



1



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Part 1:

THE SEARCHERS:

Part 2:

PERSPECTIVES: THE SEARCH FOR TRUTH & KNOWLEDGE

WHO ARE WE?



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Cotton Incorporated

Mission

Improve the demand for and profitability of cotton through research and promotion



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Image sources: Cotton Incorporated and Getty Images

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Cotton Incorporated

- **Science-based organization**
- **Worldwide sharing of research and knowledge**
- **Not-for-profit company**



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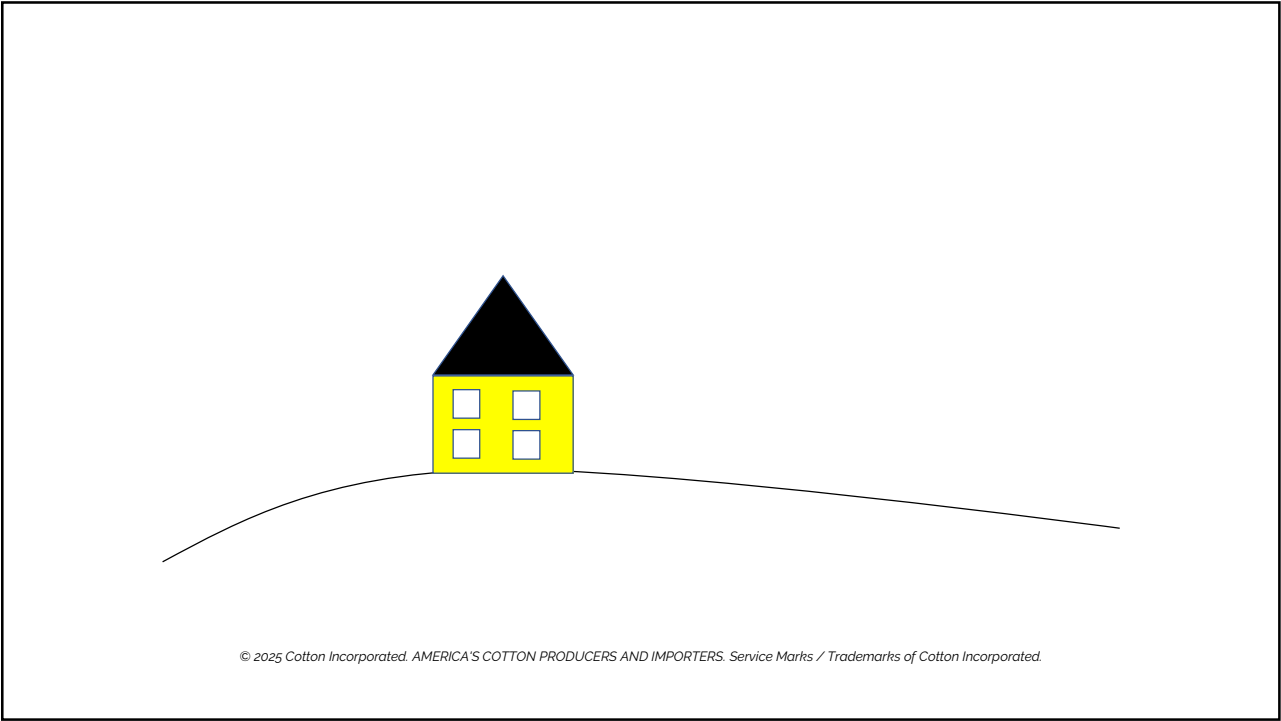
Image sources: Cotton Incorporated and Getty Images

Cotton Incorporated is the sole contractor for the Cotton Research and Promotion Program

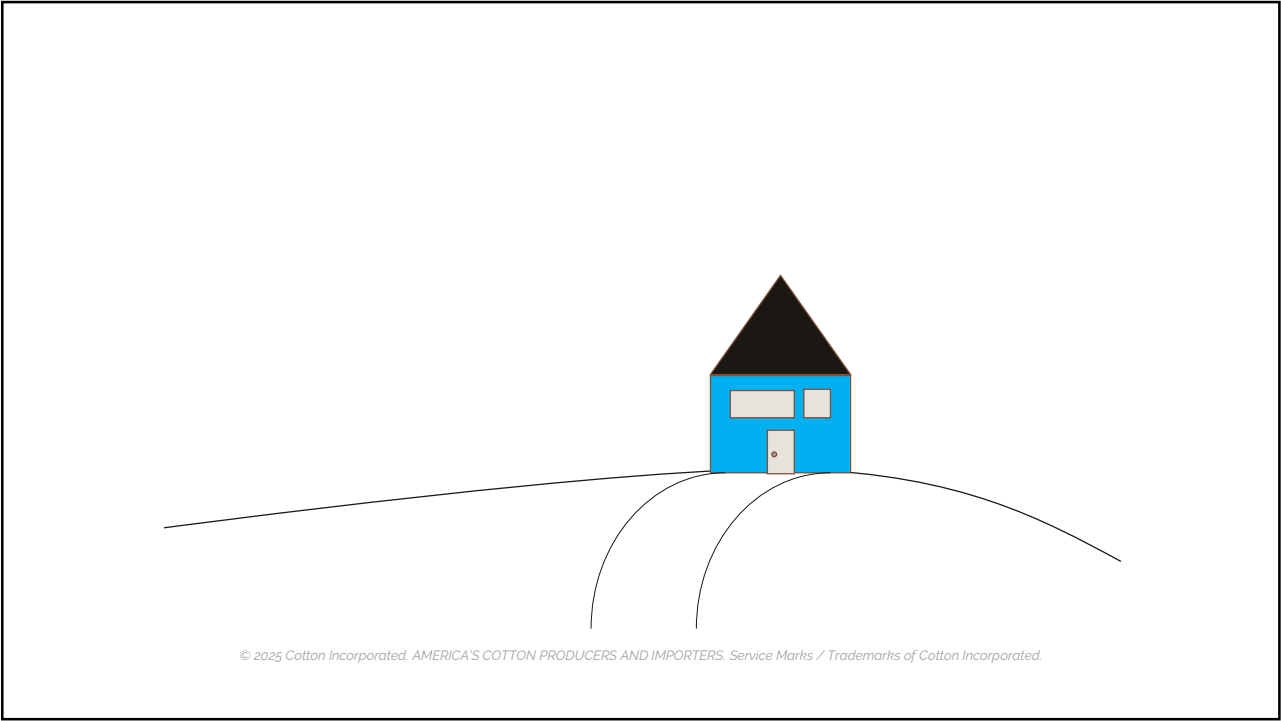
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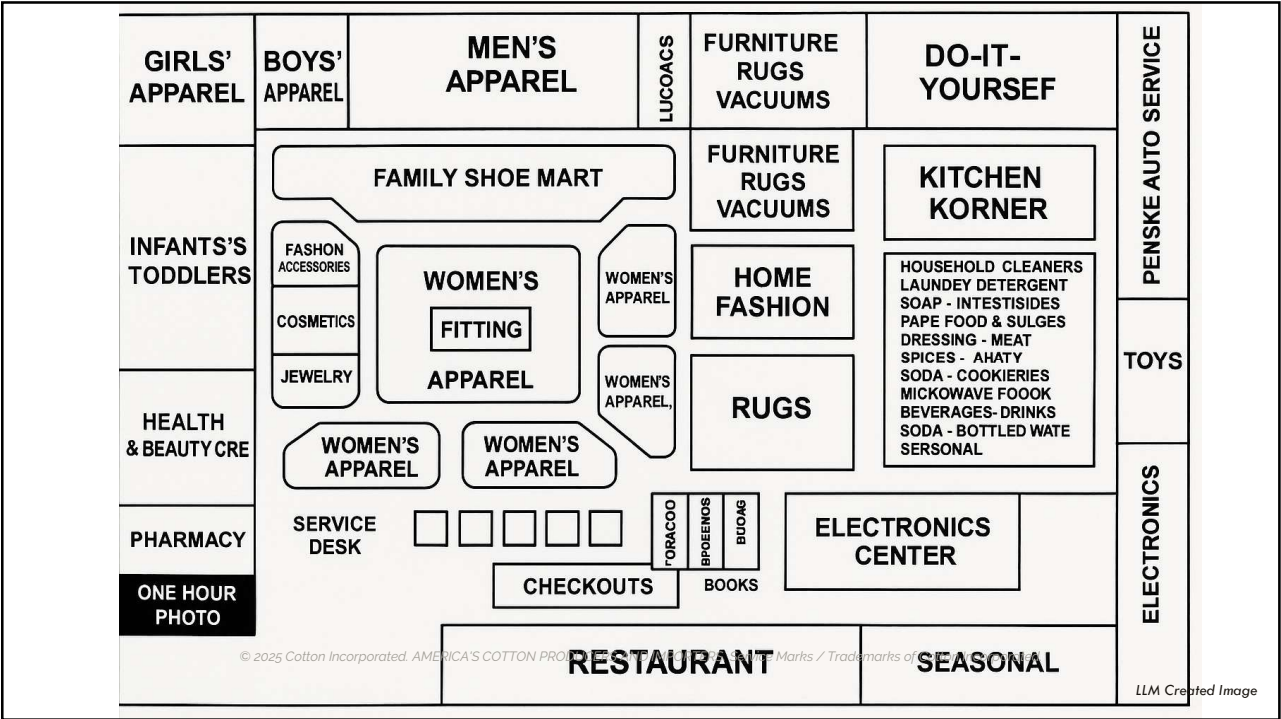
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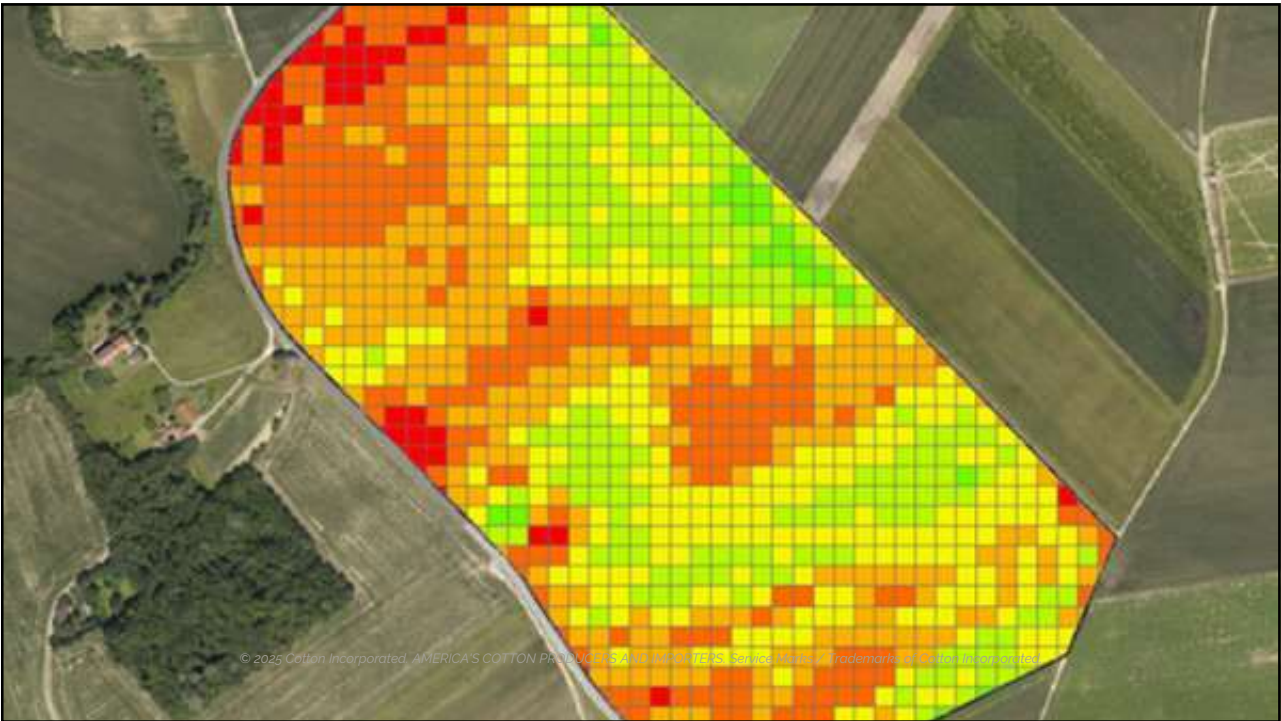
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PERSPECTIVES: THE SEARCH FOR TRUTH AND KNOWLEDGE

The incentive is to use less, not more.

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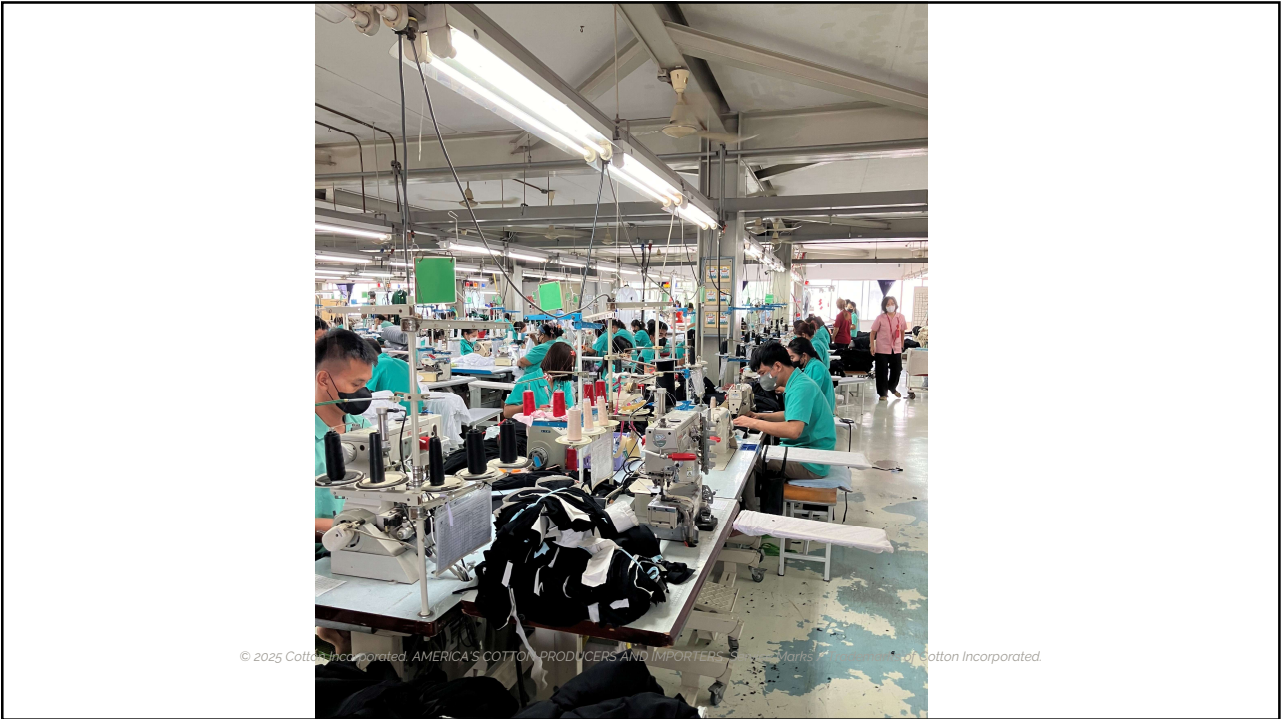
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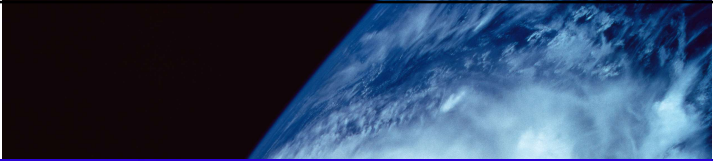


What do these factories have in common?

17



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Harvey Slams Bumper Texas Cotton Crop at `Worst Possible Time'

By **Jen Skerritt** and **Brian K Sullivan**
August 26, 2017, 5:20 PM EDT Updated on August 27, 2017, 3:09 PM EDT



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Texas’ cotton industry is facing its worst harvest in years — costing the state more than \$2 billion

Cotton is Texas’ largest crop, and industry experts say they expect just half the normal annual yield — which will drive up costs for consumers.

BY JAYME LOZANO CARVER AUG. 31, 2022 5 AM CENTRAL

SHARE REPUBLISH ↗



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LLM generated image

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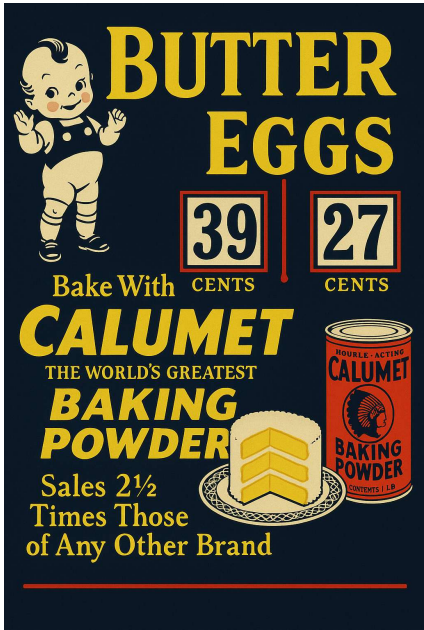
PERSPECTIVES: THE SEARCH FOR TRUTH AND KNOWLEDGE

The incentive is to use less, not more.

Even if you do everything right, cotton farming is a risky business.

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\$6.99



\$5.99

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Source: Food Lion Grocery Store

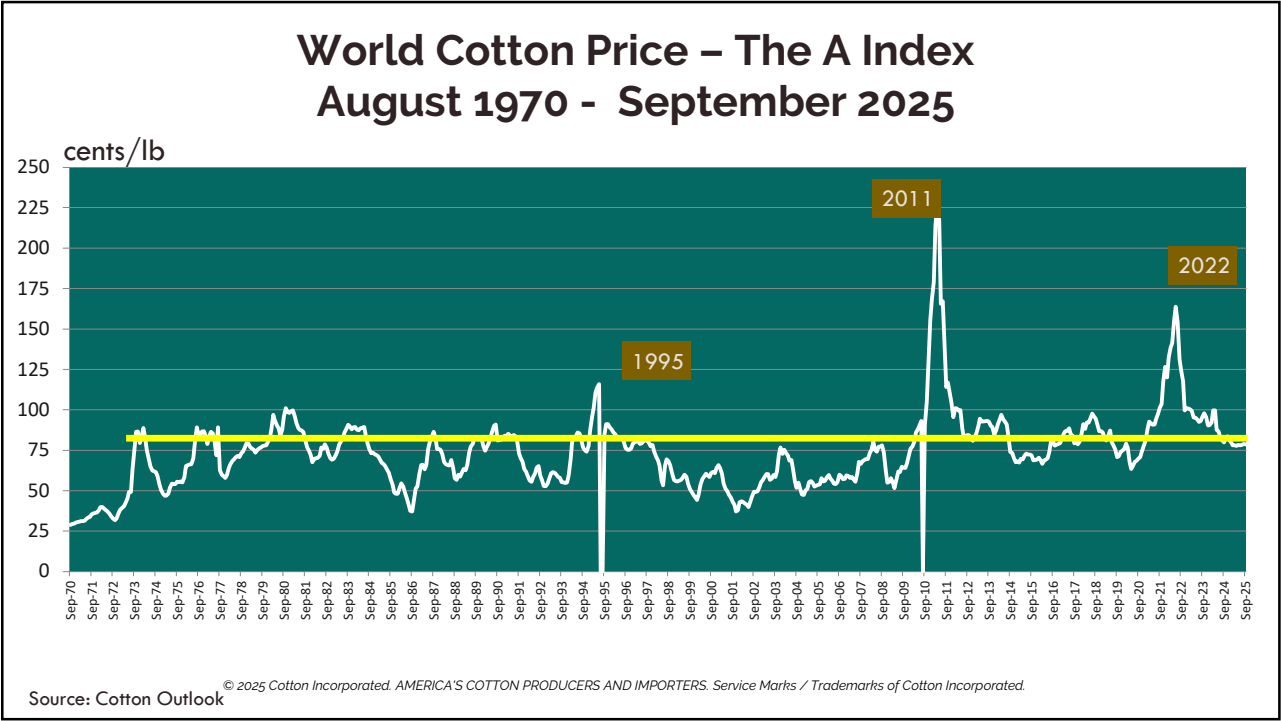
23

Item	1970s	2025
Eggs	61 cents / dozen	\$5.99/ dozen
Butter	86 cents / lb.	\$6.99 / lb

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Sources: US Bureau of Census, Cotlook, Food Lion in Raleigh, NC on September 28

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PERSPECTIVES: THE SEARCH FOR TRUTH AND KNOWLEDGE

The incentive is to use less, not more.

Even if you do everything right, cotton farming is a risky business.

If you cannot be efficient and improve, your farm will not survive.

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	1	2	3
	Responsible Cotton Production	Farm Tour	USDA Classing Office
	Cotton Sustainability	Field Research	Closing Thoughts
	USCTP	Gin & Warehouse Tour	Lunch and departure
Group Dinner			
Cocktails & Conversation			
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OUR OBJECTIVES

See

Ask

Learn

Judge for yourself



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AGRICULTURAL AND ENVIRONMENTAL RESEARCH



Dr. Ryan Kurtz
VP AERD



Dr. Ed Barnes
Ag Engineering



Dr. Don Jones
Breeding



Dr. Evy Jaconis
Cottonseed
Human & Animal Nutrition



Dr. Gaylon Morgan
Soil Health
Weed Science

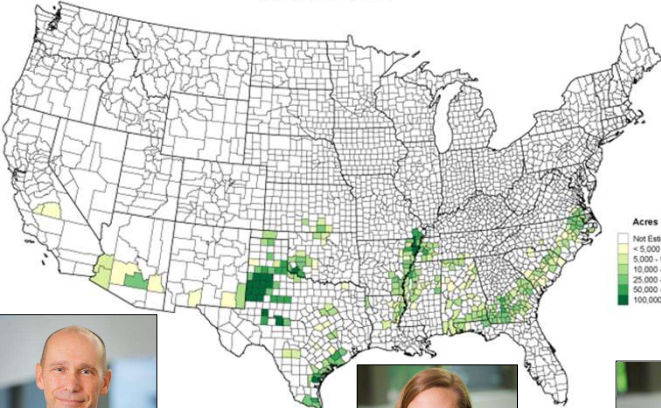


Dr. Kaitlyn Bissonnette
Pathology & Nematology



Dr. Sally Taylor
Entomology

Upland Cotton 2023
Planted Acres by County
for Selected States



Acres

- Not Estimated
- < 5,000
- 5,000 - 9,999
- 10,000 - 24,999
- 25,000 - 49,999
- 50,000 - 99,999
- 100,000 +

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TODAY'S TAKEAWAYS

Technology is contributing to a reduction in the impacts of cotton production.

