# SAFI Consortium

sustainable & alternative fibers initiative

**Department of Forest Biomaterials**
**College of Natural Resources**

# Rising interest to develop substrates from alternative sources

Sustainability is in Our Jeans

## THIS IS COTTONIZED HEMP

Sustainability / January 2021

Something you'll see a lot of this season (and beyond) is Cottonized Hemp. Why hemp? Because compared to cotton, it grows quicker, uses less water and leaves behind cleaner, healthier soils. Specially designed for Levi's®, this new innovative hemp yarn is soft like cotton — and easily woven into denim styles like our new **551™Z Authentic Straight**. So you get the same authentic Levi's® look and feel in a garment that's easier on the environment.


https://www.levi.com/US/en_US/blog/article/this-is-cottonized-hemp/

# Rising interest to develop substrates from alternative sources

June 10, 2021
2:25 PM EDT
Last Updated 5 months ago

Sustainable Business

## Adidas invests in Finnish sustainable fibre firm Spinnova

2 minute read

Reuters


1/2 The Adidas logo is pictured during celebrations for German sports apparel maker Adidas' 70th anniversary at the company's headquarters in Herzogenaurach, Germany, August 9, 2019. REUTERS/Andreas Gebert

https://www.reuters.com/business/sustainable-business/adidas-invests-finnish-textile-recycling-firm-spinnova-2021-06-10/

