



COTTON

Review of the World Situation



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International Cotton Advisory Committee

The International Cotton Advisory Committee (ICAC) is an organization of member countries that share an interest in cotton and the textile value chain. Formed in 1939, it is the only intergovernmental body for cotton producing, consuming, and trading countries and is one of only seven International Commodity Bodies recognized by the United Nations.

ICAC acts as a catalyst for positive change in the cotton and textile value chain by helping member countries and stakeholders support and improve the global cotton economy. ICAC accomplishes its mission by providing transparency to the world cotton market by serving as a clearinghouse for technical information and analysis on cotton production, consumption, and trade and by serving as a forum for discussing and addressing issues of international significance.



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After the Gin: Where Brazil's Cotton Competitiveness Is Actually Decided



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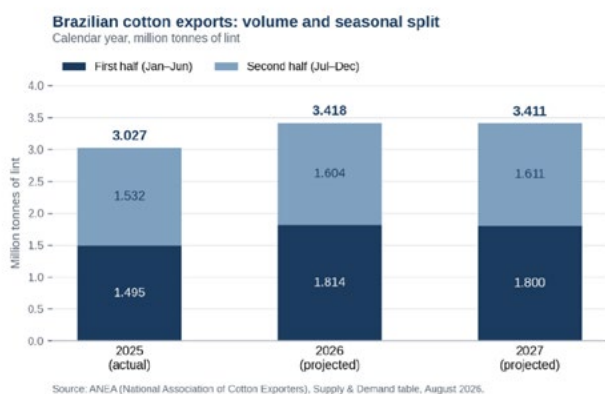
Brazil earned global leadership in cotton exports in the field. It will defend that leadership in the corridor.

Over the past two decades, the competitive gains of Brazilian fiber came from productivity, seed technology, crop management and a quality program that turned the country into a reliable supplier to the world's most demanding spinning mills. That work is consolidated. What is less consolidated — and now weighs more on the exporter's margin than an additional percentage point of yield per hectare — is what happens to the lint between the gin and the vessel.

Within that stretch, which can run to more than 2,000 kilometers of road, lie a terminal window disputed with other cargoes, a container that must be available at the port, a vessel call that may simply not happen, and a set of documents that, if late, generates cost in dollars. None of these variables appear in the crop report. All of them appear in the bottom line.

Nor is this an isolated concern. In November 2024, the Santos Trade Association (ACS), ABRAPA (through the Cotton Brazil program), ApexBrasil and ANEA brought the supply chain together at the 1st Cotton Day Santos

to discuss precisely this: port capacity, container availability, operational efficiency, coordination among government agencies, and shipment predictability. A second edition, in June 2026, returned to the same agenda. That same month, Cotton Connect gathered more than 100 professionals from 25 companies in Santos — growers, merchants and logistics operators — for two days devoted to the bottlenecks of moving the fiber through the port. The industry has opened this agenda. This article attempts to advance it.



The corridor

In practice, Brazilian cotton logistics is organized into two corridors, each with dynamics of its own.

The first links Mato Grosso to the Port of Santos. It is the dominant and the longest one: journeys that can exceed 2,000 kilometers, mostly by road, crossing the Center-West at the very time when soybeans and corn are competing for the same trucks. According to the Mato Grosso Institute of Agricultural Economics (IMEA), Santos concentrates around 95% of Brazil's cotton export volume — a concentration that is, at once, evidence of efficiency and of exposure. In physical terms, that means between 110,000 and

120,000 containers of cotton leaving Santos every year, roughly 9,000 a month.

The second links western Bahia to the Port of Salvador. It is shorter, less congested and has been gaining share consistently in recent years.

The difference between the two is not only distance. It is seasonality. Brazilian cotton is harvested and moved within a window that collides with the export peak of second-crop corn. That overlap is the structural fact from which nearly all the bottlenecks described below derive.

And volumes keep growing. According to the National Association of Cotton Exporters (ANEA), Brazil exported 3.027 million tonnes in 2025 and is expected to reach 3.418 million in 2026, a new record — a projection revised upward in August, alongside a 2025/26 crop now estimated at 4.178 million tonnes of lint. In the 2025/26 season, Brazil set monthly export records in seven of the twelve months. For 2027, the association already projects 3.411 million tonnes.

The bottlenecks

Truck scarcity at the peak. When the shipping window opens, the exporter is not competing on road freight price — it is competing for truck availability. The fleet is the same one that serves grains, and grains carry larger volumes and longer contracts. The result is an origin-to-port freight cost that rises precisely in the weeks when cotton needs to ship, and that is not negotiable at the moment it occurs: it is a function of physical scarcity, not bargaining power. The seasonality of agricultural road freight is measured

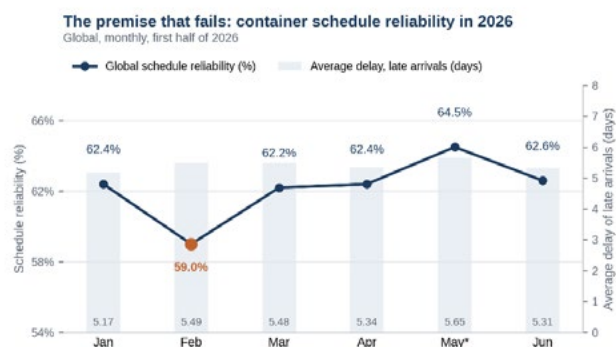


and published monthly by Sifreca, run by the ESALQ-LOG group at the University of São Paulo, which tracks the rates actually charged on the country's main routes.

Who bears that cost depends entirely on contract design. In many cases, the grower or the merchant absorbs in full a swing that could have been mitigated by contracting earlier.

Shipment predictability. This is where the data is most uncomfortable. According to Sea-Intelligence, global schedule reliability for container lines stood at 62.6% in June 2026, down 4.7 percentage points year on year; in February of the same year, the index fell to 59.0%, its lowest level since April 2025. The average delay for late vessel arrivals exceeded five days.

Translated into operations: an exporter who plans a shipment assuming the schedule will be met is working with a premise that fails in roughly four out of ten cases.



Source: Sea-Intelligence, Global Liner Performance report, issues 174–179.
* May 2026 derived from the month-on-month change reported in issue 179.

It is worth separating two things that are usually treated as one. Installed capacity and operational predictability are different problems, with different solutions and different timelines. Capacity is solved with construction, investment and a long horizon — and a significant port investment cycle is under way in Brazil. Predictability is solved with management, information and a short horizon. Both matter, but it is the second that decides the margin of the crop being shipped right now.

Detention exposure. The most expensive consequence of unstable schedules is also the most silent one. When a shipment is rolled from vessel to vessel, the container stays with the exporter — and free time keeps running. It is not unusual for a cargo to go through several rebookings before it actually sails. Each one pushes the exporter closer to the end of free time, and the cargo reaches the vessel already carrying an accumulated liability that has nothing to do with the efficiency of the exporter's own operation.



That cost is rarely priced into the sale. It shows up later, as a surprise, and becomes a case-by-case negotiation with the carrier under poor bargaining conditions.

Documentation timing. Export cotton is documentation-heavy cargo: quality certification, phytosanitary requirements and destination-specific rules. A document presented outside the carrier's window generates extra cost in dollars on a shipment whose margin was set months earlier, when the fiber was sold. It is the kind of loss with no upside — nothing is gained by presenting on time; loss is merely avoided.

Where there is room to gain

Port diversification. The 95% concentration in Santos is efficient while Santos runs well, and expensive when it does not. But diversifying does not mean redirecting Mato Grosso cotton to another port: the distances do not add up. It means recognizing that Bahia has a corridor of its own — shorter, less congested and still operating below its potential. Salvador has been gaining share consistently and is undergoing an expansion that should double its capacity.

The real opportunity, therefore, is not to reduce Santos — it is to use Salvador to the full

measure of what Bahia produces. Every Bahian tonne that leaves through Salvador is a tonne that does not compete for windows, trucks and equipment in Santos at the height of the season. Both corridors gain at once.

Planning as a discipline, not a reaction. This is the central point of this article.

Most of the costs described above are not caused by poor execution. They are caused by late decisions. Port and shipping window defined after the bottleneck has appeared. Ocean freight negotiated without regard to the route's historical reliability.

Cotton logistics planning should begin at the very moment the fiber sales contract is signed — because that is when degrees of freedom still exist. From then on, every passing week narrows the set of available choices and shifts risk onto the exporter. Those who treat logistics as a consequence of the sale pay the price of scarcity. Those who treat logistics as a variable of the sale are able to price it.



Contract design. It follows from the previous point. It is worth stating explicitly, in the contract, who bears the cost of rebooking and detention when the cause lies with the carrier or the terminal, and what free time is adequate given the route's historical reliability. These are examples of clauses that cost nothing to negotiate before — and a great deal to negotiate after.

What to watch in 2027/28

Route geopolitics. Brazilian cotton's main destinations are served by routes that cross or skirt the Middle East. In June 2026, Bangladesh, Türkiye, Pakistan and Vietnam together accounted for 71.1% of Brazilian shipments. Escalating tensions in the region have produced booking stops, revised schedules, war risk surcharges and a return to routings via the Cape of Good Hope.

For the Brazilian exporter, this means longer transit times, surcharges and less predictability precisely in the destinations that concentrate most of the volume. It is the variable with the widest range and the least control on the horizon — and the one least amenable to internal planning.

Port capacity. Container throughput at Brazilian ports reached 15.3 million TEU in 2025, up 10.2% on 2024, according to ANTAQ, Brazil's national waterway transport agency. The infrastructure response is under way: in Salvador, Brazil's national development bank (BNDES) approved, in November 2025, a R\$848 million financing package expected to take the container terminal's capacity from 553,000 to more than 1 million TEU a year; in Santos, terminals remain in a cycle of expansion and automation. The relevant question is not whether capacity

is coming, but whether it arrives before the next demand peak — and what the exporter does in the meantime.

Traceability moving into the corridor. The sustainability and traceability debate is no longer confined to the farm. The ABR-LOG certification, run by ABRAPA, covers precisely the off-dock terminals responsible for stuffing containers with bales — meaning the socio-environmental requirement has already formally reached the logistics leg. Tracing a bale to a garment requires records at every transshipment, every warehouse and every terminal. This stops being a matter of farm certification and becomes a requirement of the logistics system. Origins that solve this integration first will have access to buyers that others will not.