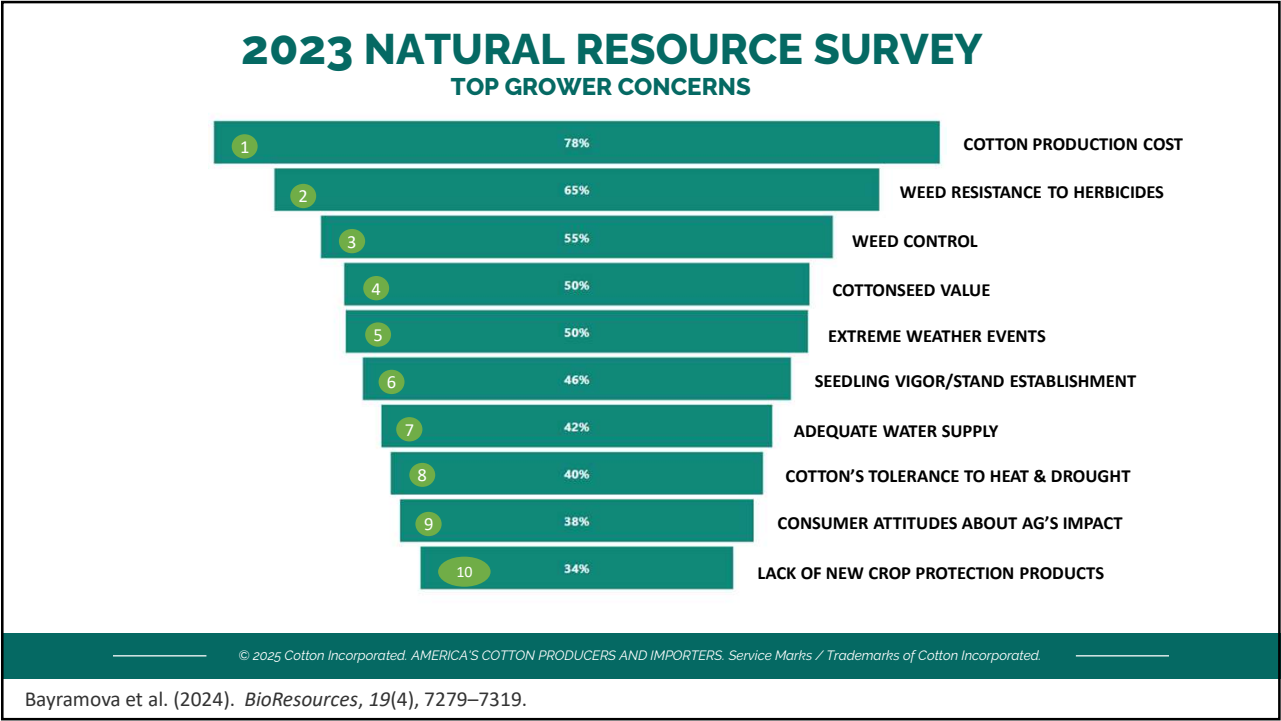
Cotton is:

- Increasing its land use efficiency
- Storing atmospheric carbon dioxide
- Water efficient and drought tolerant
- Reducing pesticide applications
- Continually adopting new technologies
- A food AND fiber AND fuel crop



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COTTON PRODUCTION INPUT COSTS

To protect yield and resource investments in the crop, farmers rely on many inputs.

Farming Goals:

- Maximize yield
- Minimize inputs

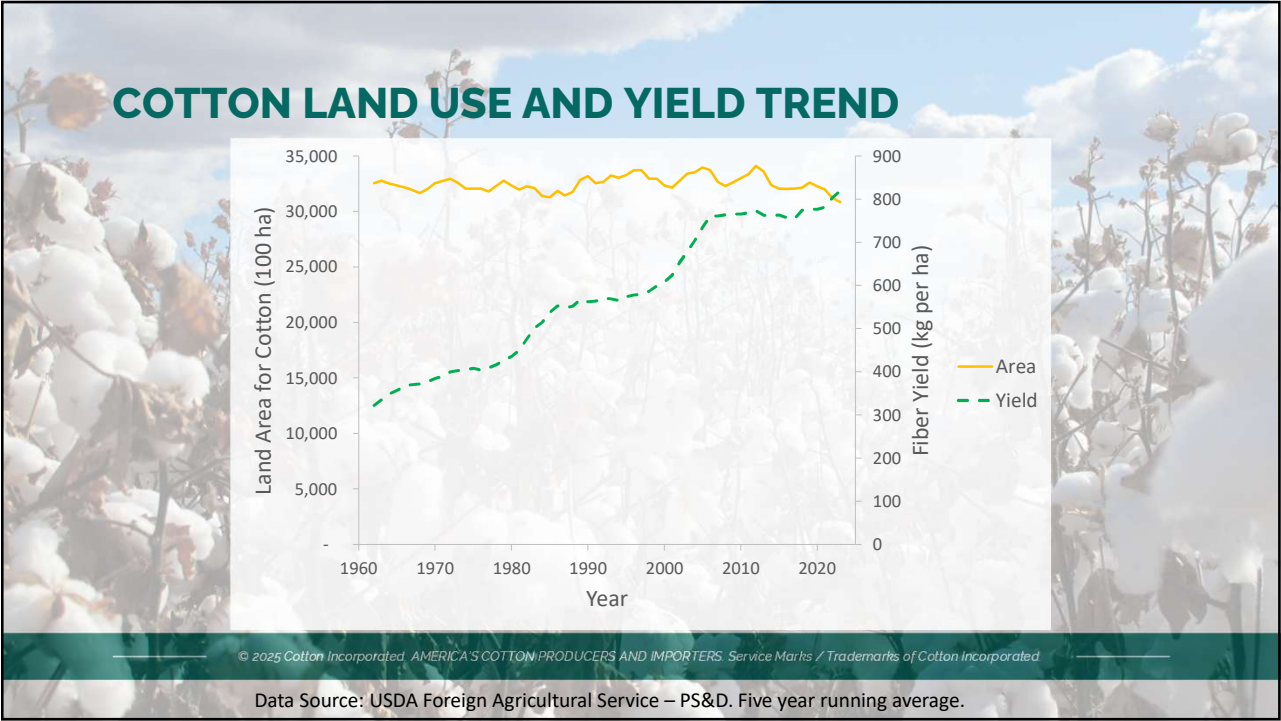
* Not including Fixed costs (land, equipment, infrastructure, etc.)

Inputs	Cost per acre*
Seed	\$133
Fertilizer	\$137
Ginning	\$186
Chemicals	\$159
Fuel, lube, and elect.	\$57
Repairs	\$75
Custom applications	\$38
Interest on op. inputs	\$19
Total Operating Costs*	\$804

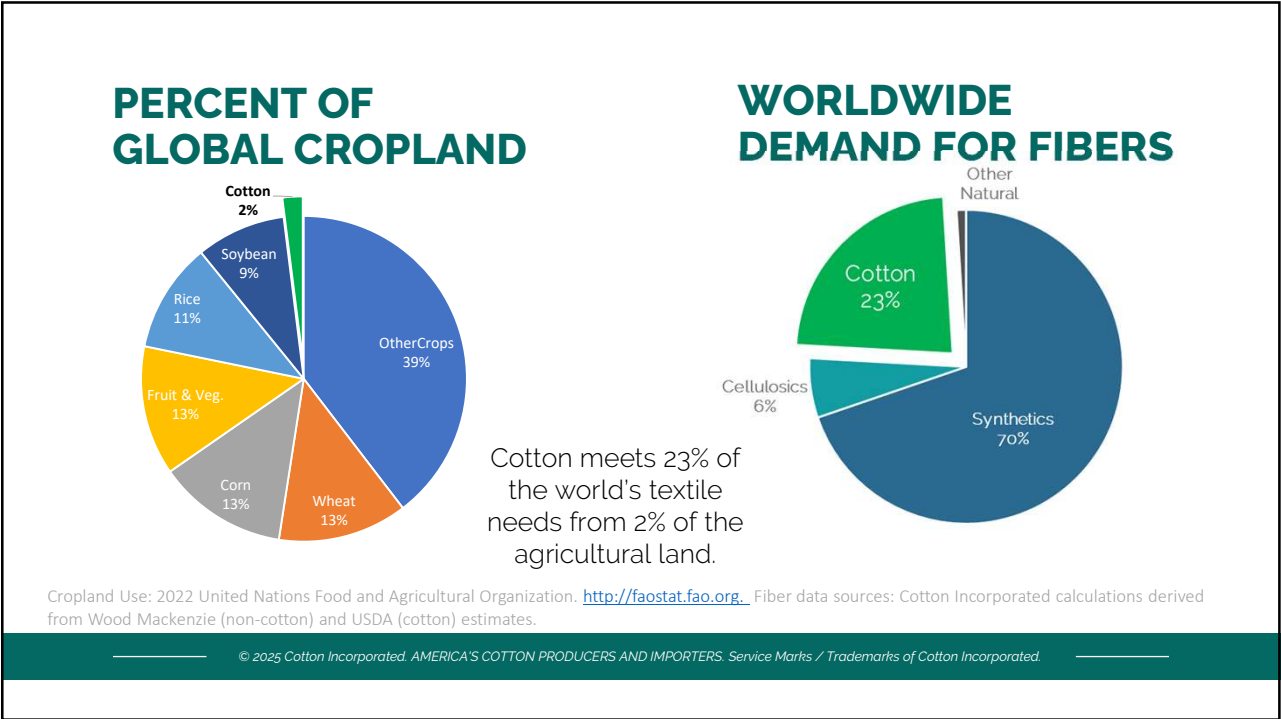
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<https://www.cotton.org/econ/cropinfo/costsreturns/portal.cfm>

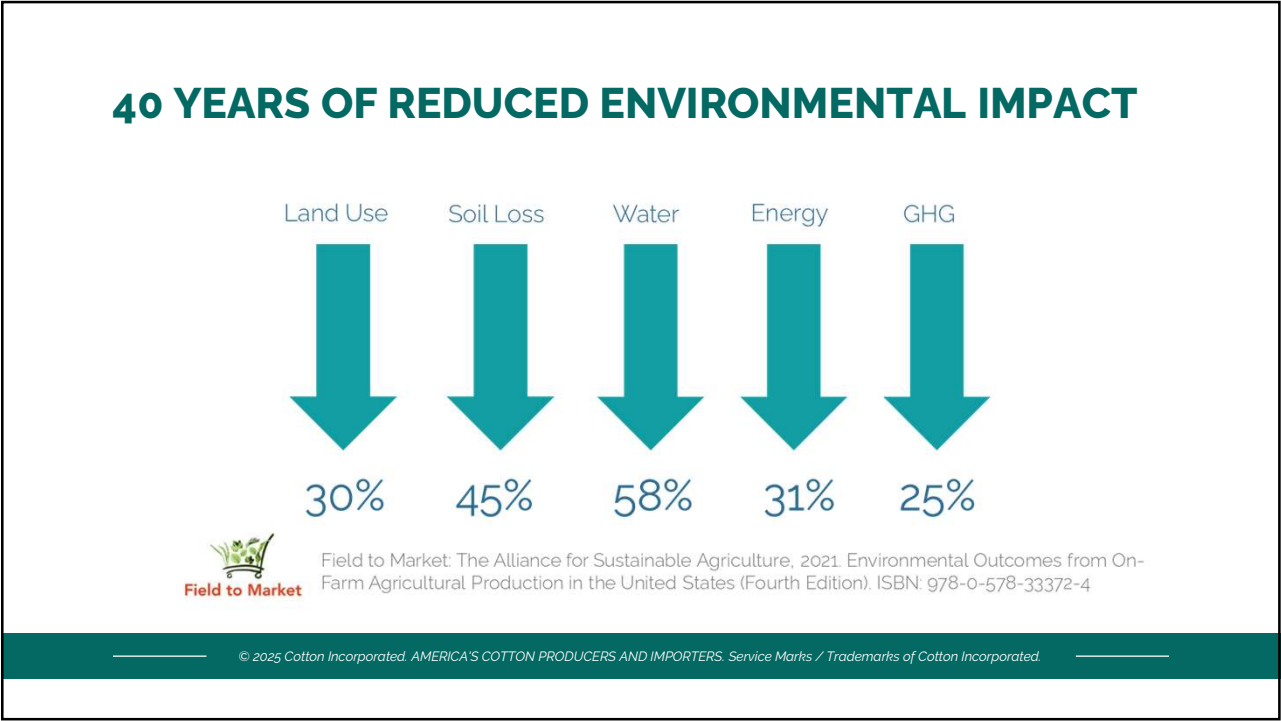
36



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FIELD TO MARKET

The Alliance for Sustainable Agriculture.

Members Include:

- The Nature Conservancy
- Environmental Defense Fund
- The Sustainability Consortium
- University of Arkansas
- Bayer Crop Science
- John Deere
- Cotton Incorporated
- National Corn Growers Association
- Kontoor
- The Coca Cola Company



Field to Market®

<https://fieldtomarket.org/our-members/>

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HOW WE DEFINE SUSTAINABLE AGRICULTURE ?



Meeting the needs of the present while improving the ability of future generations to meet their own needs by:

- Increasing productivity to meet future food and fiber demands
- Improving the environment
- Improving human health
- Improving the social and economic well-being of agriculture communities

Outcomes-based approach.

<https://fieldtomarket.org/defining-sustainability/>

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PRODUCTION SYSTEMS: ORGANIC, CONVENTIONAL, GMOs

The internet and social media are full of polarizing information to affirm whatever you want to believe.

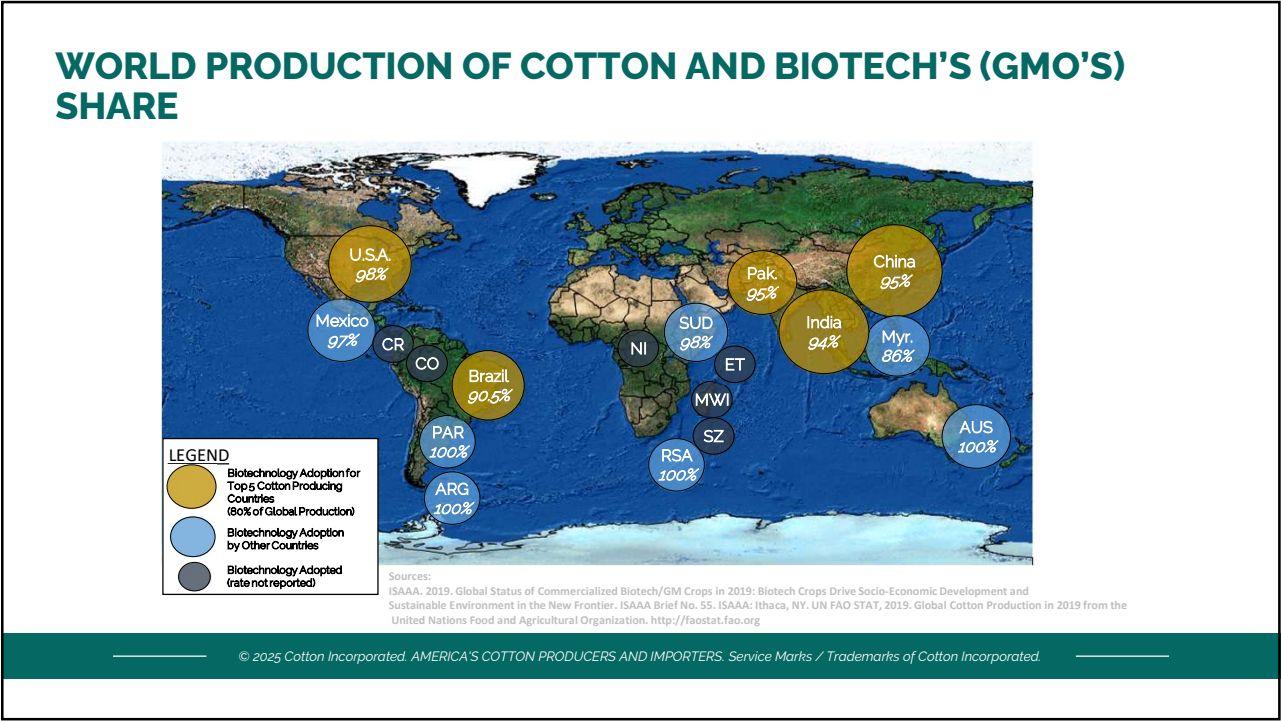
There are no perfect production systems.

All production systems have pros and cons.

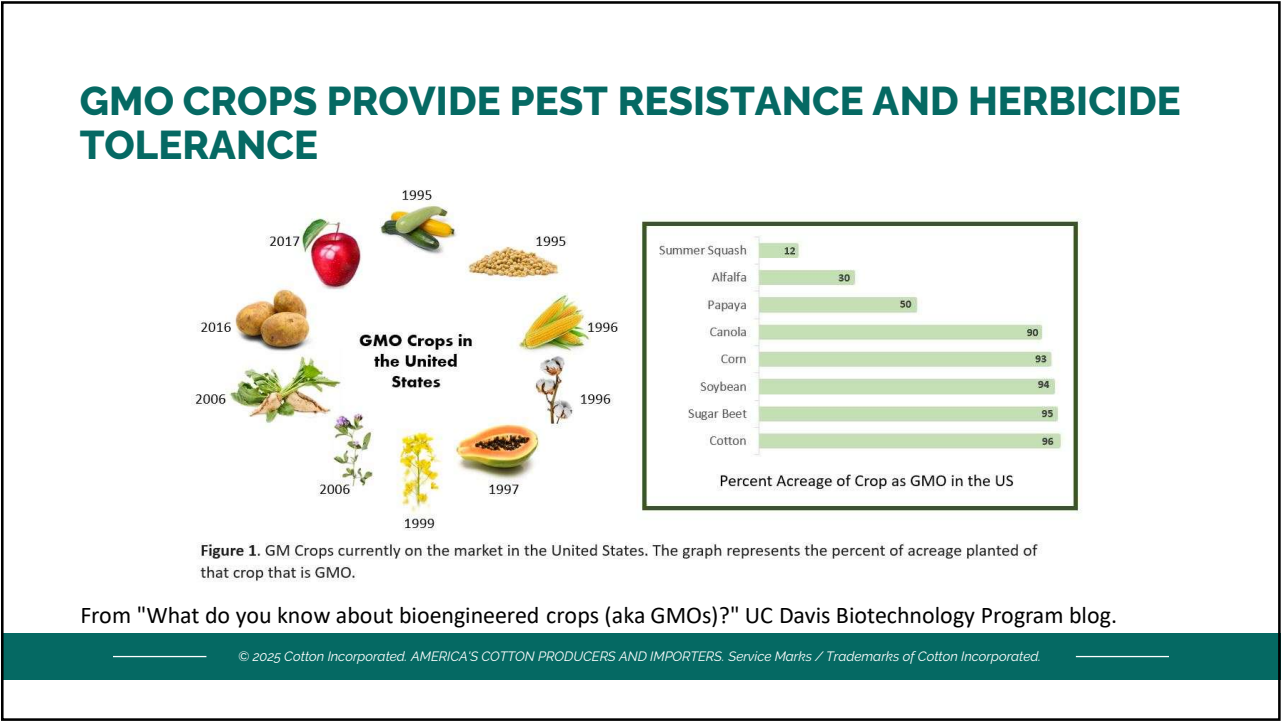


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ORGANIC & CONVENTIONAL

- Neither use GMO seed
- The difference isn't whether chemicals and pesticides can be used, it's the source.
- Organic allows most natural substances while prohibiting most synthetics.
- Conventional allows most natural substances as well as all EPA approved synthetics.
- There is no inherent safety or hazard in being natural or synthetic.

A close-up photograph showing a pair of hands, one wearing a black watch, gently holding and separating white cotton bolls from a plant. The background is blurred, showing more cotton plants.

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ORGANIC & CONVENTIONAL

- Both systems:
 - Use as few chemical inputs as necessary to maximize ROI
 - Implement and benefit from practices that protect soil health
 - Comply with the same EPA worker protection standards
 - Can be sustainably produced
- The fiber characteristics are indistinguishable

A close-up photograph of a large pile of white cotton bolls, showing their fluffy texture and natural shape.

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REGENERATIVE AGRICULTURE

- “Using a systems-based perspective, regenerative agriculture sequesters carbon in the soil and intentionally improves soil health, biodiversity, water quality, and air quality while ensuring the viability of farm production.
- This definition is accompanied by five principles, which are based on Indigenous ways of land management and are adaptive to local conditions and culture:
 - minimize [soil] disturbance;
 - maintain living roots in the soil;
 - continuously covering bare soil;
 - maximize diversity; and
 - integrate livestock where it is feasible.”

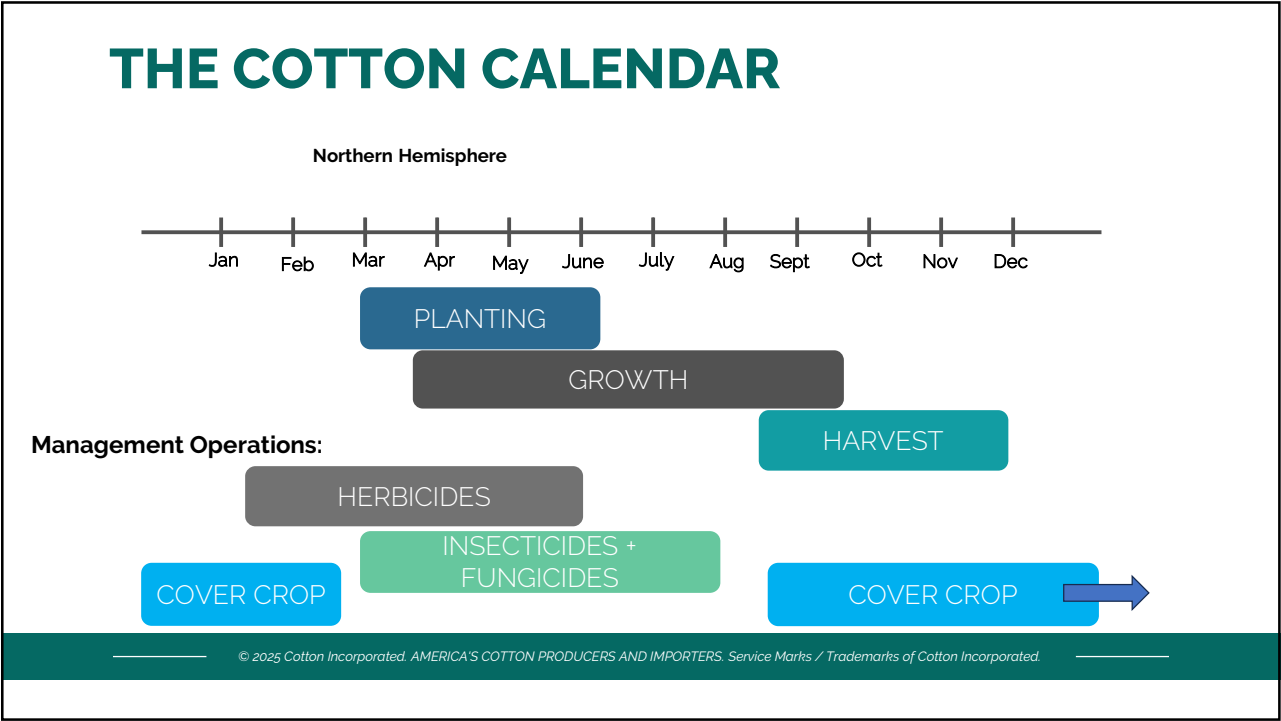
- Field to Market



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<https://fieldtomarket.org/regenerative-agriculture-guidance/>

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COVER CROPS

- Planted in the fall to protect soil through winter and spring
- Decrease soil erosion
- Increases water infiltration
- Suppresses weeds
- However, there are always some trade-offs and they depend on region and production system



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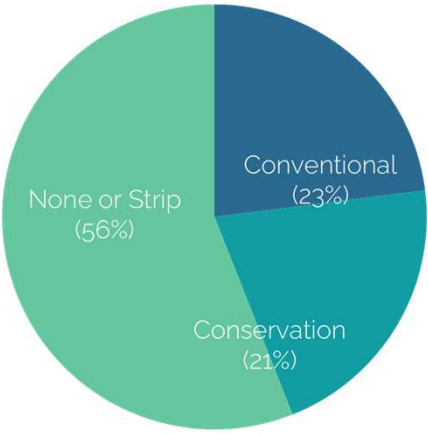
49

SOIL HEALTH: TILLAGE SYSTEMS IN THE U.S.