# Rising interest to develop substrates from alternative sources

## Over 60% of Adidas products to be sustainable in 2021

04
Jan '21

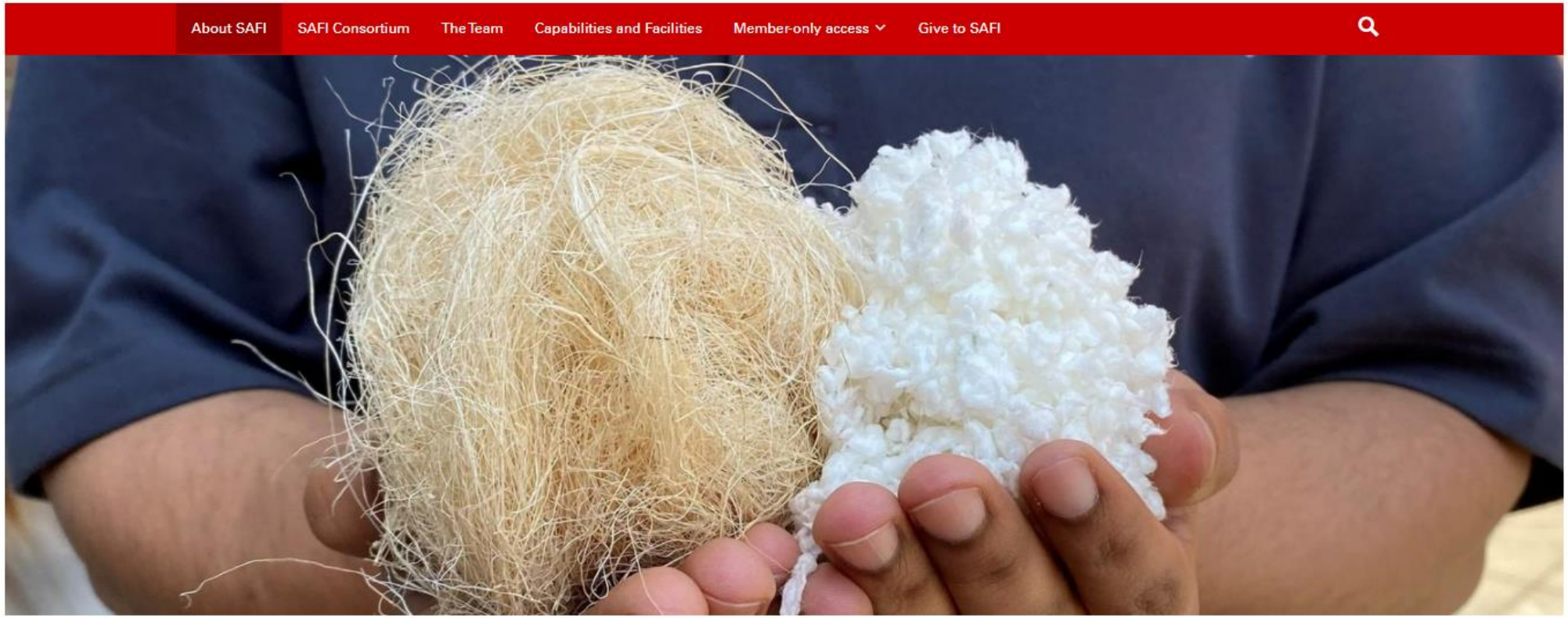
Pic: Adidas

0:00 / 0:00

For the first time in 2021, over 60 per cent of Adidas products will be made with sustainable materials like recycled polyester or sustainable cotton. With this, the company moves closer toward its objective to end plastic waste, it said recently. From 2024 onwards, Adidas will shift to using only recycled polyester. Since 2018, it has been using exclusively sustainable cotton.

https://www.fibre2fashion.com/news/apparel-news/over-60-of-adidas-products-to-be-sustainable-in-2021-271693-newsdetails.htm

# Sustainable & Alternative Fibers Initiative




**The SAFI Consortium aims to combine the creative efforts of its diverse stakeholders to create knowledge and foster technological developments that promote responsible and sustainable practices for fiber production, sourcing, conversion, and utilization to make a global impact.**

# Our partners

BioProducts Institute
bpi.ubc.ca
UBC
RAYONIER Advanced Materials
suzano
NationalBamboo
adidas
GP Georgia-Pacific
SunGrant INITIATIVE Southeastern Regional Center
BAST FIBRE TECH
Central National
Red Leaf Pulp
EASTMAN
cmpc
PSF
familia
Valmet
MERCER
TREECO THE NORTH CAROLINA TREE COMPANY
Kimberly-Clark
WestRock
GENERA
Cascades
MINIFIBERS, INC.

# About our proposed consortium

1. The most systematic and aggressive global effort to unlock sustainable and alternative fiber potential.

1. Leverage on USDA – SunGrant federal funds $420,000*

1. We expect to raise $600,000 from consortium members, for a total $1 million research effort

4. 22 companies have agreed to participate (available in the web page go.ncsu.edu/fiber)

5. Great opportunity to perform high-risk R&D at the lowest cost

NC STATE UNIVERSITY

Tissue Pack Innovation Lab

SunGrant INITIATIVE Southeastern Regional Center

conecsus conversion•economics•sustainability

BioProducts Institute bpi.ubc.ca

UBC THE UNIVERSITY OF BRITISH COLUMBIA

*Please contact us to discuss restrictions & opportunities in intellectual properties.

# Goals – Feedstock & Conversion

SAFI

- **Develop pre-competitive and fundamental knowledge on the potential of nonwood fibers for different consumer good products applications**

## Specific objectives:

1. Comprehensive review on the global production of nonwood fibers.
2. Identify pretreatment and pulping routes to unlock fiber potential to develop suitable furnishes for tissue, textile, packaging, and nonwoven applications.
3. Investigate morphological, chemical and physical properties, for most important nonwood fibers (depending on # members).
4. Understand and model the pulping/bleaching/refining interaction and explore different fiber blending (including wood fibers) for synergies in product properties.
5. Develop techno-economics and life cycle analysis for the most attractive options.