Conclusion

Brazilian cotton's competitiveness was built in the field and is decided, increasingly, in the corridor. The gains available today do not lie only in producing more fiber per hectare — they lie in losing less margin between the gin and the vessel.

Part of that margin depends on infrastructure, and the infrastructure is coming. But construction has a timeline of its own, and the crop does not wait. The other part depends on anticipation — deciding the route earlier, negotiating free time earlier, designing the contract earlier — and that part is executable within next season. The two agendas run in parallel; only one of them is under the exporter's control.

Brazil will not lose its cotton export leadership to another producing country. If it loses margin, it will lose it to its own corridor.

All photos: Magna Logistics Solutions



Cotton at the Crossroads

A Broker's Perspective on Price Risk and the 2026–27 Outlook



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Market reference 15 September 2026

From a broker's seat, the current cotton market is being asked to price two conflicting facts. The global balance sheet is tightening, but physical supply is becoming more available across origins and across the calendar. December 2026 futures rose from a life-of-contract low near 66 cents per pound to a recent high near 93 cents before giving back roughly nine cents. The move shows how far futures can travel before the textile chain adjusts. The fundamental backdrop is con-

structive. USDA's September projections put 2026/27 world production at 117.3 million bales against consumption of 122.9 million, leaving a projected 5.6-million-bale gap. That deficit supports a firmer market, but prices must still ration demand, draw stocks, encourage production or move supply between origins and delivery periods.

My view is constructive but cautious. Cotton can test higher levels if crop risk, commercial fixing flows and speculative demand meet together; in part what brought Z26 up to 93.

Price Volatility Has Returned

The August rally showed how quickly the market can change character. December futures moved toward 93 cents, then fell sharply as funds took profits, the dollar strengthened and part of the weather premium was removed, at least for now. The September correction thus far showed that a supportive balance sheet does not prevent aggressive liquidation.

The correction also exposed the tension between futures and cash. The nearby December 2026 and March 2027 spread reached full carry even while certified stocks remained low but available. The market is paying 2.5 cents to carry cotton forward instead of bidding aggressively for nearby ownership. That is not a clean scarcity signal.

This is where demand elasticity matters. At higher prices, mills can delay coverage, reduce inventories, shift origins, draw on reserves or accelerate polyester substitution. A sustained rally will need evidence that mills are accepting higher replacement costs rather than waiting for a better buying opportunity.

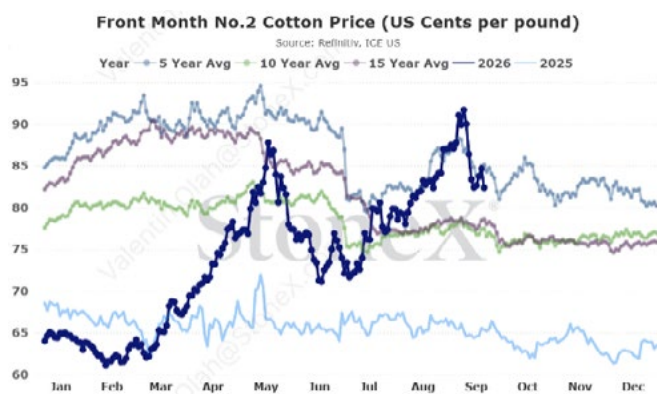


Figure 1. No. 2 cotton price performance in 2026 compared with recent seasonal patterns.
Source: Refinitiv and ICE US



Figure 2. No. 2 cotton prices remain above the ten-year average but below the upper-decile range.

Source: Refinitiv

The Polyester Alternative Is Also Repricing

Relative economics matter too. Polyester is not a fixed-price substitute for cotton: its cost curve runs from crude oil through paraxylene and PTA, with MEG as another important feedstock. Brent has recently moved back above \$100 per barrel as the Middle East war intensified. That shock raises the energy, feedstock, freight and working-capital costs embedded in synthetic fiber.

The supplied benchmarks show the pass-through across the chain. Paraxylene is marked at 9,406 after a roughly 27% rise over the chart's measured range; polyester fiber at 8,362 after a roughly 28% move; MEG has risen about 54%; and PTA has recovered to 6.3k after a 7.1k peak. The exact transmission is not one-for-one—capacity, inventories, currency and local basis matter—but the direction is important. Higher polyester replacement cost can slow substitution at the margin, although expensive oil also raises freight, inflation, financing and apparel costs. The effect is therefore medium-term relative support for cotton, not a stand-alone bullish demand signal.



Figure 3. Chinese polyester fiber futures have repriced sharply in 2026, raising the cost floor of the synthetic-fiber alternative.

Source: CZCE; chart by cmdtyView

The U.S. Balance Is Tighter but Uneven

The U.S. balance sheet has tightened more visibly than the global headline. USDA reduced 2026/27 production to 13.2 million bales and yield to 776 pounds per harvested acre. Ending stocks are projected at 3.6 million bales, with a 26.1% stocks-to-use ratio. U.S. mill use is only 1.5 million bales, so exports must carry most of the burden of using the crop.

The latest Crop Progress data sharpen the supply picture. As of September 13, 57% of the U.S. crop had bolls open, compared with 49% last year and 48% on average. That pace narrows the weather-premium window and points toward earlier harvest flow, but it does not establish yield or quality.

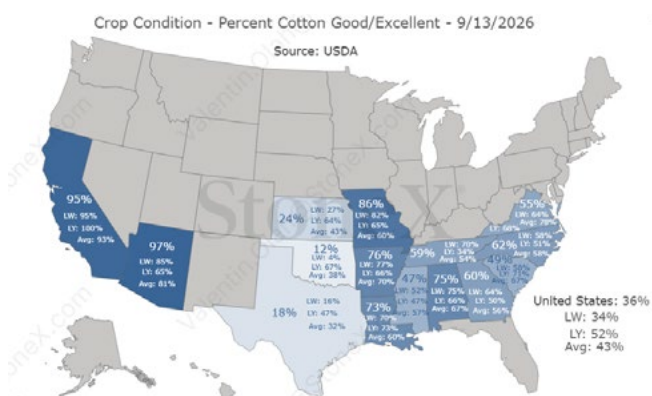


Figure 4. U.S. cotton condition shows a sharp regional split as of September 13, 2026.

Source: USDA

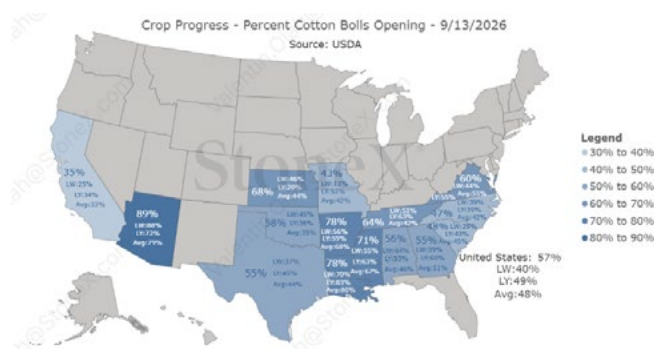


Figure 5. Boll opening is ahead of last year nationally, with especially rapid progress in Texas and Oklahoma.

Source: USDA

Only 36% of the U.S. crop was rated Good or Excellent, versus 52% last year and 43% on average. Texas was at 18%, compared with 47% last year and 32% on average. Fast opening in the Southwest may reflect heat and moisture stress rather than a large, well-filled crop.

The market is moving from the weather-premium phase to harvest confirmation. Final yield, abandonment, quality and ginning pace now matter more than the remaining weather window. Faster maturity limits new weather premium, while poor condition keeps supply risk alive. Volatility should remain two-sided.

Brazil Has Changed Cotton Seasonality

Brazil's expansion has changed the seasonal architecture of cotton. The industry once treated the interval between Southern Hemisphere harvests and new Northern Hemisphere supply as a period when readily available U.S. bales carried a special scarcity premium. Brazil's production, exports and logistics have made that intercrop gap easier to fill.

The result is a structural shift toward year-round availability. Mills and merchants have a more reliable alternative source through much of the year, reducing the premium attached to U.S. origin and making traditional seasonality less dependable. A smaller U.S. crop still matters for traceability, quality, timing and specific mill requirements.

The forward curve reflects this change. Dec26/Mar27 has reached full carry, while Dec/Jul is also on the carry side of its historical distribution, among the deeper carries of recent years. Accessible cotton across origins and time can prevent a persistent near-by scarcity premium, shifting the burden of adjustment toward demand and origin substitution.

Trade Flows Will Decide Whether the Deficit Becomes Support

The U.S. export program gives a mixed but not bearish signal. USDA estimates 2025/26 U.S. exports at 12.3 million bales, or about 27% of global exports. Early 2026/27 commitments were above last year's pace, led by Vietnam, Pakistan, Bangladesh, Mexico and India. That is encouraging, but weekly sales have not shown mills consistently chasing the board.

China's reserve auctions are another important flow variable. Full clearance of daily offerings confirms that Chinese mills are taking fiber at prevailing values while meeting part of their near-term requirement from domestic reserves. That can delay imported cotton demand without eliminating consumption. The timing and size of future releases will matter for Chinese buying and competing origins.

Policy can redirect trade just as quickly. India's textile sector has sought an extension of duty-free cotton imports beyond October 31, showing how sensitive mills are to raw-material costs.

