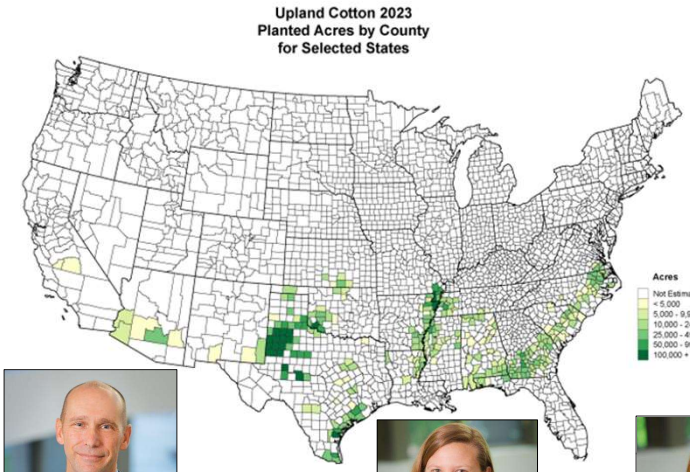
1

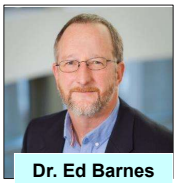
SETTING THE STAGE:
RESPONSIBLE COTTON PRODUCTION

2

AGRICULTURAL AND ENVIRONMENTAL RESEARCH

Dr. Ryan Kurtz
VP AERD



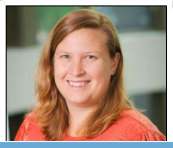


Dr. Ed Barnes
Ag Engineering

Dr. Don Jones
Breeding

Dr. Evy Jaconis
Cottonseed
Human & Animal Nutrition

Dr. Gaylon Morgan
Soil Health
Weed Science

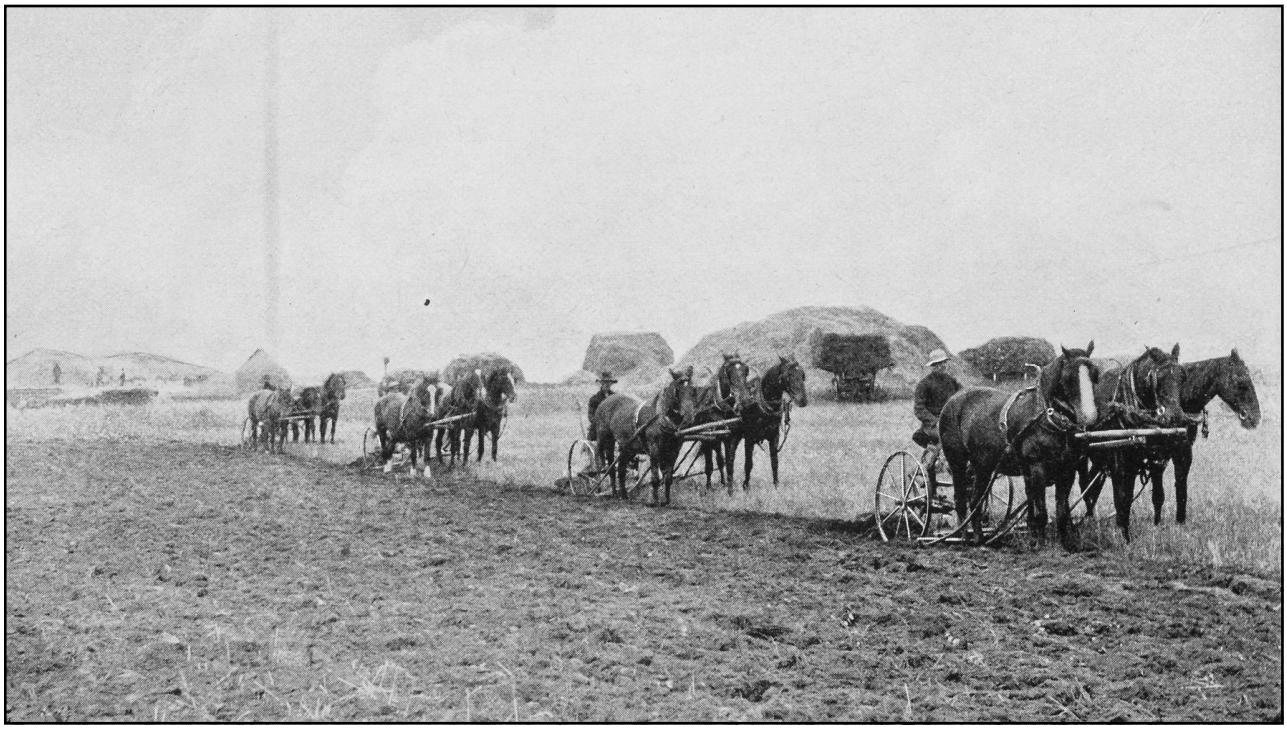


Dr. Kaitlyn Bissonnette
Pathology & Nematology

Dr. Sally Taylor
Entomology

3

4

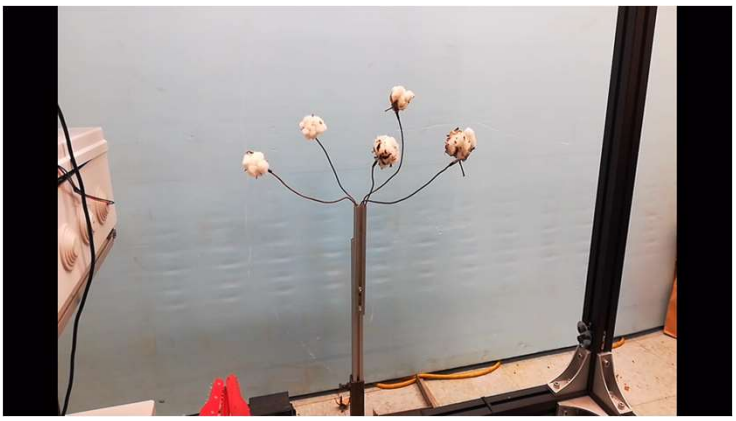


5

6

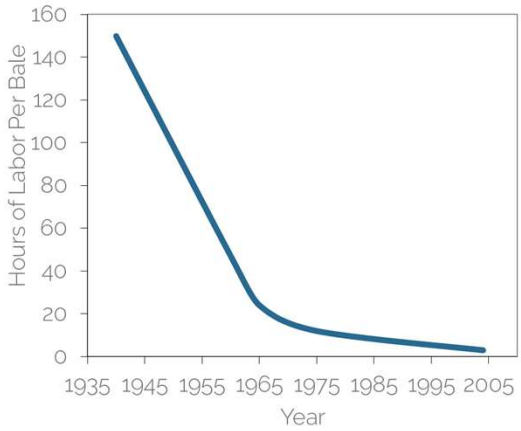
7

MSU END EFFECTOR



8

IMPACT OF MECHANIZATION ON LABOR



9

TODAY'S TAKEAWAYS

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

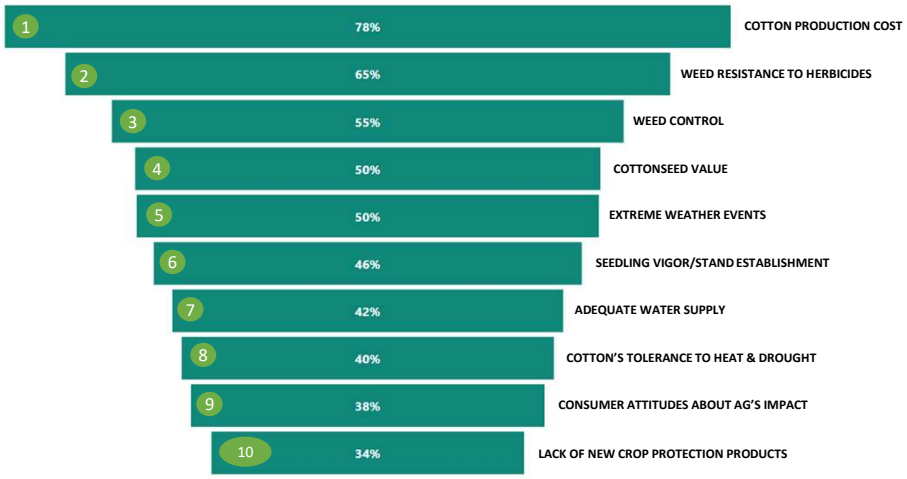
Cotton is:

