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Can agricultural residues be the future of textiles?

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NC STATE UNIVERSITY

Textile fiber demand increasing

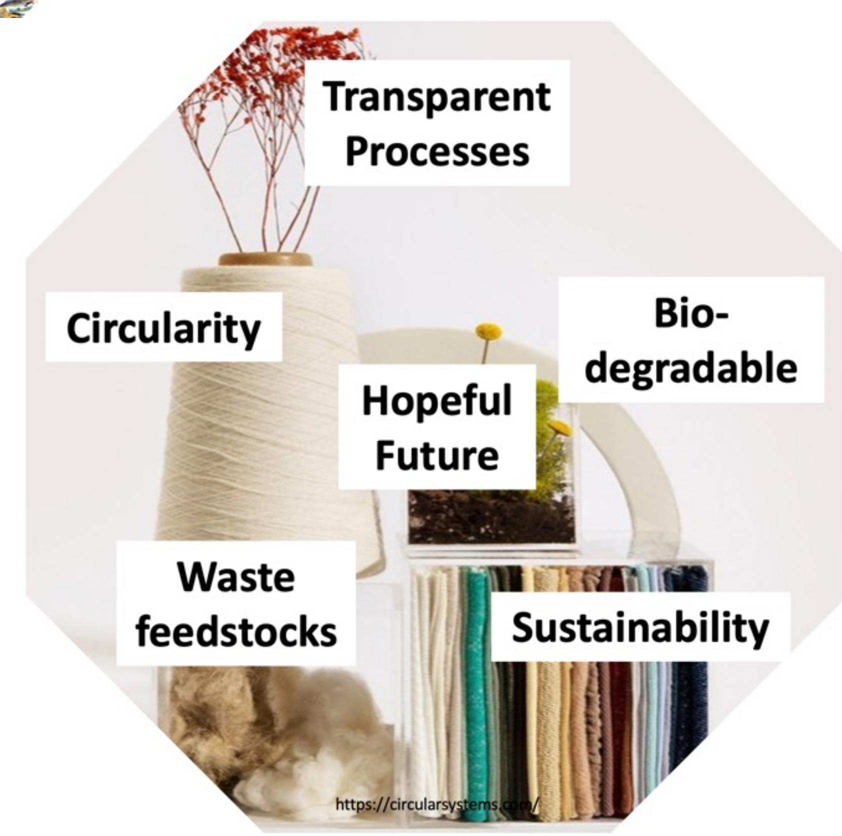
- Population growth
- Fast fashion trends

