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ORGANIC COTTON ACCELERATOR

COTTON AND BIODIVERSITY

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Author:
Tamar Hoek (Solidaridad Europe)

Additional text contributors:
Ioana Betieanu (OCA), Rakshanda Bhat (OCA), Agnes Molgaard (Solidaridad), Sarah Oxley (The Green Pencil)

Editor:
Sarah Oxley (The Green Pencil)

Reviewed by:
Action for Social Advancement, Better Cotton, IKEA, Organic Cotton Accelerator (OCA), Pesticide Action Network UK, Sarah Compson, Director - Standards Innovation, Soil Association

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BOTTOM UP! COTTON, ETHIOPIA
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EXECUTIVE SUMMARY

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The impact of cotton farming on biodiversity

Biodiversity is being lost at an alarming rate[1]. While not the biggest contributor to its global decline, cotton farming has a clear role to play in restoring and maintaining biodiversity across its vast growing regions.

The benefits of this are mutual; by implementing biodiversity-enhancing farming approaches such as organic and regenerative agriculture, cotton growers can improve both the health of their soil and the ecosystems that rely on it, improving the resilience of their farms – and consequently the entire cotton supply chain – in the face of extreme weather conditions.

However, there are four major contributing factors to biodiversity loss that cotton industry stakeholders must urgently address:

HEAVY USE OF AGROCHEMICALS

Excessive use and misuse of fertilizers and pesticides, including herbicides, insecticides and fungicides, in cotton farming have a detrimental effect on biodiversity as they cause water pollution, soil degradation and habitat loss.

Significantly reducing, and ideally eliminating, the use of harmful agrochemicals is an effective way to conserve biodiversity on existing cotton farms and the surrounding areas.

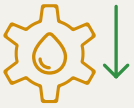
Implementing nature-positive farming approaches, like organic and regenerative agriculture, or integrated pest-management (IPM) strategies, can have notable advantages for biodiversity.

MONOCULTURES

Focused on growing a single species of cotton plant across larger areas of land, monocultures deteriorate soil health and fertility, while interfering with surrounding ecosystems.

As an alternative to this detrimental and outdated approach to cotton farming, practices such as sustainably managed crop rotation and intercropping can positively impact local biodiversity while improving pest management and providing farmers with economic benefits.

DROUGHT HURTS COTTON FIELD IN NEED OF WATER © GETTY IMAGES



POOR WATER MANAGEMENT

While cotton is known for thriving on more arid land, the amount of water needed to successfully cultivate it varies greatly within and across growing regions. In regions where cotton producers rely heavily on irrigation rather than rainfall, poor water management can harm local biodiversity. It can cause increased salinization, drain rivers and lakes, and destroy ecosystems.

Implementing modern irrigation methods, cover cropping and other sustainable agricultural practices that reduce use of freshwater supplies can support biodiversity. There are also techniques to avoid increased salinization of cotton farming land, though these can be costly to implement.

LAND CONVERSION

As cotton grows well in more arid conditions, grasslands rather than rainforests are at risk of being converted for cotton farming purposes. Protecting or restoring these species-rich landscapes is an essential step for conserving biodiversity.

Climate change may soon force cotton farmers to convert more natural land for agricultural use. This means we must consider how we can mitigate the impact of this on species and ecosystems. High conservation value assessments can support farmers and farming organisations to do this.

COTTON FARMER, INDIA © FREE

The smallholder factor

With smallholders responsible for the vast majority of global cotton production, this hugely significant yet often excluded group must be supported to contribute to a more sustainable future for cotton farming while receiving a fair price for their produce

Each of the biodiversity-enhancing measures and approaches we propose require significant time and financial investment that can quickly become a barrier to smallholders transitioning to nature-positive cotton farming.

Large-scale farms impact and responsibility

While practices differ across regions, it's more common for industrial-scale farms to use modern technologies like mechanized irrigation systems and drones and aircraft for applying agrochemicals, all of which can negatively impact surrounding biodiversity. They are also more likely to cultivate monocultures for efficient harvesting with machinery, which can reduce soil health.

However, there are cases of large-scale farms effectively coordinating landscape-level pest control strategies, which can reduce pesticide use, like in Australia. Opportunities to expand this approach to industrial farming are ripe in Brazil, for example.

We must act now to reverse biodiversity loss

Without taking urgent collective action to support the restoration and conservation of biodiversity on and around cotton growing land, farmers – and consequently the entire cotton industry – face an uncertain future. More fundamentally, without biodiversity there is no life on earth. Much is at stake, and cotton industry players with the most economic capacity must do everything within their power to halt this decline.

A FARMER TENDS TO AN ORGANIC COTTON FIELD IN TÜRKIYE, WHERE ORGANIC PRACTICES PROTECT SOIL, BIODIVERSITY, AND ENSURE A SUSTAINABLE FUTURE FOR FARMING COMMUNITIES. © ORGANIC COTTON ACCELERATOR (OCA)

OUR RECOMMENDATIONS IN BRIEF

- **Brands and retailers**
  Go beyond purchasing cotton from certified sources and establish sustainability budgets to invest in supporting farmers to transition to nature-positive practices that enhance biodiversity.
- **Farmer organizations and standards systems**
  Invest your resources in training farmers and workers on biodiversity-enhancing and socially responsible farming practices.
- **Governments**
  Support and strengthen public institutions' and universities' research into cotton seed development, input optimization and effective crop combinations to enhance biodiversity.

See more on page 33

A SMALL WHITE BUTTERFLY RESTS ON A FLOWERING PLANT IN AN ORGANIC FIELD IN PAKISTAN. BIODIVERSITY LIKE THIS SUPPORTS POLLINATION, NATURAL PEST CONTROL, AND ECOLOGICAL BALANCE. © ORGANIC COTTON ACCELERATOR (OCA)

Chapter 1

INTRODUCTION

Greater biodiversity supports greater environmental stability; the more genetically diverse a species (or crop) is, the better it can adapt to and resist extreme weather conditions and disease.

With around 35 million hectares under cotton cultivation around the world, representing about 2.5 percent of Earth's arable land[2], this presents the cotton industry with a huge opportunity to improve farming practices to restore and maintain biodiversity while building its resilience in response to the worsening climate crisis.

If well managed, agriculture and biodiversity can have a mutually beneficial relationship; farming practices that support biodiversity are fundamental for healthy ecosystems and their related agricultural services, such as soil fertility, pollination, water regulation and pest control. This means biodiversity-enhancing cotton cultivation has the potential to play a major role in turning around the current downward spiral towards extinction that tens of thousands of species face today[3].

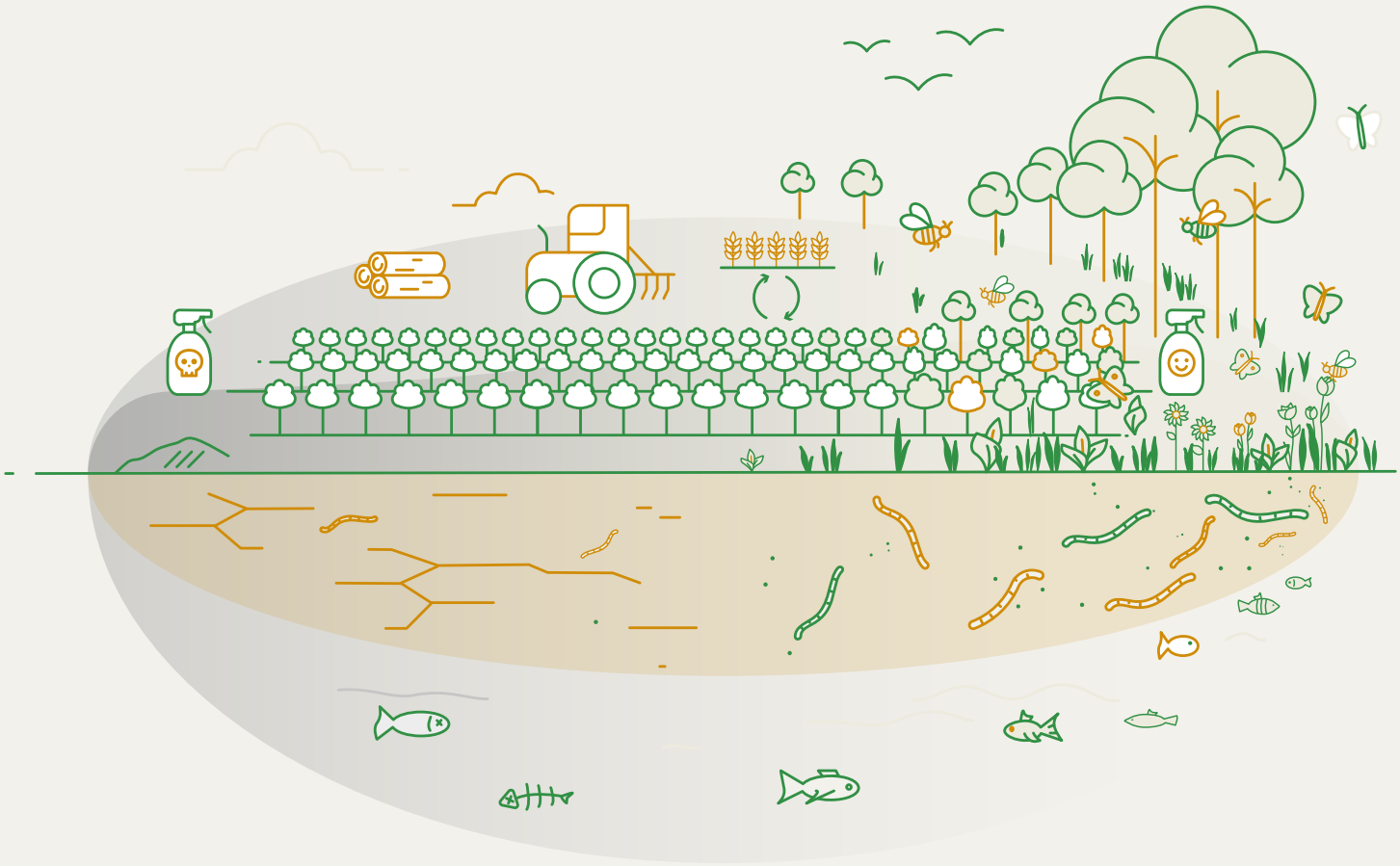
However, four major elements of cotton farming currently contribute to rapidly declining levels[4] of biodiversity;