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

10

2023 NATURAL RESOURCE SURVEY

TOP GROWER CONCERNS



11

COTTON PRODUCTION INPUT COSTS

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

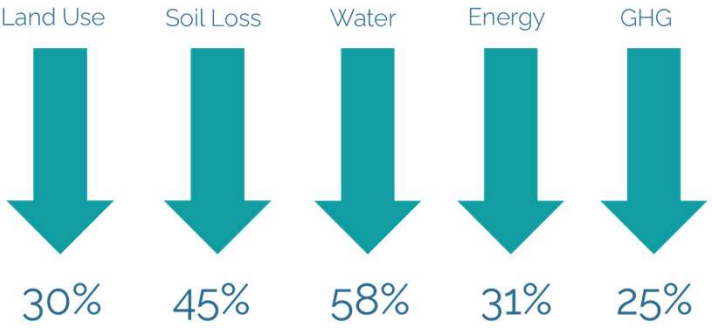
Farming Goals:

- Maximize yield
- Minimize inputs

Input	Cost per acre*
Seed	$115
Fertilizer	$140
Ginning	$120
Chemicals	$200
Fuel, lube, and electricity	$110
Repairs	$26
Custom applications	$50
Total Operating Costs*	**$761**

12

40 YEARS OF REDUCED ENVIRONMENTAL IMPACT



Field to Market

Field to Market: The Alliance for Sustainable Agriculture, 2021. Environmental Outcomes from On-Farm Agricultural Production in the United States (Fourth Edition). ISBN: 978-0-578-33372-4

13

FIELD TO MARKET

Alliance for Sustainable Agriculture Member Include:

- The Nature Conservancy
- Environmental Defense Fund
- WWF
- ASABE
- NC State University
- BASF
- John Deere
- Cotton Incorporated
- National Corn Growers Association
- Kontoor
- The Coca Cola Company

Field to Market®

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

14

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

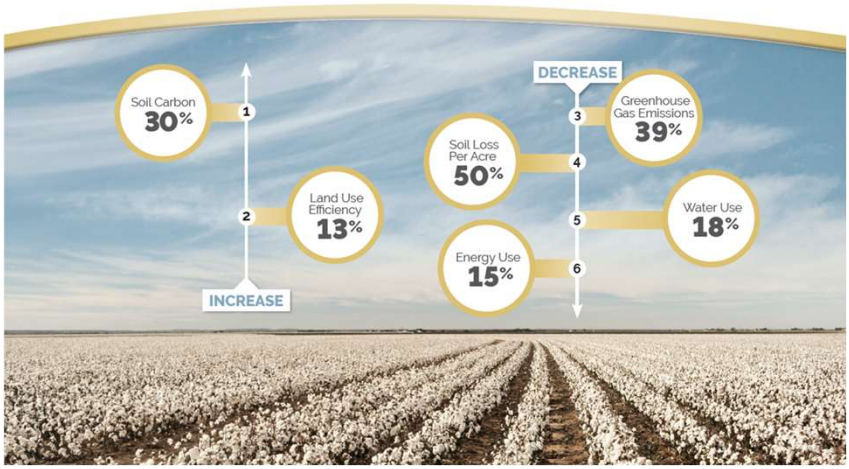
15

REGENERATIVE AG: A SYSTEMS-BASED APPROACH

- 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
- The principles of regenerative agriculture are adaptable to local conditions:
  - Minimizing soil disturbance
  - Maintaining living roots in soil
  - Continuously covering bare soil
  - Maximizing diversity, with emphasis on crops, soil microbes, and pollinators
  - Integrating livestock where feasible
- Practices such as no-till or reduced tillage, crop rotation, cover crops, integrated pest management and composting play pivotal roles in achieving regenerative agriculture's goals. They improve soil quality, enable water retention, reduce erosion and foster a biodiverse ecosystem.

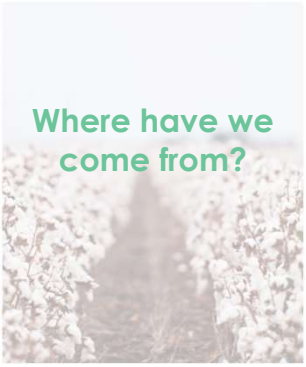
16

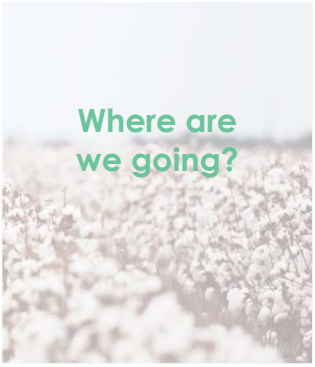
U.S. COTTON SUSTAINABILITY GOALS FOR 2025



17

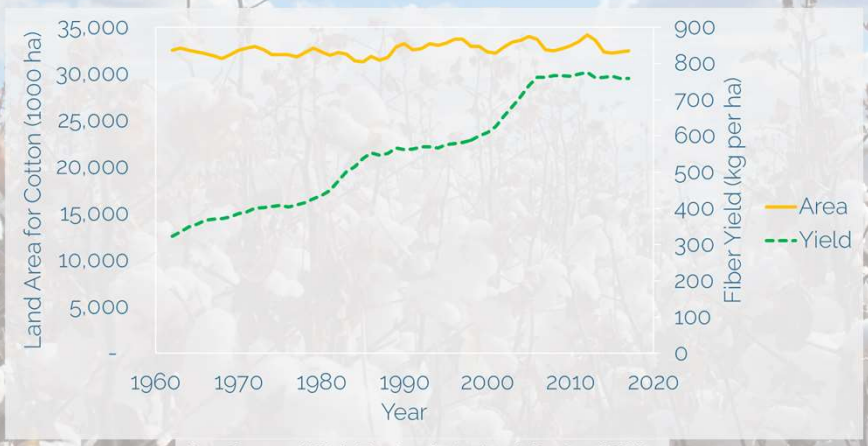
IN DEPTH: LAND, CARBON, WATER, PESTICIDES





18

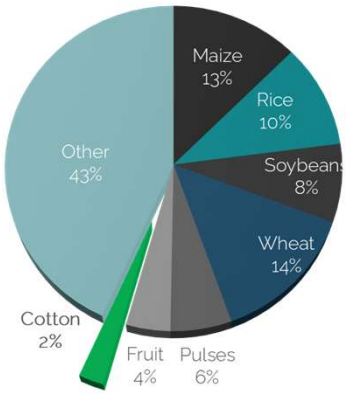
COTTON LAND USE AND YIELD TREND



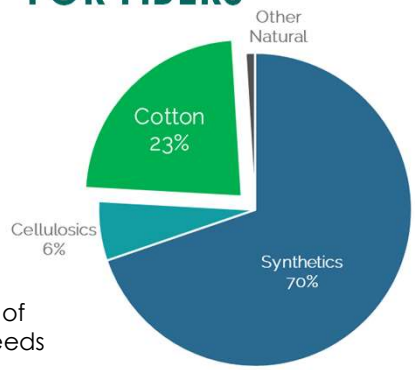
Data Source: USDA, Foreign Agricultural Service, PS&D

