

ABSTRACT

Problem: Viable menstruation management solutions

Around the world menstruators are **losing their human rights** to health, sanitation, education and participation in the work force, because the global community lacks the education and resources needed to manage menstruation.

✓ Goal: A reusable menstrual pad users can fabricate

To address both period poverty and pollution, design a pad from natural fibers, readily available in both virgin and upcycled forms.

Phase I – Research Fabric Options

- ✓ **Natural/Sustainable** (Cradle → grave ecological impact)
- ✓ **Available** (resourced and under resourced communities)
- ✓ **Affordable** (Low cost/free)

Phase II – Evaluate Candidate Fabrics

- | Topper (Wick) | Middle (Absorb) | Bottom (Barrier) |
|---|---|---|
| <ul style="list-style-type: none"> Develop and Validate Test Method Test Virgin Fabric Age Test Aged Fabric Analyze Data | <ul style="list-style-type: none"> Develop and Validate Test Method Test Virgin Fabric Age Test Aged Fabric Analyze Data | <ul style="list-style-type: none"> Develop and Validate Test Method Test Virgin Fabric Age Test Aged Fabric Analyze Data |

Phase III – Engineer Pad

Determine best shape, size, channel stitching, fasteners

- Develop and Validate Test Methods for sensory experience, heat retention, and liquid distribution
- Analyze Data

Phase IV – Cleaning, Maintenance and Disposal

Utilize research from other global partners

Phase V – Information Distribution

Use collected data to help combat Period Poverty

- Publish (immediate impact)
- Make and distribute (short term impact)
- Educate and empower targeted communities (long term impact)
- Shift cultural and behavioral norms (lasting impact)

INTRODUCTION

Inspired by *Period. End of Sentence* (book and documentary), I began researching period poverty. My local science fair in January 2023 provided the opportunity to take action, leveraging nearly six months of personal research.

~25% of the world population menstruates. ~800 million people menstruate daily.

Around the world menstruators are **losing their human rights** to education and participation in the work force, because the global community lacks the education and resources needed to manage menstruation.

Surveys suggest >50% cannot access proper menstrual products regularly.

>50% of the world lacks proper disposal facilities, forcing users to use unsafe methods of disposal.

Burning → toxic chemicals. Burying (at night) → violent crime. Disposing in watersheds.

Even in places with formal sanitation services,

disposal of 4.8 billion products A DAY would be unsustainable to landfills.

The United States is not immune:

16.9 million U.S. citizens living below poverty menstruate,

1/2 choosing between menstruation products and food.

>10% of our college students remain in monthly period poverty.

>23% our menstruating high school students regularly miss classes when they do not have access to proper menstrual products.

HYPOTHESIS

Research Question

Which fabric is best suited for fabricating the absorbent layer?

Specifically, which textile will best maintain absorbency over usage where absorbency is determined by calculating the change in percent of absorbed liquid over usage lifetime?