- use of agrochemicals (fertilizers and pesticides, including herbicides, insecticides and fungicides)
- monocultures
- poor water management
- land conversion.

While we cannot separate biodiversity loss from the parallel environmental crises of climate breakdown and mass land degradation, here we take a closer look at cotton farming's particular impact on biodiversity, while reviewing effective approaches and techniques to improve soil health and therefore enhance biodiversity in agricultural settings. Improvements in farming practices can also enhance labor conditions and mitigate climate impacts, as explored in detail in previous Sustainable Cotton Hub papers on Cotton and Labor and Cotton and Climate..

This paper summarises the impact on biodiversity of agrochemical use, monocultures, poor water management and land conversion in the context of cotton farming. We review various farming systems, approaches and practices that can be adopted as biodiversity-enhancing alternatives. Finally, we share a set of recommendations designed to guide stakeholders throughout the cotton value chain to make essential changes that will support the restoration and maintenance of biodiversity in cotton farming.

Throughout the paper we refer to specific examples of farming practices, both detrimental and beneficial in terms of biodiversity, that are particularly common with small-scale farmers in contrast to their larger-scale



HARMFUL FARMING PRACTICES **BIODIVERSITY-ENHANCING FARMING PRACTICES**

counterparts. While smallholders in some contexts can face specific challenges when it comes to overuse of agrochemicals, large-scale commercial farms are more likely to negatively impact biodiversity through widespread indiscriminate use of agrochemicals, growing monocultures, poor water management and converting land for agricultural use[5].

We hope to emphasise throughout that there is no one-size-fits-all approach to enhancing biodiversity in cotton farming. Every farm is different, even within specific growing regions, neighbouring farms may have different growing conditions and be confronted with different challenges in terms of maintaining biodiversity and yields.

In this paper we focus on cotton farming. We acknowledge that subsequent steps in garment production, and the life cycle beyond, also impact biodiversity (such as spinning, weaving, dyeing, trading, retail, recycling and disposal). As recommended in our Cotton and Climate paper, carrying out full life-cycle assessments (LCA) of commodities provides an overview of the total impact that cotton and its uses have on our environment. These should be used to inform a company's target, like science-based biodiversity targets.

The Sustainable Cotton Hub

This paper is published on the Sustainable Cotton Hub, which aims to provide a comprehensive overview of sustainability challenges in cotton production. It's home to a series of papers looking at economic, social and environmental sustainability factors.

Following in the footsteps of four editions of the Sustainable Cotton Ranking published in 2016, 2017, 2020 and 2023, the first paper on Corporate Responsibility in the cotton sector was published in April 2023. Two more papers followed; Cotton and Climate (Nov 2023) and Cotton and Labor (2024).

Solidaridad

About Solidaridad
Solidaridad is an international civil society organization working to improve the conditions of small-scale farmers and workers while simultaneously addressing the most pressing environmental challenges of our time.

About OCA
Organic Cotton Accelerator (OCA) is a multi-stakeholder organisation advancing farmer prosperity while creating a transparent, resilient and responsible organic cotton supply chain. Through collaboration with the Sustainable Cotton Hub, we share ground-level knowledge to foster collective learning and promote organic farming practices.

Please get in touch with your comments and questions, or join the conversation on social media using #sustainablecottonhub.

The Sustainable Cotton Hub is open for collaboration with other civil society organizations.

Request for information can be addressed to:

Solidaridad Europe

Tamar Hoek
Senior Policy Advisor Sustainable Fashion
tamar.hoek@solidaridadnetwork.org

Annemiek Smits
Corporate Partnerships Manager - Cotton, Leather & Textiles
annemiek.smits@solidaridadnetwork.org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Three levels of biodiversity

Biodiversity – or biological diversity – encompasses all forms of life on earth that coexist across three interconnected levels: genetic diversity, species diversity and ecosystem diversity.

Genetic diversity

Genetic diversity refers to the variety of genes within a species. The more diverse the gene pool, the more able a species is to adapt to environmental changes and resist pests and diseases.

In agriculture, the shift toward high-yield monocultures has reduced crop diversity, making crops more vulnerable to failure.

Crops like Bt cotton (genetically modified to be toxic to certain cotton pests) threaten genetic diversity of cotton[6].

Species diversity

Species diversity refers to the variety and abundance of different species within a given area. Greater species diversity supports essential ecological processes, including:

- pollination
- nutrient cycling
- pest control

In cotton cultivation, integrating pollinator-friendly plants and companion crops like legumes can enhance biodiversity while improving yields and soil fertility.

Ecosystem diversity

Ecosystem diversity encompasses the range of different habitats and ecological communities across a landscape. This includes forests, wetlands, grasslands and agricultural systems, each supporting distinct species and interactions.

Ecosystem diversity provides critical services including:

- water filtration
- carbon sequestration
- climate regulation
- pest regulation

The loss of ecosystems due to deforestation, land conversion and pollution not only endangers species but also weakens nature's ability to support human life.

Conventional cotton farming risks land degradation[7], but sustainable water management, agroforestry and intercropping practices can help preserve ecosystem diversity by maintaining natural habitats and improving land-use efficiency.

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GENETIC DIVERSITY
SPECIES DIVERSITY
ECOSYSTEM DIVERSITY

Chapter 2

USE OF AGROCHEMICALS

A COTTON FARM THAT IS PARTICIPATING IN THE BOTTOM UP! PROJECT. AFAR REGION, ETHIOPIA, 30 NOVEMBER 2022.
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Globally, cotton is the sixth most pesticide-intensive crop[8], and it ranks third in terms of the volume of highly hazardous insecticide used in its cultivation[9]. Agrochemical producers will argue that farming input products are an important tool for cotton farmers to protect the crop against pests and diseases and, if used according to specification and with training, should have limited wider impacts[10]. However, research shows that the widespread use of inorganic pesticides and chemical fertilizers in cotton production can have major implications for biodiversity, as well as farmer and consumer health. For more information on the impact of agrochemical inputs on smallholder farmers, please consult our Cotton and Labor paper.

Farmers may depend on agrochemical use for a number of reasons. First, there is the economic pressure to improve yields to earn a basic living and to protect against crop losses. Second, many farmers have not been trained to understand the complexities of soil health, ecosystem dynamics, pest management, plant management, or the consequences of over-using synthetic chemicals[11]. They therefore may be unaware of different ways of working that are better for their own health, the health of cotton plants, of their land and the wider environment.

Use of agrochemicals has led to widespread resistance to common pesticides used on cotton plants and seeds among pests, such as bollworms and spider mites[12]. This has triggered outbreaks of secondary pests like whiteflies, mirid bugs and aphids, further escalating pesticide dependence.

Excessive use and misuse of agrochemicals in cotton farming has knock-on effects that impact biodiversity on multiple levels.

AS THE ONLY TOXIC CHEMICALS DELIBERATELY APPLIED IN THE ENVIRONMENT WITH THE INTENTION TO KILL OR DISRUPT LIVING ORGANISMS, PESTICIDES HAVE A CONSIDERABLE IMPACT ON BIODIVERSITY AND ECOSYSTEM FUNCTIONING.