19

PERCENT OF GLOBAL CROPLAND



WORLDWIDE DEMAND FOR FIBERS



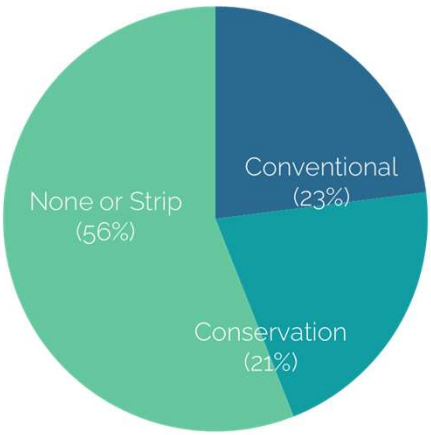
Cotton meets 23% of the world's textile needs from 2% of the agricultural land.

Land use: FAO 2022: Fiber Data Sources: Cotton Incorporated calculations derived from Wood Mackenzie (non-cotton) and USDA (cotton) estimates

20

21

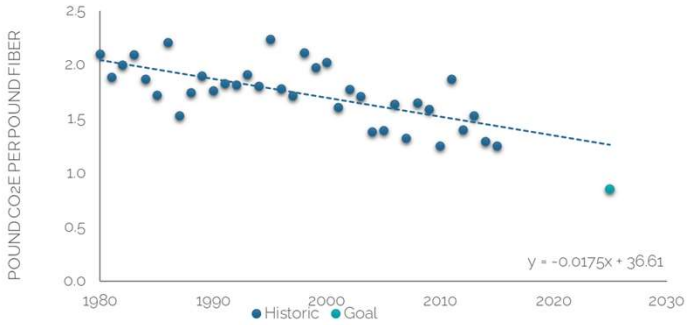
SOIL HEALTH: CONSERVATION TILLAGE IN THE U.S.



22

GREEN HOUSE GAS EMISSIONS

Goal: 39% Reduction



Field to Market: Keystone Alliance for Sustainable Agriculture 2016 | https://fieldtomarket.org/national-indicators-report-2016/

The Green House Gas Goal matches the spirit U.S. commitment under the Paris Accord and exceeds our historic trend line by 30% and our current F2M FieldPrints.

This metric does not account for carbon sequestered in the fiber (biogenic carbon).

23

DRIVERS TO LOWER GHG EMISSIONS

- Nitrogen Use Efficiency Improvements
- Yield (genetic gains)
- Carbon capture from cover crops & no-till

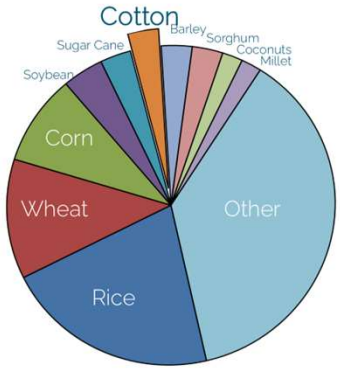
24

COTTON'S GLOBAL WATER USE

Cotton production uses

3%

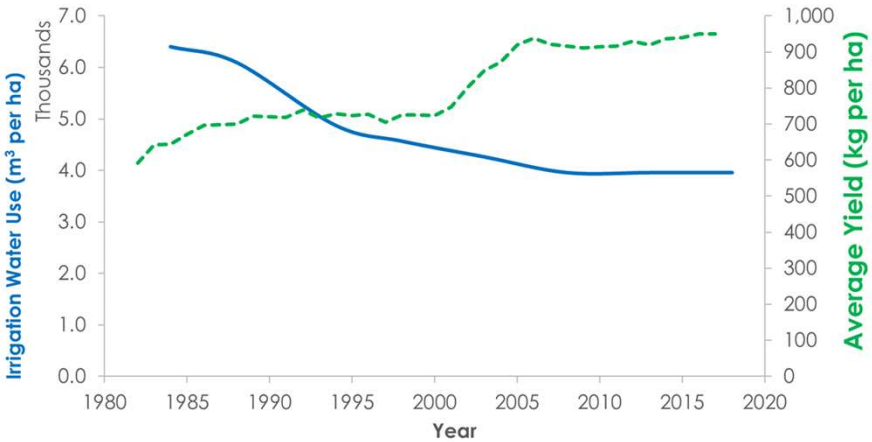
of the world's agricultural water.



Source: Mekonnen, M. M. and Hoekstra, A. Y.: The green, blue and grey water footprint of crops and derived crop products, Hydrol. Earth Syst. Sci., 15, 1577–1600, https://doi.org/10.5194/hess-15-1577-2011, 2011.

25

U.S. WATER & YIELD TRENDS

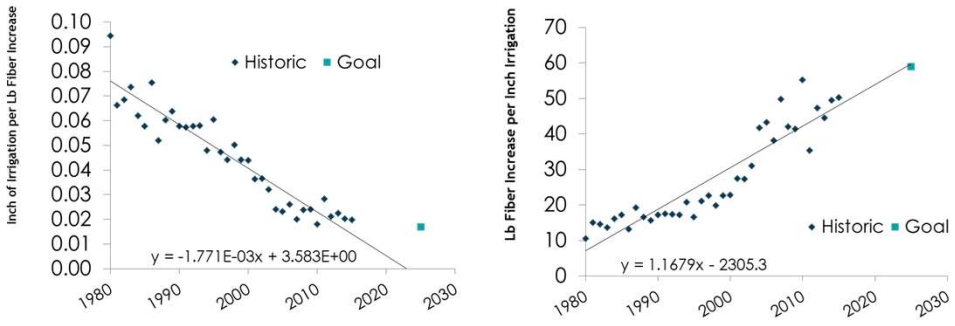


Source: USDA Farm and Ranch Irrigation Surveys

26

IRRIGATION WATER USE EFFICIENCY (WUE)

Goal: 18% Increase



Field to Market: Keystone Alliance for Sustainable Agriculture 2016 | https://fieldtomarket.org/national-indicators-report-2016/