Another policy variable is the proposed Buying American Cotton Act (BACA), H.R. 7230, introduced in January 2026 and referred to the House Ways and Means Committee. It would create a domestic cotton-consumption credit for qualifying products made with traceable U.S.-grown cotton. The scenarios in Figures 8 and 9 show its potential scale. The U.S. retail market represents about 20 million bales, of which roughly 4 million are supplied domestical-

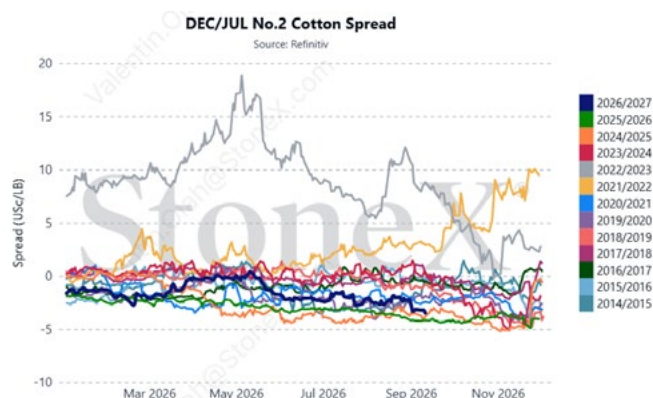


Figure 6. The longer Dec/Jul No. 2 cotton spread remains in carry, consistent with a full-carry nearby structure. Source: Refinitiv

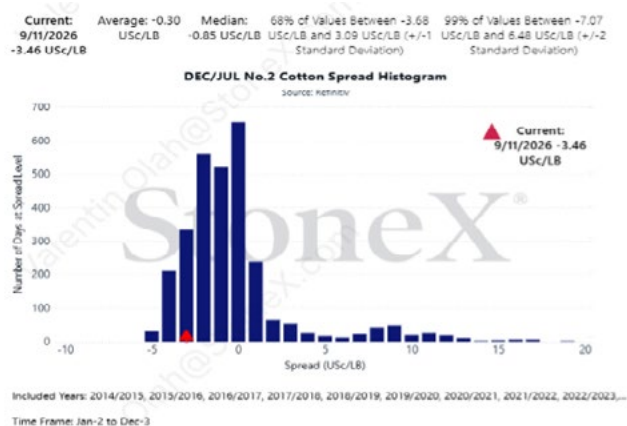


Figure 7. The current Dec/Jul spread is near the lower end of its historical distribution, but not an unprecedented extreme. Source: Refinitiv

ly and 16 million are imported. Redirecting 5% of those imports would add about 800,000 bales of domestic use; a 10% shift would add 1.6 million bales. Under the latest September WASDE, projected 2026/27 ending stocks are 3.6 million bales and the stocks-to-use ratio is 26.1%. Holding production and trade assumptions constant, a 5% shift would lower the ratio to about 19.2%, 10% to 13.0% and 15% to 7.4%. A 25% shift would require 4.0 million bales, exceeding projected ending stocks by 0.4 million. BACA remains a proposal, not a confirmed demand source, but it illustrates how a modest policy-driven change could materially tighten the U.S. balance.

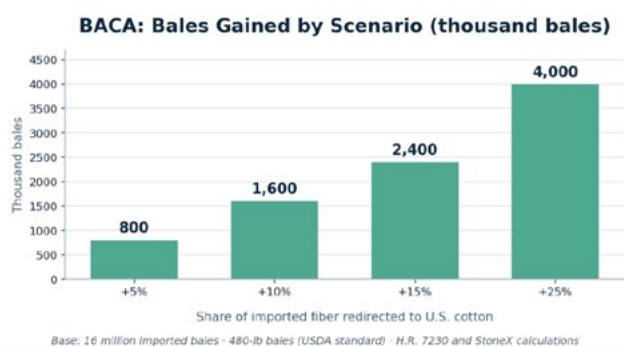


Figure 8. BACA substitution scenarios show the additional U.S. cotton use created by redirecting imported fiber.
Source: H.R. 7230 and StoneX calculations

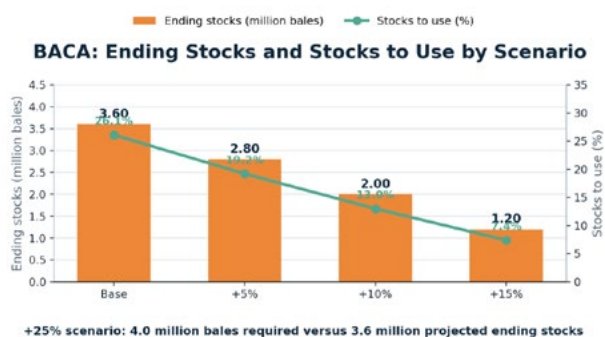


Figure 9. Using the latest September WASDE balance, even a modest substitution shift would draw U.S. ending stocks sharply lower.

Source: USDA WASDE September 2026 and StoneX calculation

The Futures Market Is Asking Who Will Sell

The most interesting feature of the market may be the positioning structure. Producers, consumers and merchants hold a futures short position equivalent to more than 60% of total open interest, while managed money has moved from a substantial net short earlier in the year to a large net long. Gross managed-money longs approach one-quarter of total open interest. This is a pronounced commercial-short versus speculative-long asymmetry.

That structure does not prove a squeeze, but it frames the risk-transfer question: if managed money keeps adding longs, where will the next futures sellers come from? Commercial shorts may cover when physical positions are fixed or transferred, while producers may delay hedging. If speculative longs keep adding as commercial sellers step back, prices can move in discontinuous steps.

Grower-to-merchant fixations help explain the recent behavior. As December moved through 78–82 cents, producers fixed meaningful volumes with merchants. Merchants carried the basis exposure and generally hedged by selling futures. That created natural futures supply during the move, but reduced uncommitted grower cotton available to sell into a later rally.

Brazil adds a more complex version of the same risk-transfer story. Brazilian growers use OTC accumulator structures, including contracts with Double-Up features. Details vary, but some structures can require the producer to commit twice the original vol-

ume when prices move outside the agreed range. That can leave less uncommitted cotton and less capacity to act as a natural seller during a breakout. It helps explain the absence of willing sellers outside the 78–82 range, but it is a market-structure effect, not proof of aggressive mill demand.

On-Call data show why fixing flows remain relevant. As of September 4, December had 28,119 unfixed call sales against 30,185 purchases, while March had 20,835 sales against 6,453 purchases. Across all reported months, sales totaled 79,814 against 65,989 purchases. Commercial price risk remains in the pipeline and differs by delivery month.

The ratio chart adds context. The current new-crop purchase-to-sales ratio is 0.54, below the ten-year reference near 0.75, while the total current ratio is 0.83. This is far below the high-ratio episodes associated with a heavy pipeline of unfixed farmer sales and fixation pressure on a futures recovery. On-Call data are therefore a positioning and timing tool, not a stand-alone bullish or bearish signal.

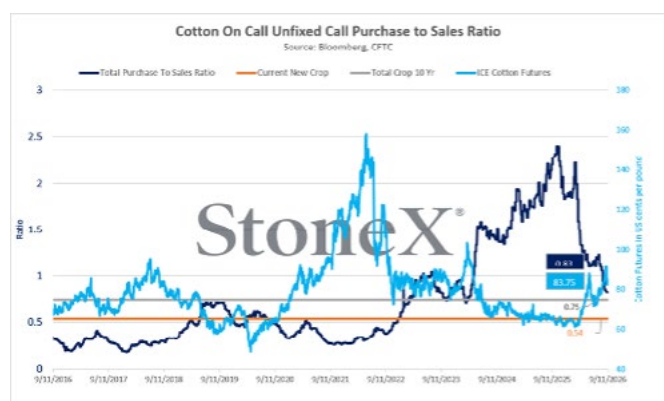


Figure 10. The current new-crop purchase-to-sales ratio is 0.54, while the total ratio is 0.83.
Source: Bloomberg and CFTC

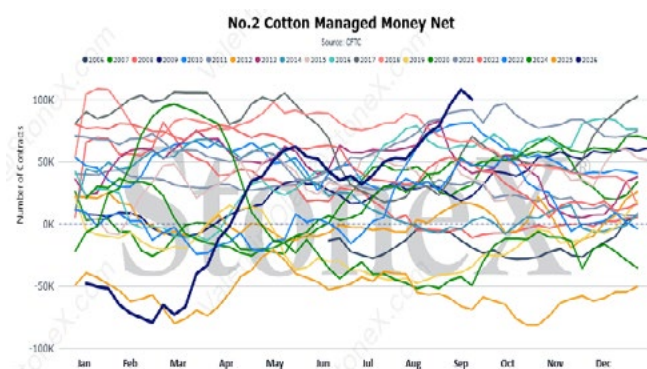


Figure 11. No. 2 cotton managed-money net positioning shifted from heavy selling early in 2026 to a large net long by September.
Source: CFTC

Outlook and Watchlist

The medium-term outlook remains constructive, but it is not unconditionally bullish. A world balance in which consumption exceeds production, a smaller U.S. crop, weather and quality uncertainty, tight certified stocks and a large commercial short position can support further upside tests. The market may need to reach a price high enough to ration mill demand and encourage future acreage, but not so high that mills accelerate polyester substitution, delay orders or rely more heavily on reserve and alternative-origin supply.

For the remainder of the season, I expect cotton to trade through phases of price discovery rather than follow a straight trend. The first phase is confirmation of U.S. harvest size and quality. The second is the interaction between export execution, commercial fixations and managed-money positioning. The third is the market's attempt to price the next planting decision. A sustained move back above 90 cents would require more than a supportive headline; it would likely need stronger export demand, additional crop deterioration or commercial buying that absorbs available futures supply.

Conversely, a failure to hold the mid-80s would leave the market exposed to a deeper fund-led correction toward the low-80s if new-crop supply is better than feared or mills continue to defer coverage. This is the demand-elasticity test now facing the market. The balance sheet can remain constructive while the futures market searches for a price that brings enough physical demand forward.

The most useful watchlist is cross-market and physical: U.S. ginnings and classing data; crop progress and weather in Texas and the Delta; certified stocks and the December-March spread; CFTC commercial and managed-money positioning; On-Call fixations; weekly export sales and shipments; Chinese reserve activity; Brazil's export pace; and the relationship between crude oil, polyester and cotton. Their value comes from showing whether futures are being confirmed by the physical chain or are running ahead of it.

The central message for growers, mills, merchants and traders is simple. Cotton is entering a period in which the cost of being wrong is rising while the market's signals are becoming more complex. The opportunity is real, but so is the risk of a violent correction. Participants who manage the transfer of risk deliberately will be better positioned for whichever side of the balance sheet the market chooses to test next.