CoP to the Convention on Biological Diversity (2024)[13]

Water pollution

Fertilizers and pesticides run off farm land into nearby water supplies. The runoff introduces excessive nutrients, such as nitrogen and phosphorus, into freshwater ecosystems. This causes overgrowth of algae which in turn limits photosynthesis for plants beneath the surface (eutrophication). This process suffocates fish and other organisms, destroying their habitat[14]. Several mainly cotton producing regions are considered highly affected by pesticide pollution including the Indus Valley in Pakistan, the Yellow River valley in China and the Murray River catchment in Australia[15], with effects on freshwater ecosystems.

A 2024 study from Pakistan showed pesticide-induced effects on local fish such as impaired reproduction and developmental abnormalities, with potential health risks to humans such as liver tumors and cancer, if people consumed the affected fish[16].

Soil degradation

In terms of biodiversity, healthy soil provides a vital life source. FAO defines soil degradation as 'a change in soil health status resulting in a diminished capacity of the ecosystem to provide goods and services for its beneficiaries.'[17]

Inorganic fertilizers and agrochemicals can be responsible for chemical, physical and biological soil degradation. They are known to reduce soil fertility and porosity, hardening and depleting its organic carbon levels and increasing soil acidity, thereby decreasing the number of microorganisms that live in the soil[18].

FERTILIZER © FREE

While pesticides may not always kill organisms essential for healthy soil, they can lead to severe harm, reducing their ability to function effectively. Several studies concluded numerous negative effects of pesticides on soil invertebrates, which are organisms that live in the soil like earthworms or mites. These effects included changes in abundance, impacts on reproduction, reduced growth and mortality. This means that they cannot, or not fully, perform ecosystem services like nutrient cycling, maintenance of soil structure or regulation of pests and diseases which risks future stability of yields[19] [20].

Inorganic fertilizers, which aim to replenish soils to increase yields, are often nitrogen-based (60 percent of global consumption in 2022[21]). Excessive use of nitrogen fertilizers can harm soil health by speeding up the breakdown of organic matter, which reduces soil's ability to store carbon. To keep soil healthy and productive, it is important to maintain a balance of carbon and nitrogen, as described by FAO's Intergovernmental Technical Panel on Soils. This balance supports soil fertility and the growth of helpful soil organisms, while ensuring that it can store enough nutrients for crops to thrive[22].

Loss of habitat

Alongside inorganic fertilizer use, cotton farming's high and growing use of herbicides (use of highly hazardous herbicides grew from 804 tonnes in 2018 to 1,984 tonnes in 2024[23]) is a major driver of decline in species diversity. This is, in part, due to its indirect impact through the loss of habitat caused by indiscriminate use against all plants, and not just those targeted as weeds[24].

Role of agrochemical companies

Agrochemical companies are key actors in shaping modern agricultural practices through the development and distribution of chemical inputs, including pesticides and inorganic fertilizers. Better Cotton's Fakhar Zaman notes; "the persistent need to meet sales targets can lead to biased advisory services resulting in unnecessary pesticide application, subsequently leading to pest resistance and loss of biodiversity".

Agrochemical companies' influence extends beyond agricultural production into policymaking and regulatory frameworks. In major markets such as the United States, the European Union and Brazil, corporations invest in lobbying and advocacy to shape pesticide regulations, regularly sidelining environmental and farmer advocacy groups in the policymaking process. This influence can contribute to regulatory frameworks that are more favourable to industry perspectives, with less representation from environmental and farmer advocacy groups. For example, in Brazil, between 2019 and 2022, agribusinesses, including pesticide manufacturers, were granted disproportionately high levels of access to policymakers, securing 160 meetings between 2019 and 2022, compared to just two with farmer organizations[25].

As a result, certain pesticides remain in use, despite documented risks to biodiversity, soil health and human well-being.

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Approaches to reducing agrochemical use

Responsible for many harmful effects on biodiversity, reducing and eliminating the use of harmful, toxic and hazardous agrochemicals is an effective way to conserve biodiversity on existing cotton farms and surrounding areas.

Integrated Pest Management

Integrated Pest Management (IPM) combines strategies such as crop rotation, field hygiene, biological controls and physical barriers. It promotes long-term pest prevention and healthier cotton cultivation. Crop selection and rotation help disrupt pest life cycles, while maintaining clean fields reduces the spread of infestations. Natural predators and pest-repellent cotton varieties further reduce chemical dependency. Traps and netting serve as physical barriers, and infestation control measures, such as quarantining and pruning, help prevent outbreaks. IPM integrates these diverse techniques into a resilient, sustainable pest management system, complementing regenerative farming methods like agroforestry and crop rotation.

Australia, which has mainly large cotton farms, has successfully implemented IPM strategies thanks to a coordinated effort. This has contributed to a significant reduction in insecticide use[26], by 95 percent per hectare between 1993 and 2019[27]. Australia's national research and extension service infrastructure has played a key role in managing pesticide resistance through coordinated action between farm agronomists, cotton consultants and researchers.

Similar strategies in regions dominated by smallholder farming, such as India, China, and parts of Africa, would require a high level of coordination and institutional support to implement across a large number of small farms[28].

CASE STUDY - A FARMER'S SHIFT TO SUSTAINABLE COTTON FARMING

In Challagarige village, India, Samala Venkateshwarl, a cotton farmer with 4 acres (1.6 hectares) of land once relied heavily on chemical fertilizers and pesticides. His conventional practices – excessive urea use (a nitrogen-rich fertilizer) and frequent pesticide sprays – led to escalating costs, pest outbreaks and declining yields.

Determined to find a better way, Samala joined the Better Cotton project in 2019, implemented by WWF. Through hands-on training, he embraced Integrated Pest Management. He adopted intercropping, border cropping and natural pest control methods like neem oil and vitex decoction. With support from Krishi Vigyan Kendra (an agricultural extension center), he also started using biocontrol agents like BMV, further strengthening his pest management strategy.

The impact was notable. Samala reduced his urea usage from three bags per acre (0.4 hectares) to one and cut pesticide sprays from six to just two per season. His Environmental Impact Quotient (EIQ) – a measure of pesticide impact – showed a significant drop as he phased out highly hazardous chemicals:

- 2022-23: Heavy chemical use (Acephate, Cypermethrin) – EIQ: 114, 6.6
- 2023-24: Shift to safer alternatives (Actara, reduced Cypermethrin) – EIQ: 1.9, 26.3

These changes led to a resurgence of beneficial insects like spiders, dragonflies, and praying mantises, a healthier ecosystem and lower cultivation costs.

"SUSTAINABLE FARMING HAS TRANSFORMED MY FIELDS; FEWER CHEMICALS, LOWER COSTS AND THRIVING CROPS. I AM SECURING A BETTER FUTURE FOR BOTH MY FARM AND THE ENVIRONMENT.

Samala Venkateshwarlu, cotton farmer

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GM crops

Genetically modified (GM) varieties are grown on around 79 percent of global cotton growing area[29]. Countries that have adopted these seeds are now dominated by GM cotton. In the US[30] and India[31] around 96 percent of area under cotton cultivation is with genetically engineered crops while Türkiye, for example, has opted out[32].

On average, the adoption of GM technology across a variety of crops has reduced chemical pesticide use by 37 percent, increased crop yields by 22 percent and increased farmer profits by 68 percent[33].

Research from Northern China found that the reduction in use of insecticide sprays associated with Bt cotton crops could support natural pest control, noting an increase in numbers of ladybirds, spiders and lacewings[34].

However, GM crops pose a threat to the genetic biodiversity of cotton as widespread cultivation can lead to genetic contamination of wild or traditional cotton varieties through gene flow[35]. Often occurring through cross-pollination, a resulting concern is genetic homogenization. When genetically uniform crops crossbreed with neighbouring plants or wild species, this may reduce genetic diversity, making crops and wild plants more vulnerable to diseases, pests and climate change. This is because they lose the variety of traits that would normally help them adapt to changing conditions[36].

Furthermore, while planting Bt cotton has been shown to initially decrease the need to use pesticides, a reduction of bollworm can lead to an increase in other kinds of pests, in turn increasing the need for pesticides once more[37].

Unlike other major cotton-producing countries, Türkiye rejected GM cotton, with its farmers focusing their attention instead on IPM. Its yields have doubled since the 1980s to around 1700 kg/ha; approximately double the global average[38].

In an Interview conducted with the Indian non-profit organisation Action for Social Advancement, we heard anecdotal evidence that yields of untreated cotton can match Bt cotton's yields after about three years, if managed well with organic practices.

Pesticide resistance to GM cotton in India

In India, the rapid and near-total adoption of hybrid Bt cotton by the early 2010s led to an initial drop in insecticide use and an increase in cotton production. However, this reduction was short-lived. As bollworm threats decreased, farmers began planting cotton more densely, which, along with increased fertilizer and irrigation inputs, created ideal conditions for other pests like whiteflies and leafhoppers to thrive[39].