27

MAXIMIZE RAINFALL CAPTURE

OPTIMIZE IRRIGATION WATER USE

WATER STRATEGY

INCREASE PLANT WATER PRODUCTIVITY

EVALUATE WITH METRICS

28

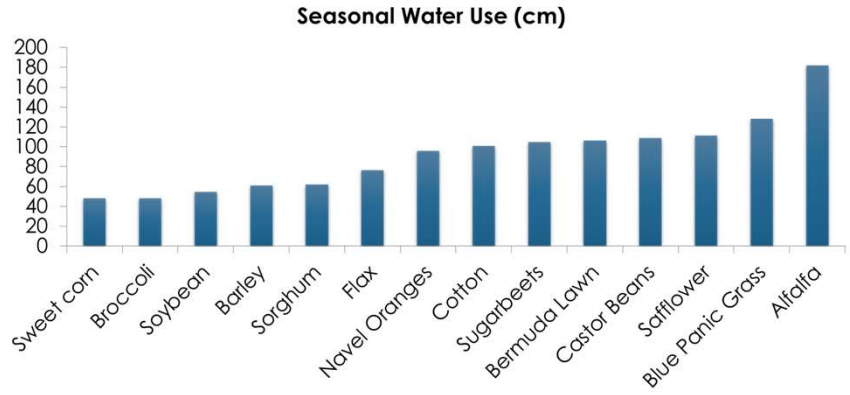
MAXIMIZING RAINFALL: SOIL HEALTH AND FARM PONDS

29

OPTIMIZING IRRIGATION DELIVERY AND TIMING SYSTEMS

30

SEASONAL WATER USE - ARIZONA



USDA, ARS CR Report #29

31

INCREASING COTTON'S WATER PRODUCTIVITY

Tap Root Development

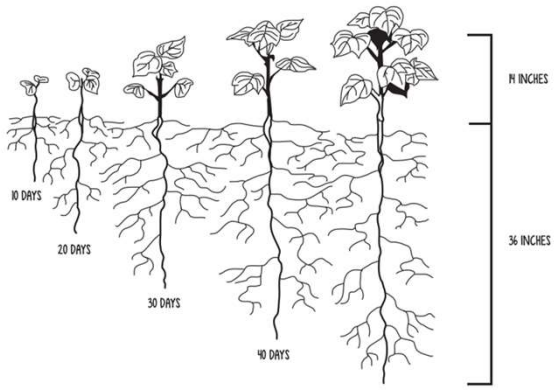


Image source: Dr. Derrick Oosterhuis, U. of Arkansas

32

FOR MORE DETAILS ON COTTON IRRIGATION:

FORTY YEARS OF INCREASING COTTON'S WATER PRODUCTIVITY AND WHY THE TREND WILL CONTINUE

E. M. Barnes, B. T. Campbell, G. Vellidis, W. M. Porter, J. O. Payero, B. G. Leib, R. Sui, D. K. Fisher, S. Anapalli, P. D. Colaizzi, J. P. Bordovsky, D. O. Porter, S. Ale, J. Mahan, S. Taghvaeian, K. R. Thorp

Applied Engineering in Agriculture Vol. 36(4): 457-478

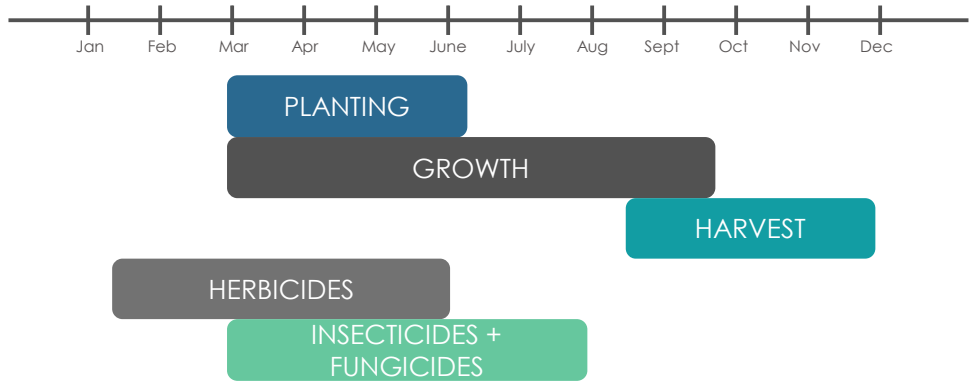
Beyond 2020, VISION OF THE FUTURE Collection Review

https://cottoncultivated.cottoninc.com/resource-directory/?_sft_category=production+water-management

33

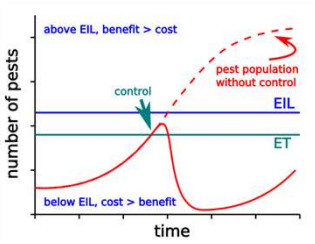
THE COTTON CALENDAR

Northern Hemisphere – Pesticide Use



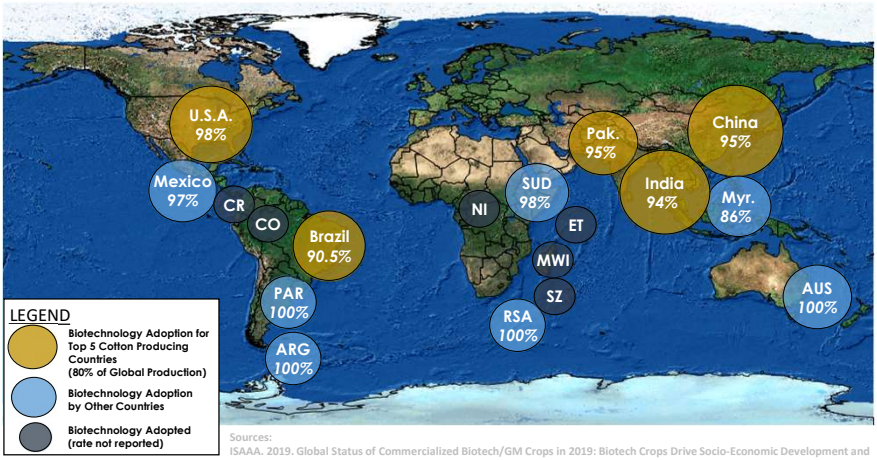
34

INTEGRATED PEST MANAGEMENT (IPM)



35

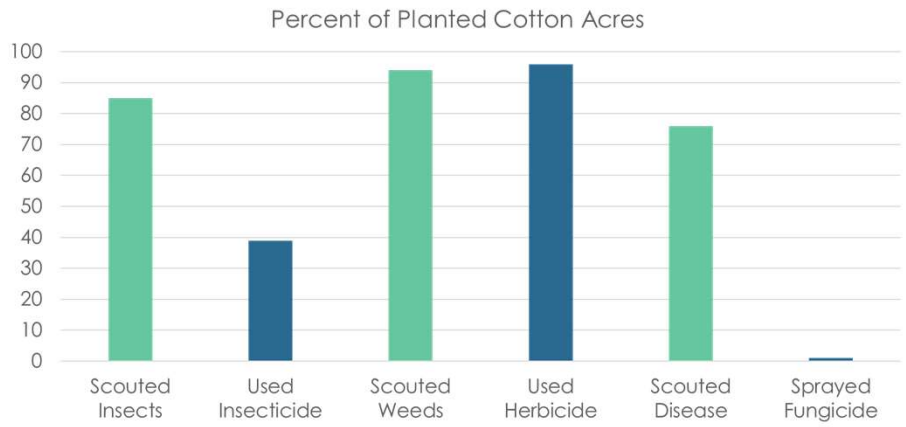
WORLD PRODUCTION OF COTTON AND BIOTECH'S SHARE



Sources:
ISAAA. 2019. Global Status of Commercialized Biotech/GM Crops in 2019: Biotech Crops Drive Socio-Economic Development and Sustainable Environment in the New Frontier. ISAAA Brief No. 55. ISAAA: Ithaca, NY. UN FAO STAT, 2019. Global Cotton Production in 2019 from the United Nations Food and Agricultural Organization. http://faostat.fao.org