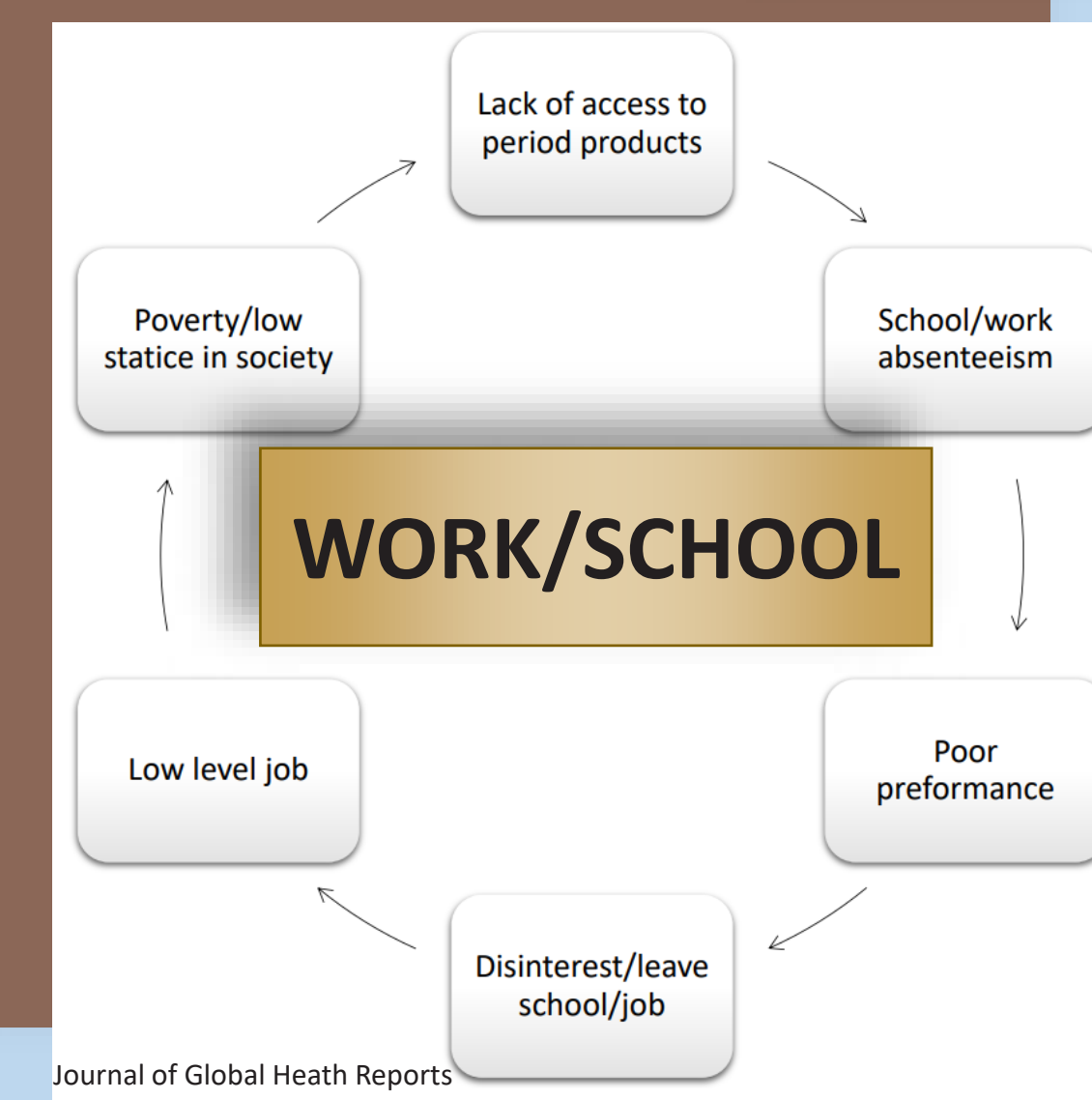
Hypothesis

Bamboo fiber will maintain the highest absorbency over aging.

