

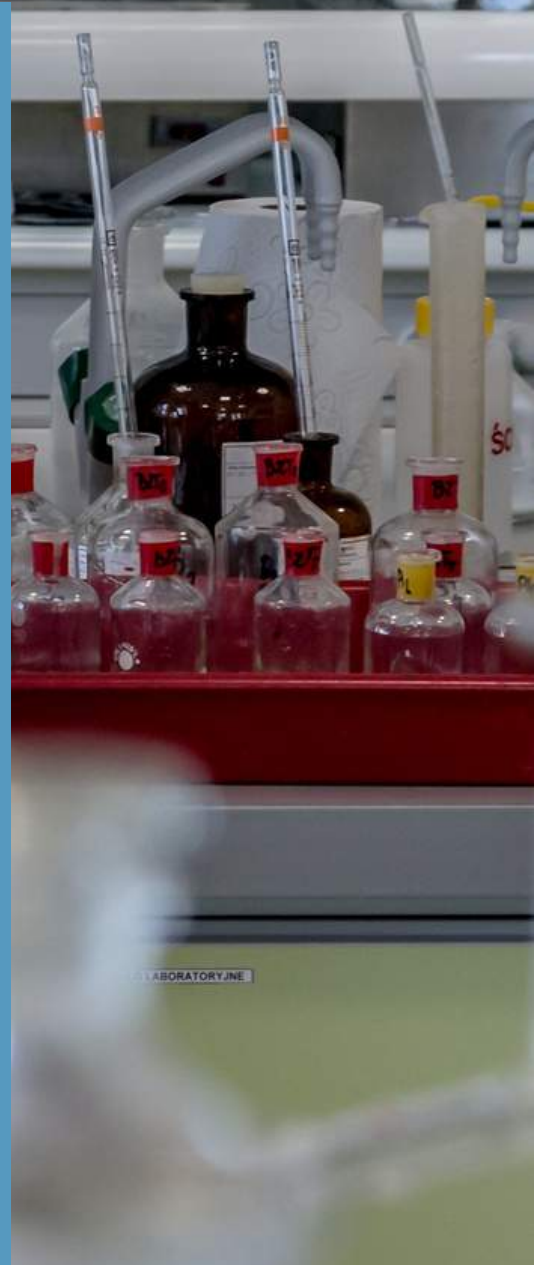


EVERGREEN LABS

Commercializing Innovation in Vietnam: The Materials Lab Pilot

A case study on new materials' development to replace single-use plastic from hyperlocal and regenerative feedstock in Vietnam

September 2023





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Executive summary

In February 2023, the ICM Falk Foundation funded the Materials Lab Pilot, a project to develop new alternative materials to single-use plastic and validate a novel collaboration model for improved technological transfers. Evergreen Labs implemented the project in collaboration with a leading technical university in Ho Chi Minh City and its students.

The project was ideated from the work of the ICM Falk Foundation in identifying and developing early-stage materials with university students and Evergreen Labs' extensive experience working with social innovators and through the Single-Use Plastic (SUP) Challenge. Vietnam has untapped potential in leveraging agricultural byproducts to tackle its single-use plastic problem at the source, combined with low technological transfers for new innovative materials.

The Materials Lab Pilot is the second phase of the Venture Lab approach developed by the ICM Falk Foundation and Evergreen Labs, with the aim to bring more upstream innovative materials from the labs to markets. Through the pilot, the team worked

closely with student innovators to investigate new formulations with clear improvements, while determining market potential for such material in the local context. The developed materials, namely starch-based films for agricultural and food usage, went through various rounds of improvements and showed significant mechanical improvements in external laboratory tests.

The pilot concluded in May 2023 with positive results for the developed starch materials, while requiring further technical assistance and funding to get the existing materials to a commercially viable stage and incorporate new input sources into the program.

The Materials Lab aims to bring more upstream innovative materials from the lab to market.



Key findings

The key learnings from the Materials Lab Pilot are as follows:



Alternatives to fossil-fuel-based single-use plastics are in high demand in various industries, namely hospitality and food and beverage. However, **novel, innovative solutions coming from renewable and regenerative sources remain scarce**. The commercial potential for such products in Vietnam promises to align with global trends and standards with the right investments.



Universities in Vietnam offer a large talent pool, coupled with Vietnam's rich natural agricultural resources that can be leveraged for innovative material R&D but **need more collaborative partnerships with leading funders, corporates, and SMEs** for meaningful technological transfers in the long term.



Small-scale initiatives are resource-efficient (small team, quick reporting, and low-cost) and result-effective (clear planning and procedures for positive end results) by guaranteeing funders concrete results within a 3-month period.

Background

Challenges with biodegradable plastic and innovation pipelines for plastic alternatives in Vietnam

As the plastic issue becomes more pressing, alternative materials are being heavily researched and developed to transition the packaging and single-use markets. Typically, these materials are locally or regionally manufactured bioplastics and other under-researched materials. However, these alternative materials, typically still in part fossil fuel-derived, can cause downstream recycling issues and mislead consumers on end-of-life due to unclear claims and language (i.e. home-compostable, industrially compostable, biodegradable, bio-based, etc.).