Synthetic fibers easy and cheap, to produce

- Non-renewable materials
- Environmental burden at end-of-life

Sustainability Megatrends

- Transparency
- Circularity
- Natural alternatives

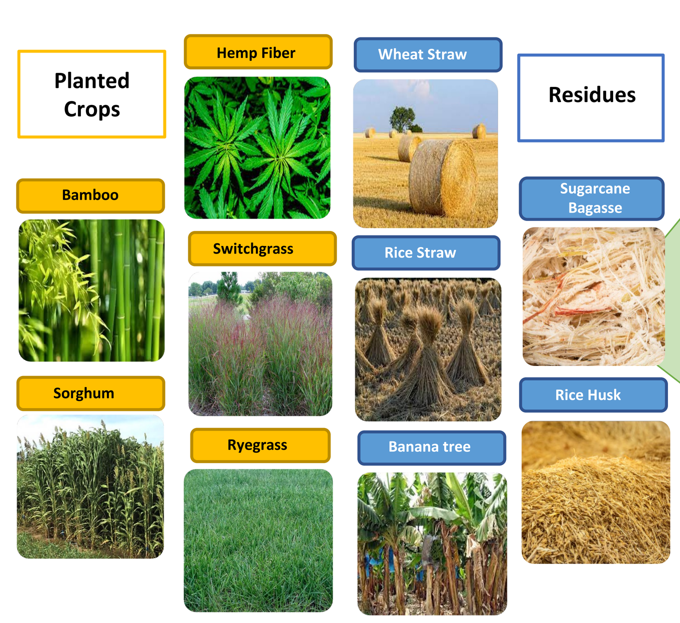


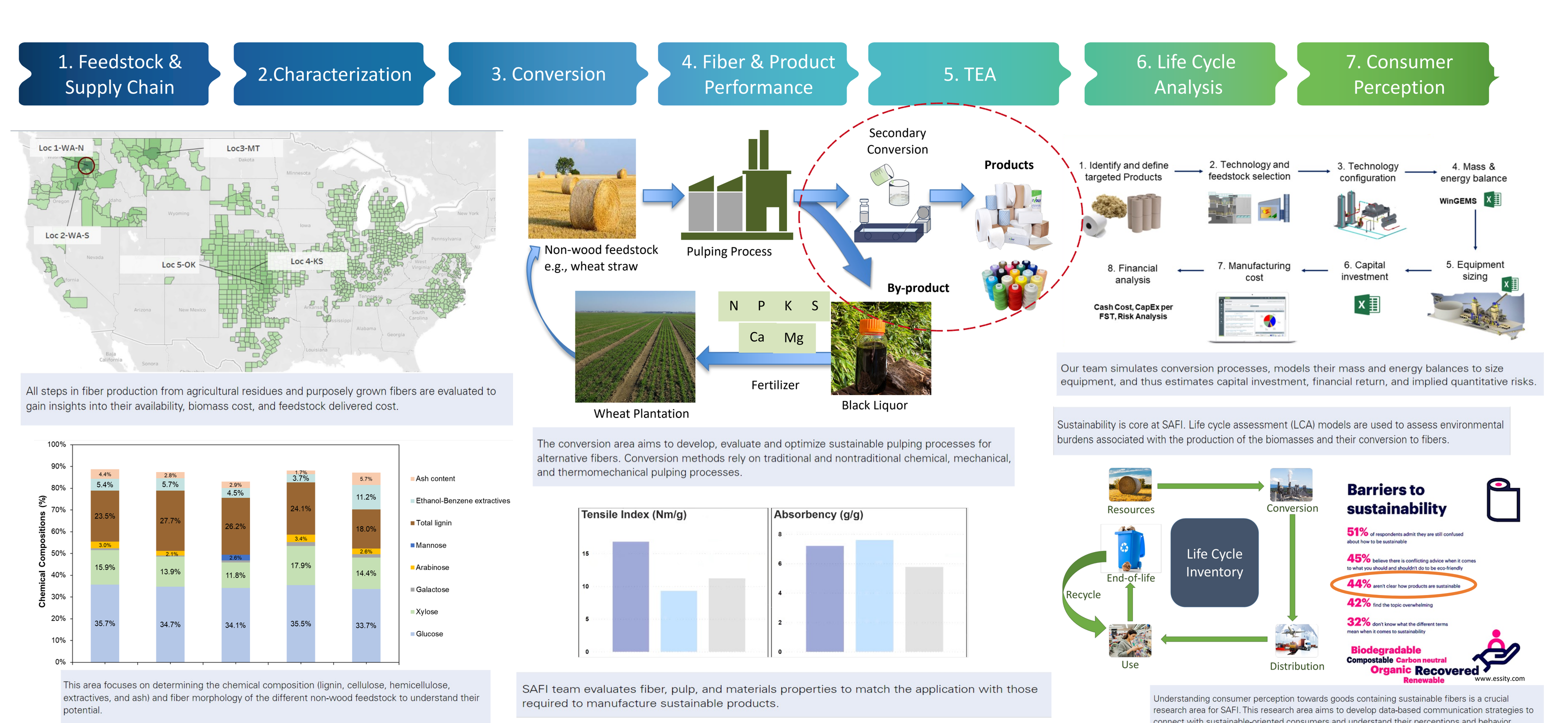
Agricultural residues

- Renewable feedstock sources
- Otherwise burned or treated as waste

Sustainable Alternative Fibers Initiative (SAFI)

