leaf damage	lessens immature fibers
prevents boll damage	reduces fiber deterioration

Cotton's low yield and special requirements for harvest stem from its growth pattern. Unlike corn or wheat or rice, cotton is a perennial shrub and puts more of its energy into building roots, stems and branches (these structures in wild cotton would support growth for the following year). Other crops prepare themselves for harvest by naturally senescing (growing old), shedding leaves and drying down. Cotton, on the other hand, must be coaxed into stopping its growth, focusing on the maturing of existing bolls and forgetting about continued vegetative and fruit growth. In practice we coax cotton into harvest with cold weather that injures the plant or by cutting off its supply of nutrients or water and by applying harvest aids that hasten leaf senescence. Without this coaxing, cotton would continue to grow allowing late season insects and diseases to proliferate, thereby disrupting yield and quality.

In the desert west, preparing the crop for harvest is relatively straight forward. Producers curtail irrigation, allowing water stress to slowly build in the cooling fall. Water stress first curtails growth, then it senesces the leaves and speeds the opening of the last few bolls. To insure the cleanest possible harvest (especially in wetter parts of the field), defoliants are applied to remove any leaves left on the plant. This harvest preparation process in the desert west results in very clean cotton (for 1991 over 85 percent of the bales from California and Arizona were middling or better) and few short fibers since drying and lint cleaning in the gin can be reduced (average uniformity of 82.1 in 1991).

Harvest preparation in the rainbelt is more difficult. Although harvest is timed to occur in the driest months — from July in the Lower Rio Grande Valley to November in the High Plains — unseasonal rainfall may prevent the plant from adequately drying for harvest. In the rainbelt, producers must prepare the plant for harvest by letting it run out of nitrogen — the main nutrient used by the plant. Producers here apply substantially lower rates of nitrogen fertilizer (half of that used in the desert west). A gradual increase in nitrogen deficiency at the season's end performs the same roles that water stress does in the west — growth is curtailed, leaves are senesced and boll opening is speeded.

In both regions the objective is the same — reduce the amount of new growth and leaves that decrease quality. Late season leaves decrease yield and quality by physically interfering with picking, staining the lint and adding moisture to the seedcotton (which promotes rot in the module and requires more heat in the gin). In addition leaves support late season insects — worms, aphids, whiteflies — which damage yield and quality by physically feeding on developing bolls and secreting honeydew that can cause stickiness. When leaves remain on the plant, the restricted sunlight and air movement may result in boll rot which damages yield and quality by degrading and staining the fiber in lower bolls. Defoliating the fields is the most effective method to control late season insects and diseases.

The cotton market provides strong incentive for producers to manage their fields closely at harvest. Maximum economic return is attained by allowing the bolls set on the plant to reach maturity and maximum weight and by preparing the crop for the cleanest and most complete leaf drop producing high grade cotton which requires reduced gin lint cleaning.

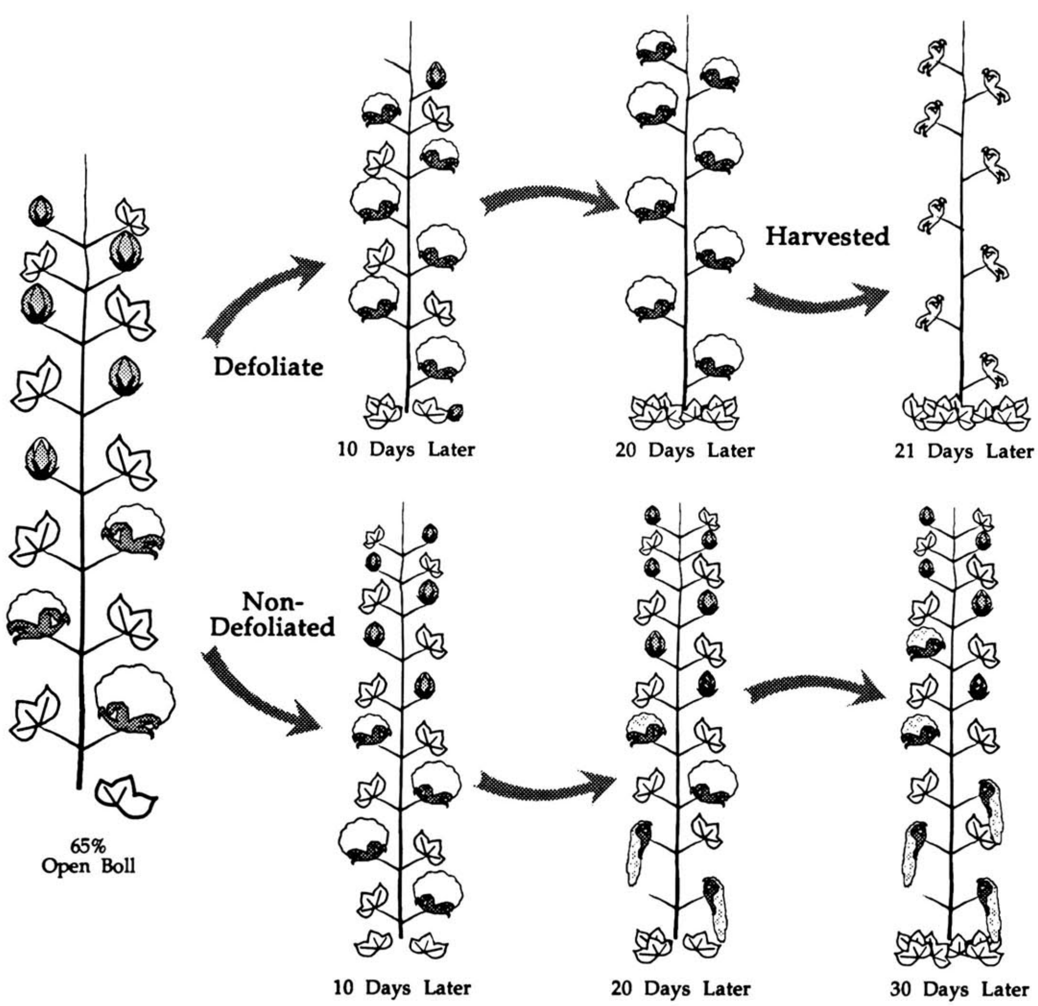
Quality preservation is almost an instinctual part of U.S. cotton production. U.S. producers have learned that maximum profit in variety selection, field management and harvest preparation also brings top quality in the finished bale. With the additional scrutiny of HVI on each and every bale, the textile mill and the grower have a written report of how well that lesson was learned. The quality trend in recent crops is testimony that this is one lesson well-learned.

