

# The Bi-Directional Impacts of Climate Change *and* Menstrual Health

Opportunities  
for Innovation  
and Action

JUNE 2026



Reproductive Health  
**SUPPLIES COALITION**

## Authors

**Dr. Meg “Bee” Brown, Nicole Loher, and Nomi Rachel Fuchs**

*Climate Communications Collective*

## Contributors

**Sarah Webb and Madison Schoeben**

*Reproductive Health Supplies Coalition*

## Advisory Group

**Dr. Ayman Abdelmohsen:** Chief, Sexual and Reproductive Health and Rights Branch, Programme Division at UNFPA

**Dr. Pascale Allotey:** Director at WHO (HRP & LHR) UN Special Programme on Human Reproduction (HRP) & WHO Department of Sexual, Reproductive, Maternal, Child & Adolescent Health & Ageing (Lifecourse Health and Reproduction)

**Dr. Manjulaa Narasimhan:** Lead, Menstrual Health, WHO Department of Sexual, Reproductive, Maternal, Child & Adolescent Health & Ageing (LHR)

**Wendy Anderson:** Co-Founder and Partner of The Case for Her

**Megan White Mukuria:** Founder and CEO of ZanaAfrica

**Diana Sierra:** Founder and CEO of Be Girl

**Naomi Tulay Solanke:** Founder and Executive Director of the Community Healthcare Initiative (CHI)

**Karla Welch:** Founder of The Period Company

## Suggested Citation

**Brown, M., Loher, N., and Fuchs, N.R. (2026).** *The bi-directional impacts of climate change and menstrual health: Opportunities for innovation and action.* Reproductive Health Supplies Coalition.

## Acknowledgements

We thank RHSC’s donors for their pivotal role in advancing the development of reproductive health markets globally. Special thanks to the United Nations’ Sanitation and Hygiene Fund (SHF) for their support of this project. The findings and conclusions within are those of the authors and do not necessarily reflect positions or policies of RHSC’s donors.

We are grateful to RHSC staff, RHSC working groups, advisory group members, and the many stakeholders from across multilaterals, non-governmental organizations, advocacy groups, menstrual health product development, and more who shared their time, expertise, and insights with us as we developed this report.

# Table of Contents

<b>4</b>	<b>Acronyms</b>
<b>5</b>	<b>Introduction</b>
7	About this Report
7	Centering Choice and Navigating Trade-Offs: Advancing Sustainability across Menstrual Health Products
<b>8</b>	<b>Menstrual Health and Climate Change: Why It Matters</b>
<b>9</b>	<b>Stories from the Frontlines: The Impact of Climate Change on Menstrual Health</b>
<b>11</b>	<b>Carbon Emissions across the Menstrual Health Product Life Cycle</b>
<b>13</b>	<b>Emerging Innovations and New Frontiers for Climate-Responsive Menstrual Products</b>
<b>15</b>	<b>Understanding the Climate Impact of Key Menstrual Health Products</b>
16	Single-Use Pads
18	Tampons
20	Menstrual Cups
22	Period Underwear
24	Reusable Cloth Pads
<b>26</b>	<b>Advancing Data and Transparency across the Menstrual Product Life Cycle</b>
<b>29</b>	<b>Looking Forward: Driving Collective Action for a More Sustainable Menstrual Product Marketplace</b>
<b>31</b>	<b>Recommendations</b>
<b>32</b>	<b>Resource Toolbox</b>
<b>33</b>	<b>References</b>

# Acronyms

**COP:** Conference of Parties, the annual UN climate summit

**COGS:** Cost of goods sold

**ISO:** International Organization for Standardization

**IUD:** Intrauterine device

**LCA:** Life cycle analysis

**LMIC:** Low- and middle-income country

**NGO:** Non-governmental organization

**PFAS:** Per- and polyfluoroalkyl substances, also referred to as “forever chemicals”

**PUL:** Polyurethane laminate

**SAP:** Super-absorbent polymer

**SRHR:** Sexual and reproductive health and rights

**TPE:** Thermoplastic elastomer

**UNFCCC:** United Nations Framework Convention on Climate Change



# Introduction

## Menstrual products represent a valuable opportunity for climate mitigation and adaptation action.

There are about 1.72 billion menstruators living in low- and middle-income countries (LMICs) and among those using purpose-made products, an estimated 93% of these menstruators use single-use products.<sup>1</sup> Menstrual product production processes and waste contribute to the greenhouse gas emissions driving climate change.<sup>2,3,4</sup> Globally, an estimated 12 billion single-use menstrual products are produced and used each year, generating 250,000 tons of carbon dioxide annually, equivalent to 58,314 gas-powered vehicles driven per year.<sup>5,6</sup> Despite this, reusable menstrual products are currently only 5% of total market share in LMICs.<sup>1</sup>

**At the same time, we recognize that climate change is impacting every part of our world, and menstrual health is no exception.** Climate-linked natural disasters threaten reproductive health supply chains, interrupt access to quality menstrual products, disrupt menstrual health education efforts, and change the context in which people use menstrual health products.<sup>7</sup> In many contexts, menstrual health products are not included in climate disaster response because they are not viewed as a necessity. Yet access to menstrual products and related supplies is critical for reducing the risk of infections, enhancing overall sexual and reproductive health, improving school attendance for young women and girls, promoting gender equality and bodily autonomy, and expanding access to economic opportunity—all vital components for women and girls' overall well-being, as well as their resilience to climate change.<sup>8</sup>

Ultimately, the responsibility for addressing these challenges should not fall on the shoulders of menstruators, but rather is shared among all stakeholders in the menstrual health product space: there is a role to play for menstrual health product designers, manufacturers, supply chain actors, distributors, procurers, users, policymakers, and advocates.

---

[1 Weinberger et al. 2024](#)  
[2 Khorsand et al. 2023](#)

[3 Anand et al. 2022](#)  
[4 Harrison and Tyson 2022](#)

[5 Aujla et al. 2024](#)  
[6 EPA](#)

[7 UNFPA](#)  
[8 World Bank](#)



## Addressing these challenges also offers several key opportunities for those across the menstrual health product ecosystem:



**Achieving climate and environment goals:** Developing lower-emissions menstrual health products is an important part of reducing global emissions and building a climate just future. These products are a critical component of ensuring menstrual health manufacturers and suppliers meet organizational goals around carbon emissions and waste as well as comply with health and environment regulations.



**Meeting menstruators' needs in a changing climate:** The impacts of climate change on water access, economies, sanitation, housing, and other aspects of life may shift users' preferences and needs around menstrual health products. Developing a range of climate-responsive menstrual health products can be an opportunity to ensure that menstrual health products work better for menstruators, enabling them consistent access to safe and effective menstrual health products.



**Integrating menstrual health into climate agendas:** Menstrual health products offer opportunities for both climate mitigation and adaptation action, meaning that they are a valuable entry point for advancing gender equity and sexual and reproductive health and rights (SRHR) goals within climate adaptation, disaster response, and climate mitigation efforts, such as national-level adaptation plans and climate commitments.

Addressing the bidirectional impacts between climate change and menstrual health represents an opportunity for menstrual product suppliers and distributors to advance climate resilient supply chains while simultaneously enhancing health and equity outcomes for people who menstruate.<sup>9</sup> A strong foundation of evidence about the connections between climate change and menstrual health products is critical to advance research, policy reform, and product innovation efforts.<sup>2,9</sup>

---

<sup>9</sup> Alungoa et al. 2022

# About this Report

This report provides an overview of emerging evidence about how menstrual health products may contribute to climate change, as well as the impact of climate change on those products. It includes evidence regarding:

- Why climate change matters for menstrual health—and for people who menstruate
- Carbon emissions across the menstrual health product life cycle, and opportunities for innovation
- How different menstrual health products compare in terms of climate impacts
- Recommendations for advancing sustainable, climate-resilient, and user-centered menstrual health products
- Tools and resources for taking action around climate and menstrual health

The report was developed through a desk review of peer-reviewed, grey, and non-traditional evidence sources and was informed by a series of key informant interviews with stakeholders in the menstrual health product space.

## Centering Choice *and* Navigating Trade-Offs: Advancing Sustainability *across* Menstrual Health Products

Multiple studies have demonstrated that **reusable products like menstrual cups, menstrual underwear, and reusable pads** have the overall lowest climate and environmental impact—with menstrual cups generally emerging as the lowest impact option.<sup>7,8,10</sup> However, single-use products currently play an important part in the menstrual product market, given their global scale. Unilateral policies that eliminate single-use menstrual products can restrict menstrual health product access and choice. All menstrual health products are critical for ensuring the health and well-being of people who menstruate. More importantly, **choice is a fundamental tenet of menstrual health**. People who menstruate deserve to choose the product that works best for them—a choice that is often shaped by personal preferences, accessibility, affordability, and environmental considerations, such as access to clean water and product sustainability.

**There are opportunities to reduce environmental impacts across the menstrual product life cycle.** Rather than recommending a specific menstrual health product as the “best” product in terms of climate impact, this resource serves as a guide to support menstrual health product manufacturers, distributors, consumers, and advocates in thinking through how a range of menstrual health products contribute to emissions, considering how to weigh the pros and cons of different options, and exploring opportunities for innovation.

