Cotton: A Case Study in Misinformation

NO LONGER RECOGNISABLE

A report on building critical data consumption in fashion

TRANSFORMERS FOUNDATION

This report was commissioned and authored by the Transformers Foundation. Our goal is to help suppliers share their expertise and opinion on industry threats and solutions, brands and retailers transform their jeans from a commodity into unique and valuable fashion, and consumers choose the most environmentally-sound denim products and avoid greenwashing. Our events connect industry professionals who want a deeper understanding of the denim industry, covering topics ranging from energy and water to social responsibility, technology and waste.

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Acknowledgements

Though this report represents the views of the Transformers Foundation only, the authors would like to thank all the organizations and people who contributed their expertise and ideas. We would like to acknowledge the contributions of ICAC, the International Cotton Advisory Committee, that were critical to the successful completion of this report.

Our Revision Board was critical in reviewing the content of this paper:

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Marc Lewkowitz, President and C.E.O. at Supima

We would like to thank cotton experts, journalists, and independent researchers who lent their time and expertise to this report:

Anita Chester, the head of materials at Laudes Foundation.

Beth Jensen, Climate and Strategy Director of Textile Exchange

Damien Sanfilippo, Senior Programmes Director of Better Cotton Initiative

Litul Baruah, program manager at Laudes Foundation

Maxine Bédat, Executive Director at New Standard Institute

Sarah Kent, London Editor at Business of Fashion

We also thank the contribution of the Cotton Diaries community members and the subject experts who wish to stay anonymous.

This report would not have been possible without the generous contributions of our founding members:

Cannon Michael, President/CEO, Bowles Farming Company

Alberto Candiani, Global Manager, Candiani Denim

Mostafiz Uddin, owner/Managing Director, Denim Expert Ltd.

Ali Abdullah, founder/Managing Director, Diamond Denim by Sapphire

Michael Kininmonth, Project Manager, LENZING Group

Tricia Carey, Director of Global Business Development, LENZING Group

Andrew Olah, CEO, Olah Inc.

Stafford Lau, Managing Director, Prosperity Textile

Dr. Wolfgang Schumann, Managing Director, Rudolf Group

Alberto De Conti, Head of Marketing and Fashion Division, Rudolf Group

Sanjeev Bahl, Founder and Chief Executive, Saitex International

Rizwan Shafi, Executive Director, Crescent Bahuman Ltd

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Contents

Executive summary

Fashion has a major misinformation problem. Half-truths, out-of-date information and shocking statistics stripped of context are widely circulated, from the notion that fashion is the second-most polluting industry to the idea that cotton is thirsty or that it consumes 25% of the world's insecticides.

While there have been attempts to debunk fashion misinformation, we have not taken the problem seriously enough. Fashion misinformation is part of the same society-wide information disorder destabilizing democracies and undermining public trust. While we need not agree on a one-size-fits all solution to environmental and social problems, all players in fashion—from journalists and nonprofits to consumers, suppliers and brands—need to agree on the facts, or hope for progress will fade from view.

This report aims to take a new approach, using the cotton industry as a lens through which to tackle misinformation. Most of the common claims about the cotton industry are inaccurate or highly misleading (from the idea that cotton is water-thirsty to the notion that it takes 20,000 liters of water to make a T-shirt and a pair of jeans). It is an ideal place to begin to unpack how misinformation operates.

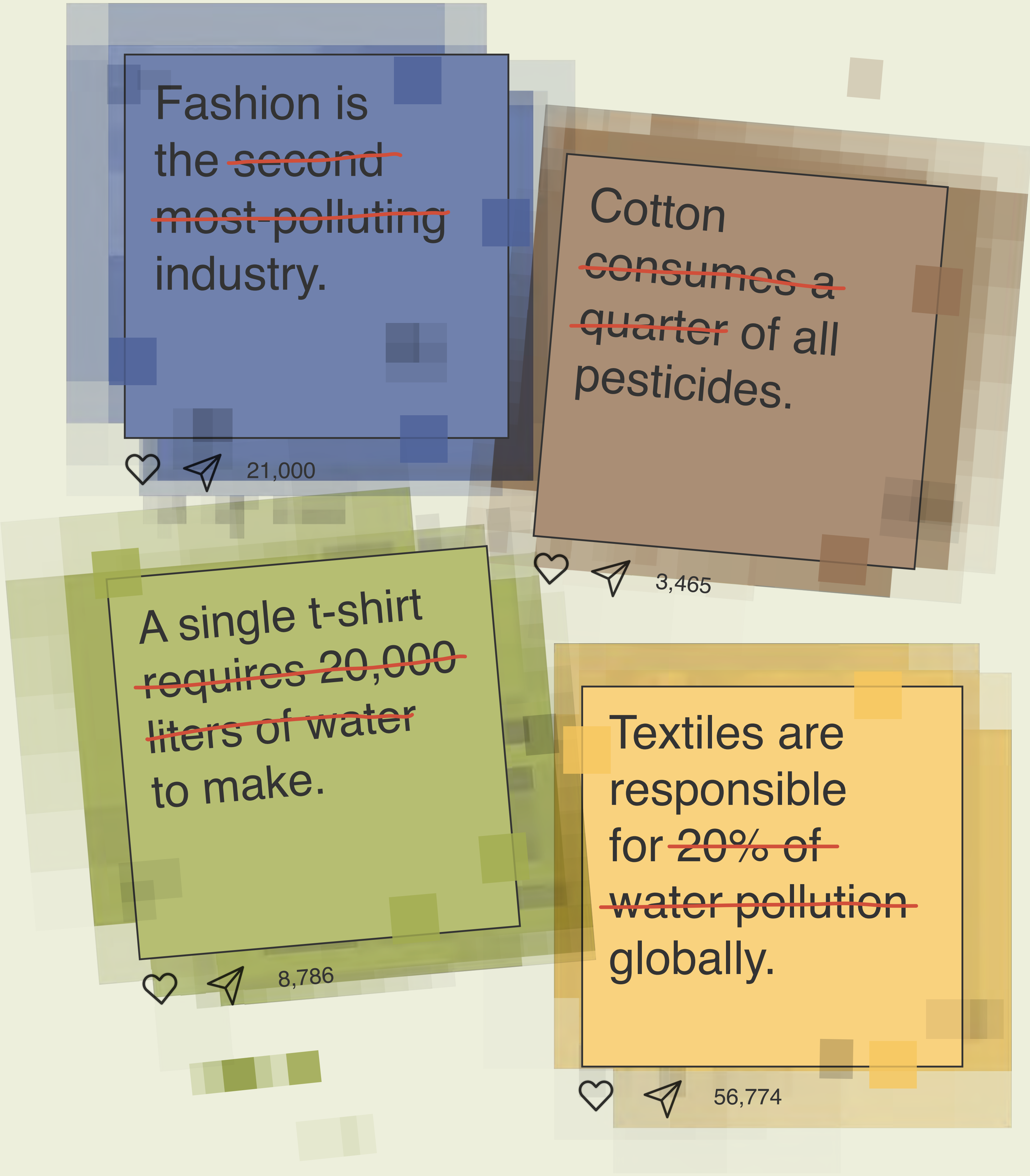
In this paper, readers will:

- Become critical consumers of data, using the cotton industry's environmental impact as a case study.
- Learn how to debunk the most common myths about the cotton industry and gain much-needed context about water consumption and pesticide use in the cotton industry.
- Gain access to the latest and best available public data and context on cotton's environmental impact to use in place of misinformation.

By teaching critical data consumption skills, such as how to fact check claims, locate primary sources, understand and be critical of data's role in society, and to identify how misinformation originates and spreads (through "erratic copying" and the "credibility trap" for example), we hope this report is an important tool in slowing and reversing this corrosive problem.

We aim to foster consensus around our report, so that the industry has a trusted source to point to when it comes to cotton and sustainability. We ultimately hope this approach can be applied to other sectors of fashion outside of cotton.

These are just a few of the claims circulated widely about the fashion industry's environmental impact that are flat-out false, highly misleading, or stripped of all context:



We know that fashion has a *misinformation* problem.

Misinformation: information "considered incorrect based on the best available evidence from relevant experts at the time."[1]

Half-truths, out-of-date statistics and numbers taken out of context are spread on social media, by brands, nonprofits, multi-stakeholder initiatives aiming to transform the industry, and advocates, by the mainstream press, and everyday people looking to share information or participate in a cause. We're all complicit. And we haven't taken the problem seriously enough.

There have been efforts to debunk cotton myths and fashion misinformation, both by cotton industry groups, nonprofits, and journalists alike.[2] Perhaps the most notorious bit of fashion misinformation is the notion that ~~the industry is the second most pollutin~~g after oil. This oft-cited claim was originally debunked by journalist Alden Wicker, who attempted to trace the claim back to a primary source in a 2017 Racked article and came up empty-handed.[3] The New York Times did a follow-up, titled "The Biggest Fake News In Fashion" and likewise found no primary resource.[4]

MYTH

Many cotton industry trade groups have worked to debunk cotton myths in recent years. Yet attempts to call out misinformation in fashion have thus far had limited power to slow it. In fact, the claim that fashion is the second most polluting industry has been back in the news recently.[5]

Our approach attempts to go further. We aim to tackle fashion misinformation both by teaching the skills to use information critically (and explain why it matters) and by providing accessible quality data on cotton that is easy for the public and the industry to use and understand. While no one paper or approach can reverse the tide of misinformation on its own, collating the sound data in one place alongside best practices of how to use information responsibly and in context is urgently needed.

Misinformation is not unique to fashion, but what we've so far failed to recognize is that it is also inseparable from society's broader information disorder. Fashion misinformation is complicit in the same systems of misinformation breaking down public trust in our institutions and our trust in one another.

Misinformation's impacts are becoming more catastrophic, linked to public inaction around climate change, the questioning of the 2020 U.S. election results, the rise of authoritarianism, and the threat to democracy worldwide.[6] Sharing half-truths about how much water cotton consumes or the fashion industry pollutes might seem innocent by comparison, but we argue it's all part of the same information disorder with troubling shared consequences.

Quality, trusted information is critical to our social order. Without it, we are moving quickly towards a world where the public may come to "disbelieve all content," including content coming from genuine expertise, according to Cherilyn Ireton and Julie Posetti in "Journalism, fake news & disinformation: handbook for journalism education and training."[7]

Damien Sanfilippo, Senior Programmes Director of Better Cotton Initiative:

"Everybody has an interest in data. And that's good, because it means that everybody has an interest in sustainable development. But using data correctly is a skill. Right? And it needs to be done in a scientific manner."

Look around, there is mistrust growing between those looking to improve the fashion industry, including between nonprofits and brands, between consumers and brands, factions of the textile and farming industries and even within the ethical and sustainable fashion movement. We don't have to agree on one-size-fits-all solutions, but we do have to agree on the facts or else society will continue to unravel and hope for positive change will move beyond our reach.

While we do aim to understand where misinformation is originating from and how it spreads, we are not here to dish out blame. Many of us have been cognizant of the erosion of information standards within our own fields. Some of us have personally or professionally gained from sharing exaggerated and misleading claims. We've often operated as if we don't live in a post-truth world, where statistics are unreliable and manipulated. In fashion, an industry that has in many ways functioned the same way for a century or more, we have been slow to connect how society's information disorder has infected our own space.

IMPORTANT

The stakes couldn't be higher. The $2.5 trillion fashion industry's environmental impact grows every year, with only a temporary slowdown during the pandemic.[8] We believe that misinformation is a key reason why we aren't moving towards positive change. It is crucial for industries and society to understand the best available data and context on the environmental, social and economic impact of different fibers and systems within fashion, so that best practices can be developed and implemented, industries can make informed choices, and farmers and other suppliers and makers can be rewarded for and incentivized to operate using more responsible practices that drive more positive impacts. By using credible information, and learning to use information more responsibly, we can hopefully begin to move past mistrust towards actual improvements.

Now that we've hopefully gotten your attention, we want to reassure you that we don't think it's too late for fashion.

But we have to course-correct now, to take misinformation seriously and to commit to being more responsible consumers, creators and sharers of information. That is the purpose of this paper, which uses cotton as a case study through which leaders in the institutions shaping fashion (brands, journalists, nonprofits, consumers, suppliers, farmers and beyond) can be trained in the tools they need to become critical consumers of data and skilled combatants against the spread of false and misleading data and other claims.

This paper is for:

- ☑ **brands**
- ☑ **journalists**
- ☑ **NGOs**
- ☑ **consumers**
- ☑ **suppliers**
- ☑ **farmers**
- **and beyond**

The aim of the paper is to:

1. Train readers to become critical consumers of data and information, using cotton's water and pesticide use as a case study.

2. Debunk and *pre-bunk* the most common myths about the cotton industry, showing how to vet claims and data and confront misinformation whenever you encounter it.

Pre-bunk: myths prevention or the process of debunking lies, tactics or sources *before* they strike.

3. Gather and share publicly the best available sound data and context on cotton to use in place of misinformation.

4. Foster the cotton industry's consensus around the data contained in the report, so that it's trusted and usable for the industry and the wider public.

Our misinformation disorder

Why is misinformation careening out of control? Digital tools and social media networks make it possible to instantaneously share information that can quickly travel across the Internet.[9]

Social media and more precisely the amplification of fake news stories on social networks are picked up and released through mainstream media. This pipeline has overpowered newspapers as a main way that new stories are discovered, and much of this information is moving too quickly to be vetted. Exaggerated claims and sensationalism (and algorithms that prioritize them) drive more likes, garners more followers, and rewards users for spreading misinformation.

Greenwashing: misinformation spread by private actors, namely corporations or marketers in the process of selling a product and who describe their products or services as more sustainable than the competition or another product.

But it's not just social media that's to blame. Misinformation is also spread by private actors, namely companies who use deceptive marketing to describe their products or services as more sustainable than the competition or compared to an earlier iteration of their own business. This is known as *greenwashing*, and it's a massive problem in fashion. In 2020, the European Commission analyzed 344 consumer product claims made online about sustainability, a quarter of which were made about clothing, fabric, and shoes. Almost half of all claims analyzed were flagged as possibly deceptive.[10]

Journalists are also under increasing pressure to produce more content, more sensationalist content and fewer on-the-ground reported features and investigative stories, on a tighter budget.[11] Digital publishing and social media has crushed the business model of legacy journalism, leading to scaling back of fact checking and editorial departments, eroding standards further.[12] This is particularly troubling as journalists play a key role in upholding democracy both by maintaining rigorous fact-checking standards and by holding the powerful to account.[13]

Misinformation is also spread by nonprofits and advocacy organizations. Advocates hold a central role in making change. They get information to citizens, mobilize society to focus on the right issues and make change, and hold brands and governments accountable. And while these organizations are instrumental in galvanizing the public, they often lack accountability[14] when it comes to data usage and may not have access to technical expertise or resources to interpret claims correctly.

Across all of these institutions is the wider problem of accountability. There are few consequences doled out for spreading misinformation. In fact, many companies, institutions, and individuals are rewarded for doing so, either by gaining an audience or customers.

There are many ways of thinking about misinformation. One of the most common is to evaluate it based on intent.

> According to the European Commission, **misinformation** is “verifiably false information that is spread *without the intention* to mislead, and often shared because the user believes it to be true.”[15]
>
> **Disinformation**, also verifiably false or misleading, is “disseminated for economic gain or to intentionally deceive the public.”[16]

MYTH!

However, the working definition we use does not factor in intent, as false information has the same corrosive impacts regardless of motive. As you might imagine, deciphering whether fashion misinformation is spread intentionally is challenging. Many of those sharing the false claim that ~~*fashion is the second most polluting industry*~~ likely didn't stop to wonder if it was accurate or inaccurate, what Tam Nguyen would refer to as "blurring the line between innocence and deception".[17] What's more, brands might, whether unknowingly or not, share data without vetting it or use it in a misleading way without context because there is a clear economic gain, while journalists and nonprofits might share shocking statistics and exaggerated claims to gain readers or followers. Considering the steep cost of misinformation, intent matters less than actions and impact. **That's why we all need to be more intentional, responsible users of information.**

Is misinformation a data problem?

Misinformation in fashion is also arguably spreading because good data on the industry's impacts is relatively hard to come by and complicated to gather (although lack of good data doesn't justify spreading bad data).[18] Several of our stakeholders felt that fashion's environmental impact compared to other large industries is understudied, potentially because it hasn't been under scrutiny until relatively recently as well as because of its complex supply chains. "Because fashion is an industry that has not been taken seriously, historically, it does not have the degree of independent or non-corporate actors scrutinizing and analyzing the sector that other sectors do," says Sarah Kent, London Editor at Business of Fashion.

Sarah Kent, London Editor at Business of Fashion:

“Because fashion is an industry that has not been taken seriously, historically, it does not have the degree of independent or non-corporate actors scrutinizing and analyzing the sector that other sectors do.”

Silenced data: data that exists but is privately controlled or exorbitantly expensive and thus not accessible to the public.[14]

Accessible data: data that is analyzed, broken down and easy for the public to use.

Other experts told us they feel that scientific understanding and proper usage of data in fashion is lacking in comparison to other sectors. “We have an urgent need to build out this technical-scientific expertise in our industry, which has mostly been dominated by creatives to date,” says Beth Jensen, the climate and strategy director of Textile Exchange, a nonprofit advocating sustainable textile and fiber production. A major cotton grower we interviewed likewise expressed surprise and concern at the lack of understanding of cotton production amongst brands.

As we’ll explore throughout the paper, there is also an issue of *silenced data* in fashion, meaning data that exists but is privately controlled or exorbitantly expensive and thus not accessible to the public. *Data is often siloed* within organizations, and marketing and corporate social responsibility teams within brands are often distanced from those with an understanding of scientific findings or of the supply chain, to name one example.[19] One expert told us that their own data was packaged into reports by marketing teams within their organization, and it was there that data was reshaped in a more misleading way. "Generally, and in fashion in particular, sustainability has been driven by marketing teams, and it hasn't been driven by scientists,” says Maxine Bédat, author of “Unraveled:The Life and Death of a Garment” and director of the New Standard Institute. There is also a lack of *accessible data* that is analyzed, broken down and easy for the public to use as well as a lack of public education about how to use information critically. This is where we’ll focus most of our attention.

We are too obsessed with data

As this paper demonstrates, good data about fashion's environmental impact does exist. We just aren't using it or aren't using it correctly. We are favoring shocking, outdated, and simplified claims over accuracy, context and nuance. Why are we so drawn to numbers, especially ones that attempt to simplify or exaggerate the world around us?

Part of what pulls us towards data and statistics is that they're closely linked to our ideas of objectivity and truth, as we tend to assume that data transcends all human relations and stands alone with no outside influences. In essence, we have a deep-seated belief that, as Anthony Van Witsen, a communications professor wrote in Journalism Practice, "knowledge, expressed in numbers, represents undebatable truth that cannot be argued with."[20] It's just the facts, right? We share these shocking statistics because we trust the numbers and know that others will trust us in return. They're numbers. And we assume numbers don't lie.

This deep-seated belief in the objectivity of data influences all of us. Journalists tend to value data since they are supposed to be objective, and numbers are perceived to be objective.[21] Likewise, as Van Witsen points out, advocacy groups use numbers to give themselves more credibility and gain access to media coverage. Some scientists worry that research has come to prioritize big data rather than qualitative output and context as well.[22] And individuals rely on data on social media to bolster their personal opinions by appearing to just be stating the facts.

And yet numbers aren't neutral. Some scholars have pointed out that quantifying something is a social and even political act, as someone is making the decisions about what to measure, how to measure it and what metrics to include and exclude.[23] In fact numbers about cotton's environmental impact are rarely a "straight physical measure," explains Allan Williams, General Manager, R & D Investment, Cotton Research and Development Corporation (CRDC), a partnership between the Australian government and the nation's cotton farmers. Instead, they are derived and the methodologies used to gather and analyze the data that produces these numbers vary. Nevertheless, numbers that aren't designed to be compared are often compared anyway, producing more misinformation.

Fig 01

Take for example the tweet we've included in Fig 01. By comparing large and shocking numbers that weren't designed to be compared, like 900 million people lack access to safe drinking water and cotton "wastes" 20,000 liters of water per outfit, a viewer might be convinced these two issues are causally related (as we'll learn in Section 1, they're not, and the 20,000 liters stat is inaccurate). If the viewer is already primed to think fashion and cotton are unsustainable, they might in turn believe that every cotton outfit is taking water from human beings (as we'll learn in Section 2, this is highly misleading).

Numbers are easy to misinterpret and transpose. And the way that they get used is also in-turn often politicized. Numbers have power. They persuade, and when numbers match our preconceived notions, we are easily convinced by them.[24]

It's time to fill in the missing context

Perhaps the most important reason to challenge numbers is that they so often don't tell a complete story or even the right story. Context is what's needed. "Data by itself is not useful and is sometimes dangerous, unless it is being used in context," says Damien Sanfilippo, Senior Programmes Director of Better Cotton Initiative, a nonprofit promoting sustainable standards in the cotton industry.

As we'll see throughout our report, there is a tremendous amount of context and nuance that goes missing when we use a single statistic to sum up a complex topic. There's been a society-wide shift towards using data in isolation without context, potentially because we're trying to communicate on platforms that provide us with 280 characters or a few small tiles. This is a very worrying trend indeed, one we aim to reverse. Using the example of cotton: As you'll see, cotton isn't one ubiquitous, singular thing. It is a complex industry and talking about it with complexity and nuance is key to talking about it truthfully. The same goes for every other sector in fashion. Thus, we need to be both better consumers of data, but we also must learn how to use data in context.

"It is highly technical and very difficult to make broad statements without caveats. This leads to misinformation. People want a straightforward message, but that results in lots of simplification, which misses the complexity of the situation," one nonprofit representative told us.

It’s time to be more critical consumers of data.

Here’s some tips on how to use data responsibly and retain a healthy skepticism of data without becoming anti-science or anti-data:

- Don’t accept data and statistics at face value.
- Bring the same kind of healthy skepticism to data you apply to other kinds of claims.
- Understand that data and statistics are powerful tools that can be easily misused and misinterpreted.
- Recognize that data gathered via different methodologies can’t and shouldn’t be compared.
- Strive to always use data in context. If you can’t fit the context in a tweet or Instagram post or an ad, don’t share it.
- Before sharing data, ask yourself if you’re using it to inform and open a meaningful conversation or to persuade and mislead.

Why should you trust us?

You might have wondered how you can trust us and the information we share. This is the right sort of question to be asking.

We are writing on behalf of Transformers Foundation, a nonprofit that aims to support a responsible denim industry. Aren't we biased towards cotton? Yes, we are, and here's what we did to balance that bias to ensure that this paper is built around credible data and context that isn't misleading:

- All data in the report comes from a primary source (meaning we have verified the original study or first-person report from which it came) and the most recent publicly available data. We draw on peer reviewed data whenever possible, meaning drawn from studies evaluated for quality by other experts in the same field, before being published.
- All claims have been fact-checked using an independent and experienced fact checker that is not employed by any industry association, including our own. Likewise, our writer is an experienced journalist and not employed by any cotton industry associations, including our own.
- We've drawn on dozens of interviews, email exchanges and input from a wide range of stakeholders and experts, including industry and trade groups with a wide variety of perspectives, as well as independent researchers, consultants, farmers, scientists and journalists in order to gain a holistic understanding of each topic.

We've made every effort to research the best available and more relevant figures around cotton and make them available to you. We hope you'll find this isn't a paper written to make cotton look good, but to shine a light on responsible information usage, starting with cotton. And here are a few final disclaimers before we get started:

- We've done our research, but you should, too! Check our sources against your own, and always exercise critical thinking and sound judgment.
- This is the best available data we have found yet. If you have better sources or can help us fill our data gaps, please contact us hello@transformersfoundation.org
- This is qualitative research. Accordingly, the results should not be used to describe the fashion sector at large. This research does, however, deliver a detailed summary of the behaviours and perspectives that consistently emerge with respect to the fashion sector.

SECTION 1:

Cotton's Environmental Impact: The Myths Versus the Reality

Cotton is an ideal case study in misinformation as so many of the widest circulated "facts" about cotton are not facts at all or are highly misleading.

The plain white fiber grown for thousands of years and found in much of the world's clothing and textiles has morphed into an environmental bogeyman, blamed and castigated for a range of transgressions, from the draining of the vast Aral Sea in Central Asia to alarmingly high levels of pesticide and water consumption. What's more, misinformation about cotton is often used to make arguments that the fashion industry more broadly is unsustainable.

Cotton is also an ideal case study because getting the facts right about the industry matters so much. Cotton is 80% of the natural fiber market and is the second most-commonly produced fiber after polyester, accounting for 24.2% of global fiber production as of 2020.[25] What's more, the cotton industry supports the livelihoods of an estimated 22 million households across 75 countries.[26] When seasonal labor and ancillary industries such as ginning are included, some estimates are that between 100 million and 150 million people, representing between 1.5% and 2% of the world's population, depend on cotton for their cash incomes.[27]

Seeking credible information and reliable data about cotton doesn't mean ignoring or downplaying the industry's contributions and links to severe global problems. Many cotton farmers live in nations "suffering many serious problems of governance, poverty and environmental stress," says independent cotton researcher Simon Ferrigno in "The 21st century cotton blues," and cotton can and does play a key role in these challenges in many regions.[28] Credible data and context are key to addressing these challenges.

Myth-busting cotton sustainability claims

To demonstrate cotton's misinformation problem, we will begin by vetting four widely-circulated claims about the industry. We'll also trace the origins of the claims, explain how they spread and then provide credible information to use instead:

1. Cotton consumes 20,000 liters of water per kilogram of fiber
2. 25% of the world's insecticides are used on cotton
3. Cotton is a water-thirsty crop
4. Organic cotton uses 91% less water than conventional cotton

How we rank claims

Each claim is given a rating from Red to Gold, inspired by the claims-ranking system by the New Standard Institute, a nonprofit advancing science-backed sustainability claims in fashion. The ratings go from Red, which indicates a claim that has no known or credible primary source and shouldn't be used, all the way up to Green and Gold-rated claims, which are based on the highest-quality data. Their use is encouraged.

We've added a few additional qualifiers to our ratings to make them a bit more stringent. Our Red-rated claims include claims that are unverified or based on obsolete data, in addition to those without a known primary resource.

Gold: Gold standard

Gold standard, peer reviewed articles. Transparent about funding and authors' affiliations.

Green: Generally reliable

Robust methodology, government source or direct reporting. Transparent about funding and authors' affiliations.

Yellow: Questionably reliable

Has primary resource but methodology is questionable. Limited transparency around funding and/or affiliations.

Orange: Not reliable

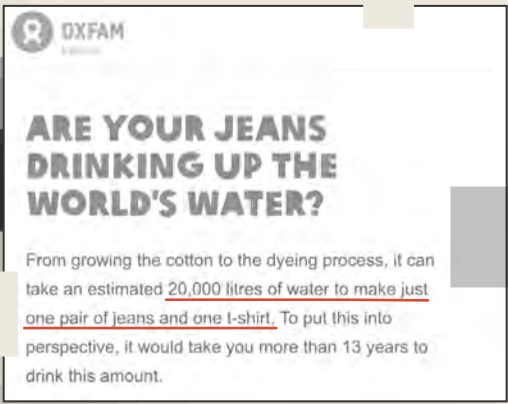
Highly contested data. Avoid use.