By 2012, when Bt cotton adoption exceeded 90 percent, insecticide use had already surpassed pre-Bt levels[40]. Over time, bollworms also evolved resistance, leading to their resurgence[41]. This shift in pest dynamics and the increased need for insecticides illustrate the unintended long-term consequences of Bt cotton's early efficiency.

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Chapter 3

MONOCULTURES

DROUGHT HURTS COTTON FIELD IN NEED OF WATER © GETTY IMAGES

Monocultures, where one single species is repeatedly grown across larger areas of land, deteriorate soil health and fertility, while hampering local plant and animal ecosystems. This is due to practices like overtilling and leaving soil exposed.

Declining soil health leads to weaker cotton plants that are more vulnerable to pests and diseases, increasing the reliance on inorganic fertilizers and pesticides[42]. Pesticide and fertilizer use increases with the planting of monocultures. These can kill micro and macrofauna in the soil, affect pollinators, inhibit natural pest control, pollute waterways and enter the food chain. Nutrient depletion and growing resistance to pesticides only makes this a downward spiral[43].

Cotton can be part of a diverse crop production system, but it is often grown in vast monocultures in short rotation. Monocropping is particularly common on larger-scale cotton farms as it provides economies of scale, with more efficient planting and harvesting using large machinery, for example[44].


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Moving away from monocultures

Crop rotation

Crop rotation plays a crucial role in sustainable cotton cultivation as it can improve soil fertility and reduce pest buildup while mitigating the crop's negative impact on local food production. Since in many regions cash crops like cotton use the most fertilizers, rotating it with local food crops allows these to benefit from residual nutrients, enhancing food security and providing income for smallholder farmers[45].

Additionally, legumes used in rotation naturally enrich the soil, reducing the need for inorganic fertilizers. Crop rotation also disrupts the life cycles of weeds and diseases, promoting healthier growth and soil through a decrease in pesticide use. Strategic seed selection further supports future crop rotations, ensuring long-term productivity and resilience.[46]

Economically, diversified cropping systems provide farmers with varied income streams and greater household food security while maintaining earnings comparable to monoculture systems.

By integrating crop rotation, cotton farmers can achieve long-term yield stability, improved nutrient efficiency and reduced pressure on land resources while reaping both agronomic and environmental benefits.[47]

Crop rotation: Fuelling the fire

While crop rotation in cotton farming is largely beneficial in terms of sustainability, when farmers burn their fields after harvesting and before planting the secondary crop, the environmental benefits of crop rotation can be cancelled out. For example, to lessen the environmental impact caused by growing cotton monocultures, in 2018 the Turkish government introduced a policy that removed subsidies from farms that grew the same crop on a piece of land for more than three consecutive years. As well as leading to a reduction in the amount of cotton produced, this policy saw a big increase in field fires, which tripled in number in comparison to years before the policy was introduced[48].

Intercropping

Intercropping involves planting multiple crops in alternating rows, which supports soil health through microbial interactions. Intercropping cotton with nitrogen-fixing legumes like gram, beans or cowpea improves soil fertility and optimizes land use, as legumes grow quickly and complete their life cycle before cotton matures.

By integrating intercropping cotton farmers can achieve improved pest management, enhanced biodiversity and additional economic benefits. However, farmers can face barriers to adopting intercropping, such as upfront investment costs, lack of research on effective crop combinations and education gaps. In countries where mechanized cotton farming dominates, such as the United States and Brazil, intercropping can be difficult to implement due to conventional machinery being optimized for uniform, large-scale monocultures.

Chapter 4

WATER MANAGEMENT

A COTTON FARM THAT IS PARTICIPATING IN THE BOTTOM UP! PROJECT. AFAR REGION, ETHIOPIA, 30 NOVEMBER 2022.
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Generally, farmers grow cotton where there is not enough water to grow other crops, like corn or soy[49]. However, among major cotton producers, climatic conditions vary considerably through evaporative demand and annual rainfall levels. This leads to significant variations in water stress depending on the volume of irrigation water required to produce a given crop. For example, cotton from Turkmenistan uses more than 800 times as much irrigation water as cotton farmers in Brazil[50].

In some cases, large cotton producers' irrigation needs can have a hugely detrimental impact on local biodiversity. For example, the death of more than one million fish in Australia's Lower Darling River System in 2019 was attributed to its water being diverted for cotton irrigation during a drought[51].

Salinization

Cotton producers' reliance on heavy irrigation can cause reduced soil biodiversity through increased soil salinization. The European Soil Data Centre defines salinization as a process that leads to an excessive increase of water-soluble salts in the soil[52]. While salinization can occur naturally, with salts released from weathering minerals or via shallow ground water, for example, excess salts can also be introduced through irrigation water and fertilizers[53].

Salinization of soils has several negative effects including harming soil biodiversity and soil enzyme activities, reducing soil organic carbon content and altering GHG emissions. In extreme cases it can also lead to desertification status. Additionally, crop yields can suffer up to 58 percent losses[54].

Cotton production is linked to environmental devastation in the Central Asian inland sea; once the world's fourth largest lake, the Aral sea 'completely dried' in August 2014[55] and has been described as 'one of the most toxic and saline places on earth'[56].

Overall, it is estimated that one third of irrigated cotton production globally is affected by salinity or is expected to become affected by salinity in the near future[57].

Irrigated and rainfed cotton

Globally around 45 percent of cotton growing area is manually irrigated. Many African cotton growing countries rely completely on rainfall while countries like China, Pakistan or Egypt rely solely on manual irrigation. Iran, Pakistan, Egypt and Australia use the most extracted water per hectare[58].

Water availability will become more of a challenge as the climate crisis develops, as further explored in the projected physical water risk maps of the paper on Cotton and Climate. In cases of poor water management, irrigated cotton can lead to overconsumption of water, which has adverse effects on biodiversity and soil health. Direct effects on species diversity were the focus of a 2022 study in Spain that showed that shifting from rainfed to irrigated agriculture led to a significant decline in bird populations and overall species richness[59].

Improving water management

Sustainable water management practices

In general, we must support producers to implement sustainable agricultural practices that either directly or indirectly reduce the stress cotton farming puts on freshwater supplies while enhancing biodiversity. For example:

- modern irrigation methods (drip or automated)
- minimal tillage
- cover cropping
- mulching
- other technological solutions, such as remote sensing to measure soil moisture.

To avoid salinization farmers need to prevent the gathering of excess saline water that then evaporates, leaving salts behind. This can be done through more efficient irrigation, introduction of vegetative cover crops that can absorb excess water, or mechanical solutions such as pumps or subsurface and surface drainage systems[60]. Introducing deep-rooted perennial plants or agroforestry can help reduce the amount of water passing beyond crops' roots. For detailed information on salinization management consult the Salinity Management Handbook by the Queensland Department of Environment and Resource Management.

Improving water management requires urgent financial support and capacity development[61]. Desalinating soils can be a lengthy process, and the benefits of improved soil quality often only become apparent some time after the initial investment. Furthermore, it requires holistic and landscape-level action as negative or positive effects on soil salinity spread beyond boundaries of a single farm.