Three-quarters of U.S. farmers use reduced tillage.

2021 Natural Resource Survey of US Cotton Producers.



Tillage System	Percentage
None or Strip	56%
Conservation	21%
Conventional	23%

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PLANTING



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EMERGENCE – 5 TO 7 DAYS

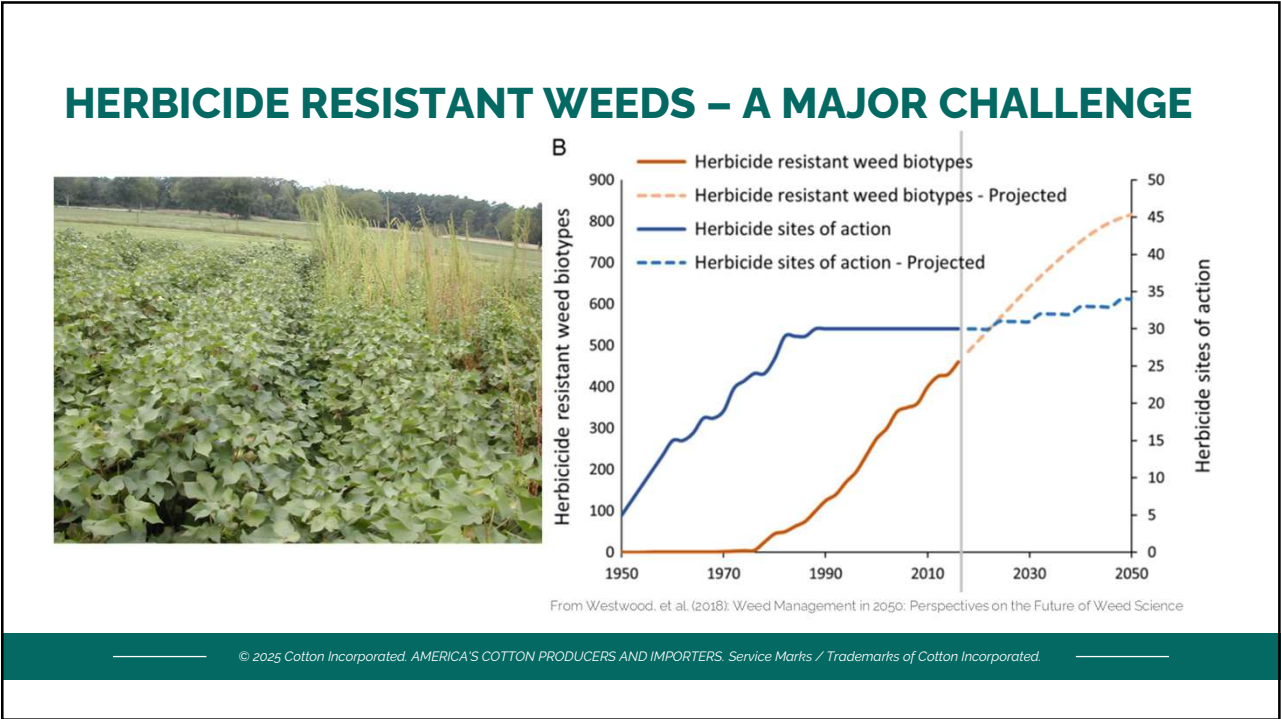


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TARGETED WEED MANAGEMENT



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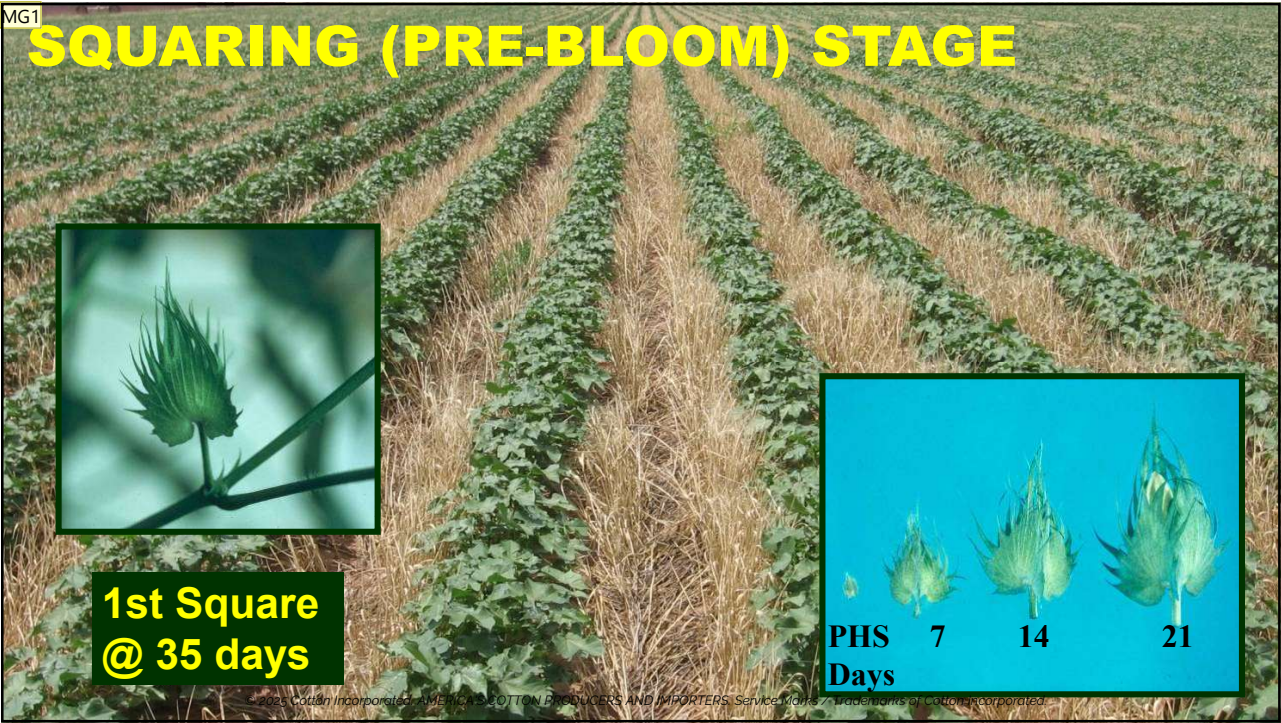
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COMMERCIAL AI WEED CONTROL EXAMPLE

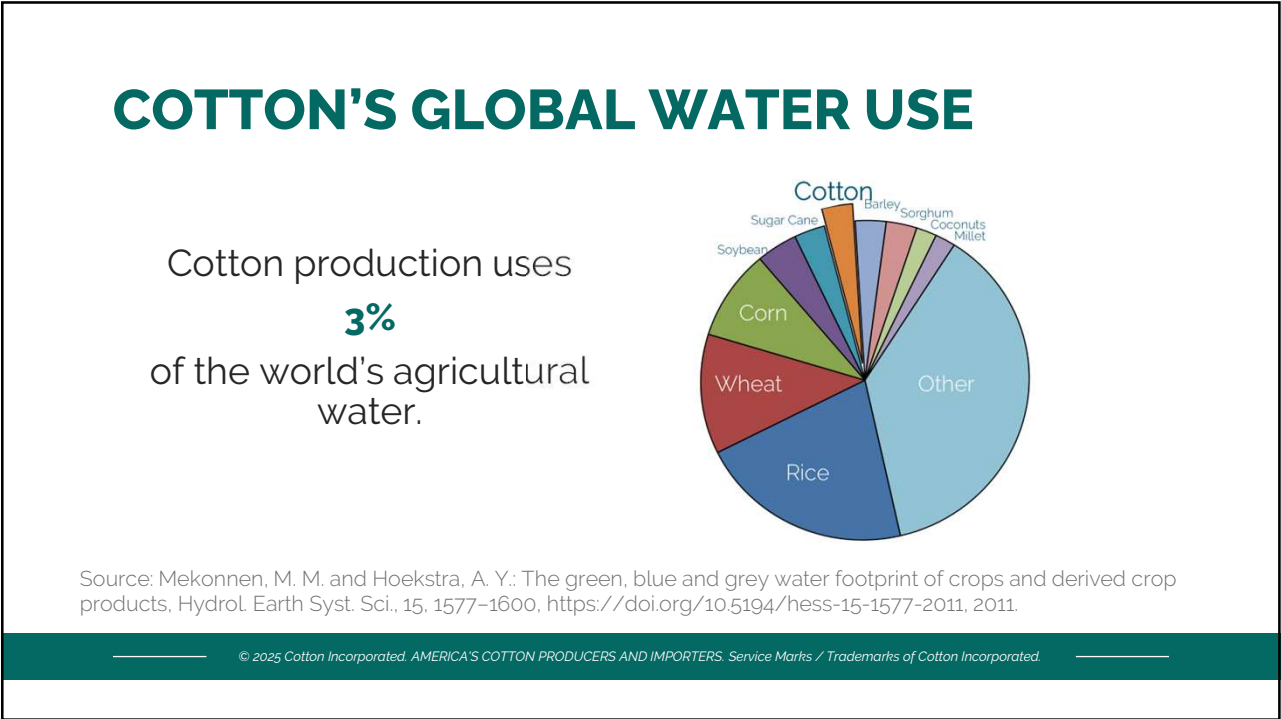


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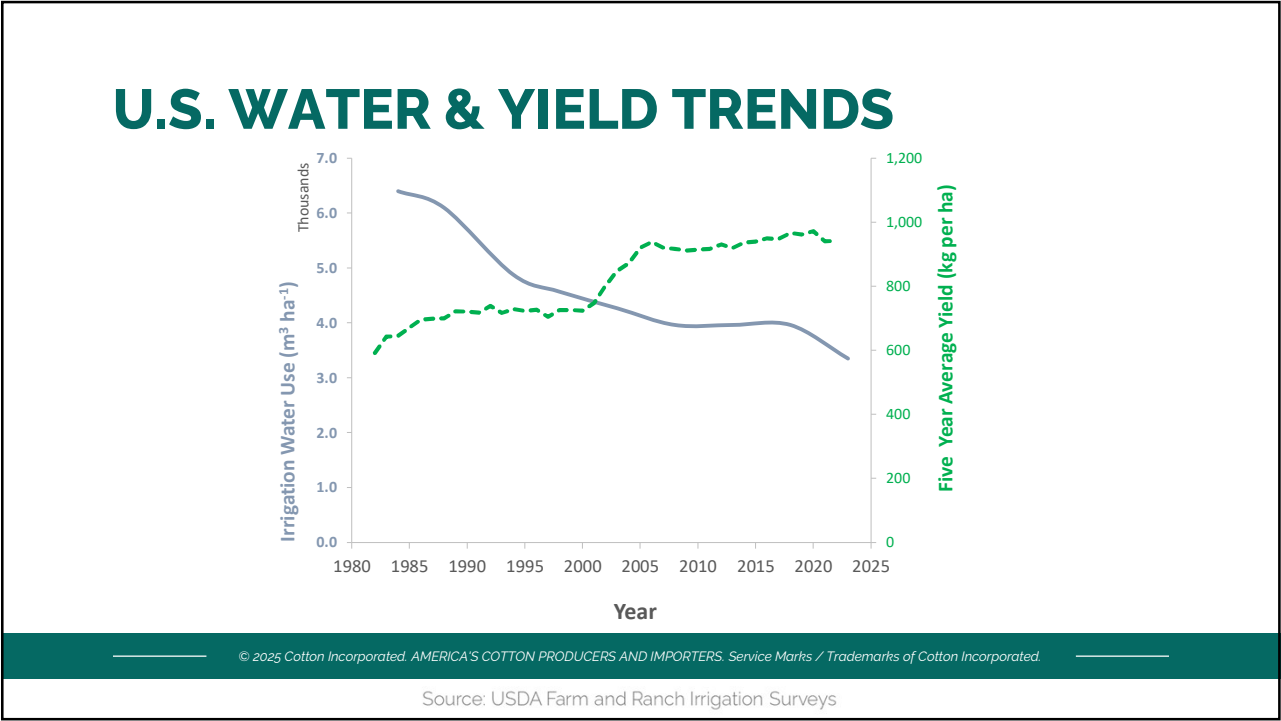
Slide 57

MG1 I added the words "pre-bloom stage" to the title. I am not sure if it is worth trying to introduce a new term "squaring" to this group because they will not likely see one in the field portion. I think "pre-bloom" will make more sense to them.

Morgan, Gaylon, 2025-09-17T12:14:15.589

EB1 0 I like making the joke that a square is a triangle.

Barnes, Ed, 2025-09-22T15:28:47.073



59

MAXIMIZE RAINFALL CAPTURE

OPTIMIZE IRRIGATION WATER USE

WATER STRATEGY

INCREASE PLANT WATER PRODUCTIVITY

EVALUATE WITH METRICS

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MAXIMIZING RAINFALL: SOIL HEALTH AND FARM PONDS



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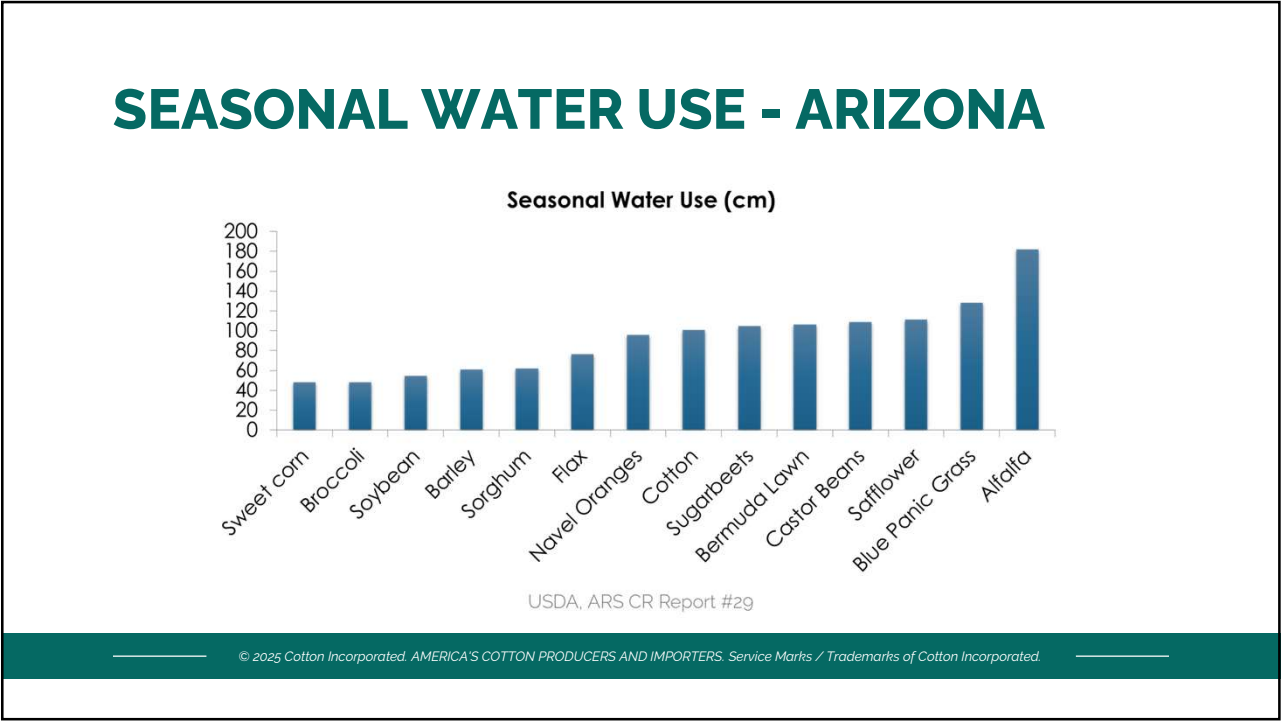
61

OPTIMIZING IRRIGATION DELIVERY AND TIMING SYSTEMS

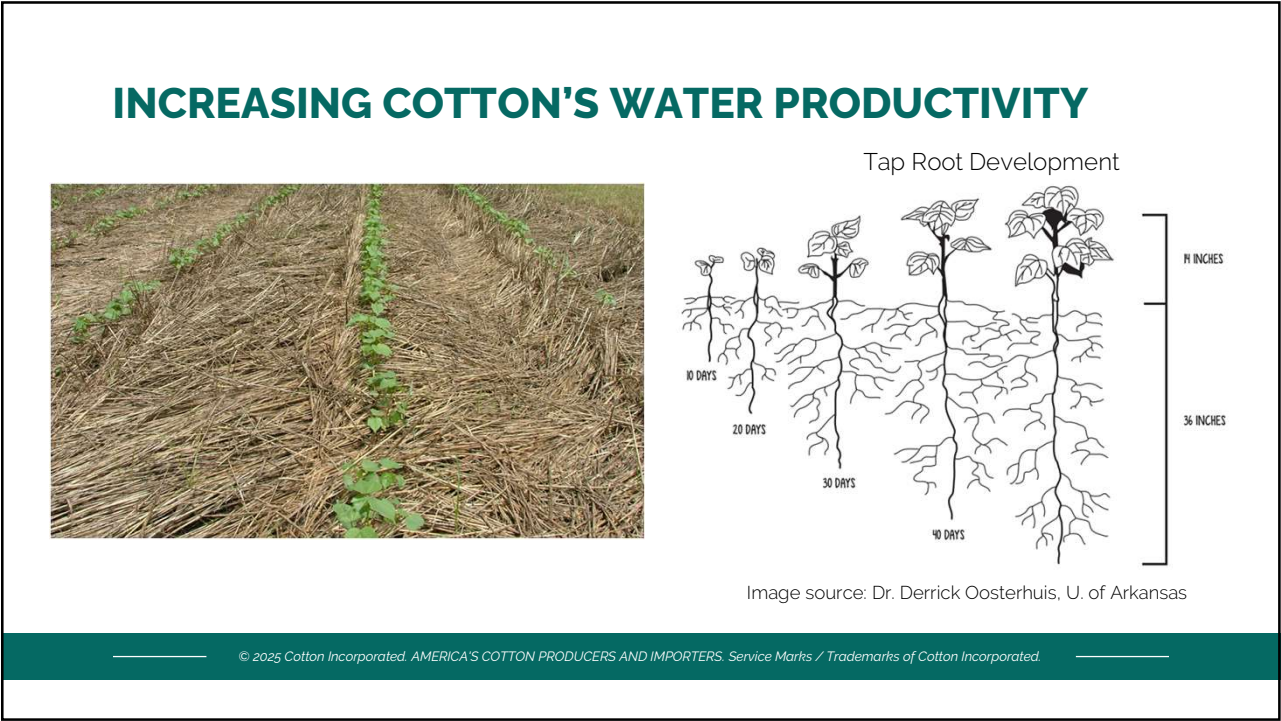


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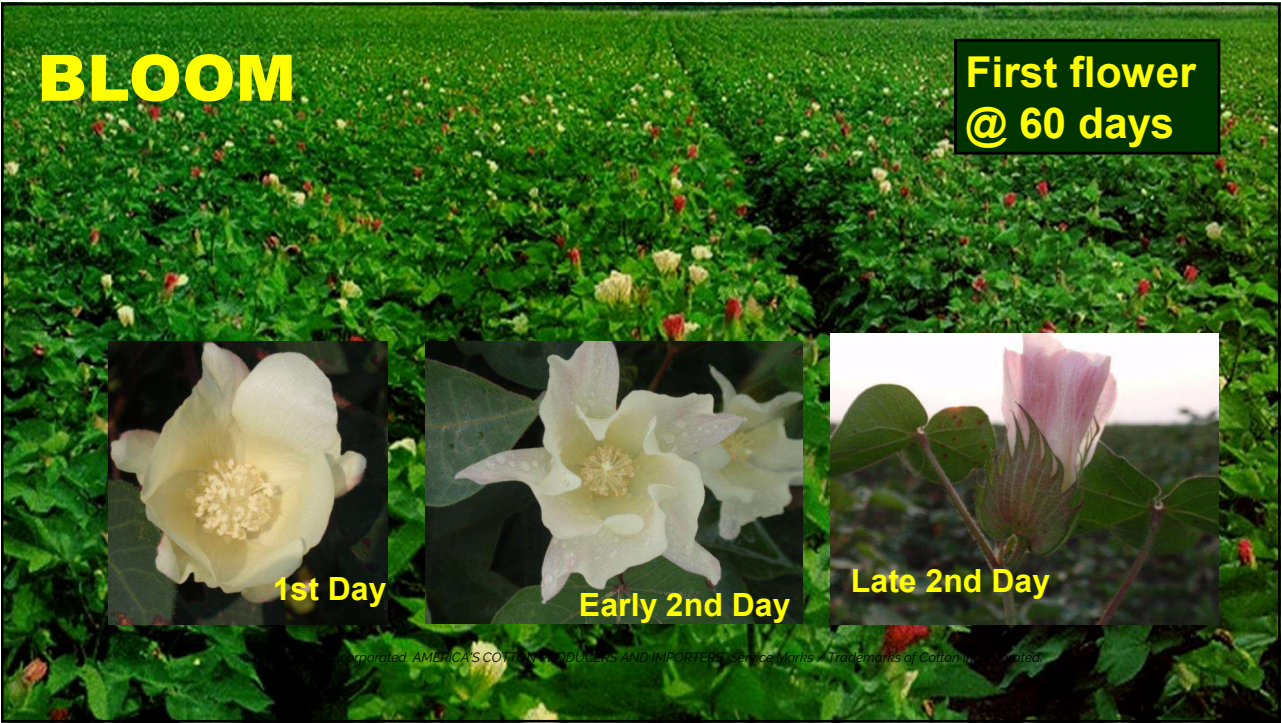
62



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INTEGRATED PEST MANAGEMENT (IPM)

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66

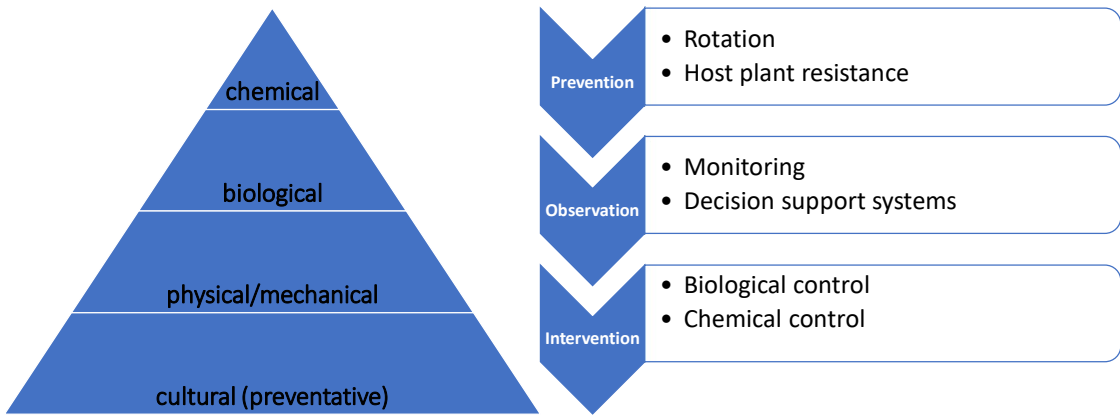
WHAT IS IPM ANYWAY?