Red: Not at all reliable

Unverified or based on obsolete data, no known primary resource. Do not use!

This system is adapted from the claims-ranking system by the New Standard Institute

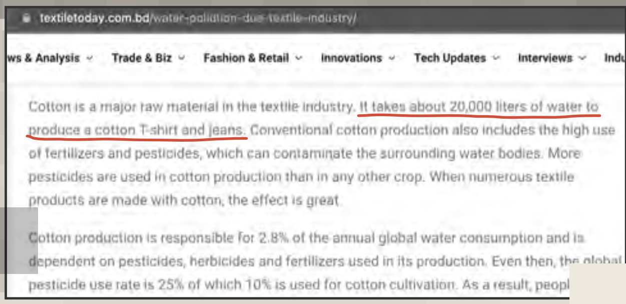
Myth-busting exercise #1:


OXFAM

ARE YOUR JEANS DRINKING UP THE WORLD'S WATER?

From growing the cotton to the dyeing process, it can take an estimated 20,000 litres of water to make just one pair of jeans and one t-shirt. To put this into perspective, it would take you more than 13 years to drink this amount.

Oxfam claims it takes 20,000 liters of water to make one pair of jeans and a shirt in their “Second hand September”

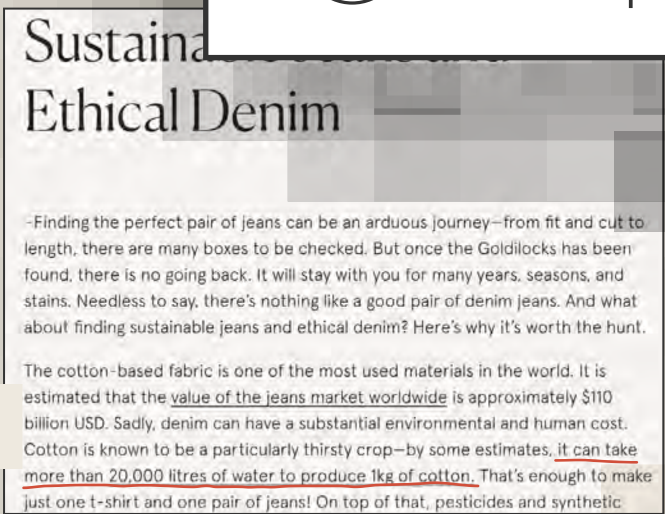

textiletoday.com.bd/water-pollution-due-textile-industry/

Cotton is a major raw material in the textile industry. It takes about 20,000 liters of water to produce a cotton T-shirt and jeans. Conventional cotton production also includes the high use of fertilizers and pesticides, which can contaminate the surrounding water bodies. More pesticides are used in cotton production than in any other crop. When numerous textile products are made with cotton, the effect is great.

Cotton production is responsible for 2.8% of the annual global water consumption and is dependent on pesticides, herbicides and fertilizers used in its production. Even then, the global pesticide use rate is 25% of which 10% is used for cotton cultivation. As a result, peopl

Screenshot of a June 3, 2020 Textile Today article, “Water pollution due to textile industry article,” referencing the misleading 20,000 liters of water figure.

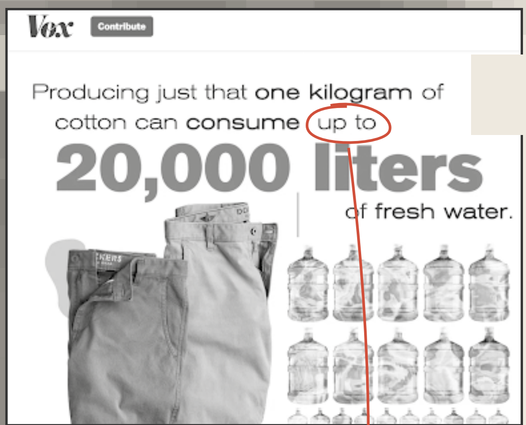
1 Cotton consumes 20,000 liters of water per kilogram of fiber


Sustaina… Ethical Denim

Finding the perfect pair of jeans can be an arduous journey—from fit and cut to length, there are many boxes to be checked. But once the Goldilocks has been found, there is no going back. It will stay with you for many years, seasons, and stains. Needless to say, there's nothing like a good pair of denim jeans. And what about finding sustainable jeans and ethical denim? Here's why it's worth the hunt.

The cotton-based fabric is one of the most used materials in the world. It is estimated that the value of the jeans market worldwide is approximately $110 billion USD. Sadly, denim can have a substantial environmental and human cost. Cotton is known to be a particularly thirsty crop—by some estimates, it can take more than 20,000 litres of water to produce 1kg of cotton. That's enough to make just one t-shirt and one pair of jeans! On top of that, pesticides and synthetic

Good on You claims 1 kg of cotton uses over 20,000 liters of water in “The Ultimate Guide to Sustainable Jeans and Ethical Denim,” published on June 12, 2020.



Vox.com sponsored article “How to reduce your wardrobe's water usage in 4 easy steps,” published on July 24, 2020.

GOOD STARTING POINT

This claim is often presented as “it takes 20,000 liters of water to grow the cotton in a single T-shirt or pair of jeans.” Sometimes the figure is given in terms of gallons. It's often paired up with further details about how many bathtubs or glasses of water growing cotton consumes. We've included several examples of how this claim is used by the media, nonprofits, and brands.

The current and accurate claim about cotton and water consumption and how to use it:

According to the most recent data from the International Cotton Advisory Committee (ICAC), as of 2020, cotton uses 1,931 liters of irrigation water *(blue water)* on average to produce 1 kilogram of lint.[29] Globally, cotton uses 6,003 liters of rainwater *(green water)* on average to produce 1 kilogram of lint.[30] Based on our own internal calculations done by consulting with cotton farmers and mills, 1 kilogram of lint does produce approximately one T-shirt and pair of jeans, although this figure will vary based on the size and weight of the garment. And these numbers do not factor in the water used to manufacture a cotton garment. What's more, we warn against using even these accurate and updated global averages about cotton's water use, especially without additional context, as water use and consumption is not a reliable indicator of impact. To understand more about the difference between green and blue water and water use and water consumption, see Section 2.

How we rate this claim: Red.

This claim has no known primary source. It is also missing key context, is inaccurate in a modern context, and shouldn't be used.

Tracing the origins of the claim

The primary source of the 20,000 liters claim is often cited as the World Wildlife Fund, an environmental nonprofit, from its 1999 report "The Impact of Cotton on Fresh Water Resources and Ecosystems," coupled with the WWF Cotton page, which from at least 2013 to late 2020 featured a large infographic saying "20,000 liters: The amount of water needed to produce one kilogram of cotton, equivalent to a single t-shirt and a pair of jeans."[31] The statistic was only recently taken down.

Data on cotton's water consumption from the WWF report shouldn't be used for several reasons. If you'd like to do your own investigation, it is publicly available and in the footnotes.[32] First, it's outdated and inaccurate in a modern context. Current accurate data on cotton's water consumption, which we listed above, reflect much lower global averages.[33] We were unable to find a current credible and publicly available global average figure that combines blue and green water consumption for cotton.

As Snopes, the internet misinformation resource, explains, outdated information is information where "subsequent events" have rendered their original truth rating irrelevant. Cotton farming techniques, technology, and cropland under cultivation to cotton have changed dramatically over the decades. It is our recommendation that, given the pace of change in the cotton industry, any data about cotton's environmental impacts older than five years should be questioned for its veracity and data older than ten years should be considered outdated and not used or used with a disclaimer.

Water withdrawal: The volume of freshwater abstraction from surface or groundwater. Part of the freshwater withdrawal will evaporate, another part will return to the catchment where it was withdrawn, and yet another part may return to another catchment or the sea.

What's more, the WWF report does not in fact state that cotton uses 20,000 liters of water per kilogram of cotton. It states that cotton consumes between 7,000 and 29,000 liters of water withdrawals[34] per kilogram of lint. It's unclear how or if this statistic morphed into the 20,000 liters figure (we'll discuss the different ways misinformation morphs and spreads in the next section). We were unable to find a primary source to support it. The low end of the range is for Israel, which as of 2019, uses 98 liters of irrigated water per kilogram of lint.[35] The source for the 29,000 liters is not provided. The report also isn't a credible source of data because it's methodology isn't transparent. It appears to compare different data sets, which aren't disclosed, and its findings aren't peer reviewed.

Takeaway !

Use the latest and best available data. Obsolete data that is not relevant or accurate in a modern context is misinformation.

The trouble with global averages

The 20,000 liters claim is also problematic because it's based on a global average, which fails to capture the complexity of cotton and water. Average rarely means typical, especially when it comes to farming. There is no typical cotton farm. There are staggering global differences in the way cotton is grown and how much water farmers use, as well as how and if they use these inputs efficiently. Climate, rainfall, and irrigation technology vary greatly from one country to another, and often from region to region, and even field to field. To name an example, in the United States, cotton farmers in the southeast use 234 liters of irrigated water per kilogram of cotton on average compared to farmers in the west, which use 3,272 liters of irrigated water per kilogram. As Simon Ferrigno states in his 2020 report "The Inside Guide to Cotton & Sustainability," "global averaging is useless with cotton and means local reality is not addressed. Each distinct cotton region needs to address its own specific problems."[36]

More to the point, global averages also fail to capture impact. Twenty thousand liters sounds like a shocking amount of water, as does 234 liters, but in fact these figures alone do not reveal anything about whether water is sustainably managed on a local level where cotton is growing.

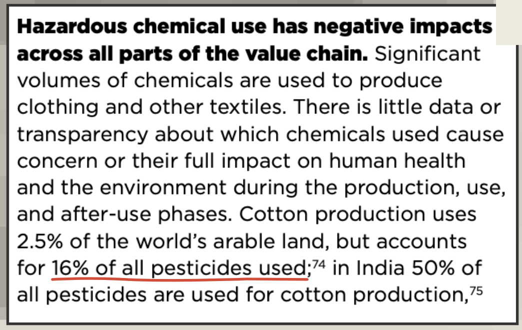
Takeaway !

Global averages about cotton's environmental impact can be misleading, as they fail to capture huge local variations in resource usage and impacts. While global data can be useful to tell whether cotton's overall impact is going up or down decade over decade, context and local data are key.

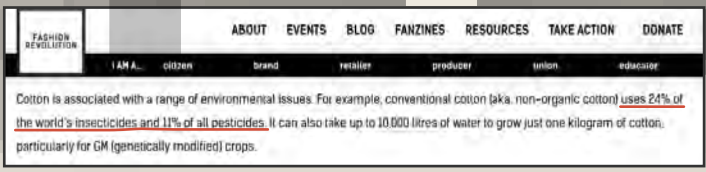
Simon Ferrigno, “The Inside Guide to Cotton & Sustainability”:

“Global averaging is useless with cotton and means local reality is not addressed. Each distinct cotton region needs to address its own specific problems.”

Myth-busting exercise #2:


Hazardous chemical use has negative impacts across all parts of the value chain. Significant volumes of chemicals are used to produce clothing and other textiles. There is little data or transparency about which chemicals used cause concern or their full impact on human health and the environment during the production, use, and after-use phases. Cotton production uses 2.5% of the world's arable land, but accounts for 16% of all pesticides used;[74] in India 50% of all pesticides are used for cotton production,[75]

The Ellen MacArthur Foundation's[37] 2017 report, "A New Textile Economy: Redesigning Fashion's Future," claims cotton accounts for 16% of all pesticides use by citing data from the Rodale Institute[38] that is no longer online.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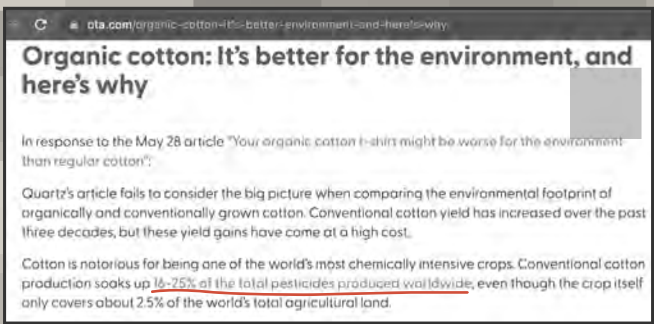
I AM A... citizen brand retailer producer union educator

Cotton is associated with a range of environmental issues. For example, conventional cotton (aka. non-organic cotton) uses 24% of the world's insecticides and 11% of all pesticides. It can also take up to 10,000 litres of water to grow just one kilogram of cotton, particularly for GM (genetically modified) crops.

Fashion Revolution's "Challenges facing the farmers who grow our cotton," from 2021, citing World Wildlife Fund.

2 25% of the world's insecticides are used on cotton


ota.com/organic-cotton-it's-better-environment-and-here's-why

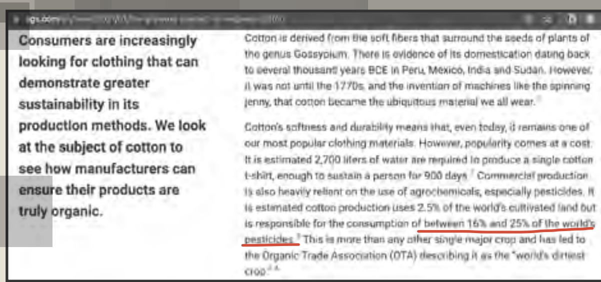
Organic cotton: It's better for the environment, and here's why

In response to the May 28 article "Your organic cotton t-shirt might be worse for the environment than regular cotton":

Quartz's article fails to consider the big picture when comparing the environmental footprint of organically and conventionally grown cotton. Conventional cotton yield has increased over the past three decades, but these yield gains have come at a high cost.

Cotton is notorious for being one of the world's most chemically intensive crops. Conventional cotton production soaks up 16-25% of the total pesticides produced worldwide, even though the crop itself only covers about 2.5% of the world's total agricultural land.

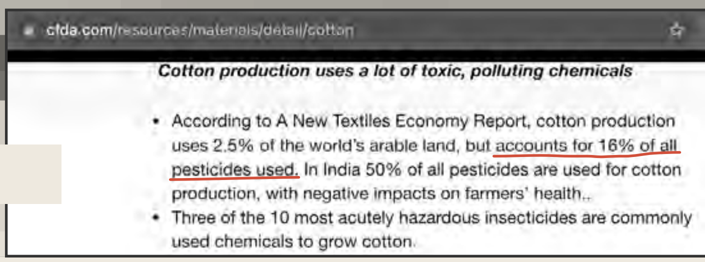
An explainer from the Organic Trade Association uses inaccurate ranges on pesticide applications worldwide. The source it uses is no longer an active link.


Consumers are increasingly looking for clothing that can demonstrate greater sustainability in its production methods. We look at the subject of cotton to see how manufacturers can ensure their products are truly organic.

Cotton is derived from the soft fibers that surround the seeds of plants of the genus Gossypium. There is evidence of its domestication dating back to several thousand years BCE in Peru, Mexico, India and Sudan. However, it was not until the 1770s and the invention of machines like the spinning jenny, that cotton became the ubiquitous material we all wear.

Cotton's softness and durability means that, even today, it remains one of our most popular clothing materials. However, popularity comes at a cost. It is estimated 2,700 liters of water are required to produce a single cotton t-shirt, enough to sustain a person for 900 days. Commercial production is also heavily reliant on the use of agrochemicals, especially pesticides. It is estimated cotton production uses 2.5% of the world's cultivated land but is responsible for the consumption of between 16% and 25% of the world's pesticides. This is more than any other single major crop and has led to the Organic Trade Association (OTA) describing it as the "world's dirtiest crop."

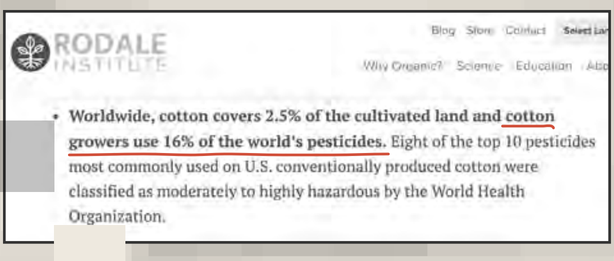
Testing firm SGS's claim on cotton and pesticides is footnoted to a dead link.


cfda.com/resources/materials/detail/cotton

Cotton production uses a lot of toxic, polluting chemicals

- According to A New Textiles Economy Report, cotton production uses 2.5% of the world's arable land, but accounts for 16% of all pesticides used. In India 50% of all pesticides are used for cotton production, with negative impacts on farmers' health..
- Three of the 10 most acutely hazardous insecticides are commonly used chemicals to grow cotton.

The Council of Fashion Designers of America's Materials Index resource page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Why Organic? Science Education

- Worldwide, cotton covers 2.5% of the cultivated land and cotton growers use 16% of the world's pesticides. Eight of the top 10 pesticides most commonly used on U.S. conventionally produced cotton were classified as moderately to highly hazardous by the World Health Organization.

9 Ways You May Not Realize Cotton Is In Your Food; Rodale Institute article from April 25, 2019.

There are a number of variations of this claim in circulation. Sometimes it's presented as cotton uses 24% or 25% of all insecticides globally, or 16% to 25% of pesticides, and so on. We've included several examples of where these claims appear.

The current and accurate claim about cotton and pesticides usage and how to use it:

Based on 2019 data from the International Cotton Advisory Committee (ICAC), cotton accounts for 4.71% of all pesticides measured as a percentage of total pesticides sales and 10.24% of all insecticide sales.[39] Another potentially useful current stat is that, according to Terry Townsend, the former Executive Director of ICAC and an independent cotton consultant, cotton on average uses about 1 kilogram (2.2 pounds) of active ingredient per hectare (2.5 acres).[40] However, we warn against using global sales data about pesticides, as sales data is not an indicator of actual pesticide usage, what types of pesticides are being used, or conditions of use. Most importantly, global sales data does not capture pesticide impacts.

How we rate this claim: Red.

All of the following claims are inaccurate and have no known primary source and shouldn't be used:
24-25% of all pesticides are used on cotton;
24-25% of all insecticides are used on cotton;
16% of all pesticides are used on cotton; and 16% of all insecticides are used on cotton.

Tracing the origins of the claim

Most of the experts we spoke with agree that the 24-25% claims have their origins in obsolete data from the 1980s or 1990s, when cotton's pesticide and insecticide usage was at its peak. And yet these figures are a misrepresentation of data from earlier decades as well. They were never accurate.

We were able to track down what we believe to be the primary source of the 24-25% claim: A 1995 marketing report created for companies in the seed and agrochemical industries. Though the report is not publicly available, one of the co-authors confirmed to us that it stated that cotton accounted for 10% of pesticides sales and 22.5% of *insecticides* sales globally.[41] It's unclear how the figure morphed into a higher figure [We speculate it's likely erratic copying, which we'll explain in an upcoming section].

There are two primary sources that are often attributed to the 16% figure: The first is a report from the Environmental Justice Foundation from 2007,[42] which in turn quotes a market report from 2003 that is no longer publicly available, but which we were able to obtain.[43] It does not in fact state that cotton uses 16% of insecticides. The second is a 2014 report by market research firm Cropnosis. Though this report is not public, we were able to confirm that it states that cotton accounted for 5.7% of all the plant protection chemicals sold that year, by value, and 16.1% of all insecticide sales.

To start, these statistics shouldn't be used because they're obsolete and inaccurate in the current context. Modern cotton pesticides sales figures are much lower. Based on 2019 data, cotton accounts for 4.71% of all pesticides measured by total pesticides sales and 10.24% of insecticides.[44]

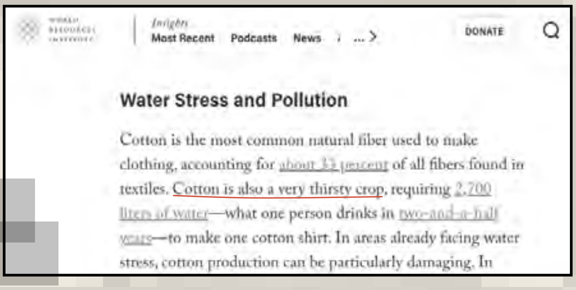
These claims are also often misused. For example, institutions commonly use insecticide figures as a stand-in for pesticide figures though the two aren't interchangeable. Insecticides are one subset of pesticides, and thus using a sales data figure about insecticides and saying it represents all pesticides is inaccurate.

A bigger issue is that sales data is *not in fact synonymous* with pesticide impacts or how much pesticides are being used on cotton farms. As we will discuss in Section 3, to understand the impact of pesticides, we have to know how much pesticides are being used, which pesticides are being used and their conditions of use. Sales data does not at all capture the impact of certain pesticides on humans and the environment.

Takeaway !

Use pesticide data responsibly and carefully. Sales data for all pesticides and insecticides used in cotton is not the same thing as actual pesticide usage nor is it an indicator of which pesticides are being used and the impacts they're having on humans and the environment. Global sales data should not be used as a stand-in for pesticide impacts. And insecticide and pesticide data should not be used interchangeably.

Myth-busting exercise #3: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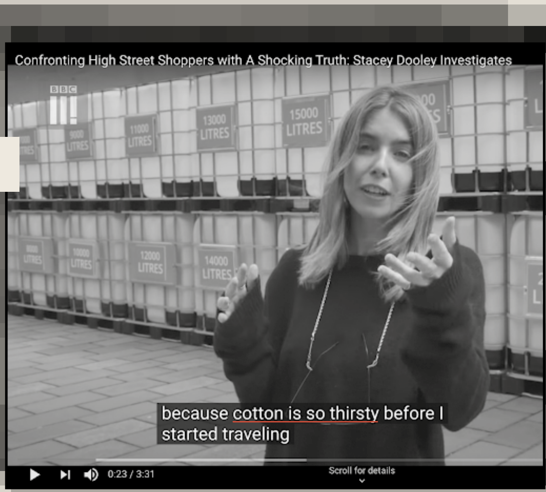
Water Stress and Pollution

Cotton is the most common natural fiber used to make clothing, accounting for about 33 percent of all fibers found in textiles. Cotton is also a very thirsty crop, requiring 2,700 liters of water—what one person drinks in two-and-a-half years—to make one cotton shirt. In areas already facing water stress, cotton production can be particularly damaging. In

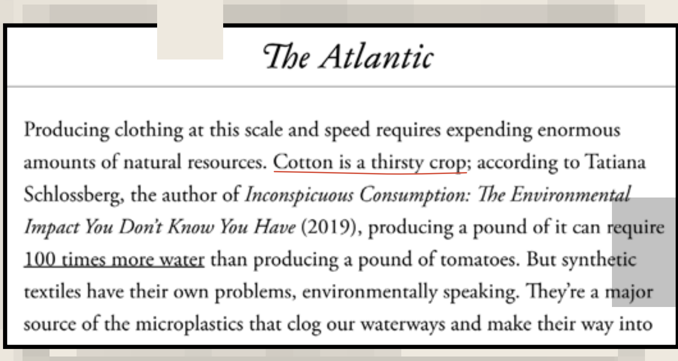
The World Resources Institute references the widely-cited myth that cotton is water thirsty and uses inaccurate data on cotton's water consumption.



A still from "Fashion's Dirty Secret", a 2018 episode of the BBC's "Stacy Dooley Investigates." The docuseries makes inaccurate claims about cotton and water.

3 Cotton is a water-thirsty crop

The third claim we'll vet is that cotton is a thirsty or water-thirsty crop, a sentiment repeated so regularly it's on the cotton Wikipedia entry. We've included a few other references to it.


The Atlantic

Producing clothing at this scale and speed requires expending enormous amounts of natural resources. Cotton is a thirsty crop; according to Tatiana Schlossberg, the author of *Inconspicuous Consumption: The Environmental Impact You Don't Know You Have* (2019), producing a pound of it can require 100 times more water than producing a pound of tomatoes. But synthetic textiles have their own problems, environmentally speaking. They're a major source of the microplastics that clog our waterways and make their way into

The Atlantic's "Ultra-fast fashion is eating the world" published on February 6, 2021, uses inaccurate claims about cotton's water consumption.

An accurate claim about cotton and water and how to use it:

Cotton is grown in many water-stressed regions and can contribute to water management challenges, but calling cotton water-thirsty in isolation without additional context is misleading. Cotton is a drought-tolerant plant adapted to arid regions. It is not a proportionally high consumer of irrigation water (blue water) compared to many other crops. Seed cotton uses 3% of the world's agricultural water globally,[45] based on the latest available data from 2010, which is roughly equal to the 2.7% of arable land planted to cotton.[46] Local water availability, climate change, a lack of water-saving technology on farms, poverty, and failures in governance are among the key contributing factors to water scarcity.[47] As a third of all irrigated crops are grown in highly water-stressed regions, we warn against blaming unsustainable water management on a single crop or a particular subset of farmers.[48]

How we rate this claim: Orange.

Though this claim's origins are known, aspects of it are misleading enough for us to discourage its usage without context. Cotton's water consumption is not high relative to many other crops, and it varies dramatically from place to place.

Tracing the origins of the claim

Calling cotton water-thirsty has an elastic meaning compared to the other data-driven claims we've looked at so far. But one of the original sources appears to be, once again, the WWF, specifically a 2003 report called "Thirsty Crops: Our food and clothes: eating up nature and wearing out the environment?," which singles out cotton as contributing to "the degradation of large-scale ecosystems including the Indus River Delta in Pakistan, the Yangtze and Yellow Rivers in China, the Aral Sea in central Asia and the Murray-Darling River Basin in Australia."[49] The report warned that unsustainable water usage in cotton could result "in limited supplies for other human needs, such as for drinking, washing, cooking and sanitation."

Water stress is a serious issue facing the planet, as we'll discuss in section 2, but plucking the phrase "thirsty" from this WWF report and using it in isolation is highly misleading for a few reasons: Cotton is "a drought and heat tolerant crop, well suited to climates with low rainfall," according to CRDC's Allan Williams.[50] What's more, relative to other crops, cotton is not among the largest users of irrigated water (blue water) globally. It uses less irrigated water per hectare than rice, wheat, maize, soybeans and many vegetables.[51]

What's more, the water-thirsty claim is often used out of context to portray the cotton industry as an inherently unsustainable user of water. This is false, as many water-stressed regions are working to square their agricultural sectors with the urgent need to sustainably manage water. In fact, the original WWF paper, a 37-page document, makes a nuanced argument for sustainable water usage and water stewardship in the cotton sector, including in the water-stressed regions we mentioned above. And yet this data is misused and appropriated in non-scientific ways to make different arguments than what the science backs up. We call this problem shifting.

Takeaway !

The relationship between farming, cotton, and sustainable water management is complex. Calling cotton—a plant that's grown in arid regions because it's drought-tolerant—water-thirsty is misleading and can lead consumers to villainize a crop or a fiber rather than open up a conversation about water stewardship and sustainability in the cotton sector.