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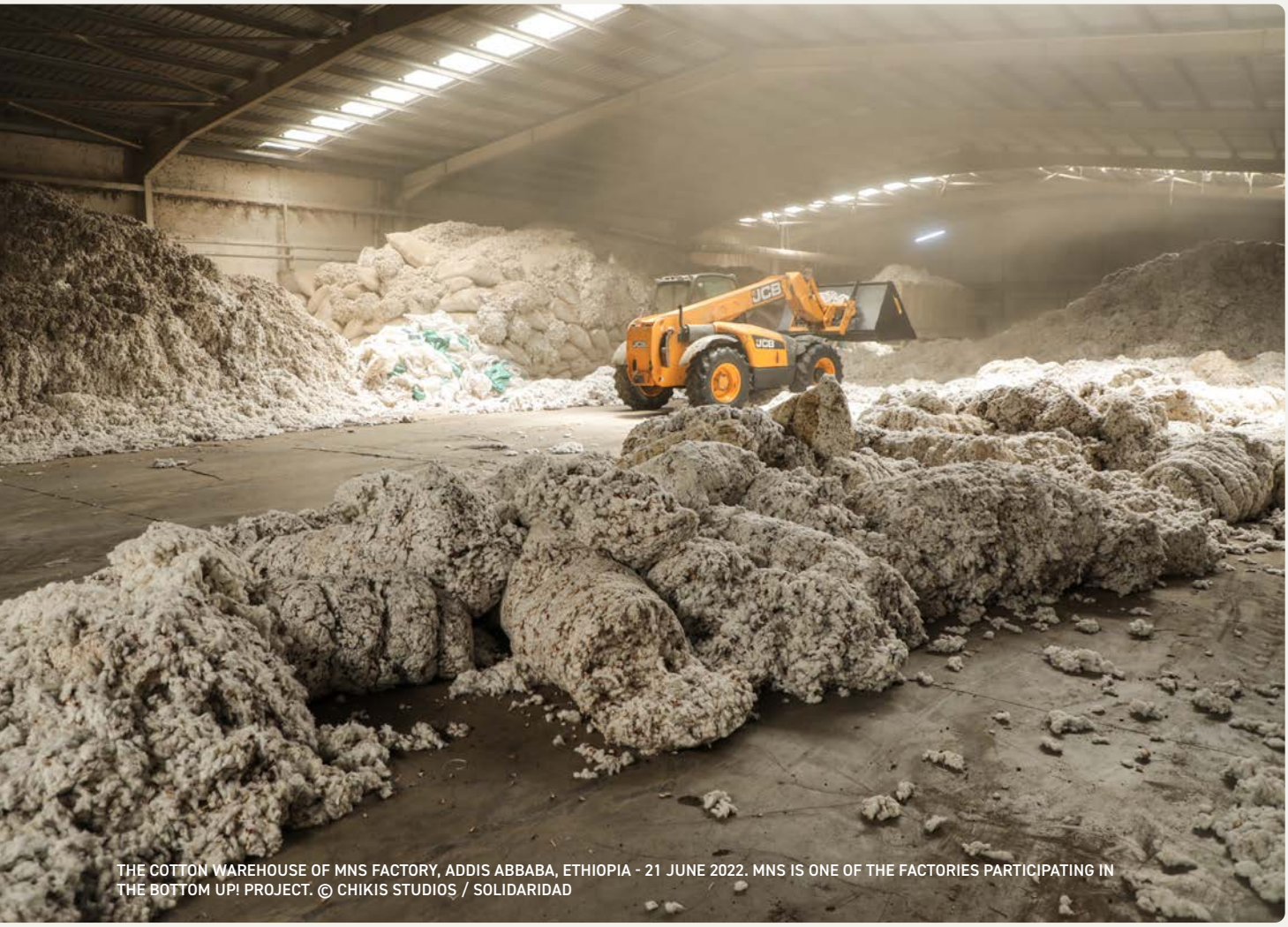
Is increased biodiversity always to the detriment of yield?

Many conventional farming practices, such as the use of inorganic fertilizers or GMO seeds, are implemented to maximize yields. This means that replacing them with biodiversity-promoting methods can pose a short-term risk of yield decline. In 2019 cotton grown under voluntary sustainability standards yielded more than conventional cotton in 11 countries, while yielding less in 17 countries[62].

However, conventional practices that degrade soil and ecosystems over time, harming biodiversity, ultimately risk declining yields in the future. Furthermore, monetary gains for farmers, such as higher farm gate prices and fewer upfront costs for agrochemicals, may counteract financial loss caused by declining yields.

An effective transition to nature-positive practices requires solutions such as organic fertilizers, integrated pest management and techniques like agroforestry. For example, growing cotton alongside jujube trees improved yields in a 2016 case study by the Wageningen University[63].

To maintain smallholder farmer livelihoods during a shift to nature-positive systems, robust extension services are critical, particularly in regions without the institutional support we see in larger exporting countries. Countries that experienced higher yields under voluntary sustainability standard compliant cotton were major cotton exporters including India, the United States, Brazil, Pakistan and Türkiye.



THE COTTON WAREHOUSE OF MNS FACTORY, ADDIS ABBABA, ETHIOPIA - 21 JUNE 2022. MNS IS ONE OF THE FACTORIES PARTICIPATING IN THE BOTTOM UP! PROJECT. © CHIKIS STUDIOS / SOLIDARIDAD

Chapter 5

LAND CONVERSION

Converting species-rich ecosystems, such as rainforests and savannahs, to farmland is still the strongest driver of biodiversity loss. Agricultural expansion is said to account for 70 percent of the projected loss of terrestrial biodiversity[64]. This makes the protection and restoration of these landscapes essential.

As cotton thrives on more arid land, it is less associated with rainforest destruction than other crops such as oil palm. However, as a rotation crop to soy, cotton is likely linked to huge losses of native vegetation in the savannahs of the Brazilian Cerrado[65] [66], one of the world's most important biomes[67]. Similarly, the savannas in Australia's Northern Territory[68] and bushland in New South Wales[69] are under threat from cotton farming expansion.

While cotton farming isn't currently evidently a major driver for the loss of highly biodiverse rainforests and other woodlands, as the climate crisis takes hold, how and where we farm is set to change. With this in mind, we must consider how cotton farmers of the (near) future may be forced to expand, and steps we can take to mitigate their impact on biodiversity. Below we suggest some approaches that can support this.

COTTON FARMER, INDIA © FREE

Farming in balance with existing natural habitats

Diverse habitats, such as forests, hedgerows, riparian areas and other wild spaces found around farms, support a range of species, including natural pest predators, ultimately having the potential to benefit agricultural productivity[70]. A precision conservation approach can enhance these already biodiversity-rich areas by repurposing low-yielding farmland into wildlife habitats that support pollinators, birds and other species.

A similar approach used as part of agroecologic farming systems is sometimes referred to as 'land sharing' rather than 'land sparing'. It keeps agricultural land and wilderness closely together while incorporating biodiversity-rich features such as ponds and hedgerows. This approach positions on-farm biodiversity as an essential component to healthy farm systems.

High Conservation Value assessment

The High Conservation Value (HCV) framework is used to assess land based on ecological, social and cultural significance before allowing land conversion, supporting more sustainable cotton expansion. While cotton is not typically grown on HCV land, carrying out an assessment ensures that growers verify any potential impact on on-site and surrounding biodiversity and, if growing goes ahead, mitigate effects accordingly. Should climate change shift cotton farming into new regions, this approach will become increasingly critical for protecting biodiversity and community livelihoods.

Alongside this, frameworks like the Science-Based Targets for Nature (SBTN) are growing in influence and require companies to commit to zero conversion of natural ecosystems by 2025 and remediate past land use changes.

Chapter 6

COMPARING SMALL AND LARGE COTTON FARMS' IMPACT ON BIODIVERSITY

COTTON FARMER, ETHIOPIA © CLIMAX FILM PRODUCTION / SOLIDARIDAD

Small-scale cotton farming

Smallholder cotton farmers, a huge group that produces the majority of the global cotton supply while farming on plots smaller than two hectares, have great potential to farm in balance with nature. They typically avoid the intensive practices common in large-scale operations, such as monocropping, use of heavy machinery and blanket agrochemical applications via drones or aircraft, that can negatively impact surrounding biodiversity. However, we see that smallholder cotton farming can also present its own particular risks to biodiversity in terms of pesticide and fertilizer use;

1. **Lack of training**
   While the cotton growing context differs hugely across regions and farms, typically smallholder farmers depend on chemical inputs while often lacking the training or access to resources necessary for safe and effective application[71].

2. **Lack of regulatory oversight**
   Generally speaking, it is more difficult to regulate pesticide use by smallholders in low-income countries. This, along with a lack of farmer knowledge, can lead to pesticides being misused, applied at incorrect dosages, used on the wrong crops, or obtained through informal markets where counterfeit or obsolete pesticides are common[72].

3. **Lack of access to resources**
   Smallholder farmers often lack access to resources like soil testing and nutrient management tools, making it difficult to optimize fertilizer application.

Addressing these challenges requires:

- More funding for better extension support for smallholders who may need training in agrochemical safety, independent pesticide and seed advice, and implementation of a sustainable transition while maintaining stable yields.
- Investment in local research, for example, into seeds and input.
- The implementation of nature-positive farming practices tailored to smallholder production systems. For example, neighbouring farms coordinating their pest control methods, as some approaches will be more effective when implemented across a wider area.

See Recommendations for more.

Nature-positive approaches, such as regenerative or organic farming, hold great potential for smallholders to reduce their impact on biodiversity. There is also a financial incentive to move away from conventional pesticide-intensive practices to reduce cost of chemical inputs and maintain steady yields as homemade organic fertilizers require less upfront monetary investment.

Large-scale cotton farming

Contrary to their smaller counterparts, large industrial farms benefit from economies of scale. They rely on the use of machinery and modern technologies such as genetically modified crops and mechanized irrigation systems[73] to produce efficiently. Large-scale farming also often employs monocultures for efficient harvesting with machinery, which can lead to biodiversity-harming soil degradation, like compaction, and increased greenhouse gas emissions.

