

# Beyond Bed and Bath



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Textile Waste and Double Loop Circular Economy

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# Agenda

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- Environmental impacts of cotton
- Cotton recycling
- Hospitality industry pilot project
- Secondary market
- Double loop circular economy





# 85% of textiles wind up in landfills

- EPA estimates 15.5 million tons in 2018
- Globally enough to fill 1.5 Empire State Buildings every day
- US produces 82 pounds of textile waste per person per year
- Average consumer bought 60% more clothing in 2014 than 2000...  
...and kept each garment half as long.

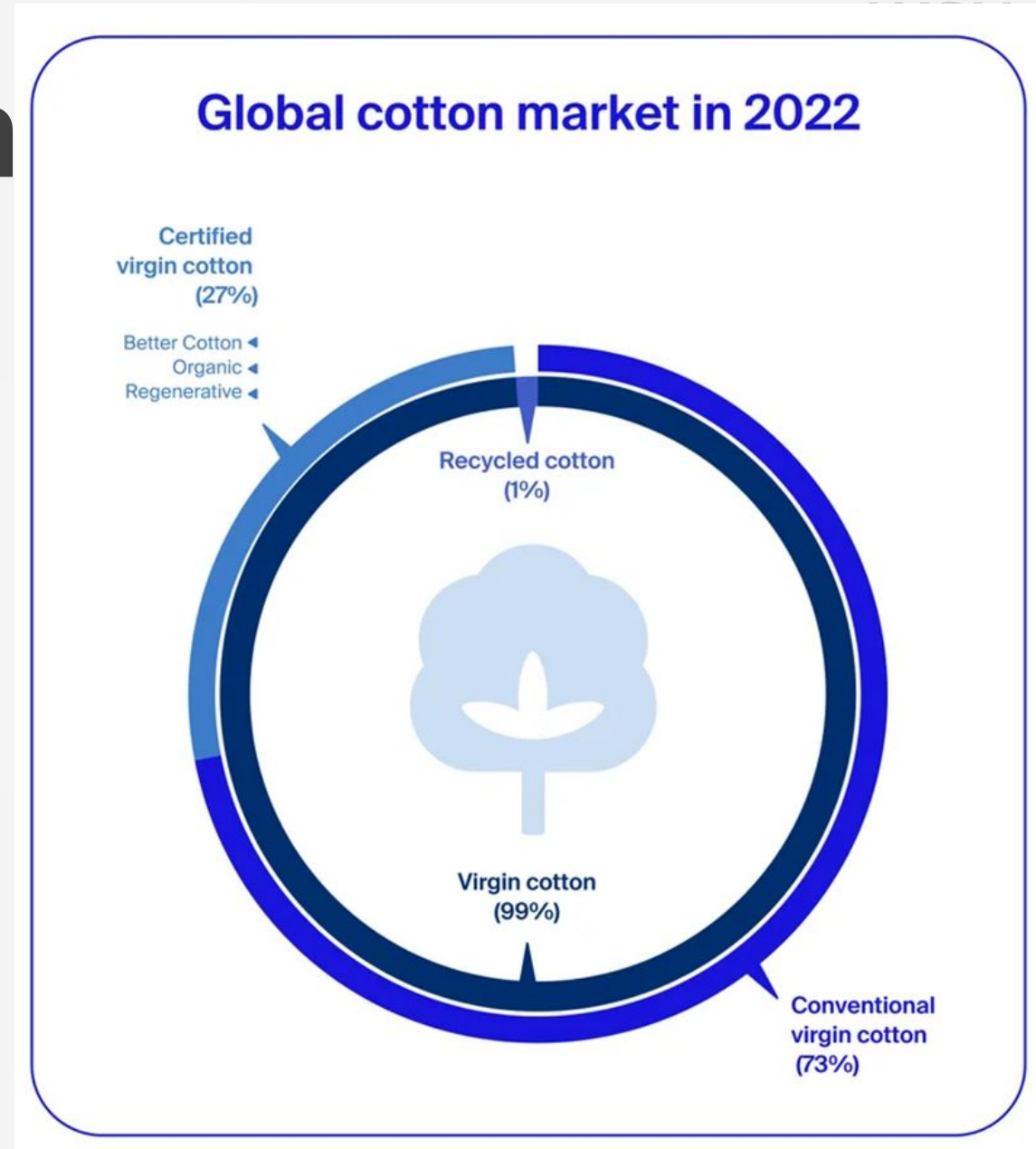


# Cotton production

99% virgin cotton

- 73% - conventionally grown
- 27% -
  - Better cotton
  - Organic cotton
  - Regenerative cotton