- Management, not control.
- People-oriented. Decisions are made on the farm level.
- Preventative and therapeutic practices.
- First principle of IPM – take no action unless a pest is present and poses an actual or potential threat (usually economic).

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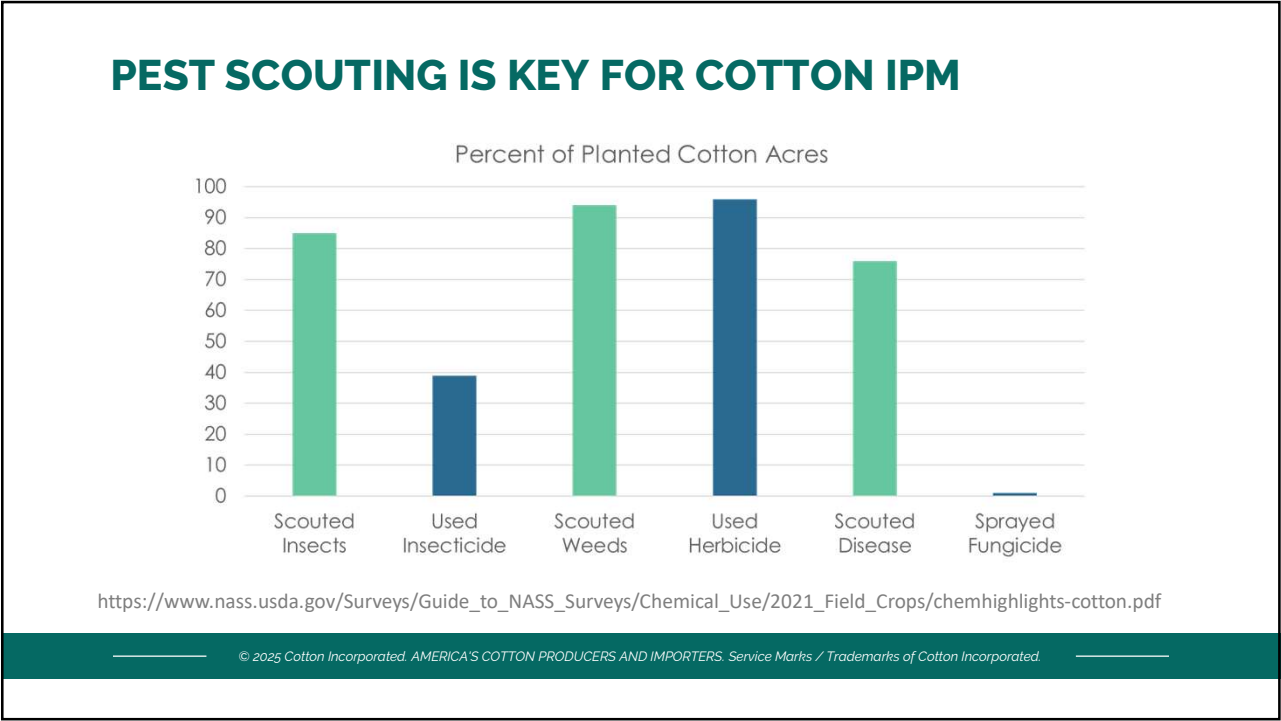
67

IPM PYRAMID

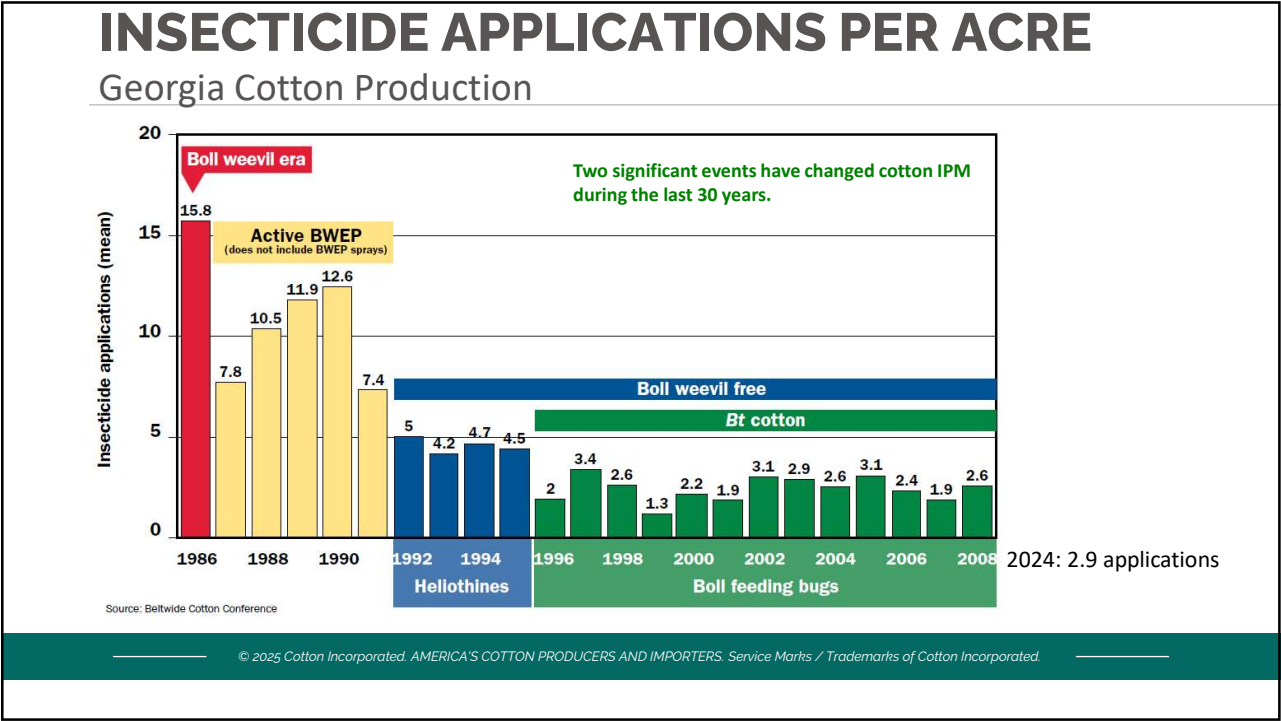


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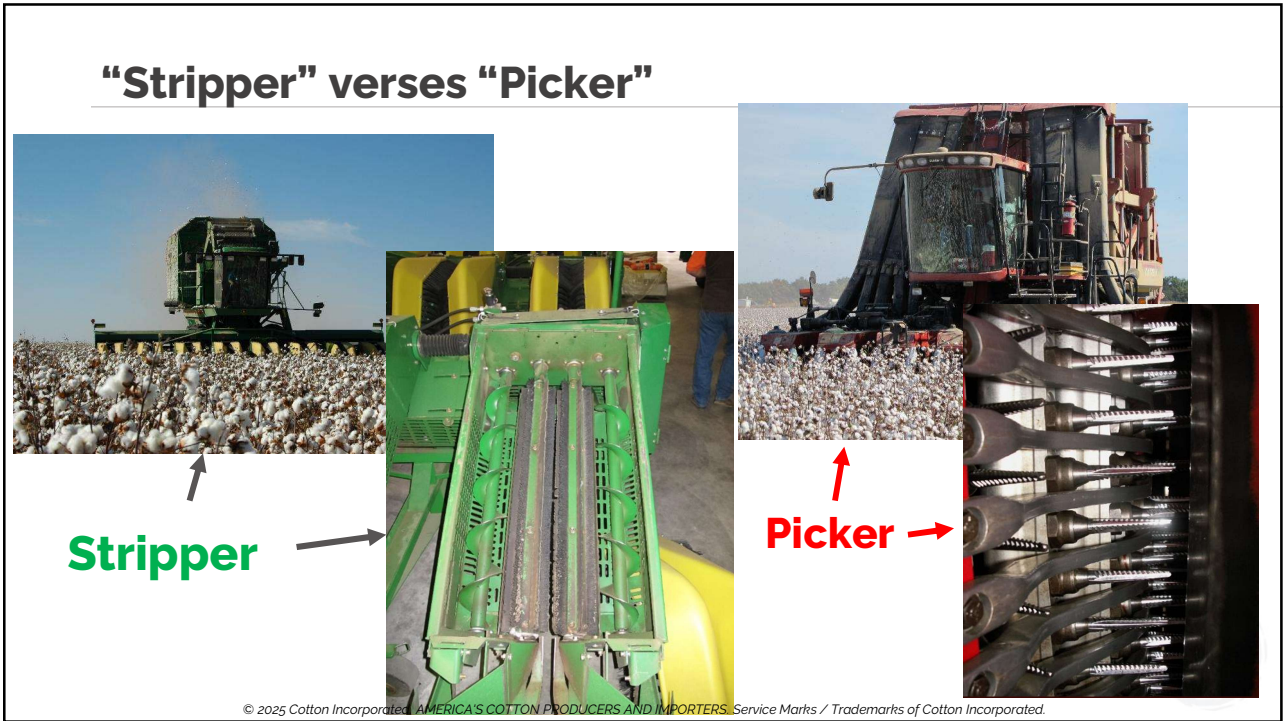
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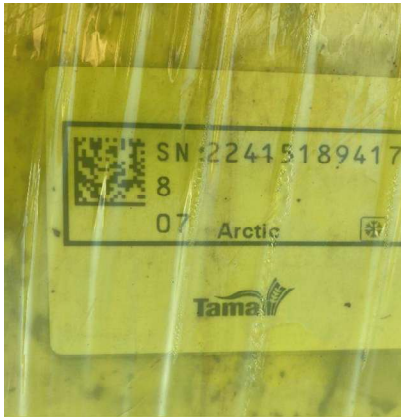
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74



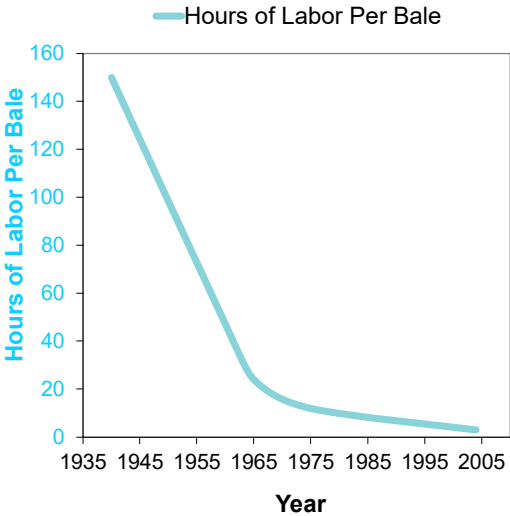
Current Harvest System

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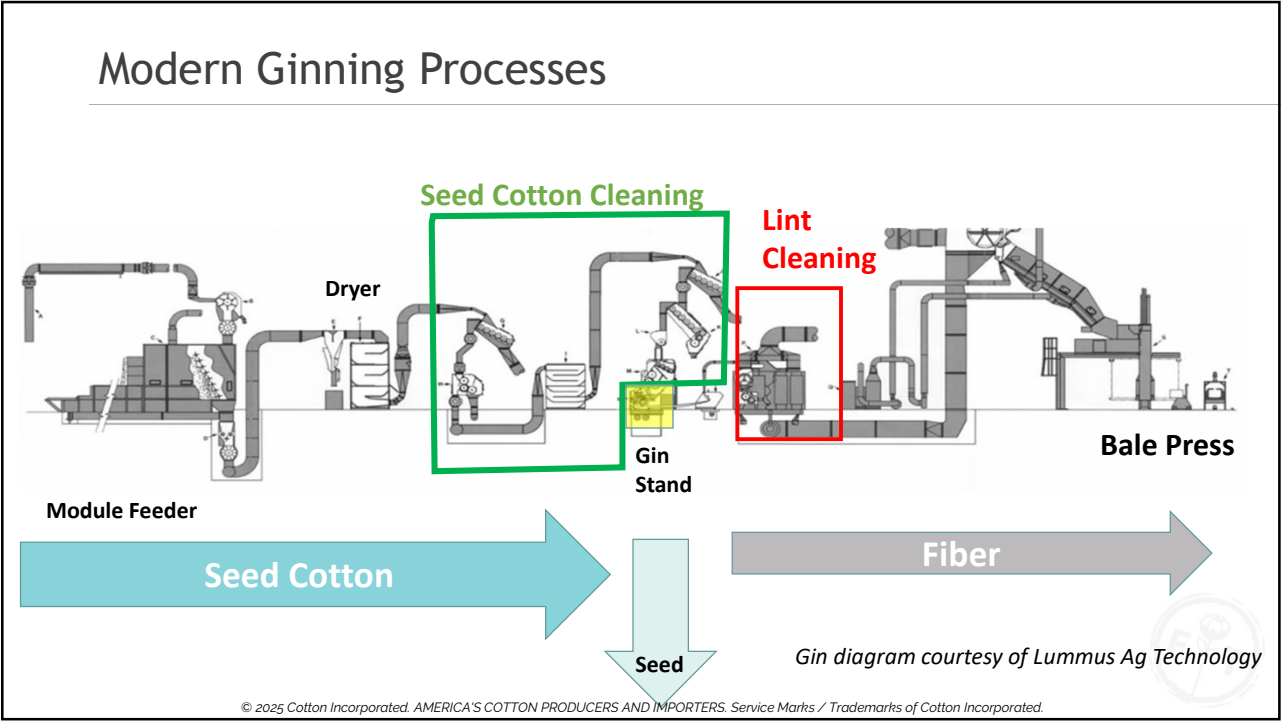
Impact of Mechanization on Labor



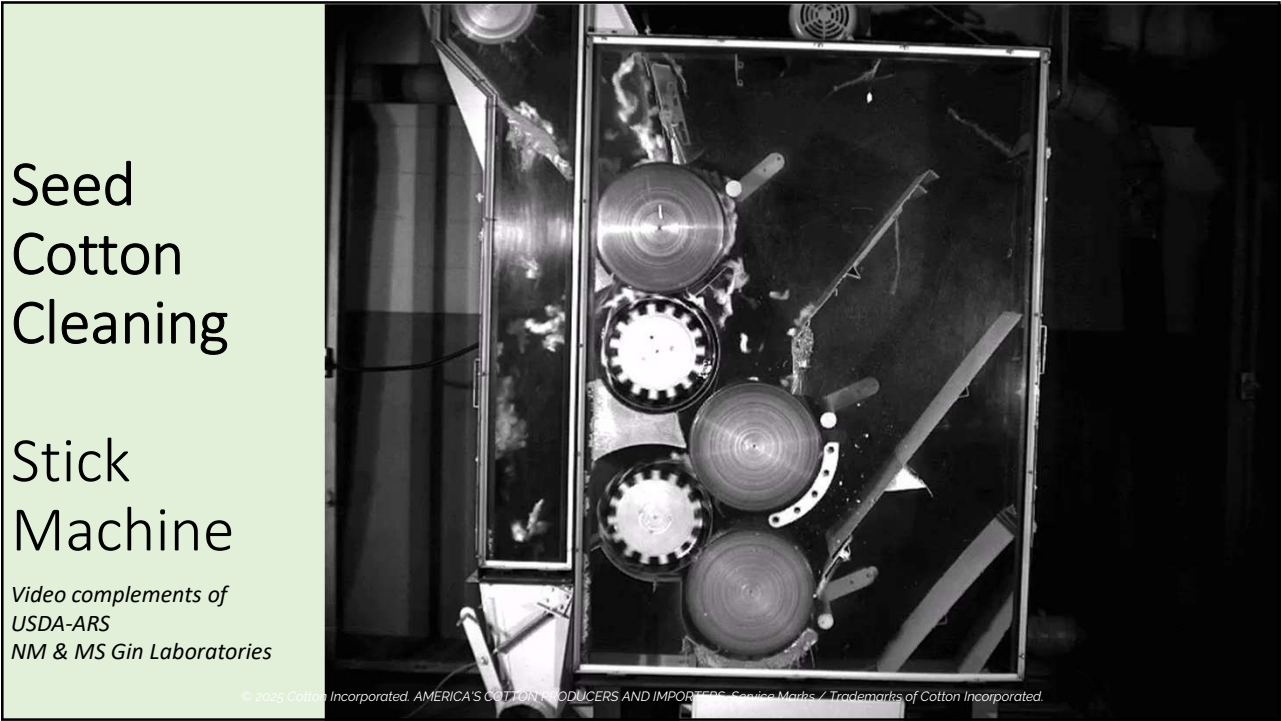
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FOOD, FIBER & MORE

5,200 lbs. of "Seed Cotton"	
2,800 lbs. Seed	  
2,000 lbs. Fiber	  
400 lbs. Co-Product	 

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NEW TECHNOLOGIES

Photo credit: Simer Virk, UGA

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AUTOMATION APPLICATIONS



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Cotton Has a History of Data Use

Data Flow at Harvest



Harvester → Gin → Bale → AMS → Warehouse → Merchant → Mill

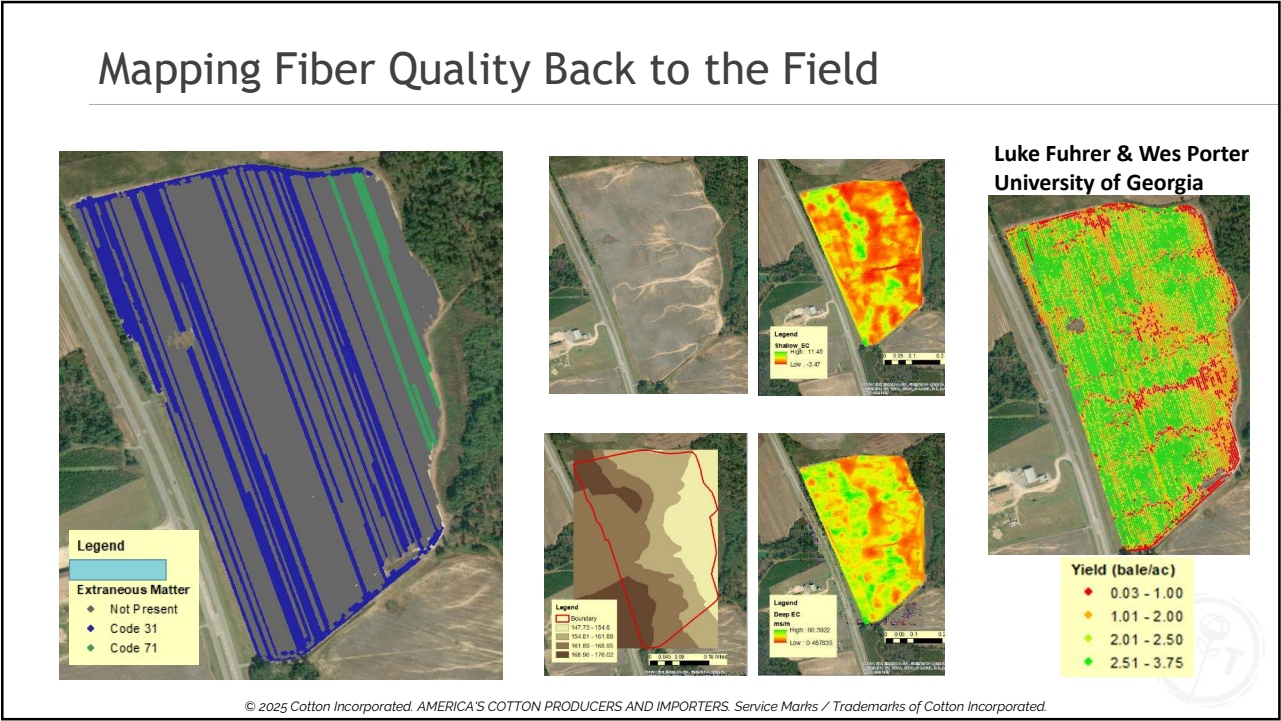
Location → RFID → Gin/Grower

- Quality Map
- Linked with PBI tags
- PBI + HVI Data



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COMMON THEMES FOR IMPROVEMENT

Yield Increase

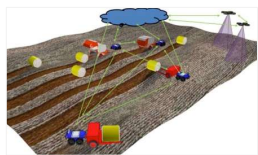
- Genomics & Breeding

Cover Crops

- Soil improvement (erosion, quality, & carbon)
- Weed suppression
- Rainfall capture (water quantity & quality)

Precision Management

- IPM to Optimize pesticide use
- Sensor-based fertilizer and water use
- Robots to reduce GHG, energy, labor, and since harvested when boll opens, less field loss and better quality



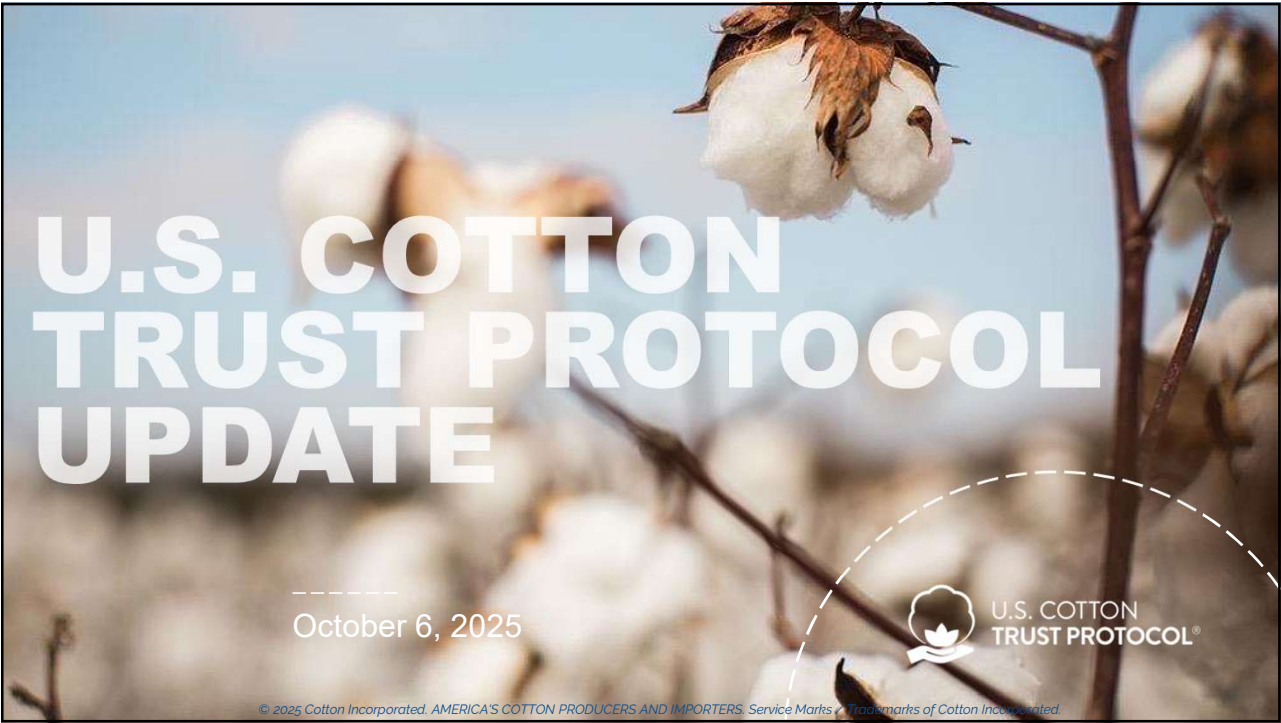
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QUESTIONS?