Research has shown strong positive correlations between on-farm landscape heterogeneity – more common in smaller or mixed systems – and higher numbers of breeding birds, butterflies and herbaceous plant species[74]. This underscores the ecological cost of large-scale simplification. It is, however, important to acknowledge the differences in large-scale farming across different regions and countries. For example, cotton farms in the United States rely on mechanized harvesting, whereas even large farms in Pakistan still depend on manual labor for picking cotton[75].

Large-scale systems can also present opportunities to protect biodiversity; with greater resources and less fragmentation they can coordinate landscape-level pest control strategies and invest in local research and extension services. Australia offers a successful example of overarching IPM strategies with reduced use of agrochemicals. Whereas countries with high potential, such as Brazil, have yet to fully leverage this opportunity for biodiversity gains. Globally Brazil applies the most pesticides to its cotton fields: over 10,000 tonnes more than the United States in second place. This is particularly alarming when considering that Brazil has two-thirds less land under cotton cultivation than the United States[76].

A COTTON FARM THAT IS PARTICIPATING IN THE BOTTOM UP! PROJECT. AFAR REGION, ETHIOPIA, 30 NOVEMBER 2022.
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Chapter 7

HOLISTIC FARMING APPROACHES TO ENHANCE BIODIVERSITY

© MICHEL BOULOGNE / SOLIDARIDAD

Agriculture can play an important role in enhancing biodiversity, if done in balance with nature. However, before cotton farming can become truly environmentally and economically sustainable, we first need to restore what's already been lost to excessive use of agrochemicals, land conversion, monocultures and poor water management.

In recent decades nature-positive farming systems such as regenerative, organic and landscape approaches have picked up momentum in an attempt to counteract the environmental damage done by conventional farming. As discussed above, IPM provides another holistic, ecosystem-based approach to controlling pests, diseases and weeds while minimizing reliance on chemical pesticides.

These approaches incorporate a variety of techniques that can improve soil fertility, increase carbon sequestration and reduce water pollution all while supporting biodiversity. Here we look at their relevance in the context of cotton farming.

A COTTON FARM THAT IS PARTICIPATING IN THE BOTTOM UP! PROJECT. AFAR REGION, ETHIOPIA, 30 NOVEMBER 2022. © CLIMAX FILM PRODUCTION / SOLIDARIDAD

Regenerative agriculture

There is no universal definition of regenerative agriculture, with varying definitions used by NGOs, companies, academics and practitioners. Textile Exchange puts this down to regenerative agriculture's 'contextual and nuanced' nature, and say it 'instead calls for a fundamentally holistic systems approach that puts humans and ecosystems at its core'[77]. The acknowledgement that Indigenous and Native peoples have been employing these circular and restorative practices for centuries, and that regenerative agriculture must include a focus on social justice, is also crucial[78].

Regenerative agriculture focuses on improving soil health through a wide range of practices that often include:

- minimising soil disturbance
- implementing crop diversity
- maintaining living roots in the soil
- keeping bare soil covered by mulching or planting cover crops.

Regenerative agriculture's focus on minimising soil disturbance is in response to the degradation caused by excessive tillage and overgrazing by livestock which can lead to compacted soil. Compaction affects biodiversity; restricting growth of beneficial soil microorganisms and reducing habitats for macroinvertebrates and access to nutrients. Long-term reduction in tillage, or implementing conservation tillage, is one way to avoid soil compaction[79]. A study conducted on cotton fields in North Carolina, United States, showed that practicing continuous conservation tillage improves soil organic carbon by 55 percent and that a history of cover cropping more than triples surface residue carbon[80].

Another recent study from India showed that implementing zero tillage; instead focusing on crop residue retention and integrated weed management, significantly improved soil quality. Integrated weed management entails using local context-specific mechanical, biological and chemical solutions along with herbicides. Soil quality is indicated through a number of factors including soil organic carbon and nitrogen[81].

While regenerative agriculture doesn't prohibit the use of agrochemicals, it focuses on a gradual reduction, allowing farmers to transition to using less inorganic fertilizer over time.

COTTON FIELD © GETTY IMAGES

CASE STUDY - TRANSITIONING TO REGENERATIVE AGRICULTURE IN MAHARASHTRA, INDIA

During the 2020-2021 crop cycle Solidaridad worked with 8,000 cotton farmers to introduce more regenerative practices in Maharashtra, India, using Regenagri certification as a framework for implementation and assessment.

In the programme's first year, participating farmers recorded on-farm production of 5,500 metric tonnes of organic compost. They planted over 10,000 trees to improve soil health and biodiversity. The regenerative practices created about 1,050 tonnes of potential CO_2 sequestration. The reduction in use of chemical fertilizers and pesticides also helped in maintaining the ecological balance in the fields, allowing natural predators to facilitate pest control.

Five years on, as of May 2025, 39,498.05 hectares are under regenerative agriculture in Maharashtra as part of the programme, representing about 1 percent of the total area under cotton production in the region. On-farm benefits include a 12-30 percent reduction in cost of cultivation, 12-18 percent increase in yields and 35 percent water savings since the programme began.

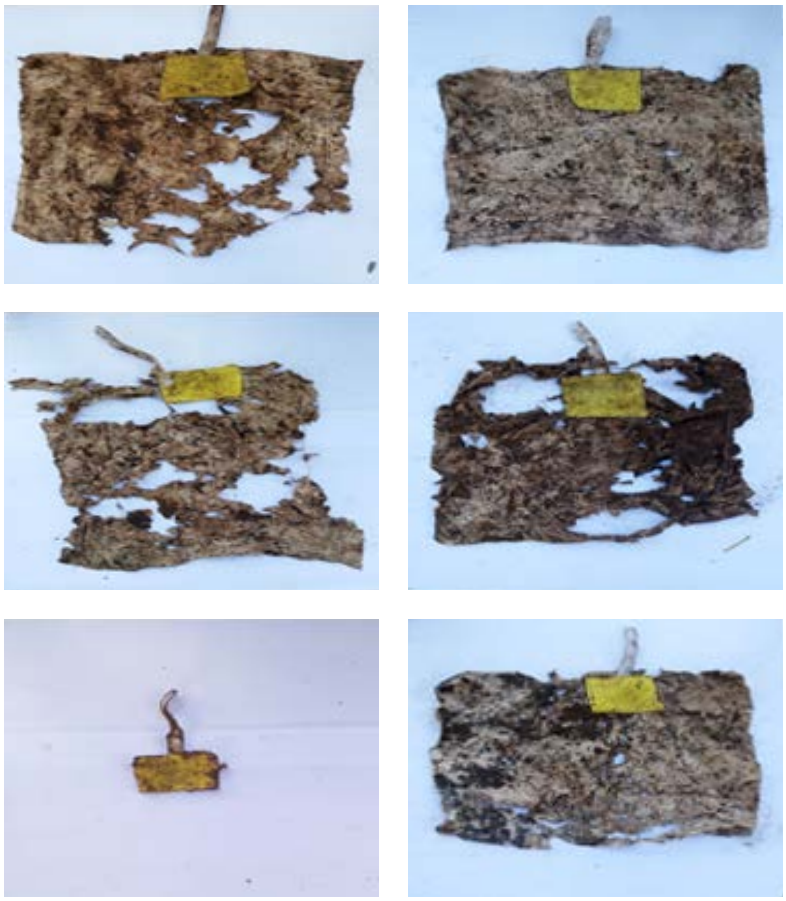
Organic farming

As defined by the international organic community; 'organic farming is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and good quality of life for all involved.'

Unlike regenerative farming, organic agriculture is regulated by law in many countries around the world, taking a hard line against the use of artificial fertilizers and hazardous inorganic pesticides. It instead takes a preventative approach to pests by incorporating techniques such as introducing natural enemies and crop rotation, alongside cover cropping, integrated livestock management and composting. These support both better soil health and biodiversity.

COTTON FARMERS WEEDING THE NEWLY PLANTED COTTON FIELD. BIOSUSTAIN HAS SOME 3500 FARMERS FAMILIES UNDER CONTRACT. THEY ALL PRACTICE ORGANIC FARMING METHODES. © H. P. ALTING VON GEUSAU / SOLIDARIDAD

Organic **Conventional**



A recent project led by Pesticide Action Network UK (PAN UK) and The Benin Organisation for the Promotion of Organic Farming (OPEPAB) aimed to scale up organic cotton in Benin. It used the 'soil your underwear' method to analyse soil health in cotton fields. This agroecologic technique involves burying 100 percent cotton cloth into the soil for a period of time and assessing the rate of its decomposition. The cotton cloth decomposition rate was 37 percent greater in the organic fields than in the non-organic fields, highlighting that the organic fields had healthier soils with a higher abundance of micro-organisms.