1% recycled cotton



# Water use and pollution

Cotton is a water intensive crop

20% of industrial water pollution

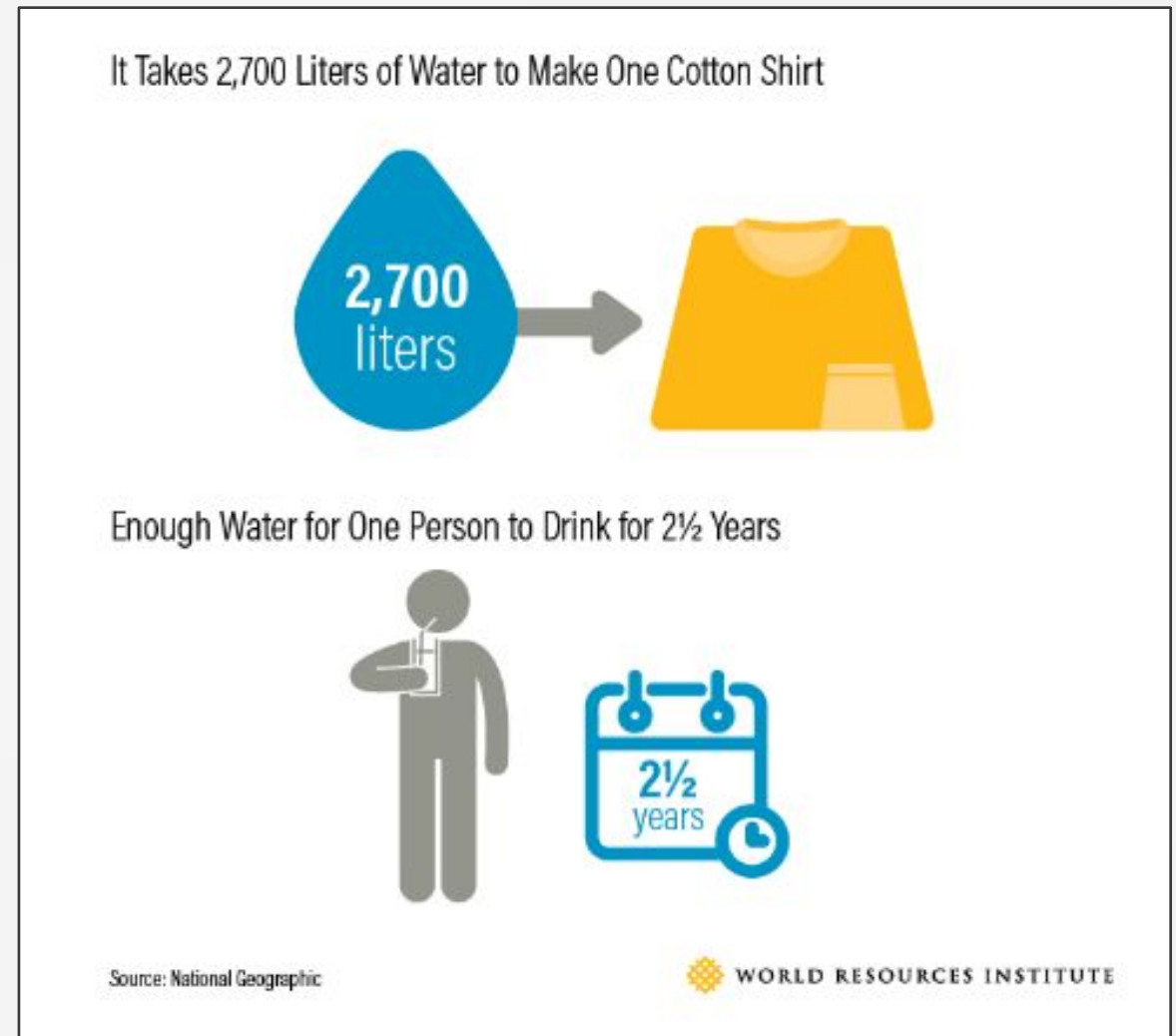
- Much of this is from textile dyeing

Second biggest consumer of water

- Pair of jeans needs 2,000 gallons H<sup>2</sup>O

International concern

- Scale and impact of the industry
- UN Alliance for Sustainable Fashion





# Chemical use

- 2.4% of the world's cultivated land
- 6% of the world's pesticides
- 16% of its insecticides