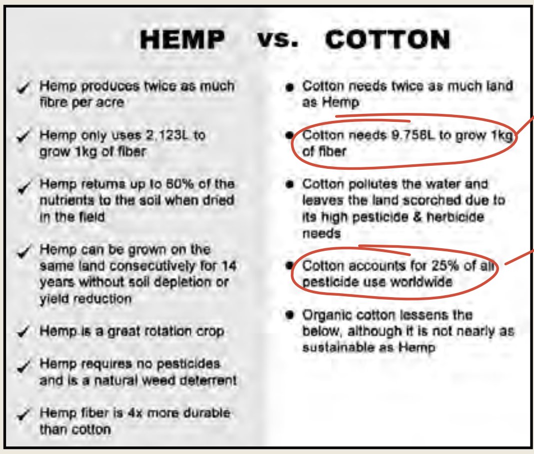
Problem shifting: using data out of context to disparage the cotton sector rather than to solve its challenges.

Are we *problem shifting?*

Using data out of context to disparage the cotton sector rather than to solve its challenges is what we call problem shifting. Data in scientific systems is collected in order to answer a question and understand more about that system or process. And yet data is often used to pit materials or sectors against each other and to vilify what it was designed to understand. There is growing concern that data about fashion and cotton's impacts are used to largely justify switching materials (like from cotton to polyester or hemp), to make one fiber look more sustainable than another,[52] or to switch sourcing locations (from a water-stressed region to one that's not) rather than to improve the locally-situated problem that specific data was collected to understand. We worry that little is changing on the ground for cotton farmers and across fashion because of problem shifting.

Examples of problem shifting in order to justify using one fiber over another:

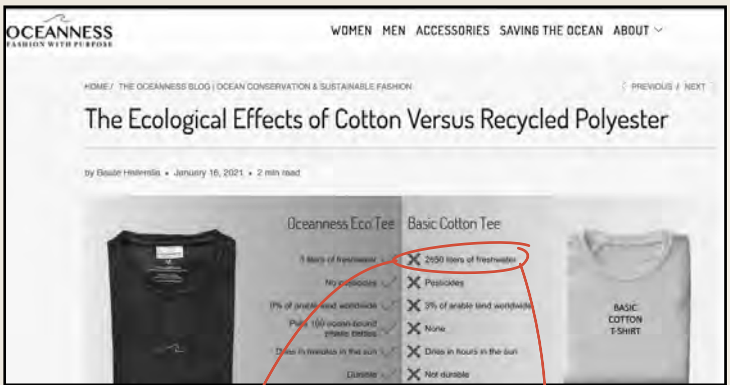
Fig. 02



THIS COMPARISON USES INACCURATE FIGURES ON PESTICIDE AND WATER USE

Sustainable brand Molfo's "Hemp vs. Cotton" graphic uses incarnate figures on pesticide and water use.

Fig. 03



Apparel brand Oceanness' blog uses inaccurate numbers on cotton's water use in comparison to polyester, claiming the plastics-based garment is more ecologically sound.

USES MISINFORMATION TO SUGGEST POLYESTER IS THE MORE ECOLOGICALLY SOUND MATERIAL

INACCURATE NUMBERS ON COTTON'S WATER USE

Damien Sanfilippo, Senior Programmes Director of Better Cotton Initiative:

“A brand or a retailer shifting their supply from one place to another by itself doesn’t create any change. What creates change is brands and retailers identifying their supply chain, the origin of their product, identifying what are the sustainability hotspots, helping to invest in addressing those hotspots, sticking with those producers and suppliers and working together to improve and measure that improvement and report it. This is what matters.”

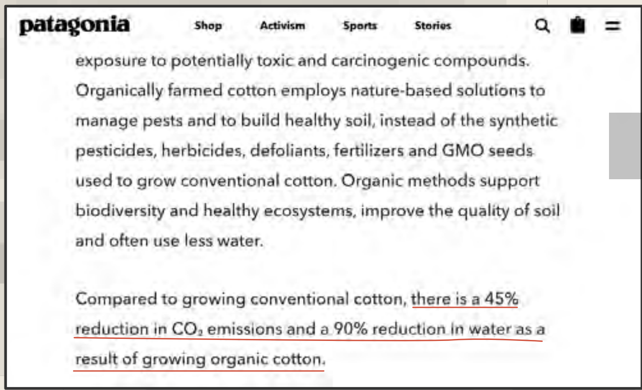
Myth-busting exercise #4:

Why organic cotton?

On average, organic cotton uses up to 62% less energy and 91% less water in production, compared to conventional cotton. No synthetic fertilisers or pesticides have been used to grow the cotton.

Today, all of our kids' cotton is more sustainably sourced, whether it's organic, recycled or sourced through the Better Cotton Initiative (BCI). When you shop kidswear at H&M, you are supporting a more sustainable cotton industry for generations of little ones to come.

H&M Group repeats inaccurate percentages about cotton and water.



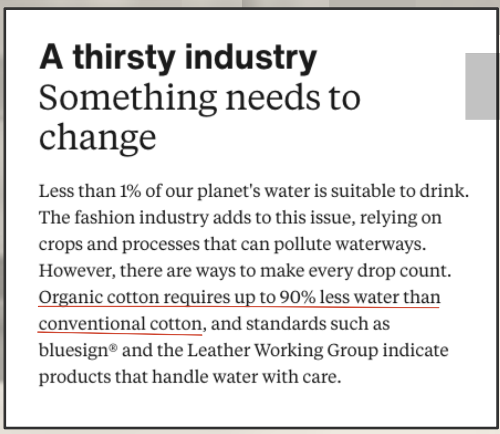
patagonia Shop Activism Sports Stories

exposure to potentially toxic and carcinogenic compounds. Organically farmed cotton employs nature-based solutions to manage pests and to build healthy soil, instead of the synthetic pesticides, herbicides, defoliants, fertilizers and GMO seeds used to grow conventional cotton. Organic methods support biodiversity and healthy ecosystems, improve the quality of soil and often use less water.

Compared to growing conventional cotton, there is a 45% reduction in CO_2 emissions and a 90% reduction in water as a result of growing organic cotton.

Sustainable brand Patagonia publishes an inaccurate percentage about cotton and water.

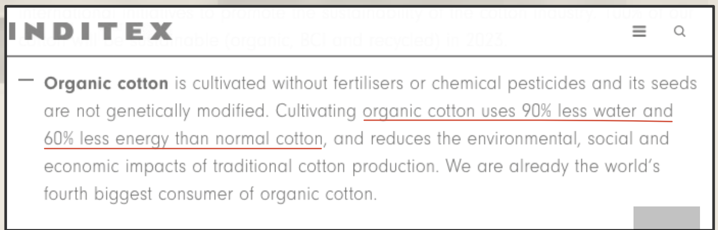
4 Organic cotton uses 91% less water than conventional cotton



A thirsty industry
Something needs to change

Less than 1% of our planet's water is suitable to drink. The fashion industry adds to this issue, relying on crops and processes that can pollute waterways. However, there are ways to make every drop count. Organic cotton requires up to 90% less water than conventional cotton, and standards such as bluesign® and the Leather Working Group indicate products that handle water with care.

German retailer Zalando purports inaccurate information about cotton and water.



INDITEX

— **Organic cotton** is cultivated without fertilisers or chemical pesticides and its seeds are not genetically modified. Cultivating organic cotton uses 90% less water and 60% less energy than normal cotton, and reduces the environmental, social and economic impacts of traditional cotton production. We are already the world's fourth biggest consumer of organic cotton.

Inditex, the Spanish multinational retailer and parent company for Zara makes inaccurate claims about cotton and water use.

The fourth claim we'll look at is that organic cotton consumes 91% less water than conventional cotton. We've included some examples of where it appears.

A current and accurate claim about organic cotton's water savings and how to use it:

There is not one at the moment. There is no known critically-reviewed correlation between organic cotton farming and reduced water consumption in cotton farming. Nor is cotton's irrigated (blue water) water consumption known to be determined by its organic or conventional status.

How we rate this claim: Orange.

This claim is highly contested, based on a comparison of two LCAs that is not critically-reviewed, and thus should be avoided.

Tracing the origins of the claim

This claim comes from the Summary of Findings of a 2014 Life Cycle Assessment published by Textile Exchange.[53] The summary findings compare two LCA studies, one about organic and another about conventional cotton farming. Organic cotton is cotton grown without synthetic chemicals and synthetic pesticides or genetically modified seeds, while conventional cotton refers to cotton grown with synthetic chemical inputs or genetically modified (GMO) seeds.

LCAs offer a useful glimpse of the different impact hotspots for a product or process, but using them for comparison purposes can be contentious. As the United Nations Framework Convention on Climate Change describes, LCAs produce "specific data that cannot be used easily for comparison," namely because of differences in methodologies, modelling software, time periods of data selection, and other factors. [54]

Multiple experts we spoke to contested the organic cotton LCA's findings. The reason is that it arrives at its conclusion —that organic achieves dramatic water savings —by comparing organic fields that happen to be largely rainfed (green water) to conventional cotton fields that happen to use irrigation (blue water). They also point out that this is not an apples to apples comparison. Cotton's irrigated (blue water) water consumption is not known to be determined by its organic or conventional status. As the LCA Summary of Findings states, it's largely determined by climate and irrigation techniques.[55] What's more, while each LCA study was verified by an independent critical review process, the comparison was not critically reviewed.

Textile Exchange recently confirmed they removed the 91% water savings claim from its forthcoming new website, noting that comparing organic and conventional cotton in this way is misleading. "As scientific understanding has evolved, we now know that comparison of specific LCA studies should not be used to make broad claims about material categories, given the differences in regionally-appropriate parameters and other assumptions used in each LCA study," says Textile Exchange's Beth Jensen.

Be sure to compare like-for-like

The LCA comparison is not the only problem. The way some brands use the 91% claim is additionally misleading, which is to state that by sourcing organic cotton, they've achieved 90-91% total water savings compared to conventional cotton. Our experts say that the only way that a brand can claim to save water is by working to reduce water within its own supply chain (otherwise they're problem shifting). What's more, generalized data shouldn't be used to make water-savings claims. As regulations tighten up on greenwashing, brands are also discouraged from making unverified comparisons, as well as focusing on a single aspect of a product's lifecycle, like water or pesticides, in order to give consumers the impression a product is green.[56]

The reason we go into such detail here is to point out that even quality or reliable data can be misused, taken out of context or used to make misleading comparisons, even by knowledgeable people. Vigilance is key, as is taking responsibility.

Takeaway!

When using data, take care when making comparisons that they are valid, critically-reviewed and compare like-for-like. Only use Life Cycle Assessments to compare products and processes if the LCA is approved for comparison. If your organization has misused data, correct it publicly and educate your community on the new claim.

How cotton misinformation is spread

So far, we've mostly looked at how misinformation originates, but now let's look a bit closer at how it spreads. While misinformation may originate in a well-intentioned report by a nonprofit or advocacy organization or by the mainstream press, it often gets further distorted by other parties, whether journalists, brands, civil society groups or other trusted institutions or by individuals.

As we've seen, misinformation can spread when individuals or institutions are making an argument or trying to persuade, whether it's to buy more organic cotton or click on an article about toxic pesticide usage. Framing itself is not a type of misinformation but can tip into misleading people when key context is removed or data is selectively edited, or the highest, most outdated figures are used simply because they're the most convincing. We call this *"irresponsible framing."* Avoid it.

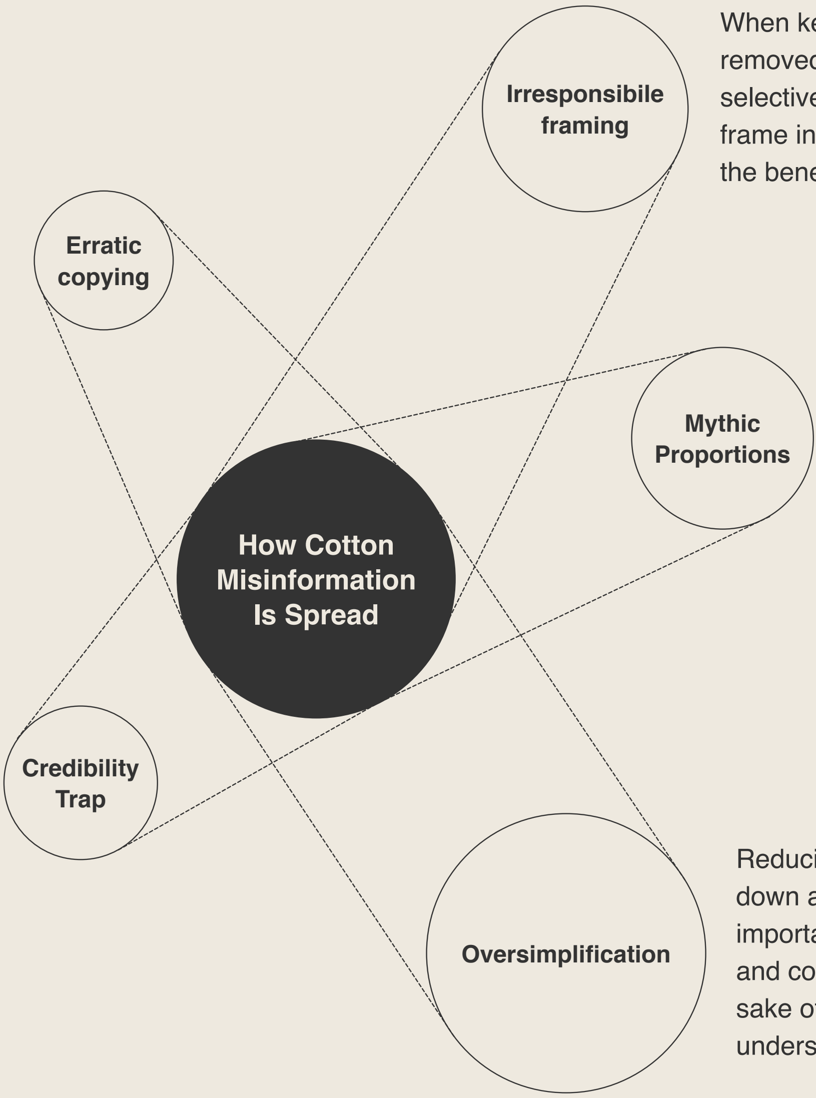
Irresponsibile framing: when key context is removed or data is selectively edited to frame information for the benefit of the sharer.

The second way that cotton misinformation spreads is through *"erratic copying,"* a tribute to the British evolutionary biologist Richard Dawkins who noted that when humans make copies of copies, information rarely improves. Instead, errors are introduced over time and "become cumulative and serious."[57] As information is remixed and re-edited on social media and linked from one website, news site, or social media feed to another, the primary source gets lost and statistics and data often get transposed and degrade in quality, becoming less accurate and more misleading with each iteration.

Erratic copying: when information is copied and edited multiple times, losing its original source, degrading in quality and becoming less accurate.

How cotton misinformation is spread

Fig 04



When key context is removed or data is selectively edited to frame information for the benefit of the sharer.

When information is copied and edited multiple times, losing its original source, degrading in quality and becoming less accurate.

When a claim is used for so long and by so many that it gains a false sense of legitimacy.

Non-scientific institutions that are not primary sources of information but are viewed as trustworthy and credible at all times.

Reducing information down and removing important content and context for the sake of ease of understanding.

You've already come across numerous examples of erratic copying in this paper. The statistic that cotton accounted for 22.5% of insecticide sales in the 1990s was later presented as 16% to 25% of all pesticides are used in the cotton industry. It also appears the 20,000 liters claim might be an erratic copy. The erroneous claim that organic cotton has 91% water savings has been erratically copied by some brands as 90%. Erratic copying can also impact words as well as numbers (as we saw with people inverting the terms "insecticides" and "pesticides").

Mythic proportions: when a claim is used for so long and by so many that it gains a false sense of legitimacy.

Another way misinformation spreads is through a phenomenon we call *"mythic proportions."* Once a claim is widely circulated and circulated for years, it's legitimized. We tend to think a claim can't possibly be false if so many people are citing it! In fact, studies show that misinformation is very difficult to dislodge from our brains if it's regularly repeated, even after it's been corrected, as it continues to echo in our minds as fact.[58] That cotton is water-thirsty has been repeated so often that it is taken as the gospel truth. That cotton uses 16% of pesticides is now so familiar it feels like it must be true. We have to remember that misinformation is everywhere and is reinforced over time.

Oversimplification: reducing information down and removing important content and context for the sake of ease of understanding.

Misinformation also spreads via *"oversimplification."* In a world where more people fit content into a 700-word online news story, a 280-character tweet or an Instagram post, misinformation has found itself at home. Even large institutions and brands via marketing are pulled towards oversimplifying. Yet many issues in our world, especially when it comes to fashion and sustainability, simply can't be communicated with such limited space or a simplified score or shocking metric. By trying to make a subject more immediately understandable at a glance or a scroll or on the tag of a garment, we are prone to misleading the public.

Jesse Daystar, VP and Chief Sustainability Officer of Cotton Inc.:

“Sustainability is complex and designers and brands want something easy and simple. Unfortunately, when people create single scores or other metrics simplifying the complex science for ease of business, bad things can happen, one of which is misinformation.”

Credibility trap: non-scientific institutions that are not primary sources of information but are viewed as trustworthy and credible at all times.

A final way that misinformation spreads is through a psychological hiccup we've dubbed the *"credibility trap."* Certain institutions in our society are viewed as unquestionably trustworthy and credible sources of information, including mainstream media outlets, elected leaders, established nonprofits, international institutions like the World Bank and the United Nations, and even some influencers and educational Instagram accounts. But it's important to remember that these are not scientific institutions in and of themselves and are often not the sources of primary data. Everyone is capable of spreading misinformation. We aren't telling you to doubt all sources of information. But don't let overconfidence in a source stop you from confronting and questioning dubious claims.

"Sometimes it can be rather circular, like one organization will cite another organization, which will, two years later, in another article, cite the original organization that cited them. And it just keeps going round and round in a circle," says journalist Alden Wicker.

IRRESPONSIBLE FRAMING

Often the forces of misinformation work in tandem. A fascinating case study is the claim that ~~fashion is responsible for a fifth of all water pollution~~, which EcoTextile News' John Mowbray and Simon Glover debunked in 2019[59], yet it continues to circulate. Mowbray and Glover traced the claim back to a 2012 peer-viewed paper that made a textual reference to a World Bank figure of 17 to 20% of "industrial water pollution." This academic work provided no citation for an original World Bank source.

We located an earlier reference to the figure by China Water Risk that said the percentage applies to industrial water pollution in China[60], not globally. We also found a 2007 report jointly published by the World Bank and China that states "industry" is associated with 20% of "polluted water supply" in seven rivers in China and textile dyeing and processing was named as one of six industries.[61] We believe this is likely the original source.

As to how it was plucked from obscurity, in 2021 independent analyst Veronica Bates Kassatly found the likely start of the claim within sustainability circles stemmed from a 2009 blog post by AirDye, a waterless technology that prints and dyes polyester. This seems to be the earliest extrapolation of those regionally specific numbers.

“I surmise that AirDye found a World Bank report that made that claim for one or more Chinese river basins at the beginning of the millennium,” Kassatly wrote. “In a moment of inspiration they decided to refer to it in their blog, without source link - leaving it to others to conclude that this was a global statistic, and to report it as such.”[62]

The inaccurate claim was further distorted by nonprofits using erratic copying. And by naming the World Bank as the source, the credibility trap sprang into action, and it quickly spread.

Best practices to stop the spread of misinformation:

1. **Frame responsibly.** Making an argument or persuading an audience isn't a justification for using obsolete or inaccurate data, cherry-picking data or using it selectively and out of context to persuade.

2. **Halt erratic copying.** Double-check the primary source of data and carefully ensure that you haven't introduced errors, transposed numbers or changed the source or the meaning of a claim.

3. **Question the credibility trap.** Even credible institutions can share misinformation. Do your own due diligence.

4. **Resist the urge to oversimplify.** Don't use exaggerated and shocking claims and avoid the temptation to oversimplify (e.g. cotton is water-thirsty; fashion is the second-most polluting industry, cotton consumes a quarter of the world's pesticides).

5. **Dispel mythic proportions.** Just because a claim is widely-cited doesn't make it true. Misinformation is everywhere and is reinforced over time.

Cotton fact-checking exercise

To improve your misinformation-spotting skills, we have an exercise for you to try at home.

1. Start with this branded story written by Vox Creative and Dockers, “Fashion uses 1.5 trillion liters of water per year — here’s how we can do better.”

   NOTE: nowhere in the advertisement (designed to look like a news article) does it give a primary source for the 1.5 trillion liters of water stat, so that shouldn’t be shared without locating and verifying the primary source, which we were unable to find.

2. Next, scroll down to our now-familiar claim that cotton consumes 20,000 liters of water to produce a kilogram of cotton and click on the link and try to find what this ad uses as the primary source. If a link takes you to a dead-end, Google the source instead, and keep going.

   Primary source: the original research and data set that produces a claim, or it describes first-hand experience of a subject, like when a journalist does on-the-ground reporting.

3. How many different reports and links do you have to click through to find a primary source?

   ----

4. Are you able to finally figure out where the 20,000 liters claim comes from?

   ----

5. Are you surprised at how hard it is to find?

When we conducted this exercise, we hit a dead end. We clicked through a total of 14 links and landed on three error or 404 pages before discovering what was claimed as the primary source of this statistic, a 2006 study of the worldwide, country-by-country water consumption used for cotton.[63] And yet when we read this study, it did not seem to support the notion that cotton consumes 20,000 liters of water per kilogram.

SECTION 2:

Cotton and Water: The Reality

How Much Water Does it *Really* Take to Grow a Pair of Jeans?

The way we commonly use data to talk about cotton's water consumption is false or misleading. It's also missing key context and a deeper level of understanding. That's why, as you read through this section, we'll ask you to hold some complex ideas at once.

Water stress: when the demand for water exceeds the available amount during a certain period or when poor quality restricts its use.

Water stress is a critical and mounting issue facing humans and the environment.[64] Cotton can sometimes contribute to that water stress and can even be a victim of water stress. And cotton's role in water stress is also oversimplified and overblown, and correcting this requires an understanding of how crops and farmers use water, the way water circulates globally, and of sustainable water management.

Xerophyte: a drought tolerant plant adapted and bred to survive in drier and more arid climates.

"Cotton does require water, as do humans and all living things," writes Simon Ferrigno in "The Inside Guide to Cotton & Sustainability"[65] This shouldn't come as a surprise. Cotton is a plant. What's more, cotton is actually a *xerophyte*, adapted and bred to survive in drier and more arid climates.[66] And yet, as we'll explain, cotton farmers' water usage varies dramatically and those variations are influenced by a number of factors, including but not limited to climate. As you can already tell, the story of cotton and water is far more nuanced than we're led to believe.

Cotton got its reputation as water-thirsty because it is in fact grown in many water-stressed regions. But there's more to the story than meets the eye. Farmers in dry climates often choose to grow cotton precisely because it can survive and produce a crop in harsher environments. Farmers grow cotton in these regions often because it can withstand the climate better than other crops.

Marc Lewkowitz, President and CEO of Supima, a trademarked extra-long staple cotton grown in the United States:

“Cotton is specifically grown in some of these areas because it is the only thing that will grow.”

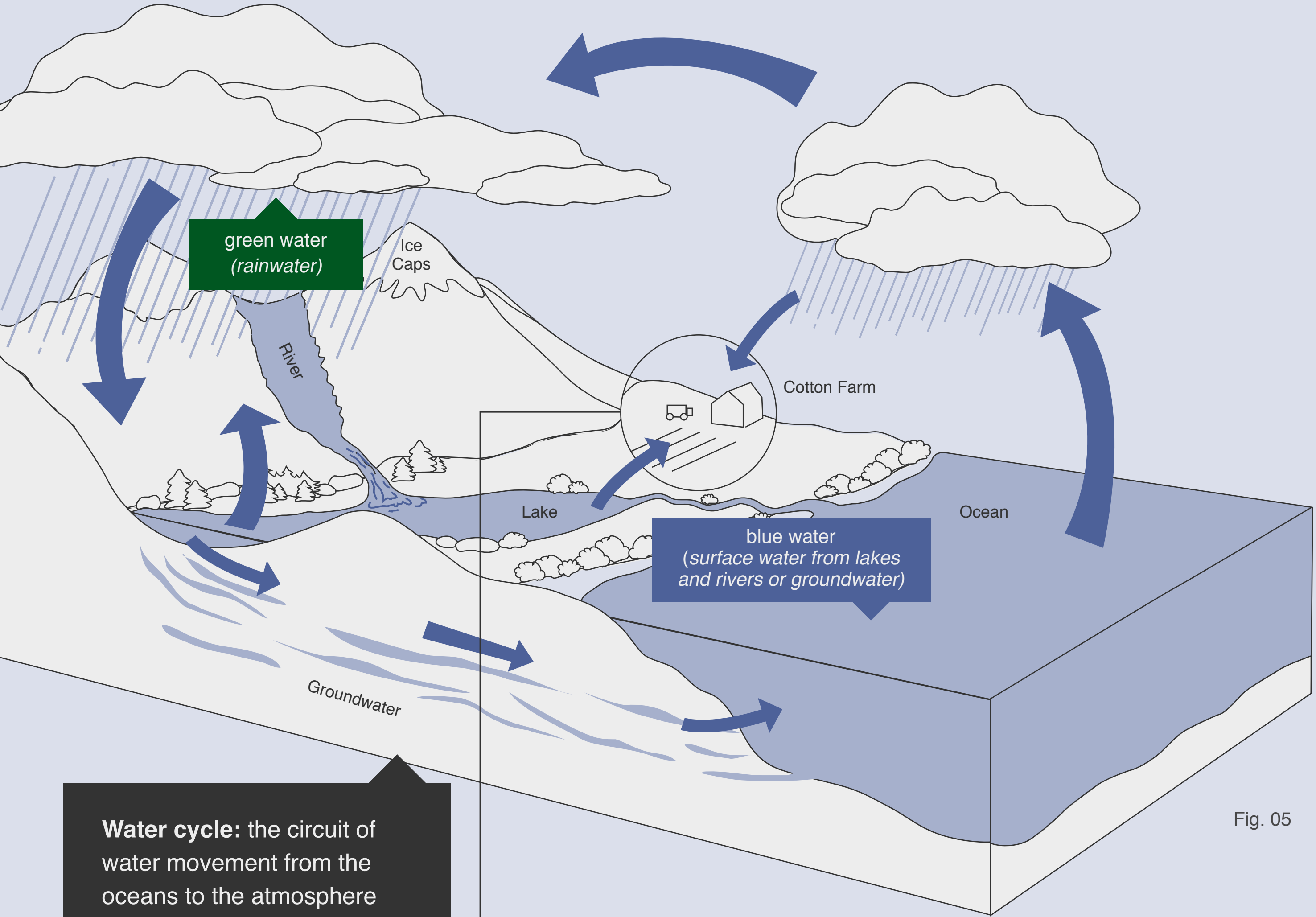


Fig. 05

Cotton In The Water Cycle

Water cycle: the circuit of water movement from the oceans to the atmosphere and back down to the Earth and then back to the atmosphere through various stages and processes.