---

<sup>10</sup> Notten et al. 2021

<sup>11</sup> RHSC 2021

# Menstrual Health *and* Climate Change: Why It Matters

**1.72 billion**

menstruators in LMICs

**93%**

Use single-use products, among those using purpose-made products

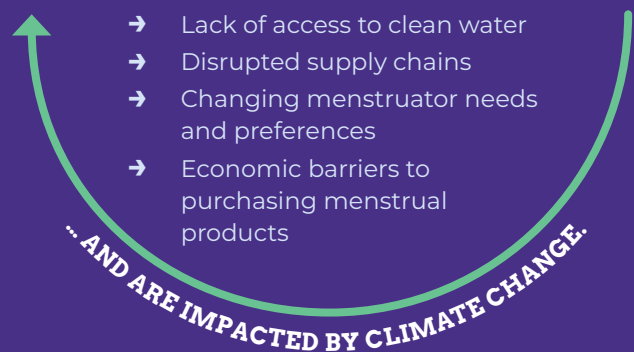
**250,000 tons**

of CO2 emissions globally from single-use menstrual products each year

Across the globe, menstruators use a wide range of purpose-made and non-purpose-made materials to manage their menstruation, including:

- Single-use pads
- Tampons with and without applicators
- Reusable cloth pads
- Menstrual cups
- Menstrual discs
- Menstrual cloths

Access to menstrual products of one's choosing is critical for reducing infection risks, expanding access to education and economic opportunity, and ensuring every menstruator can manage their period in a safe and dignified manner.



By considering climate risks and impacts to menstrual products, menstrual health stakeholders have the opportunity to innovate lower-carbon SRHR commodities while developing product designs and delivery approaches that better meet the needs of menstruators in climate-affected regions.

**Sustained market growth in regions vulnerable to climate change**

**Reduced carbon emissions across the menstrual health production chain**

**Greater health and equity for climate-impacted menstruators**

# Stories *from the Frontlines*: The Impact of Climate Change on Menstrual Health

Globally, menstrual health is often left out of climate change policies and preparedness plans.

As a result, menstruators who experience climate crises often do not have the tools and resources that they need to manage their periods in a safe, healthy, and dignified manner. In addition to directly disrupting health systems and supply chains, climate disasters also create water shortages, food insecurity, and economic vulnerabilities, all of which can make managing menstruation more challenging.<sup>12,13</sup>

---

<sup>12</sup> Hiabu et al. 2025

<sup>13</sup> Muralidharan et al. 2025



**In Coastal Bangladesh, cyclones and rising sea levels are compromising menstrual health.**

Menstrual product supply chains are disrupted during cyclones, and floods may submerge toilets and make clean water unavailable. As sea level rise increases the salinity of water in coastal communities, women lack access to fresh water for hygiene while menstruating, leading to increasing discomfort, rashes, and higher risk of infections.<sup>14</sup>

**For women in the Pacific, climate change disrupts nearly every aspect of menstrual health.**

During disasters, menstrual product supply chains and information networks are disrupted, making it difficult for women to access menstrual products and health information. Shelters and evacuation centers often do not have safe, private, and sanitary spaces for managing menstruation. Water insecurity during these crises makes menstrual health even more challenging to manage.<sup>12</sup>

**In rural India, drought-induced migration** is pushing women into exploitative and low-wage labor conditions where they are vulnerable to cycles of perpetual indebtedness and predatory private health clinics. For women who work in sugarcane fields, any decrease in their work capacity results in loss of wages, so women may opt for hysterectomies as a way to avoid wage cuts due to pregnancy or menstruation, as well as to avoid the difficulty of managing menstruation during long work days with no sanitation facilities. These women often experience additional gynecological issues and expenses as a result.<sup>15</sup>

**Across the globe,** menstrual health behavior change is increasingly shaped by competing visions of the future. Government agencies and NGOs often promote “zero-waste” menstrual products as the most desirable and sustainable option, framing behavior change around environmental responsibility. Yet for women living in communities where informal waste work provides essential income, disposable menstrual products are embedded within existing waste streams and livelihood systems. These women may envision futures that prioritize economic security and continuity over waste elimination, revealing how menstrual behavior change is negotiated through lived realities rather than abstract sustainability goals.<sup>16</sup>

Climate change is shifting the context in which menstruation occurs. What remains consistent is that people who menstruate need consistent access to a wide range of affordable menstrual health product options. This requires product innovation, systemic shifts, and new business models to ensure menstrual health products respond to menstruators’ needs and the impacts of climate change on their lives.

---

<sup>14</sup> Yasmin 2025

<sup>16</sup> Dicken et al. 2025

<sup>15</sup> Bharadwaj et al. 2024

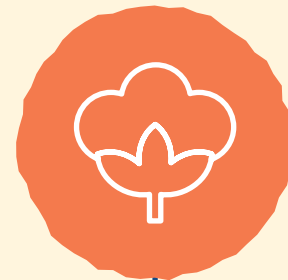


# Carbon Emissions *across the Menstrual Health* Product Life Cycle

## RAW COMPONENTS

This includes all of the energy and materials needed to produce the components of the menstrual product, which can include cotton, polyester, silicone, organic materials, and more. Impact in this category is influenced by the type of materials needed, the quantity of materials needed, and the resources required to extract and process those materials.

For example, cottonseed production requires intensive water and land use; agricultural chemicals can contribute to human and environmental health risks. Plastic production, particularly for tampons with applicators and single-use pads, likewise contribute to these products' environmental impact, as fossil fuel products.



## PRODUCT MANUFACTURING

This includes all of the energy and materials needed to manufacture and treat the menstrual product itself, as well as the emissions occurring at the manufacturer.

This varies not only by product type but also by manufacturer and country of manufacture, based on energy source, manufacturing environment, and specific manufacturing processes.



## PACKAGING AND TRANSPORT

This includes packaging of menstrual products and transportation from the manufacturing site to the point of use.

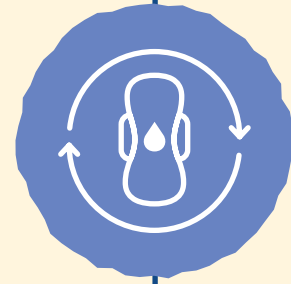
The weight of each product and its packaging, as well as the overall distance traveled, influence the impact from packaging and transport. Menstrual products may be individually wrapped in plastic or cotton and are typically packaged in cardboard containers. Container ships are a major mode of transport for menstrual products shipped internationally, and trucks typically provide road transport.



## USE

This includes energy, materials consumed, and emissions during the washing or laundry process for reusable products.

It can also include the typical number of times a product can be used and the number of products needed per year or per menstrual cycle.



## DISPOSAL

This includes transportation of waste, waste treatment (e.g., incineration, disposal in landfills), and other forms of disposal (e.g., flushing down toilets).

The product's composition influences how long it will take to break down as well as any harmful chemicals released during the disposal process.



---

Adapted from: [Fourcassier et al. 2022](#)



# Emerging Innovations and New Frontiers for Climate-Responsive Menstrual Products

## RAW COMPONENTS

### Reusable Tampon Applicators

DAME has developed a **reusable tampon applicator** to reduce waste from single-use plastic applicators. The applicator is self-sanitizing and plastic free. By eliminating single-use plastic applicators, the reusable applicator reduces the overall emissions from both raw materials and manufacturing processes. Since the reusable applicator only needs to be rinsed, it is less energy- and water-intensive to clean than other sustainable menstrual product options, which require more resources for washing. The applicator can be reused for up to 10 years.<sup>17</sup>

## PRODUCT MANUFACTURING

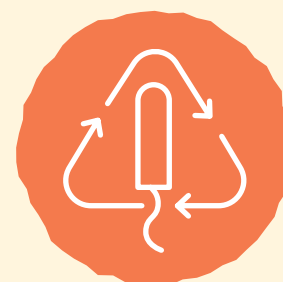
### Local and Regional Manufacturing

When trying to make menstrual health products more accessible for women in Kenya, ZanaAfrica realized that because menstrual products are so lightweight, long-distance transport costs were expensive. Working with Kenyan women, ZanaAfrica developed a locally manufactured single-use alternative, the Nia pad, with biodegradable and reusable alternatives in development. With the right enabling environment and policies in place, investing in local manufacturing can reduce the cost of goods sold, improve profit margins, and keep the prices to end consumers lower, making products more accessible. Doing so also reduces emissions associated with long-distance transportation.<sup>18</sup>

## PACKAGING AND TRANSPORT

### Low-Waste Packaging and Shipping

Many menstrual product suppliers are shifting towards product packaging that uses recyclable or compostable materials, uses less materials, or reduces components. For example, Aunt Flo designed their packaging to minimize waste and reduce emissions, including removing unnecessary items like banding straps. Aunt Flo also changed their shipping approach: shipping their products by full containers instead of air freighting goods reduced their greenhouse gas emissions in the supply chain by 47x.<sup>19</sup>