FIGURE 1. Examples of the cloth excavated from organic cotton fields (left) and conventional cotton fields (right) following the 'soil your underwear' method that was refined and tested in 2023. The cloth was buried over a three-week period.
IMAGE CREDIT: PAN UK / OBEPAB

OCA's Life Cycle Assessment of lint cotton in India study shows that organic farming practices reduce ecotoxicity by 84-96 percent compared to conventional cotton farming in the same region. This is mainly due to the absence of synthetic crop protection products – particularly those containing zinc, cadmium and acephate.

TOGO-COTTON-HARVEST © SOLIDARIDAD

ORGANIC COTTON GROWS HERE ALONGSIDE NATIVE TREES AND VEGETATION, SHOWING HOW FARMING AND NATURE CAN WORK WELL TOGETHER. © ORGANIC COTTON ACCELERATOR (OCA)

CASE STUDY - ORGANIC FARMING'S IMPACT ON BIODIVERSITY

Deep in the tribal belt of Petlawad, Madhya Pradesh, India, the village of Dhanpura is home to a farming couple who are reconnecting with the land. Through OCA's Farm Programme, Rama and Sajan Bhilji have spent the past five years transitioning their farm to organic cotton. A key part of this transition is a demonstration plot; a small section of their farm where they experiment with nature-based practices. The couple's demo plot acts as a living classroom for the community, where local farmers can see for themselves how biodiversity benefits the land. The practices adopted in the demo-plots help bring back beneficial insects, improve soil health and reduce dependency on inorganic inputs.

On their plot, cotton grows alongside green gram, pigeon pea and sunflowers. Intercropping builds soil fertility and attracts pollinators. Cover crops like lobia and black gram reduce erosion and nourish the earth, while marigold borders offer natural pest control. Along the edges, neem, bamboo, acacia, mango and jujube trees form a living fence that provides shade, invites birds and bees and helps retain soil moisture.

As Rama puts it: "Each crop, each tree and each insect has a role. I'm growing a healthy system that can support itself."

Rama and Sajan's experience is just one example of how OCA's broader organic cotton farming framework is benefiting the environment. OCA's recent regional Life Cycle Assessment (LCA) study in India shows that organic farming reduces environmental impacts such as greenhouse gas emissions, eutrophication and water use compared to conventional practices. It also significantly lowers ecotoxicity; reducing harmful chemical exposure to soil, water and wildlife. By eliminating inorganic pesticides and fertilizers, organic farming directly supports healthier ecosystems and greater biodiversity.

DEMO PLOTS SHOWCASE HOW ORGANIC PRACTICES LIKE CROP DIVERSIFICATION FOSTER AN ECOSYSTEM WHERE PLANTS, INSECTS, AND SOIL ORGANISMS INTERACT TO SUPPORT LOCAL BIODIVERSITY. © ORGANIC COTTON ACCELERATOR (OCA)


© ORGANIC COTTON ACCELERATOR (OCA)

Agroforestry

Agroforestry, a practice used in both regenerative and organic farming, integrates native trees with crops, including cotton, to improve water quality, soil health and resilience to extreme weather. Beyond these benefits, trees also act as carbon sinks and provide habitats for wildlife. While tree-crop systems can increase early yields, further research is needed to determine specific benefits of agroforestry for yields and biodiversity.

Border cropping

Border cropping, also used in both regenerative and organic farming systems, involves planting specific crops around cotton fields. These crops serve as trap crops, attracting pests such as bollworms away from the cotton plants, thereby protecting the main crop.

Border crops can enhance natural pest control by:

- increasing in-field biodiversity
- acting as barriers that limit pest dispersal
- providing habitats or food for beneficial insects

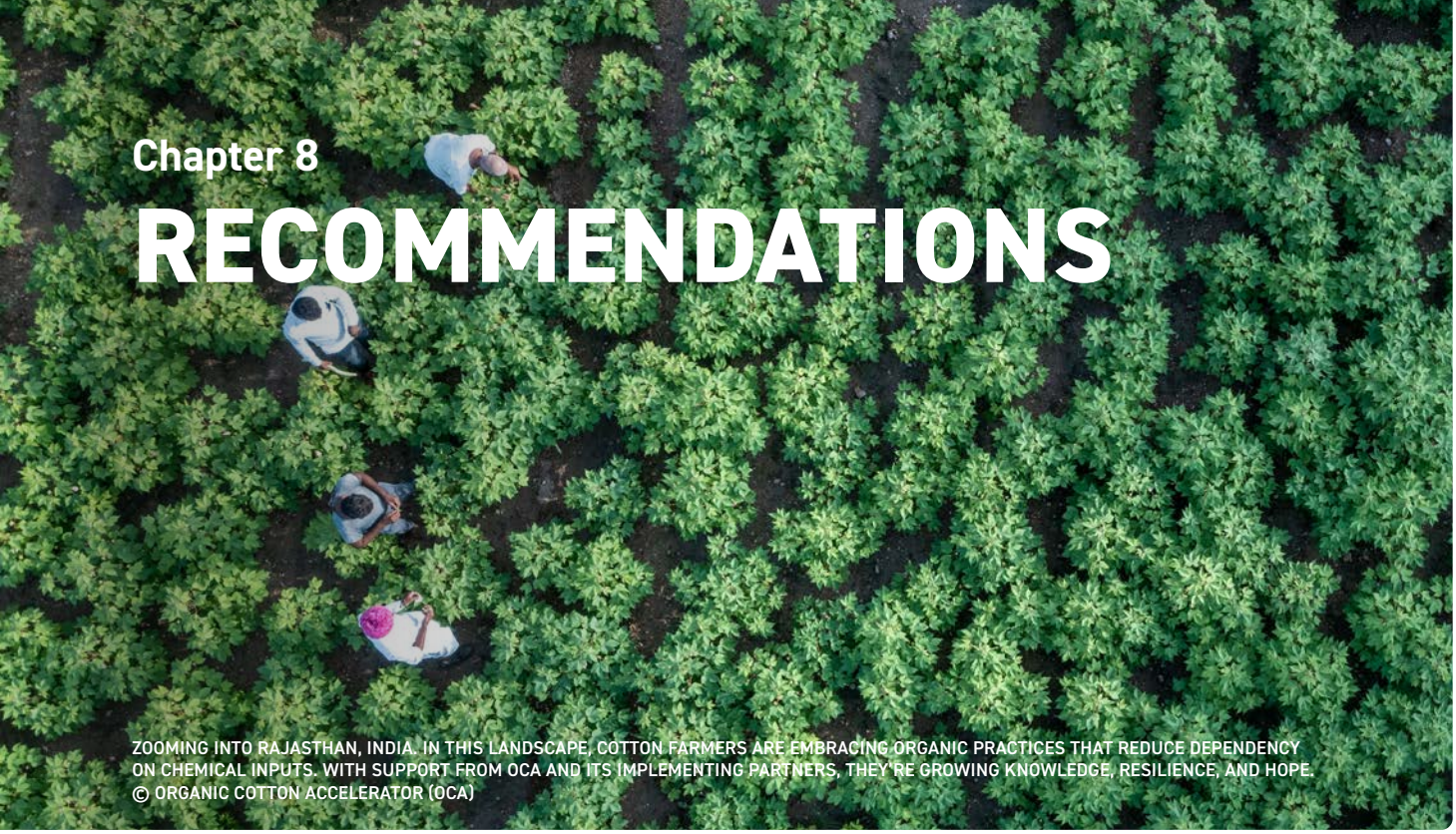
Landscape farming approach

Landscape farming takes a more holistic approach to agriculture. It takes into consideration sustainability challenges that extend beyond individual farms including:

- water stewardship
- habitat conversion
- land rights
- rural development

Enhancing biodiversity at farm-level includes individual efforts such as crop rotations or intercropping and border cropping while a landscape system considers entire ecosystems and involves multiple stakeholders. This can include producers, sourcing companies, governments, NGOs and investors. This system seeks to balance agricultural production with environmental conservation and social equity. It promotes collaborative goal-setting, shared monitoring and coordinated action to address large-scale challenges that cannot be effectively tackled at farm level alone. By managing land and water use across broader regions, the landscape system aims to contribute to both ecosystem health and rural livelihoods.[82]

See chapter 3 of Solidaridad's Landscape Approach – Lessons learnt report for more information about this approach and how it can be put into practice.



Chapter 8

RECOMMENDATIONS

ZOOMING INTO RAJASTHAN, INDIA. IN THIS LANDSCAPE, COTTON FARMERS ARE EMBRACING ORGANIC PRACTICES THAT REDUCE DEPENDENCY ON CHEMICAL INPUTS. WITH SUPPORT FROM OCA AND ITS IMPLEMENTING PARTNERS, THEY'RE GROWING KNOWLEDGE, RESILIENCE, AND HOPE.
© ORGANIC COTTON ACCELERATOR (OCA)

Retailers and brands

Consumers are concerned about sustainability and biodiversity loss and expect brands to change their behavior. As the community with the greatest share of money and influence in the value chain, cotton retailers and brands must be a driving force for good.