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HOW IS THE TRUST PROTOCOL UNIQUE?

As the world's first cotton fiber program to offer article-level traceability, we are at the forefront of delivering full transparency and accountability throughout the cotton supply chain.

Verified Field Data

+

Transparent Supply Chain

=

Sustainability and Transparency you can trust.

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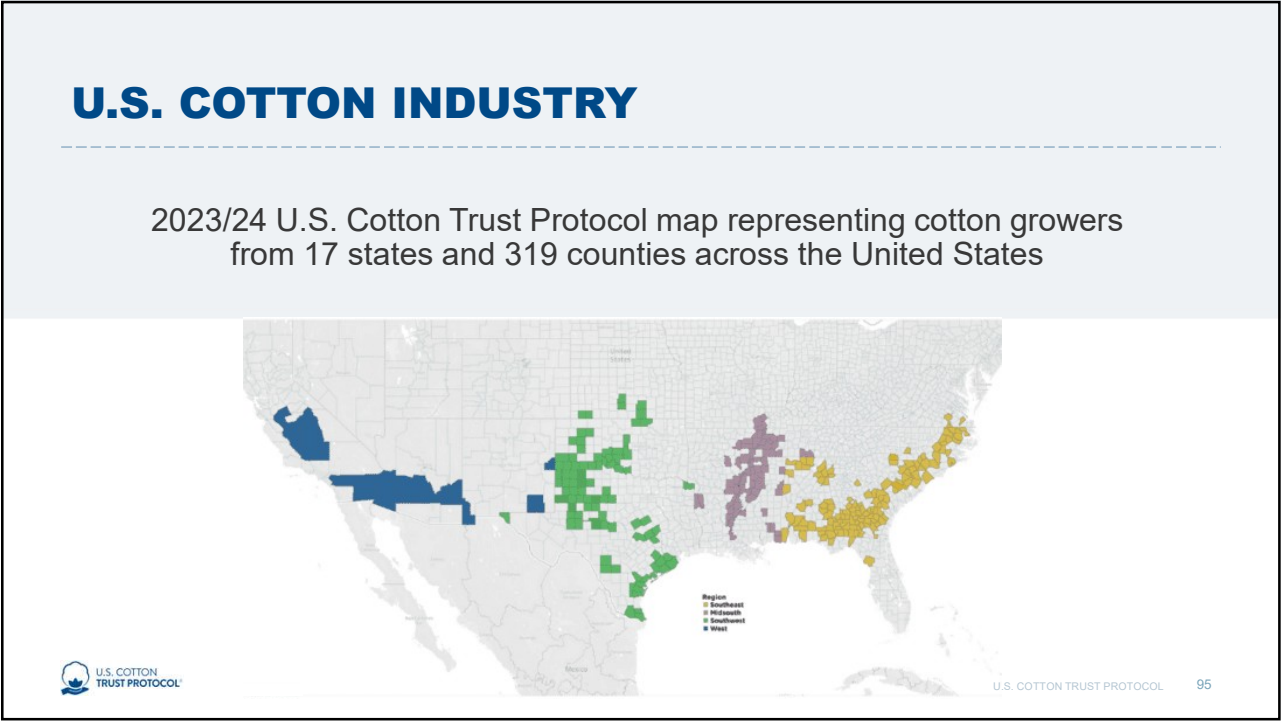
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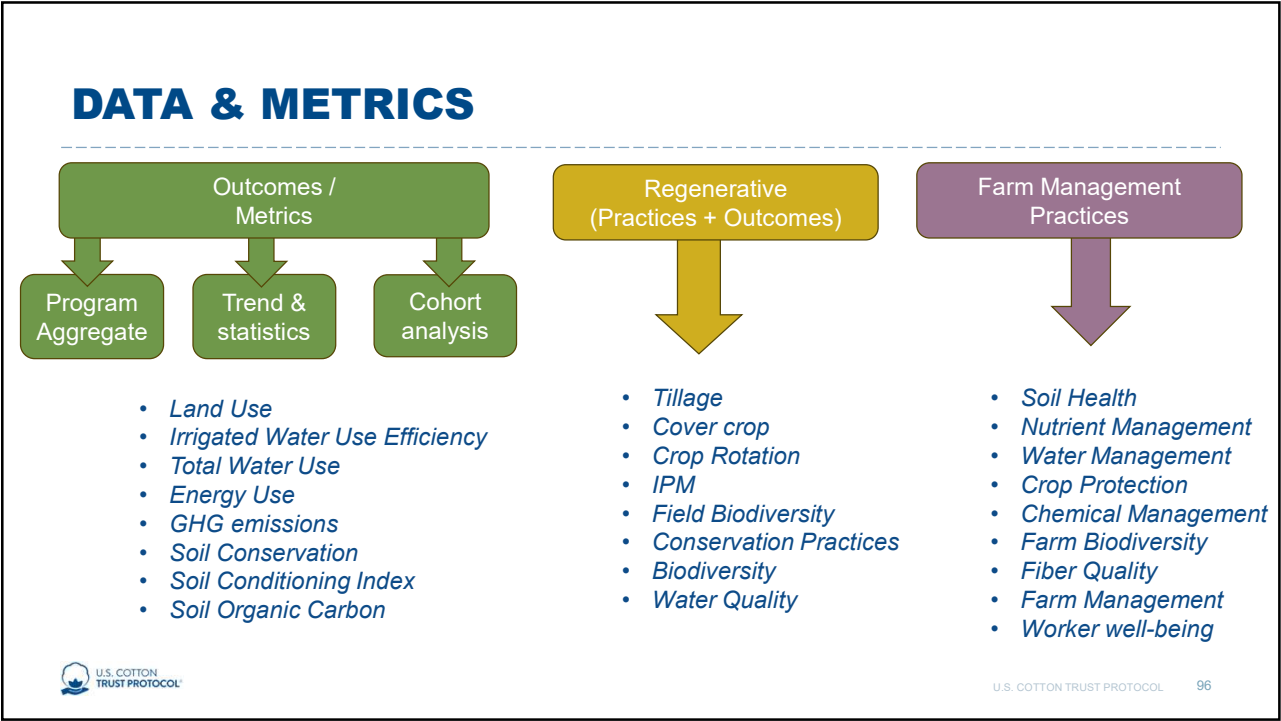
BEGINNING AT THE FIELD

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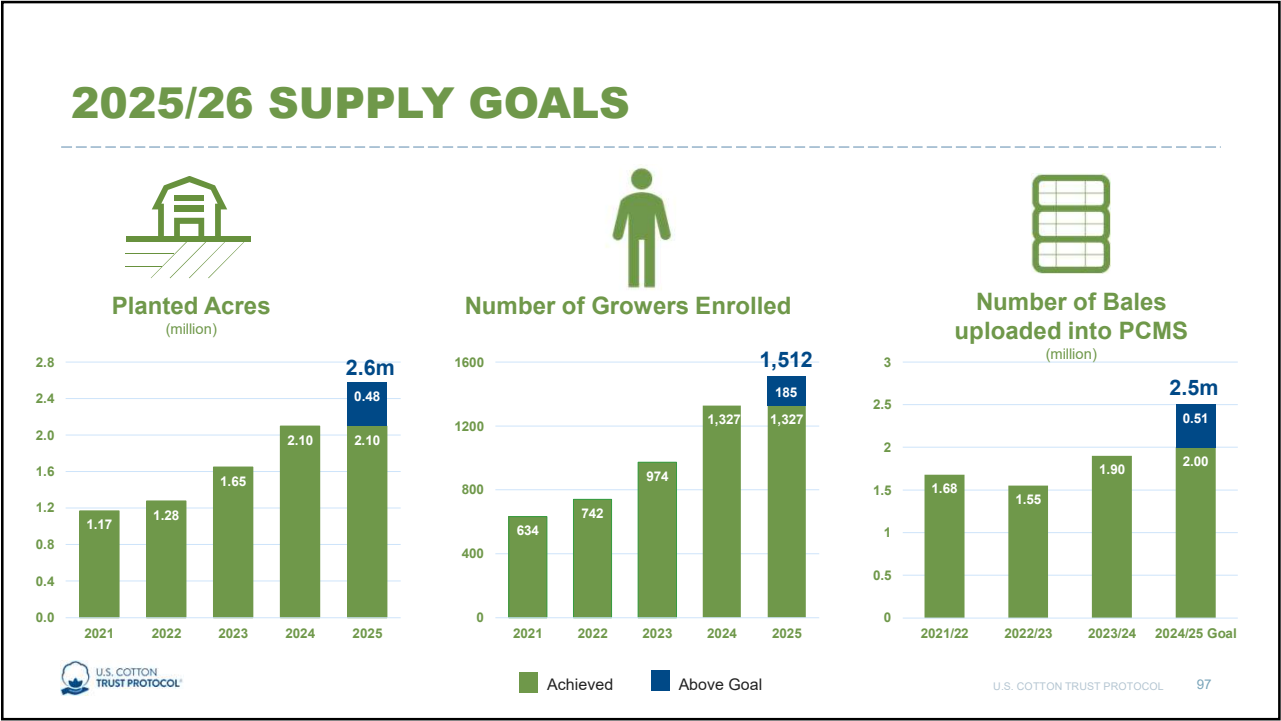
94

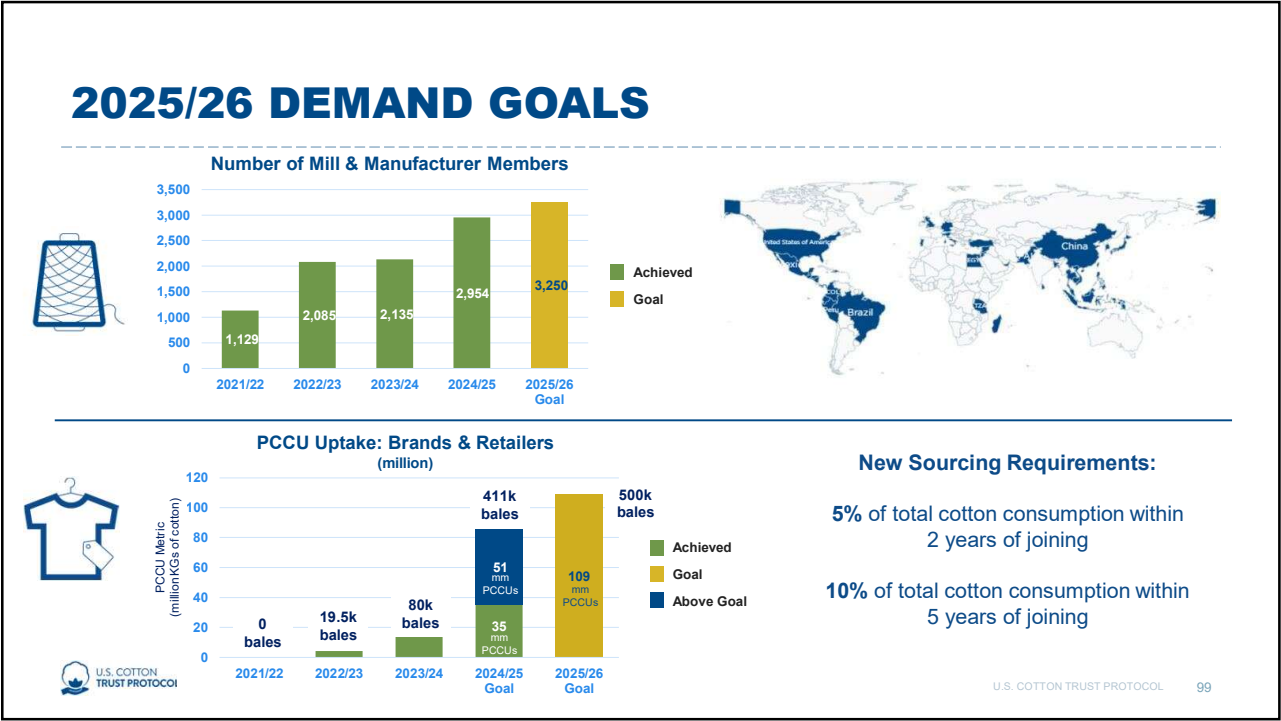


95



96







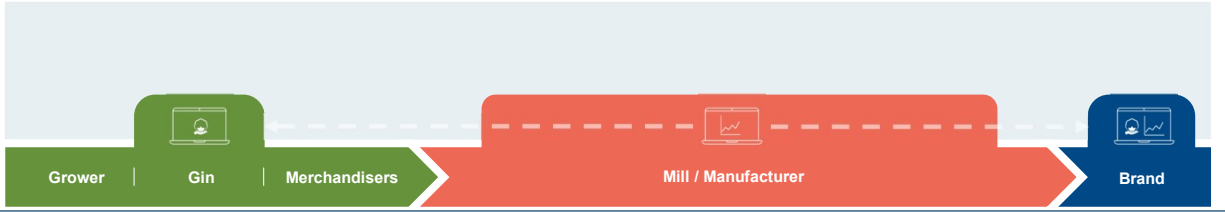
SUPPLY CHAIN TRANSPARENCY AND TRACEABILITY

101

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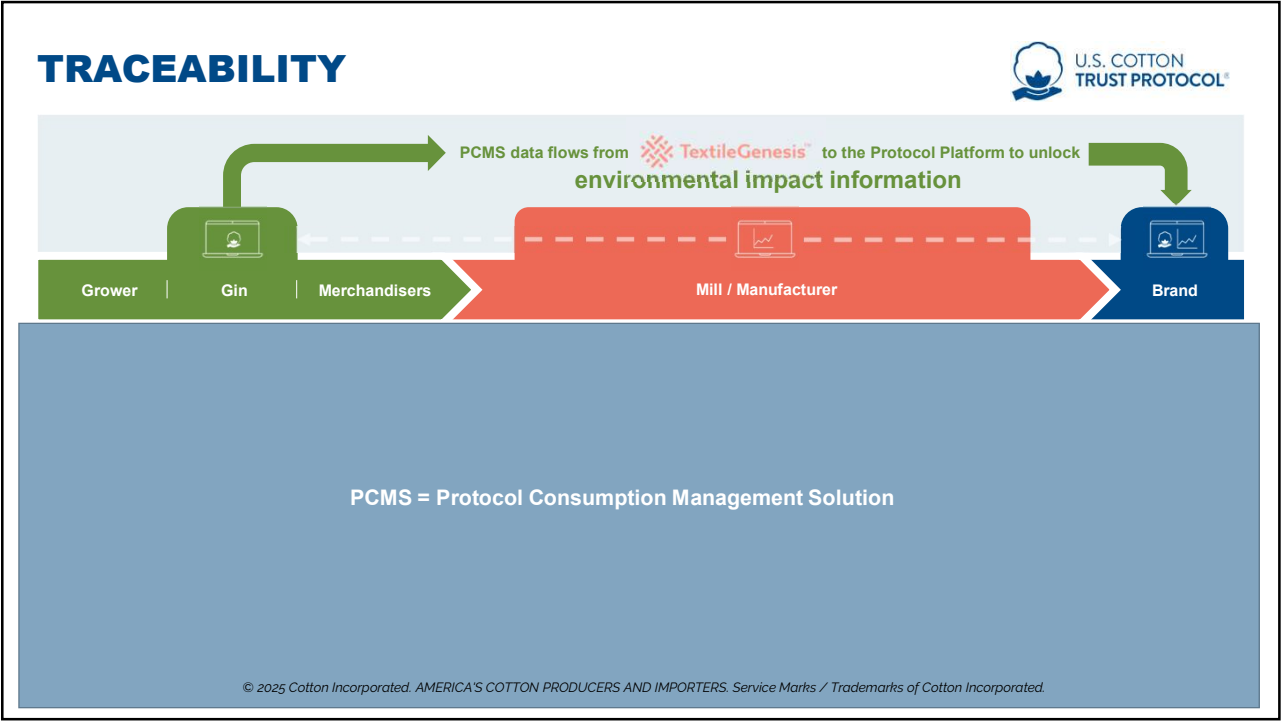
101

TRACEABILITY

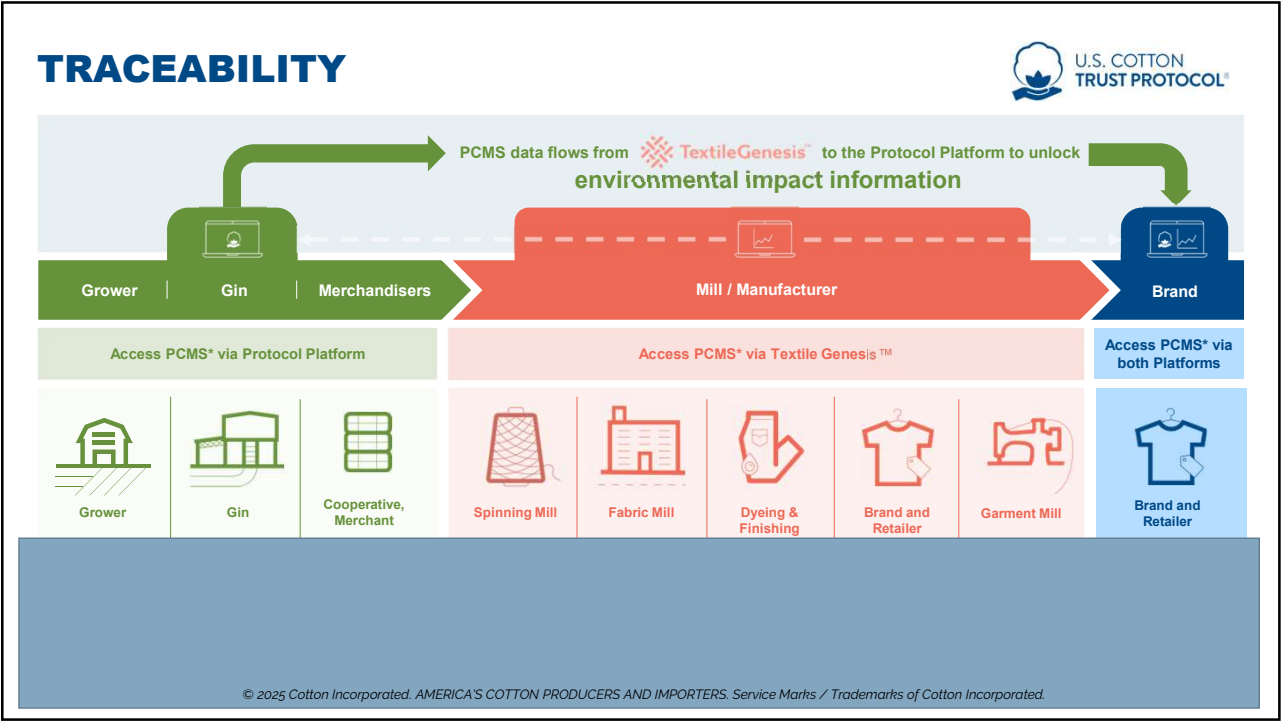


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102

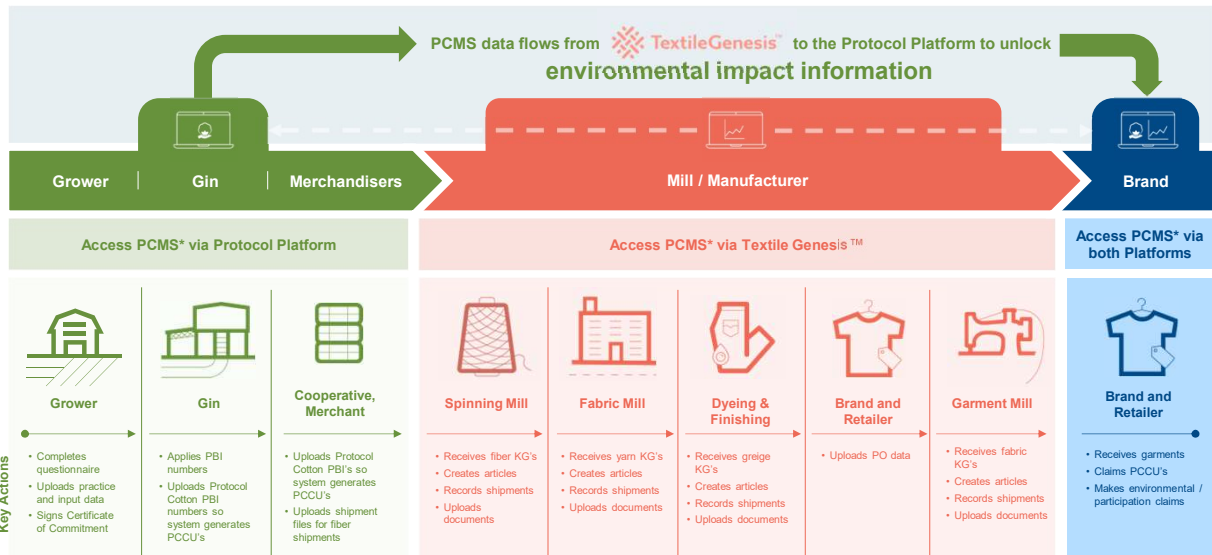


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TRACEABILITY

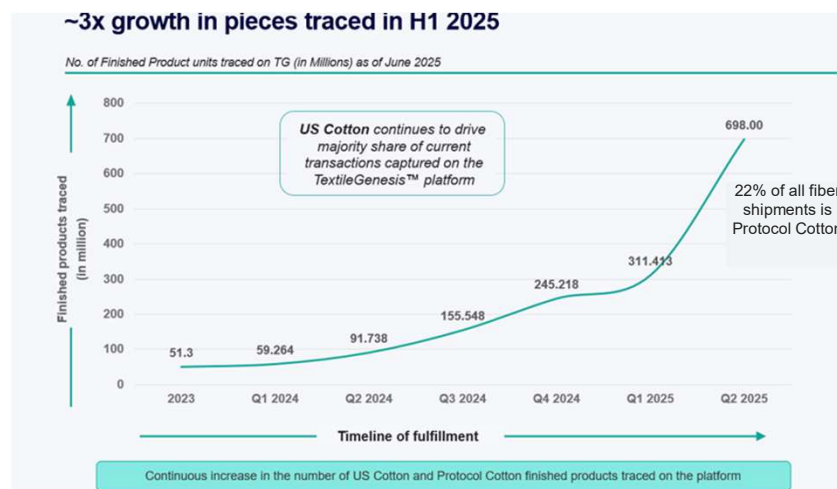


*The Protocol Consumption Management Solution (PCMS) is a holistic technology solution that allows tracking of U.S. Cotton and Protocol Cotton under the Trust Protocol program.