In developing new material solutions, it is crucial to fully consider their life cycle, starting from the input feedstock (renewable, local byproducts instead of food supplies) to their end-of-life treatment in order to ensure their effective sustainability.

Abundant materials and innovations

Current Vietnam-based plastic replacement ventures utilize unique, innovative materials such as cassava starch, bamboo, and coconut shells that can be harvested easily and in a regenerative manner (using industrial byproducts in the agrifood sector).

Through the Single-Use Plastic (SUP) Challenge implemented by Evergreen Labs and funded by The Incubation Network and across the 7 years of sourcing innovation in Vietnam, Evergreen Labs has not identified scalable ventures in the alternative material sector.

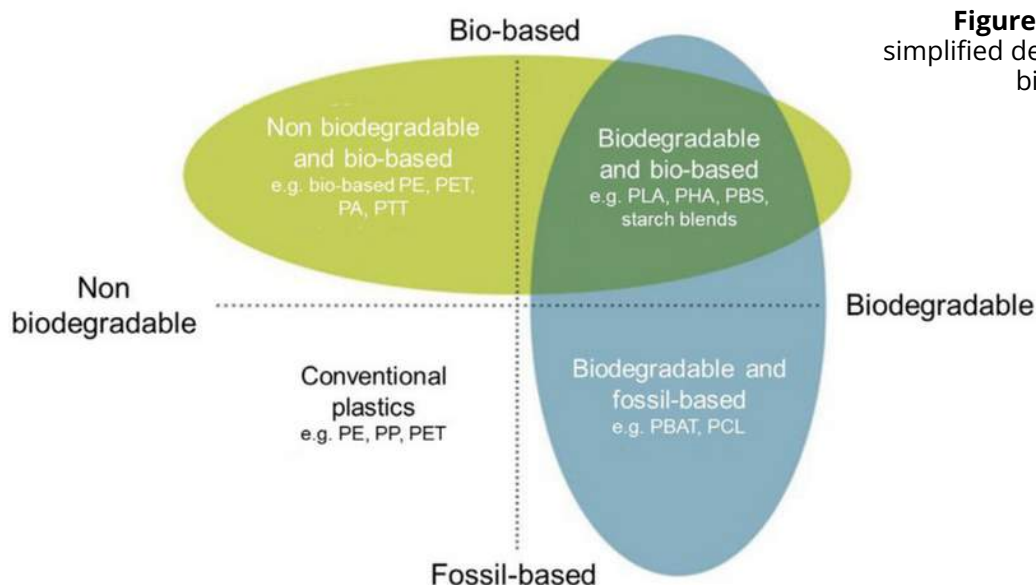


Figure 1. Matrix of simplified definitions for bioplastics (1)

(1) Source: Mehta, Neha & Cunningham, Eoin & Roy, Deborah & Cathcart, Ashley & Dempster, Martin & Berry, Emma & Smyth, Beatrice. (2020). Exploring perceptions of environmental professionals, plastic processors, students and consumers of bio-based plastics: Informing the development of the sector. Sustainable Production and Consumption. 26. 10.1016/j.spc.2020.12.015.

Moreover, the application of these materials still remains standard for the Food and Beverage industry (F&B), such as cutlery, straws, and single-use packaging, despite numerous opportunity fields of applications for agriculture or textile. Overall, locally-developed materials also lack scalability as well as commercialization know-how in order to tackle the single-use plastic issue on a larger scale in Vietnam.

Limited R&D pipeline from research institutions

Through the ICM Falk Foundation's past work with university-based innovators, students, and professors have the capacity to bridge the abundant Through the ICM Falk Foundation's past work with university-based innovators, students, and professors have the capacity to bridge the abundant agriculture waste resources of Vietnam to useful innovations. Various models of successful lab-to-market products have been developed around the world where robust research funding coupled with incubators/accelerators supported an effective technological transfer pipeline.

However, Vietnam-based projects typically struggle to go beyond discovery stages in the labs due to three main reasons:

- Low interconnectivity between universities and external stakeholders for business mentoring and technological expertise
- Limited financial resources and technological knowledge to develop, scale, and assess formulations within the market's context
- Unclear understanding and nascent skillset for the technology transfer process (including the industrial knowledge to test formulations in a scaled setting).