# Goals – Consumer perception

SAFI

- **Understanding consumer perception and behavior towards products containing sustainable and alternative fibers.**

## Specific objectives:

1. Understand consumer perception by contrasting consumer surveys and text and image analytics.
2. Identify and rank sustainability attributes based on consumer perception.
3. Develop trade-off models (performance, pricing, sustainability)
4. Explain current consumer behaviors based on demographics and psychographics and model evolution of consumer behaviors (demand ) for the next 5-10 years

## Consortium information

- USD 30,000 per year, for two years
- ***Start date: First week July 2021***
- We expect 12 consortium members

## Benefits of joining

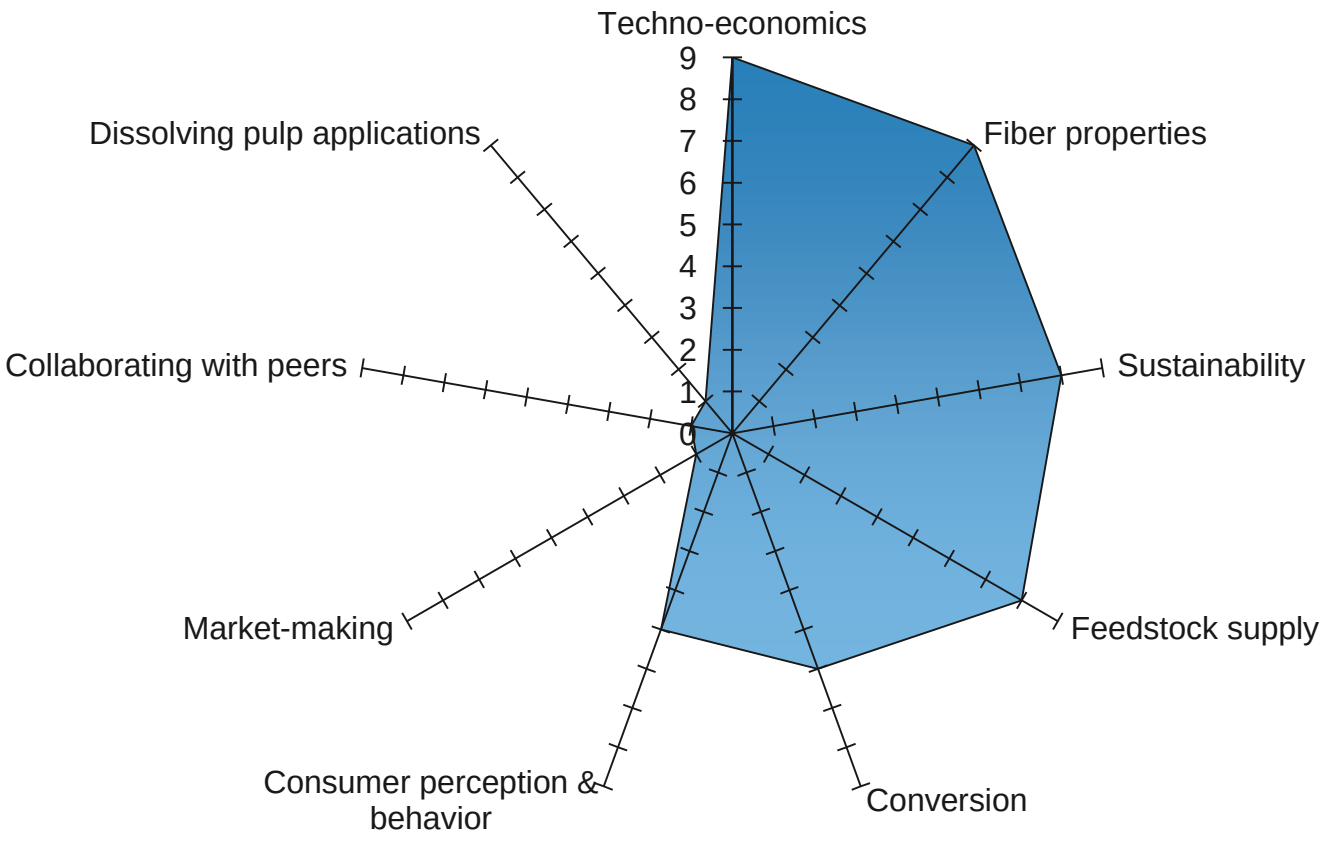
- Participate in a USD 1,000,000 research portfolio
- Unlock fundamental information for your business
- Participate in the direction of this global research effort (members to select feedstock & pulping methods of their interest
- Interact with our PhD students and faculty
- Leverage 20+ years of experience researching a wide variety of nonwood materials at both bench and pilot scale