How and why cotton uses water

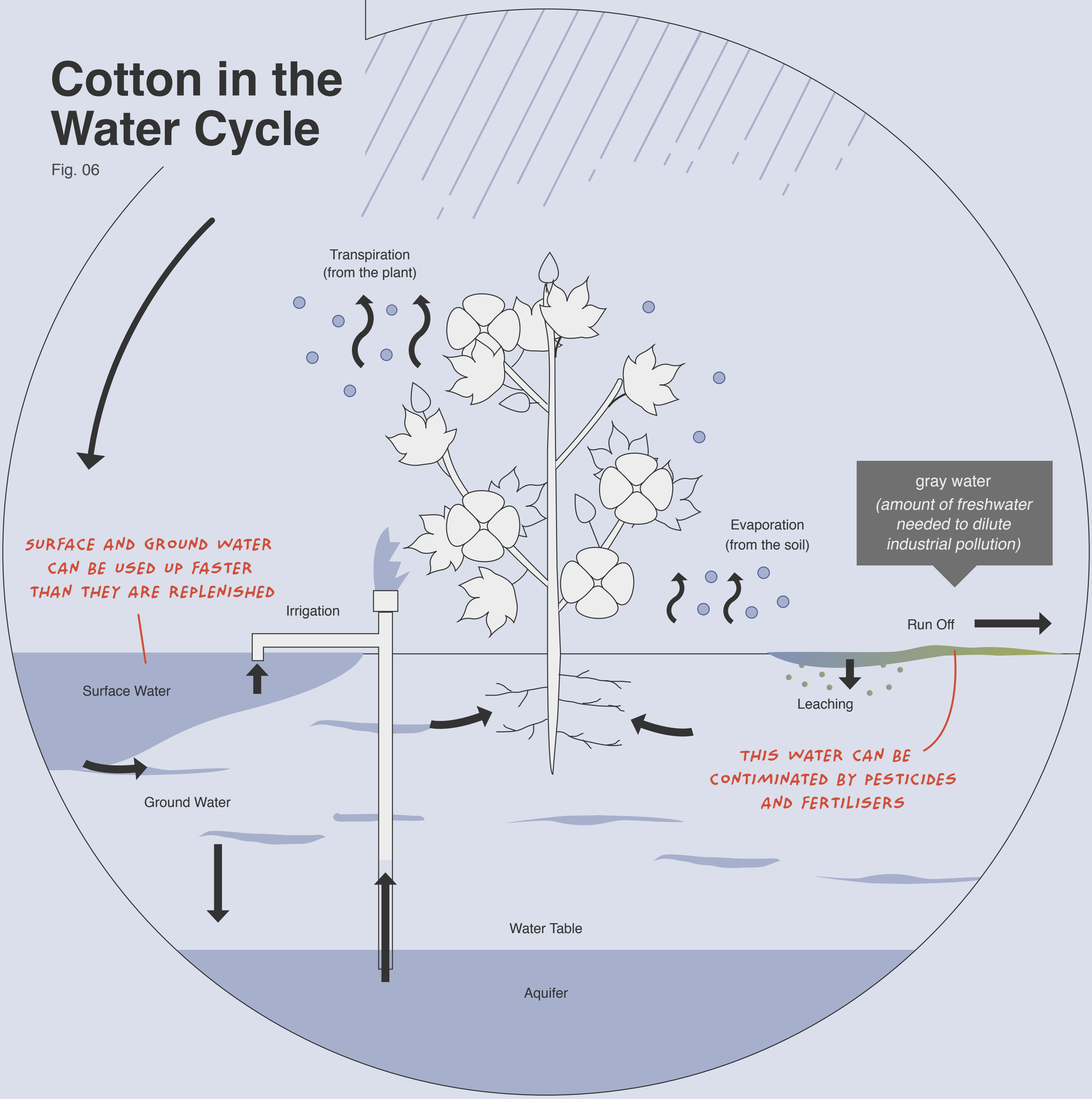
To fully grasp cotton's complex relationship to water, we have to start with the *global water cycle*[67] The total amount of water on the planet can't actually be used up. It's instead borrowed from the water cycle and returned.

However, *freshwater* is a finite resource, comprising just 2.5% of Earth's water, and that can be polluted, moved or consumed too quickly, preventing further local use.[68] Of the freshwater on the planet, only a small fraction is available for use. The rest is "locked away" in glaciers and groundwater.[69] When freshwater is borrowed from the water cycle, it can be returned responsibly from whence it came, it can be polluted and degraded, or it can be exported in products. A single metric about cotton's water usage does not tell this full story.

Freshwater: the water used for human activities like drinking water, agriculture, and industry

Cotton in the Water Cycle

Fig. 06



Evapotranspiration: when water evaporates from the soil surface or surface of a plant and goes into the atmosphere or transpires through the body of a plant and the pores of leaves.

Cotton (and other plants) uses water via *evapotranspiration* [70] The water that cotton uses via evapotranspiration eventually returns to the Earth as rainfall, but not quickly nor to the same place.[71] A small percentage of the water used by cotton is incorporated into the body of the plant.[72] From there, the water is often exported to other places as cotton lint. Some countries import water-intensive products (known as *embedded* or *virtual water*), while others export them.

As you might have noticed, a very specific lexicon has been developed to talk about how humans utilize water and to communicate when water usage tips into concern.

Water use: water that has been withdrawn and "used," but no water has been lost or gained in a local system.

Water use refers to the total amount of water that has been withdrawn from its source to be "used" for human activities, like industry, household use, or irrigation.[73] But water use does not indicate whether water has been lost or gained in a local system. For example, the amount of water drawn from a river by a factory is water usage, but does not reveal if the water used was cleaned and returned to the river in equal proportions. Thus, if you see a claim that a certain cotton T-shirt **uses** a certain amount of water, that's not revealing, as it is no indication that the water was irresponsibly managed or that it took water away from human needs or the environment.

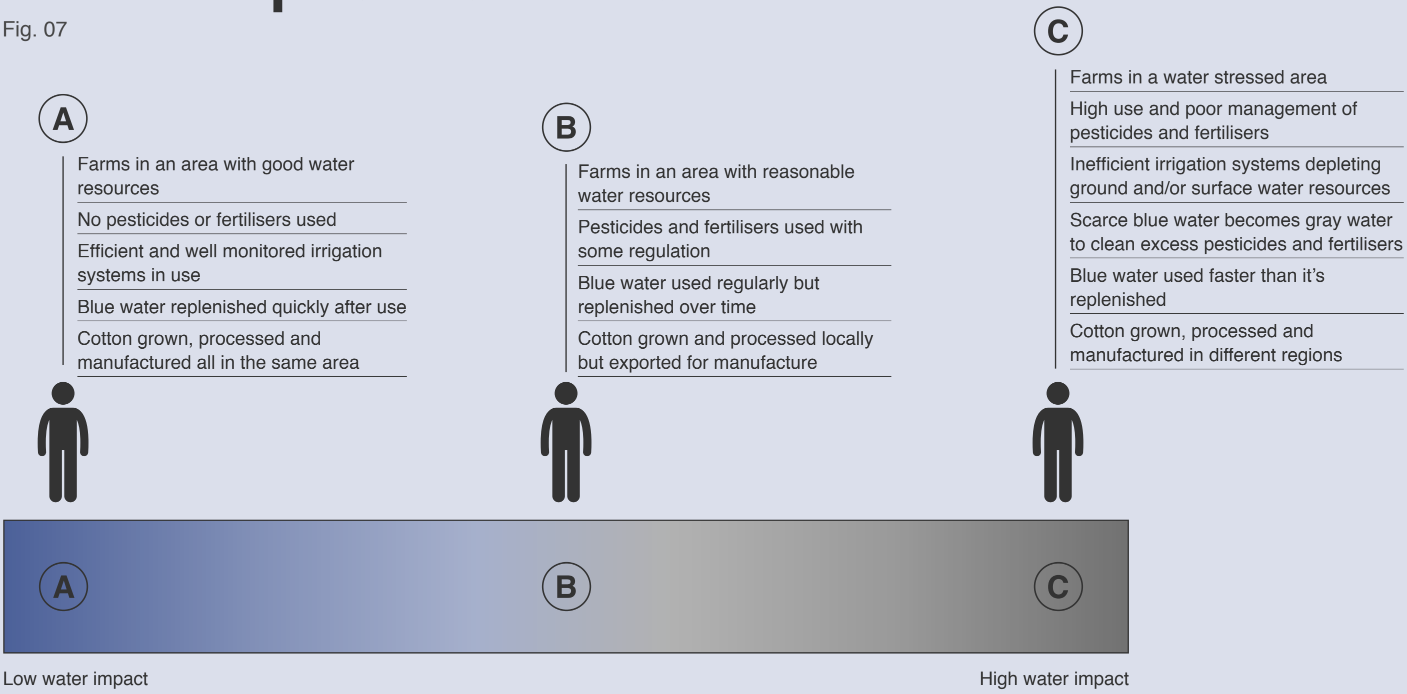
Water consumption: the portion of water used that is not returned to the same system within a short period of time and is no longer available locally for other uses.

Water consumption refers to the portion of water used that is not returned to the same system it came from within a short period of time, either through evaporation or incorporating it into a product or moving it from one catchment into another or into the ocean.[74] Agriculture, not just cotton, is a large *consumer* of water, responsible for approximately 70% of water withdrawals[75] globally on average and an even higher share of water consumption.[76] That's because crops don't just use water, they mostly "consume" it, as water is not returned to the same system it came from within a short period of time.

Water consumption (or "consumptive" use) is a more useful term for understanding a product or sector's impact on available freshwater, since the water is being moved elsewhere or changing into a different and sometimes less usable form. Nevertheless, water consumption is not alone an indicator of irresponsible water management or environmental impact without additional context about water availability in a given region.[77] What's more, because all plants and crops consume water, singling out cotton as a high consumer of water can be misleading.

Water impact scenarios

Fig. 07



A cotton T-shirt's water consumption can be seemingly quite high and be sustainable if it's coming from a region where water is plentiful or where water resources are responsibly managed. Considering that water is borrowed and not "used up" from the global water cycle, if cotton uses or consumes 1,931 liters of irrigation water per kilogram on average, is that a lot? Is it too much?

Water footprint: the volume of water taken from the water cycle minus the volume of water returned.

Another way of analyzing how water is utilized by humans is via its *water footprint*, which is the total volume of freshwater consumed to create a specific product.[78] A water footprint can be further specified as green, blue, and gray water footprints.[79] *Green water* is rainwater. *Blue water* is surface water from lakes and rivers or groundwater, for irrigation for example. *Gray water* is the amount of freshwater needed to dilute industrial pollution, such as fertilizer and pesticide runoff caused by cotton production, and to return water back to agreed-upon water quality standards. Gray water is another important facet of the water issue, as cotton production can also cause significant water pollution, which not only harms the environment but prevents water from being used for human needs.[80]

Green Water: rainwater.

Blue water: surface water from lakes and rivers or groundwater, for irrigation for example.

Gray water: the amount of freshwater needed to dilute industrial pollution, such as fertilizer and pesticide runoff caused by cotton production, and to return water back to agreed-upon water quality standards.

Some water footprint reports combine green, blue and gray water into a single footprint. Combining these figures will of course produce a higher number than simply measuring blue water alone, for example. But the available credible data that combines green, blue and gray water footprints for cotton is obsolete, from 1996 to 2005, from a report co-authored by professor Arjen Y. Hoekstra, creator of the water footprint concept.[81] At that point, cotton was found to have a water footprint, including green, blue and gray water, of 9,113 cubic meters per ton of cotton lint. You may have seen another statistic in our screenshots that claims cotton has a water footprint of 10,000 liters per kilogram.[82] Don't use it. It's pulled from another report using the same obsolete data dating back to 2005 (it is also referencing the water footprint of cotton textile production, not just cotton lint). More to the point, the claim is erratically often copied today to say cotton consumes 10,000 liters per kilogram, when the original claim was presented in cubic meters per *ton*.

Including green and gray water in water footprints measurements is not without its critics. Some of our experts told us that including green water, meaning rainwater, is misleading because if crops didn't use rainfall, it would pass through the ecosystem anyway and natural vegetation would consume it. Irrigated water consumption (called blue water) continues to be considered a more sensitive source of water compared to rainfall (green water), as groundwater and surface water can be overused or irresponsibly managed via manmade systems like irrigation.[83] Rainfall, by contrast, is for now, out of our control.

Perhaps a more complete way to analyze cotton's water impacts is to not only consider water use, water consumption or the water footprint but the local water availability, the **water stress** and **water risks** of where cotton is grown. There are a number of tools (listed below) which provide interactive maps and case studies of *water risks.*[84] Water risk adds another layer of helpful context, by showing which regions are struggling to provide water to everyone. This is moving the conversation in the right direction, as it puts water in the context of local use. But we warn against using any of this data to problem shift.

Water risk: the possibility of an entity experiencing a water-related challenge (e.g., water scarcity, water stress, flooding, infrastructure decay, drought). The extent of risk is a function of the likelihood of a specific challenge occurring and the severity of the challenge's impact. The severity of impact itself depends on the intensity of the challenge, as well as the vulnerability of the actor.

The water footprint of rainfed and irrigated agriculture for selected crops (1996 - 2005)

Fig. 08

Crop	Farming system	Yield (Ton ha^{-1})	Total water footprint related to crop production (Gm^3 yr^{-1})				Water footprint per ton of crop (m^3 yr^{-1})			
			Green	Blue	Gray	Total	Green	Blue	Gray	Total
Wheat	Rainfed	2.48	610	0	65	676	1629	0	175	1805
	Irrigated	3.31	150	204	58	411	679	926	263	1868
	Global	2.74	760	204	123	1087	1278	342	08	1828
Maize	Rainfed	4.07	493	0	85	579	1082	0	187	1269
	Irrigated	6.01	104	51	37	192	595	294	212	1101
	Global	4.47	597	51	122	770	947	81	194	1222
Rice	Rainfed	2.69	301	0	30	331	1912	0	190	2102
	Irrigated	4.67	378	202	81	661	869	464	185	1519
	Global	3.90	679	202	111	992	1146	341	187	1673
Apples	Rainfed	8.93	24	0	6	30	717	0	167	883
	Irrigated	15.91	8	8	2	18	343	321	71	734
	Global	10.92	33	8	7	48	561	133	127	822
Soybean	Rainfed	2.22	328	0	5	333	2079	0	33	2112
	Irrigated	2.48	24	12	1	37	1590	926	85	2600
	Global	2.24	351	12	6	370	2037	70	37	2145
Sugarcane	Rainfed	58.70	95	0	7	102	164	0	12	176
	Irrigated	71.17	85	74	10	169	120	104	14	238
	Global	64.96	180	74	17	271	139	57	13	210
Coffee	Rainfed	0.68	106	0	4	110	15251	0	523	15774
	Irrigated	0.98	1	1	0	2	8668	4974	329	13971
	Global	0.69	108	1	4	112	15249	116	53	15897
Rapeseed	Rainfed	1.63	62	0	12	74	1783	0	356	2138
	Irrigated	1.23	4	9	1	14	1062	2150	181	3394
	Global	1.57	66	9	13	88	1703	231	336	2271
Cotton	Rainfed	1.35	90	0	13	103	3790	0	532	4321
	Irrigated	2.16	41	75	13	129	1221	2227	376	3824
	Global	1.73	132	75	25	233	2282	1306	440	4029
All crops	Rainfed	-	4701	0	472	5173	-	-	-	-
	Irrigated	-	1070	899	261	2230	-	-	-	-
	Global	-	5771	899	733	7404	-	-	-	-

The blue, green and gray water use of cotton and other crops was examined over a nine-year period in the pioneering research on the concept of the water footprint. Source: Mesfin Mekonnen and Arjen Hoekstra/Hydrology and Earth System Science

Comparison between the results from a 2005 study and the results from previous studies

Fig. 09

Study	Period	Global water footprint related to crop production (Gm3 yr-1)		
		Green	Blue	Total
Chapagain and Hoekstra (2004), Hoekstra and Chapagain (2007), Hoekstra and Chapagain (2008)	1997 - 2001	5330	1060	6390
Rost et al. (2008)	1971 - 2000	7250*	600 - 1258	7850 - 8508*
Liu and Yang (2010)	1998 - 2002	4987	951	5938
Siebert and Döll (2010)	1998 - 2002	5505	1180	6685
Hanasaki et al. (2010)	1985 - 1999	5550	1530	7080
Fader et al. (2011)	1998 - 2002	6000	923	6923
Current study, green & blue only	1996 - 2005	5771	899	6670

*Unlike the other values, this value includes the evapotranspiration from cropland outside the growing period

The green, blue and gray water footprints of crops. Data is obsolete and collected between 1996 and 2005.

Source: Mesfin Mekonnen and Arjen Hoekstra/Hydrology and Earth System Sciences.

How much water does cotton really use?

The amount of water that farmers use and consume around the world varies dramatically, as do the methods by which farmers water their cotton. Some farmers only use only rainwater **(green water)** and others use irrigation **(blue water)** or a mix of the two. A little over half (52%) of all cotton is rainfed.[85] In Africa, approximately 95% of cotton is rainfed **(green water)** and 13 African nations have an irrigated water **(blue water)** footprint of 0 liters per kilogram.[86] In the U.S. and India, two of the world's largest cotton-producing nations, the ICAC found that more than 60% of all cotton acres are rainfed.[87]

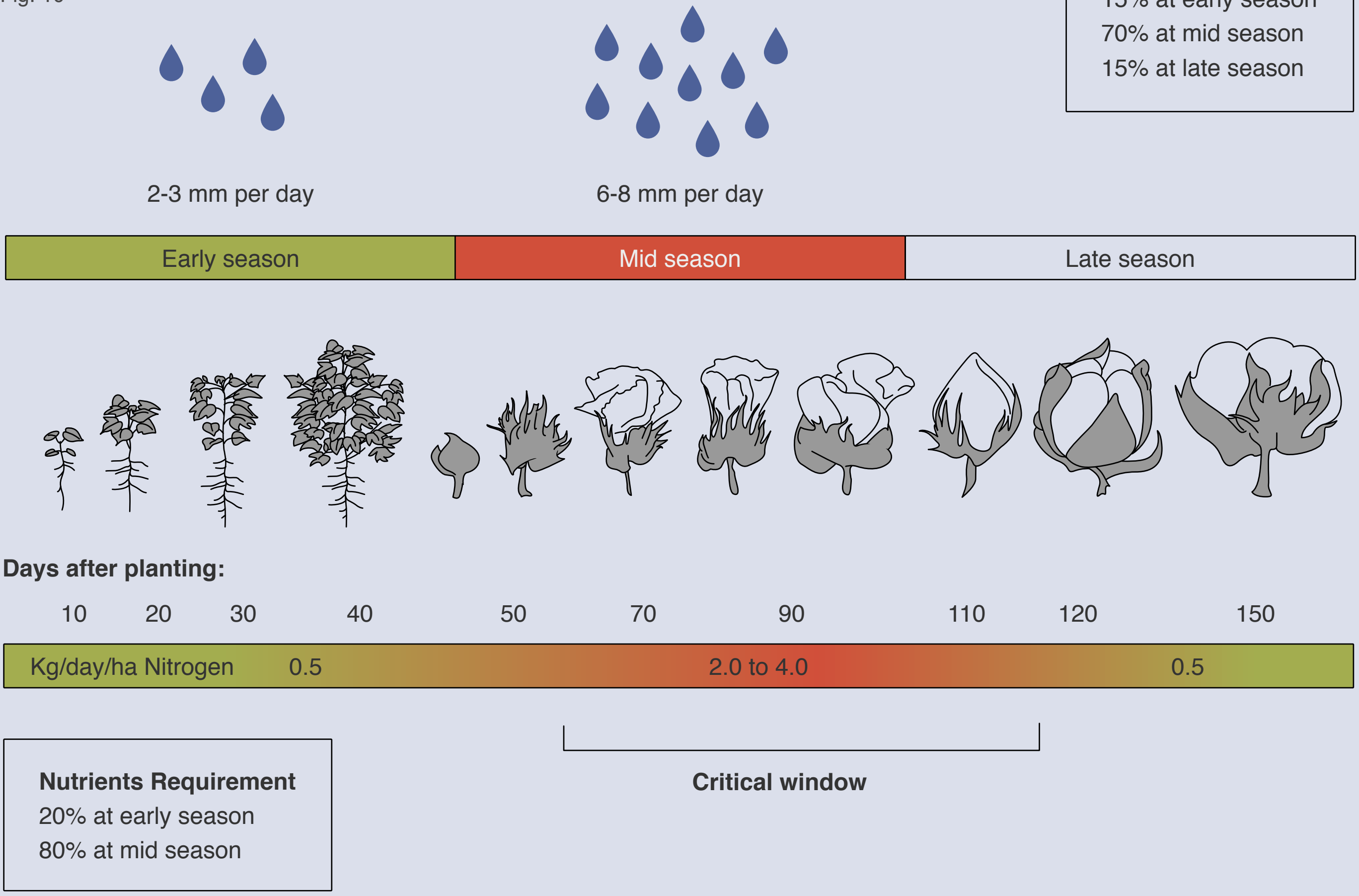
The green water footprint of cotton is determined by local rainfall and is as high as 42,300 liters of rainwater per kilogram in Zambia, which experiences downpours during the rainy season, while dry nations like Egypt, Australia, and Iran have the smallest green water footprints.[88]

However, nearly half of the land planted to cotton is grown using additional irrigation water throughout the growing season.[89] Irrigation is viewed as crop protection, and a powerful tool to make cotton plants more productive and predictable, especially in areas where enough rain doesn't fall or doesn't fall at optimal times of the year.[90] Irrigation allows farmers to water during droughts (which can stress plants and make them underproduce or even die) and to water plants during key growth moments, like the critical middle part of the growing season [see Fig 10].

Our cotton experts say that irrigation also generally leads to higher-quality fiber, another economic benefit. To put irrigated cotton's higher productivity and yields in perspective, according to 2014 figures, irrigated cotton accounts for approximately half the area under cotton production globally but produces around 75% of the annual crop.[91]

Cotton's water requirements

Fig. 10



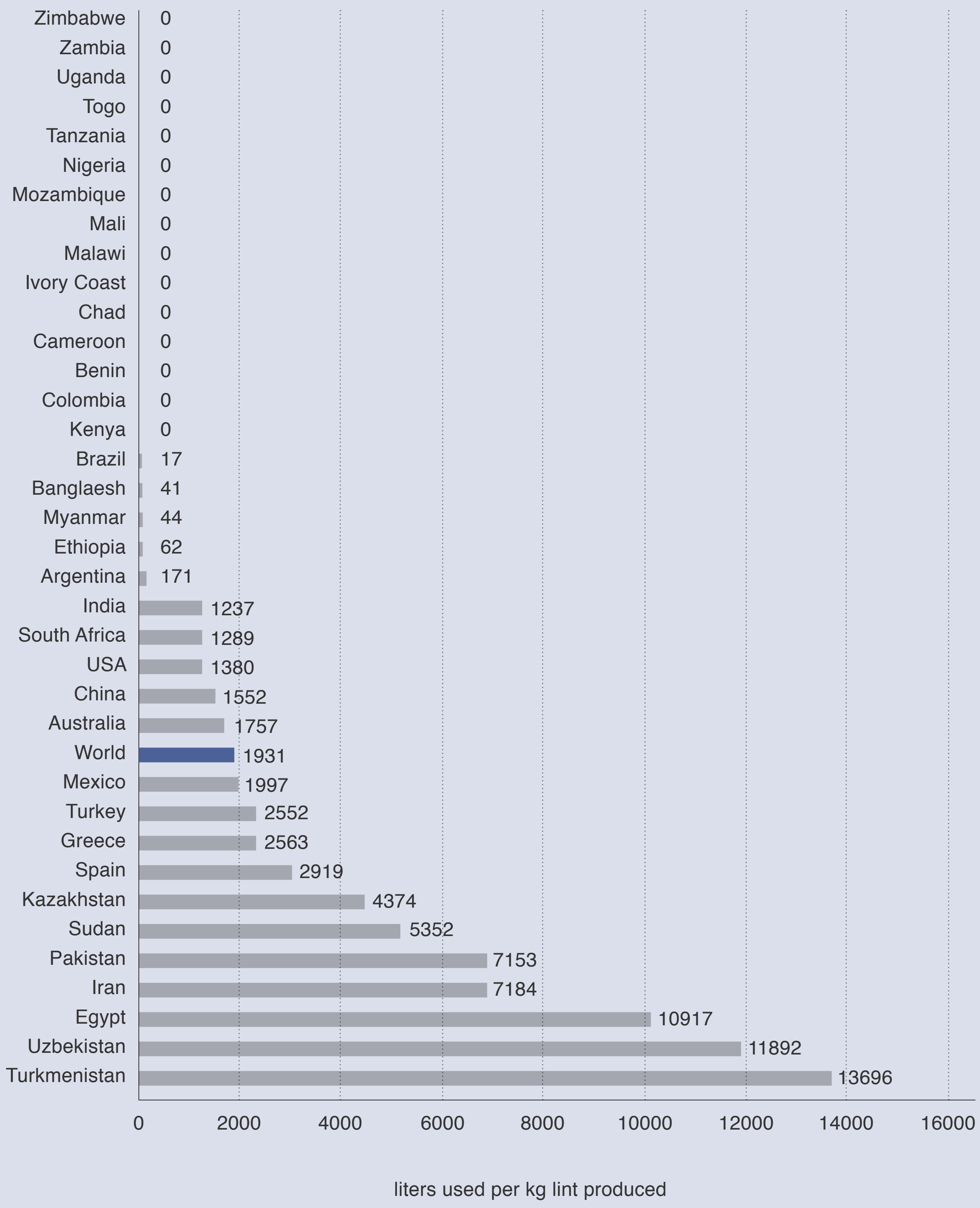
The water needs for crops varies throughout the growing season and irrigation often provides protection against droughts.

Source: ICAC

The amount of irrigated water (blue water) that cotton farmers use varies dramatically, depending on a number of factors, including climate, available rainfall and available groundwater, soil type, rate of evapotranspiration and the availability and efficiency of irrigation systems.[92] In fact, according to ICAC, there is a 805-fold difference in the amount of irrigation water used in cotton between nations, from Brazil's 17 liters per kilogram of lint to Turkmenistan's 13,696 liters per kilogram.[93] The global average, as we've mentioned, is 1,931 liters per kilogram, and with this additional context, you can understand why a global average on cotton's water consumption doesn't reveal much.

Blue water used per kg lint produced

Fig. 11



Source: ICAC Cotton Data Book 2021

The amount of irrigation water that farmers use is also based on technique and irrigation technology. The majority of irrigated cotton (approximately 75%) uses what's known as surface irrigation methods (usually either flood or furrow), which allow water to flow across the soil.[94] Surface irrigation can be associated with high water losses both from evapotranspiration and run-off from the field, among other reasons. On the other hand, one cotton expert told us that in some cases blue water is pulled from mountainous or hilly regions and redirected to agricultural centers, and there are examples where flood irrigation can help replenish local groundwater resources.[95] Mobile irrigation, sprinklers, and drip irrigation systems, by contrast, can reduce water depletion, although they do increase energy consumption.[96] It's also important to note that these more efficient irrigation systems are more expensive[97] and not widely available in many low-income nations.