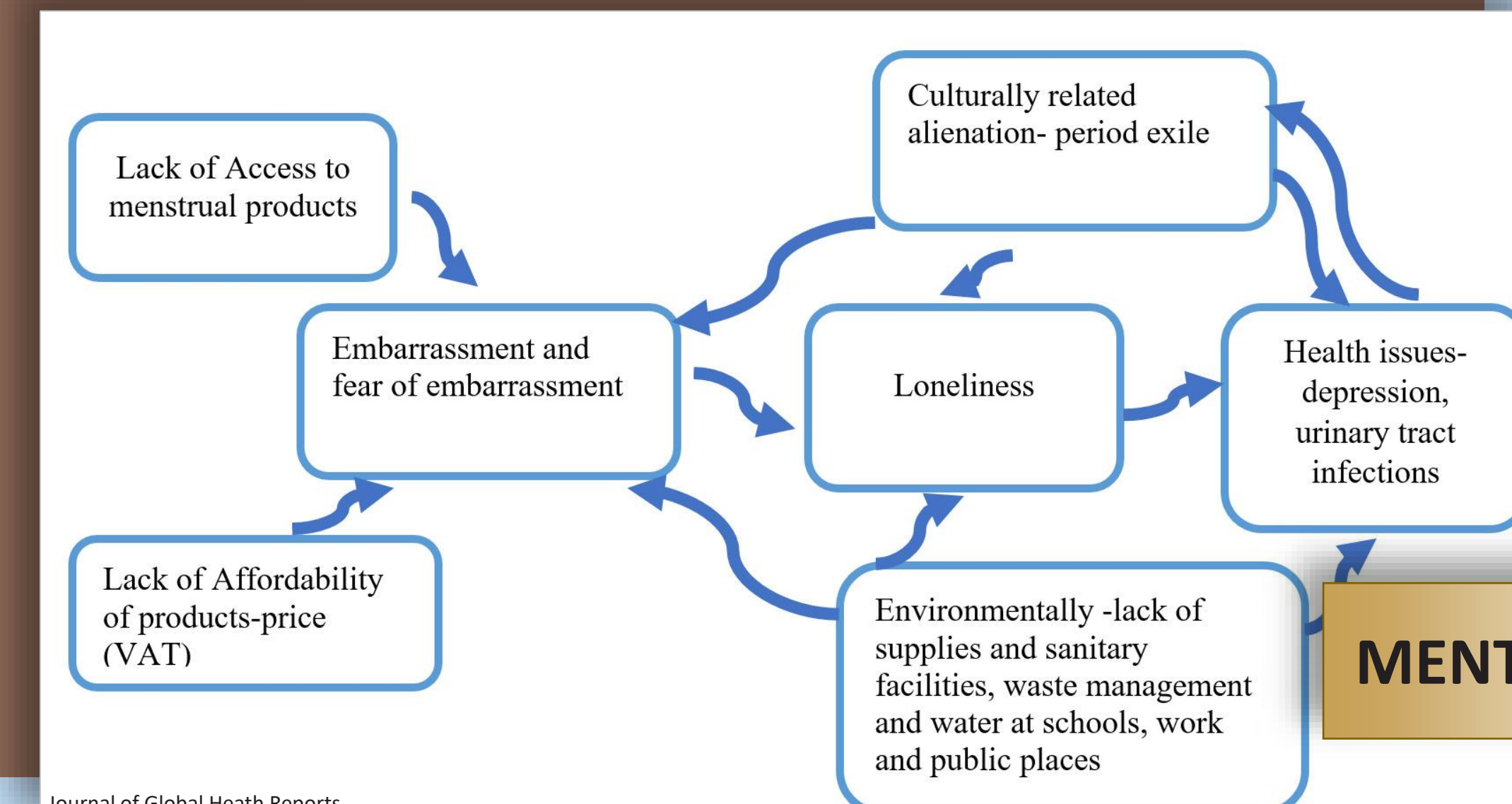
- Fiber cross-section is shaped like a gear, creating channels (Fig. A).
- Moderate adhesion to the bamboo fibers and the strong cohesion to itself, allow the liquid molecules to collect in the channels (Fig. A).
- Processed bamboo fiber has been successfully engineered for applications such as 'paperless' towels, reusable diapers, etc.

BEST NATURAL FABRIC FOR REUSABLE MENSTRUAL PAD

PERIOD POVERTY CYCLES



Journal of Global Health Reports



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TEST METHOD

TM 001: Absorbency of Hydrophilic Fabric (%)

Preparation: weigh empty and full syringe, weigh reabsorbent material
Data Goal: grams of liquid absorbed by sample and reabsorbent material after pressure and rest
Calculation Goal: % of liquid absorbed before and after aging, difference in %
Statistical Goal: average % of liquid absorbed, average difference and sigma



Photo by EL Olvera

Step 1: Weigh Sample

Add 10mL (10.00±.50g) liquid (RO Water)