36

PEST SCOUTING IS KEY FOR COTTON IPM



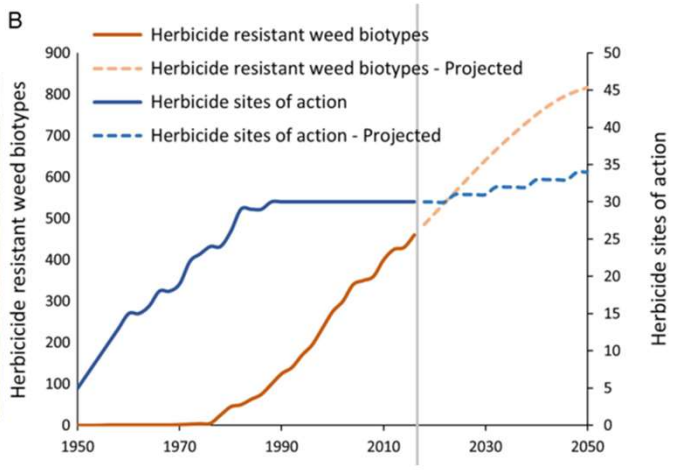
https://www.nass.usda.gov/Surveys/Guide_to_NASS_Surveys/Chemical_Use/2021_Field_Crops/chemhighlights-cotton.pdf

37

38

39

HERBICIDE RESISTANCE – CHALLENGES



From Westwood. et al. (2018): Weed Management in 2050: Perspectives on the Future of Weed Science

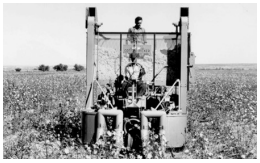
40

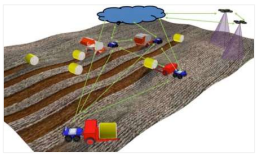
COMMERCIAL AI WEED CONTROL EXAMPLE

41

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





42

FOOD, FIBER & MORE

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

43

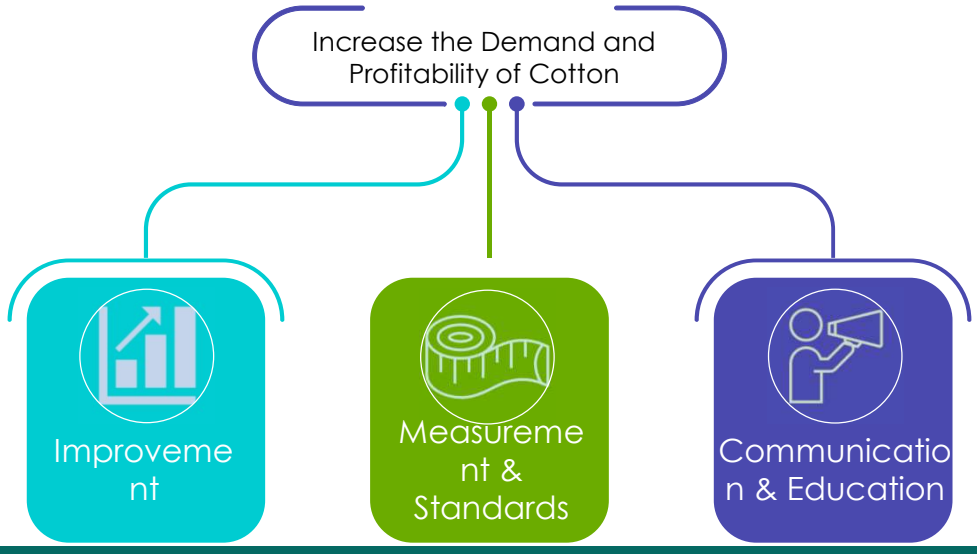
THANK YOU!

44

COTTON SUSTAINABILITY

45

SUSTAINABILITY STRATEGY ACROSS THE COMPANY



46

SUSTAINABILITY FOCUS AREAS

47

DATA AND UPCOMING ENVIRONMENTAL LEGISLATION


CNN style Arts Design Fashion Architecture Luxury Beauty Video

Style / Fashion

French lawmakers approve bill penalizing fast fashion

By Reuters and Oscar Holland, CNN

2 minute read · Published 5:54 AM EDT, Fri March 15, 2024

BRUSSELS - The Sustainable Apparel Coalition (SAC) has expressed disappointment with the European Commission's newly published plan to combat greenwashing which it says "falls short" of its target.

PEF in spotlight at natural fibres event

Brett Mathews 28th September 2023

Spread the love

BIELLA – Efforts by European regulators to rank the environmental impact of clothing are ignoring climate change. Th was a key message on the opening day of this year's Natural Fibre Connect conference being staged in Biella, Italy.

U.S. Politics World Opinion Media Entertainment Sports Lifestyle Video AI More Login Watch TV

Glimpact Launches First Digital Platform for American Companies to Evaluate Overall Environmental Footprint, Measuring 16 Categories of Impact of Human Activity

GLIMPACT GLOBAL ENVIRONMENTAL SCORE

Companies can now measure their contribution according to the 9 planetary boundaries with Glimpact's technology, the first modeled on the new scientific framework adopted by the EU in the form of a digital SaaS platform — accessible to all industries and now deployable on a large scale worldwide