To add one more wrinkle to the story, there are huge variations in irrigated water consumption within nations, too, from region to region. In India, for example, and based on ICAC data, the central western state of Maharashtra, where most cotton is rainfed and irrigated fields use furrow irrigation, cotton consumes 59 liters of blue water per kilogram of lint.[98] Compare that to farmers in the interior, which is drier and largely irrigated and where farmers almost exclusively use flood irrigation. Here, cotton consumes 3,429 liters of irrigation water per kilogram on average.

While cotton farmers are often portrayed as greedy consumers of irrigated water, our farmer experts said it's in their best interest to be judicious with water. "If we look at water from a farmer's perspective, it's a precious resource, and it's about *how do I use that most effectively, to maximize the value of that water to my farming operation*?" says Allan Williams, General Manager, R&D Investment, Cotton Research and Development Corporation (CRDC). What's more, overwatering produces oversized plants with very little fiber. And by contrast, even too much rain can waterlog fields, and ruin a crop.[99]

Allan Williams, General Manager, R&D Investment, Cotton Research and Development Corporation (CRDC):

“If we look at water from a farmer’s perspective, it’s a precious resource, and it’s about how do I use that most effectively, to maximize the value of that water to my farming operation?”

Water stress: refers to the ability, or lack thereof, to meet human and ecological demand for water. Compared to scarcity, "water stress" is a more inclusive and broader concept. It considers several physical aspects related to water resources, including water scarcity, but also water quality, environmental flows, and the accessibility of water.

Water scarcity: the volumetric abundance, or lack thereof, of water supply. This is typically calculated as a ratio of human water consumption to available water supply in a given area. Water scarcity is a physical, objective reality that can be measured consistently across regions and over time.

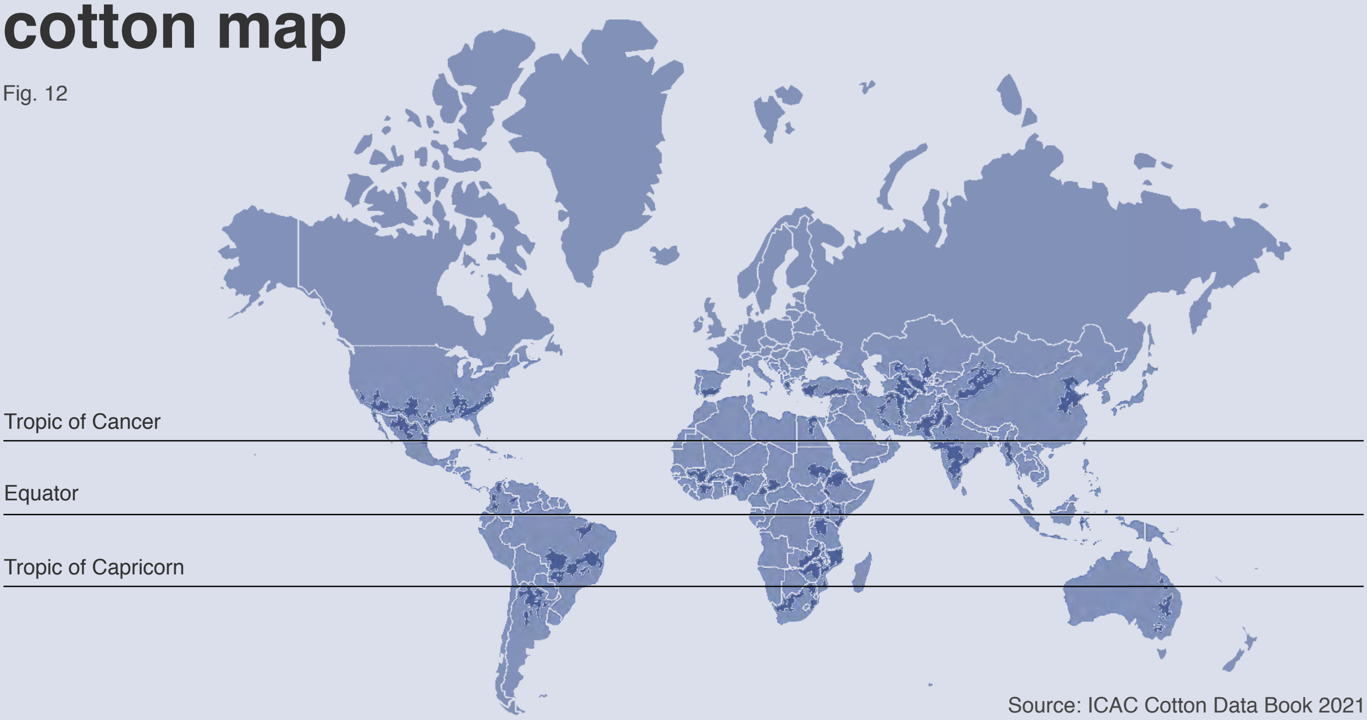
Can cotton's water consumption be sustainable?

As we've mentioned, *water scarcity* and *water stress*[100] are huge issues facing humanity. At least four billion people on the planet face water scarcity during some part of the year,[101] and pressures on freshwater resources are only intensifying. Among them are climate change, population growth, and economic development.[102]

Water scarcity also intersects with the cotton industry. According to the World Resource Institute, there are ten million hectares of irrigated cotton growing under high and extremely high water stress conditions.[103] In Pakistan and India, two of the world's largest cotton-growing nations, 84% and 97% of the population respectively face blue water scarcity at least one month out of the year.[104] Cotton is grown in many other countries where water is in short supply, including Egypt, Australia, Uzbekistan, Turkmenistan, and Turkey, where a high percentage of the population experiences water scarcity at some point throughout the year.[105]

Global cotton map

Fig. 12



Source: ICAC Cotton Data Book 2021

And yet painting cotton, both the plant and the industry, as the root cause of water challenges is misleading. Many of the water stress and water pollution issues that are often blamed on the cotton industry “do not have any direct relationship to the crop being grown,” explains Allan Williams of CRDC.[106] Water scarcity in cotton-producing regions can be caused by a lack of water-saving technology on farms, poverty, and failures in governance, among many other factors.

What’s more, conserving water is not as simple as asking farmers to use less water or grow something else. The public tends to idealize a switch away from cotton, but as we’ll discuss in Section 4, if the cotton industry evaporated tomorrow, this would have devastating consequences for rural cotton-growing communities. There's also the reality that most farmers would simply switch to growing something else. “Farmers will grow what the market wants them to grow,” says Williams. He adds that,

“There's an issue of agency so that, in theory, someone sitting in Europe is saying, we don't want to buy your cotton because it's got a high water impact, even though the impacts are very much a local issue.”

Cotton’s water challenges need solutions that are far more sophisticated and nuanced than just commanding farmers to use less water. In Gujarat, India, for example, the state government is incentivizing moving from inefficient water management to drip-irrigation. Water harvesting and other efficiency projects should be developed to preserve resources, says Simon Ferrigno. Tajikistan’s water stress is likewise often blamed on the cotton sector, but there are other challenges at play. For example, climate change caused largely by high-income nations is melting the glaciers that provide farmers with their irrigation water, threatening farmers’ livelihoods.[107]

Terry Townsend, the former Executive Director of ICAC and an independent cotton consultant:

“We know some areas are water deficient, and yet water continues to be used for irrigation and is just wasted, especially in Uzbekistan, Tajikistan and Turkmenistan, where they have a very wasteful irrigation system they inherited from the Soviet Union. And it has nothing to do with the agronomic needs of cotton. It’s just a wasteful system.”

It's also important to point out that cotton can in fact be grown sustainably, and cotton farmers can use water responsibly. Cotton water consumption is sustainable, according to FAO, "if the amount of water withdrawn is replenished by equal amounts in a timely manner."[108] Some cotton-growing nations have in fact moved towards greater water stewardship. For example, our experts based in Australia, a major cotton-growing country facing high water stress, describe the nation's highly regulated system of water-sharing, in which water to communities, livestock and the environment take precedence, and then finally farmers can use remaining freshwater for irrigation.[109] The Australian cotton industry's water efficiency improved by 40% in the decade ending 2012, according to Cotton Australia, an industry group.[110]

Likewise, in California, our experts describe that the state's growers are allocated a certain amount of water each year. Human and environmental needs come first, and sometimes farmers are allocated little to no water, our cotton farming experts explain, if there's a drought.

Water stewardship can be more of a challenge in low-income countries and those facing governance problems or instability. But it's not an inevitability. In the smallholder region of Malawi's Shire Valley, farmers are learning to harvest rain, which can be collected for both farmers and local communities. The fashion industry should work to improve the situation by supporting farmers and local communities in water management and access and by reducing pollution. In short, brands and consumers should work with the cotton industry to help manage water sustainably.

IMPORTANT!

In conclusion, there are many different factors that influence the amount of water cotton consumes. It's based on access to irrigation, the local climate, the style of irrigation available, farmer knowledge and governance. In light of the sheer variety in styles of cotton farming and access to and usage of water, local data about cotton and water is far more meaningful than global averages. “We should talk about a cotton T-shirt made from cotton grown in Mandvi, Gujarat, processed entirely within India, that uses X litres of water, using water from X source, with impacts,” argues Simon Ferrigno. While we don’t always have this level of granular quality data, we should strive to communicate this much context and detail relative to any claims that are to be made or communicated.

What’s more, data that captures how much water farmers use or consume is not a reliable or complete indicator of environmental impact. Water is borrowed and not used up from the global water cycle and in some places, water is ample and is used sustainably without negative local impacts. We have to start asking more questions beyond how many liters of water does it take to grow a pair of jeans.

With a more attuned understanding of the global water cycle, we also understand that “saving water” on a global level does not make it more available to the places that need it. “There is no shortage of water in the state of Mississippi in the United States, and saving water in Mississippi does not provide a single extra drop to Burkina Faso,” explains Dr. Terry Townsend, the former Executive Director of ICAC and an independent cotton consultant, with a doctorate in agricultural and resource economics.

The ultimate goal for the cotton industry is not the reduction of cotton’s water consumption or footprint per se but a just, sustainable and equitable water footprint for cotton. Water Witness, a UK charity, defines a fair water footprint as water use at production sites and in supply chains which guarantees zero pollution, sustainable withdrawals, preparedness to droughts and floods, ecosystem protection, legal compliance and full access to safe water, sanitation and hygiene.[111]

As we conclude this section on cotton and water, hopefully, you are prepared to have more informed conversations and make solutions-driven decisions about cotton and water.

Here are some key takeaways:

1. Water is borrowed from the global water cycle. It can be moved, polluted, change forms, or returned from where it came, but it can't be "used up." Cotton *can* use water sustainably.

2. Data about cotton's water usage, consumption or footprint is not alone a complete indicator of impact or unsustainable water management. Key questions include where is the water coming from? Is it being withdrawn at a sustainable rate? Is cotton denying or polluting water availability for other uses?

3. If cotton is grown in water-stressed regions, consider external factors causing water stress on a local level, such as climate change, outdated technology and weak governance. Would the water scarcity challenges be eliminated if cotton was no longer grown? Is that realistic, feasible or desirable?

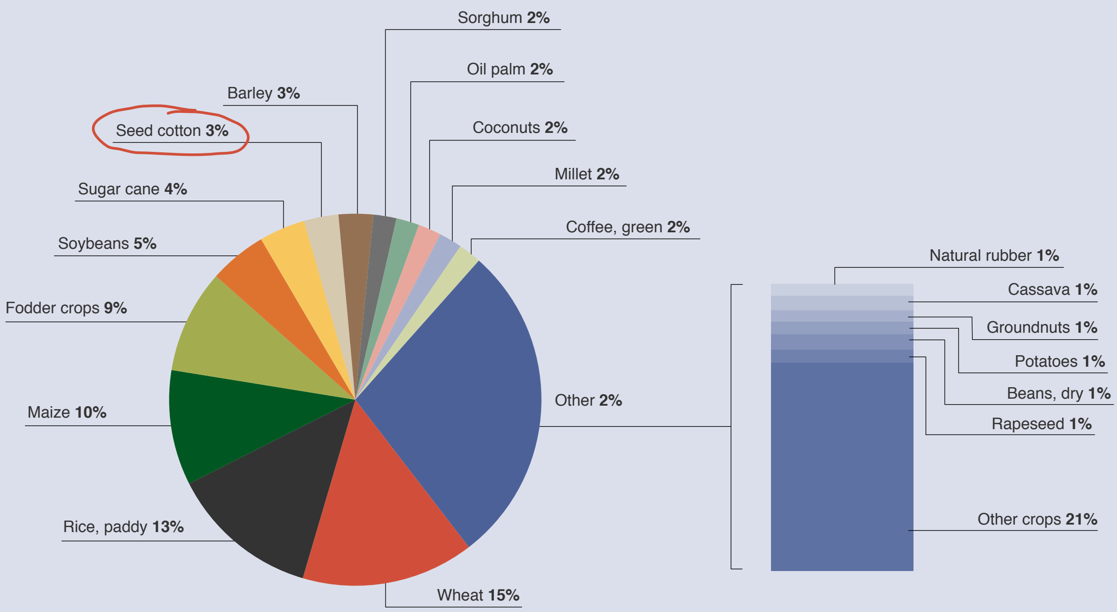
4. Avoid problem-shifting and invest in just, sustainable and equitable water management in cotton. If water is from a water-stressed region, help drive local solutions that provide for social, economic and environmental sustainability and communicate about water and cotton responsibly.

Cotton and water: additional data and figures

Through our research, we were able to identify a few credible and recent data points on cotton and water that are useful. For those that are outdated, we've made a note of it.

Contribution of different crops to the total water footprint of crop production (1996 - 2005)

Fig. 13

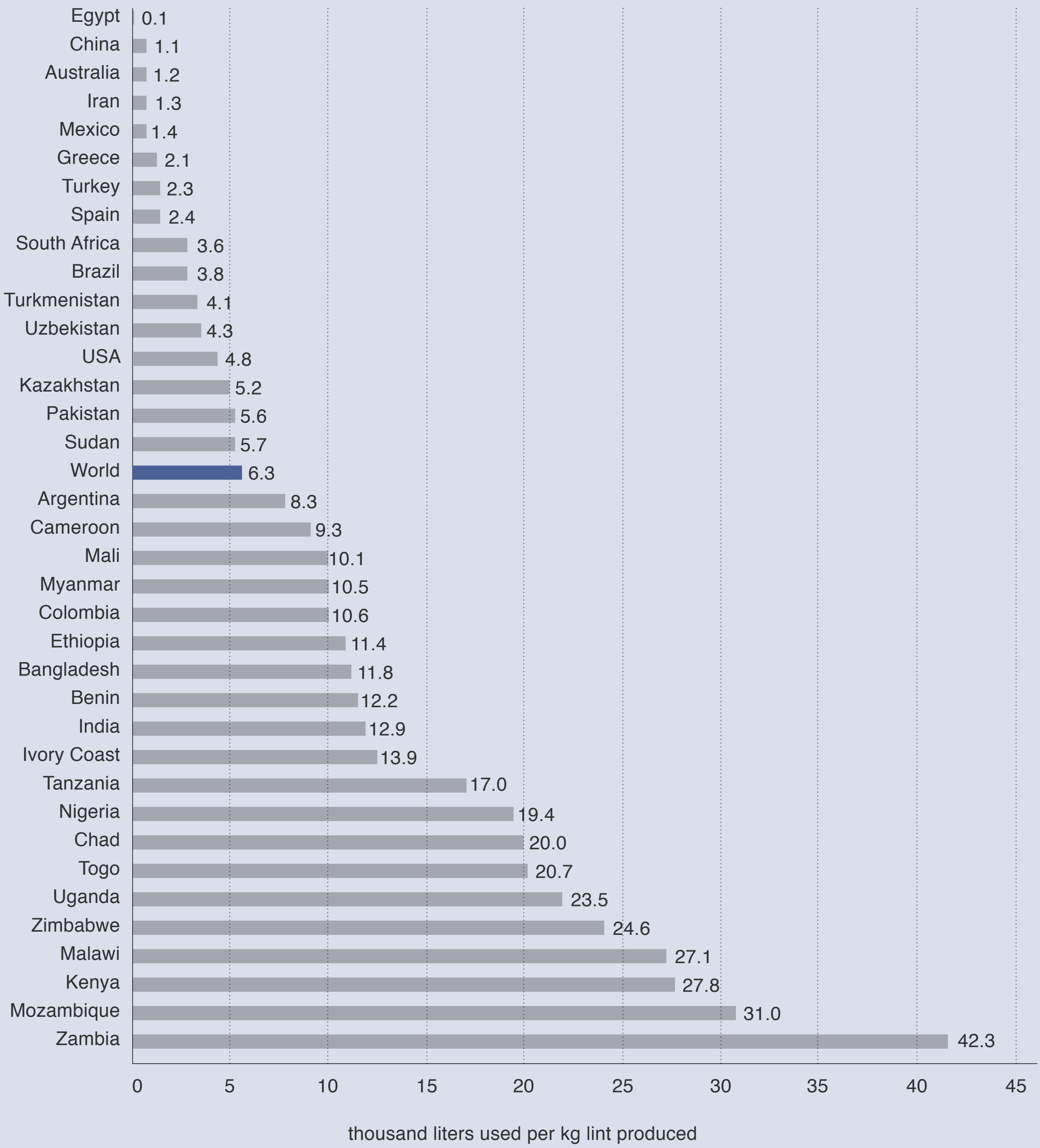


Cotton's water footprint is lower than many other crops, however, this data was collected between 1996 and 2005. We were unable to find a current source.

Source: Mesfin Mekonnen and Arjen Hoekstra/Hydrology and Earth System Sciences.

Green water used per kg lint produced

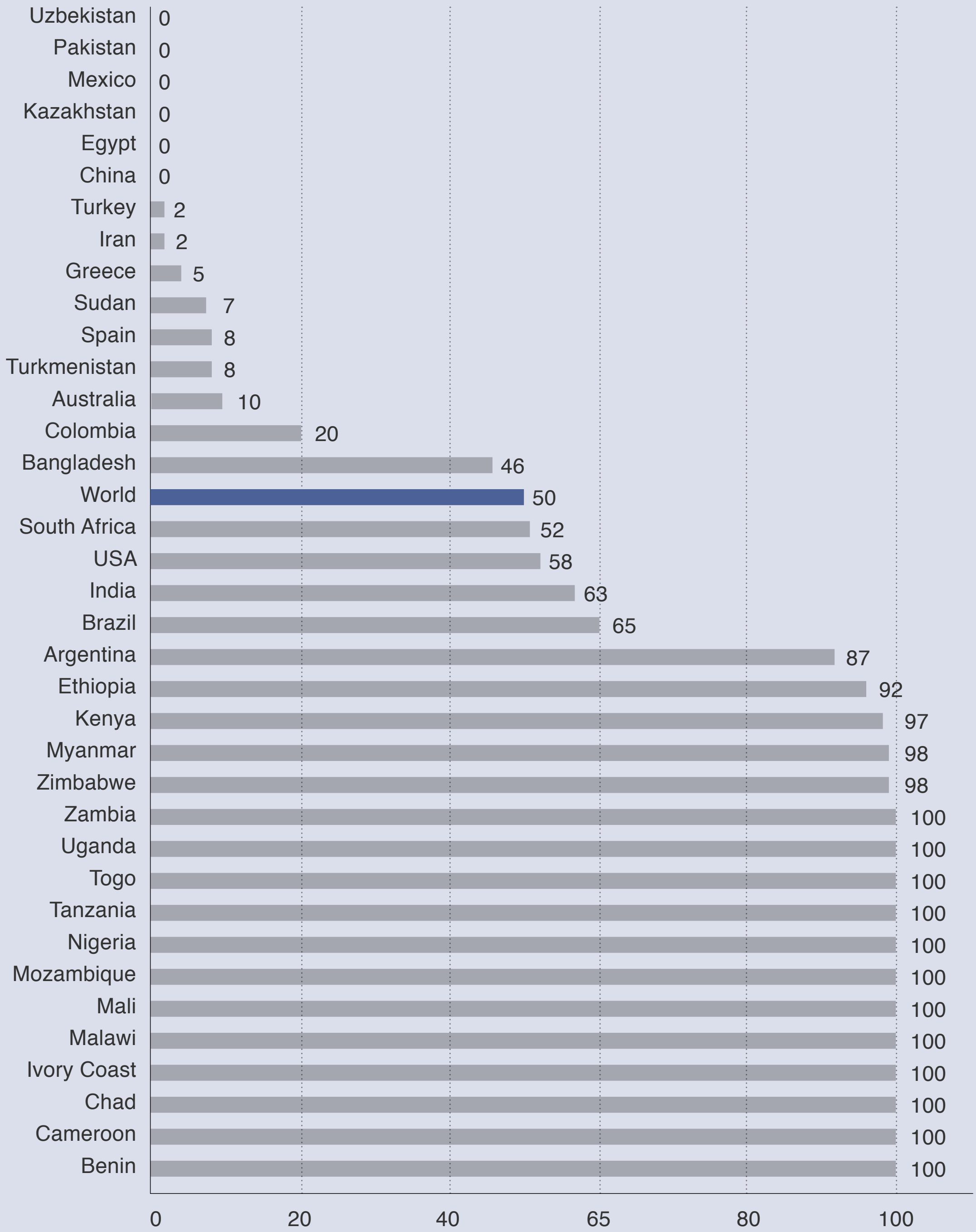
Fig. 14



Source: ICAC Cotton Data Book 2021

% Rainfed area

Fig. 15



Source: ICAC Cotton Data Book 2021

Irrigation methods & footprint

Fig. 16

	Region/Province/State	Flood	Furrow	Sprinker	Drip	Billion liters	Irrigation Water L/Kg Lint	Rain Water L/ Kg Lint
Australia	NSW	1	69	21	8	564	1,566	1,406
	Queensland	2	70	19	8	422	2,098	1,041
	National	1	80	17	1	986	1,757	1,163
Benin	National	0	0	0	0	0	0	12,160
Brazil	Bahia	0	0	50	50	41	69	3,293
	Goias	0	0	100	0	2	30	7,075
	Mato-Grosso	0	0	100	0	7	3	3,642
	National	0	0	80	20	50	17	3,842
China	Hebei	20	80	0	0	391	1,872	2,676
	Shandong	14	86	0	0	226	1,237	4,545
	Hubei	47	12	12	29	205	1,905	7,166
	Xinjiang	6	8	12	74	8,006	1,551	727
	Others	14	68	6	12	341	1,365	0
	National	9	20	10	60	9,170	1,552	1,071
Greece	Thessaly	0	10	60	30	298	2,654	1,892
	Macedonia	0	8	65	17	280	3,734	2,989
	Thraki	0	12	70	18	260	2,992	2,054
	National	0	10	65	22	838	2,563	1,961
India	Andhra Pradesh	15	75	3	7	73	240	13,806
	Gujarat	10	85	0	5	1,466	953	9,281
	Haryana	80	14	0	6	2,769	6,511	6,922
	Karnataka	10	80	0	10	154	451	13,313
	Madhya Pradesh	34	55	0	11	193	551	12,523
	Maharashtra	25	65	0	10	68	47	20,222
	Odisha	0	100	0	0	0	0	23,308
	Punjab	90	4	0	6	1,760	8,633	7,023
	Rajasthan	88	7	0	5	1,139	2,482	3,411
	Tamilnadu	80	18	0	3	45	530	11,678
	Telangana	52	40	0	8	87	85	15,213
	National	36	56	0	8	7,755	1,237	12,955
Pakistan	Punjab	25	75	0	0	7,766	8,968	8,135
	Sindh	15	85	0	0	2,397	4,212	1,743
	Others	60	40	0	0	259	11,745	0
	National	23	77	0	0	10,422	7,153	5,600
Turkey	Aegean	35	45	4	16	376	2,088	2,020
	Cukurova	0	85	1	14	367	2,073	2,471
	Turkey-Gap	0	70	22	8	1,335	2,967	1,860
	National	6	69	14	11	2,078	2,552	2,513
USA	Alabama	0	11	89	0	29	182	6,880
	Arizona	0	95	5	0	698	10,153	503
	Arkansas	0	89	11	0	516	1,856	3,875
	California	0	92	0	8	728	5,246	1,889
	Georgia	0	0	100	0	313	653	4,772
	Kansas	0	0	100	0	45	656	6,168
	Louisiana	0	0	100	0	15	198	6,138
	Mississippi	0	61	39	0	110	429	4,613
	Missouri	0	91	9	0	137	922	4,186
	New Mexico	0	50	50	0	65	3,310	1,298
	North Caro- lina	0	0	100	0	6	49	5,070
	Oklahoma	0	43	57	0	141	963	5,489
	South Caro- lina	0	0	100	0	23	342	6,157
	Tennessee	0	0	100	0	7	51	4,663
	Texas	0	17	83	0	1,968	1,633	5,277
	Virginia	0	0	100	0	0	3	6,908
	National	0	37	60	3	4,772	1,380	6,051
Uzbekistan	Kashkadar	97	0	0	3	938	13,164	3,339
	Bukhara	96	0	0	4	627	10,609	1,823
	Syrdarya	97	0	0	3	432	11,929	3,283
	Syrkhandar	97	0	0	3	530	12,155	2,975
	Ferghana	96	2	0	2	496	11,141	2,029
	Dzhizak	90	3	0	7	515	13,199	2,960
	Karakalpak	99	0	0	1	537	15,384	4,304
	Khorezm	98	0	0	2	513	11,173	3,244
	Andizhan	98	0	0	2	486	10,845	3,898
	Tashkent	99	0	0	1	423	10,360	5,180
	Samarkhand	91	0	0	9	465	12,118	6,502
	Namangam	98	0	0	2	391	10,903	3,717
	Navoi	94	0	0	6	212	12,008	3,510
	National	96	0	0	3	6,564	11,892	4,284
WORLD		**24.82**	**47.09**	**15.14**	**12.9**	**48.3**	**1931**	**6320**

Top 10 cotton producing countries.