Seven of the 15 pesticides commonly used on cotton in the US are listed as “possible,” “likely,” “probable” or “known” human carcinogens by the EPA

Additional chemicals and dyes used in the production of textiles



# Cotton Regeneration

Dr. Hang Liu –

- Environmentally Friendly Cotton/Cellulose Waste Recycling
  - Eco-friendly, non-toxic & inexpensive solvents
  - Wet spinning – a well established industry fiber production process
- Patent issued in China, India, UK, Germany, Portugal, and Turkey. US application is under review.
- Seeking industry collaborators to commercialize

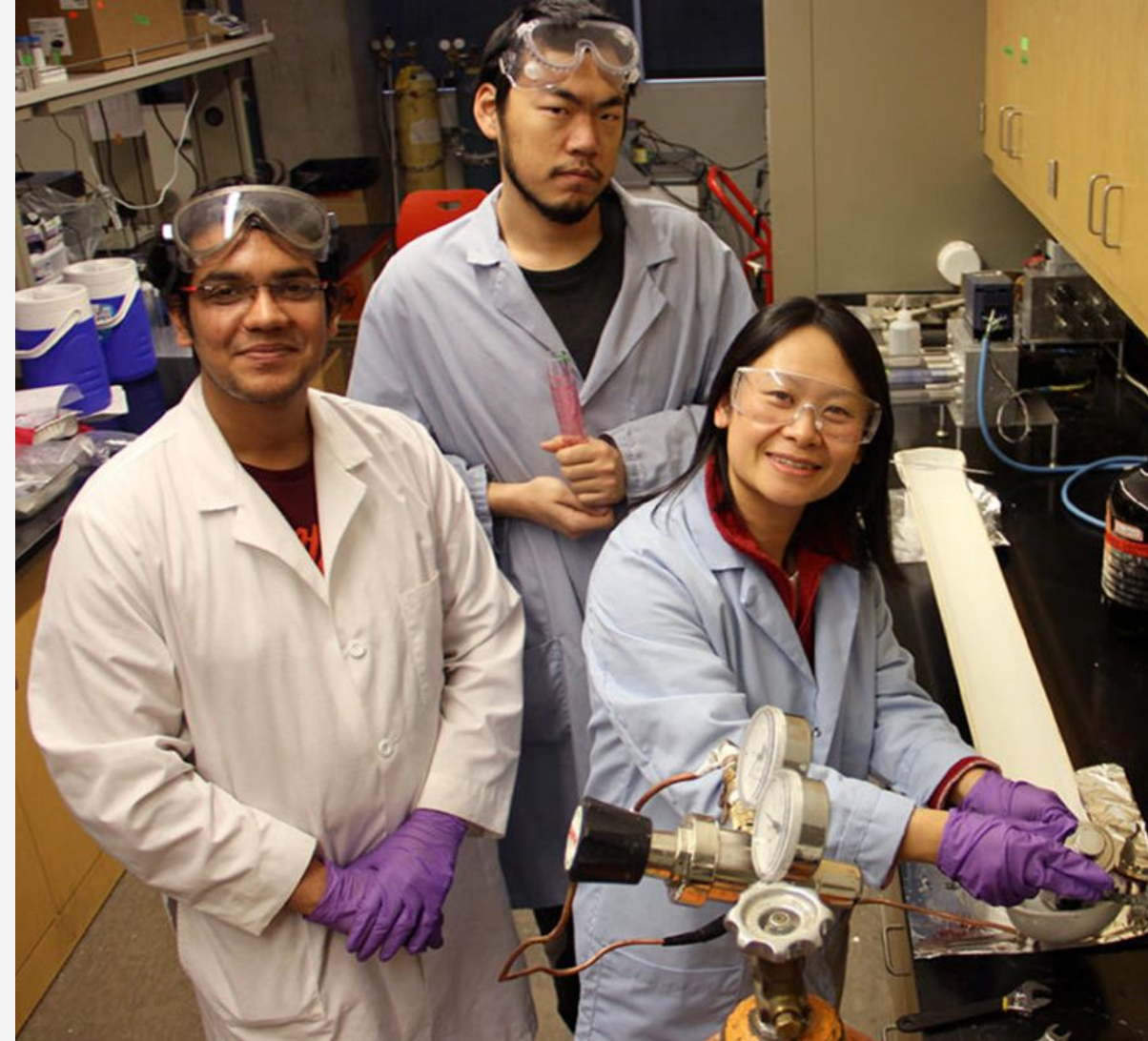


Photo by Seth Truscott, WSU Insider

# Collaborators

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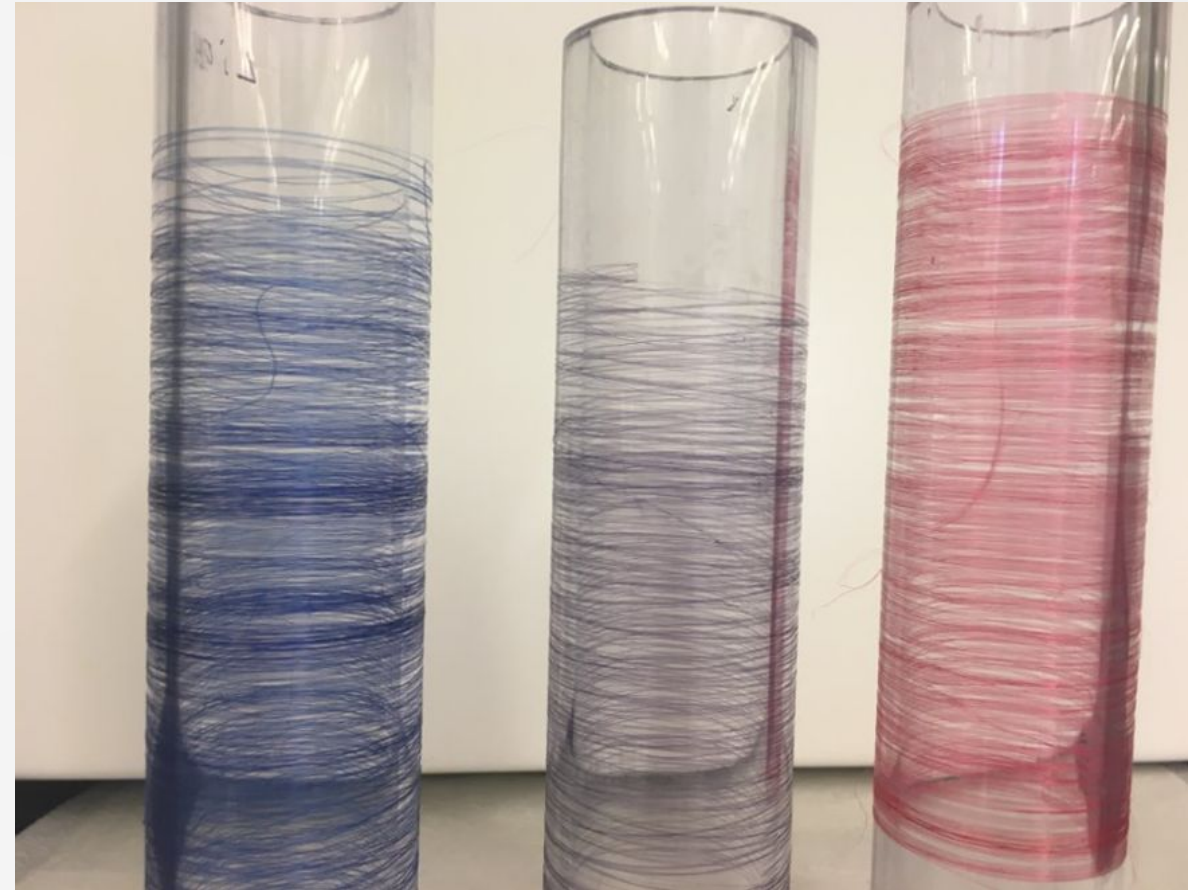
- Patricia Townsend, Ph.D., Assoc. Prof., WSU Extension
- Hang Liu, Ph.D., Assoc. Prof., Department of Apparel, Merchandising, Design and Textiles
- Martha Aitken, Asst. Dir., WSU Metropolitan Center .
- Mark Beattie, Ph.D., Asst. Prof., School of Hospitality Business Management, Carson College of Business
- Giuseppina Menconi, Ph.D., Assoc. Prof., Cesar Ritz Colleges Switzerland
- Project Interns, WSU Students (seniors)
  - Kolby Keaouli Ross & Risa Bridge, School of Economic Sciences
  - Gene Brown, Department of Apparel, Merchandising Design and Textiles



# Challenges of textile recycling

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- Supply chain – predictable source of textile waste
- Preparation – clean, dry, sorted, notions removed
- Technology – replicable, environmentally conscious
- Scaling
- Economics
- More.....