Photo by EL Olvera

Step 2: Weigh sample w/ liquid

Rest for 60 seconds

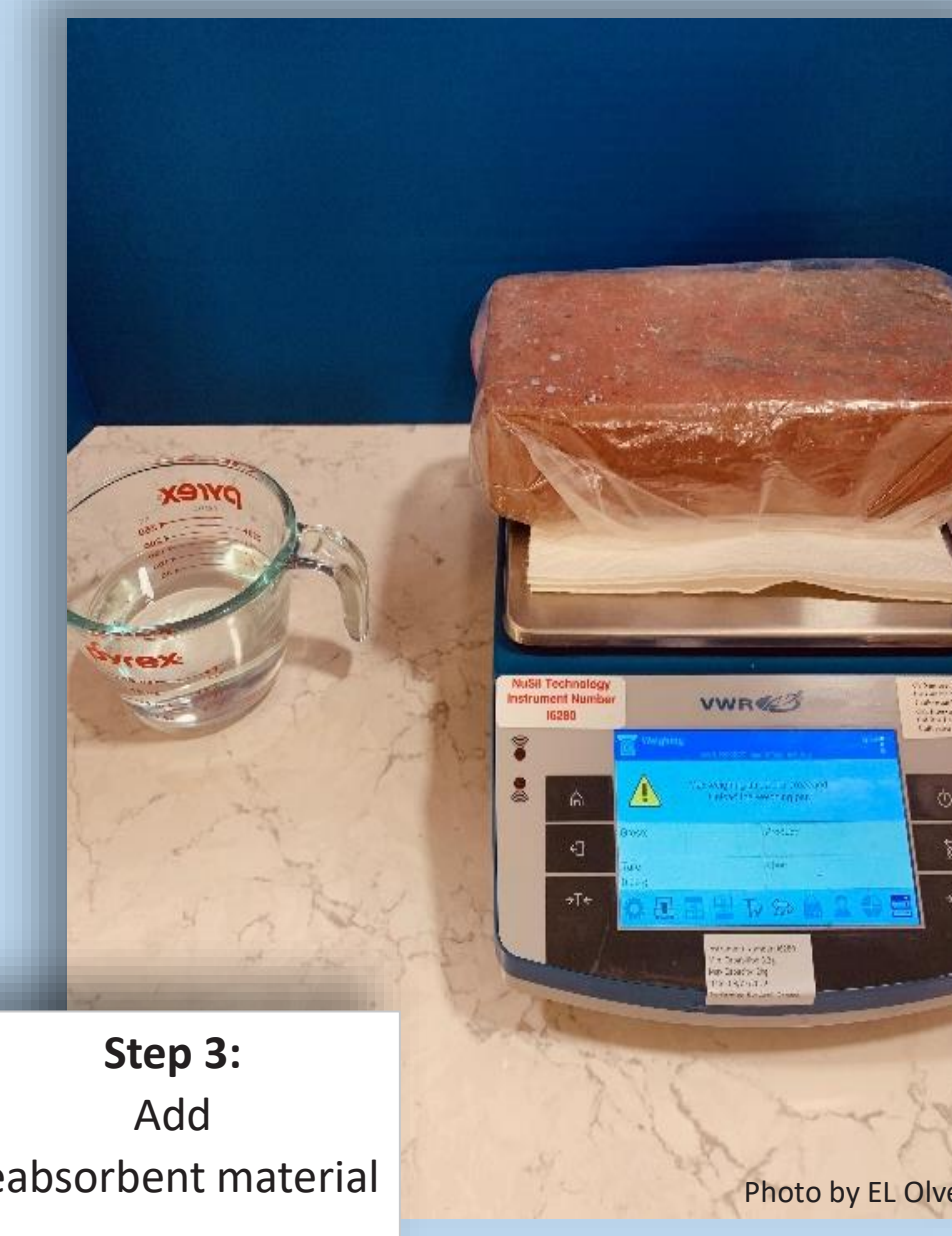


Photo by EL Olvera

Step 3: Add reabsorbent material

Add pressure

Rest for 60 seconds



Photo by EL Olvera

Step 4: Remove reabsorbent material and pressure

Weigh sample

Weigh reabsorbent material

OBSERVATIONS

Fabric	Observation
Cotton\Hemp	Liquid wicked on contact and dispersed towards the edges without leaving the fabric.
Cotton Batting	Initial – Before pressure was applied, fabric appeared to have absorbed no liquid; liquid had puddled on top. Aged – Fabric became noticeably more condensed; no liquid puddled on top, and; fabric absorbed most of the liquid.
Cotton Toweling	Liquid wicked on contact and dispersed towards the edges without leaving the fabric.
Cotton Flannel	Liquid wicked on contact and dispersed towards the edges without leaving the fabric.
Cotton Jersey	The liquid did not disperse throughout the sample. The sample did not wick the liquid as quickly as the others. The liquid puddled onto top for a few seconds, then slowly soaked in. Unlike the other samples, the liquid stayed pooled in the center.
Bamboo Fleece	Liquid wicked on contact and dispersed towards the edges without leaving the fabric.