<sup>17</sup> Sheriff 2019

<sup>19</sup> Aunt Flo

<sup>18</sup> ZanaAfrica

## USE

### Self-Cleaning Menstrual Cups

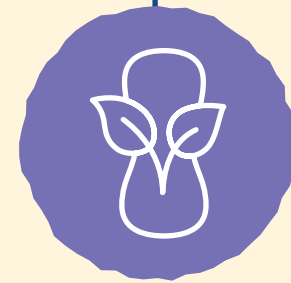
Researchers have developed **self-cleaning menstrual cups** using a silicone-based coating on the surface of the cup and a plant-based, super-absorbent tablet inside the cup. This resulted in less spillage, fewer bacteria, and easier clean-up, which could make menstrual cups easier to use in low-water contexts, as well as more convenient to use.<sup>20</sup>



## DISPOSAL

### Biodegradable Pads from Plant Materials and Agricultural Waste

Researchers have begun testing **biodegradable pads that use sugarcane, banana, and plantain waste** as a biodegradable, super-absorbent core in sanitary pads. These pads reduce the need for fossil-fuel based plastic products in the pads and are compostable. By repurposing agricultural waste, they have the potential to be part of lower-impact manufacturing processes across sectors. Kodu Technology's approach in Ghana directly links the production of these menstrual health products with job creation for women in rural areas.<sup>21,22</sup>



<sup>20</sup> Moghimikandelousi et al. 2025

<sup>22</sup> Pant et al. 2025

<sup>21</sup> Kodu Technology



# Understanding *the* Climate Impact of Key Menstrual Health Products

In this section, we highlight a few of the most common menstrual products, looking across their product life cycles to explore their contribution to carbon emissions—and opportunities for strengthening sustainability.

We've provided the carbon emissions as the estimate of kilograms of CO<sub>2</sub> equivalent per user per year in India, as estimated by Fourcassier et al. (2022). Fourcassier et al.'s estimates are consistent with other research, but it is important to note that in practice, actual emissions vary by product type, brand, use behaviors, manufacturing site, manufacturing methods, geography of use, and more.



# SINGLE-USE PADS



## How They're Made

**Raw materials and manufacturing:** Disposable pads are often made with a wood pulp and polyethylene or superabsorbent polymer (SAP) absorbent core. Polyethylene or polypropylene are typically used to form the waterproof bottom layer and the wicking top layer. Polyacrylate polymer foams may also be used for the absorbent cores. These materials may be bleached using an elemental chlorine-free process. Adhesives, colorings, silicone-coated paper peel strips, may also be added.<sup>2-4</sup>

### Other components and materials:

- Plastic wrapping for individual pads
- Outer packaging (often plastic-coated cardboard) for distribution of pads to consumers
- Adhesives for wings (if applicable)
- Generally designed to be worn with underwear



## Getting to Market

**Shipping and local procurement:** Large-scale manufacturers typically employ centralized manufacturing approaches in regional hubs. Smaller-scale enterprises may import white-label products, often produced in China, as well as India, other Asian countries, or Middle Eastern countries.<sup>5</sup>

## CARBON EMISSIONS

ESTIMATED

~11.12 kg

CO<sub>2</sub>-EQ PER YEAR.<sup>1</sup>

The majority of emissions come from raw material production and disposal.<sup>2</sup>



## Product Life Cycle

**Number of uses:** Single-use only, with an average of 20 pads needed per cycle depending on absorbency and flow.<sup>3</sup>

### Disposal and decomposition:

- Most single-use pads contain plastics that take up to 500 years to break down in landfills.<sup>2</sup>
- Burning single-use pads incorrectly creates toxic emissions like dioxins.<sup>6,7</sup>
- Traditional single-use pads are not compostable or recyclable; compostable pads are newer, and may be more costly and less accessible as a result.<sup>4</sup>
- Disposal in flush toilets, pit latrines, and other toilets can cause sewage blockages and microplastic pollution.<sup>2,7</sup>



## Developing Climate Resilient Approaches



### PRODUCT FACTS AND CONSIDERATIONS:

- Single-use pads are the most widely used product worldwide; in countries where data exist, they generate the largest volume of menstrual waste.<sup>8,9</sup>
- Single-use pads have a high water and energy footprint from pulp processing, plastic production, and packaging.<sup>1,8,10,11</sup> Overall emissions may be lower when accounting for carbon sequestration in wood products (estimated ~3.03 kg CO<sub>2</sub> equivalent per user per year).<sup>3</sup>
- Pads are often preferred and considered aspirational by many people who menstruate due to ease of use, comfort, reliability, and cultural norms. In many regions, they are the most accessible and socially acceptable commercial menstrual management product.<sup>7, 8,12,13</sup>
- Single-use pads have a lower upfront cost than reusable products, which makes them more accessible, particularly in LMIC contexts. However, they are significantly more expensive over time than reusable alternatives.<sup>8, 13</sup>
- Since single-use pads have existed much longer than alternative products, they have more widely established product standards, a broader geographic distribution of manufacturing facilities, and manufacturing at scale.<sup>11,14</sup>



### RISKS AND LIMITATIONS TO CONSIDER:

- Assessing the full environmental and health impact of single-use pads is difficult due to lack of transparency from manufacturers about chemical composition.<sup>14</sup>
- Microplastic pollution can occur from degradation of plastic components over time.<sup>12</sup>
- Safe disposal of single-use pads is highly reliant on strong waste management infrastructure; in areas with inadequate waste infrastructure, used pads may end up in open dumps, pit latrines, or waterways.<sup>8,11</sup>



### OPPORTUNITIES FOR INNOVATION:

- Plant-based pads (e.g., bamboo, banana fiber, organic cotton, agricultural waste fibers) with biodegradable or compostable components can be an effective alternative to traditional materials for single-use pads.<sup>10,15</sup>
- Plastic-free wrappers and packaging can reduce emissions.
- Reusable pad designs are gaining traction among bulk buyers.
- Regional production is one way to reduce carbon emissions and support circularity.

#### References

1 Fourcassier et al. 2022  
2 Notten et al. 2021  
3 Hait and Powers 2019

4 Blignaut et al. 2025  
5 RHSC 2021  
6 Weber et al. 2024  
7 UNICEF 2019

8 Harrison and Tyson 2022  
9 Blair et al. 2022  
10 Mirzaie et al. 2025  
11 Auja et al. 2024

12 Sommer et al. 2020  
13 van Eijik et al. 2021  
14 Mahajan et al. 2025  
15 Paul et al. 2026

# TAMPONS



## How They're Made

**Raw materials and manufacturing:** Tampons have an absorbent core, typically made from viscose, rayon, cotton, or cotton-rayon blends. Non-organic tampons may also have a polyethylene or polypropylene cover to support smooth removal. Tampons have a withdrawal string that may be made from polyester, rayon, or cotton. These materials may be bleached using an elemental chlorine-free process. Plastic tampon applicators are typically made of polyethylene, polypropylene, and colorants, though some brands use cardboard applicators. Assembly requires integration of multiple material components, including plastics and synthetics.<sup>2,3</sup>

### Other components and materials:

- Plastic wrapping for individual tampons
- Outer packaging (often plastic-coated cardboard) for distribution of tampons to consumers
- Clean water and soap for handwashing before and after insertion



## Getting to Market

**Shipping and local procurement:** Most major tampon brands use centralized manufacturing approaches in regional hubs. Applicators (especially plastic) are often sourced globally. Most white-label tampons are manufactured in Europe.<sup>4</sup> Because of their simpler design, tampons without applicators can be shipped in smaller, lighter-weight packages, resulting in a comparatively lower shipping footprint and reduced transport emissions.

## CARBON EMISSIONS

ESTIMATED

~6.22 kg

CO<sub>2</sub>-EQ PER YEAR.<sup>1</sup>

The largest emissions drivers are rayon/cotton production, raw material extraction, production of the products (including the applicator), and packaging.<sup>2</sup>

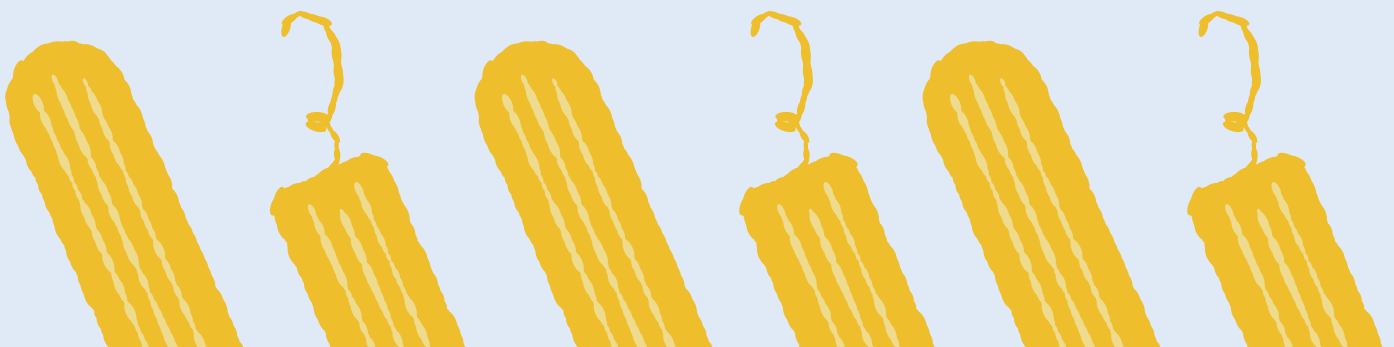


## Product Life Cycle

**Number of uses:** Single-use only, with an average of 20 tampons needed per cycle depending on absorbency and flow.<sup>3</sup>