NEWS PROVIDED BY
Glimpact
Apr 24, 2024, 8:00 AM ET

48

U.S. AND E.U. LEGISLATION/ REGULATION

Extended Producer Responsibility

Corporate Sustainability Due Diligence

Corporate Sustainability Reporting

Climate Reporting

CO_2

Ecodesign for Sustainable Products

49

SUSTAINABILITY DATA FOR COTTON AND COTTON APPAREL

Increase data availability

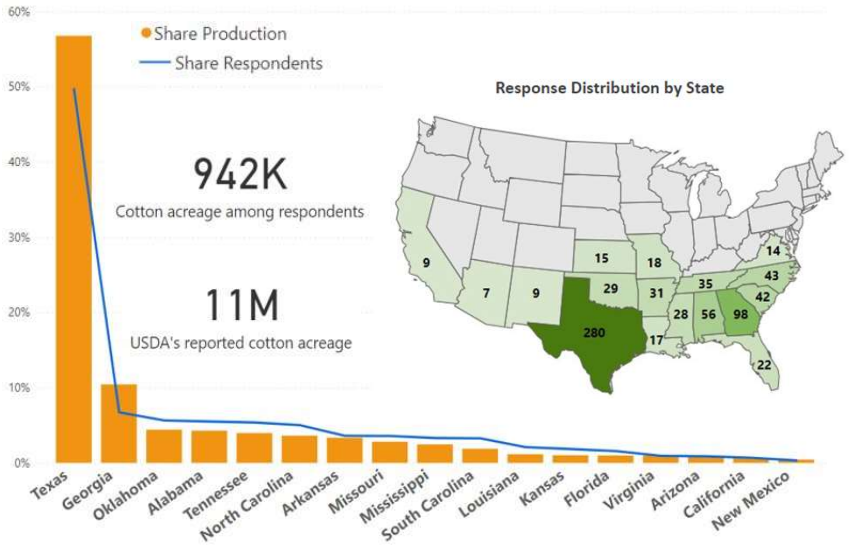
Standards and methodology development

LCA and sustainability research

50

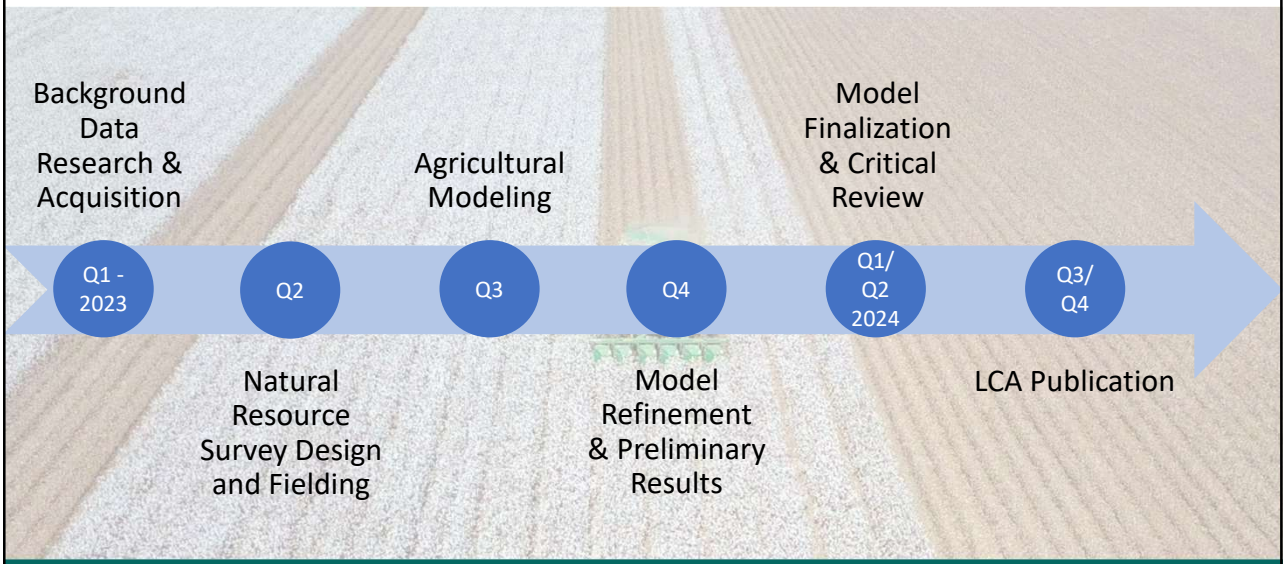
NATURAL RESOURCE SURVEY & U.S. LCA

- Collected 753 responses from all cotton producing states
  - Southeast – 275
  - Midsouth – 129
  - Southwest – 324
  - Far West - 25
- Data used in life cycle assessment for U.S. cotton production



51

U.S. COTTON LIFE CYCLE ASSESSMENT



52

HIGG COTTON EXPERT METHODOLOGY GROUP

53

HIGG MSI COTTON EXPERT METHODOLOGY TEAM OBJECTIVES

1

Publish a Methodology for Cotton LCA that is

- Industry-aligned
- Independently reviewed
- Provides clear guidance on data requirements (Data Collection Template)

2

Add new cotton data to the Higg MSI that is

- Region- & Program-specific
- Consistent
- Continuously updated (every 1-3 years)

3

Educate and focus on the appropriate use-cases for LCA data

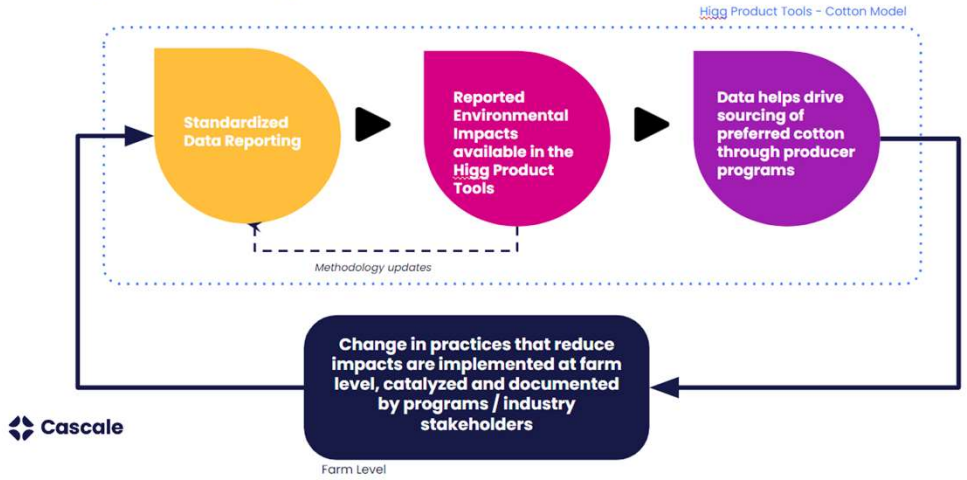
- Avoid just chasing/comparing the lowest number
- Understand implications of different field practices also beyond those captured in the impact results

Cascale

54

HIGG MSI COTTON EXPERT METHODOLOGY TEAM

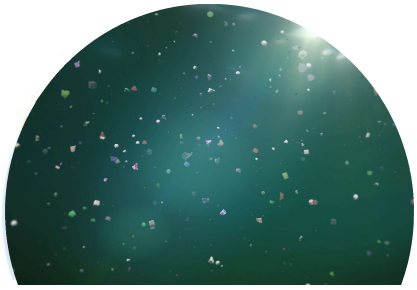
Theory of Change



55

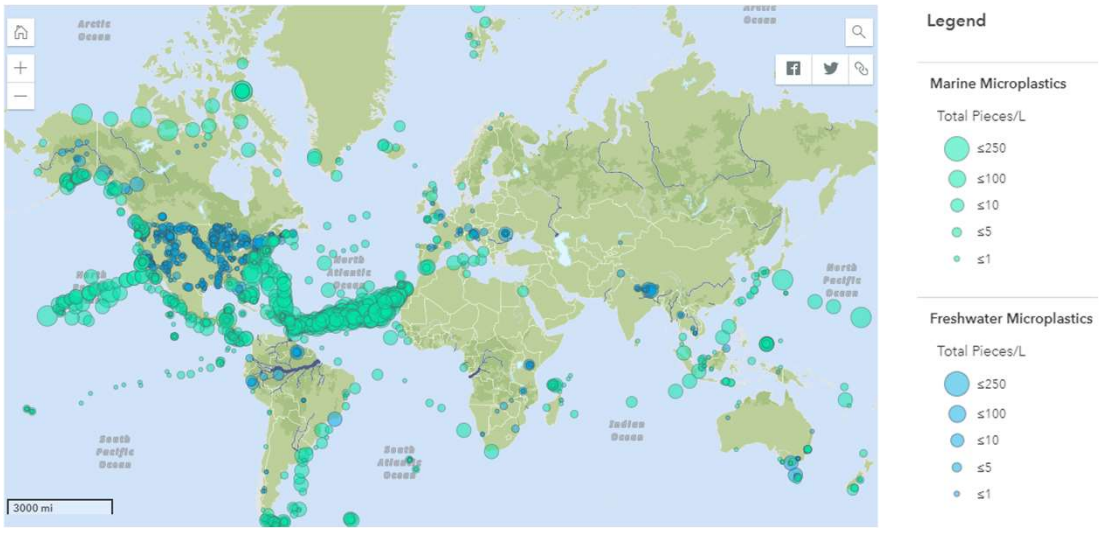
MICROPLASTICS IN THE E.U.