RESULTS

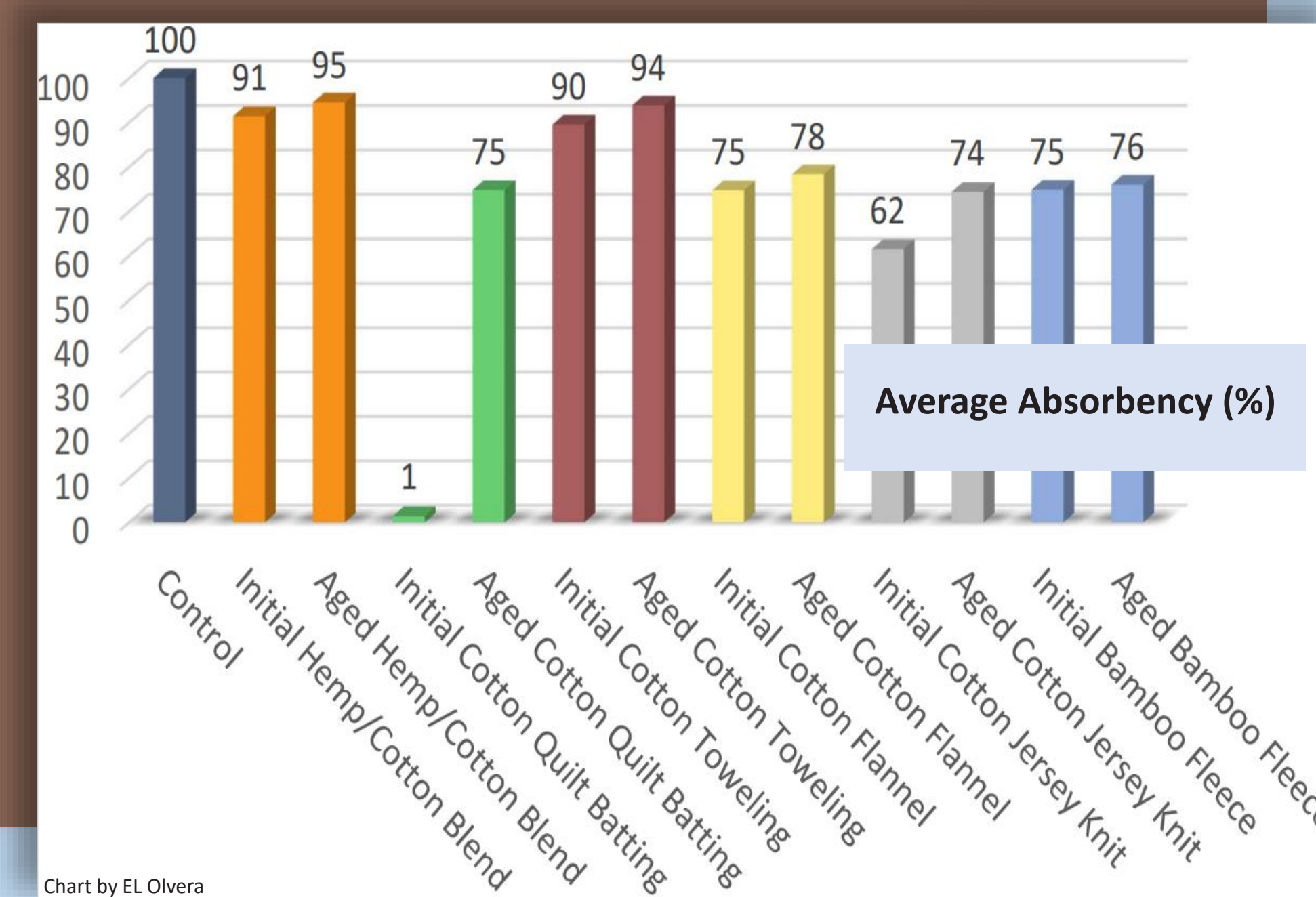


Chart by EL Olvera

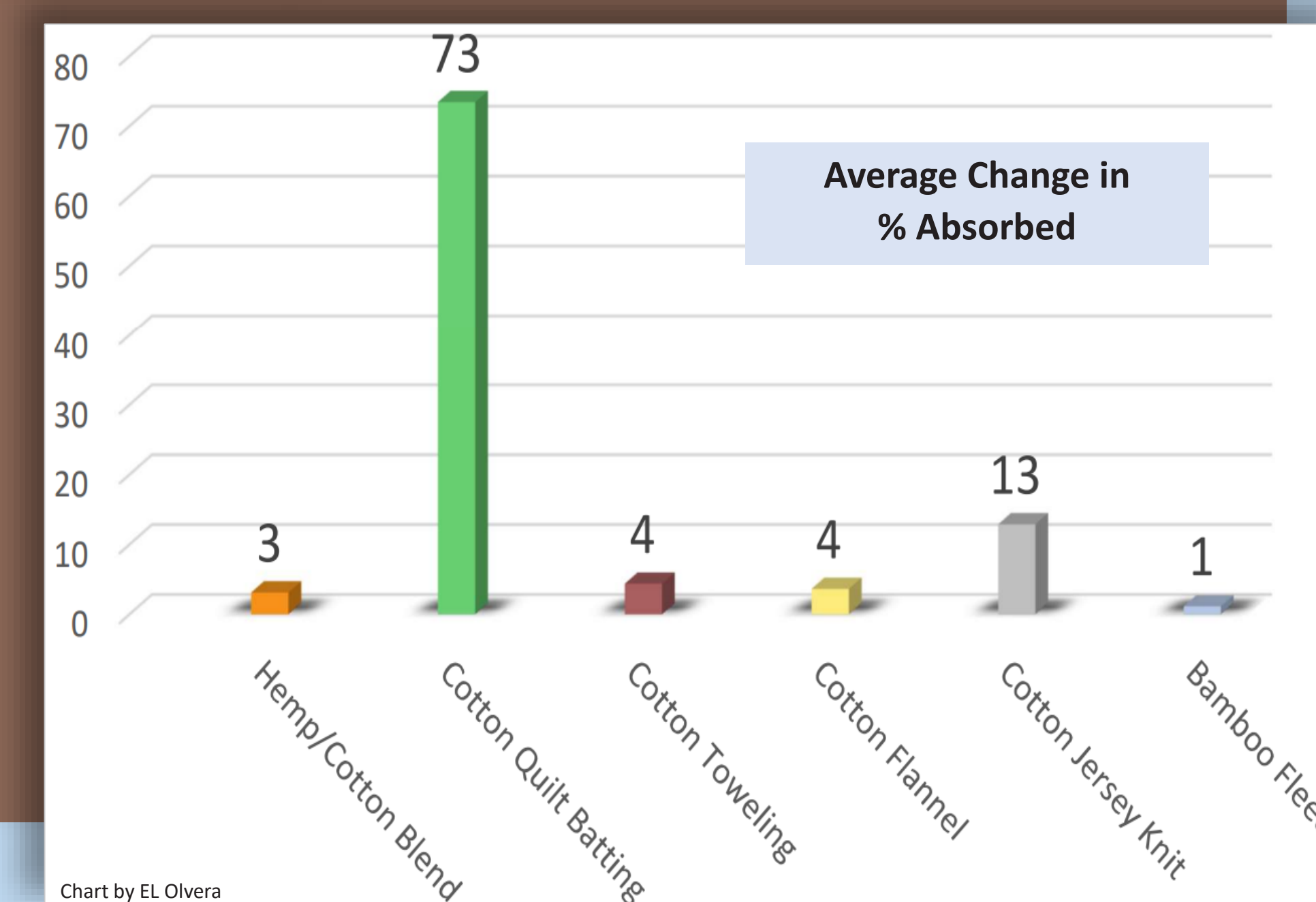


Chart by EL Olvera