Data References

Market data and chart sources used

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[USDA WASDE September 2026](#)

[USDA Crop Progress September 13 2026](#)

[CFTC Cotton Commitments of Traders September 8 2026](#)

[CFTC Cotton On Call September 2026](#)

[Refinitiv ICE US cotton futures and spread data](#)

[Reuters, Brent crude rises above \\$100 as Middle East conflict intensifies, September 9 2026](#)

[Buying American Cotton Act of 2026, H.R. 7230](#)



Ethiopia's Cotton Sector: Weaving a Future from Vast Potential



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Introduction

Ethiopia stands at a critical juncture in its economic development, with the cotton sector identified as a cornerstone of its industrialization drive. Blessed with an estimated three million hectares of land suitable for cotton cultivation, abundant water resources from major river basins, and a favorable climate, the country possesses the fundamental ingredients to become a major player in the global cotton and textile value chain. For decades, this potential has remained

largely untapped, with cultivation hovering at a fraction of its capacity. However, a renewed focus from the government, combined with strategic initiatives from the private sector and development partners, is beginning to transform the sector's landscape. This article provides an overview of the current situation and outlook for the Ethiopian cotton sector, highlighting the significant opportunities, persistent challenges, and the strategic path forward as we aim to build a resilient, sustainable, and globally competitive industry.

Current Production and Recent Trends

Historically, Ethiopia's cotton production has been characterized by significant fluctuations and underperformance relative to its potential. For many years, the area under cultivation stagnated at around 100,000 hectares, with yields well below international averages. This was largely due to a combination of factors including limited investment, a lack of focus on research and development, and the dominance of rain-fed agriculture, which left production vulnerable to climate variability.

The sector has been on a recovery path in recent years. After a period of decline due to the market fluctuation, less efficient marketing strategy in the cotton value chains, and global dynamism of global cotton price, severely affected key production areas like the Afar, Amhara, Benishangul and Gambela Regional State and a shift by some farmers to more profitable crops like sesame and other lowland crops.

The 2025/26 season has shown signs of significant recovery. The 2017 Ethiopian cal-



Figure 1. Ethiopian Cotton producing regions

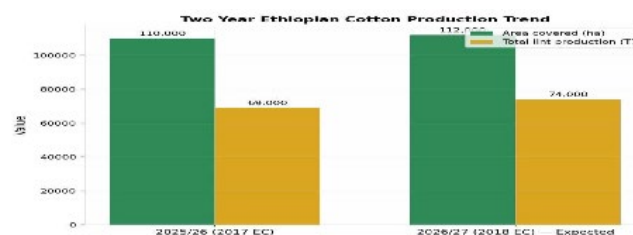


Figure 2a. Projected figures based on Ministry of Agriculture estimates.

endar year (2024/25 Gregorian) was a landmark season, with the government reporting a successful harvest that produced 1.9 million quintals (190,000 metric tons) of raw cotton from 110,000 hectares, that would help on meeting the quantity and quality requirements of local textile factories.

Looking at the current 2025/26 season, the outlook is positive. The Ministry of Agriculture projects a cotton harvest of approximately 74,000 metric tons from an estimated 112,000 hectares. This represents a notable increase in area and production, signaling a strong rebound and a commitment to expanding the sector. The government's import substitution strategy has been a primary driver of this focus, aiming to secure 100% domestic supply of cotton for the local textile industry to save foreign currency and guarantee national economic sovereignty. This strategy is creating a stable and growing domestic demand, which is a critical incentive for both large-scale commercial farms and smallholder farmers.

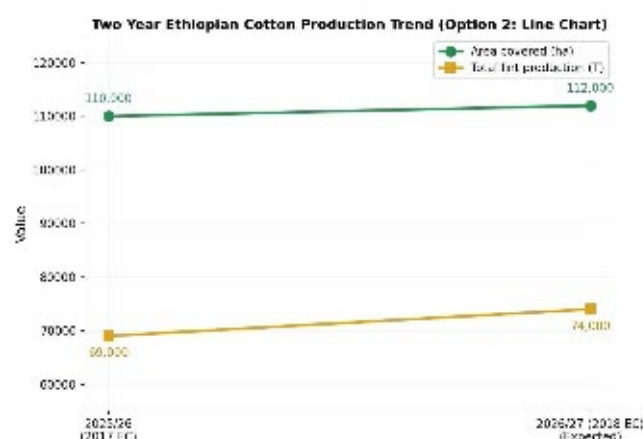


Figure 2b. Projected figures based on Ministry of Agriculture estimates.

Production is structured between two operational groups: smallholder farmers, who contribute approximately 26% of national seed cotton output, and medium-to-large commercial farms, accounting for the remaining 74%. Achieving sustained volume expansion requires moving from rain-fed farming to managed irrigation infrastructure in lowland river basins.



Cotton Quality, Processing, and Standardization

The Ethiopian Cotton Association I the last 2025/26 crop year has prepared a guideline on cotton quality and marketing strategy areas for its members and overall the cotton sector as well. Accordingly in the quality section ECA tried to address quality management in cotton farms, ginning and different logistic operations in the value chains.

Maximizing lint value requires implementing objective quality grading systems across production, ginning, and textile procurement.

The Ethiopian Cotton Association (ECA) introduced technical guidelines establishing

quality criteria and standardized marketing procedures. Commercial value determination uses High Volume Instrument (HVI) testing protocols. Fiber classification evaluates staple length, strength, micronaire, uniformity, short fiber content, and contamination levels.

No	Parameters	Grading			Weight Grade		
		A	B	C	A	B	C
1	Staple length	21	18	15	28.5mm and above	27mm-28.4mm	25mm-26.9mm
2	Micronaire	16	13	9	3.5-4.2	4.3-4.9	3.2-3.4 and 5-5.2
3	Strength	16	13	11	≥29g/tex	26-28.9g/tex	25-25.9g/tex
4	Stickiness (honey dew)	11	9	6	0-10	11-20	21-32
5	Short fiber content	6	3.5	2.5	≤10%	11%-12%	13%-14%
6	Trash content	10	8	4	Less than 3.5%	3.5%-4.5%	4.6%-5.0%
7	Moisture content	-	-	-	≤8%	≤8%	≤8%
8	Maturity Ratio	5	4	3	≥85%	81-84%	75-80%
9	Uniformity ratio	5	4	3	≥83%	81-82%	76-80%
10	Color	5	4	3	11-1 up to 21-4	31-1 up to 31-4	41-1 up to 51-4
11	Contamination	5	3.5	2.5	≤5 grams/bale	5-10 grams/bale	10-15 grams/bale
Total		100	80	59	PREMIUM	BASE	DISCOUNT

Table 1: Quality standards of Ethiopian cotton for price determination

Operations and Technical Parameters

Ginning efficiency directly affects downstream mill performance. Outdated processing machinery in regional ginning facilities can cause mechanical fiber degradation, shortened staple length, elevated short fiber content (SFC), and neps.

Moisture Range (%)	Impact on Ginning Efficiency	Impact on Fiber Quality	Recommendation and Consequences
Below 5%	High energy use for baling; facilitates cleaning for high leaf grade	High Damage Risk: Increased fiber breakage, neps, and short fibers	Avoid this range; prioritizes grade over functional quality.
5% to 7%	Optimal balance of cleaning and fiber preservation	Maximized Integrity: Maintains fiber length and strength; lowers neps	Target operational range; crucial for mill performance.
Above 7%	Reduces cleaning efficiency; increased energy costs	Risks discoloration, microbial activity, and spoilage during storage	Requires careful drying or humidified blending post-ginning.

Table 2: Optimal Moisture Management Guidelines for Cotton Ginning

Textile Mill Procurement and Lay-down Standards

To prevent fabric shade variation (barré) and maintain spinning efficiency, modern spinning facilities operate under Ethiopian Standard ES 6678:2021. Mills rely on HVI lay-down strategies adhering to strict tolerance thresholds:

Value Chain Structure and Byproduct Marketing

Value Chain Structure: Collection & transportation: for packing and transportation, cooperative unions are responsible. There are around 6 unions in the country with large membership that supports smallholder farmers in provision of information, technology and market to optimize their benefits. Most of them have their own aggregation stores. Market channels and relationship between actors: Based on the value chain mapping 4 market channels have been developed & listed below:

1. Input suppliers - small scale farmers - textile factories
2. Input suppliers - small scale farmers- cooperative unions - Ethiopian industry input supplier enterprise - textile factories/Ginneries
3. Input suppliers - medium commercialized farmers - Ethiopian industry input supplier enterprise - textile factories/ginneries
4. Input suppliers - large scale commercial farmers - textile factories/export market/

As we decrease the value chain length, we maximize profit, decrease raw material cost & carrying cost of the factory as well the pro-

ducer, and increases customer satisfaction as well. Till now, in Ethiopian scenario, there is no proper means of handling the value chain of cotton, so with the use of the discussed market channels, the value chain can be corrected.

Level	Constraints	Opportunities
Macro	> Lack of Market information > Lack of Finance > Lack of contractual production, marketing and standards > Lack of infrastructure > Limited research works	> The government settles the institution that leads the sector (Ethiopian Textile Industry Development Institute) > Minimum production cost
Meso	> Shortage of inputs (cotton seed, fertilizers, pesticides, etc) > Shortage of improved seed varieties > Bureaucratic procedures followed by the institutions	> Government incentives belonging to the sector > Benchmarking programs for the sector following international standards
Micro	> Inadequacy of support through service Co-operatives > Poor agricultural practices > Limited irrigation practices > Absence of extension services	> Country's better peace and stability > Availability of cheap and easily trainable manpower > Availability of land and good weather suitable for cotton cultivation

Table 3: Opportunity and constraints of the cotton value chain

Farm-level marketing historically faced price discovery challenges due to asymmetrical market information. A national pricing committee—comprising the Ministry of Agriculture, the Ministry of Industry, and industry stakeholders—establishes base prices tied to quality grades.

Byproduct Marketing

A critical but often overlooked aspect of ginnery marketing is the management of byproducts. Seed cotton typically yields 35-37% lint and 60-62% seed. Ginneries must establish formal linkages with the animal feed industry, cotton seed oil factories and other industries, to compensate for fluctuations in raw cotton prices directly impact the cost of producing these byproducts.