EU action against microplastics



56

GLOBAL DISTRIBUTION OF MICROPLASTICS



57

MICROPLASTICS AWARENESS IS GROWING & CHANGING BEHAVIOR

Microplastic pollution is influencing clothing purchase decisions

40% AWARE OF MICROPLASTIC POLLUTION

62% BOTHERED BY BRANDS & RETAILERS USING SYNTHETIC FIBERS DUE TO MICROPLASTIC POLLUTION

65% MICROPLASTIC POLLUTION WILL AFFECT MY PURCHASES

Source: 2022 Cotton Incorporated's *Lifestyle Monitor™* Survey https://lifestylemonitor.cottoninc.com/how-fashion-can-give-the-people-what-they-want/
Photo: Getty

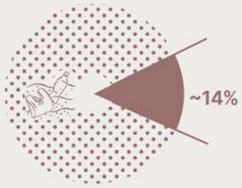
58

59

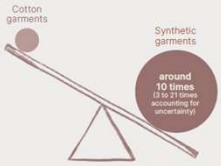
PLASTIC POLLUTION FROM THE APPAREL INDUSTRY

nature COMMUNICATIONS

1 Apparel industry responsible for 14% of plastic leakage



2 Synthetic garments leak around 10x more than cotton garments



Published: 06 February 2024 Written by Simon Glover

Plastic textile waste 'polluting Africa'

BERLIN - Textile waste exported to African countries, such as Ghana, is a significant source of plastic pollution, according to new joint research by Greenpeace Germany and Greenpeace Africa.

60

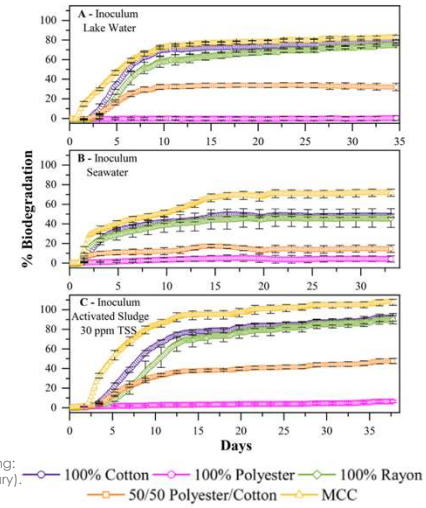
61

SYNTHETIC MICROFIBER PERSISTENCE AND THE AQUATIC ENVIRONMENT

Cotton microfibers readily biodegrade in aquatic environments whereas polyester microfibers do not

Cotton biodegrades in:

- Wastewater environments
- Fresh water
- Salt water

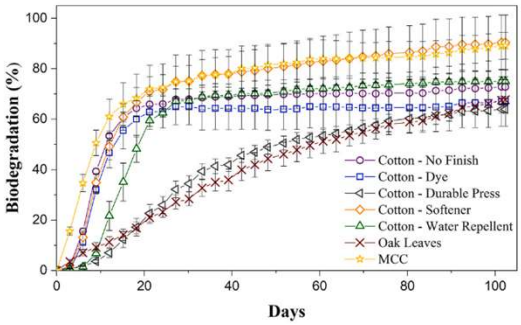


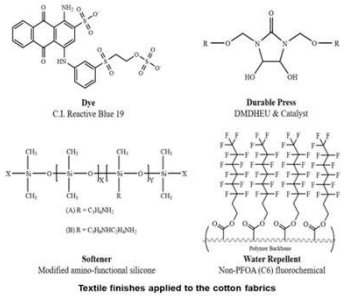
Source: Zambrano, M. C., Pawlak, J. J., Daystar, J., Ankeny, M., Goller, C. C., & Venditti, R. A. (2020). Aerobic biodegradation in freshwater and marine environments of textile microfibers generated in clothes laundering: Effects of cellulose and polyester-based microfibers on the microbiome. *Marine Pollution Bulletin, 151*(January). https://doi.org/10.1016/j.marpolbul.2019.110826

62

EFFECT OF FINISHES ON THE BIODEGRADATION OF COTTON FABRICS IN AQUATIC ENVIRONMENTS

Cotton microfibers generated from dyed and finished fabrics degrade faster than an oak leaf.



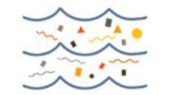


Test method ISO 14851, **Source**: Zambrano, M. C., Pawlak, J. J., Daystar, J., Ankeny, M., & Venditti, R. A. (2021). Impact of dyes and finishes on the aquatic biodegradability of cotton textile fibers and microfibers released on laundering clothes : Correlations between enzyme adsorption and activity and biodegradation rates. *Marine Pollution Bulletin*, *165*(January), 112030. https://doi.org/10.1016/j.marpolbul.2021.112030

63

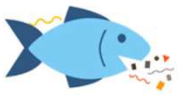
ENVIRONMENTAL EFFECTS OF PLASTICS

Modelling impacts of microplastic emissions



Fate

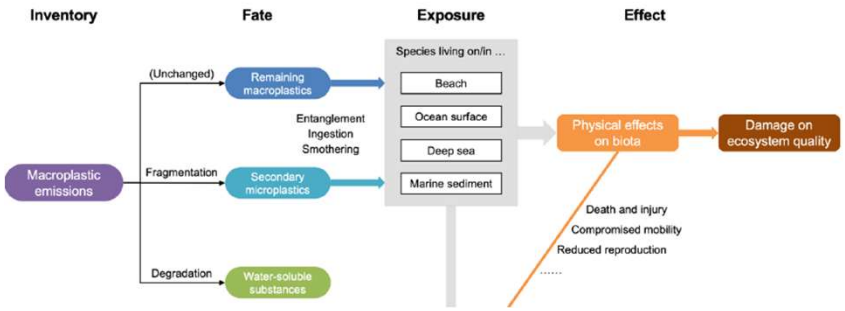
X



Exposure

X

Effect



Source: Tang and Boulay, Research Project 21-850, MarILCA Fragmentation 2023 report

- ✓ Characterization of physical effects on marine ecosystem – *completed*
- Modeling fragmentation of macroplastics into secondary microplastics - *underway*
- Expanding beyond exposures in marine environment - *sediments underway*
- Expanding to other effects

MarILCA
MARINE IMPACTS IN LCA

Source: Corella-Puertas, et. al., MarILCA characterization factors for microplastic impacts in life cycle assessment: Physical effects on biota from emissions to aquatic environments, Journal of Cleaner Production, Volume 418, 2023, https://doi.org/10.1016/j.jclepro.2023.138197.

64

The need for realistic and scalable circular solutions that reduce environmental impacts

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.