### Disposal and decomposition:

- Plastic applicator-based tampons create significant plastic waste. Tampons cannot be recycled.<sup>1,5-7</sup>
- Plastic components, like plastic applicators, and other synthetic materials can take up to 500 years to break down in landfills.<sup>2</sup>
- Burning tampons incorrectly creates toxic emissions like dioxins.<sup>7</sup>
- Tampons and tampon components made from natural materials, such as cotton tampons and cardboard applicators, can biodegrade more quickly than those made from synthetic materials.<sup>5,7</sup>
- Disposal in flush toilets, pit latrines, and other toilets can cause sewage blockages and microplastic pollution.<sup>2,7</sup>





## Developing Climate Resilient Approaches



### PRODUCT FACTS AND CONSIDERATIONS:

- Most studies do not differentiate between tampons with and without applicators. Elimination of the applicator reduces overall environmental impacts, but their footprint is still far higher than reusable products.<sup>1-3</sup>
- Some brands are shifting to plant-based or recyclable cardboard applicators.<sup>3</sup>
- Tampons provide a comfortable and discreet menstruation management option for users who choose this method. Tampons without applicators are more common in regions where users are comfortable using a finger to insert the tampon.



### RISKS AND LIMITATIONS TO CONSIDER:

- Tampons have a lower upfront cost than reusable products, which makes them more accessible, particularly in LMIC contexts. However, they are significantly more expensive over time than reusable alternatives.<sup>5,8</sup>
- In many regions, there are cultural barriers to internal menstrual products. Since tampons without applicators must be inserted manually, typically using a finger, there may be resistance towards these products in communities where such practices are uncommon or taboo.<sup>9</sup>
- Handwashing with soap and clean water before and after insertion is important to reduce the risk of infection, especially for tampons without applicators.<sup>7</sup>
- Tampon availability varies across global supply chains.<sup>4</sup>



### OPPORTUNITIES FOR INNOVATION:

- Biodegradable applicators (sugarcane, bamboo fiber) and reusable applicators can be an effective alternative to plastic applicators.
- Tampons that use recyclable single-material designs can reduce climate impacts related to production and degradation.<sup>6</sup>
- Plastic-free wrappers and packaging can reduce emissions.
- Localized manufacturing can reduce transport emissions.

---

#### References

1 Fourcassier et al 2022  
2 Notten et al. 2021

3 Hait and Powers 2019

4 RHSC 2021

5 Harrison and Tyson 2022

6 Auja et al 2024

7 UNICEF 2019

8 van Eijik et al. 2021

9 UN Women 2025

# MENSTRUAL CUPS



## How They're Made

**Raw materials and manufacturing:** Most menstrual cups are made out of medical-grade silicone derived from silica (sand). They are generally made by injecting heated silicone into molds. Cups can also be made of thermoplastic elastomer (TPE) or rubber.<sup>3-5</sup>

### Other components and materials:

- Soap and water for handwashing before and after removal and insertion
- Clean water to rinse the cup out every 6-12 hours
- Boiling water to clean the cup at the end of each cycle
- Outer packaging (often plastic-coated cardboard) for distribution of cups to consumers
- Cotton pouch to store cup



## Getting to Market

**Shipping and local procurement:** Menstrual cups are often manufactured in China, Europe, and North America, with a few brands in India and South Africa, such as ShePowHer.<sup>6</sup>

### CARBON EMISSIONS

ESTIMATED

# 0.066 kg

CO<sub>2</sub>-EQ PER YEAR.<sup>1</sup>

Emissions are often driven by silicone production, cotton storage pouches, cardboard packaging, and disposal.<sup>2</sup>

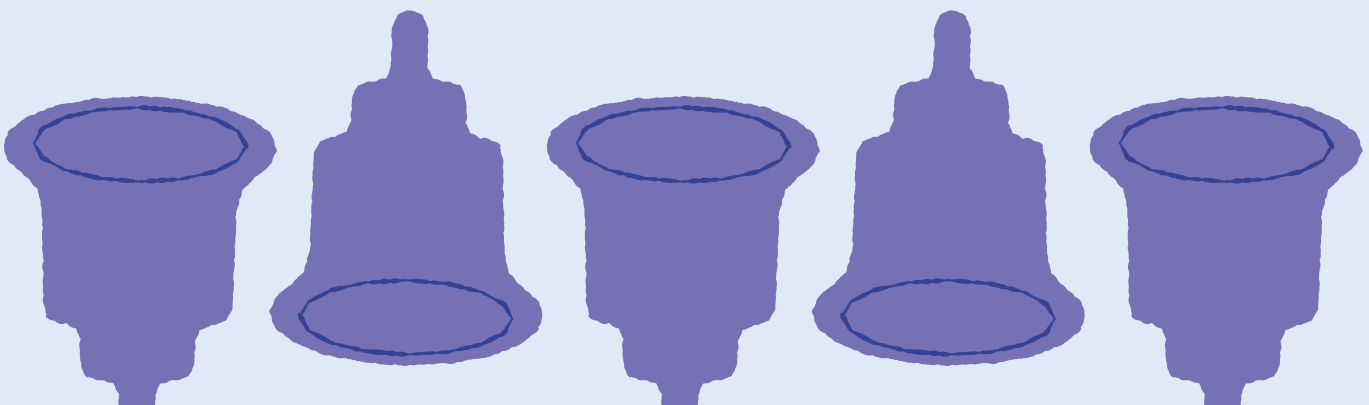


## Product Life Cycle

**Number of uses:** 1 cup is needed per cycle. A single cup can be used for up to 10 years.<sup>2</sup>

### Disposal and decomposition:

- There is no formal guidance on end-of-life disposal for menstrual cups.
- Most menstrual cup materials do not easily degrade in landfills. When landfilled, cups made from TPE can contribute to toxic gases, microplastic pollution, and water pollution. Recycling options for materials like silicone and TPE are limited.<sup>7-8</sup>
- Silicone menstrual cups can be incinerated with household waste, leaving behind only silica ash, CO<sub>2</sub>, and water.<sup>7</sup>
- Over 5 years, using menstrual cups can avert approximately 99% of the volume of waste that would be generated by single-use products.<sup>9</sup>



## Developing Climate Resilient Approaches



### PRODUCT FACTS AND CONSIDERATIONS:

- Menstrual cups are estimated to have the lowest environmental impact of any menstrual health product, with less than 1.5% of the impact of tampons or pads.<sup>2</sup>
- Even if a cup is used for just one or two cycles, it is estimated to be lower impact than non-reusable options.<sup>2</sup>
- Menstrual cups use less water than other reusable products that require washing, like reusable cloth pads and menstrual underwear.<sup>1,4</sup>
- Menstrual cups have minimal health risks, like toxic shock syndrome, infections, and skin irritations, compared to other menstrual materials.<sup>4</sup>



### RISKS AND LIMITATIONS TO CONSIDER:

- Menstrual cups may have low initial acceptability in regions where insertable menstrual products are not used.<sup>4</sup>
- Menstrual cups may leak; leakage may be associated with cup placement, uterine anatomy, or cup size. Additional guidance may be required to ensure correct insertion, particularly for users who also have IUDs.<sup>4,10</sup>
- The high up-front cost of menstrual cups is a barrier to access, despite their lower cost per year and lifetime cost.<sup>2-4</sup>
- Access to clean water and soap is essential for safe use of menstrual cups. Users may throw away reusable products when water is not available.<sup>4,11</sup>
- National and organizational standards approvals may limit accessibility.<sup>12</sup> In some countries, menstrual cups are considered medical devices and cannot be sold retail.
- Impact estimates need to more deeply consider LMIC contexts, including manufacturing availability, shipping distances, and water and fuel for washing cups. Analyses to date suggest the menstrual cup is the lowest impact option in these contexts, but are limited in their scope.<sup>1-2</sup>



### OPPORTUNITIES FOR INNOVATION:

- Lower the carbon emissions of menstrual cups further by developing lower-emissions packaging and storage pouches.<sup>2</sup>
- Expand local manufacture of menstrual cups to reduce emissions associated with shipping.
- Provide education and socialization around proper use and disposal of menstrual cups to ensure the benefits of menstrual cups are maximized.
- Make menstrual cups more accessible by lower up-front costs through payment plans and innovative financing mechanisms.