Byproduct	Primary Market	Value Proposition
Cottonseed Oil	Domestic Food Market	High demand; import substitution opportunity
Cottonseed Oilcake	Dairy and Livestock	Enhances milk viscosity and cattle health
Cotton Linters	Chemical and Industrial	Cellulose source for advanced manufacturing

Table 4: Cotton byproducts market opportunity

Seed cotton yields approximately 35–37% lint and 60–62% seed by weight. Developing structured byproduct marketing channels helps processing units offset seed cotton price fluctuations.

Research, Development, and Breeding Program Trajectory

Over the past several decades, the focus of cotton breeding in Ethiopia has been on improving seed cotton yield. However, more recently, efforts have expanded to include fiber quality and fiber yield attributes such as ginning outturn to meet both national and international fiber qualities standards.

National breeding efforts released 45 varieties over thirty years. Experimental yield performance demonstrates potential seed cotton yields up to 5,433 kg/ha (variety Arkebe), with lint turnout reaching 46.5%, compared to the standard national baseline of 37%. On-farm commercial small-holder productivity averages approximately 726 kg/ha of seed cotton, pointing to a large yield gap relative to research results.

To meet specialized high-count spinning requirements, research programs released *Gossypium barbadense* varieties WARC-LS1 and WARC-LS2. These extra-long sta-

ple (ELS) varieties deliver upper half mean lengths of 32.9–33.9 mm, micronaire values of 3.6–3.7, and fiber tenacity levels of 38.4–38.7 g/tex.

Key Opportunities Driving Growth

- **Policy Support:** The Homegrown Economic Reform agenda prioritizes cotton and textiles, supporting public-private alignment through the National Cotton Development Stakeholder Platform.
- **Domestic Demand Integration:** Local textile mills consume an estimated 55,000 metric tons of lint annually. Expanding domestic processing converts raw fiber into value-added finished products, reducing reliance on lint exports.
- **Irrigable Land Expansion:** Expanding irrigation infrastructure along major river basins offers opportunities to increase yields and reduce reliance on rain-fed systems.
- **Sustainability Frameworks:** Initiatives such as pilot projects under Cotton made in Africa (CmiA) and organic production programs align Ethiopian cotton with international standards.
- **International Partnerships:** Collaborations with development partners (such as GIZ) facilitate platform implementation, while initiating a formal engagement with the International Cotton Advisory Committee (ICAC) supports global best practices and standard adoption.

Strategic Challenges

- **Yield Gaps and Input Constraints:** Limited distribution networks for certified seed, high input costs, and inadequate



extension coverage contribute to low farm productivity. Pests and diseases affect yields, with up to 68 known pest species causing significant production losses if left unmanaged.

- **Quality Inconsistencies:** Contamination during manual harvesting, variable storage conditions, and aging saw-gin machinery create quality variation that leads some domestic mills to rely on imported lint.
- **Financial and Logistical Limits:** High capital requirements for land preparation, irrigation installation, and machinery acquisition challenge both smallholders and commercial investors.
- **Supply Chain Alignment:** Fragmented relationships between growers, ginneries, and textile operations lead to supply mismatches. Contract farming models offer a framework to align production directly with industrial demand.

Outlook for Coming Seasons (2026/27–2027/28)

The medium-term trajectory for Ethiopia's cotton sector points toward expanding production and deepening industrial integration. Building on the 2025/26 forecast, planned yield enhancements target raising total lint production to 74,000 metric tons for the 2026/27 cycle. Achieving these targets depends on expanding irrigation infrastructure, scaling up certified seed multiplication, enforcing HVI grading standards, and integrating sustainable production certifications across regional growing zones. Through structural alignment between agricultural production and domestic textile manufacturing, Ethiopia continues to strengthen its position within the African cotton economy.

Photos: Ethiopian Cotton Association





AGOA to 2028: Extension Without Full Reform



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On September 1, 2026, the U.S. House of Representatives voted 370–48 to include a two-year reauthorization of the **African Growth and Opportunity Act-AGOA** to a stopgap government funding bill, mirroring a 90–6 Senate vote from early August. The measure **extends AGOA’s duty-free access through December 31, 2028**, and now awaits the President’s signature. The program had lapsed entirely a year earlier, on September 30, 2025, and had been operating on a series of short-term extensions since. Against

that backdrop, the scale of bipartisan support for this extension is notable in a period when Congress has reached agreement on comparatively little.

Continuity of the program, however, should not be equated with the program functioning as originally intended. This renewal leaves substantial unfinished business in place: eligibility criteria that can shift with limited notice, rules of origin that have not been substantively revised in two decades, and an unresolved policy con-

flict between AGOA's stated industrial development goals and the interests of the U.S. secondhand clothing export sector.

Overview of AGOA's Legal and Institutional Structure

The **African Growth and Opportunity Act-AGOA** is U.S. domestic legislation, not a treaty or a reciprocal trade agreement. It was enacted by Congress in 2000, and its terms can only be amended or renewed by Congress and the President. Under the program, eligible sub-Saharan African countries may export a defined range of goods to the U.S. market duty-free, in addition to the roughly 5,000 products already duty-free under the Generalized System of Preferences (GSP). AGOA adds more than 1,800 additional tariff lines to that list, with apparel, ordinarily among the most heavily tariffed categories in the U.S. schedule, representing the program's most consequential addition.

AGOA differs from a standard free trade agreement in two main ways. First, it is non-reciprocal, meaning beneficiary countries receive preferential access to the U.S. market without having to lower their own tariffs on U.S. goods. Second, eligibility is conditional and reviewed every year. Countries must meet U.S.-defined criteria on economic policy, rule of law, worker rights, human rights, and barriers to U.S. trade and investment. Countries can lose eligibility if they fail to meet these criteria, and in some cases, eligibility has also been withdrawn because of broader policy disputes. As of the latest 2026 designation, 33 of the 49 potentially eligible sub-Saharan African countries qualify for AGOA benefits¹.

AGOA Eligible Countries – 2026

■ Not eligible ■ Eligible



It should also be noted that AGOA operates independently of comparable arrangements maintained by other trading partners. The European Union maintains its own preferential trade agreements with the region; China, as of May 2026, offers near-universal duty-free access to African countries with which it maintains diplomatic relations; and African countries are separately implementing the African Continental Free Trade Area (AfCFTA) among themselves.

A Volatile Reauthorization Process

The renewal also highlights one of AGOA's main weaknesses: uncertainty. The program lapsed at the end of September 2025 after

Based on the 2026 Federal Register AGOA eligibility list. Rwanda remains subject to suspension of AGOA apparel benefits. Angola, Benin, Botswana, Cabo Verde, Chad, Comoros, Democratic Republic of Congo, Republic of Congo, Côte d'Ivoire, Djibouti, Eswatini, Gabon, The Gambia, Ghana, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mauritania, Mauritius, Mozambique, Namibia, Nigeria, Rwanda, São Tomé and Príncipe, Senegal, Sierra Leone, South Africa, Tanzania, Togo and Zambia.

1 https://www.govinfo.gov/content/pkg/FR-2026-05-22/pdf/2026-10398.pdf?utm_

Congress did not act before the deadline, leaving exporters and importers operating without clarity until a retroactive one-year extension was signed in February 2026. A further extension to 2028 has now avoided another lapse, but the process shows how dependent AGOA remains on short-term political negotiations.



This matters because the value of AGOA depends on predictability. Exporters, buyers and investors need enough certainty to make decisions on sourcing, production, employment and investment. A two-year extension is better than another temporary lapse, but it still does not provide the long-term planning horizon that would be needed for AGOA to support deeper trade and investment decisions.

Assessing the Scale and Composition of U.S.-AGOA Trade

ITC Trade Map data show that the scale of trade between the United States and AGOA-eligible countries has changed considerably over the past two decades. U.S. imports from AGOA countries increased from US\$59.5 billion in 2006 to a peak of US\$85.1 billion in 2008, before declining sharply in subsequent years. After falling to US\$19.3 billion in 2015, imports remained broadly

in the US\$19 billion to US\$32 billion range through 2024, before rising to US\$34.2 billion in 2025. Despite this recent recovery, import values remain substantially below the levels recorded during the late 2000s and early 2010s.

U.S. exports to AGOA countries have been considerably less volatile. They rose from US\$11.4 billion in 2006 to US\$24.7 billion in 2014, before declining to US\$13.1 billion in 2016 and subsequently recovering. By 2025, U.S. exports to AGOA countries had reached US\$22.5 billion, their highest level since 2014. As a result, the U.S. trade deficit with AGOA countries narrowed significantly, from US\$67.0 billion in 2008 to US\$11.7 billion in 2025. Total two-way trade stood at approximately US\$56.7 billion in 2025, compared with more than US\$100 billion at its 2008 peak.

The composition of U.S. imports also shows a high degree of concentration. In 2025, precious stones and precious metals were the largest product category, at approximately US\$12.5 billion, followed by mineral fuels and oils at US\$6.6 billion and cocoa and cocoa preparations at US\$2.7 billion. Together, these three product groups accounted for approximately 63.5% of total U.S. imports from AGOA countries, illustrating the continued importance of commodities in the overall trade relationship.



Textiles and apparel represent a much smaller, but more manufacturing-intensive, component of this trade. U.S. textile and apparel imports from AGOA countries declined from approximately US\$1.4 billion in 2006 to US\$0.8 billion in 2010, before beginning a gradual recovery. Imports reached US\$1.5 billion in 2019 and a period high of approximately US\$1.9 billion in 2022, before moderating to US\$1.6 billion in 2025. U.S. textile and apparel exports to AGOA countries, by comparison, remained between approximately US\$0.1 billion and US\$0.3 billion annually throughout the period and stood at around US\$0.1 billion in 2025.



