Engineering Sustainable Fiber Based Composites from Food and Crop Waste

Project Id: HS-CHMS-224

Q1: Engineering Problem & Objectives

Agricultural and food crop waste is **underutilized** while demand for sustainable composite materials is **increasing globally.**

The objective is to engineer a **systematic approach** that integrates computational crop selection with material workflow for sustainable composite development.

Crop Waste → **Fiber Extract** → **Composite Fabric.**

110+	**9**	**4**	**0.842**
Food Items Analyzed	Food Groups	Key Parameters	Top CE Score

**Images created by finalists*

Q3: Data Analysis & Results

The computational model identified crops with **balanced nutritional value** and **high agricultural residue potential**, demonstrating clear ranking trends. Material workflow analysis showed that extracted agricultural waste fibers could be **successfully incorporated into epoxy-based composites** at a small scale.

0.842	**0.784**
Top CE Score (Banana)	Coir-Epoxy CE Score
68.4	**89.4**
Tensile Str. (MPa)	Flexural Str. (MPa)

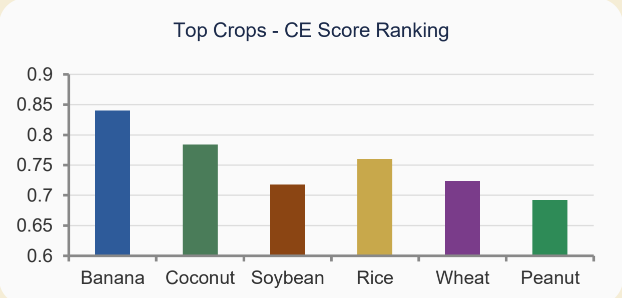
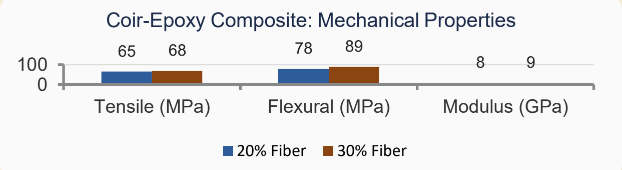


Fig. 1. CE Score ranking of top crop residues (n=110). Banana (0.84) and Coir (0.78) lead.



**Graph created by finalists using Python*

Fig. 2. Coir-Epoxy mechanical properties — 30% fiber achieves 68 MPa tensile, 89 MPa flexural.

Q2: Project Design

A computational model was designed to rank food crops using key parameters such as **nutritional value, crop yield, agricultural residue quantity, and fiber potential.**

Selected agricultural residues were processed through **cleaning, drying, fiber extraction, and composite fabrication** using epoxy resin to evaluate material feasibility.

Input Data → **Computational Crop Ranking** → **Material Workflow** → **Composite Feasibility**

Crop Ranking Results

- High Residue Potential
- Crops Identified
- Balanced Nutritional
- Profiles Observed

Crop Ranking Results

- Agricultural Waste
- Selected
- Suitable Fiber
- Characteristics

Crop Ranking Results

- Fiber Integrated into
- Epoxy Matrix
- Feasibility Demonstrated
- at Small Scale

**Diagram developed by finalists using Canva*

Q4: Interpretation & Conclusion

The integration of **computational decision-making** with material engineering supports systematic crop selection for sustainable composite development.
Results demonstrate **feasibility rather than industrial optimization**, aligning with available data and lab constraints.
Trade-offs between **material performance and sustainability** were identified. Framework can be expanded with larger datasets for **circular-economy research.**

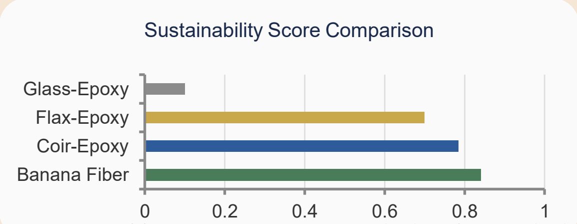


Fig. 3. Sustainability score comparison — Coir-Epoxy (0.80) vs. Glass-Epoxy (0.10).

High Sustainability
Banana & Coir fibers:
CE Score 0.784–0.840
Biodegradable, low cost

High Performance
Flax-Epoxy composite:
100–150 MPa tensile
Better for structural use

Trade-off Identified
Sustainability ↔ Strength
No single 'best' material
Depends on application

Future Scope
Larger datasets, 200+ crops
Hybrid coir+flax composites
App-based farmer tools

**Graph created by finalists using Python*