#### References

[1 Fourcassier et al. 2022](#)

[2 Notten et al. 2021](#)

[3 Hait and Powers 2019](#)

[4 UNICEF 2019](#)

[5 van Eijik et al. 2021](#)

[6 RHSC 2021](#)

[7 Wolf and Stammer 2024](#)

[8 Fazil and Rodrigue 2020](#)

[9 Cabrera and Garcia 2019](#)

[10 van Eijik et al. 2021](#)

[11 Schmitt et al. 2020](#)

[12 SHF 2025](#)

# PERIOD UNDERWEAR



## How They're Made

**Raw materials and manufacturing:** Period underwear are typically made from a combination of natural and synthetic fibers. They are generally composed of multiple layers, including a wicking layer, an antimicrobial layer, an absorbent layer, and a leak-resistant outer layer. Absorbent layers often use petroleum-based materials like polyurethane laminate, polyester microfibers, and sometimes super-absorbent polymer technology. Per- and Polyfluoroalkyl Substances (PFAS) are used in some period underwear for water repellence and stain resistance, despite risks to female reproductive health. Manufacturing involves multi-layer textile assembly.<sup>3-7</sup>

### Other components and materials:

- Detergent and water for washing after each use
- Stain removers (optional)
- Mesh laundry bags for gentle washing (optional)



## Getting to Market

**Shipping and local procurement:** Many period underwear brands manufacture in major textile and apparel hubs across Asia, requiring transcontinental shipping. Some regional brands (US, EU, Australia) exist, but often still rely on imported textiles.

## CARBON EMISSIONS

ESTIMATED

~0.54 kg

CO<sub>2</sub>-EQ PER YEAR.<sup>1</sup>

Emissions are primarily driven by textile production and laundering.<sup>1-2</sup>

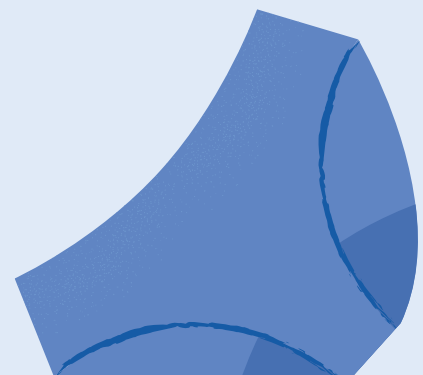
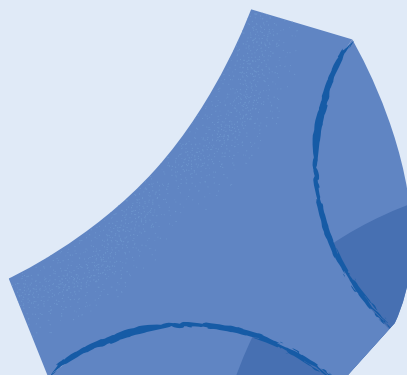
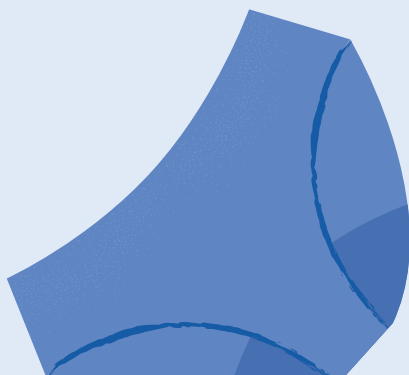


## Product Life Cycle

**Number of uses:** 3 pairs are typically needed to cover a full cycle, depending on laundry frequency and flow. Period underwear are reusable for up to 5 years depending on care and fabric quality.<sup>1</sup>

### Disposal and decomposition:

- Synthetic components will take hundreds of years to break down in landfill.
- PFAS-containing underwear can release persistent chemicals during disposal.<sup>5-7</sup>
- Period underwear are currently not recyclable due to their multi-layer fabric blends. Some brands are exploring textile take-back programs, but uptake is limited.



## Developing Climate Resilient Approaches



### PRODUCT FACTS AND CONSIDERATIONS:

- Period underwear has a lower environmental impact than disposable pads or tampons, but higher than menstrual cups.<sup>1,2</sup>
- Period underwear requires consistent washing. In regions without efficient washing machines, this can result in high water use.<sup>2</sup>
- Among users, period underwear has high acceptability and comfort. These products are particularly popular among teens and people new to reusable products.



### RISKS AND LIMITATIONS TO CONSIDER:

- Period underwear requires access to clean water, soap, and adequate drying conditions, which may be challenging in water-stressed regions, humid climates, or humanitarian settings. Social stigma around washing and drying menstrual materials remains a barrier in many regions.<sup>8</sup>
- Machine drying generates significantly higher emissions compared to line drying.<sup>2</sup>
- Some period underwear products contain PFAS, raising concerns about potential human and environmental health impacts.<sup>4-7</sup>
- These products are typically more expensive upfront than pads or tampons, though they may be cheaper over 2-3 years<sup>1</sup>
- National and organizational standards approvals may limit accessibility.<sup>9</sup>



### OPPORTUNITIES FOR INNOVATION:

- Develop PFAS-free and plastic-free waterproofing technologies to reduce plastics in period underwear.
- Use biodegradable absorbent layers derived from cellulose or waste fibers to reduce emissions associated with current absorbency materials.
- Develop monomaterial designs to support future textile recycling.
- Scale local manufacturing hubs to reduce emissions from shipping.

#### References

[1 Fourcassier et al. 2022](#)

[2 Notten et al. 2021](#)

[3 Peberdy et al. 2019](#)

[4 VanLeeuwen and Torondel 2018](#)

[5 Wicks et al. 2025](#)

[6 Good and Charbonnet 2025](#)

[7 Mogale et al. 2024](#)

[8 Schmitt et al. 2020](#)

[9 SHF 2025](#)

# REUSABLE CLOTH PADS



## How They're Made

**Raw materials and manufacturing:** Cloth sanitary pads are typically made from cotton, bamboo, hemp, or natural/synthetic textile blends. Their absorbent cores use cotton fleece, bamboo terry, or synthetic microfiber. Their waterproof layers often use polyurethane laminate (PUL), polyester/nylon fabrics, or other synthetic water-repellent materials, though sometimes biopolymers are used. Manufacturing ranges from local micro-enterprises to larger textile producers; many pads are handmade or small-batch produced.<sup>4-5</sup>

### Other components and materials:

- Detergent and water for washing after each use
- Stain removers (optional)
- Mesh laundry bags for gentle washing (optional)
- Storage pouches (optional)



## Getting to Market

**Shipping and local procurement:** Cloth pads are highly feasible for local production, including community-based enterprises and women-led cooperatives. Some components may still require import (e.g., PUL, snaps, microfiber). Locally sourced fibers significantly reduce transport emissions.

### CARBON EMISSIONS

ESTIMATED

~0.6 kg

CO<sub>2</sub>-EQ PER YEAR.<sup>1</sup>

Emissions are primarily driven by textile production and laundering.<sup>1,2</sup>



## Product Life Cycle

**Number of uses:** 5-10 pads minimum per cycle depending on absorbency and washing frequency. Cloth pads are reusable for 2-5 years depending on material quality and laundering.<sup>1,6</sup>

### Disposal and decomposition:

- Natural-fiber pads (cotton, bamboo, hemp) are biodegradable over a period of several months, depending on fabric weight. Plastic and synthetic components take longer to biodegrade, and microplastic pollution can occur from degradation of plastic components over time.<sup>1,3,7</sup>
- Reusable cloth pads are not recyclable due to their multi-layer construction and sanitary waste regulations. However, clean end-of-life pads can be repurposed as cleaning cloths or textile fill.
- Disposal in flush toilets, pit latrines, and other toilets can cause sewage blockages and microplastic pollution.<sup>8</sup>



## Developing Climate Resilient Approaches



### PRODUCT FACTS AND CONSIDERATIONS:

- Handwashing with cold water and line-drying significantly reduces the carbon impact of reusable cloth pads.<sup>3</sup>
- Compared to disposable pads and tampons, cloth pads have a much lower environmental impact and are generally more affordable long term.<sup>1,3</sup>
- Reusable cloth pads have high acceptability in areas where cultural norms support washing and drying.<sup>6,8</sup>



### RISKS AND LIMITATIONS TO CONSIDER:

- Cloth pads require access to clean water, soap, and adequate drying conditions, which may be challenging in water-stressed regions, humid climates, or humanitarian settings.<sup>6,8</sup>
- Cloth pads with synthetic cores or waterproofing are not fully plastic-free.
- The quality of cloth pads varies widely; poorly made pads may leak or degrade quickly.<sup>6</sup>
- Social stigma around washing and drying menstrual materials remains a barrier in many regions.<sup>6,8</sup>
- Cloth pads have lower absorbency compared to disposable pads for very heavy flow and thus must be changed frequently.
- National and organizational standards approvals may limit accessibility.<sup>12</sup>



### OPPORTUNITIES FOR INNOVATION:

- Develop PFAS-free and plastic-free waterproofing technologies to reduce plastics in cloth pads.
- Use monomaterial designs to support future textile recycling.
- Scale community-based production with standardized quality control to increase accessibility.

---

#### References

1 Fourcassier et al. 2022

2 Mirzaie 2025

3 Notten et al. 2021

4 Paul 2025

5 Rajah et al. 2025

6 UNICEF 2019

7 Foster and Montgomery 2021

8 Schmitt et al. 2020

# Advancing Data *and* Transparency *across the* Menstrual Product Life Cycle

## Evidence about the connections between menstrual health products and climate change is growing—

but significant data gaps create barriers to fully quantifying the contribution of menstrual health products to global greenhouse gas emissions, including limiting the level of detail that can be provided in this report. Addressing these gaps would enable more accurate impact assessments—so menstrual product stakeholders could make more informed decisions, scale effective approaches, and realize their full potential as contributors to a more climate-resilient future.