65

66

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

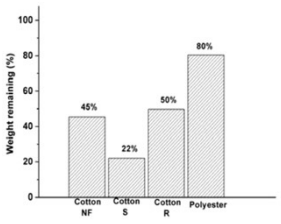


FIGURE 5. Biodegradation of fabrics in composting

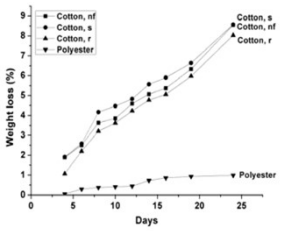


FIGURE 6. Biodegradation of fabrics by enzymatic hydrolysis

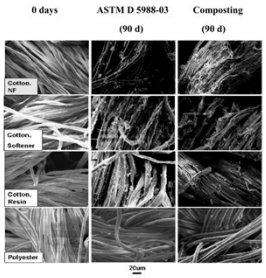
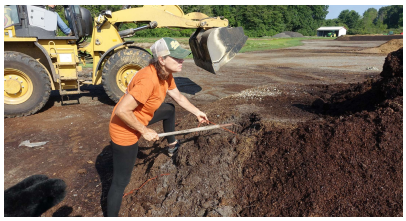


FIGURE 7. SEM images of fabric samples after degradation (1000×)

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

67

COMPOSTING AT CORNELL



Images: courtesy of Cotton Incorporated research at Cornell, photographed by Insights International, Inc.

68

100% COTTON

Images: courtesy of Cotton Incorporated research at Cornell, photographed by Insights International, Inc.

69

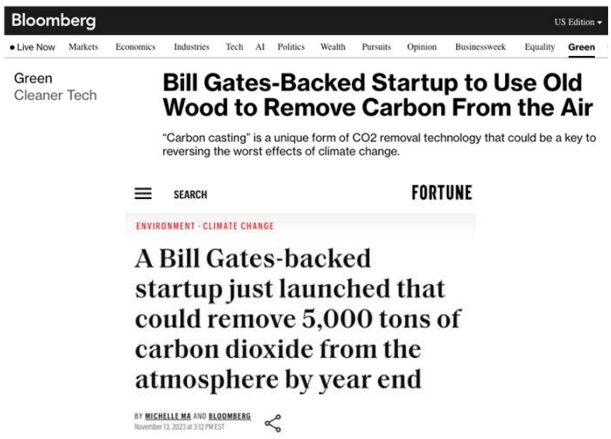
COTTON BLEND

Images: courtesy of Cotton Incorporated research at Cornell, photographed by Insights International, Inc.

70

BIOSEQUESTRATION FROM WASTE CLOTHING

"GRAPHYTE" CARBON CASTING


Bloomberg

US Edition

• Live Now Markets Economics Industries Tech AI Politics Wealth Pursuits Opinion Businessweek Equality Green

Green
Cleaner Tech

Bill Gates-Backed Startup to Use Old Wood to Remove Carbon From the Air

"Carbon casting" is a unique form of CO2 removal technology that could be a key to reversing the worst effects of climate change.

SEARCH FORTUNE

ENVIRONMENT · CLIMATE CHANGE

A Bill Gates-backed startup just launched that could remove 5,000 tons of carbon dioxide from the atmosphere by year end

BY MICHELLE MA AND BLOOMBERG
November 13, 2023 at 3:12 PM EST


The Washington Post

CLIMATE SOLUTIONS

The Lego-like way to get CO2 out of the atmosphere

A company says that it has found a way to remove CO2 from the air for less than $100 per ton

By Shannon Osaka

November 13, 2023 at 7:00 a.m. EST

71

REUSE AND DURABILITY

Hypothesis:

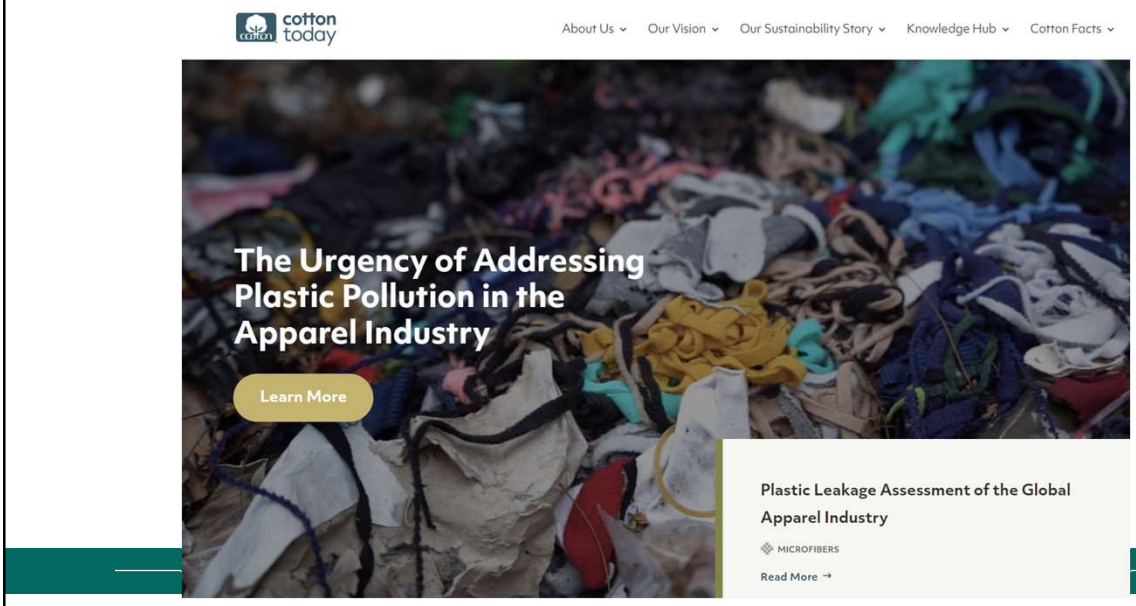
Cotton fabric is commonly reused a second or third time before being discarded, which reduces its overall environmental impact

Goal:

Perform LCA around the multiple uses of cotton fabric and determine how that reduces the overall impact of cotton fabric used in apparel

72

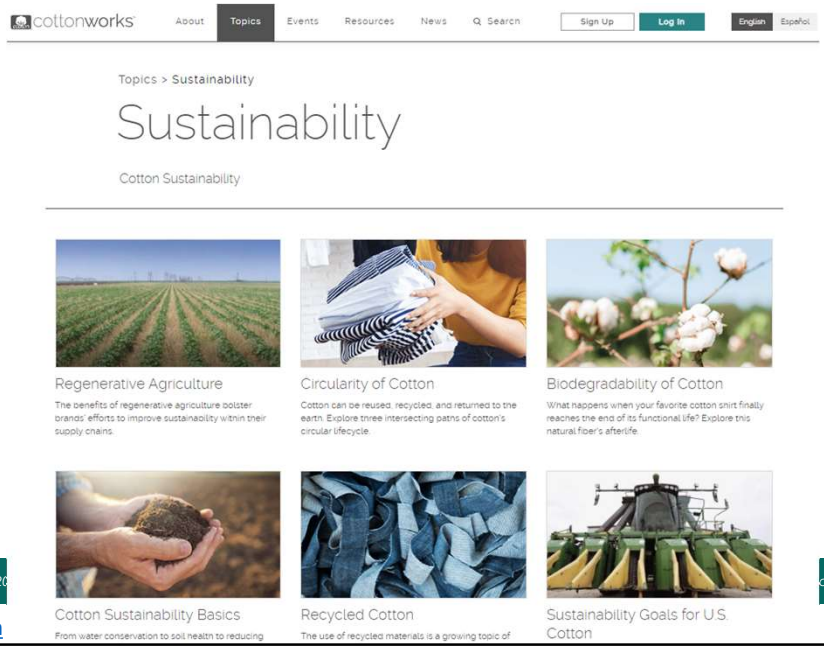
COTTON SUSTAINABILITY RESOURCES



www.cottontoday.com

73

COTTON SUSTAINABILITY RESOURCES



www.cottonworks.com

74

75

76