# Linen waste

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- Worldwide, 1.5 million tons of textile waste annually is comprised of just sheets, pillowcases, and towels (linens), with hotels being a significant contributor to this waste stream.
- 118,996 hotel rooms in the state (WA Hosp Assoc, 2023)
- Over 8.3 million pounds of linens in the market for textiles supplied to WA state hotels.





# Pilot project

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2023 –\$42K grant from the Washington State Department of Commerce to focus on 5 specific deliverables:

1. Estimate quantity of discarded hotel linens in WA
2. Textile quality testing
3. Secondary market potential
4. Policies the encourage the circular market
5. Reinvention hack-a-thon with WSU students



Sheraton Hotel, Seattle WA



# Timeline

2018 - Aitken and Townsend learn of Liu's cotton recycling technology, begin exploring the circular textile economy.

2021 – Pilot research indicates potential in recycling hospitality linens due to high cotton content and ease of recycling compared to garments (zippers, etc.).

2022 – Initial survey of hoteliers indicates willingness to recycle old linens. Lack of information cited as a primary barriers.

2022 - Beattie and Menconi join the team, help forge connections to hospitality industry.



# Hotel survey

With collaboration of the Washington Hospitality Association  
37 hotels of various quality levels across the state

Collected data on:

- Quantity of linens use and purchasing standards
- Linen disposal – process and quantity
- Willingness to pay a premium for recycled linens
- Likelihood of participating in the “linen reuse market”



Holiday Inn Express -- Pullman, WA

# Survey results

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## Key findings:

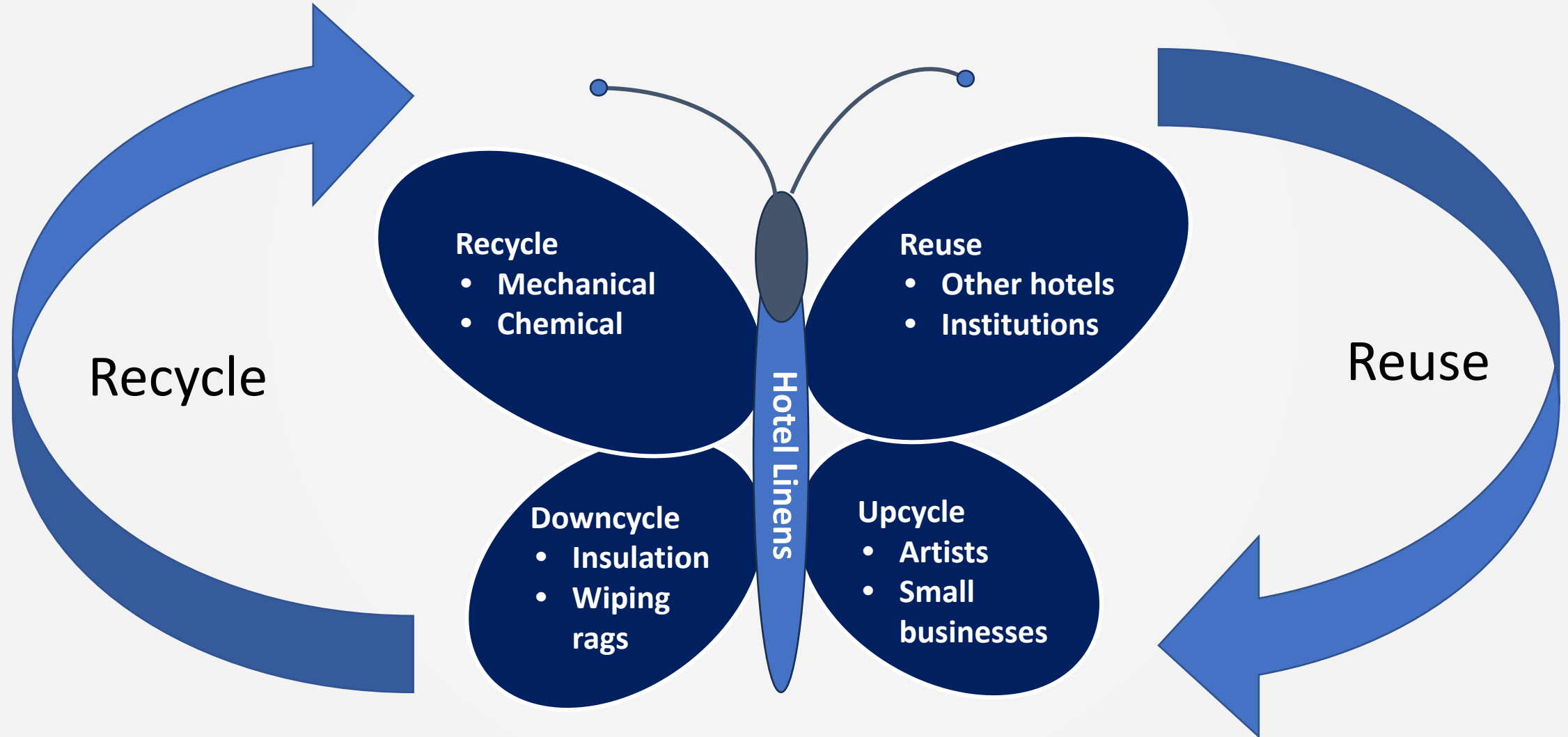
- 1) Linens per room -- 19.74 (average)
- 2) Unwilling to pay a premium for recycled textiles
- 3) Most hotels discard their linens in landfills due to stains and tears, some are donated
- 4) Discarded commercial linens creates an opportunity
- 5) Estimate 539,773 lbs. discarded hotel linens per year