## Faculty expertise

- Our scientists are well-known, with global expertise in:
- Crops and soil science
- Feedstock supply chain analysis
- Fiber anatomy, morphology and chemistry
- Pulping, refining and bleaching operations for nonwoods
- Fiber and furnish physical properties
- Hygiene tissue manufacturing at lab, pilot and commercial scale
- Nonwoven substrate & textiles
- Techno-economic analysis
- Sustainability & life cycle analysis
- Social science

# Members' preferences

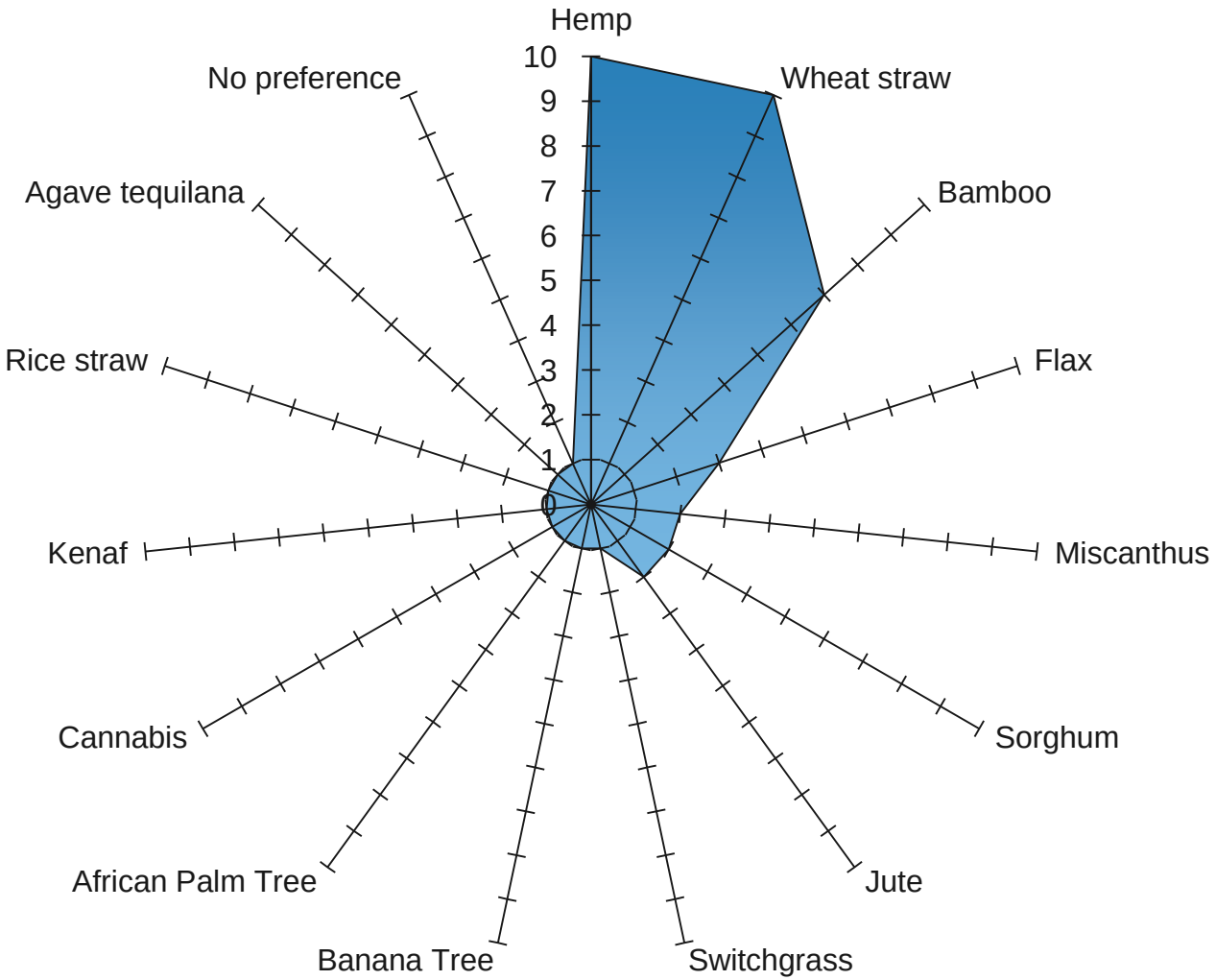
## Major Interests to Join SAFI Consortium