## **PROPRIETARY INFORMATION**

### **Greater transparency would strengthen our ability to effectively compare products—and consumers' ability to make informed decisions based on specific products' environmental impacts.**

Menstrual health product designs and manufacturing processes are considered proprietary information. As a result, information about the type and quantity of materials used and the resources required for manufacturing is typically not publicly available. Though recent shifts in product reporting requirements have expanded transparency around materials used and chemical treatment of menstrual health products, disclosure remains inconsistent in terms of the degree of specificity and quantities used. Moreover, because this information is provided with a consumer protection lens, rather than a climate or environment lens, it does not typically have the level of detail required to facilitate in-depth impact assessments.

## **PRODUCT DIVERSITY**

### **More detailed information about how specific design features influence total product emissions would accelerate sustainability innovations across all types of menstrual health products.**

Even within a single menstrual health product category (e.g., single-use pads, washable pads, tampons, menstrual cups), the products themselves can be highly diverse in terms of their compositions. For example, tampons come in different sizes (different quantities of raw materials), may be produced from a range of materials (different types of raw materials), and may or may not include an applicator (different manufacturing and decomposition impacts). This complexity makes it difficult for impact analyses to cover the full scope of product features—meaning that current assessments of emissions contributions may be inaccurate, and advantageous design features may be going unaccounted for.

## SUPPLY CHAIN

### **Disclosures around manufacturing and shipping could further improve LCA results and amplify efficient approaches.**

As with information about raw materials and manufacturing processes, information about supply chains, including specific manufacturers, manufacturing sites, shipping modalities, and distance traveled, are typically not publicly available. Locally manufactured products are often not included in life cycle analysis (LCA) studies. However, menstrual product researchers have developed robust estimation approaches with the information available in LCA studies, such as incorporating multiple products and multiple geographies into their estimates.<sup>17</sup>

## TYPICAL USE

### **Collecting data around typical menstrual health product use behaviors in a range of contexts—especially in LMICs—and using this data to inform LCA results would enable these analyses to better reflect real-world use.**

People who menstruate often have different patterns of product use and preference. For example, some people may only use one type of product to meet all of their menstrual health needs. Other menstruators may try a product for only a short period of time, or they may use multiple types of products within a cycle. For example, they may use tampons and menstrual underwear, or they may use a menstrual cup for only a few months instead of its full 10 year lifespan. LCA studies account for this by looking at combinations of products, accounting for menstruators needing several menstrual products within the same product category (e.g., needing 2 menstrual cups), and looking at the impact of using reusable products for only a short duration (e.g., one cycle).<sup>7,23,18</sup>

## TRADE-OFFS

### **Robust quantification of design and manufacturing trade-offs would enable evidence-based decision-making around the most effective strategies for emissions reductions for menstrual health products.**

Each product type and manufacturing approach has distinct advantages and costs. For example, locally manufactured products may have a shorter distance to reach the user, and thus generate fewer emissions during shipping. However, it is often difficult for local manufacturers to compete with centralized manufacturers, who are often more established, less costly, and are better equipped to meet global safety standards. Similarly, centralized manufacture can generate cost-saving efficiencies, but imported products are often subject to tariffs and other import fees that are passed down to the consumer at point of sale.

---

<sup>17</sup> Fourcassier et al. 2022

<sup>18</sup> Notten et al. 2021

## PRODUCT STANDARDS

**Strengthened product standards could improve the accessibility and profitability of sustainable menstrual health products, while ensuring consumer safety.**

Gaps in product standards are frequently a barrier to scaling new menstrual health products, which can keep sustainable products from reaching key markets and ultimately, becoming profitable. A lack of product standards and ingredient transparency also mean that limited evidence exists around product toxicity, including potential negative impacts on both humans and the environment. RHSC's ongoing work to advance product standards in LMICs is a critical step towards improving global understanding of the environmental impacts of menstrual commodities.

## ENVIRONMENTAL AND END-OF-LIFE COSTS

**Cradle-to-grave cost data would create a runway for developing product responsibility approaches that ensure menstrual health products are affordable and accessible for consumers.**

One major advantage of single-use products like pads and tampons is their comparatively low up-front cost compared to reusable products. Particularly for low-income menstruators, product affordability is critical to making products more accessible and enabling safe and dignified menstruation management. However, the costs of single-use products do not reflect the true cradle-to-grave costs, including costs of disposal and long-term environmental impacts, which currently must be borne by consumers and their communities. Internalizing these costs into the sale price could close the price gap between single-use and reusable products—but could come at the risk of making all menstrual products unaffordable for vulnerable groups and exacerbating gender inequities. With more geographies instituting extended product responsibility policies, it is imperative for menstrual health stakeholders to have comprehensive cost assessments so they can effectively develop strategies to ensure a range of menstrual health products, including reusables, are safe and accessible.

## CLIMATE RESILIENCE

**Evidence about how menstrual products contribute to climate resilience could be used to mobilize investment and action benefitting climate-impacted menstruators.**

Access to the knowledge, products, and resources needed for menstrual health management is critical for addressing gender inequity, particularly via women and girls' access to education, ability to earn income, and overall health.<sup>19</sup> Gender equity, education, income, and health are all critical elements of climate resilience.<sup>20,21</sup> However, right now, there is little-to-no evidence about how access to menstrual products may benefit climate resilience—or how specific product characteristics may enhance resilience to climate change in climate-impacted contexts. Such evidence is an important part of ensuring menstrual health is a part of adaptation agendas—and essential to developing and scaling menstrual products that are responsive to menstruators' evolving needs and preferences in a changing climate.

---

<sup>19</sup> UNICEF 2019  
<sup>20</sup> UNDP 2026

<sup>21</sup> Chapagain et al. 2025

# Looking Forward: Driving Collective Action *for a More Sustainable* Menstrual Product Marketplace

Moving towards a more sustainable menstrual product marketplace requires all stakeholders to participate along the product's entire life cycle.

While there is a focus on the visible issue of menstrual health waste, a significant amount of menstrual health products' climate contributions occur upstream, in raw material sourcing, energy-intensive manufacturing, and long-distance transport. Coordinated action to develop innovative approaches, generate evidence, refine procurement strategies, and advocate for effective practices is essential for scaling solutions that meet both user needs and climate adaptation needs. True change will require not only product innovation, but also innovation within business models and broader health and waste management systems to ensure that a wide range of lower-carbon options are available at affordable prices.





*“Novel menstrual products (including cups, reusable pads or period underwear) are more durable and sustainable, increase choice to users and significantly reduce cost. The absence of standards for these products have prevented their introduction across many markets in LMICs.”*

—**The Sanitation Hygiene Fund (SHF)**,  
*Global Standards for Menstrual Products:  
Shaping a Thriving Menstrual Health  
Market for All*

**Global policy also has an important role to play.** While COP30 failed to reach consensus on how the global community will approach climate mitigation, the agreement to triple adaptation finance by 2035 may signal continued opportunities for government commitment and resourcing for climate adaptation efforts. Within the UNFCCC framework, the Belem Gender Action Plan will accelerate momentum for climate-responsive gender action, even if menstrual health was not addressed explicitly. Supportive health policy is equally important: standards for novel menstrual products, supportive fiscal and tariff environments, and product transparency requirements are all vital for ensuring novel sustainable menstrual products are accessible to users, and for fostering lower-carbon approaches among traditional products.<sup>10,22</sup>

**On a planet increasingly impacted by the climate crisis,** menstrual product supply chains offer a rich opportunity for developing and scaling lower-carbon, more sustainable strategies. By reducing greenhouse gas emissions in menstrual health supply chains, the menstrual health sector can contribute progress towards organizational, national, and global climate mitigation goals. Doing so would offer a critical model that other reproductive commodities could follow.

**Users of menstrual products must remain at the center** of sustainability efforts. Menstruators should not bear the brunt of the climate crisis. Menstrual products must be developed in a way that is better adapted to the effects of climate change. They should be responsive to the ways users' needs and preferences change in the face of the climate crisis (and beyond). Ultimately, these shifts will contribute to improved access to menstrual health products of choice for all people who menstruate, resulting in greater dignity, increased gender equality, and improved health.

<sup>22</sup> SHF 2025

# Recommendations



**CENTER USERS** and align sustainability goals with user dignity, feasibility, and choice in diverse use contexts. Conduct rigorous research that documents not only the environmental impacts of different product types, but also the benefits for menstruator access to products, health, and well-being. Ensure a wide availability of product options suitable to each context, and consider the impact of climate change on the context of use.



**FOSTER GREATER TRANSPARENCY** around climate impacts across the menstrual health product life cycle. Develop a shared repository of menstrual health-climate data—covering emissions, materials, manufacturing, and end-of-life—to guide procurement, purchasing, and innovation. Advocate for global and national product standards that include ingredient disclosures, product safety (e.g., toxicity and consumer protection), and environmental considerations.