Courtyard by Marriott, Pullman, WA



# Clothing and Textile Butterfly: The Circular Economy



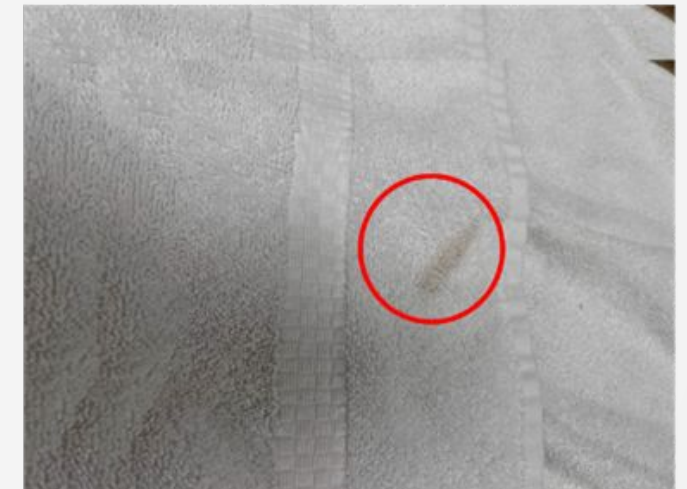
# Textile testing

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Compared new hotel linens with discarded ones donated by hotels in the survey.

Conclusions based on limited testing quantity:

- Retained tensile strength
- Good water absorption
- Supported the potential for secondary market uses



# Secondary market potential

- Reuse
  - WA State Dept. of Corrections has 20,000 beds statewide
  - Homeless shelters
- Small businesses and artists/designers
  - Upcycling
- Downcycling
  - Animal shelters
  - Wiping rags
  - Insulation





# AMDT Hack-a-Thon

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- Creative second uses for discarded linens
- Open to WSU students
- Cash prizes donated by Pullman Marriott hotels
- Linens contributed by Pullman Marriott and Holiday Inn
- Hotels will donate discarded sheets for AMDT students to use in class projects



# Hack-a-Thon winners





# Secondary market challenges

- Identifying secondary uses (i.e., prisons)
- Supply chain
- Storage (volume from renovation cycles)
- Transportation