Biomass Sources **Target Products**

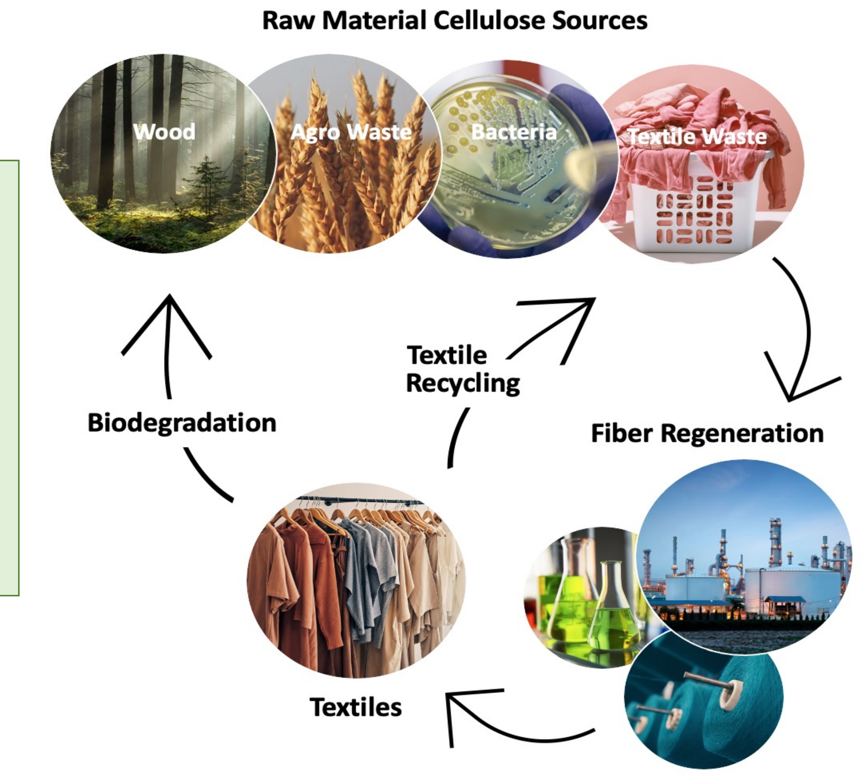




Methodology

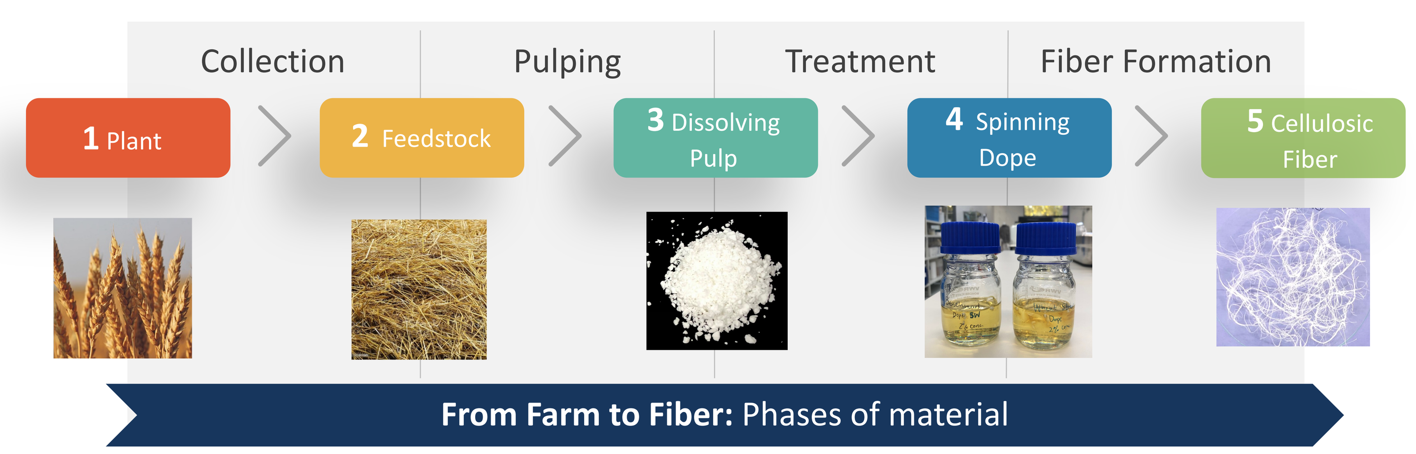
Goal

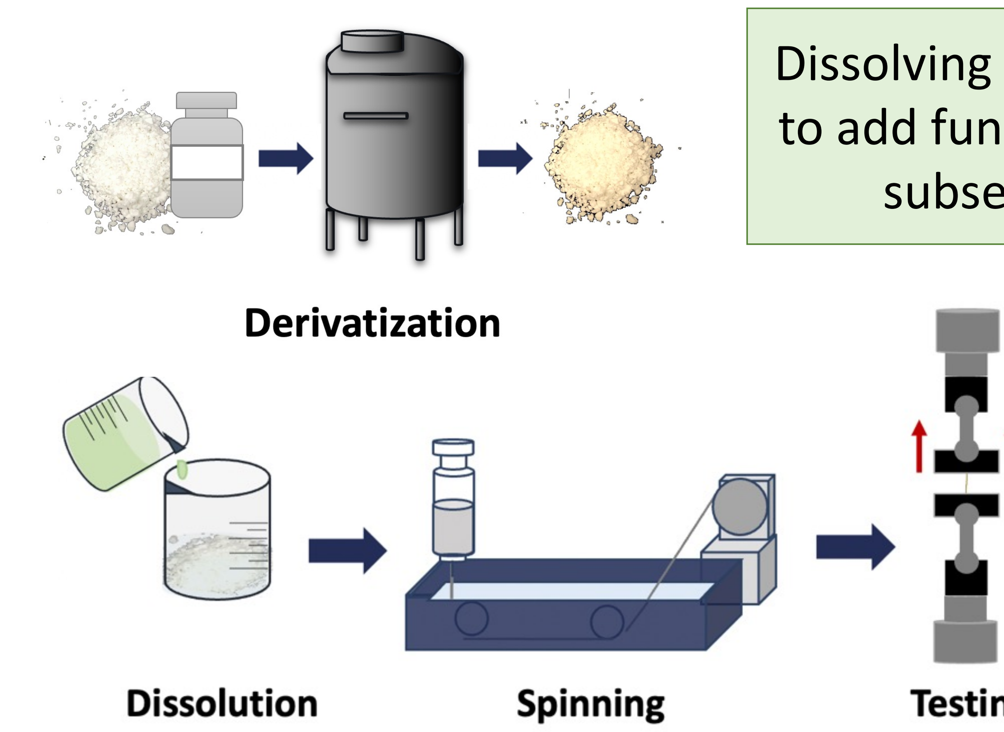
Produce textile-grade cellulosic fibers from natural sources which are more environmentally friendly than synthetics and cotton.



Carbamate