**PILOT INNOVATIONS** in product design, manufacturing, shipping, use, and disposal to reduce the climate impact of menstrual health products from end to end. Ensure innovations consider high quality alignment with updated global standards and low cost of goods sold (COGS). Advocate for stronger enforcement of intellectual property and patent laws to incentivize innovation.



**SUPPORT SCALING** of local and regional manufacturers and innovative products through transparency around procurement guidelines, strengthening information around product testing requirements, coordinated advocacy around standards for emerging reusable and sustainable products, and expanding information networks. Develop a shared database of manufacturers to facilitate procurement and purchase of lower emissions or locally manufactured products.



**ENGAGE IN CLIMATE POLICY** at global, national, and sub-national levels. Engage policy and donor communities to address upstream factors—like material sourcing, manufacturing emissions, and financing—to scale sustainable solutions. Position the menstrual health sector as an active participant and potential exemplar in both climate mitigation and climate adaptation. Within menstrual health policies, integrate climate mitigation and adaptation to ensure menstrual health products and programming meet climate adaptation needs and support scale-up of new, more sustainable menstrual health product options.

# Resource Toolbox



Visit our **Climate Change and Menstrual Health Partner Database** to discover new partners and key stakeholders working to advance sustainable, climate-resilient solutions for menstrual health.

## FOUNDATIONAL RESEARCH ON MENSTRUAL HEALTH AND CLIMATE CHANGE

**Menstrual Health, Climate Change, and Resilience:** UNFPA, 2025

**Environmental Impact of Menstrual Hygiene Products:** Aujla et al., 2025

## ENVIRONMENTAL IMPACT OF MENSTRUAL HEALTH PRODUCTS

**Single-use menstrual products and their alternatives: Recommendations from Life Cycle Assessments:** Notten et al., 2021

**Menstrual products: A comparable Life Cycle Assessment:** Fourcassier et al., 2021

**The Environmental & Economic Costs of Single-Use Menstrual Products, Nappies, & Wet Wipes:** REZERO, 2019

**Design-based classification of sanitary napkins with a focus on sustainable solutions and safety standards—a comprehensive review:** Joseph et al. 2026

## IMPLEMENTING LOWER-CARBON APPROACHES FOR MENSTRUAL HEALTH PRODUCTS

**Beyond waste and reusables: redefining sustainability in menstrual policies:** SEI, 2024

**Guide to Menstrual Hygiene Materials:** UNICEF, 2019

**Menstrual Disposal, Waste Management, & Laundering in Emergencies: A Compendium:** Columbia University and IRC, 2020

**Sustainable Menstruation in India: Challenges, Innovations, and the Way Forward:** Yadav et al. 2025

# References

- Alugnoa, Desmond N., Trevor Cousins, and Mayumi Sato.** "Period poverty and menstrual belonging: a matter of climate justice." *The Lancet Planetary Health* 6, no. 7 (2022): e551-e552. <https://www.thelancet.com/pdfs/journals/lanplh/PIIS2542-5196%2822%2900141-3.pdf>
- Anand, Uttpal, Meththika Vithanage, Anushka Upamali Rajapaksha, Abhijit Dey, Sunita Varjani, and Elza Bontempi.** "Inapt management of menstrual hygiene waste (MHW): An urgent global environmental and public health challenge in developed and developing countries." *Heliyon* 8, no. 7 (2022). <https://www.cell.com/heliyon/fulltext/S2405-8440%2822%2901147-1>
- Aujla, Mandip, Carmen H. Logie, Anita Hardon, and Manjulaa Narasimhan.** "Environmental impact of menstrual hygiene products." *Bulletin of the World Health Organization* 103, no. 3 (2024): 223. <https://pmc.ncbi.nlm.nih.gov/articles/PMC11865846/>
- Aunt Flo.** "Our sustainability steps." (n.d.). <https://goauntflow.com/sustainability/>
- Bharadwaj, Rita, N. Karthikeyan, Ira Deulgaonkar and Arundhati Patil.** "Women paying the cost of the climate crisis with their wombs: Quantifying loss and damage faced by women battling drought, debt and migration." IIED. (2024). <https://www.iied.org/sites/default/files/pdfs/2024-02/22281IIED.pdf>
- Blair, L. A. G., Yadira Bajón-Fernández, and Raffaella Villa.** "An exploratory study of the impact and potential of menstrual hygiene management waste in the UK." *Cleaner Engineering and Technology* 7 (2022): 100435. <https://www.sciencedirect.com/science/article/pii/S2666790822000404>
- Blignaut, Janine, Hendrik Gideon Visser, Elizabeth Erasmus, and Marietjie Schutte-Smith.** "sanitary pads—composition, regulation, and ongoing research to address associated challenges." *Journal of Materials Science* 60, no. 31 (2025): 13109-13155. <https://link.springer.com/article/10.1007/s10853-025-11151-7>
- Cabrera, Alba and Rosa Garcia.** "The environmental and economic costs of single-use menstrual products, baby nappies, and wet wipes." *Zero Waste Europe*. (2019). [https://zerowasteeurope.eu/wp-content/uploads/2019/12/bffp\\_single\\_use\\_menstrual\\_products\\_baby\\_nappies\\_and\\_wet\\_wipes.pdf](https://zerowasteeurope.eu/wp-content/uploads/2019/12/bffp_single_use_menstrual_products_baby_nappies_and_wet_wipes.pdf)
- Chapagain, Prem Sagar, Tibendra Raj Banskota, Shobha Shrestha, Narendra Raj Khanal, Zhang Yili, Jianzhong Yan, Liu Linshan et al.** "Studies on adaptive capacity to climate change: a synthesis of changing concepts, dimensions, and indicators." *Humanities and Social Sciences Communications* 12, no. 1 (2025). <https://www.nature.com/articles/s41599-025-04453-3>
- Dickin, Sarah, Sara Gabrielsson, Collins Rutto, Priscilla Tatani, and Neville Okwaro.** "Entangled risks: knowledge co-production with sanitation workers to address current and future challenges of handling menstrual waste in informal settlements in Kenya." *Health & Place* 95 (2025): 103513. <https://www.sciencedirect.com/science/article/pii/S1353829225001030>
- EPA.** "Greenhouse gas equivalencies calculator." (2025). <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>
- Fazli, Ali, and Denis Rodrigue.** "Waste rubber recycling: A review on the evolution and properties of thermoplastic elastomers." *Materials* 13, no. 3 (2020): 782. <https://pmc.ncbi.nlm.nih.gov/articles/PMC7040846/>

**Foster, Jasmin, and Paul Montgomery.** "A study of environmentally friendly menstrual absorbents in the context of social change for adolescent girls in low-and middle-income countries." *International journal of environmental research and public health* 18, no. 18 (2021): 9766. <https://pmc.ncbi.nlm.nih.gov/articles/PMC8465734/>

**Fourcassier, Sarah, Mélanie Douziech, Paula Pérez-López, and Londa Schiebinger.** "Menstrual products: A comparable life cycle assessment." *Cleaner Environmental Systems* 7 (2022): 100096. <https://www.sciencedirect.com/science/article/pii/S2666789422000277>

**Good, Samantha, and Joseph A. Charbonnet.** "Extractable Per-and Polyfluoroalkyl substances in menstrual underwear." *Environmental Engineering Science* 42, no. 3 (2025): 137-140. <https://journals.sagepub.com/doi/10.1089/ees.2024.0270>

**Hait, Amy, and Susan E. Powers.** "The value of reusable feminine hygiene products evaluated by comparative environmental life cycle assessment." *Resources, Conservation and Recycling* 150 (2019): 104422. <https://www.sciencedirect.com/science/article/abs/pii/S0921344919303179>

**Harrison, Megan E., and Nichole Tyson.** "Menstruation: Environmental impact and need for global health equity." *International Journal of Gynecology & Obstetrics* 160, no. 2 (2023): 378-382. <https://obgyn.onlinelibrary.wiley.com/doi/full/10.1002/ijgo.14311>

**Hiabu, Abeer, Hannah Tamata, and Chelsea Huggett.** Exploring the links between climate change and menstrual health in the Pacific, Pacific Menstrual Health Network and WaterAid. (2025). [https://washmatters.wateraid.org/sites/g/files/jkxoof256/files/2025-05/Exploring\\_the\\_links\\_between\\_climate\\_change\\_and\\_menstrual\\_health\\_in\\_the\\_Pacific.pdf](https://washmatters.wateraid.org/sites/g/files/jkxoof256/files/2025-05/Exploring_the_links_between_climate_change_and_menstrual_health_in_the_Pacific.pdf)

**Khorsand, Parnian, Sara Dada, Laura Jung, Siufung Law, Poorvaprabha Patil, Marie-Claire Wangari, Omnia El Omrani, and Kim Van Daalen.** "A planetary health perspective on menstruation: menstrual equity and climate action." *The Lancet Planetary Health* 7, no. 5 (2023): e347-e349. [https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196\(23\)00081-5/fulltext](https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(23)00081-5/fulltext)

**Kodu Technology.** "Pioneering sustainable solutions in women health and hygiene." (n.d.). <https://kodutechnology.com/>