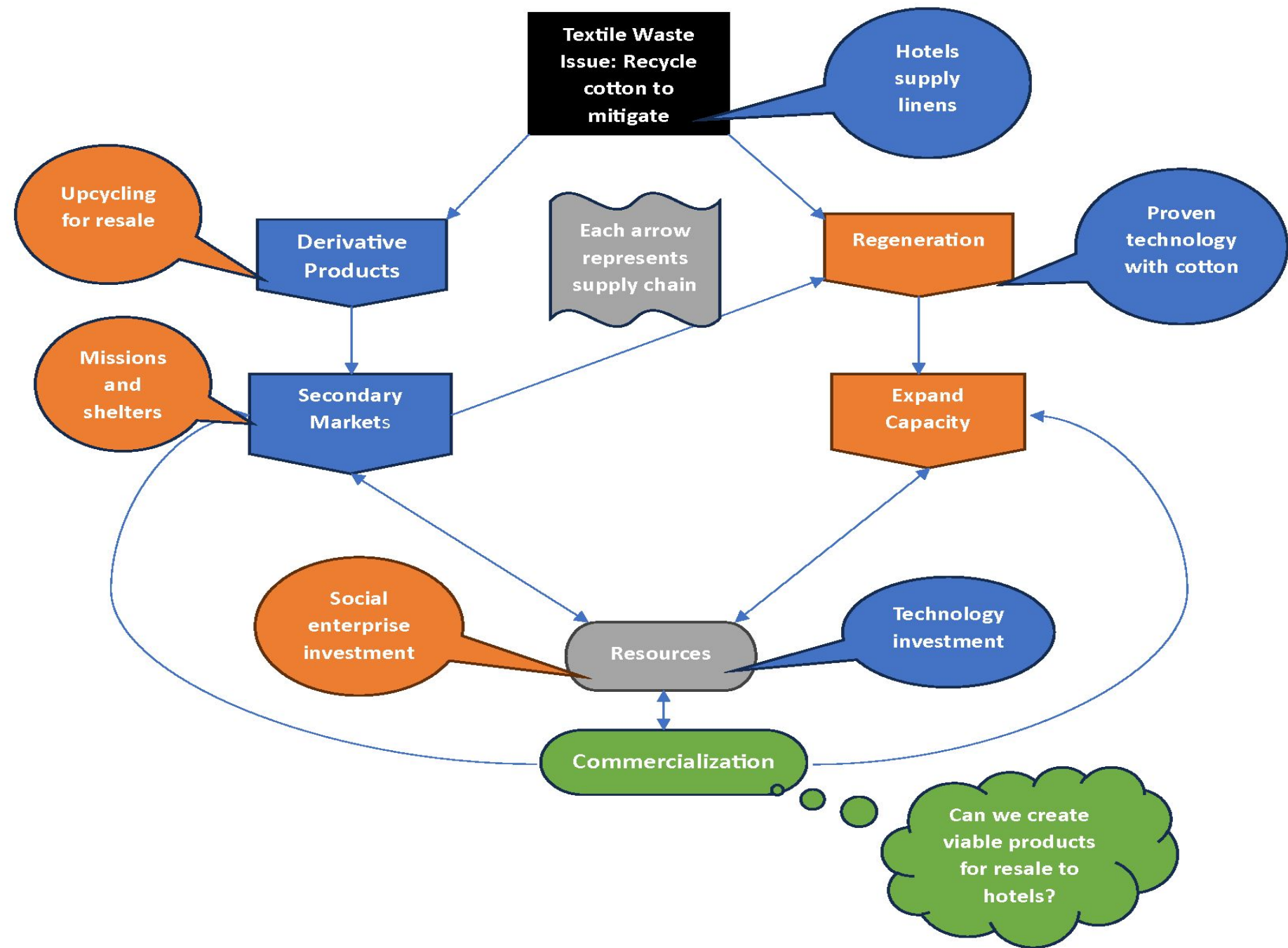
Developing a viable business model

Developing policies that encourage the donation or sale of linens before discarding them





# Double Loop Circular Economy



# Further study for hotels

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- A more detailed exploration of the cost of purchasing and discarding hotel linens.
- Key market forces which encourage sustainable linens policies.
- Municipal policies to encourage recycling and discourage discarding.
- Meaningful incentives, financial or otherwise, which encourage hotels to practice and promote linens recycling.



# Policy recommendations

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More areas for further study:

- Market forces which encourage sustainable linens policies
- Municipal policies to encourage reuse and recycling and discourage discarding
- Meaningful incentives, financial or otherwise, which encourage hotels to practice and promote linen reuse and recycling





# On going work

- Outreach
  - Communication, build awareness, gather stakeholders
- Manufacturers
  - Interest hotel linen manufacturers in making linens from recycled cotton
- Circular Market
  - Build the circular market within the hotel industry
  - Address supply chain challenges (transportation and storage)

# This project was made possible by support from:



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- Pullman Holiday Inn Express
- Washington State Department of Corrections, Walla Walla State Penitentiary
- Seattle Marriott Bellevue
- Courtyard by Marriott Seattle

# Thank you!

## Questions?

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