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PROGRAM GROWTH



U.S. COTTON
TRUST PROTOCOL®

U.S. COTTON TRUST PROTOCOL 106

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BRAND & RETAILER MEMBER BENEFITS

 TRACEABILITY	 ENVIRONMENTAL DATA	 COMMUNICATIONS
• Comprehensive technology access • Strengthened supply chain and stakeholder confidence	• Support transparency and corporate reporting • Collective impact and continuous improvement	• Transparent and streamlined pricing • Comprehensive toolkit and brand visibility



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TRUST PROTOCOL DATA APPLICATIONS

Science-Based Targets for Nature (SBTN) Target Setting

Trust Protocol metrics align with SBTN targets for freshwater, land, biodiversity, and climate, providing data for setting and tracking progress towards science-based goals.

Corporate Sustainability Reporting Directive (CSRD) Benchmarking

Trust Protocol data can be used to benchmark performance against CSRD requirements, demonstrating transparency and accountability in sustainability reporting.

Scope 3 Reporting

Trust Protocol provides data on emissions from cotton cultivation, enabling brands to accurately report their Scope 3 GHG emissions and track progress towards reduction targets.



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NOW IN REPORTS, ONLINE AND IN STORES

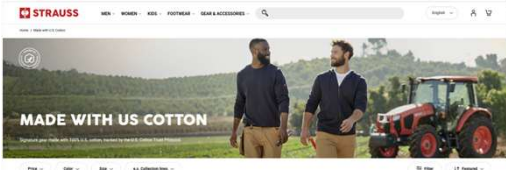
Sustainably grown cotton:
Natural, traceable and
transparent from
farms to fiber.

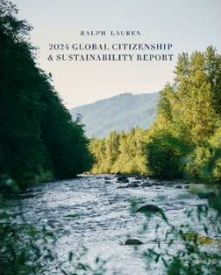
Macy's, Inc. is a proud
member of the U.S. Cotton
Trust Protocol.

All of the cotton for this product
is verified by the
U.S. Cotton Trust Protocol,
a program which works with
family farms committed to
improving their environmental
footprint by minimizing
water usage, improving
soil diversity and reducing
greenhouse-gas emissions.











U.S. COTTON TRUST PROTOCOL

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THANK YOU

Daren Abney
Executive Director
Dabney@cotton.org

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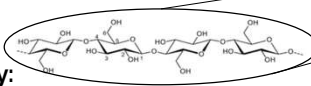
114



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GLOBAL CELLULOSE SOURCES AND NATURAL CYCLING

- Cellulose is the most abundant polymer on earth [1, 2], found in plant cell walls (repeating chains of glucose 1,000 – 30,000 long [2])
- 1.5 trillion (1,500,000,000,000) tons of cellulose produced and decomposed by earth/year [2]
- Cotton is 95% cellulose [3]
- Important sources of cellulose globally:



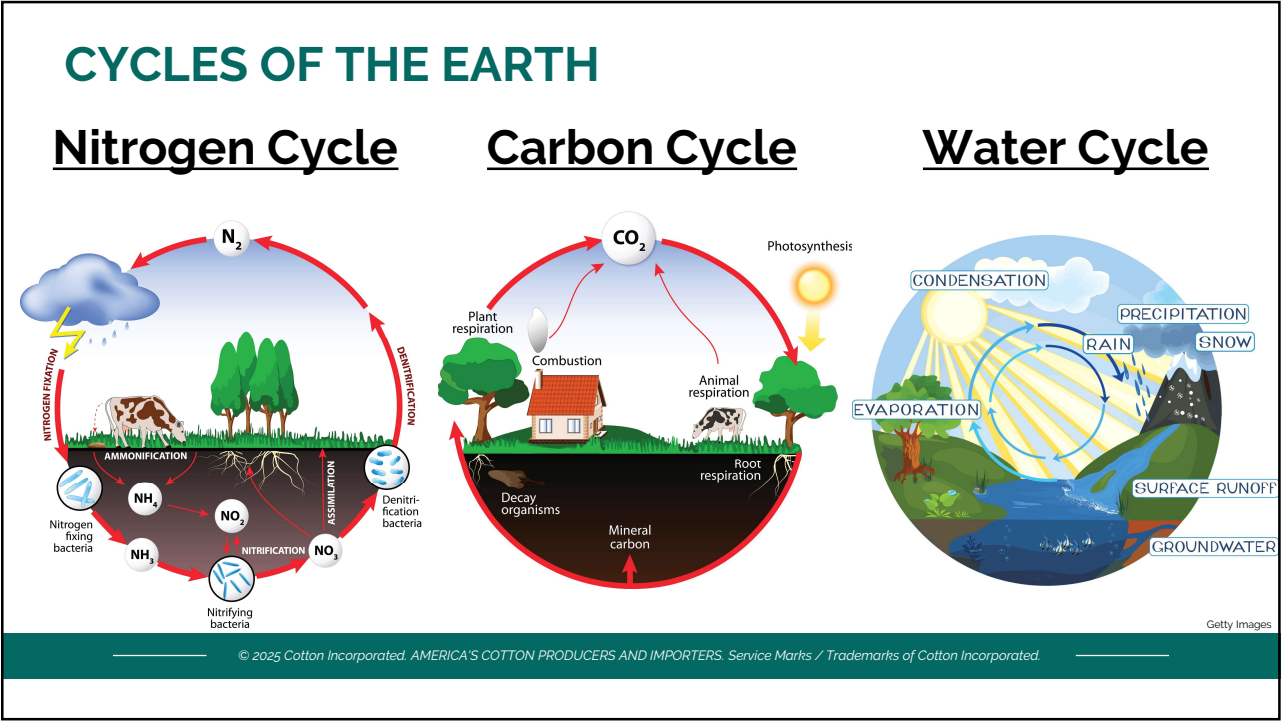


Sources: [1] Ho, N. W. Y., Ladisch, M. R., Sedlak, M., Mosier, N. & Casey, E. (2011). Biofuels from Cellulosic Feedstocks. Comprehensive Biotechnology, Second Edition, 3: 51–62. <https://doi.org/10.1016/B978-0-08-088504-9.00155-0>
[2] Thomas Heinze (2015). Cellulose: Structure and Properties. Cellulose Chemistry and Properties: Fibers, Nanocelluloses and Advanced Materials, pp 1-52. https://link.springer.com/chapter/10.1007/12_2015_319
[3] Wakelyn, P.J. (2006). Cotton Fiber Chemistry and Technology (1st ed.). CRC Press. Chapter 3

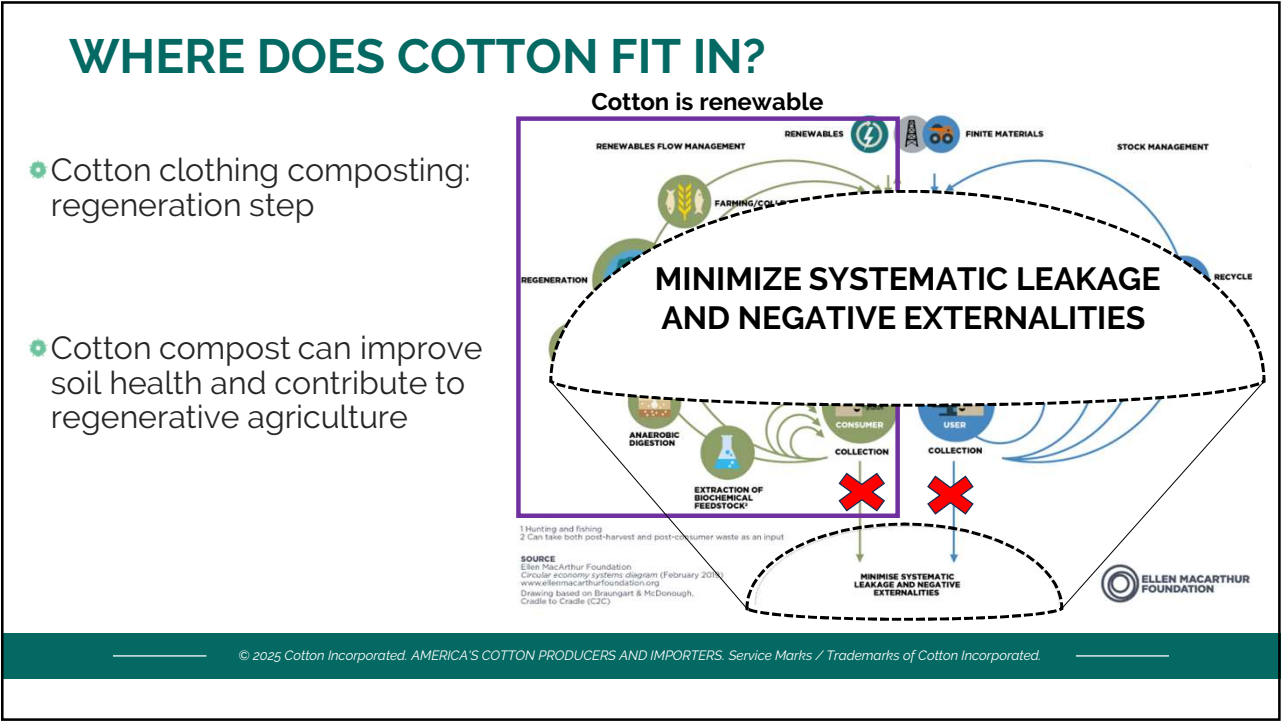
Getty Images

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TEXTILE WASTE IS A GROWING ISSUE

Fast fashion has spawned a mountain of leftover clothes in the Chilean desert that's so massive it can now be seen clearly from space



Getty Images

HOME > SUSTAINABILITY > NEWS
Fashion is Falling Short When it Comes to 'Closing the Loop'

BY KATE NISHIMURA JUNE 1, 2023 2:38PM



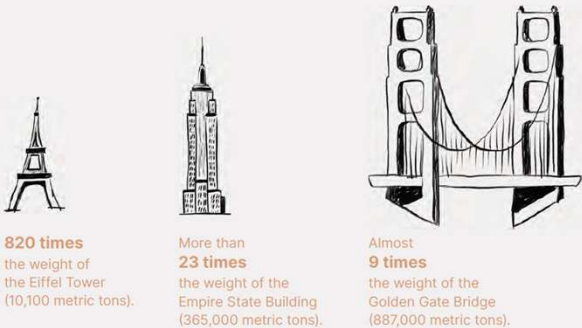
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SITUATION OF THE APPAREL INDUSTRY

This plastic weight of ~8,300,000 metric tons is equivalent to:

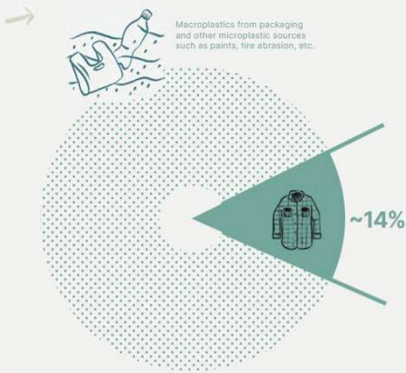
This plastic weight of ~8,300,000 metric tons is equivalent to:



https://cottontoday.cottoninc.com/wp-content/uploads/2024/06/Plastic_Leakage_Assessment_of_Global_Apparel_Industry_Topline_Report.pdf

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Global plastic leakage

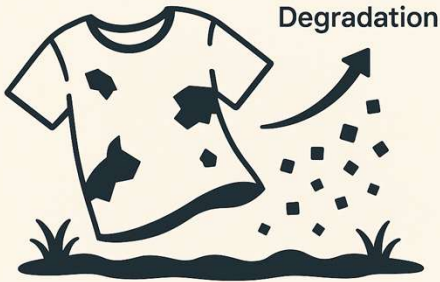


The global apparel industry is responsible for 14% of overall plastic leakage.

120

TYPES OF MICROPLASTICS/FIBERS FROM TEXTILE

Secondary Microfibers



Degradation



Laundering

PRIMARY MICROFIBERS

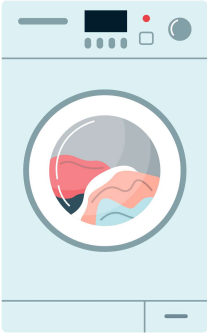
Graphics created by ChatGPT

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UNINTENDED CONSEQUENCES OF LAUNDERING

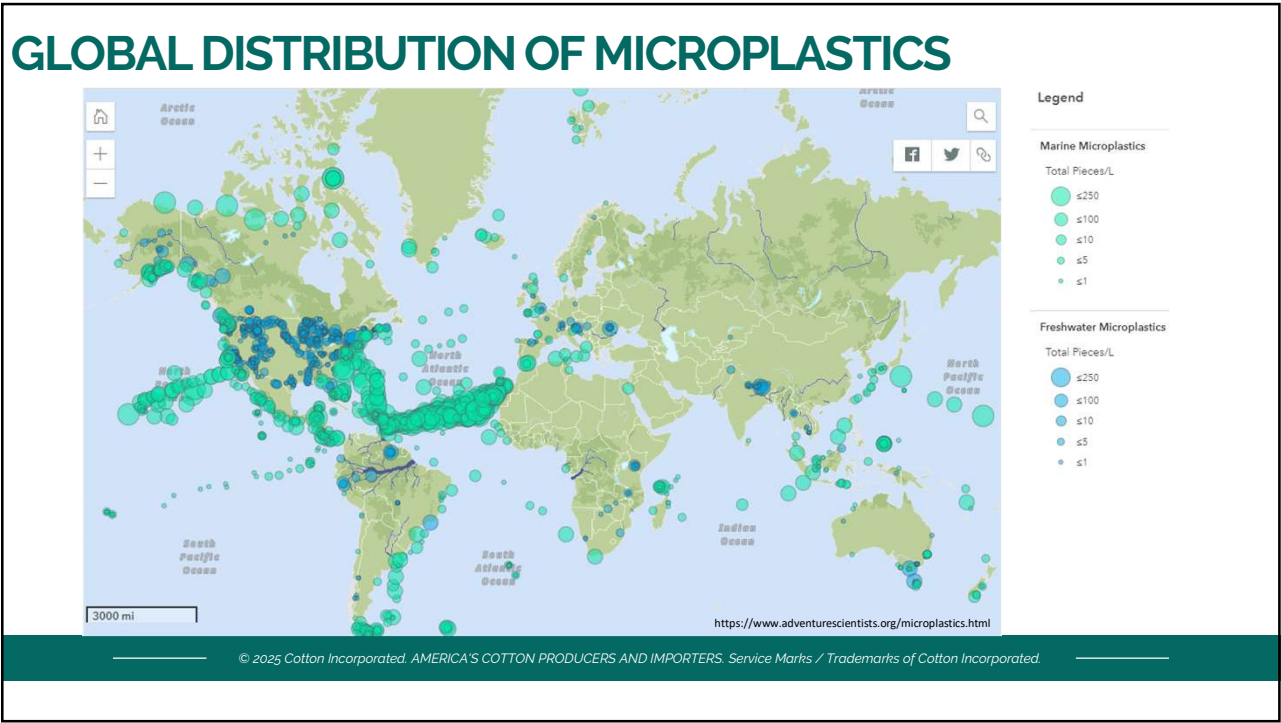
- Every load of laundry releases thousands of microfibers into the wastewater
- Some microfibers are filtered out at sewage treatment plants
- Many microfibers continue to rivers and streams to the oceans



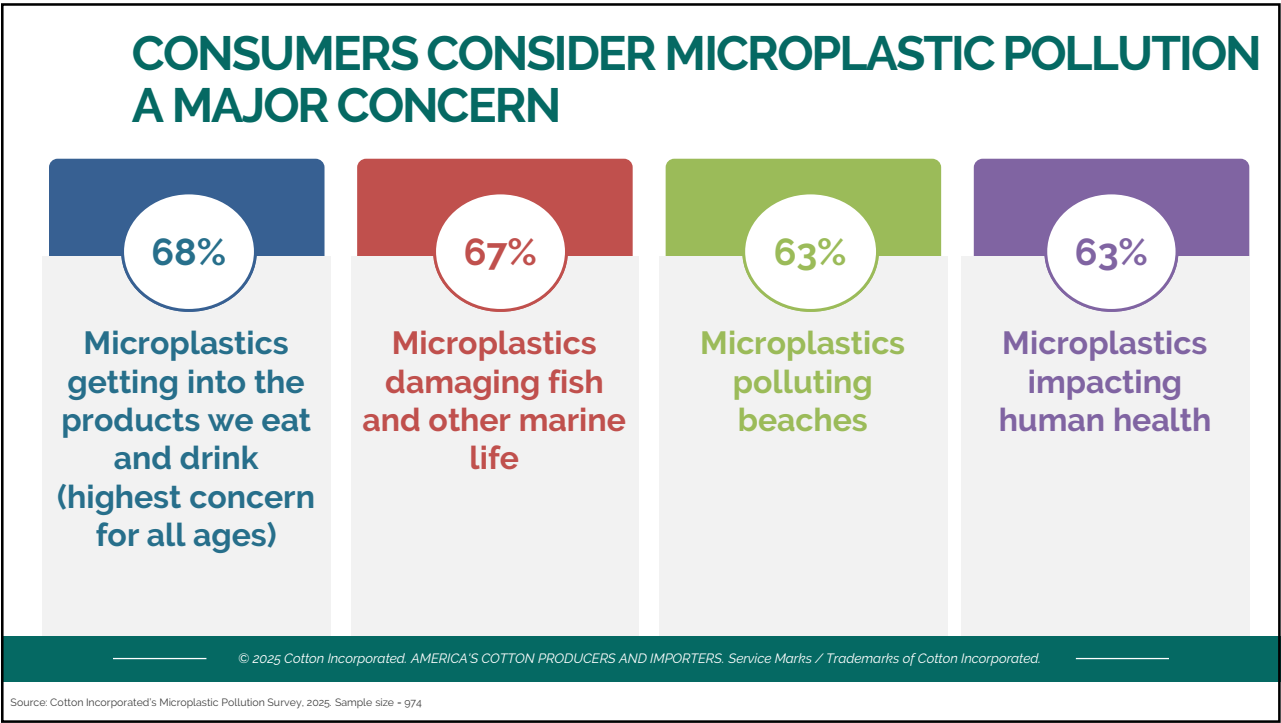
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GU1

NATIONAL COTTON COUNCIL CAMPAIGN

Plant
not
plastic

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GU1

The Guardian

US

Tom Perkins Thu 28 Aug 2025 08:00 EDT

Humans inhale as much as 68,000 microplastic particles daily, study finds

Particles are small enough to burrow into lungs, says report, with health impacts 'more substantial than we realize'



PLOS One

RESEARCH ARTICLE

Human exposure to PM₁₀ microplastics in indoor air

Nadiia Yakovenko¹*, Lucía Pérez-Serrano¹*, Théo Segur¹, Oskar Hagelskjaer^{1,2}, Henar Margenat², Gaël Le Roux², Jeroen E. Sonke¹*

1 Géosciences Environnement Toulouse, CNRS/IRD/Université de Toulouse, Toulouse, France, 2 Centre de Recherche sur la Biodiversité et l'Environnement, CNRS/INP/Université de Toulouse, Auzeville-Tolosane, France

© These authors contributed equally to this work.

* nadiia.yakovenko@get.omp.eu (NY); jeroen.sonke@univ-tlse3.fr (JES)

"The MP_{1-10 μm} exposure estimates are 100-fold higher than previous estimates that were extrapolated from larger MP sizes, and suggest that the health impacts of MP inhalation may be more substantial than we realize."

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<https://www.theguardian.com/environment/2025/aug/28/microplastics-in-hair-study>

Yakovenko N, Pérez-Serrano L, Segur T, Hagelskjaer O, Margenat H, Le Roux G, et al. (2025) Human exposure to PM10 microplastics in indoor air. PLoS One 20(7): e0328011. <https://doi.org/10.1371/journal.pone.0328011>

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Slide 125

GU1 Sue Coleman - Please make it clear this is the NCC campaign.

Guest User, 2025-09-30T12:22:50.418

SP1 0 See new slide header.

Pires, Steven, 2025-09-30T17:29:09.479

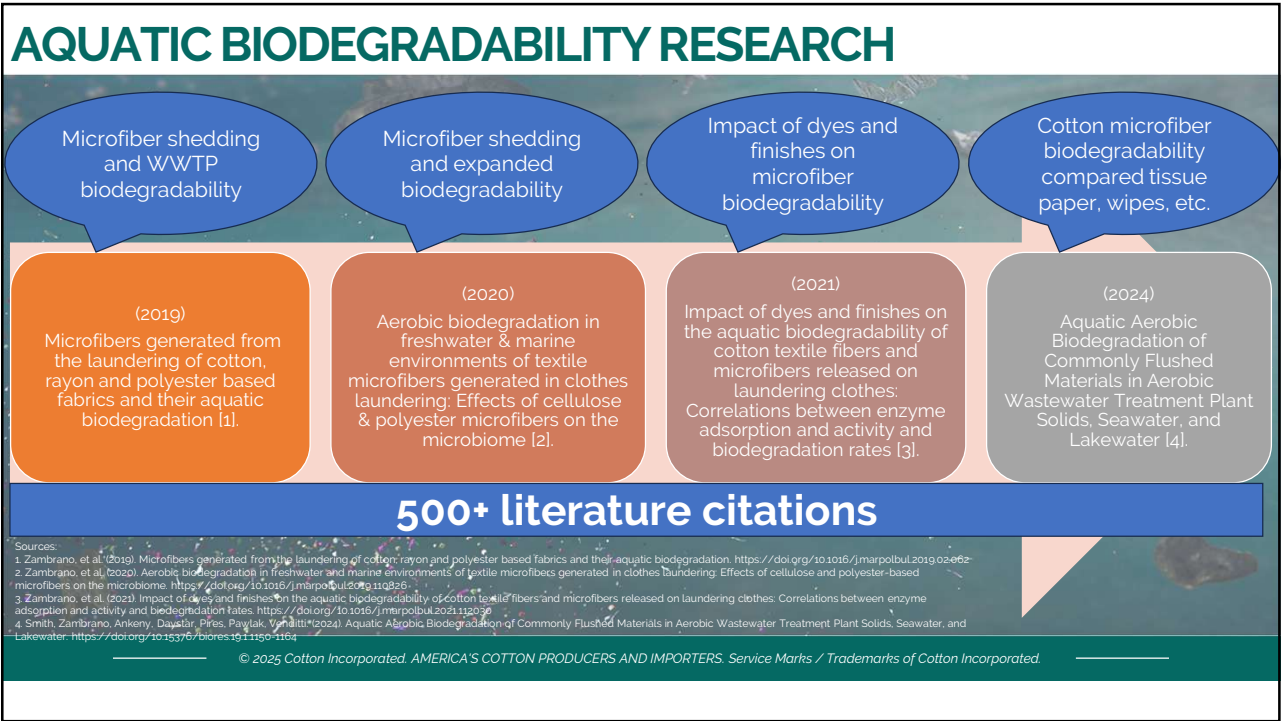
Slide 126

GU1 Sue Coleman - The evidence you are showing are research articles which cannot be used to communicate a result. From what you provide it lacks evidence of casual effect.