CONCLUSION

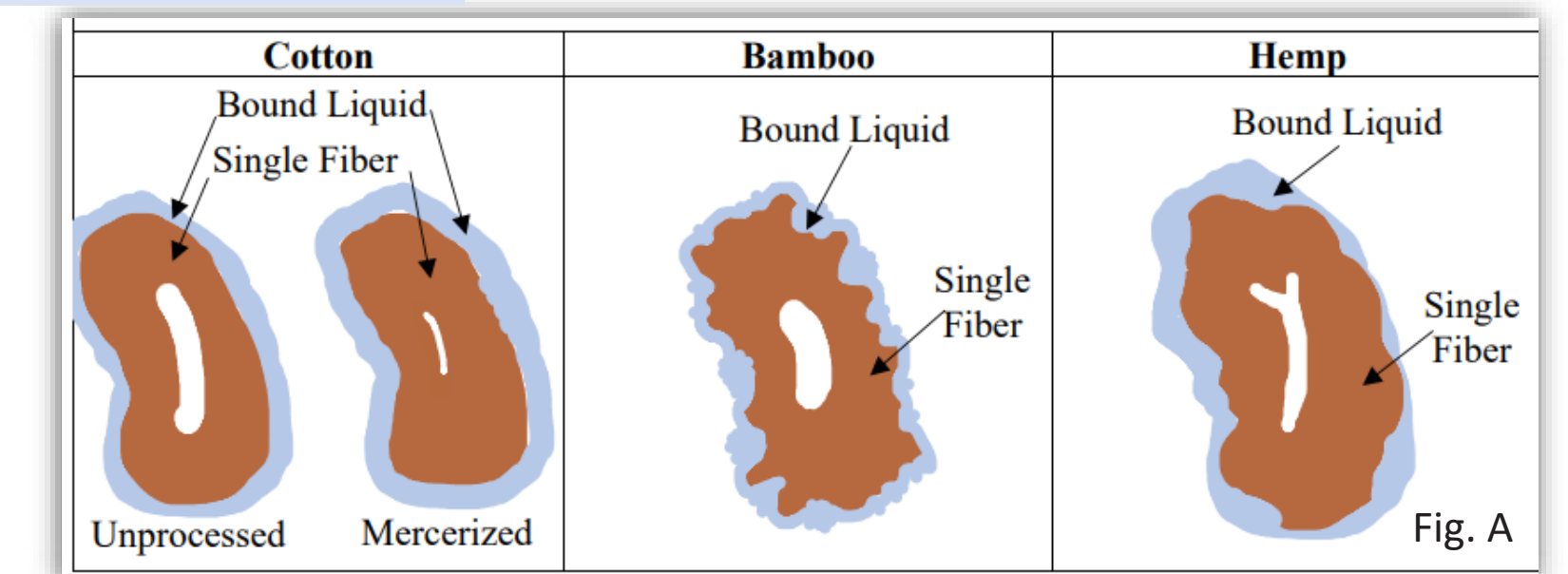
My hypothesis was incorrect.

- The hemp/cotton blend, not the bamboo, is most absorbent after aging.
- I was correct that aging would loosen the cotton fiber. I was incorrect in predicting that would decrease absorbency.