Trade values, however, should not be interpreted as equivalent to the economic value generated by AGOA preferences. A 2023 UNCTAD assessment estimated that AGOA has resulted in approximately US\$250 million to US\$300 million in tariff savings annually, or roughly US\$5 billion to US\$6 billion over 2001–2021. The distinction is important because some major exports from AGOA-eligible countries already benefit

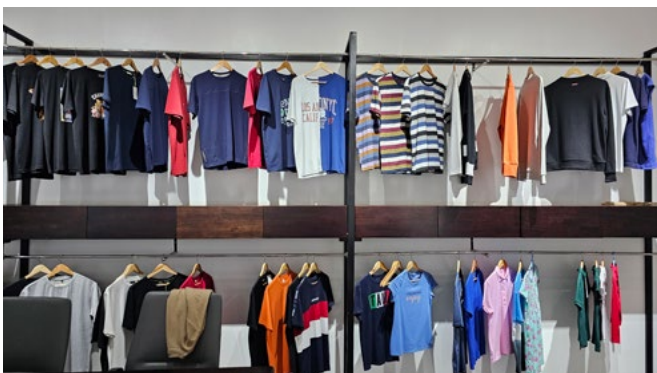
from low or zero U.S. most-favored-nation tariffs and therefore derive little or no additional tariff advantage from AGOA. UNCTAD notes that preferential access is of limited value where the normal U.S. tariff is already low or zero.

This is particularly relevant to the composition of current trade. South African exports of products such as platinum-group metals, for example, have historically included major tariff lines that already entered the United States duty-free on a non-preferential basis. AGOA's economic significance therefore varies substantially by product and country and is greater in sectors where U.S. tariffs would otherwise be meaningful, particularly apparel. Recent empirical research confirms that the effects have been uneven: while some studies have questioned the program's aggregate impact, other analyses find significant gains in apparel exports and positive effects for many beneficiary countries.

Taken together, the evidence suggests that AGOA's impact has been concentrated rather than uniform. It has provided meaningful market access in particular countries and sectors, especially apparel, while the broader U.S.-AGOA trade relationship remains dominated by a relatively small number of commodities and has not produced broad-based export diversification across beneficiary countries.

Second-Hand Clothing and AGOA Eligibility: A Persistent Policy Tension

The trade in second-hand clothing illustrates a longstanding tension within AGOA between maintaining access for U.S. exports



and supporting the development of domestic manufacturing industries in beneficiary countries.

In 2016, the East African Community (EAC) agreed to progressively phase out imports of used clothing and footwear as part of a broader strategy to strengthen the region's cotton, textile, apparel and leather industries. The EAC Heads of State directed partner states to procure textiles and footwear from within the region, where competitive supply was available, with a view to phasing out imports of used textiles and footwear within three years.



The initiative prompted opposition from the U.S. second-hand clothing industry. In 2017, the Secondary Materials and Recycled Textiles Association (SMART) petitioned the U.S. government to review the AGOA eligibility of Rwanda, Tanzania and Uganda, arguing that restrictions on used-clothing imports would harm U.S. exporters. USTR subsequently initiated an out-of-cycle eligibility review under AGOA, whose statutory criteria include progress toward eliminating barriers to U.S. trade and investment. Kenya was not included in the review after committing to reverse tariff increases and not proceed with a ban, while Tanzania and Uganda



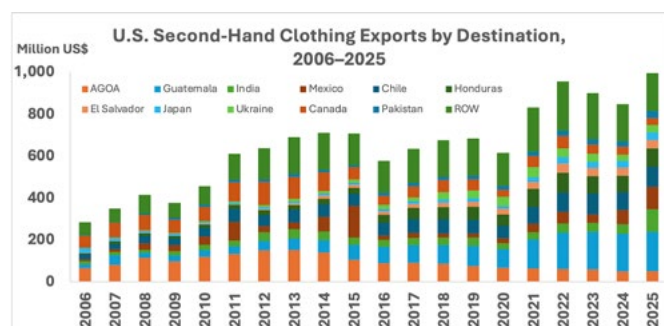
later made similar commitments. Rwanda maintained its restrictions.

In July 2018, the United States suspended duty-free treatment under AGOA for Rwanda's eligible apparel exports, rather than terminating Rwanda's participation in the programme altogether. Rwanda remained eligible for other AGOA benefits, while its apparel preferences were suspended. USTR continues to identify Rwanda as AGOA eligible but with its apparel benefits suspended. According to ITC Trade Map, U.S. exports of second-hand clothing to AGOA countries increased from US\$64.3 million in 2006 to a peak of US\$148.5 million in 2013. They subsequently declined to US\$104.5 million in 2015, US\$87.6 million in 2016, and US\$49.3 million in 2025. From the 2013 peak to 2025, exports to AGOA countries therefore fell by approximately 67%.

The trend contrasts sharply with overall U.S. exports of second-hand clothing. Worldwide exports increased from US\$282.4 million in 2006 to US\$688.3 million in 2013 and US\$993.7 million in 2025. As a result, AGOA countries' share of total U.S. second-hand clothing exports declined from approximately 22.8% in 2006 and 21.6% in 2013 to just 5.0% in 2025. By 2025, the United States

exported US\$186.8 million in second-hand clothing to Guatemala alone, almost four times the US\$49.3 million exported to all AGOA countries combined.

These figures point to a substantial shift in the geography of the U.S. second-hand clothing trade. They should not, however, be interpreted as evidence that the EAC initiative or the subsequent AGOA dispute caused the decline. U.S. exports to AGOA countries had already fallen substantially before the 2016 EAC decision, from US\$148.5 million in 2013 to US\$104.5 million in 2015. What the data demonstrate more clearly is that AGOA countries have become a much smaller destination for U.S. second-hand clothing at a time when the United States' global exports of these products have continued to expand.



What the 2026 Extension Leaves Unresolved

The 2026 extension keeps AGOA in place until December 2028, but it does not make major changes to how the program works. This is important because the United States had already started a discussion on how AGOA could be modernized. In April 2026, USTR requested public comments on possible changes to the program, including how to make trade more reciprocal, address barriers facing U.S. exporters and create more opportunities for U.S. businesses. However,

the legislation adopted in September mainly extended AGOA and its apparel provisions. It did not include a broader reform package. One unresolved issue is AGOA's rules of origin. For most non-apparel products, AGOA generally requires 35% of the product's value to be added locally. UNCTAD has argued that this requirement can be difficult to meet in modern supply chains, where inputs often come from several countries. The report points to other trade arrangements that use lower or more flexible thresholds. The main point is not that AGOA should adopt one specific new number, but that the current rule could be simplified and made easier for firms to use.

Another related issue is regional cumulation. AGOA already allows eligible countries to count inputs from other AGOA beneficiaries. UNCTAD has proposed going further by allowing inputs from all AfCFTA members, even if those countries are not AGOA beneficiaries. This could help companies build supply chains across Africa while still meeting AGOA requirements. It would also make AGOA more consistent with Africa's own regional integration efforts.

UNCTAD also notes that the main problem is not necessarily the number of products covered by AGOA. In many cases, the bigger challenge is whether firms can actually use the preferences available to them. Rules-of-origin requirements, compliance costs and other U.S. tariff measures can limit the benefits of AGOA even when a product is formally covered.

This has become more relevant because AGOA eligibility does not protect countries from all other U.S. tariffs. Some products

may still face additional duties under other U.S. trade measures, including Section 232 tariffs on certain metals and automobiles, or Section 301 measures linked to specific policy concerns. These measures are separate from AGOA, but they matter because an AGOA-eligible country is not automatically guaranteed duty-free access for every export. For this reason, the modernization debate is not only about extending AGOA. It is also about making the program easier to use, aligning it better with African regional value chains and clarifying how AGOA works alongside other U.S. trade measures. The September extension did not resolve these questions, so they are likely to remain part of the discussion before the new December 2028 deadline.

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Challenges, Opportunities and Innovations of Cotton Cultivation and Production in Iran



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Introduction

Cotton has long been an important agricultural, commercial and industrial crop in Iran, providing raw material for the textile sector while generating income and employment throughout its production chain, including within the rural areas. Iran has a long history of cotton cultivation, with production historically occurring across regions ranging from temperate humid regions in the north to warm, arid desert areas in the center and east, and warmer, humid zones in the south. The country possesses a significant

number of active cotton ginning factories, as well as numerous associated spinning and textile industries and furthermore food processing (such as oil extraction facilities) and animal feed units related to cotton production chain. Over the time, cotton cultivation and production in Iran have faced various booms and busts and challenges. The resulting trends were influenced by economic, political and geographical Parameters and etc..., as well as by the adoption of either optimal or non-optimal strategies or decisions in response to those conditions by government and private sectors.

Alongside existing challenges, there have been numerous opportunities that Iran's cotton community has successfully leveraged to advance the sector and improve production conditions, thereby ensuring the crop remains part of the country's cultivation patterns in recent years. We also observe practical innovations in Iran from the seed stage through all phases of the production chain and related industries that can assist producers in achieving optimal and cost-effective production, notwithstanding the challenges we will outline. In this review article, we aim to present the challenges, opportunities, and recent innovations associated with cotton production in Iran by investigating and analyzing cultivation trends and the evolution of the sector.

The status of cotton cultivation and production

Iran is located in Asia and is historically considered to be in the Old World and can be considered as one of the centers of diversity of the genus *Gossypium*. In this regard, indigenous cotton of the diploid species *G. herbaceum* has long been cultivated in its warm and dry central and eastern regions. Note that fibers of this species, apart from being used in traditional hand spinning, have been used mostly to make and fill bedding. In the late 1840s, upland cotton (*G. hirsutum* L.) as an allotetraploid species was introduced to Iran, and due to its higher yield compared to the native diploid species, its cultivation was expanded, and related industries such as ginning factories and spinning and textile apparatus were gradually developed. Subsequently, with the codified programs of the government and related private sectors in the 1970s and 1990s, the area under cotton

cultivation and lint production in Iran increased significantly, and fiber production in these two decades exceeded domestic consumption, and Iran became a cotton exporting country. After that, due to the decrease of attention to this crop compared to other competing crops (such as rice in north of Iran and fodder plants), its cultivation area decreased in its main cultivation areas that had suitable climate, water and soil, and only in areas such as desert areas where it was not possible to cultivate other crops, it did not decrease, but rather developed in these areas. Therefore, cotton cultivation and production in Iran often moved to areas with salinity, drought and heat stress. These latter areas were mainly located in central and eastern Iran. Therefore, a number of related industries have also been transferred from the northern regions of the country to these new areas. In these new desert areas, both the persistence of droughts and the farmers' interest to develop orchards, and in particular pistachio orchards - a new horticultural competitor to cotton farming - emerged. Although technical and economic measures were taken by the government and the private sector during these years to revive and continue cotton cultivation, they were insufficient. The lack of systematic communication with international forums, including the International Cotton Advisory Committee (ICAC), the suspension of Iran's membership in this committee, the lack of use of international financial resources, and consequently the lack of proper access to modern technological updates and its lack of modernization, were also considered as possible reasons for the decline in the cultivated area. However, in the research sector, during these years, in 1997, the Iranian Cotton Research Institute was established by upgrading a cot-

ton and fiber plants department in the Iranian Seed and plant Research Institute. The Cotton Research Institute in Iran has various research departments in breeding, agronomy, mechanization and irrigation, plant protection, and seeds. In the years following the establishment of the Cotton Research Institute, the number of improved cotton varieties increased, and in this regard, it was a turning point for cotton production and the cotton farmers of Iran. Recent research on Iranian cotton germplasm confirms substantial genetic variation for drought tolerance, providing a valuable foundation for breeding climate-resilient cultivars.