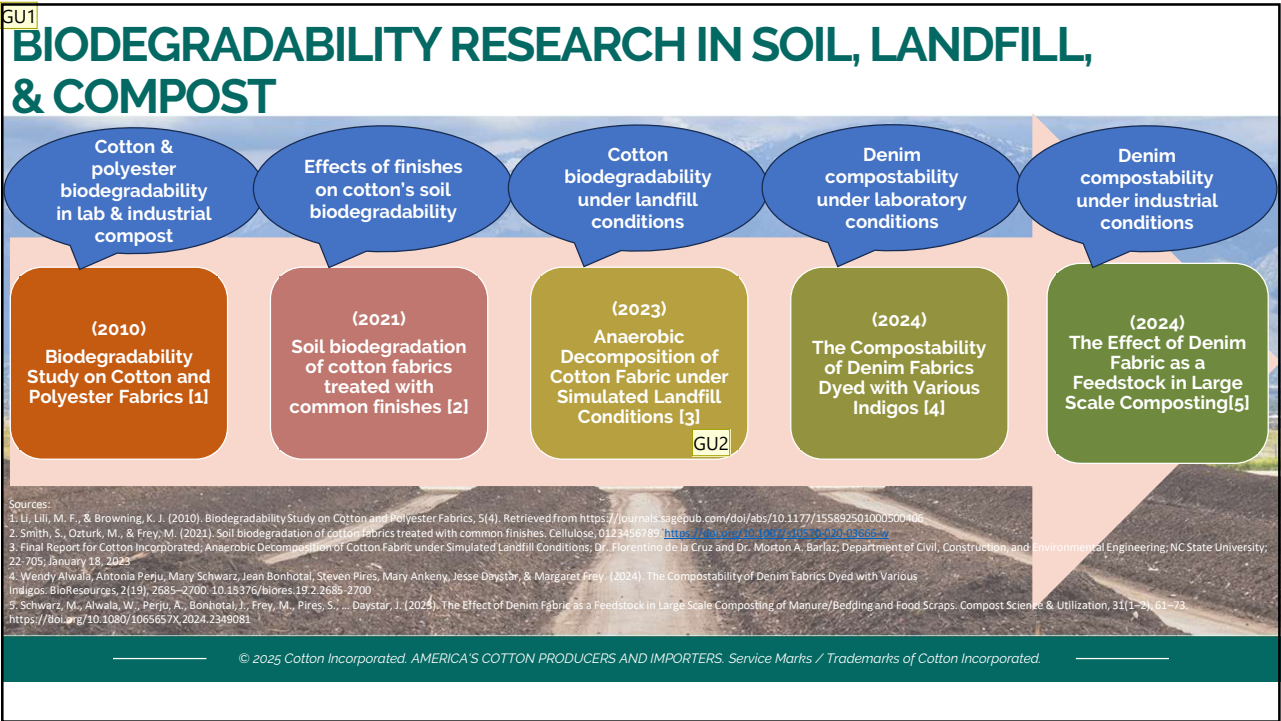
Guest User, 2025-09-30T12:23:58.794

SP1 0 Notes of lung cancer impacts removed. OK to keep with those notes removed, based on our 9/30 conversation at CI.

Pires, Steven, 2025-09-30T17:36:42.660



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Slide 128

GU1 Sue Coleman - Needs reference numbers to the citations below.

Guest User, 2025-09-30T12:24:43.139

SP1 0 Numbers added to text.

Pires, Steven, 2025-09-30T18:22:15.213

GU2 Sue Coleman - This is a thesis paper that is not published in a peer reviewed journal.

Guest User, 2025-09-30T12:26:58.892

SP2 0 OK to show as is based on our 9/30 conversation at CI. Citation 3 is referencing the project report that was provided by NC State following the conclusion of the Cotton Incorporated funded project #22-705.

Pires, Steven, 2025-09-30T18:23:39.856

FOCUS FOR OUR CIRCULARITY EFFORTS



Environmental Benefits

The potential for significant positive impact on the environment.



Economic Viability

The practicality of the solution in terms of cost effectiveness and potential for return on investment.



Near-Term Scalability

The ability to rapidly and effectively scale the solution.



Gaps in Industry Efforts

The opportunity to make a unique contribution where current industry efforts are lacking.

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WHAT IS THE “CIRCULAR ECONOMY” AND “CIRCULARITY”?



International
Organization for
Standardization

ISO 59020:2024(en) Circular economy — Measuring and assessing circularity performance

3.1 Terms related to circularity and the circular economy

3.1.1 circular economy

economic system that uses a systemic approach to maintain a circular flow of resources, by recovering, retaining or adding to their value, while contributing to sustainable development

3.1.3 circularity

degree of alignment with the principles for a *circular economy* (3.1.1)

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Source: The International Organization for Standardization. Online Browsing Platform: Terms & Definitions. <https://www.iso.org/obp/ui/#home>

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THE PROBLEM

Take

Make

Waste

Linear systems



Image: Courtesy Dr. Jesse Day-Har

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TEXTILE WASTE WILL BE REGULATED

 FASHION DIVE

[Deep Dive](#) [Events](#) [Press Releases](#) [Topics](#) ▾

DIVE BRIEF

California passes Responsible Textile Recovery Act

SB 707, which makes apparel producers responsible for the recycle, reuse and collection of their products, marks the nation's first extended producer responsibility program for textiles.

Published Oct. 3, 2024

 **Laurel Deppen**
Reporter

[in](#) [f](#) [X](#) [p](#) [e](#) [m](#)



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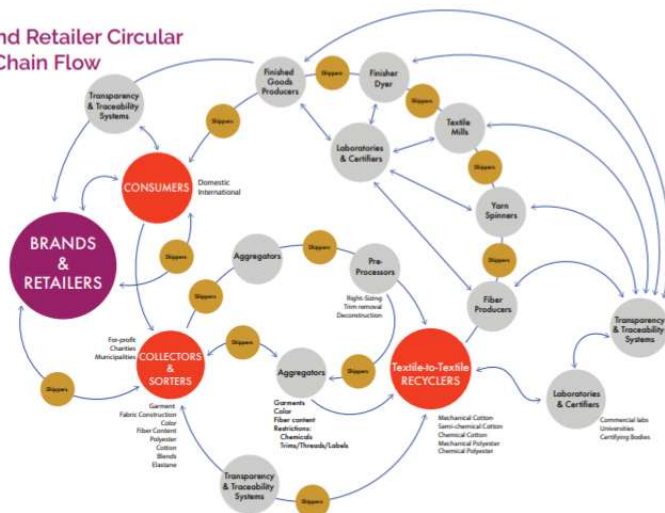
 AI Overview

 Sustainable Packaging Coalition

Oct 24, 2023 – Key Takeaways. Extended producer responsibility (EPR) is a policy approach that assigns produce...

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Brand and Retailer Circular Supply Chain Flow



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CIRCULARITY ISN'T SUSTAINABILITY

"Growing cotton doesn't produce a lot of emissions, so recycling cotton may actually have a higher climate impact than simply harvesting cotton."

<https://iopscience.iop.org/article/10.1088/1748-9326/abfac3/pdf>
<https://www.fastcompany.com/90651753/renting-clothing-is-worse-for-the-planet-than-just-throwing-it-away-study-shows>

07-01-21

Renting clothing is worse for the planet than just throwing it away, study shows

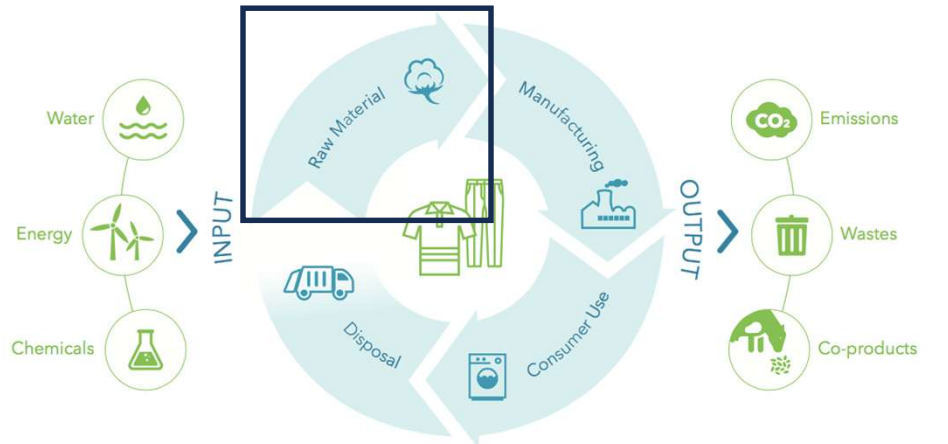
Brands are trying to convince us that recycling and renting clothes is sustainable. A new study suggests otherwise.



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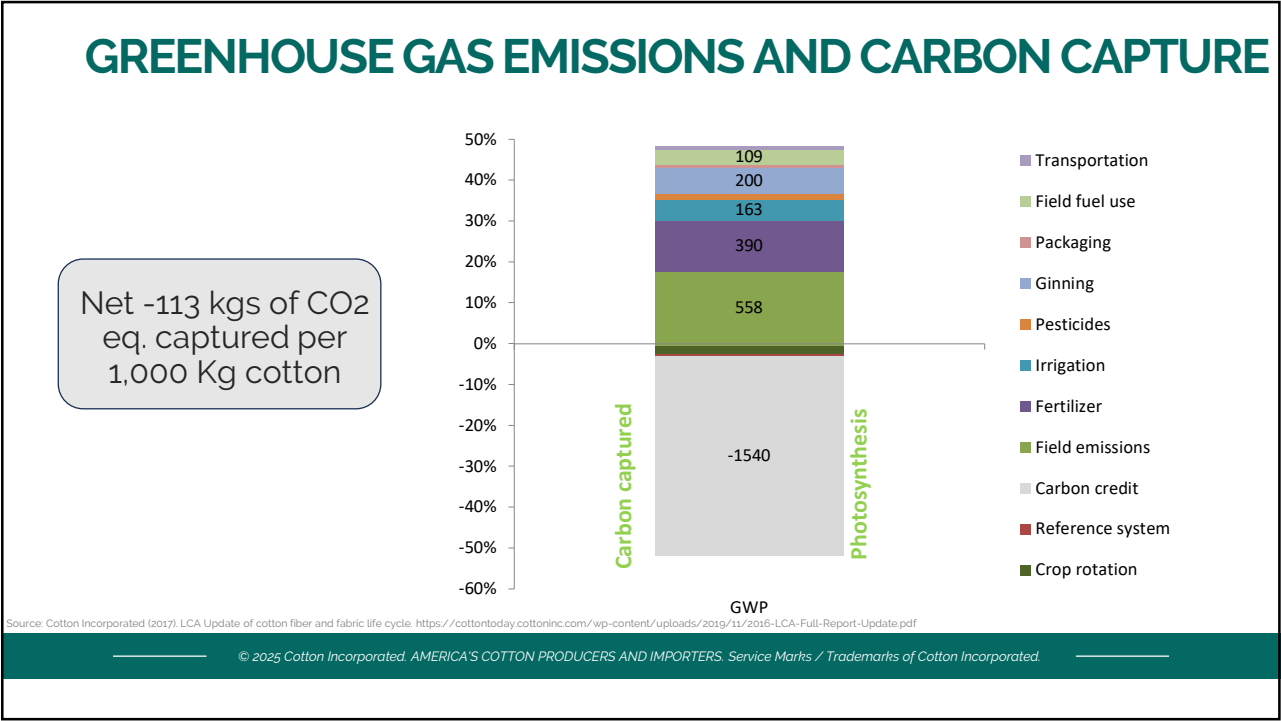
GLOBAL COTTON LIFE CYCLE ASSESSMENT



Source: Cotton Incorporated (2017). LCA Update of cotton fiber and fabric life cycle. <https://cottontoday.cottoninc.com/wp-content/uploads/2019/11/2016-LCA-Full-Report-Update.pdf>

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Billions spent on carbon capture

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Nearly £22bn pledged for carbon capture projects

4 October 2024

Paul Burnett & Gemma Sherlock & Ruth Comerford

BBC News

Getty Images

OCED Announces \$1.3 Billion in New Funding to Bolster Carbon Capture, Utilization, and Storage Technologies

The U.S. Department of Energy (DOE) Office of Clean Energy Demonstrations (OCED) today opened applications for up to \$1.3 billion in funding to catalyze investments in transformative carbon capture, utilization, and storage (CCUS) technologies.

[Office of Clean Energy Demonstrations](#)

December 17, 2024

3 min

The U.S. Department of Energy (DOE) Office of Clean Energy Demonstrations (OCED) today [opened applications](#) for up to \$1.3 billion in funding to catalyze investments in transformative carbon capture, utilization, and storage (CCUS) technologies. This funding—provided by OCED's [Carbon Capture Demonstration Projects Program](#) and the [Carbon Capture Large-Scale Pilot Projects Program](#) will help to catalyze the development and commercialization of carbon capture technologies with significant investments target in design, construction, and operation of large-scale point-source carbon capture projects. OCED aims to use this funding to enhance

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The ‘world’s largest’ vacuum to suck climate pollution out of the air just opened. Here’s how it works

By Laura Paddison, CNN
4 min read · Updated 2:26 PM EDT, Wed May 8, 2024

Climeworks’ Mammoth plant in Hellisheidi, Iceland, started operating on May 8. Oli Haukur Myrdal/Climeworks

(CNN) — The “world’s largest” plant designed to suck planet-heating pollution out of the atmosphere like a giant vacuum began operating in Iceland on Wednesday.

“Mammoth” is the second commercial direct air capture plant opened by Swiss company Climeworks in the country, and is 10 times bigger than its predecessor, Orca, which started running in 2021.

Direct air capture, or DAC, is a technology designed to suck in air and strip out the carbon using chemicals. The carbon can then be injected deep beneath the ground, reused or transformed into solid products.

36,000 tons of carbon from the atmosphere a year at full capacity

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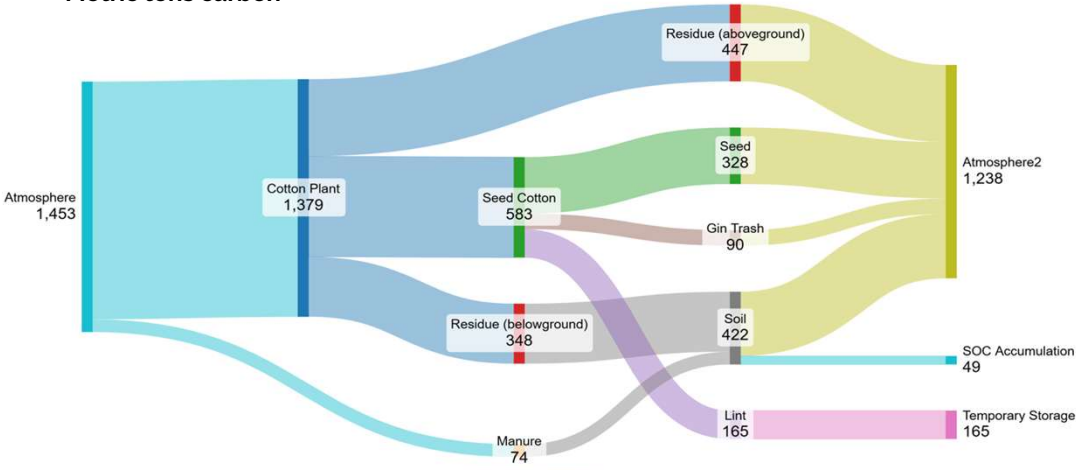


Getty Images: Climeworks Orca, the first large-scale CO2 direct air capture site in Iceland

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US COTTON BIOGENIC CARBON FLOWS

*Metric tons carbon



Flow / Stock	Value (Metric tons carbon)
Atmosphere (Initial)	1,453
Cotton Plant	1,379
Residue (aboveground)	447
Seed Cotton	583
Residue (belowground)	348
Manure	74
Seed	328
Gin Trash	90
Soil	422
Lint	165
Temporary Storage	165
SOC Accumulation	49
Atmosphere (Final)	1,238

Preliminary data from Cotton Incorporated's US Cotton Life Cycle Assessment
Made at SankeyMATIC.com

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LARGEST BIOCHAR REMOVAL PURCHASE

By Randy Spock

Jan 16, 2025

🔗

We're announcing our first partnerships to scale biochar for CO2 removal.

Today Google is announcing two long-term purchase agreements to help scale biochar as a carbon removal solution. We're partnering with Varaha and Charm to purchase 100,000 tons of biochar carbon removal from each company by 2030. These are the largest biochar carbon removal deals to date.

These deals will enable 200,000 tons of carbon removal to help Google achieve our net zero emissions goal — and help catalyze biochar production toward a scale that can help the planet mitigate climate change.

With these partnerships with Varaha and Charm, we're adding biochar to a growing toolkit of carbon removal solutions Google supports (such as [enhanced rock weathering](#) and [direct air capture](#)), and as a complement to our ongoing efforts to kickstart the carbon removal field through [Frontier](#) and [Symbiosis](#).



Getty Images

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IN FIELD BIOCHAR CREATION

- Developed a **mobile pyrolyzer** that processes agricultural residues into biochar directly on farms.
- Biochar provides **durable carbon storage** (potential ~2 Gt CO₂/year globally).
- Potential **agronomic benefits**: ~16% yield increase, ~50% higher water retention, ~95% higher nitrogen retention.
- Awarded **\$21.5M Series A, \$500K Wilkes Climate Prize, Top 20 XPRIZE finalist**.

22: Interview with Applied Carbon – the 2024 Wilkes Climate Launch Prize Winner

Published on September 23, 2024



ChatGPT Generated Conceptual Image

<https://wilkescenter.utah.edu/podcast/22-interview-with-applied-carbon/>

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COTTON STALK VALORIZATION



Renewable and Sustainable Energy Reviews
Volume 202, September 2024, 114651

Cotton stalk valorization towards bio-based materials, chemicals, and biofuels: A review

Chenggu Cai^{a,b,1}, Zhanbiao Wang^{a,b,1}, Lei Ma^{a,b}, Zhaoxian Xu^c, Jianming Yu^d, Fuguang Li^{a,b}

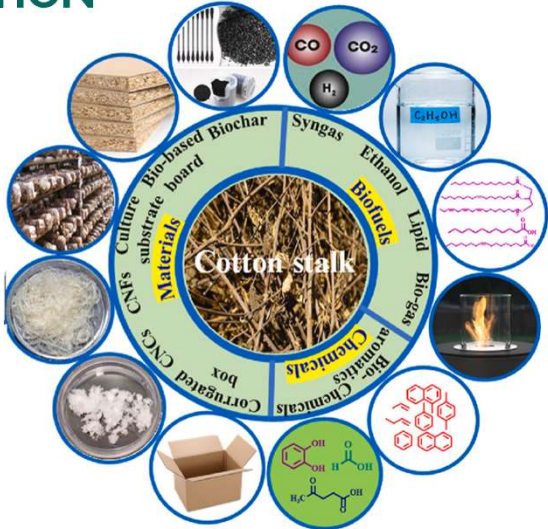
Show more

+ Add to Mendeley Share Cite

<https://doi.org/10.1016/j.rser.2024.114651> [Get rights and content](#)

Highlights

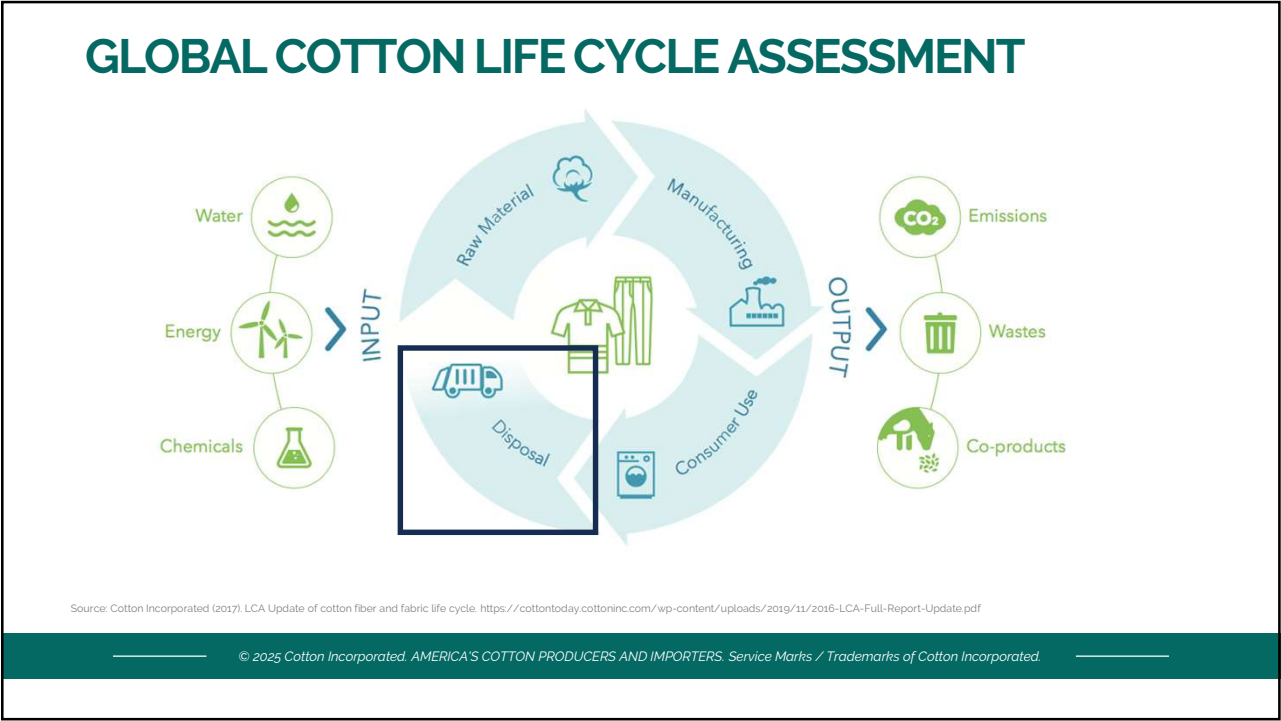
- The specific properties of cotton stalks are elucidated.
- Advancement in cotton stalk valorization for three applications is summarized.