**Interest across the value chain:**

- Supply chain
- Fiber conversion
- Fiber & product performance
- Techno-economics
- Sustainability
- Consumer perception & behavior

# Members' preferences



# Activities Roadmap

SAFI

## 1. Feedstock & Supply Chain

### 1.1 Feedstock
- a. Hemp
- b. Wheat straw
- c. Bamboo
- d. Rice straw & husk
- e. Corn stover
- f. Sorghum
- g. Switchgrass
- h. Banana tree
- i. Ryegrass

### 1.2 Availability
- a. Spatial distribution
- b. Year-round supply
- c. Volume by supply distance

### 1.3 Delivered cost
- a. Biomass cost
- b. Establishment cost
- c. Maintenance cost
- d. Harvesting cost
- e. Storage cost
- f. Handling cost
- g. Transportation

## 2.Characterization

### 2.1 Chemical characterization
- a. Extractives
- b. Sugar content
  - b.1 Cellulose
  - b.2 Hemicellulose
- a. Ash and silica
- b. Lignin
- c. Others

### 2.2 Physical characterization
- a. Fiber anatomy analysis
- b. Bulk density

### 2.3 Advance analytics
- a. Near-IR
- b. Image analytics
- c. XRD
- d. Others

## 3. Conversion

### 3.1 Mechanical
- a. CTMP
- b. TMP
- c. APMP
- d. Steam explosion

### 3.2 Chemical

3.2.1 Solvent
- a. SEW
- b. Alcohol/water
- c. Organic/acid

3.2.2 Traditional pulping
- a. Soda
- b. Kraft
- c. Sulfite

3.2.3 Dissolving pulp
- a. Sulfite

### 3.3 Pulp assessment
- a. Viscosity
- b. Kappa number
- c. Brightness
- d. FQA

### 3.4 Bleaching

## 4. Fiber & Product Performance

### 4.1 Fiber
- a. FQA
- b. Surface chemistry
- c. Cell wall thickness
- d. Fiber flexibility
- e. Other

### 4.2 Furnish
- a. Freeness
- b. Water retention
- c. Response to fibrillation
- d. Other

### 4.3 Hand sheet
- a. Strength
- b. Softness
- c. Absorbency
- d. Response to creping
- e. Benchmark
- f. Other

### 4.4 Regenerated cellulose characterization
- a. Denier
- b. Tensile Properties

## 5. TEA

### 5.1 Technical feasibility
- a. Small scale pulping
- b. Technology risk
- c. CAPEX
- d. Other

### 5.2 OPEX
- a. Pulping cost
- b. Sensitivity analysis
- c. Benchmark

### 5.2 Scenarios
- a. Co-location
- b. Green field
- c. Retrofit

## 6. Life Cycle Analysis

### 6.1 Life cycle assessment & sustainability
- a. Sustainability metrics
- b. Environmental impact
- c. Responsible sourcing
- d. Social aspects
- e. Biodiversity
- f. Carbon sequestration

### 6.2. Life cycle methodologies
- a. Attributional life cycle Assessment
- b. Consequential life cycle assessment

### 6.3 Social aspects of sustainability
- a. Responsible sourcing
- b. Social investment
- c. Safety
- d. Gender equity
- e. No. of employees

### 6.4 Non-common sustainability metrics
- a. Non and renewable resources
- b. Depletion of abiotic resources
- c. Biogenic carbon