Source: ICAC Cotton Data Book 2021

Rainwater, ETc & irrigation (mm)

Fig. 17

	Region/Province/ State	%Rain- fed	Total Rainfall (mm)	Effective Rainfall (mm)	Crop Evapo Transpiration ETc	Number of irrigations	Irrigation/Ha (mm)
Australia	NSW	13	464	281	790	6	360
	Queensland	32	674	182	720	9	540
	National	20	307	221	740	7	420
Benin	National	100	1,039	581	528	0	0
Brazil	Bahia	84	1,040	626	724	2	80
	Goias	94	3,003	1,198	742	2	80
	Mato-Grosso	100	963	656	790	4	120
	National	87	1,678	692	741	4	84
China	Hebei	14	482	295	694	6	240
	Shandong	12	848	582	690	6	180
	Hubei	12	1,305	596	596	6	180
	Xinjiang	0	261	150	720	8	320
	Others	8				6	180
	National	2	349	200	711	7	296
Greece	Thessaly	8	418	236	710	6	360
	Macedonia	8	510	257	724	5	350
	Thraki	7	480	229	690	6	360
	National	7	474	220		6	357
india	Andhra Pradesh	69	1,200	806	560	2	45
	Gujarat	28	980	628	728	2	90
	Haryana	4	625	399	710	6	390
	Karnataka	67	980	628	720	2	65
	Madhya Pradesh	48	1,062	681	680	2	58
	Maharashtra	97	1,100	706	700	2	60
	Odisha	100	1,650	1,061	698	0	0
	Punjab	2	449	286	790	6	360
	Rajasthan (incl. central)	3	367	233	784	5	175
	Tamilnadu	68	998	640	620	3	90
	Telangana	91	1,020	654	680	1	41
	National	65	975	627		2	169
Pakistan	Punjab	0	550	379	780	12	418
	Sindh	0	250	161	680	11	390
	Others	0				12	680
	National	0	475	325	755	13	415
Turkey	Aegean	0	648	409	890	5	423
	Cukurova	0	726	459	956	6	385
	Gap	4	459	289	840	7	480
	National	2	650	428		6	449
USA	Alabama	89	1,501	609		5	152
	Arizona	5	201	66		12	1401
	Arkansas	20	1,225	512		8	305
	California	1	451	348		12	975
	Georgia	64	1,166	474		6	183
	Kansas	73	926	541		7	213
	Louisiana	82	1,541	678		4	122
	Mississippi	66	1,375	557		5	152
	Missouri	35	1,257	536		6	183
	New Mexico	18	247	137		9	427
	North Carolina	97	997	431		4	122
	Oklahoma	79	788	432		8	366
	South Carolina	86	1,193	553		7	213
	Tennessee	93	1,411	557		3	91
	Texas	63	868	405		8	335
	Virginia	100	980	597		2	61
	National	63	770	574		7	361
Uzbekistan	Kashkadar	0	285	175		3	690
	Bukhara	0	157	110		3	640
	Syrdarya	0	265	164		3	596
	Syrkhandar	0	324	175		3	715
	Ferghana	0	165	110		3	604
	Dzhizak	0	280	148		3	660
	Karakalpak	0	290	174		3	622
	Khorezm	0	280	180		3	620
	Andizhan	0	384	220		3	612
	Tashkent	0	415	290		3	580
	Samarkhand	0	550	330		3	615
	Namangam	0	348	210		3	616
	Navoi	0	310	190		3	650
	National	0	315	229	887	3	635
World		**52.4**		**501**	**12.9**	**48.3**	**321.6**

Top 10 cotton producing countries.

Source: ICAC Cotton Data Book 2021

Data gaps and challenges to collecting credible data on water and cotton

There are limits to what we know about cotton and water. There are significant **data gaps** on cotton's water consumption, with more data available in high-income cotton-growing countries like the United States compared to smallholder farmers or growers in low-income countries. For some nations, we have no data. What's more, one cotton expert told us that oftentimes, remote sensing of input usage or harvest data is used to calculate global averages, meaning the data we're using is an abstraction. What's more, some of the data that does exist about cotton farming is often self-reported and lacking oversight. There's a need for **transparency.**

There is also the problem of **silenced data** about cotton and water, meaning more data exists than is publicly available but it's not used either because it's privately owned or because it's behind a paywall and is prohibitively expensive. Two cotton industry insiders expressed frustration to us that Better Cotton Initiative, which currently covers 23% of global cotton production, and Cotton Made in Africa, another nonprofit that works with cotton farmers, have detailed data on input use and farming methods but don't make the data publicly available.

We must also consider ethical uses of data, especially considering the cost and challenges of collecting it. As farmers and suppliers are pushed to provide more data about their inputs and impacts, this data shouldn't just be sent up the supply chain for brands to use to problem shift, with limited benefits to farmers and suppliers. Data should be used towards solutions, not used against cotton farmers.

Where should you go for more information?

Credible sources, data and tools on water and cotton

A list of additional credible data and information online about cotton's water impacts. Keep in mind the data gaps and lack of local data in many regions. Please always apply your own critical thinking and do your own due diligence when using these sources.

WWF Water Risk Filter - Interactive maps and case studies of water risk globally.*

National reports - Within the WWF Water Risk Filter. Countries such as Australia, Benin, Burkina Faso, China, Egypt, Ethiopia, Greece, Mali, Pakistan, Tajikistan, the United States, Uzbekistan, have national reports full of detail and data.*

World Wildlife Fund - Tchibo water risk report, which includes cotton

Water Footprint Network tools - A suite of water footprint maps and water footprint calculators.*

World Resources Institute Aqueduct tools - Tools evaluating water risks globally.*

For more information about useful tools, we recommend looking at the WWF "Right Tool for the job" guidance.

National Level Data

The World Business Council for Sustainable Development's water tool

Field to Market national indicators report - A peer reviewed report on environmental impacts of U.S. commodity crop productions, including cotton.

Mississippi State University's cotton crop loss data - Crop loss data for U.S. cotton.

USDA's statistical service

Australian Cotton's Sustainability Report (2014, 2019)

CottonInfo's water management page - The Australian cotton industry's joint extension program, which provides cotton research.

*These are live tools and subject to change, we recommend checking the validity of sources of the data at the time.

SECTION 3:

Cotton and Pesticides: The Reality

How Much Harmful Pesticides is the Industry *Really* Using?

Pesticide: any substance or mixture of substances intended for preventing, destroying or controlling any pest, which includes disease, unwanted plants or animals that interfere with food and other types of agriculture.

Pesticides are a notorious class of substances. Since their widespread adoption in the 20th century, alongside the development of modern chemistry, they've been linked to serious incidents of environmental pollution and human and wildlife harms.

Their very mention often sparks heated debate, tensions and conflict. Likewise, the cotton industry, which is often described as the world's top user of pesticides, is closely linked to significant harms from pesticides, including farmer poisonings, toxic pollution, and long-term health impacts like cancer.

As a class of substances "designed to be toxic to certain organisms,"[112] according to Simon Ferrigno, and that are used in the open environment, pesticides do warrant our concern and a deeper understanding. Much like cotton's water impacts, it's important not to downplay the impacts that pesticides can have. There are in fact many hazardous pesticides in usage in the cotton industry.

On the other hand, it's critical that the industry and the public use credible data as well as meaningful data about pesticides and cotton. Pesticides are very often discussed using inaccurate data or with global sales data that indicates nothing about what chemicals are being used or the impacts they might be causing. Using the right kind of data is crucial to understanding pesticides impacts, and mitigating their harms.

What's more, the conversation about pesticides is often flattened, sensationalized, and talked about in oversimplified terms. In order to drive the conversation forward, institutions, the fashion industry and the public need a far more sophisticated knowledge of what pesticides are used in cotton farming and why, and how to parse and mitigate the harms they can cause. That's where we'll focus on our energies in this section.

What are pesticides and why do farmers use them?

Having informed conversations about pesticides starts with understanding some basic categorizations of pesticides and the differences between them. Pesticides are often talked about as if they're all one thing. And yet pesticides encompass more than 1,000 active ingredients.[113]

The UN Food and Agriculture Organization (FAO) provides perhaps the most comprehensive definition of a pesticide: "Pesticide means any substance, or mixture of substances of chemical or biological ingredients intended for repelling, destroying or controlling any pest, or regulating plant growth."[114]

Cotton farmers use a variety of pesticides, including those that target insects (insecticides), weeds (herbicides) and fungal infections (fungicides), and those that regulate plant growth (growth regulator) and aid mechanical harvesting (defoliants).[115] Pesticides in cotton are often used on cotton seeds (the majority of cotton seeds come pre-treated with insecticides and fungicides), on soil (to control weeds, fungus and insect pests), and as an application on the cotton crop.[116] Without going into a full chemistry lesson, pesticides are also further classified by their chemical building blocks. The major chemical families of cotton pesticides are organochlorine, organophosphates, pyrethroids, carbamates and neonicotinoids.[117]

The majority of cotton farmers use synthetic pesticides (we'll get further into how much usage varies in a moment). Organic cotton is cotton grown without synthetic chemicals and synthetic pesticides or genetically modified seeds.[118] As of the 2019/2020 growing season, organic cotton held a .95% market share of cotton.[119]

Cotton farmers use pesticides mostly as crop protection. Although, as we'll touch on later, there are other ways to manage pests than the use of synthetic pesticides. Cotton's succulent leaves, large flowers and long fruiting period make it uniquely attractive to a large variety of pests.[120] Fungal, viral and bacterial pathogens are a threat to cotton, but insects cause the most damage.[121] In Africa alone, cotton can be affected by 480 different species of insects, mites, myriapods, and nematodes (with a dozen of these being major pests).[122]

Some insect pests feed on the leaves of cotton and some feed on the cotton bolls. Others like the boll weevil infest and damage the developing cotton boll, destroying it from the inside out. The boll weevil was infamously referred to by the USDA as "the wave of evil," as it nearly wiped out the cotton industry in some areas of the U.S. and led to widespread destitution in the early part of the 20th century.[123] Pests can either stunt crop growth or wipe out a crop entirely. Different types of insect pests cause different levels of damage to the cotton plant, and our cotton experts warn this can sometimes lead to severe economic losses for cotton farmers. Crop losses in cotton also increase the environmental impact of the industry, as the water, energy and other resources that go into growing the crop are wasted.

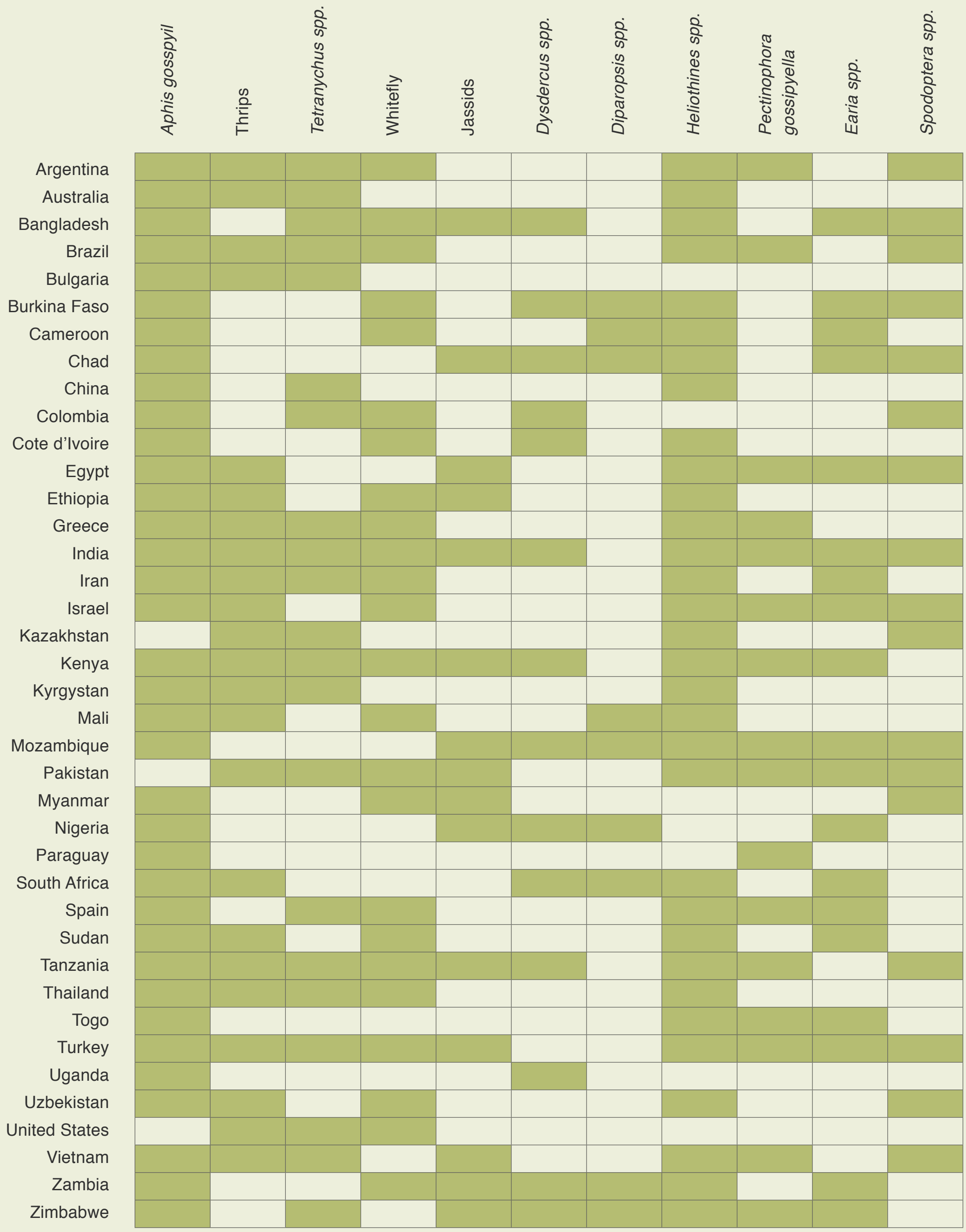
Fig. 17

Fig. 18

Fig 17: A healthy cotton boll
Fig 18: A cotton boll damaged by the boll weevil
© Ramón Chavarria

Global distribution of insect pests

Fig. 20



Source: ICAC Cotton Data Book 2021.

How much pesticides do cotton farmers use?

According to ICAC, data from 2019 shows that cotton accounts for 4.71% of all global pesticides sales.[124] Within the broader umbrella of pesticide usage, cotton accounts for 2.91% of global herbicide sales, 10.24% of insecticide sales, 1.03% of fungicides sales, and 15.74% of other pesticides, which includes growth regulators.[125] Cotton has the highest market share of insecticides measured by sales.[126] According to some estimates, cotton is the fourth-largest market for agricultural chemicals in the world as of 2017.[127]

Global crop protection pesticide market (1994 - 2017 - 2019)

Fig. 21

	Global pesticide sales all crops USD million				Global pesticide sales on cotton USD million				% share of cotton			
	1994	2017	2018	2019	1994	2017	2018	2019	1994	2017	2018	2019
Global CP sales	25,885	57003	60304	59827	2,575	2540	2910	2820	9.95	4.46	4.83	4.71
Herbicide sales	12,105	25160	26563	26175	570	609.6	727.5	761.4	4.71	2.42	2.74	2.91
Insecticide sales	7,580	14060	15121	15146	1,705	1473.2	1629.6	1551	22.49	10.48	10.78	10.24
Fungicide sales	4,750	15739	16473	16356	140	152.4	189.15	169.2	2.95	0.97	1.15	1.03
Other pesticide sales	1,450	2044	2148	2150	160	304.8	363.75	338.4	11.03	14.91	16.93	15.74

Changes in global pesticides sales over time. Sources: Data is from 1994 Allan Woodburn Associates Ltd./Managing Resources Ltd., "Cotton: The Crop and its Agrochemicals Market," published in 1995[182], and 2017 to 2019 data is from ICAC Cotton Data Book 2021.

There are significant differences in the volume and types of pesticides used from country to country; this is based partly on differences in the climate and specific pests from place to place. But it's challenging to get a complete picture of pesticides usage in cotton from the publicly available data. Based on country-specific data of pesticide usage across *all* crops, as you can see in Fig 27,[128] many cotton-growing countries in Africa use relatively few pesticides (less than 1 kilogram per hectare). But PAN UK has found that cotton is the third-largest market for pesticides on the continent.[129] Australia and the U.S., two of the world's largest cotton-producing countries, use 2.03 kilograms per hectare and 2.54 kilograms per hectare respectively across all crops.

China, the second-largest cotton producer behind India, by contrast, has the highest rates of pesticide usage in the world across all crops, at 13.07 kilograms per hectare.[130] But this data doesn't reveal much about cotton. Some estimates show that 75% of insecticides used on cotton are used in just five countries: Brazil, India, China, the U.S. and Pakistan as a percent of sales.[131] These are also the biggest cotton-producing nations.[132] It's important to note however that the 75% figure appears to come from data collected by agrochemical market research firm Phillips McDougall, which we were unable to access. This is a common problem with pesticides data.

Cotton and pesticides: the data gaps

When it comes to cotton and pesticides, there are staggering gaps in the available data. Good data on cotton and pesticide usage exists for most high-income cotton-growing countries, including the U.S. and Australia, where farmers are required to record their pesticide usage in detail. For many other cotton-growing nations, where most cotton farmers live, we have no data or little publicly available data on pesticide usage and impacts. Data is particularly scant throughout much of Africa, where chemicals can have a high human impact, as there are millions of smallholder cotton farmers, and a higher rate of usage of the most hazardous pesticides.[133]

There is also a problem of **silenced data**. Nuanced country-specific pesticide data is privately held and must be purchased from market research groups such as Phillips McDougall (IHS) and AgbioInvestor. We refer to this data as **silenced data.** We reached out to a number of organizations that have aggregated country-specific data, including these, and were not granted access. There is also a problem of **accessible data.** Fees to access pesticide data can be exorbitant. For example, some of the experts we spoke to say there are a few databases that collect global pesticide usage that cost as much as $80,000 to access.

Considering pesticides' human health and environmental implications, there is an urgent need for data that captures exactly what pesticides are being used, where, and how, including the method of application. According to our experts, the data on pesticides that needs to be in the public domain, just to start, includes the volume used per hectare as well as sales data by active ingredient (not just "insecticide" but the exact kind, such as monocrotophos). It would also be useful to know the exact formulation or product used, the area treated, the frequency of applications and the pest targeted.

Sales data reflects that there has been a decline in overall pesticide sales in cotton on a global level in recent decades, owing to significant global declines in insecticides.[134] But these global averages conceal local nuances. In Africa, total pesticide usage, including insecticides, appears to have gone up in recent decades, according to the British environmental nonprofit Pesticide Action Network UK, as well as in China and Brazil—but this is based on available data for all crops, not just cotton.[135] In India and Pakistan insecticide usage in cotton has also increased in the past twenty years after a period of decline.[136] And in the U.S., while there have been significant drops in insecticides in recent decades, herbicide usage has risen alongside the adoption of genetically modified organism (GMO) cotton bred to be herbicide-resistant to glyphosate.[137]

As we've mentioned, global averages about cotton are problematic. And global data on pesticide sales is particularly limited in what it communicates, as it doesn't reflect anything about pesticide usage or impacts. Pesticides range greatly in their potential harm to humans and the environment. Thus a single global or national figure about sales tells us nothing about which pesticides are being used (the highly hazardous ones, for example) and how they're being applied and the consequences.

Pesticides and conditions of use

Hazard: "inherent property of a substance, agent or situation having the potential to cause undesirable consequences," whether to humans, the environment and so on.

Risk: Contextual. The probability or chance of "an adverse health or environmental effect, and the severity of that effect, following exposure to a pesticide," usually based on the way pesticides are used or how often they're used.

When discussing pesticides or any potentially harmful substance, it's helpful to understand the difference between hazard and risk. According to the World Health Organization, *hazard* refers to the "inherent property of a substance, agent or situation having the potential to cause undesirable consequences," whether to humans, the environment and so on.[138] *Risk* on the other hand is contextual. It's about the probability or chance of "an adverse health or environmental effect, and the severity of that effect, following exposure to a pesticide," usually based on the way pesticides are used or how often they're used.[139] One cotton expert offered the example of electricity to power our homes. Electricity is hazardous but the type of casing on the wires and the insulation in the walls of our houses is part of what determines our risk of electrocution.

The significant differences in the way pesticides are applied have significant implications for the risks associated with these chemicals. This is often called "conditions of use" by authorities. Regulations are one-factor shaping conditions of use. For example, some pesticides used in the U.S have been banned by India and Brazil for years.[140] In some countries, like Australia, chemicals are under strict regulatory control that determines how a pesticide can be used and in what concentration.[141]

The way that pesticides are mixed, stored, and distributed also varies greatly among cotton farmers themselves, as does the style and precision of application.[142] These differences can be determined in part by farmer training, education, income level and even literacy levels, as some farmers are unable to read the directions of use and warning labels on pesticide packaging. Using application techniques that aren't accurate or precise, and spraying pesticides in wind, when they're prone to drifting off the field, increase the risk of using pesticides.[143]

Conditions of use vary greatly between large-scale cotton farming in high-income nations and the rest of the world, as does the risk associated with pesticides. Our cotton experts describe how many farmers in high-income countries, like the U.S. and Australia, apply pesticides to cotton via airplane or via a spray rig pulled behind a closed-cabin tractor. Spraying is regulated and typically done using personal protective gear.

On the other hand, in many low and middle-income countries, including across Africa and in India, Bangladesh, and Pakistan, pesticides are largely applied with hand spraying equipment, such as a knapsack, backpack or micronair sprayers, and by walking up and down the rows of cotton, often without protective gear.[144]

But which pesticides do harm?

Pesticides are capable of a range of harm to humans and the environment, and this depends both on their inherent properties, the amounts which are used and how they are used. Some pesticides can be used under certain conditions with relatively minimal risk, while others pose significant harms to humans and the environment and are challenging to use safely.

Persistent: don't readily biodegrade

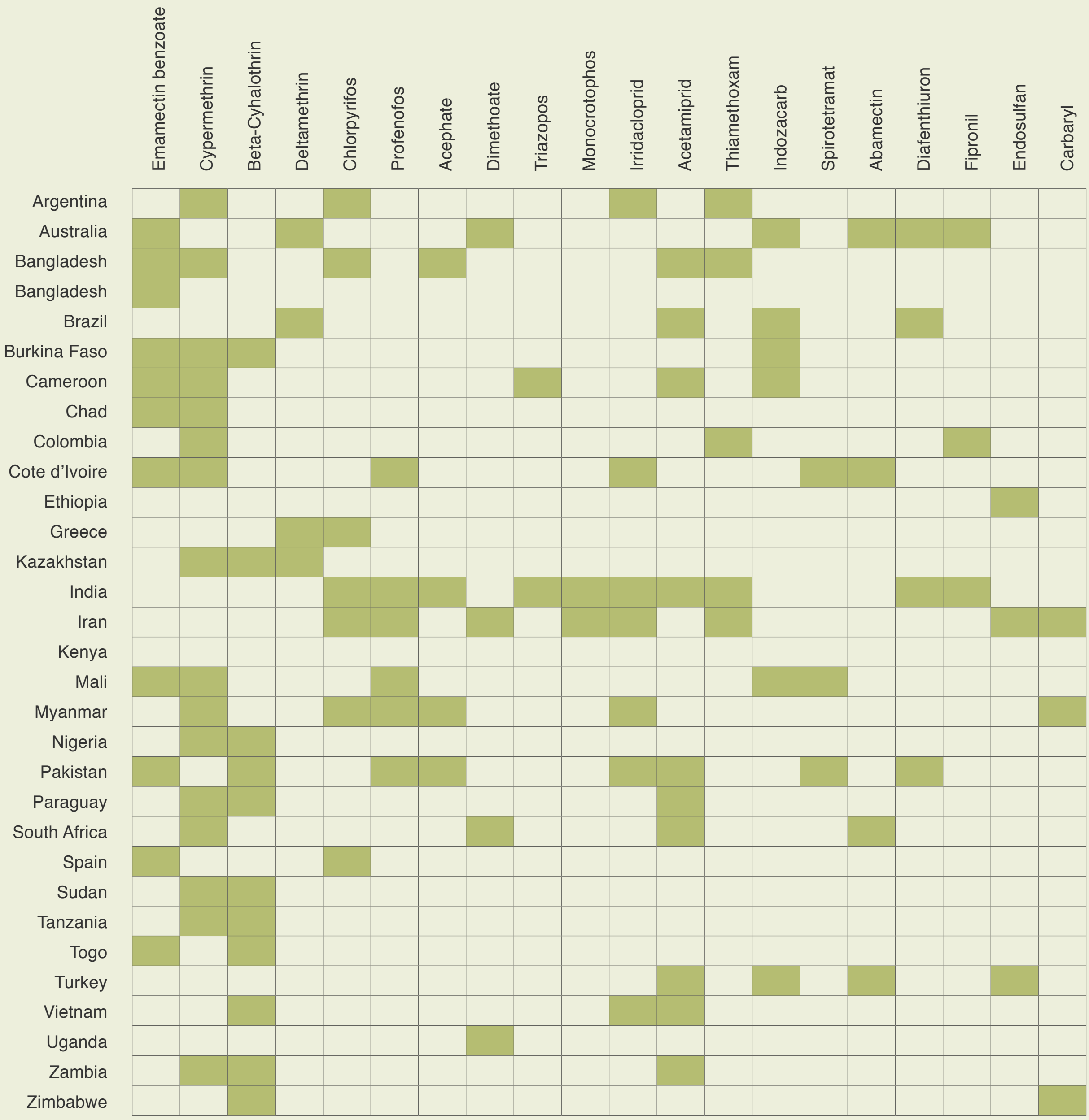
Nonselective: those whose mode of action works across a wide range of organisms are called "broad spectrum"

Broad spectrum: target a wide range of organisms

Which pesticides are most hazardous? There are a few ways to narrow down the conversation. Pesticides that are *persistent* in the environment, highly hazardous, and those that are *nonselective* tend to increase the environmental and human health risks.[145] Generally speaking, pesticides that are *broad-spectrum*, meaning they target a wide range of organisms, are more harmful for humans and the environment compared to those that are more targeted.

Commonly used insecticides across the world

Fig. 22



Source: ICAC Cotton Data Book 2021.

Insecticides are the category of pesticides most linked to human and environmental harms.[146] Our experts suggest this is both because they're used in higher volumes in cotton, compared to other types of chemicals (again because of the heightened risk of insect damage to cotton), and because they are typically sprayed multiple times throughout the season and directly onto the crops, meaning there's a greater opportunity for them to impact non-target organisms compared to pesticides used once a season and applied only on the soil or to treat seeds. Insecticides also pose unique risks as they are designed to "interfere with biological systems that are common throughout the animal kingdom," says PAN UK.[147]

To narrow the conversation further, **broad-spectrum insecticides** are one category of major concern (as these are the chemicals that target an entire group or species of organisms), and especially **organochlorine** and **organophosphate pesticides**, which are hard to use safely and also can be highly toxic to a wide spectrum of organisms, including humans, animals and insects.[148] In fact, two of the most notorious pesticides, DDT and endosulfan (both banned internationally by a United Nations treaty) are toxic and persistent broad-spectrum insecticides in the organochlorine family.[149] However, it's not just insecticides that can cause harm. Of the 300 agrochemicals classified as extremely, moderately or highly hazardous by WHO, approximately a quarter are insecticides.[150]

As we mentioned, organic cotton farmers do not use synthetic chemicals. But they do use organic pesticides, some of which can also be environmentally toxic. Several of our experts pointed out that organic programs are regulated and those organic substances that are more harmful to humans have been banned. However, as you can see in Fig 23, many common organic pesticides continue to be toxic to pollinators such as bees.