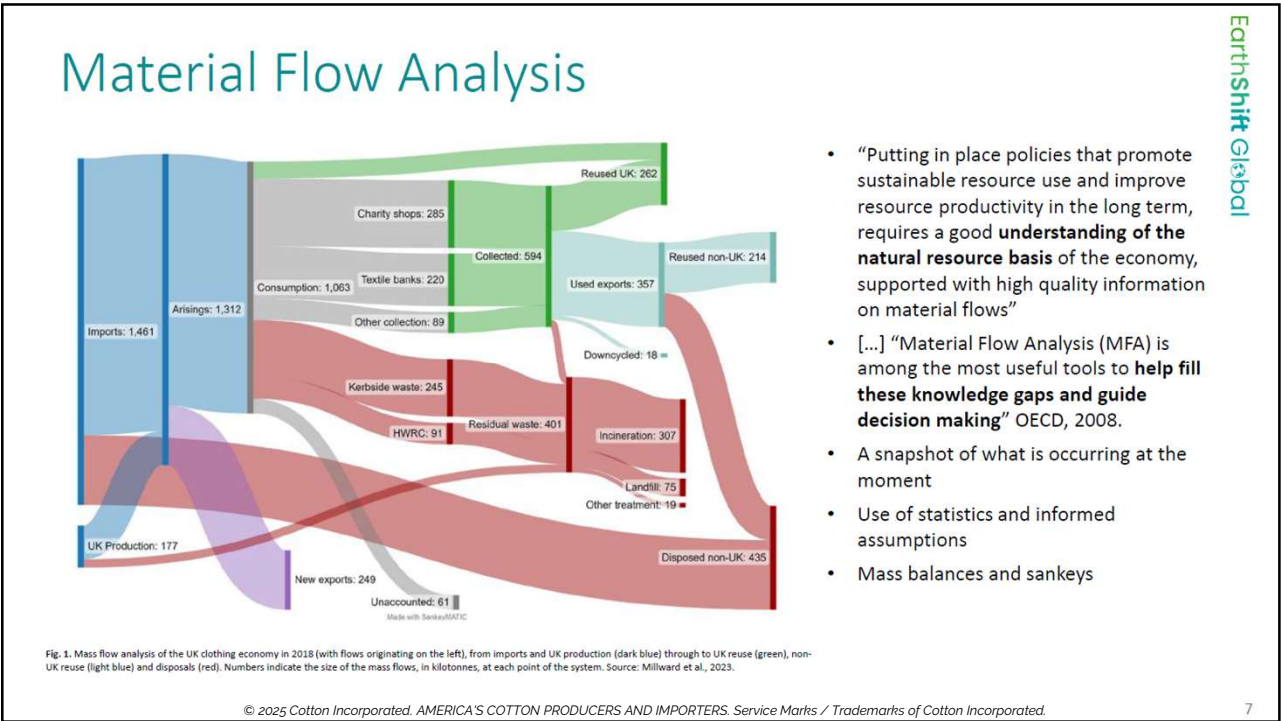
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Study Overview

A **screening-level MFA** approach was used to quickly develop information about textile flows in the US.

In a screening-level study, readily available data and information are used to build preliminary models of the studied systems so that early insights can be developed.

The focus is on **cotton** and **poly apparel** and **home textiles**, including all post-industrial, pre-consumer, and post-consumer flows.

National level flows were estimated for the **US** under possible calculation interpretations.

A **regional level** scoping analysis was also performed on US regions with large population centers.

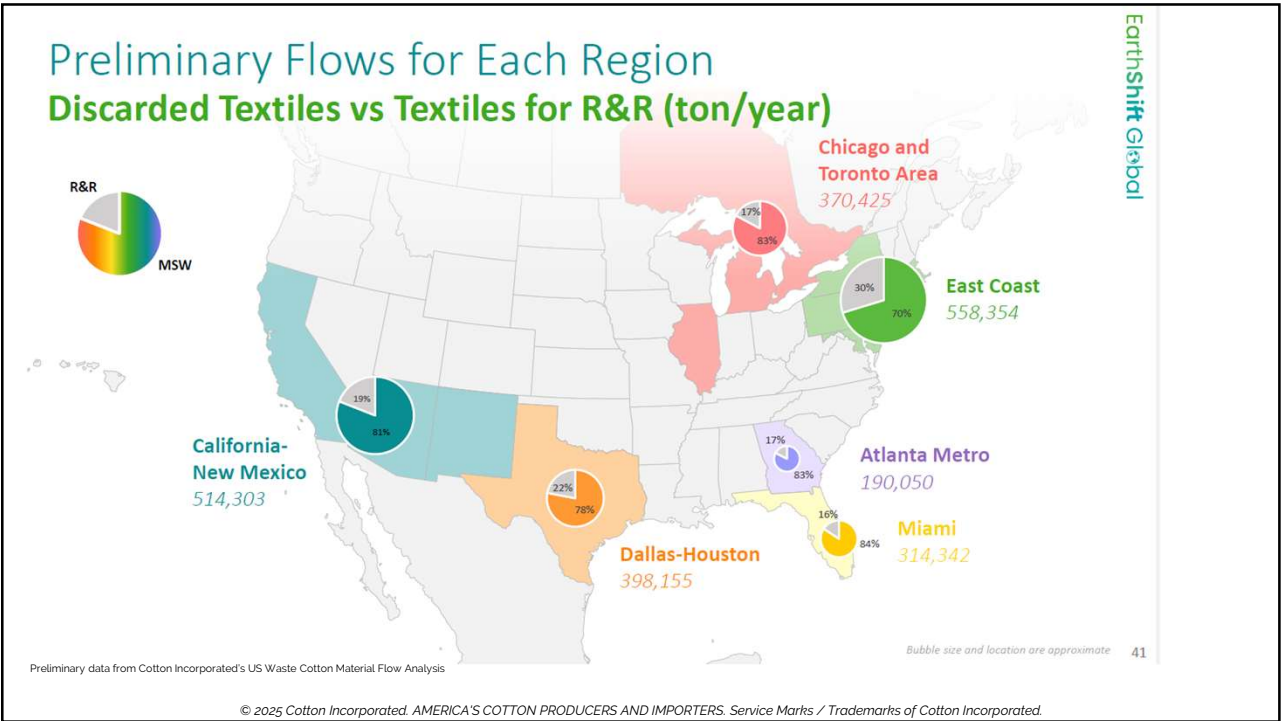


EarthShift Global

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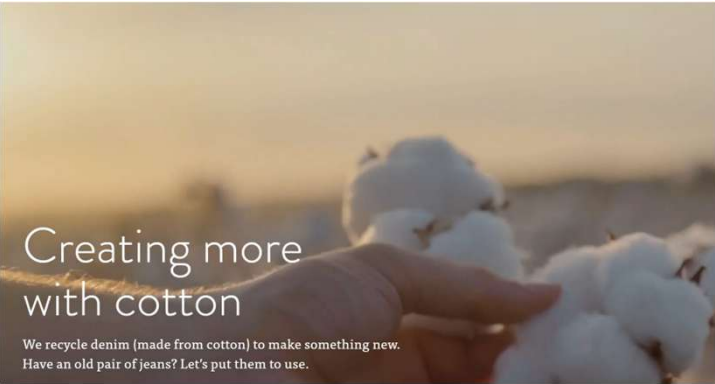
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BLUE JEANS GO GREEN™ PROGRAM



Creating more with cotton

We recycle denim (made from cotton) to make something new. Have an old pair of jeans? Let's put them to use.





DENIM DIVERTED FROM LANDFILLS:

2,832+ TONS

PIECES OF DENIM RECYCLED:

5,600,000+

SQ. FT OF INSULATION:

10,900,000+

<https://bluejeansgogreen.org/>

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Images: Courtesy Dr. Jesse Daystar

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GLOBAL COTTON LIFE CYCLE ASSESSMENT



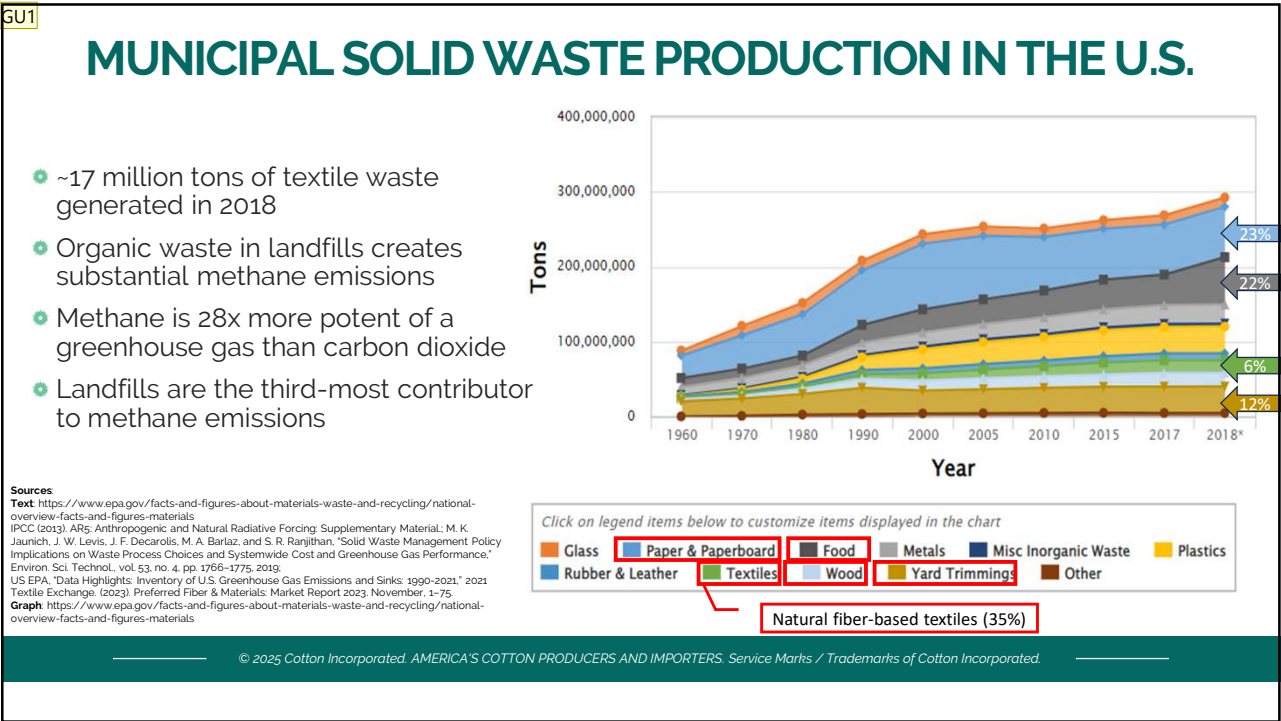
Source: Cotton Incorporated (2017). LCA Update of cotton fiber and fabric life cycle. <https://cottontoday.cottoninc.com/wp-content/uploads/2019/11/2016-LCA-Full-Report-Update.pdf>

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Slide 152

GU1 Sue Coleman - CI has been using the stat of 14MT globally, so this is saying 17MT for US alone??? Add the year - 2018
Guest User, 2025-09-30T12:32:25.708

SP1 0 The 14MT number is for global plastic leakage. This is just to frame the textile waste problem more generally, in the US. This data is from the EPA 2018, where they show textile waste is 17MT in 2018. Date added to the text (removed, per year as this is just 2018 data).

<https://www.epa.gov/facts-and-figures-about-materials-waste-and->
Pires, Steven, 2025-09-30T15:08:27.137

WHAT IS COMPOSTING?

Food Scraps Compost Fertilizer Grow

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BIODEGRADABILITY & COMPOSTING STUDY OF COTTON & POLYESTER FABRICS

Li et al, 2010 conducted industrial compost and lab trials on **three 100% knit cotton fabrics** (two with softener finish) and **one 100% polyester fabric**

- **Cotton fabrics** with common finishes **degraded** in lab conditions and were compostable in industrial trials – **polyester was not**

FIGURE 5. Biodegradation of fabrics in composting

FIGURE 6. Biodegradation of fabrics by enzymatic hydrolysis

FIGURE 7. SEM images of fabric samples after degradation (1000×)

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Test method ASTM D5988-09 & industrial compost

Source: Li, Lili, M. F., & Browning, K. J. (2010). Biodegradability Study on Cotton and Polyester Fabrics. 5(4). Retrieved from <https://journals.sagepub.com/doi/abs/10.1177/155892501000500406>

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GU1

COTTON CIRCULARITY AND COMPOSTING

- Cotton is a natural fiber that is inherently circular – grown from sunlight, water and earth – that can biodegrade back into soil
- Composting studies from 2010 show cotton fabrics are compostable in industrial compost facilities [1]
- Recent research with Cornell University focused on **denim compostability** evaluating **8 different denim fabrics with varying dye processes** under **industrial compost** and **lab compost conditions** [2,3]

Earthworms, soil microbes, enzymes

2022 project photos courtesy of Cornell University

1: Li, Lili, M. F., & Browning, K. J. (2010). Biodegradability Study on Cotton and Polyester Fabrics, 5(4). Retrieved from <https://journals.sagepub.com/doi/abs/10.1177/155892501000500406>

2: Schwarz, M., et al. (2024). The Effect of Denim Fabric as a Feedstock in Large Scale Composting of Manure/Bedding and Food Scraps. Journal of Engineered Fibers and Fabrics.

3: Alwala, W., et al. (2024). The Compostability of Denim Fabrics Dyed with Various Indigos. BioResources, 2(5), 2685–2700. <https://doi.org/10.15376/biores.19.2.2685-2700>

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COTTON CIRCULARITY AND COMPOSTING

- Results from 8 different denim fabrics with different dye processes under lab compost conditions

50ml NODM soup

1g perlite

12g dry solids + 2g sample

1g perlite

Table 1. Sample Summary

ID	Dye Process/Dye	Denim Type	Fabric Weight (g/m ²)	Carbon Content (wt %)
A-R	Dry Denim	Raw	373	44.10
B-W	Dry Denim	Washed	373	45.81
E-R	Standard Pre-reduced	Raw	407	39.42
F-W	Standard Pre-reduced	Washed	407	45.12
I-R	Natural Indigo	Raw	424	40.88
J-W	Natural Indigo	Washed	424	44.66
M-R	Brand 1 (2% natural rubber)	Raw	398	44.50
N-W	Brand 1 (2% natural rubber)	Washed	398	45.61
R-W	Brand 2 (74% cotton, 24% PET, 2% spandex)	Washed	418	51.35
U-R	Undyed	Raw	373	44.59
V-W	Undyed	Washed	373	39.73
Y-R	Brand 3	Raw	458	44.97
Z-W	Brand 3	Washed	458	44.83

All samples are 100% cotton except M-R and N-W, which contain 2% natural rubber and R-W, which contains polyester (PET) and spandex as noted.

■ Titration ▨ Mass Loss

Sample Type

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Alwala, W., et al. (2024). The Compostability of Denim Fabrics Dyed with Various Indigos. BioResources, 2(5), 2685–2700. <https://doi.org/10.15376/biores.19.2.2685-2700>

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Slide 155

GU1 Sue Coleman - Timing? Has this been done?

Guest User, 2025-09-30T12:33:15.633

SP1 0 Yes, this work is complete. Citations 2 and 3 are the results of the studies published in two separate papers.

Pires, Steven, 2025-09-30T15:10:17.781



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INDUSTRIAL SCALE DENIM COMPOSTING PUBLICATION

“Denim fabric, regardless of dye process or denim type (raw vs. washed) is compostable in large-scale thermophilic composting windrows.”

“Composting denim fabric has no detrimental effect on the composting process, nor on the quality of the resulting compost and thus can be used to grow cotton, reducing the carbon footprint, and contributing to the circular economy”

COMPOST SCIENCE & UTILIZATION
2024, VOL. 31, NOS. 1-2, 61-73
<https://doi.org/10.1080/1055657X.2024.2349081>

The Effect of Denim Fabric as a Feedstock in Large Scale Composting of Manure/Bedding and Food Scraps

Mary Schwarz^a, Wendy Alwala^a, Antonia Perju^a, Jean Bonhotal^a, Margaret Frey^a, Steven Pires^a, Mary Ankeny^a and Jesse Daystar^a

^aCornell Waste Management Institute, Cornell University, Ithaca, New York; ^bRobert Frederick Smith School of Chemical and Biomolecular Engineering, Cornell University, Ithaca, New York; ^cInstitute of Analytical Chemistry, Chemo- and Biosensors, University of Regensburg, Regensburg, Germany; ^dDepartment of Human Centered Design, Cornell University, Ithaca, New York; ^eCotton Incorporated, Cary, North Carolina

ABSTRACT
This study provides scientific evidence for the process of denim biodegradation and the viability of including denim waste in large scale composting facility feedstock streams. Fourteen samples of denim using different dyes and dye processes provided by Cotton Incorporated as well as worn and unworn whole and scrap denim fabric were incorporated into a manure/bedding and food scrap windrow at the Cornell composting facility and in a bench scale laboratory trial. Grab samples of compost were analyzed for compost parameters, metals and PFAS. Visual observation of decomposition of denim showed polyester blended denim degraded at a slower rate than non-blended denim. However, after four months of hot composting, most of the denim had decomposed into organic matter, leaving only small pieces of the polyester thread, labels, and pockets. Bench scale degradation, tracked by carbon dioxide evolution and mass difference showed significant degradation at the macro and microscopic levels at day 75. Composting denim fabric has no detrimental effect on the composting process, nor on the quality of the resulting compost and thus can be used to grow cotton and other crops, reducing the carbon footprint, and contributing to the circular economy.

Routledge
Taylor & Francis Group

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Schwarz, M., Alwala, W., Perju, A., Bonhotal, J., Frey, M., Pires, S., ... Daystar, J. (2023). The Effect of Denim Fabric as a Feedstock in Large Scale Composting of Manure/Bedding and Food Scraps. *Compost Science & Utilization*, 31(1-2), 61-73. <https://doi.org/10.1080/1065657X.2024.2349081>

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CIRCULAR APPAREL THROUGH BIODEGRADABILITY

Stella McCartney introduces the World's First Biodegradable Stretch Denim

BY TOM SHEARSMITH - 13TH JANUARY 2020



Stella McCartney has partnered with Italian manufacturer Candiani to create the world's first biodegradable stretch denim, created using plant-based yarns. The development

Image: Getty

Lee Jeans launches range of fully biodegradable denim

INSIDER - FASHION



BY CHLOE STREET | 10 Feb 2020

Image: Getty

<https://www.theindustryfashion.com/stella-mccartney-introduces-the-worlds-first-biodegradable-stretch-denim/>

<https://www.standard.co.uk/uk/insider/fashion/lee-jeans-biodegradable-denim-a4356856.html>

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TEXTILES TO BIOCHAR?



Images courtesy of Biochar Now

Getty Images



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BIOCHAR AND CARBON SEQUESTRATION

Carbon Storage

Biochar is a carbon-rich solid produced from biomass through pyrolysis, and its recalcitrant nature means it is resistant to decomposition. This allows carbon to be stored in soils when applied.



Carbon Mineralization

Biochar can slow down the carbon mineralization process in soil, which is essential for carbon sequestration as it prevents the rapid release of carbon back into the atmosphere.

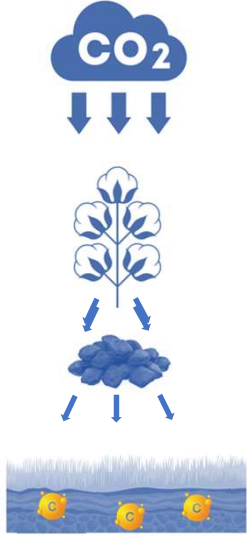


Cotton-derived Biochar

The source material for biochar affects its carbon sequestration potential. The carbon content of cotton stalk is 46%, after pyrolysis it increases to 83%. The cotton stalk biochar has a carbon sequestration potential of 24%, which is stronger compared to straw biochar (21%).
Tao et al., 2024



CLIMATE CHANGE MITIGATION



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NC STATE UNIVERSITY

RESEARCH QUESTION:

CAN COTTON TEXTILE WASTES BE CONVERTED TO HIGH QUALITY BIOCHAR AND ACTIVATED CARBON MATERIALS FOR ENERGY STORAGE APPLICATIONS?

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NC STATE UNIVERSITY

METHODOLOGY: PYROLYSIS

- Pyrolysis involves the thermal treatment of biogenic carbon at 400 – 700C in the absence of oxygen to generate biochar, a solid material that is carbon-rich and porous

ORGANIC BIOMASS

PYROLYSIS PLANT

BIOCHAR

SYNGAS

PYROLYSIS OIL

Cotton Incorporated NC State Project Files

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NC STATE UNIVERSITY

RESULTS: TEXTILE WASTE TO BIOCHAR @ 500C

100% Cotton

Char Yield: 16.9%

Surface Area: 255.06 m²/g

50% Cotton + 50% Polyester

Char Yield: 18.9%

Surface Area: 593.10 m²/g

Cotton Incorporated NC State Project Files

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The screenshot shows the top portion of the Cotton Today website. At the top, the text "COTTON TODAY FOR COTTON SUSTAINABILITY INFORMATION" is displayed in a large, teal, sans-serif font. Below this is a navigation bar with the "cotton today" logo on the left and a series of links: "About Us", "Our Vision", "Our Sustainability Story", "Knowledge Hub", "Cotton Facts", and a magnifying glass icon for search. The main hero section features a background image of cotton plants. On the left, the headline "Cotton: A Natural Fiber Free from Microplastics" is written in white, with a yellow "Learn More" button below it. On the right, a white box contains the text "New Information Hub Provides Science-Backed Insights to Help Brands, Retailers, and Consumers Make Informed, Sustainable Choices" and a "Read More" link with a right-pointing arrow.

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GU1

NATIONAL COTTON COUNCIL CAMPAIGN



What you wear matters



YOU HAVE INHALED 184 PARTICLES OF MICROPLASTICS TODAY ¹

DOWNLOAD THE FACT SHEET



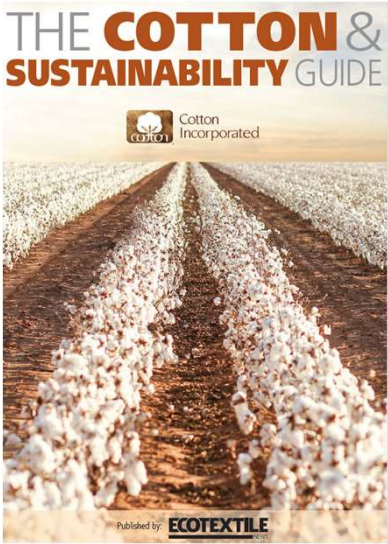
Plant not plastic

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COTTON SUSTAINABILITY GUIDE BOOK

- 2025 Master guide to the sustainable-cotton landscape
- Side-by-side comparison tool for sourcing teams
- Plain-language briefs on science and regulations
- Color-coded matrix with 25 + programs
- Action links to resources



https://cottontoday.cottoninc.com/wp-content/uploads/2025/06/Cotton_Guide_2024-2025.pdf
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Slide 171

GU1 Sue Coleman - There is not conclusive evidence to support the statement of consequences to human health.

Guest User, 2025-09-30T12:34:25.731

SP1 0 See new screenshot that does not show human health statements.

Pires, Steven, 2025-09-30T17:41:19.316

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With hundreds of easily searchable resources, we're your go-to textile tool for discovering what's possible with cotton.

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Dr. Jesse Daystar
Chief Sustainability Officer
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Jesse Daystar, Ph.D.
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