## 7. Consumer Perception

### 7.1 Insights from experts
- a. Delphi Method

### 7.2 Insights from selected respondents
- a. Screening survey
- b. Focus groups

### 7.3 Survey
- a. Online
- b. Sensory Center-NCSU

### 7.4 Text & Image Analytics
- a. Attributes & visual characteristics

### 7.5 Visual experiment
- a. Off-line
- b. Online

### 7.6 Forecasts
- a. Model evolution of consumer behavior for the next 5-10 years based on demographics and psychographics

# Timeline Roadmap

SAFI

## Techno-economics & Life-Cycle Analysis

**2023 Q3-4**
**Fiber production**
**Pilot trials**

**Integration**
Fiber interaction

**2023 Q1**

**2022 Q2-3**
**Post-treatment**
(Refining, bleaching, fractionation)

**2022 Q1-2**
**Pulping methods**
**Mechanical** (CTMP, TMP, APMP, steam explosion). **Chemical** (soda, kraft, sulfite). **Solvent** (organic/acid, SEW, alcohol/water)

**2021 Q4**
**Feedstock metrics**
**Physical pre-treatment**
Fiber fractionation, mechanical treatments

**2021 Q3-4**
**Feedstock screening (fiber morphology & supply chain)**
Hemp, wheat straw, bamboo, flax, switchgrass, miscanthus, jute, sorghum (as suggested by industrial partners)

## Consumer Perception Assessment

**2023 Q1**
**Projections on consumer appeal for the next 10 years**

**2022 Q3**
**Consumer perception modelling toward sustainable products**

**2022 Q1-Q2**
**Consumer perception survey**
Pricing, recycled fiber nonwood fiber, brown fiber

**2021 Q4**
**Focus group screening & execution**
Pricing, recycled fiber, nonwood fiber, brown fiber

**2020**
**State-of-the-art assessment**

# SAFI Graduate Students Team

## TECHNICAL

### FEEDSTOCK SOURCING


Rajnish


Amelys

### CONVERSION


Dr. Sun


Ramon


Rajnish

### BLEACHING


Amelys

### FIBER & PRODUCT PERFORMANCE


Ryen


Ivana


Naycari

## ECONOMICS & LCA

### SUPPLY CHAIN & COST


Amelys


Keren

### TEA


Alonzo


Keren

### LIFE CYCLE ASSESSMENT


Ivana


Naycari

### CONSUMER PERCEPTION & BEHAVIOR

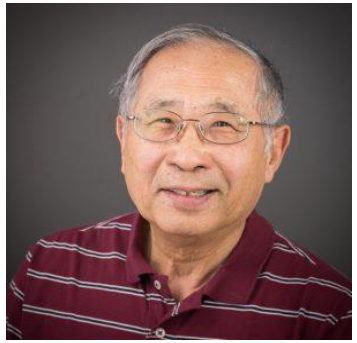

Keren

# Mentor by World-Class Scientists

SAFI

**Dr. Jameel**
Pulping & Refining

**Dr. Gonzalez**
Tissue Manufacturing & Business



**Dr. Chang**
Lignocellulosic Chemistry

**Dr. Phillips**
Process Economics

**Dr. Byrd**
Nonwood pulping

**Dr. Pal**
Product development

**Dr. Peszlen**
Fiber Morphology

**Dr. Pawlak**
Fiber & product physical properties

**Dr. Kelley**
Sustainability

**Dr. Venditti**
Sustainable fibers

**Dr. Ericka Ford**
Sustainable textile fibers

**Dr. David Suchoff**
Alternative crops

**Dr. Daniel Saloni**
Supply chain

**Dr. Melissa Pasquinelli**
Textile molecular modeling

**Dr. Jason Delborne**
Social science scientist

# Questions?

Let us know
how we can help

**go.ncsu.edu/SAFI**

**Dr. Ronalds W Gonzalez MBA**
**North Carolina State University**

rwgonzal@ncsu.edu

**Office** 919.515.7477 - **Mobile** 919.802.5219

**Research team:** go.ncsu.edu/ConEcSus

**Tissue Pack Innovation Lab:** go.ncsu.edu/tissue