**Mahajan, Tanya, Lucy Wilson, Adrian Dongus, and Diana Nelson.** "Well-functioning markets as a lever for improving menstrual health." *Journal of International Affairs*. (2025). <https://jia.sipa.columbia.edu/news/well-functioning-markets-lever-improving-menstrual-health>

**Mirzaie, Azita, Miguel Brandão, and Hamid Zarrabi.** "Toward eco-friendly menstrual products: a comparative life cycle assessment of sanitary pads made from bamboo pulp vs. a conventional one." *Environmental Science and Pollution Research* 32, no. 14 (2025): 9050-9067. <https://link.springer.com/article/10.1007/s11356-025-36269-8>

**Mogale, Refilwe, Marietjie Schutte-Smith, Elizabeth Erasmus, Kantinka De Wet, and Hendrik G. Visser.** "Toward sustainable menstrual health management: focus on super absorbent polymers." *Journal of Materials Science* 59, no. 15 (2024): 6138-6168. <https://link.springer.com/article/10.1007/s10853-024-09519-2>

**Moghimikandelousi, Shaghayegh, Fereshteh Bayat, Lubna Najm, Rida A. Malik, Aishwarya Bhavan, Farbod Azaripour Masooleh, Leisa Hirtz, Jeffrey I. Weitz, Zeinab Hosseinidoust, and Tohid F. Didar.** "Self-cleaning menstrual cups with plant-based biodegradable superabsorbent fibrous tablets for hygienic and sustainable Period Care." *ACS Applied Materials & Interfaces* 17, no. 44 (2025): 61268-61279. <https://pubs.acs.org/doi/full/10.1021/acsami.5c16140>

**Muralidharan, Arundati, Marije Broekhuijsen, Lady Lisondra, Aeka Guru, Jacquelyn Haver, and Sidra Irfan.** "The ripple effect: impacts of climate change on menstrual health and paths to resilience." *Frontiers in Global Women's Health* 6 (2025): 1569046. <https://www.frontiersin.org/journals/global-womens-health/articles/10.3389/fgwh.2025.1569046/full>

**Notten, Phillipa, Alexander Gower, and Yvonne Lewis.** "Single-use menstrual products and their alternatives: Recommendations from Life Cycle Assessments." United Nations Environment Programme. (2021). <https://www.lifecycleinitiative.org/wp-content/uploads/2021/07/UNEP-LCI-Single-use-vs-reusable-Menstrual-Products-Meta-study.pdf>

**Pant, Lakshita, Shrinkhala Upadhyaya, Shishir Kumar Singh, and Bharat.** "Sustainable and Innovative Menstrual Health Materials: A Study on Biodegradable Sanitary Pads Made of Sugarcane Waste." In *Macromolecular Symposia*, p. E70177. (2025) <https://onlinelibrary.wiley.com/doi/abs/10.1002/masy.70177>

**Paul, Suman Chandra, Sherazul Islam, Muhammad Salim Sadman, Mehedi Hasan Emon, Bushra Zaman, Boadrul Islam, Sabuj Hossen, Md Emdad Sarker, and Abdullah Al Mamun.** "Exploring Biodegradable Fibers as Sustainable Alternatives for Sanitary Napkin: A Comprehensive Review." *Environmental Technology & Innovation* (2025): 104735. <https://www.sciencedirect.com/science/article/pii/S2352186425007217>

**Peberdy, Elizabeth, Aled Jones, and Dannielle Green.** "A study into public awareness of the environmental impact of menstrual products and product choice." *Sustainability* 11, no. 2 (2019): 473. <https://www.mdpi.com/2071-1050/11/2/473>

**Rajah, Amina Suleiman, Umar Yunusa, Faiza Tijjani Tashi, Sidetu O. Abdullahi, and Abdulaziz Suleiman Tukuntawa.** "Sustainable menstrual solutions: a scoping review of novel eco-friendly materials for reusable menstrual pads." *Journal of Public Health* 47, no. 1 (2025): e127-e137. <https://academic.oup.com/jpubhealth/article/47/1/e127/7908931>

**RHSC.** Landscaping supply side factors to menstrual health access. Reproductive Health Supplies Coalition. (2021). [https://www.rhsupplies.org/uploads/tx\\_rhscpublications/Landscaping\\_Supply\\_Side\\_Factors\\_to\\_Menstrual\\_Health\\_Access.pdf](https://www.rhsupplies.org/uploads/tx_rhscpublications/Landscaping_Supply_Side_Factors_to_Menstrual_Health_Access.pdf)

**Schmitt, Margaret L., David Clatworthy, Caitlin Gruer, and Marni Sommer.** "Menstrual disposal, waste management, and laundering in emergencies. A compendium." (2020). Columbia University and International Rescue Committee. <https://www.rescue.org/sites/default/files/document/5156/ircolumbiamhmdisposalwmandlaundringinemergencies.pdf>

**Sheriff, Lucy.** Meet the people behind the world's first reusable tampon applicator. *Forbes*. (2019). <https://www.forbes.com/sites/lucysherriff/2019/05/18/meet-the-people-behind-worlds-first-reusable-tampon-applicator/>

**SHF.** "Global standards for menstrual products: Shaping a thriving menstrual health market for all." Sanitation and Hygiene Fund and Capital M. (2025). <https://capital-m.org/sites/default/files/2025-12/Global%20Standards%20for%20Menstrual%20Products.pdf>

**Sommer, Marni, Garazi Zulaika, Margaret L. Schmitt, Samantha Khandakji, Kristin Neudorf, Leeat Gellis, and Penelope A. Phillips-Howard.** "Improving the impact of menstrual health innovations in low-and middle-income countries: a theory of change and measurement framework." *Journal of Global Health Reports* 4 (2020). <https://www.joghr.org/article/12105-improving-the-impact-of-menstrual-health-innovations-in-low-and-middle-income-countries-a-theory-of-change-and-measurement-framework>

**UNDP.** "Why is gender equality crucial for tackling climate change?" (2026). <https://climatepromise.undp.org/news-and-stories/why-gender-equality-crucial-tackling-climate-change>

**UNFPA.** "Menstrual health and the climate crisis." (2023). <https://asiapacific.unfpa.org/en/news/opinion-editorial-menstrual-health-and-climate-crisis>

**UNICEF.** "Guide to menstrual hygiene materials." (2019). <https://www.unicef.org/media/91346/file/unicef-guide-menstrual-hygiene-materials-2019.pdf>

**UN Women.** "Period poverty - why millions of girls and women can't afford their periods." (2025). <https://www.unwomen.org/en/articles/explainer/period-poverty-why-millions-of-girls-and-women-cannot-afford-their-periods>

**Van Eijk, Anna Maria, Naduni Jayasinghe, Garazi Zulaika, Linda Mason, Muthusamy Sivakami, Holger W. Unger, and Penelope A. Phillips-Howard.** "Exploring menstrual products: A systematic review and meta-analysis of reusable menstrual pads for public health internationally." *PloS one* 16, no. 9 (2021): e0257610. <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0257610>

**VanLeeuwen, Crystal, and Belen Torondel.** "Exploring menstrual practices and potential acceptability of reusable menstrual underwear among a Middle Eastern population living in a refugee setting." *International journal of women's health* (2018): 349-360. <https://www.dovepress.com/exploring-menstrual-practices-and-potential-acceptability-of-reusable-peer-reviewed-fulltext-article-IJWH>

**Weber, Alison Z., Arundati Muralidharan, Brandon Scanlon, Jeff Hallowell, and Jennifer A. Pellowski.** "A fine balance: a review of incinerators for menstrual waste and recommendations for policy and practice." *Journal of Water, Sanitation and Hygiene for Development* 14, no. 5 (2024): 343-356. <https://iwaponline.com/washdev/article-abstract/14/5/343/101998>

**Weinberger, Michelle, Gillian Eva, Nicole Bellows, Meghan Reidy, Rachel Sanders, and Safia Ahsan.,** LEAP: Landscape and Projection of Reproductive Health Supply Needs. Reproductive Health Supplies Coalition. (2024). <https://leap.rhsupplies.org/menstrual-health>

**Wicks, Alyssa, Sydney Brady, Heather D. Whitehead, Thomas Hedman, Alison Zachritz, Marta Venier, and Graham F. Peaslee.** "Per-and Polyfluoroalkyl Substances in Reusable Feminine Hygiene Products." *Environmental Science & Technology Letters* 12, no. 8 (2025): 924-929. <https://pubs.acs.org/doi/10.1021/acs.estlett.5c00553>

**Wolf, Andreas T., and Andreas Stammer.** "Chemical Recycling of Silicones—Current State of Play." *Polymers* 16, no. 15 (2024): 2220. <https://www.mdpi.com/2073-4360/16/15/2220>

**World Bank.** "Menstrual health and hygiene." (n.d.). <https://www.worldbank.org/en/topic/water/brief/menstrual-health-and-hygiene>

**Yasmin, Farhana.** "The Effect of Climate Change on Menstrual Health: A Qualitative Study of Gabura Union, Shyamnagar, Satkhira, Bangladesh." *Health Science Reports* 8, no. 12 (2025): e71579. <https://pmc.ncbi.nlm.nih.gov/articles/PMC12657625/>