The area under cotton cultivation in Iran has fluctuated greatly over the past three decades, and unfortunately, the overall trend has been declining, reaching about 85,000 hectares in 2024, which is cultivated in 17 provinces of the country. According to statistics the 3 Khorasan provinces (Razavi, South and North) account for about 45 percent of the country's total area under cotton cultivation and rank first in cotton production. After them, Fars, Golestan and Ardabil provinces are in the next ranks, respectively. In 2025, the cultivated area decreased by 6% to 80,000 hectares, and for 2026, this number remained approximately unchanged. Despite the decrease in the area under cotton cultivation in Iran and the shift of this crop to marginal areas with low-quality water and soil, with favorable research activities in the cases of improving and introducing new cotton varieties and optimal seed processing, as well as agronomic research and development of integrated crop management (ICM) methods, including improved water use management and new irrigation methods, soil fertility and plant nutrition manage-

ment, and plant protection, the average yield per unit area has increased significantly, and therefore, overall total production has not decreased significantly.

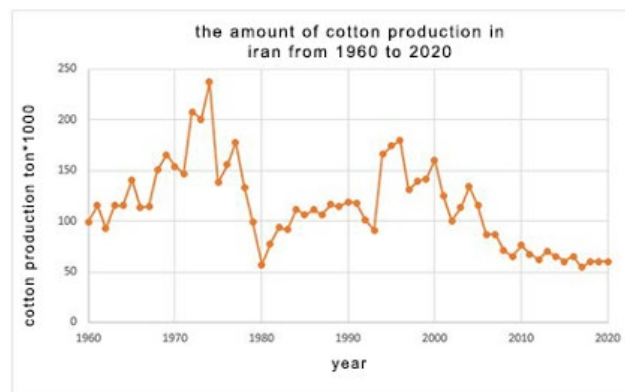


Figure1. The amount of cotton production in Iran from 1960-2020.

Cotton germplasm and cultivars developing

Today's cotton cultivars in the world have been improved by one of the methods of selection, hybridization, mutation breeding, and genetic engineering. Among the types of cotton cultivars used in the world, namely standard or open pollinated (OP) varieties, hybrid, transgenic, or transgenic hybrid, Iran uses only the seeds of standard (OP) varieties those they developed mostly by hybridization and a few numbers improved by mutation breeding. However, in recent years, with the support of the Ministry of Agriculture, interspecific and intraspecific hybrid seeds have been produced and cultivated on a limited scale by hand. In Iran, the cultivation of genetically modified (GMO) crop varieties, including cotton, is prohibited by law.

In Iran, from 1968 to 2007, 9 cotton cultivars (on average, one cultivar every 4 years) were introduced with the names Deltapine-16, Hopi Cala, Varamin, Sahel, Doctor Omumi,

Bakhtegan, Ultan, Pak, and Mehr. During the years 2007 to 2014, 9 new cotton cultivars with desirable agronomic characteristics (especially early maturity) and suitable with the country's needs were introduced with the names Khordad, Sepid, Golestan, Arma-ghan, Khorshid, Kashmar, Latif, Shayan, and Sajedi, thus the average time of production and introduction of cultivars during this period reached one cultivar per year. After that, the Hekmat variety was introduced in 2018 and two mutant varieties of Parto and Taban, were introduced during the years 2019 to 2024 and also Soroush by plant introduction method in 2026. Currently, the country has introduced more commercial varieties of cotton than its area under cotton cultivation. In addition to the above standard cotton varieties, four hybrid varieties are in the process of being registered and commercialized, so the agricultural executive department can select the appropriate seeds according to the agricultural needs of each region and supply them to cotton farmers.



Figure 2. Iranian cotton germplasm
Sepid cultivar (*G.hirsutum* L.), an allotetraploid, okra leaf and long fiber cultivar.
Khorshid cultivar (*G.hirsutum* L.),an allotetraploid, zero branch and very early mature cultivar.
Aria cultivar (*G.herbaceum*), a diploid endemic variety and salt tolerant.

The average seed cotton yield in the cotton growing area of Iran before the development of the cultivation of new improved varieties was reported to be about 2,200 to 2,500 Kg/hain different years (Iranian Textile Industry Statistical and Strategic Studies Office - 2009). The cultivation of new cotton varieties has resulted in an increase in seed cotton yield from 500 to 3,000 kg/ha, and in recent years the average yield of new improved varieties in different regions of the country has increased to more than 3,500 kg/ha. The newly introduced varieties have a shorter growing cycle and have more uniformity in maturity compared to previous cultivars. By cultivating these new cultivars, farmers can grow cotton as a second crop after wheat, barley, or rapeseed, intercrop cotton with other crops, and make greater use of mechanized harvesting.

Endemic cotton cultivars (*G. herbaceum*) in Iran are diploid and possess characteristics of course fiber (micronaire >5) and short staple (18-22mm) and based on their origin have good genes and characteristics for salinity tolerant, while upland cotton(*G. hirsutum* L.) cultivars are allotetraploid and produce fibers with micronaire lesser than 5 and 28-32 mm fiber length. In a megaproject breeding program 10 endemic cotton cultivars were used at Varamin and Kashmar stations for crossing with a cultivar of *G.arboreum* species, cultivar VTDL which have good fiber quality and has been introduced from India. In the second and third years, all F1 hybrids were backcrossed with their *G. herbaceum* parent. Evaluation of the resulting progeny showed that some plants performed better than the maternal parent (native cultivars) for one or more traits. In some cases, plants with excellent fiber length showed lower fi-

ber strength than the maternal parent. We have now identified promising genotypes with desirable fiber characteristics, which will be introduced to cotton growers once the DUS (Distinctness, Uniformity and Stability) and VCU (Value for Cultivation and Use) tests are completed.

The breeding and development of new cotton cultivars, the production of their nucleus seed, and the maintenance of their genetic characteristics in Iran are carried out by the Cotton Research Institute of Iran (CRII), a government institution. The Seed and Plant Certification and Registration Research Institute (SPCRI), also a government institution, oversees the different stages of crop seed multiplication, including cotton, and grants the required approvals and final certification labels for the seeds produced.

Over the past ten years, responsibility for the commercial production of cotton seed cultivars has been transferred from CRII to the private sector. Cotton seed production and multiplication in Iran now follow a four-category system and are carried out by private-sector companies.

For more than a decade, foreign cotton seed companies, mainly from Turkey and Greece, have been selling certified seed to Iranian cotton farmers. Some of these companies have also registered their cotton varieties in Iran's national list of varieties and established seed production and multiplication programmes in the country, potentially with the aim of supplying export markets.

In the warm and humid southern regions of Iran, near the Persian Gulf and the Sea of Oman, climatic conditions are favorable for

continuous growth. In these areas, cotton plants can also be found growing as perennial shrubs.



Figure 3. Cotton shrubs in Hormozgan Province, Bandar Abbas city, southern Iran, near the Persian Gulf

Available technologies for seed cotton ginning and seed delinting process

With the expansion of cotton cultivation in Iran, the number of cotton ginning factories increased significantly, reaching 104 factories by the late twentieth century, with relatively broad distribution across the country. However, as the area under cotton cultivation declined, the number of active ginning factories also decreased. At present, approximately 88 factories remain in operation. These factories are equipped with saw gins suited to the types of cotton produced in Iran.

The quality of cottonseed after harvest can be affected by post-harvest handling, ginning and other processing operations. Cottonseed is particularly sensitive to mechanical damage, which can have both direct and indirect effects on seed quality. Severe damage to sensitive tissues, such as the radicle, can lead to a rapid loss of germination capacity. Less

severe damage may increase the proportion of abnormal seedlings and reduce seed storability, vigor, emergence and establishment.

Mechanical damage also makes seeds more vulnerable to infection by microorganisms, which can enter through cracks or wounds in the seed coat and cause rotting after planting. Damaged seeds may also be more sensitive to subsequent processing operations and to chemicals used for seed treatment and coating. During acid delinting, for example, cracks in the seed coat can allow acid to reach the embryo, causing injury or burning. Broken or damaged seeds may also be more susceptible to chemical treatments, including systemic pesticides and mercury-based compounds. As the degree of mechanical damage increases, both germination and storage capacity tend to decline, and the harmful effects of acid treatment may become more severe.

In the 1990s, four cottonseed delinting factories were established in four provinces of Iran to improve cottonseed processing and take advantage of the benefits associated with delinted seed.

1. Gorgan factory in Golestan province, established in 1993, with a nominal capacity of 4 tons per hour, manufactured by the Greece Gin Supply Company.
2. Pars Abad Moghan factory in Ardabil province, established in 1994, with a nominal capacity of 700 kilograms per hour, manufactured by the French CFDT company.
3. Kashmar factory in Khorasan Razavi province, established in 1997, with a nominal capacity of 4 tons per hour, which was modeled by the Iranian Ma-

chine Daru Company on the Gorgan factory.

4. Darab factory in Fars province, established in 1999, with a nominal capacity of 700 kilograms per hour, which was modeled by the Iranian Machine Daru Company on the Pars Abad Moghan factory.