An overview of common organic pesticides

Fig. 23

Active Ingredient (A.I)	Type*						Bee toxicity	⊛	Notes & Special Precautions
Acetic acid (vinegar)				H		A	Medium	×	Application made with concentrations of acetic acid over 100% likely to be toxic to bees and other beneficials
Azadirachtin / neem oil	I	M					Medium	×	Mixing with hsoap increases toxicity to bees
Bacillus amyloliquefaciens			F				Low		
Bacillus subtilis			F				Medium	×	Slow acting MOA † - Impacts on nbees likely to be delayed
Bacillus thuringiensis ssp. aizawai	I						Medium - High	×	Slow acting MOA † - Impacts on nbees likely to be delayed
Bacillus thuringiensis ssp. kurstaki / israelensis	I						Low		Toxic to butterflies and other beneficials (Diptera)
Beauveria bassiana	I						Medium - High	×	Slow acting MOA † - Impacts on bees likely to be delayed ◆ (see Coppers below); W - wet formulation
Bicarbonates (sodium / potassium)			F				Low		
Boric acid	I						Low		Uses for structural pest control are unlikely to affect bees; use caution if using fertilizers containing boric acid
Burkholderia spp. strain A396	I	M					Low - Medium	×	MOA † suggests that impacts could be delayed, but no data currently available
Cedar oil	I	M					Low - Medium	×	Repellent to bees and may distrupt pollination
Chromobaeterium subtsugae	I	M			R		Low - Medium	×	Slow-acting MOA † - impacts on bees likely to be delayed; repellent to bees and may distrupt pollination for up to a week
Cinnemaldehyde	I	M	F				Low	×	Toxic to other beneficials (ground beetles, mites, nematodes)
Citrus oil (Limonene / D-limonene)	I			H			Low	×	Repellent to bees and may disrupt pollination
Coppers			F				Low - Medium	×	Avoid heavy repeated use - copper can accumulate in soils and contaminated soils are difficult to remediate
Copper sulphate ($CuSO_4$)			F				Low - Medium	×	
Copper sulphate + lime (Bordeaux mixture)			F				Medium	×	◆ Do not apply copper(s) within one week of Beauveria application
Corn gluten				H			Low		
Cydia pomonella granulovirus	I						Low		
Diatomaceous earth	I	M					Medium	×	Slow-acting MOA † - Impacts on bees likely to be delayed
Garlic, cottonseed or clove oil	I	M	F		R		Low - Medium	×	
Gibberellic acid						P	Low - Medium	×	
Gilocladium catenulatum			F				Low	×	MOA † suggests that impacts could be delayed, but no data currently available
Horticultural oil / narrow range oil	I	M	F				Medium	×	Only toxic to beens upon direct contact; if applying during bloom, apply at night to minimise risk to bees
Hydrogren dioxide, peroxyacetic acid			F				High	×	
Insecticidal soap	I	M	F				Low - Medium	×	
Isaria fumosorosea	I	M					Low - Medium	×	Slow-acting MOA † - impacts on bees likely to be delayed
Kaolin clay	I	M					Low	×	Can disrupt foraging bees at time of application; if applying during bloom, apply at night
Lime sulfur	I	M	F				Low - Medium	×	Repellent to bees and may disrupt pollination
Pyrethrins	I	M					High	×	
Pythium oligandrum			F				Low	×	MOA† suggests that impacts coul dbe dealyed, but no data currently available
Reynoutria sachalinensis extract			F				Low		
Rotenone	I	M					Medium - High		Highhly toxic to honey bee larvae, prohibited for use in U.S. organic argriculture
Ryania / Ryanodine	I						Low - Medium		Slow-acting MOA † - Impacts on bees likely to be delayed, Cancelled
Sabadilla (Schoenocaulon officinale)	I						Low - Medium	×	
Spinosad	I	M					High	×	Granular spinosad balt products generally have a much lower exposure risk for bees
Streptomyces spp.			F				Low		Only registered for greenhouses/ornamentals
Sulfur	I	M	F				Low	×	Repellent to bees and may disrupt pollination; may reduce viability for some crops
Tea tree oil			F				Low		
Trichoderma spp.			F				Low	×	Slow-acting MOA † - Impact on bees likely to be delayed

Notes

* Type - Insecticide (I); miticide (M); fungicide (F); herbicide (H); repellent (R); adjuvant (A); plant growth regulator (P)

⊛ **Do Not Apply** directly to, or allow to drift onto flowering plants

† MOA - Mode of action (e.g., how a pesticide works, or the mechanism by which it causes physiological disruption at its target site[s])

Source: Xerces Society

There are multiple schemes that now classify pesticides based on their hazard level and each draw on slightly different parameters: Two are the WHO Recommended Classification of Pesticides by Hazard, which classifies pesticides by acute human toxicity, and the Globally Harmonized System of Classification and Labelling of Chemicals (GHS), which considers both acute and chronic human toxicity and environmental toxicity. Another, the UN's Food and Agriculture Organization (FAO) Guidelines on Highly Hazardous Pesticides, released in conjunction with WHO, not only considers chemical properties, but also the conditions of use, meaning whether farmers have the knowledge, access to PPE and modern application equipment to use pesticides safely.[151]

Increasingly, there's been efforts to determine and regulate what's known as Highly Hazardous Pesticides, which the FAO and the WHO defines as those that "pose particularly high acute or chronic impacts" (you can read the full definition of an HHP here) to human health and the environment based on eight criteria. Pesticide Action Network International publishes its own HHP list based on more stringent parameters, including endocrine-disrupting properties, eco-toxicological properties, and inhalation toxicity.[152]

In Fig 24 we compare the commonly used insecticides in cotton, as reported by ICAC in their 2021 Cotton Data Book, against the 2021 Pesticide Action Network International list of HHPs and the 2019 WHO Recommended Classification of Pesticides by Hazard and guidelines to classification, so you can easily see which insecticides are considered of most concern by different international standards as well as what type of hazard they pose.

Commonly used Insecticides on cotton and their classification

Fig. 24

Insecticide / Pesticide category	Acute Toxicity	Long term effects	Environmental toxicity	Conventions	Most widely used pesticides in cotton list (PAN UK)	The WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification 2019
Emamectin benzoate (avermectin)			■			n/a
Cypermethrin (pyrethroids)			■		■	Zeta-cypermethrin Highly hazardous (Class Ib) Cypermethrin Moderately hazardous (Class II) Alpha-cypermethrin Moderately hazardous (Class II)
Beta-cyhalothrin (pyrethroids)			■			n/a
Deltamethrin (pyrethroids)		■	■		■	Moderately hazardous (Class II)
Chlorpyrifos (organophosphate)		■	■		■	Chlorpyrifos Moderately hazardous (Class II) Chlorpyrifos methyl Slightly hazardous (Class III)
Profenofos (organophosphate)			■		■	Moderately hazardous (Class II)
Acephate (organophosphate)			■			Moderately hazardous (Class II)
Dimethoate (organophosphate)			■			Moderately hazardous (Class II)
Triazophos (organophosphate)	■					Highly hazardous (Class Ib)
Monocrotophos (organophosphate)	■		■	■	■	Highly hazardous (Class Ib)
Imidacloprid (neonicotids)			■		■	Moderately hazardous (Class II)
Acetamiprid (neonicotids)					■	Moderately hazardous (Class II)
Thiamethoxam (neonicotids)			■		■	Moderately hazardous (Class II)
Spirotetramat (keto-enol)						Slightly hazardous (Class III)
Abamectin (avermectin)	■		■			Highly hazardous (Class Ib
Diafenthiuron			■			Slightly hazardous (Class III)
Fipronil (phenylpyrazole)			■			Moderately hazardous (Class II)
Endosulfan (organochlorine)	■			■		Moderately hazardous (Class II) (?)
Carbaryl (carbamate)		■	■			Moderately hazardous (Class II)

Some pesticides' pose risks to humans, others to non-target organisms, and still others to the wider ecosystem, or a combination of the above. Long-term exposure to even small doses of some hazardous pesticides can cause major health problems in humans such as cancers, birth defects and impaired development in children.[153] Humans can also be impacted via poisoning, if certain chemicals are directly inhaled, swallowed or handled and are extremely toxic. This is of particular concern for farmers and their families.[154]

Data about pesticide poisoning, including in cotton, is understudied and underreporting of poisoning is thought to be widespread.[155]A 2020 research paper estimates that as many as 44% of all farmers across all crops are poisoned by pesticides every year, but this data is not about cotton alone.[156] PAN UK's surveys of cotton farmers in Africa and Central Asia found pesticide poisoning rates of 25% to 57%.[157]

Pesticides also have the potential to harm the environment and organisms other than humans (known as non-target organisms). If not handled correctly, they have the potential to contaminate drinking water and other freshwater systems, poison fish and other aquatic organisms, persist in soils causing damage to crops and beneficial organisms, poison wildlife and diminish biodiversity, poison livestock, kill bees and other pollinators, and pollute the air.[158]

There are also side effects on the broader ecosystem from using some pesticides. Some pesticides are derived from petrochemicals, sourced from a non-renewable resource, and thus can drive up energy usage and contribute to greenhouse gas emissions.[159] Many pesticides can lead to increasing pest and weed resistance, as weeds, insects and other organisms evolve that can withstand the chemicals, throwing ecosystems out of balance, encouraging secondary pests, and introducing invasive species of insects and weeds.[160] But as we said, pesticides are not all one thing, and we encourage speaking of specific pesticides when discussing their impacts.

Is the cotton industry reducing the harms from pesticides?

This is a complex question to answer with lots of differing and even conflicting viewpoints. In recent decades, there have been changes in farmer education and public awareness of the potential harms of pesticides. Reports show and our experts agree that there has been a move globally to manufacture and use less toxic and more selective pesticides and a growth in cotton sustainability standards.[161] What's more, regulations have tightened up considerably. According to the PAN UK, international pressure "to curb the use of HHPs has continued to increase" since the early aughts, with more efforts to define HHPs, impose bans and make recommendations for safe replacements.[162]

While new pesticides tend to be less toxic to non-target organisms, PAN UK also warns that they can introduce new or unexpected impacts. Of concern to some of our experts and researchers are insecticides called neonicotinoids, developed in the 1990s, and which are often highly toxic to bees and are linked to biodiversity losses as a result.[163] The EU has banned three of the most toxic neonicotinoids, but they're still used elsewhere.[164]

What's more, older and more dangerous chemicals are still in circulation, including those that are toxic to the environment, acutely toxic to humans and non-target organisms including wildlife and bees are still widely used in the cotton industry. In 2017, PAN UK found that eleven of the 13 most commonly used pesticides in cotton are on the organization's Highly Hazardous Pesticides list, including two that are endocrine disruptors (the insecticides deltamethrin and lambda-cyhalothrin), one that's "probably carcinogenic" (the herbicide glyphosate) and three that are fatal if inhaled (the insecticides endosulfan, monocrotophos, and lambda-cyhalothrin). Many are highly toxic to bees.

Widely used pesticides in cotton

Fig. 25

Insecticides				Herbicides
Organophosphate	**Pyrethroids**	**Neonicotinoids**	**Organochlorine**	
Acephate	Cypermethrin	Imidacloprid	Not widely, but still used	Glyphosate
Chlorpyrifos	Deltamethrin	Thiamethoxam		**2, 4 D**
Monocrotophos	-Cyhalothrin	**Acetamiprid**	Endosulfan	
Profenofos				

Source: 2017 PAN UK report, “Is cotton conquering its chemical addiction?”.

Characterisation of the widely used pesticides in cotton

Fig. 26

Pesticide	International conventions		Acute toxicity		Long term effects		Environmental toxicity
	PIC*	POP**	WHO Ib Highly hazardous	H330 Fatal if inhaled	IARC probably carcinogenic	Endocrine disruptor	Highly toxic bees
Acephate							■
Chlorpyrifos							■
Cypermethrin							■
Deltamethrin						■	■
Endosulfan	■	■		■			
Glyphosate					■		
Imidacloprid							■
Lambda-cyhalothrin				■		■	■
Monocrotophos	■		■	■			■
Profenofos							■
Thiamethoxam							■

Source: 2017 PAN UK report, “Is cotton conquering its chemical addiction?”.

There is also a higher rate of usage of HHPs in lower-income countries, according to the same PAN UK report. In India, eighteen of the pesticides approved for usage in cotton are linked to cancer and seven are categorized as extremely or highly hazardous for humans by the WHO.[165] Seventy-three percent of pesticides used in Africa on cotton and 66% of those used in Asia are highly hazardous (335 in total), according to PAN UK's definition.[166]

But our analysis of country-level data revealed high-income nations like the U.S. and Australia also continue to use pesticides designated as HHPs as well. For example, glyphosate, the most widely used herbicide in the U.S., with cotton one of the most prominent users,[167] is categorized as "probably carcinogenic to humans" by the WHO.[168] Chlorpyrifos, an organophosphate insecticide which is both toxic to humans and the environment, was approved for usage in the U.S. until August of 2021, at which point the EPA introduced a ban on it.[169]

The cotton farmers we spoke to conveyed that they strive to use pesticides carefully and judiciously. It's in their own best interest to do so. Overusing pesticides can harm yields and "crop productivity."[170] No farmer wants to be poisoned from pesticides or to poison the environment and organisms with hazardous chemicals. On the other hand, many experts feel that using pesticides safely does not work in practice in many places, where farmer knowledge, regulation or even access to PPE is poor. It's important to note that approximately 80% of cotton farmers are in India, China, Pakistan and Uzbekistan, and 17% in Africa, according to ICAC data.[171] Just by the nature of the smallholder style of farming[172] and the handheld tools used by most of these farmers to apply pesticides in these nations, risk of pesticide harms is higher.[173]

Dr. Keshav Kranthi, Head of Technical Information at ICAC

“Today when people are discovering insecticides, they take care that they are more toxic to target insects at low doses and less toxic to the non-target organisms such as beneficial insects and higher animals.”

Best practices and alternative approaches

There are a range of approaches to managing pests in farming. Not all rely on synthetic pesticides. As we mentioned, organic cotton farmers do not use synthetic pesticides.

Integrated Pest Management (IPM): the careful consideration of all available pest control techniques.

Over time, as farming practices have evolved, some cotton farmers have moved away from a chemical-intensive approach towards *integrated pest management* (known as IPM). The FAO defines IPM as "the careful consideration of all available pest control techniques" that "applies pesticides as a last resort" used only after other pest control interventions, such as crop rotation and enhancing beneficial organisms, are applied and when pest damage is reaching an economic threshold.[174] "IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms," says the FAO.[175]

Australia has shown it's possible to manage problems of pest resistance without a strong reliance on insecticides. Australia's controlled use of Bt cotton in combination with IPM has led to a 97% insecticide use decline over the past two decades.[176] Turkey also takes an IPM approach and has reduced its insecticides usage.[177] It's also important to note that Australia and Turkey grow more than double the global average of cotton and are not the highest users of pesticides globally per hectare.[178] In other words, more pesticides doesn't produce more cotton.

There is a divide in approaches on how to regulate pesticides moving forward. Some nations are continuing along using what's known as a risk-based or "safe use" approach such as Australia and the U.S. by issuing guidelines about how to use pesticides based on the risks associated with each product and rules about the amount that can be used.[179]

On the other hand, an increasing number of countries and organizations, including the UK and much of the EU, take a “hazard-based” approach to pesticides, meaning they ban pesticides that are hazardous without consideration of how or in what amounts they’re used.[180] This is partly out of an acknowledgement that the conditions of use vary enormously, and that we can’t assume that all farmers will have access to the information, training and the personal protective equipment they need to protect themselves and the environment.

An emerging alternative approach is to not only ban or discourage highly hazardous pesticides, but to guide farmers in which pesticides are preferred or safer to use. In 2020, a project led by Oregon State University researchers, did just that when they classified 659 pesticides based on their toxicity to humans and the environment to produce a lower-risk pesticide list for farmers to use.[181]

There remains a range of strong opinions about how to prevent pesticides from doing harm, from those who would like to see farmers switch away from pesticides to a broader concept of ecological pest management to those who believe farmers can in fact use many pesticides within acceptable levels of risk to humans and the environment. Our goal here is not to resolve these debates, but provide the necessary credible data and context to inform them.

Here are some key takeaways:

Here are some key takeaways:

1. Pesticides are not one thing with one single type of impact. Farmers use a variety of pesticides that target different organisms. Understanding pesticide uses and impacts requires familiarizing yourself with the kinds of pesticides used on cotton and why.

2. Refrain from using global sales data on pesticides, as it is not an indicator of pesticide usage or impacts.

3. Discussing pesticides requires understanding the environmental and economic tradeoffs that come with pests and disease attacks on cotton. Cotton farmers control pests in order to protect their crops. Losing crops to pests harms the environment by wasting resources. That said, synthetic pesticides are one tool in the toolbox of pest management in cotton. Organic farmers do not use synthetic pesticides, and others such as those who practice IPM strive to use them minimally.

4. Pesticides can pose a range of potential harms to humans and the environment, based on their inherent hazardousness as well as their conditions of use. Some can be used with relatively low risk, while others are highly hazardous.

5. Familiarize yourself with categorizations of pesticides based on their hazard level, as defined by the WHO, the Globally Harmonized System of Classification and Labelling of Chemicals, the FAO and PAN UK.

6. There are different philosophies as to best approach pesticide usage moving forward, with some advocating to move away from using pesticides that are inherently hazardous in any capacity (whether it’s to humans, the environment or non-target organisms) to those who advocate for a “safe-use” approach based around managing risks.

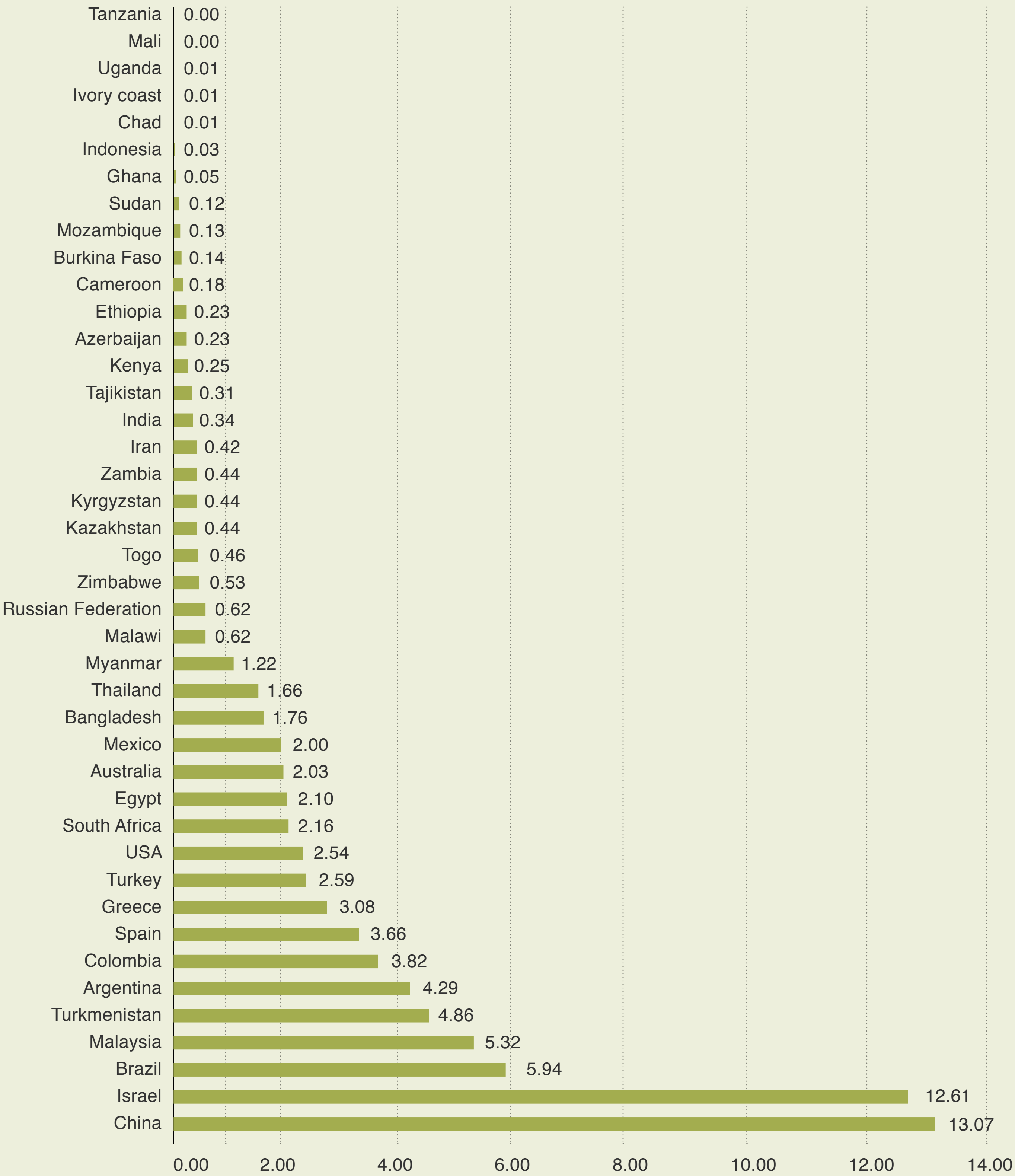
7. There are major data gaps about cotton’s pesticides usage. There is an urgent need for country-specific data on the volume of specific formulations, products used and sales data per active ingredient.

Cotton and pesticides: additional data and figures

Here are key data and figures on cotton's pesticide usage.

Pesticide use in agriculture active ingredient (Kg/Ha)

Fig. 27



Source: ICAC Cotton Data Book 2021.

Pesticide use in agriculture in cotton growing countries (Kg/Ha)

Fig. 28

	Insecticides	**Herbicides**	**Fungicides etc.**	**Others**	**Total Pesticides**
China					1,773,689
USA	65,771	255826	24,040	62,142	407,779
Brazil	60,607	234384	59,124	23,061	377,176
Argentina	3747	161502	3,427	4,252	172,928
Russian Federation	10198	34532	26,164	5,475	76,369
Australia	14196	43789	4,544	887	63,416
Spain	6488	16593	38,067	195	61,343
Turkey	16069	14794	23,047	6,110	60,020
India	20619	6335	13,055	18,151	58,160
Mexico	12991	11552	28,601	0	53,144
Malaysia	3547	37452	3,021	95	44,115
Colombia	5188		7,214	25,371	37,773
South hAfrica	6158	9469	8,928	2,302	26,857
Myanmar	4249	6925	4,023	129	15,326
Bangladesh	2184	1195	11,758	7	15,144
Kazakhstan	528	11051	1,074	405	13,058
Greece	2258	2714	2,014	2,946	9,932
Turkmenistan	1294	680	7,738	0	9,712
Egypt	3199	1245	3,599	1	8,044
Iran	1756	1564	1,100	2,421	6,841
Israel	525	1381	2,843	1,344	6,093
Ethiopia	638	3110	377	3	4,128
Sudan	654	1668	84	63	2,469
Malawi	575	1180	420	183	2,358
Zimbabwe	1092	549	360	184	2,185
Zambia	476	250	328	616	1,670
Indonesia	929	354	224	90	1,597
Kenya	303	562	711	2	1,578
Cameroon	243	417	705	8	1,373
Togo	522	709	19	43	1,293
Burkina Faso	186	657	0	0	843
Mozambique	200	442	122	5	769
Kyrgyzstan	165	400	43	-1	607
Azerbaijan	169	59	276	39	543
Tajikistan	70	70	68	57	265
Ivory Coast	75	10	8	0	93
Uganda	42	8	38	0	88
Chad	42		0	0	42
Central African Republic	22	0	0	1	23
Niger	21		0	0	21
Mali	3			1	4
Pakistan	0	0	0	1	1
Tanzania	1	0	0	0	1
Global (all countries)	**400,266**	**116330**	**530,095**	**3,749,332**	**5,896,023**

Source: ICAC Cotton Data Book 2021.

Where should you go for more information?

Credible sources, data and tools

Please always apply your own critical thinking and do your own due diligence when using these sources.

Classifications and databases:

The WHO Recommended Classification of Pesticides by Hazard and guidelines to classification, 2019 edition

To understand the toxicity of widely used pesticides, we recommend reading the 2017 PAN UK report, “Is cotton conquering its chemical addiction?”

PesticideInfo by Pesticide Action Network

EU Pesticides database which allows users to search for information on active substances used in plant protection products, Maximum Residue Levels (MRLs) in food products, and emergency authorisations of plant protection products in the Member States.

U.S. Environmental Protection Agency Databases Related to Pesticide Risk Assessment

FAO compendium of pesticides information databases (active ingredients, use types, etc.)

Pesticides - Data Europa - the EU open data portal on pesticides

Sustainability standards indicators and guidances:

Measuring Sustainability in Cotton Farming Systems: Towards a Guidance Framework - pages 014 to 017

Delta Framework Sustainability Indicators

National-level data:

The USDA Quick Stats is one of the most useful live tools and can provide information on pesticide applications across the country. You can explore them by navigating: The *Survey>Environmental>Field Crops>Cotton>Applications* and *Survey>Environmental>Field Crops>Cotton>Pest Mgmt*

SECTION 4:

Cotton, the Environment, and Cotton Farmers

Cotton directly affects the livelihoods of millions of people around the world. Thus, we can't conclude our paper without talking about cotton farmers.

So far we've focused on cotton's environmental impacts as this is where misinformation, especially data-driven misinformation, tends to thrive. And yet the topics we've addressed so far, whether water or pesticides, are local issues that are intimately connected to how cotton impacts and intersects with local communities and cotton farmers' personal environments and economies. Although this paper doesn't have the bandwidth to explore cotton's social impacts fully, we'd be remiss to not touch on this topic.

Data gaps and challenges

Social sciences is often a more subjective and an even more contested space compared to the traditional natural sciences when context and intent of the research are not clearly declared and applied. Trying to measure a social problem can give rise to what Van Witsen calls "multiple politics of numbers."[183] And thus the industry often struggles to build global consensus on how to measure or improve social impacts in cotton. "The social dimension," says Gian Nicolay, an agronomist and sociologist at the Research Institute of Organic Agriculture, "deals with power, with ideologies, with values—the subjectivity—with history and so on."

Empirical research into the social impacts of cotton is also a “neglected” space in comparison to the more traditional natural sciences, Nicolay adds. Social impacts have a particularly regional-level context that can’t be ignored, and perhaps in a way some of these human impacts have resisted quantification. “Social indicators are very difficult to talk about at a global level,” says Litul Baruah, program manager at Laudes Foundation.

“You need to define what is the context and which jurisdiction you are talking about. That is very critical.”

Social and environmental tools are currently often siloed. From our research, cotton's social impact is yet to be fully embedded in the most popular impact measurement platforms, like the Sustainable Apparel Coalition’s Higg Index and the Kering Group’s Environmental Profit & Loss tool. Another challenge is that, based on our internal analysis of cotton multi-stakeholder initiatives, most MSIs don’t align on the indicators they each use to measure social impacts, such as worker safety, earnings or women’s empowerment. The Delta Project, which brings together multiple cotton and farming nonprofits and institutions, is seeking to harmonise indicators under one single framework.[184] Another new methodological framework, the value chain analysis for development framework (called VCA4D for short) developed by Agrinatura, an Association of European Universities and Research centers, combines social and environmental indicators into one approach.[185]

What data exists on cotton and social impacts?