Nodes Above Cracked Boll

A new addition to the tools to time defoliation has arrived in the cotton field, Nodes Above Cracked Boll (NACB). This tool (based on research by Tom Kerby, James Supak, J.C. Banks and Charles Snipes) allows producers to predict how much yield is sacrificed with premature defoliation.

The developmental status of all the bolls on the plant are related based on their plant mapping position. We can estimate boll maturities based on position and the days between events. Since an early set boll matures in about 45 days after bloom and a new node develops about every 3 days during that same time period, the number of nodes to mature a boll from bloom is 15 (45 days/3 days per node = 15 nodes). The per-

Defoliation prepares the crop for harvest and preserves quality.



cent boll growth per node can be estimated by dividing 100 percent by 15 to arrive at a change per node of 6.67. In other words, the first position boll 2 nodes up is 13% less mature.

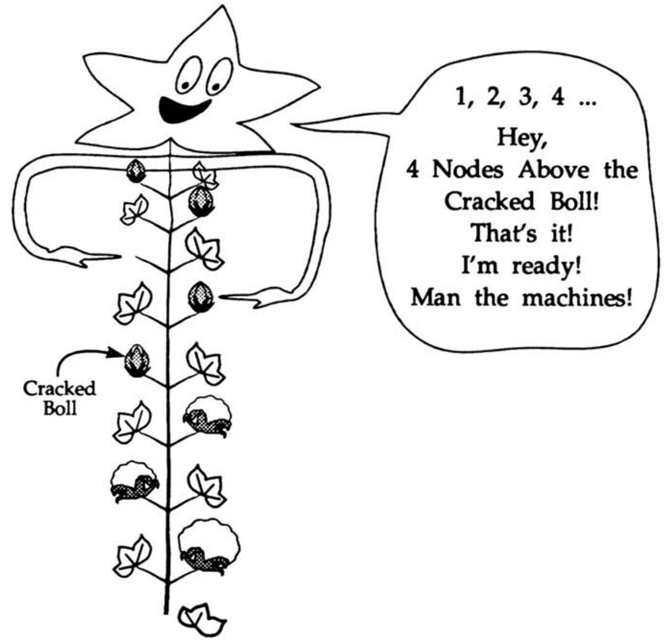
Three years of field trials in 4 states provides the data to actually calculate the reduction in weight by node up the plant. A remarkably close 6.68 percent was determined, starting from the third node above the cracked boll. A cracked boll is defined as the one with some visible lint but not enough to grab with a spindle. Under humid conditions, there may be 2 1st position cracked bolls on the same plant. Count from the highest one.

How can this information be used? The following table lists the percent weight loss due to premature defoliation for a 1st position boll located a specified number of nodes above the 1st position cracked boll at the time of defoliation.

2 nodes	0.0%
3 nodes	1.3%
4 nodes	8.0%
5 nodes	14.6%
6 nodes	21.3%
7 nodes	28.0%
8 nodes	34.7%

Most fields set a high percent (85% or more) of the late season bolls at the 1st position, the fruiting branch position closest to the mainstem. These fields can be safely defoliated when the top-most 1st position harvestable boll is only 4 nodes above the 1st position cracked boll. In fields with a significant percent of late maturing plants or late bolls not on the 1st position, it would be more conservative to wait until the top-most 1st position harvestable boll is at 3 NACB. Determine the average NACB of the top harvestable boll by walking into 4 parts of a field, finding 10 plants with a cracked boll and counting the nodes above to the top-most 1st position harvestable boll.

Just like any other new technology, it is imperative that producers ease into it slowly, evaluate fields based on both NACB and the traditional percent open or sharp knife techniques. NACB was not designed to replace these, only to supplement them, especially where yield loss from premature defoliation needs to be estimated.



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