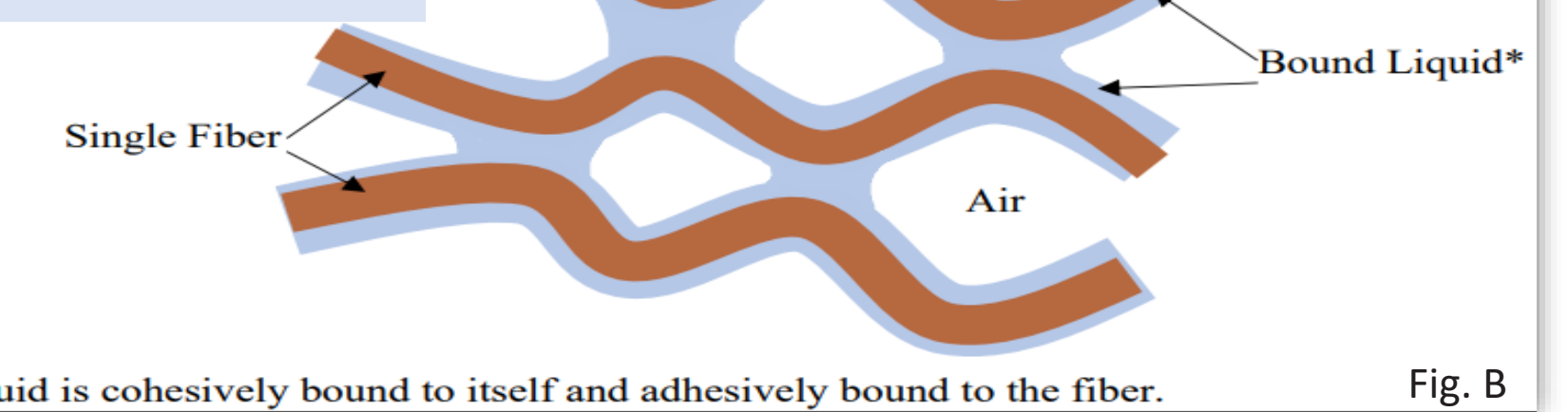
Misshaping of the cotton fabrics during aging creates more surface variations which behave similar to channels. It was not just the natural shape of the fiber but the actual weave of the fabric that made the difference in absorbency (Fig. B).

The aged fabric was more absorbent than the virgin. My data suggests our surplus of post-consumer fabrics makes a better product than virgin fabric!

Cross Sectional View of Fiber and Bound Liquid



Lateral View of Fiber and Bound Liquid



* Liquid is cohesively bound to itself and adhesively bound to the fiber.

Figures by EL Olvera based upon forensic resources (Fig. A) and ACS Schematics (Fig. B)

DISCUSSION

Biases

- My hypothesis contained a hidden bias. I assumed the absorbency of all fabrics would decrease over aging. Instead, every fabric I tested improved its absorbency over use, indicating that upcycled fabrics are more absorbent than virgin fabrics. This finding contradicts current manufacturing practices and consumer preference.

Gains and Losses of Phantom Liquid

- Precision vs. Accuracy
 - I initially designed my experiment using a common kitchen scale. Although this scale is accurate, it was not precise enough. It was rounding to the nearest gram, suggesting I was losing or gaining up to an entire gram of weight. I borrowed a calibrated scale with 1/100gram precision. I then revalidated my procedure and redid all 39 of my experiments. (Count includes control, excludes validations and invalid tests.)
- Technique
 - If I dispensed the water too quickly or too slowly, it splashed onto the scale. I had to depress the plunger at just the right speed, distance and location to prevent liquid from splashing off fabric and onto scale.
 - I had to develop a technique to make sure all the water exited from the syringe.
- Calculations
 - Most of the data recorded was not used to calculate my results. It was used to calculate and track the movement of the liquid throughout the test.

APPLICATIONS

I commit to:

- Make 1,000 pads in a year for donation
- Offer sewing kits and instructions to homeless shelters, encampments and low-income earners
- Advocate for open access to sewing resources (e.g., machines at local Libraries of Things)
- Distribute instructions for fabric selection and pad fabrication, allowing menstruators to:
 - Reduce waste over lifetime from ~220 pounds of menstrual trash to <5 pounds
 - Reduce spending over lifetime from \$3,000 – \$10,000 to ~\$0 – \$300
 - Reduced health risks such as allergic reactions or infections

As the global community continues to develop without considering the natural process of menstruation, menstruators around the world will continue to lose their human rights, including access to education and participation in the work force. Through sharing my research and data I hope to empower menstruators to pave their own path towards equity.

GLOBAL EFFORTS

My Community of Scientists and Researchers:

UN, WHO, UNICEF, American Medical Women's Association and Kotex are gathering the data necessary to classify period poverty as a global humanitarian crisis. *Period. End of Sentence* (NP), NPR, UCSB Daily Nexus and *Journal of Global Health* are researching and informing the public. *Green Periods*, *Textile Sphere*, *Ethical Consumer* and *Period.* are researching and innovating more sustainable cultivation and manufacturing practices. *Delivering Hope International*, *Days for Girls International*, *Freedom4Girls*, *Dignity.Period* and *The Pad Project* are providing education and resources to those most in need. *Flo* is innovating new solutions to launder reusable products in challenging environments.