The available data on social indicators includes the number of cotton farmers around the world. If you look at Fig 29, you'll notice the vast differences in the number of cotton farmers from country to country. India has over 10 million cotton farmers, China has nearly six million, while countries that are also large producers of cotton, like Brazil and the U.S., have dramatically fewer farmers, as their farms are highly mechanized. The U.S. has just over 13,960 cotton farmers, according to personal correspondence with the USDA, which includes those involved in farm decision-making, and growers who plant additional crops. Brazil, according to ICAC, has 3,263.[186]

In terms of the number of farmers globally, the quality of data varies greatly, and some estimates place global totals at 100 million cotton farmers,[187] while ICAC estimated there are as few as 22 million cotton farmers as of 2020. It's also unclear what status of workers these global numbers include, such as seasonal workers (hired to weed or harvest for example) or informal workers.

As we've mentioned, many low-income countries still have lots of smallholder family farms and use labor-intensive styles of farming, where planting, weeding, pesticide application, and harvesting is done manually, including the use of handheld tools. These farmers have a very different experience of day-to-day farm life than many farmers in rich countries, as we've already touched on in the pesticide section. These two styles of farming (industrial and smallholder farming) are very different and our experts say they should be measured as separate systems. While smallholder farming will have proportionally higher social impacts on a national level, it's important to note however that reducing the available jobs in farming communities also has its own social impacts, as rural communities in high-income nations have emptied out and farmers often struggle to find hired help.

Are cotton's social impacts getting better?

Much like water and pesticides, it's very difficult to make generalizations about social conditions. But we have included some metrics to help inform the conversation, including number of farmers per nation, and per hectare, yet that does not reveal all that much about quality of life or total wealth and income of farmers.

What our experts agree on is that rather than using social or environmental data to demonize cotton, or problem shift, it should be used to improve the cotton sector, largely for the benefit of the people and the communities who depend on it, especially rural and low-income farmers. Calls to stop growing cotton or demand that cotton farming move to other regions ignore the social impacts of those decisions and in some instances simply aren't realistic.

"You have to address these things holistically and first listen to and then work with the community so that the community can help themselves,"

– Anita Chester, the head of materials at Laudes Foundation.

Consumers and brands can ask similar questions when they read stories about cotton. Rather than saying what can I buy or source instead of cotton, ask *what are brands and the fashion industry doing to better support farmers?* We must seek to improve the way the cotton sector operates in a way that's socially and environmentally sustainable.

Number of farmers and farm unit area (Ha)

Fig. 29

	Area (Hectares)	Male Farmers	Female Farmers	Ave land holding (Ha)
Argentina	449 403	4 400	440	92,9
Australia	295 000	1 155	345	196,7
Bangladesh	44 430	53 000	35 000	0,5
Benin	614 297	190 657	23 408	2,9
Brazil	1 665 600	2 651,00	612	510,5
Burkina Faso	556 344	313 625	11 375	1,7
Cameroon	250 000	220 600	29 400	1
Chad	247 019	238944	9 100	1
China	3 170 000	2 118 511	3 681 489	0,5
Colombia	9 322	496	113	15,3
Cote-D'Ivoire	408 448	117 766	2 270	3,4
Egypt	76 000	67 129	25 819	0,8
Ethiopia	56 137	48 627	750	1,1
Greece	291 323	25 256	23 025	6
India	13 341 000	6 157 385	4 104 922	1,3
Indonesia	2 100	600	400	2,1
Iran	98 000	32 951	0	3
Israel	4 210	40	40	52,6
Kazakhstan	110 000	31 745	10 000	2,6
Kenya	23 782	18 745	9293	0,8
Kyrgyzstan	18 250	700	69	23,7
Malawi	34 200	21 000	14000	1
Mali	164 833	161 655	1 100	1
Mexico	143 957	6 676	788	19,3
Mozambique	132 871	110 776	39 689	0,9
Myanmar	239 090	190 424	47 606	1
Nigeria	264 000	270 000	30 000	0,9
Pakistan	2 513 000	1 440 900	59 100	1,7
Paraguay	10 800	10 000	2 000	0,9
South Africa	27 675	1 176	1 501	10,3
Spain	65 230	3 112	1 689	13,6
Sudan	180 000	180 000	20 000	0,9
Tanzania	436 590	394 021	224 393	0,7
Togo	180 588	138 580	14 072	1,2
Turkey	477 868	70 201	21 000	5,2
Turkmenistan	545 000	120 662	0	4,5
Uganda	90 000	73 900	73 200	0,6
USA*	3 521 000	6 806	1 297	434,5
Uzbekistan	1 033 629	86 260	6 144	11,2
Vietnam	980	3 000	1 000	0,2
Zambia	135 795	283 944	40 631	0,4
Zimbabwe	172 469	216 074	141 014	0,5
WORLD TOTAL	**31 622 372**	**13 434 150**	**8 708 094**	**1,43**

The number of farmers and the average size of farm holdings varies widely worldwide.

Source: ICAC Cotton Data Book 2021.

Where should you go for more information?

Credible sources, data and tools

Value Chain Analysis for Development (VCA4D)- This tool from the EU performs value chain analyses (VCAs) appraising agricultural commodities in countries in order to appraise their contribution to growth, job creation, sustainability and inclusiveness

National-level data:

Social, Economic and Environmental Impact Assessment of Cotton Farming in Madhya Pradesh

Ethiopia value chain analysis - Agrinatura's report for the European Commision

Cameroon cotton value chain analysis - Agrinatura's report for the European Commission

General information about cotton:

Credible sources, data and tools

International Cotton Advisory Committee (ICAC) - ICAC is the world's intergovernmental body for cotton producing, consuming and trading countries. A reliable source for aggregated global data on cotton.

ICAC recorder

Cotton Inc. - Cotton Inc. is a nonprofit representing U.S. growers.

FAOSTAT - Data from the Food and Agricultural Organization of the United Nations (FAO) for over 245 countries and territories and covers all FAO regional groupings from 1961 to today. Access is free.

CottonInfo - The Australian cotton industry's joint extension program, providing research, the latest news, and other information.

Readers are also encouraged to seek cotton data from the following reputable scientific journals.

Reputable Scientific Journals

Fig. 30

Journal group	Website	Open access
Elsevier	https://www.sciencedirect.com	N. Some might be or occasional articles
Academia	https://www.academia.edu/Documents/in/Academic_Journals	Y
Wiley	www.wiley.com	N. Some might be or occasional articles
Sage	https://journals.sagepub.com	N. Some might be or occasional articles
JSTOR	https://www.jstor.org	N. Some might be or occasional articles
ResearchGate	https://www.researchgate.net	Y (registration required)
BMC	https://www.biomedcentral.com/journals	Some
Springer	https://link.springer.com	N. Some might be or occasional articles
PLOS	www.plos.org	Y
Ecology and Society	https://www.ecologyandsociety.org	Y
Taylor & Francis	taylorfrancis.com	N. Some might be or occasional articles
Annual Reviews	https://www.annualreviews.org	N. Has a system for converting some existing subscriptions to open access
Nature	www.nature.com	N. Some free articles
Copernicus	https://www.copernicus.org	Open access
MDIP	https://www.mdpi.com/about/journals	Open access Some open access
Oxford Academic	https://academic.oup.com/journals	N. Some might be or occasional articles
The Lancet	https://www.thelancet.com	Open access

Registered access sites will usually offer subscription or single article purchase options; this list is not exhaustive. Individual articles may also be available for free through ResearchGate or Academia.edu

Conclusion and Calls to Action

Conclusions

As we've shown throughout this paper, using cotton as a case study, virtually every institution in our society is complicit in spreading misinformation or failing to do enough to stop it. Solving misinformation in fashion is a daunting challenge, but with better education about critical data consumption and by sharing credible data in place of misinformation, we hope we've done our part in beginning to address this crisis. It's not too late to join forces to fight misinformation and arrive at joint actions driven by best available facts.

Here are the five key takeaways from our report:

1. **Take misinformation seriously.** Every exaggerated claim shared or obsolete data cherry-picked or taken out of contest contributes to society's information disorder, no matter how seemingly trivial.

2. **Be a critical consumer of data.** Remember that numbers have power and are viewed as objective, even when they're wrong or lack context necessary to prevent their misinterpretation. Don't misuse, abuse and decontextualise data under any circumstances. Commit to avoiding generalized and exaggerated claims that are aimed to shock. Be mindful of what the data is not telling you; ask yourself "what is missing?"

3. **Use only the best and most recent data available.** Locate and use data from the primary source. Check the footnotes. Be skeptical of global averages. Never use obsolete data without context and relevant disclaimers.

4. **Don't problem shift.** Use quality data to inform and to drive action and change not just in cotton but society-wide. Use data as it was intended, and not simply to criticize or compare the incomparable or to demonize other sectors.

5. **Take ownership of mistakes.** If you make a mistake and introduce misinformation or faulty data, be open to and public about correcting that mistake. If you or your organization spread misinformation knowingly or unknowingly, be prepared to fix it and stop it from spreading. And help create a safe space where everyone can admit their errors.

Samata Pattinson, CEO at Red Carpet Green Dress at Oscars®:

"I always say footnotes are your friend, as is academia.edu. I think going into that footnote and just going to read the original article and understanding the basis of that research is so important because not only do you see the original source itself, but you're also able to get a better idea of context. How conclusions are drawn is as much a pointer to its accuracy as anything else."

Six calls to action

In addition to halting misinformation, we also need additional resources and action to fill in the data gaps and complete our understanding of the cotton industry. Here are Six Calls to Action based on our findings:

1	We call on key cotton trade organisations and nonprofits to endorse our findings, so there is a go-to place for data from which we can all build on.
2	We encourage people to send in information and new data to us.
3	There is an urgent need for data transparency about cotton and fashion's environmental impact. Data about environmental impacts should be open-source and publicly available. If you are putting data into the public sphere, be transparent in your methodology. Share how you arrived at your conclusions.
4	Let's co-invest in filling the data gaps. Data collection is expensive, especially in an industry with as many producers as cotton. The industry needs to come together with researchers, scientific institutions, foundations and governments to get better data in more places. Policymakers need to invest in good scientists and research centers to fill the data gaps.
5	Seek guidance from technical experts and openly accept their feedback.
6	There is a need for an industry cotton and fashion fact-checker, an unbiased third party group to analyze claims.

Best Practices for Citizens

- [ ] **If someone alerts you to misinformation that you've shared, investigate it and address it.** Alert your community to the misinformation as well. Also, be willing to communicate the importance of correcting the error to your audience.

- [ ] **Commit to being a critical consumer of data and information.** Ask questions, do your own due diligence into claims, and don't share content that isn't verified.

- [ ] **Don't fall into the Credibility Trap.** Data is being widely misused across society. Whether it's a brand, media outlet, nonprofit or other trusted institution, do not blindly trust anyone making vague claims with no source or context.

- [ ] **When you encounter data, always seek out the primary source.** Ask for the source if it's not clear. Always consider context. Ask yourself, Do I know why this claim is made? Is this data influenced by commercial interests? Is the data being used out of context?

Best Practices for Civil Society and Nonprofits

- [ ] **Use only high-quality, credible data in context**, even if you're advocating for a cause.

- [ ] **When producing reports, understand the normative power your data has.** It could be in circulation for decades. Commit to using sound data and verifying the data you use.

- [ ] **Cite primary sources and fact check** yourself or hire an independent fact-checker.

- [ ] **Improve data literacy within your organization.** Train your team on the high cost of misinformation across society. Make sure that marketing and those producing data have an understanding of each other.

- [ ] **When you make a mistake, correct it publicly.** Make sure your community knows not to use erroneous information. And accept feedback from experts.

Best Practices for Media

- [ ] **Understand that numbers are not in fact objective.** They are normative. Be unafraid to challenge statistics and data, as you can play a key role in addressing quality information issues.

- [ ] **Be more frank about the tentativeness of studies and other scientific knowledge you're reporting on. Lean into the gray area.** The nuance in fashion and cotton also leads to more stories and more interesting stories than cotton is “good” or cotton is “bad.” You can empower readers' critical thinking.

- [ ] **Commit to better understanding of scientific language and processes.**

- [ ] **Always locate and cite the primary source.** Don't let your reporting quality be lowered by citing secondary sources that lead to a trail of broken links.

- [ ] **Resist the temptation to create clickbait** by promoting a single satisfying statistic or exaggerated claim with a misleading takeaway.

- [ ] **If you have the leverage, ask your company to invest in fact-checkers** and/or give time or extra budget for reporters to do their own fact-checking.

Best Practices for Brands and Industry

- [ ] **Increase data literacy in your teams**; take the time to translate CSR data reports into honest marketing claims.
- [ ] **When creating marketing claims, use data only as it was intended to be used.** Don't compare findings that aren't comparable, be careful changing the wording on claims, as it can change the meaning and tip into misinformation.
- [ ] **Don't use data to demonize or problem switch.** Use it instead to improve.
- [ ] **If you are dedicated to progress, be transparent with your data.** Even in marketing, state the primary source and fact check yourself.
- [ ] **Make data-based decisions** and make sure that people with high-quality data sets are driving decisions.
- [ ] **Acknowledge that we need better data.** When possible, co-invest in filling in the data gaps.
- [ ] **Add the missing context** (i.e. do not state % of savings without letting the consumer know how these are calculated and against what).

Danielle Statham, co-owner/Director, Sundown Pastoral Co.:

“As an industry producing raw fibre, it is our responsibility to provide transparent information that is readily available to our supply chain to ensure claims of sustainability are accurate, current and able to be substantiated.

When primary raw fibre data and supply chain unity become the new normal, the conversation across all platforms will evolve from the unknown or fabricated narrative to truthful and honest messaging.”

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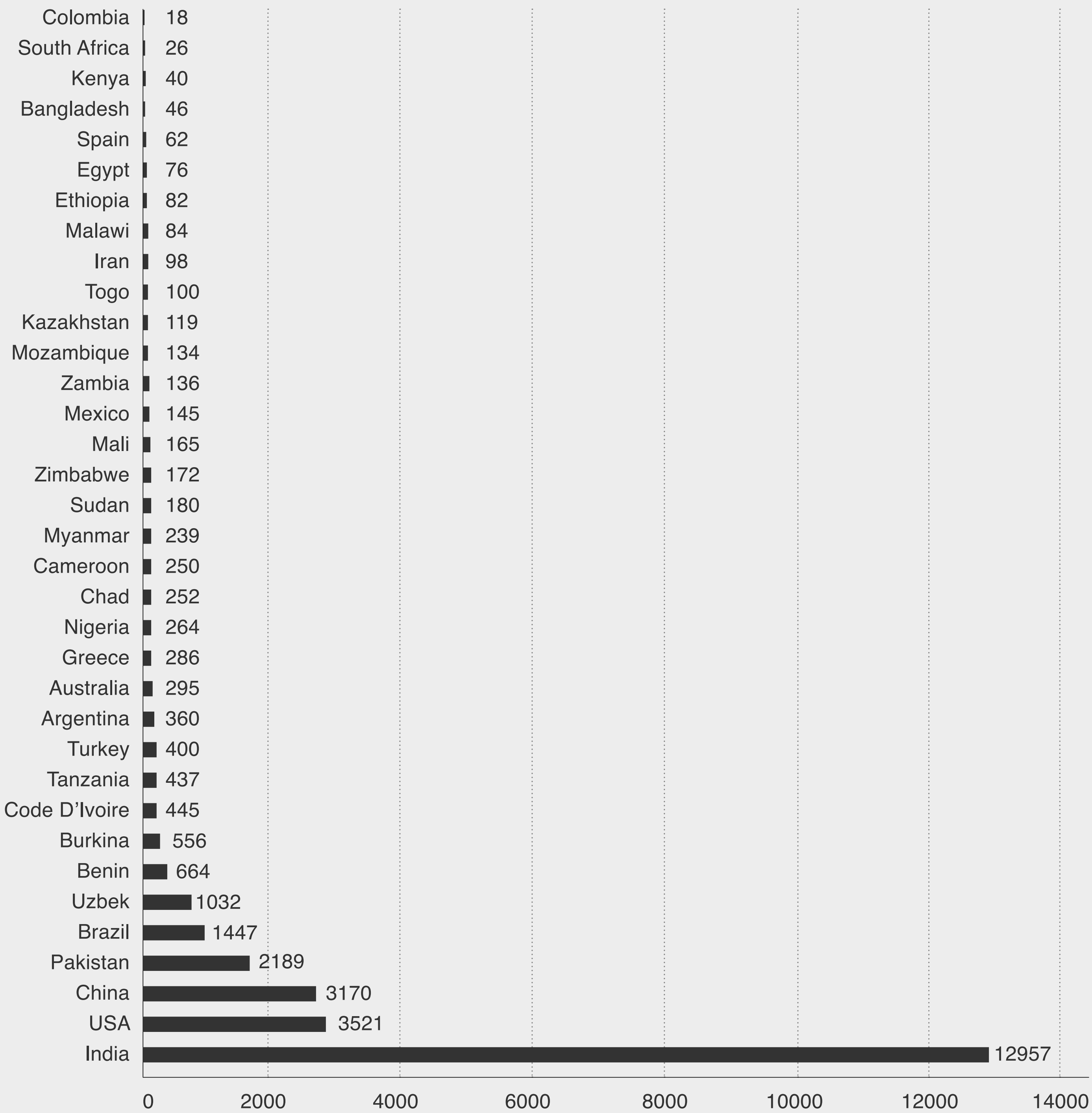
Appendix

Cotton: additional data and figures

The International Cotton Advisory Committee kindly shared with us key data and statistics about cotton from their latest Cotton Data Book, released in 2021. You can purchase the full 563-page book at this link or alternatively access the or access the free ICAC Recorder [here] for more information.

Countries Area ('000 Ha)

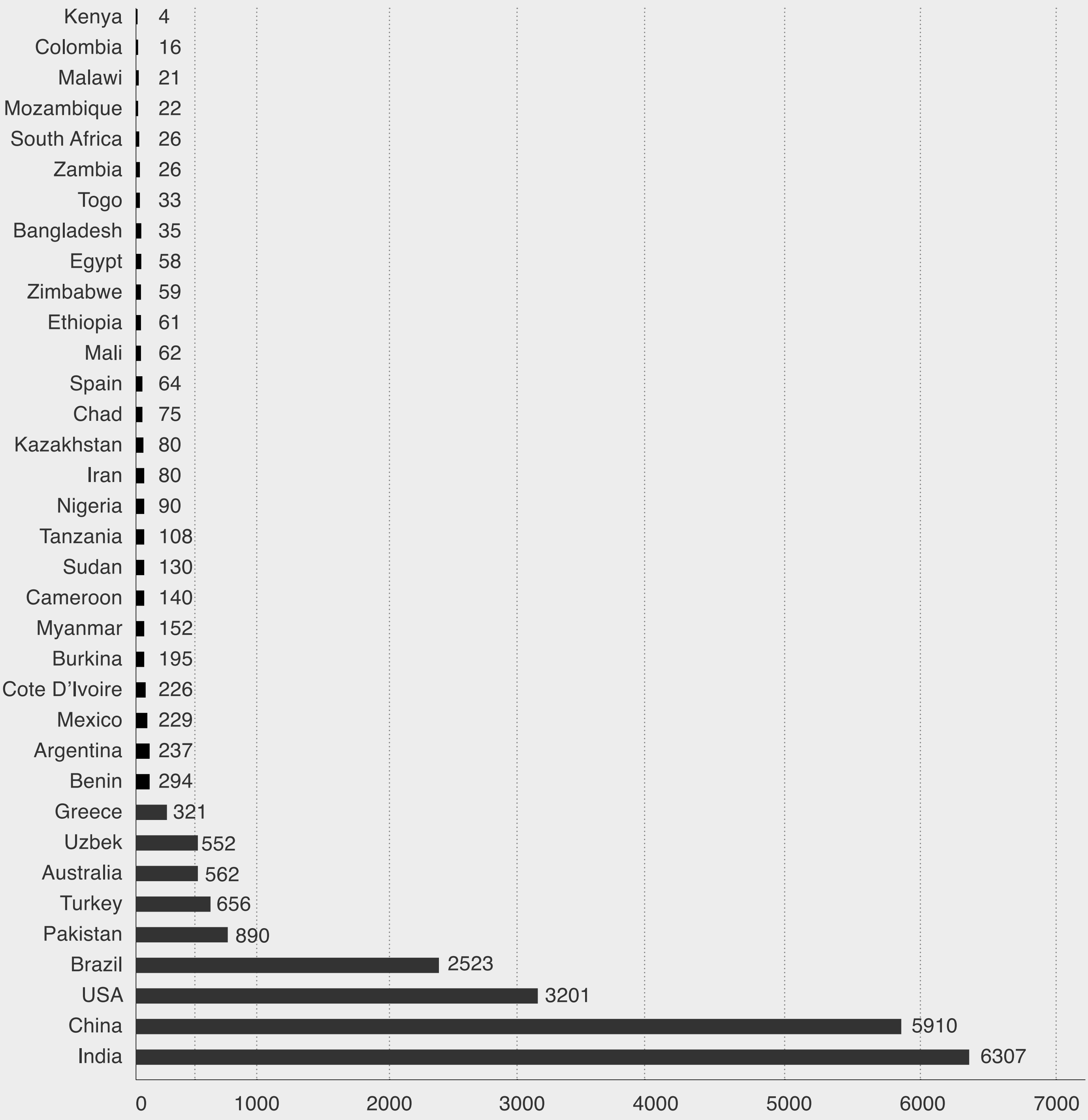
Fig. 31



Source: ICAC Cotton Data Book 2021.

Cotton Production ('000 Tonnes)

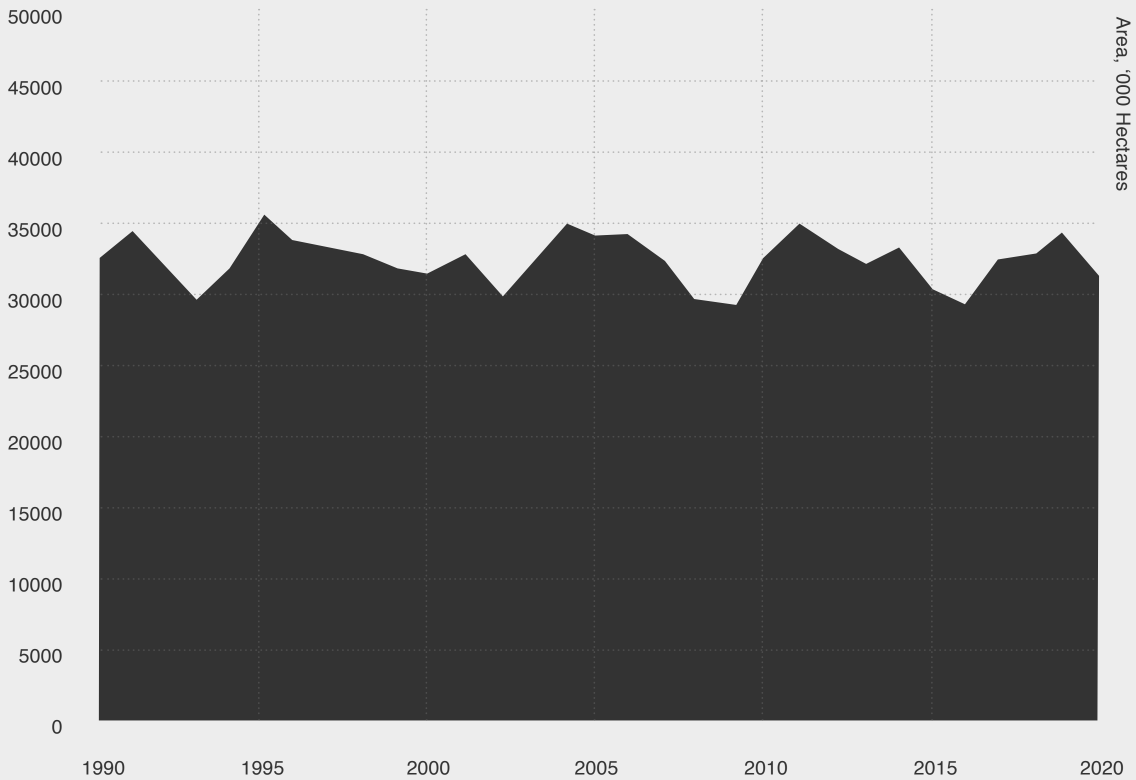
Fig. 32



Source: ICAC Cotton Data Book 2021.

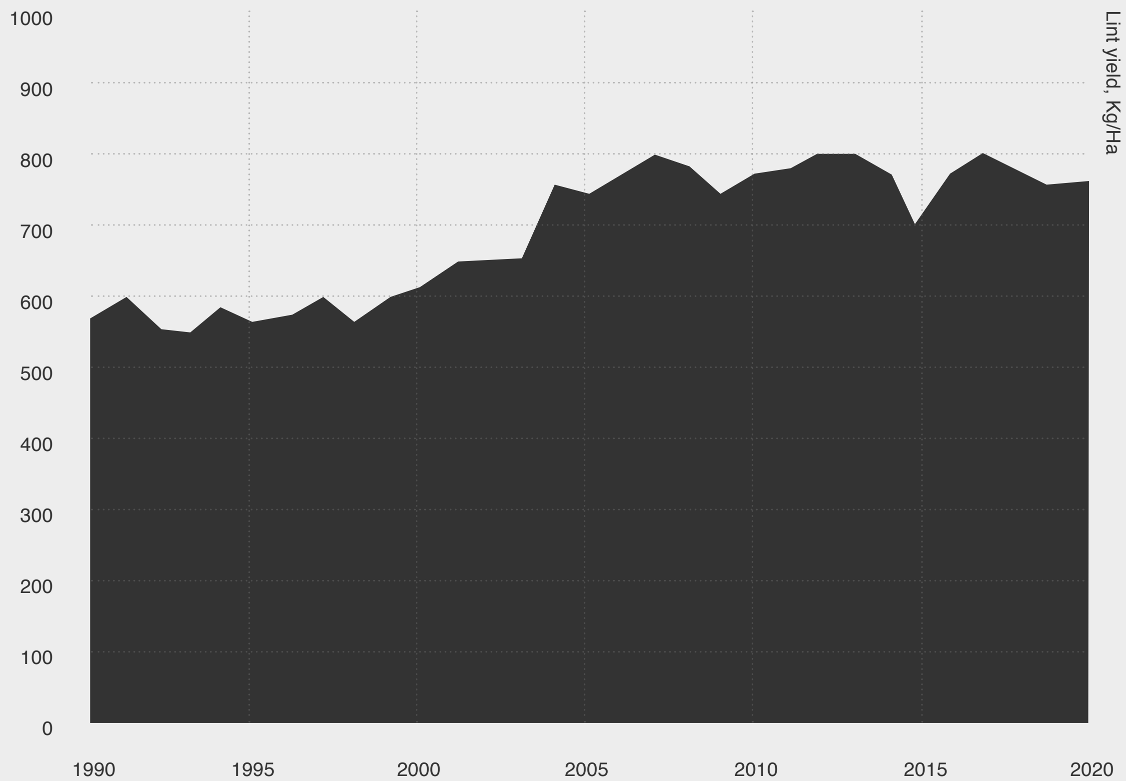
Cotton Area Trend (1990 - 2020)

Fig. 33



Lint Yield Trend (1990 - 2020)

Fig. 34



Source: ICAC Cotton Data Book 2021.

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