With the establishment and development of these four delinting factories, it was expected that Iran's domestic demand for cottonseed could be fully met. However, operational shortcomings and limitations after their launch, particularly insufficient attention to training programs and the development of skilled personnel, prevented these expectations from being fully realized.

As a result, during the 2000s and the first half of the 2010s, delinted seed accounted for only about 25–40% of the cottonseed consumed domestically. During this period, as the private sector increasingly replaced the government in the national cottonseed production program, the operational management of the delinting factories was also transferred to private companies, with the aim of improving both the quantity and quality of delinted seed production.



Figure 4. Fuzzy cotton seed (a), delinted cotton seed (b) produced in dry region at the east of Iran

Following these transfers, the processing operations and technologies of the Kashmar and Gorgan factories have been successfully upgraded in recent years. The management of these two facilities was transferred to private companies, and both factories are now equipped with gravity-based seed cleaning systems as well as seed-coating lines.

In this system, after mixing the acid, the seeds are collected around the centrifuge tank and the excess solution (acid and water) is separated from them and returned to the acid tank for reuse. To maintain the required acid concentration, it is necessary to add acid to the solution and adjust it. In this method, almost no excess acid remains as waste, but the price of the centrifuge device is expensive and the cost of setting up the system is relatively high. In this method, the possibility of damage to seed quality is more related to the drying stage.



Figure 6 - View of the interior of the Kashmar cotton seed delinting factory, one of four factories located in Iran that works with the dilute sulfuric acid and heat method.

Given the above-mentioned desirable facilities and equipment, as well as the suitable climatic conditions for seed production and active seed companies, and the technical knowledge available in Iran, it is possible to advance breeding programs and cotton seed production and technology in Iran and subsequently export the produced quality seeds to other countries.

Processing steps after cotton seed delinting

With a separating machine equipped with aeration and a screener, all large and small pieces, weeds, broken seeds and dust are separated. The gravity separator, which is of great importance, separates hallow, immature or non-viable seeds along with light solid particles from the seed mass. Thus, if the machine is regulated correctly, not only is there no damage to the seeds, but the germination and emergence rate of the seeds and the vigor of the cotton seedling are increased at this stage.



Figure 7. Gravity separator machine in Kashmar delinting factory



Figure 5. Schematic steps of dilute acid delinting in 4 cotton seed delinting factories in Iran

In recent years, a knowledge based company incubator resident in the Iranian Cotton Research Institute, in collaboration with a chemical supplier, has studied and investigated organic acids similar to those used in cosmetics for delinting cotton seeds and reported an innovation that it has achieved favorable results in its preliminary work.

Seed treatment and coating devices are usually used after or in conjunction with acid neutralization devices and coat delinted seeds with systemic fungicide and insecticide seed dressing compounds or other materials (Figure 8). In this regard, there are very valuable experiences in our country in the use of various insecticides suitable for controlling cotton Thrips, various fungicides suitable for controlling early season damping off pathogens, and in addition, in the treatment of seeds with enhancers, growth stimulants, seed priming, and also water super absorbing nanopolymers.



Figure 8. Delinted cotton seed in the Kashmar factory - without any treatment (a), dressing with Cruiser (b), coating with Gaucho (c), and super-absorbent nanopolymers and Carboxin Thiram (d)

Most of the current cotton growing areas in Iran are affected by salinity and alkalinity of water, soil, or both. Therefore, using priming could also be a solution. In a laboratory and greenhouse study by several researchers, the effect of potassium nitrate osmopriming was reported to be effective for salt stress conditions in cotton.

In the cotton seed store, each part contains a maximum of 250 packets (20kg) of delinted seeds of the same class and variety (Figure 9). The seed specifications for each part, including the date of ginning and processing, name of the ginning and processing factory, place of production, percentage of germination, date and location of the seed analysis laboratory, number of packets, and part number, are recorded. The method of stack-

ing seed packets on wooden pallets should be such that the seed parts are separate from each other so that each can be easily accessed while allowing air to pass through.



Figure 9. Storage of twenty-kilogram packets of delinted cotton seeds in the Kashmar delinting factory store

Game changing by climate smart innovations for cotton production

Since the late twentieth and early twenty-first centuries, global warming and ongoing climate change have increased potential evapotranspiration (ETp), while water resources suitable for agriculture have declined over the past 50 years. As a result, the use of saline and lower-quality water for crop production is becoming increasingly common. At the same time, greater weather variability, particularly untimely periods of cold and heat, has shortened the effective growing season in many regions. In some cases, the peak periods of abiotic stress now coincide with critical stages of plant development. Under these conditions, farmers can no longer rely entirely on the traditional cropping systems that were previously established for each region.

There is therefore a growing need to develop and adopt new cropping systems that are

better adapted to changing climatic conditions. These systems require new varieties with characteristics suited to their specific management strategies. This, in turn, calls for new breeding approaches and efficient breeding methods capable of producing cultivars adapted to emerging production conditions.

Cotton is one of the crops whose production areas are strongly affected by these challenges. In recent years, several new cultivation systems have shown promising results in different parts of the world. Dense and ultra-dense cotton production systems, commonly known as Narrow Row (NR) and Ultra Narrow Row (UNR) systems, can help reduce the effects of high potential evapotranspiration and improve water-use efficiency. However, these systems require cotton varieties with suitable plant architecture and specific growth habits to minimize competition among plants within the field.

Another important example is the use of conservation agriculture, including no-tillage and reduced-tillage cotton production in the residues of small-grain crops such as wheat, barley and triticale. This approach can be particularly valuable under saline soil and water conditions in arid regions. Such cropping systems require very early-maturing cotton varieties that can complete their growth cycle within a shorter and more constrained production window.

These varieties should also mature early enough to be used as a second crop within the cropping system. In some cases, combining two production systems has produced promising results. One example is the use of Narrow Row or Ultra Narrow Row cotton

planted into cereal residues under saline soil and water conditions in arid regions.

Cotton geneticists and breeders therefore need to focus on developing novel cultivars, plant types, architectures and genetic materials that can support the effective and sustainable expansion of these systems under climate change. In recent years, it has also become increasingly important to strengthen breeding programs by combining conventional breeding methods with biotechnology and molecular tools, allowing selection to be carried out more accurately and efficiently. Zero-branch cotton cultivars are particularly well suited to dense planting and UNR systems, where they have shown strong yield potential. UNR cultivation can also help suppress weed growth and improve water-use efficiency (WUE) by reducing evaporation from the soil surface.

Among Iranian cotton cultivars, four zero-branch varieties, Khorshid, Kashmar, Sajedi and Hekmat, are particularly suitable for UNR cultivation.



Figure 10. Khorshid a zero-branch and very early mature variety in a No-tillage (conservation agriculture) and Ultra Narrow Rows Planting system after barley. a: Esfaraaien, North Khorasan Province, (Photo by M.R. Ramazani Moghaddam July 2025). b: Anabad, Khorasan-Razavi Province, (Photo by M.R. Ramazani Moghaddam June 2026). Both of them are in the salinity stress conditions

Breeding cotton cultivars with sub-okra, okra, and super-okra leaf shapes with different growth habits is another approach being pursued in Iran's breeding programs as a solution for climate change conditions. We have a long-staple, okra-leaf cultivar named "Sepid" that has demonstrated remarkable resilience under drought, salinity, and even heat stress, and this cultivar has good performance and high yields.

Conclusion

To preserve and expand cotton cultivation in Iran, further progress in mechanization is essential, particularly through the development and wider use of mechanical cotton pickers. At the same time, contract farming and guaranteed purchasing should be promoted to strengthen the production chain. This means aligning cotton production more closely with the requirements of the next stage in the value chain, particularly the end user. In this context, the textile sector plays a central role as the main consumer within the cotton production chain.

In recent years, research and development on conservation agriculture for cotton production in Iran, particularly under saline soil and water conditions, have produced very positive results. These approaches have been well received by growers and have helped address several major challenges associated with cotton cultivation under salinity and climate change conditions.

Iranian cotton researchers and growers have also successfully implemented biological control methods for cotton pests. Today, these environmentally friendly practices are used as part of integrated pest management

across extensive cotton-growing areas in the central and eastern regions of the country.

The results of field surveys and the review of available documentation indicate that Iran has considerable potential, infrastructure, technical knowledge and successful experience in cotton research and seed production. These activities date back to the 1950s, when cotton breeding, research and seed propagation programs were established with the cooperation of France. Since then, breeding activities have expanded and new varieties with different growth habits, including early-maturing cultivars, have been introduced.

However, progress in cottonseed processing technology has not advanced at the same pace as breeding and genetic improvement. In particular, the technological infrastructure required for the broader development and use of processed cottonseed, especially during post-delinting stages such as seed coating and related treatments, still requires significant modernization. This has become increasingly important in recent years as cotton cultivation has expanded into areas affected by saline and alkaline soils and water. It is also particularly relevant because cotton has epigeal germination, making early seedling establishment highly sensitive to adverse soil and environmental conditions.

Another important issue is the availability and accumulation of valuable technical knowledge and practical experience that should be transferred more rapidly to cottonseed companies in Iran. Strengthening this knowledge transfer could further improve both the quantity and quality of cottonseed production.

Given the favorable climatic conditions in many of Iran's cotton-growing and seed-production areas, there is also strong potential for the production of high-quality seed. With appropriate planning, wider adoption of modern technologies by seed companies, and greater investment in human-resource training, Iran could potentially expand the export of seed from superior domestic cotton varieties.

The development of cottonseed technology infrastructure should therefore be considered an important component of future cotton-sector policy. Greater emphasis on advanced seed technologies can help improve crop establishment and strengthen tolerance to both biotic and abiotic stresses under climate change conditions. In this context, seed treatment and coating technologies may provide practical tools for reducing the impact of adverse environmental conditions.

Particular attention should also be given to the use of biological materials and biocontrol agents in seed coating and advanced seed treatment. These technologies can help protect cotton during the early stages of crop establishment against pests and diseases. Appropriate combinations of fungicides, insecticides and biological compounds should be carefully evaluated to ensure that they can be used together without negatively affecting seed quality or performance.

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