Modification of viscose process, but cellulose is derivatized by urea instead of toxic carbon disulfide (CS_2)





Dissolving pulp is first derivatized to add functionality and improve subsequent dissolution

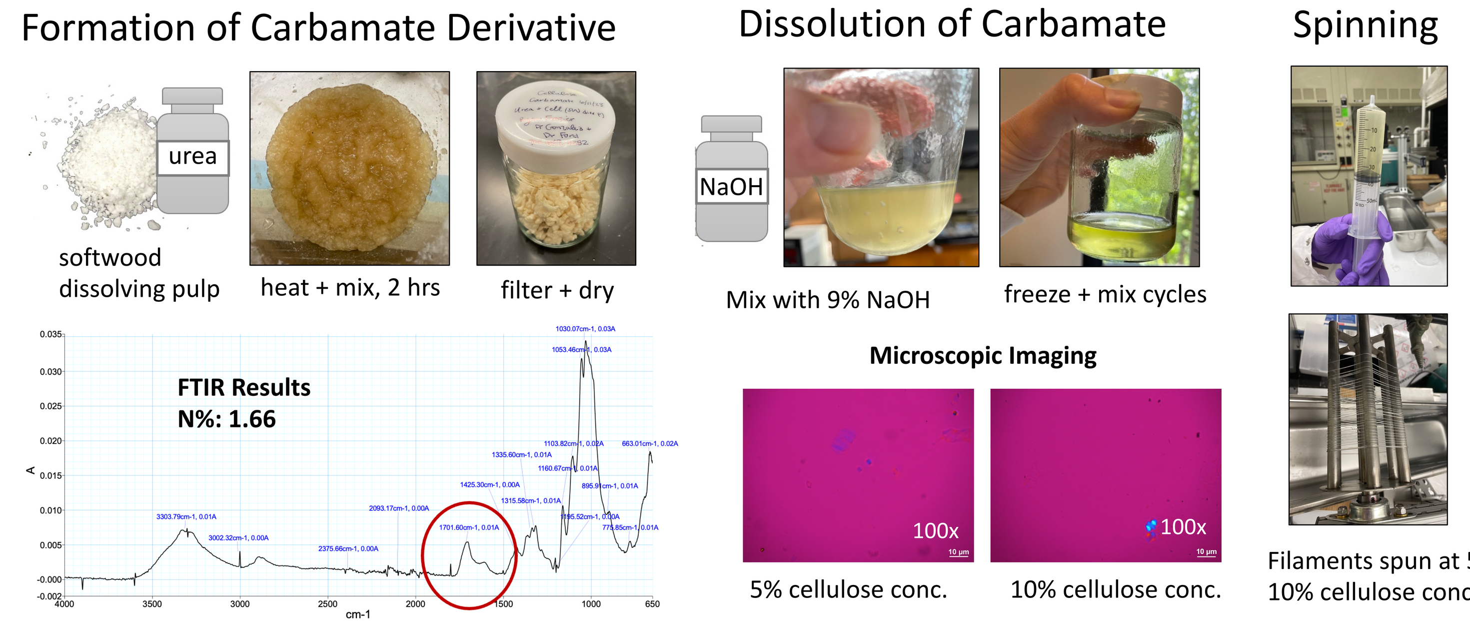
Derivative is dissolved and then wet-spun to form regenerated cellulose filaments