Take responsibility for your value chain by investing in producers:

- Go beyond purchasing cotton from certified sources; establish sustainability budgets to invest in farmers' transition to nature-positive practices that enhance biodiversity.
- Help consumers understand the social and environmental sustainability challenges in your supply chain and the need to act.
- Directly reward farmers in your value chain by making use of innovative investment tools, such as carbon insetting programmes.

Support certification standards to add more value:

- Standards systems are crucially addressing some of the worst harms in cotton production. Encourage them to raise their ambition; move from sustainable to regenerative practices, prove their impact and involve farmers even more.
- Only adopt standards that have strong commitments to reducing agrochemical use and farmer training in nature-positive approaches. This should include an overall reduction in agrochemical use and phasing out highly hazardous pesticides by 2030.

Proactively engage with multi-stakeholder initiatives (MSIs). They can play a critical role in providing forums and interventions to address issues in the cotton value chain.

- Engage with MSIs that bring smallholder farmers, workers and other supply chain actors to the table in a meaningful way.
- Enhance partnerships with producer organizations to support and enable genuine participation.

Improve purchasing practices:

- Enable long-term contracts for producers with a sufficiently high farm gate price to afford a living income and the transition to farming practices that promote biodiversity.

Raise the bar on transparency:

- Embrace due diligence; know exactly where your cotton comes from, be publicly transparent about it, and ensure you are paying suppliers sufficiently to facilitate traceability and promote biodiversity.

Take responsibility for your value chain by investing in producers:

- Include cotton farming in your due diligence to identify, mitigate, and remedy risks at the root.

Standards systems

Standards systems play a unique and crucial role. They can support biodiversity restoration, climate adaptation and mitigation on a broad scale by involving farmers more, and credibly proving their impact:

- Urgently facilitate retailers and brands partnering with smallholder cotton farmers so they significantly increase their financial investment in nature-positive farming approaches.
- Adopt ambitious strategies, including price premiums and mechanisms, to support a living income for smallholder cotton farmers so they can build resilience and adapt to growing cotton in balance with nature.
- Invest further in farmer training.
- Consumers find standards complex. Help them understand the sustainability challenges in cotton's supply chain, and your role in addressing them.
- Develop, enable and facilitate supply chain traceability mechanisms for retailers and brands, especially in smallholder contexts, to increase investment and direct claims of impact generated.
- Develop effective ways to map and measure biodiversity improvements in collaboration with farmers, governments, brands and other stakeholders.

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Farmers and farmer organizations

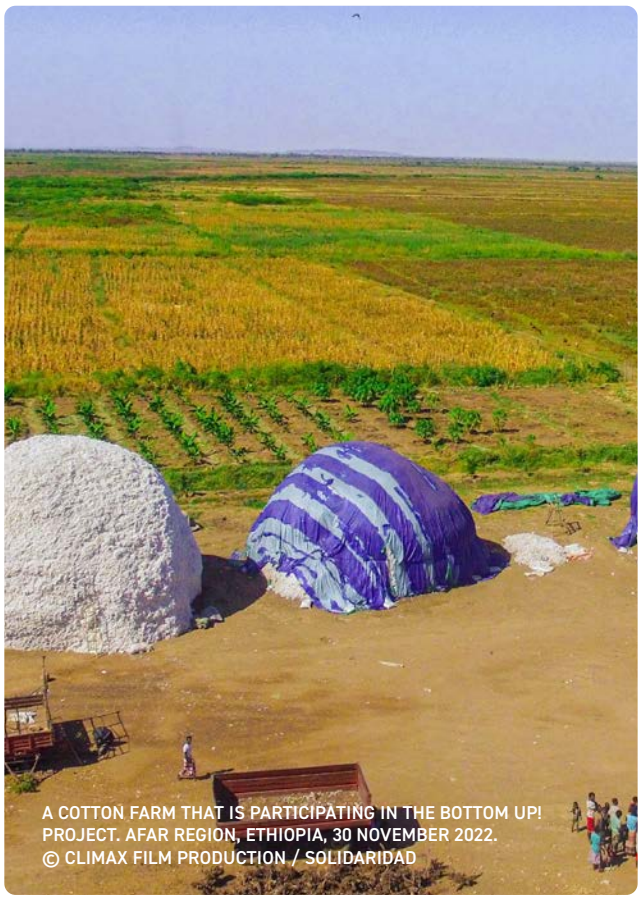
Farmers, especially smallholders who are producing the majority of the world's cotton, are fundamental to the sector. Farmers deserve a healthy environment, a greater share of the cotton sector's value and support to adapt to climate change while enhancing biodiversity.

For individual farmers, please consider:

- Declining biodiversity affects how you farm. Acting now will mean you are more likely to keep growing cotton in the future.
- Switching from conventional cotton farming to nature-positive practices can improve your health, your soil and local biodiversity while reducing production costs.
- Diversifying your crops to make your income, and environment, more resilient.

For farmer organizations, please consider:

- Training farmers and workers on biodiversity-enhancing and socially responsible farming practices.
- Making it easier for farmers to buy and use safer alternatives to agrochemicals, such as biopesticides and organic amendments.



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Traders

Traders are the gatekeepers of the cotton sector. If they choose, they could open up the value chain, connect retailers with farmers, and use their position to strongly promote adaptation and mitigation.

- Use your purchasing practices to guarantee fair prices and fair payment terms as a prerequisite for commercial arrangements.
- Proactively support producers who are transitioning to nature-positive farming.

Governments

Public policy is a key mechanism for achieving change. Standards, CSOs and responsible companies are stepping in to compensate for government failure to regulate irresponsible businesses and enable responsible production, but this is not sufficient. We need meaningful government action.

- Strengthen and harmonize institutional research into cotton seed development, input optimization and effective crop combinations, for example, by supporting public research institutions, universities and government agencies worldwide.
- Ensure that innovation is guided by sustainability and public interest rather than dominated by private commercial interests.

Governments of predominantly cotton consuming countries

- Establish multilateral partnerships and trade agreements with producing countries, involving farmers, farmer organizations and CSOs, to support farmers to adopt nature-positive farming practices.
- Introduce or enhance measures, including changes in subsidies, to support a managed transition away from inorganic agrochemicals towards safe use of organic alternatives.
- Model good purchasing practices by sourcing your own cotton products from certified or other sustainable sources.
- Adopt or enhance due diligence legislation that can lead to a positive impact for smallholder farmers, including requiring companies to take responsibility for their full value chain.

Governments of cotton producer countries

We want all producing nations to support a living wage and income, and fair conditions for cotton farmers and workers. We also want them to enable sustainable

production that supports our planet, climate and communities:

- Reward cotton farmers who cultivate sustainably.
- Consider price support mechanisms to support a living income for smallholder cotton farmers.
- Repurpose agricultural subsidies to promote climate change adaptation, crop diversification and other nature-positive farming practices.
- Regulate agrochemicals to eliminate highly hazardous pesticides and fertilizers, and promote use of safer alternatives such as biopesticides and agroecologic practices
- Support farmer organisations to establish greater collective bargaining power and influence in the value chain.
- Invest agricultural budget in research, capacity building to support nature-positive agriculture and achieve ecological, social and economic sustainability.

Multi-stakeholder initiatives (MSI)

To further their critical role in providing forums and interventions to address issues in the cotton value chain, MSIs need legitimacy through involving farmers, to drive more ambitious long-term solutions and to communicate their impacts and challenges openly.

- Drive companies to go further in ensuring cotton provides farmers with good livelihoods and is environmentally sustainable. Companies buying their cotton from certified or other sustainable sources is the bare minimum.
- Sustainable production and consumption is essential for our environment, climate, and for the livelihoods of farmers and their communities. MSIs have a role to play specifically in promoting crop diversification which can support biodiversity, climate change adaptation, mitigation and farmer resiliency.

Civil society organizations (CSO)

CSOs can bring insight and expertise to the table, but only if they engage:

- Support the transition from a harm reduction 'sustainability' mindset to a 'regenerative' mindset.
- Engage more in supporting smallholder cotton farmers in their transformation towards growing cotton using nature-positive practices.

Agrochemical companies

- Innovate and transition towards new products and services with lower or zero environmental impact and GHG emissions, and create a market for them.

Banking and insurance companies

- Come up with niche products and coverage for farmers investing in the transition to nature-positive practices who could face initial yield losses.

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BATHED IN THE SOFT GLOW OF SUNSET, TÜRKIYE'S COTTON FIELDS STAND READY FOR HARVEST. EACH COTTON BOLL REFLECTS MONTHS OF CARE BY ORGANIC FARMERS.
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ORGANIC COTTON ACCELERATOR

Solidaridad Europe
't Goylaan 15
3525 AA Utrecht
The Netherlands
+31 (0)30 272 0313