Sustainability

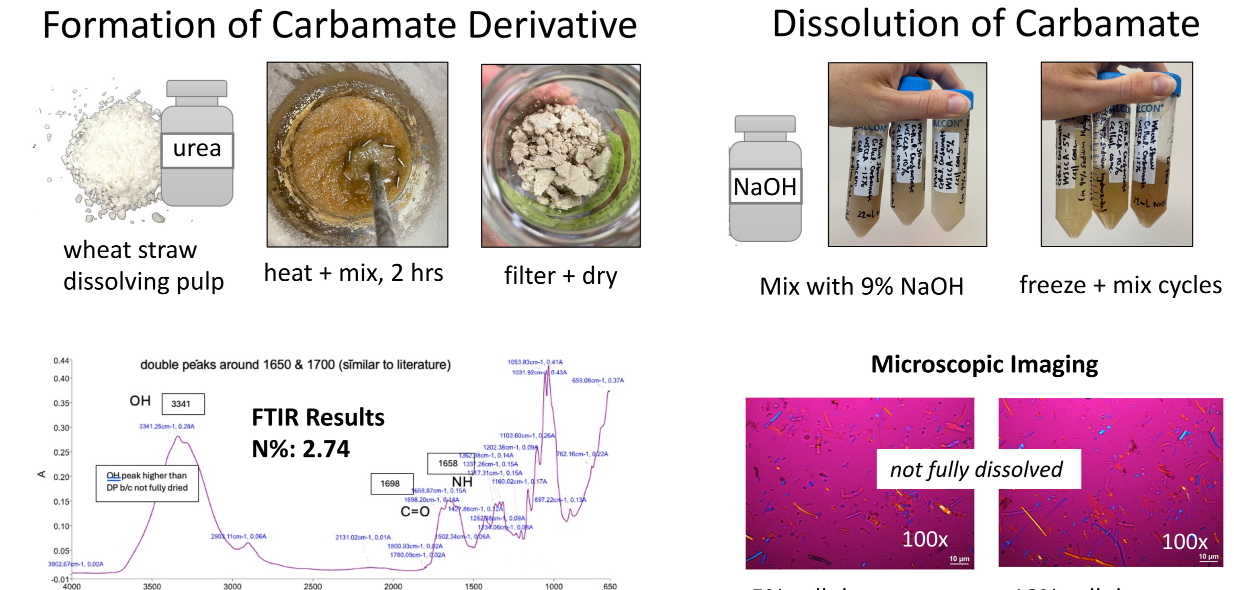
- Large reduction of water consumption in carbamate process compared to viscose and cotton production
- High energy demand of sodium hydroxide [1]
- Effective recycling of coagulant is important for keeping the process more sustainable coagulation [1]

Current Status / Results

Softwood (benchmark)



Wheat Straw (experimental)



Spinning & Testing Pending

Conclusions

Considerations with non-woods

Purity/Fiber Structure

- Lignocellulosic biomass tends to have higher silica and lignin contents than wood and higher impurity levels overall [2].
- Non-wood fiber structure differs from wood, keeping some impurities less accessible in the raw material [3].

Costs

- Storage of non-woods and logistics to keep biomass in good condition
- Dissolving pulp is more expensive than lower-grade pulps

Scaling up

- Cellulose carbamate is only done commercially by one company (Infinited Fiber), but this process could be integrated into viscose operations

Possibilities & Opportunities

- Cellulose carbamate has successfully been made from wheat non-wood dissolving pulp, spun fibers and properties pending
- Additives (plasticizers, cross-linkers, etc.) may be able to bridge the performance gap between non-wood and wood-based regenerated fibers

[1] S. Paunonen, T. Kamppuri, L. Katajainen, C. Hohenthal, P. Heikkilä, and A. Harlin, “Environmental impact of cellulose carbamate fibers from chemically recycled cotton,” *J. Clean. Prod.*, vol. 222, pp. 871–881, Jun. 2019, doi: 10.1016/j.jclepro.2019.03.063., [2] Win Win Textiles, “Introduction to Regenerated Cellulosic Fibres,” 2018., [3] C. Chen *et al.*, “Cellulose (Dissolving Pulp) Manufacturing Processes and Properties: A Mini-Review,” *Bioresources*, vol. 11, no. 2, pp. 5553–5564, 2016, doi: 10.15376/biores.11.4.5553-5564.