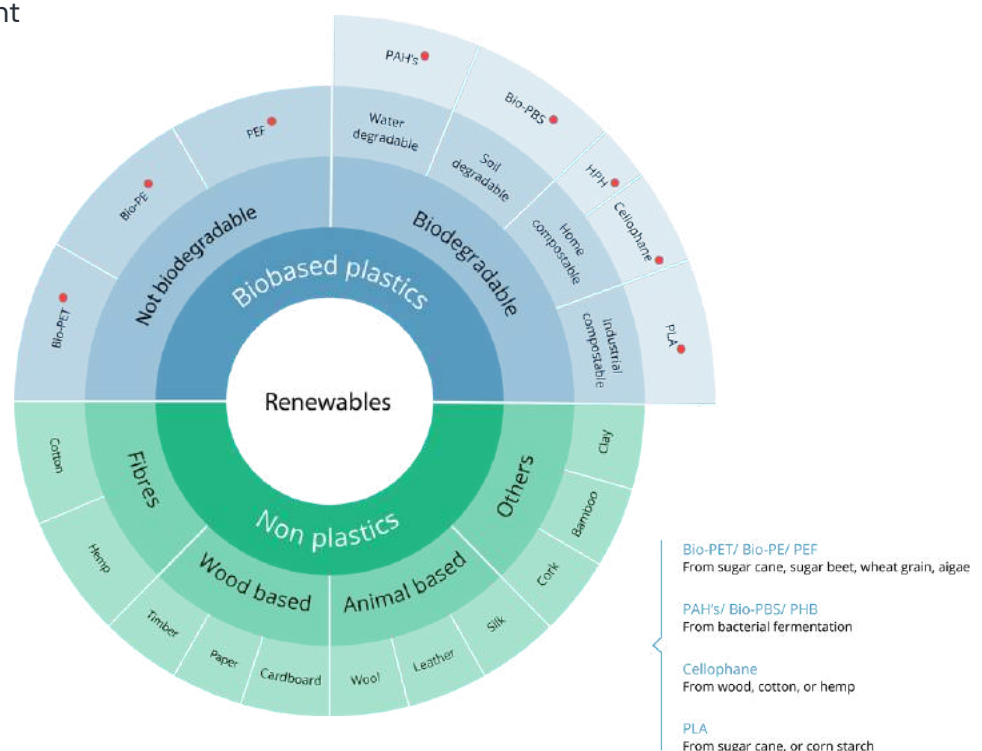


Figure 2. Breakdown of alternative material categories contextualized to Asian raw material sources (adapted from "Sustainable Packaging in a Circular Economy" course by DelftX SPCEX)

(2) Cost-effective production for competitive pricing and readily-available sources for production.

Opportunities in Vietnamese agriculture for regenerative byproducts to replace single-use plastic

Untapped agricultural waste resources

Regarding input for new materials, agro-waste resources are an innovative way to close the loop, eliminate waste and create value. Particularly in Vietnam, the total volume of agricultural byproducts in 2020 was over 156.8 million tonnes, equivalent to a profit of up to \$5 billion per year (Vietnam Statistics Office 2020).

However, the actual use of agricultural byproducts is merely at about \$275 million (DARD 2020) with byproducts usually being landfilled, burned, or composted. These sources are still largely under-researched for new applications in high-need sectors such as packaging with an underdeveloped supply chain network where up to 25% of collected and harvested food is spoiled before reaching processing plants representing 8.8 tonnes of food wastage and US\$3.9 billion ([The Saigon Times](#) 2022).



Diverse sources of feedstock

As of June 2023, Vietnam recorded a 9.9% increase in agricultural exports equating to US\$10.3 billion ([VNeconomy](#) 2023). With the processing capacities of the country, local innovators can creatively leverage various and diverse sources of byproducts (pith, peel, pulp, seed) from fruits and vegetables such as pineapple, potatoes, and dragon fruits. Vietnam also represents a multi-billion dollar export industry for seafood

processing with an estimated average of 10 to 15% of the total processed volume being byproducts ([Doanh Nhan Tre](#) 2022).

Overall, material commercialization can be done from various sources thanks to the diversity of Vietnamese industries and patent production can be increased by applying a tried-and-tested framework between manufacturers, researchers/universities, and funders.

INPUT

OUTPUT

FOOD LOSS

Vegetables &
Fruits

Meat

Seafood &
Fish

Rice

Dairy
ProductsAnnual
production
(tonne)28 million
(2021)6.69 million
(2021)8.73 million
(2021)46 million
(2021)1.2 million
(2021)Annual
revenue (USD)

\$1,645 billion

\$1,195 billion

\$580 billion

\$368 billion

\$304 billion

Export
revenue (USD)

\$3.55 billion

\$81.68 million

\$8.89 billion

\$3.3 billion

\$302.7 million
(2020)Annual
volume of
byproduct
(tonne)

7.3 million

937,600

1 million

28.9 million

937,600

% of annual
production32%
(2020)

14%

9%

21%
(2018)

14%

Value chain
stagePost-harvest
Processing

Production

Processing

Post-harvest
Processing

Production

Data compilation by the ICM Falk Foundation (May 2023)

Despite the vast agricultural byproduct opportunities within the local market, **single-use plastic replacement solutions are commonly produced by leading plastic manufacturers** with pellets of bioplastic and resin blends. **The application fields also remain narrow**, with commercial manufacturers focusing on food and beverage applications (eg., utensils, bags, and straws).

As **local consumer regulations remain unclear** with low general public awareness, these solutions are still advertised as the sole alternative to current fossil-fuel-based, non-biodegradable, single-use plastic. **Communication surrounding these alternative materials hence remains disjointed or misleading to the general consumer.**

Pilot project



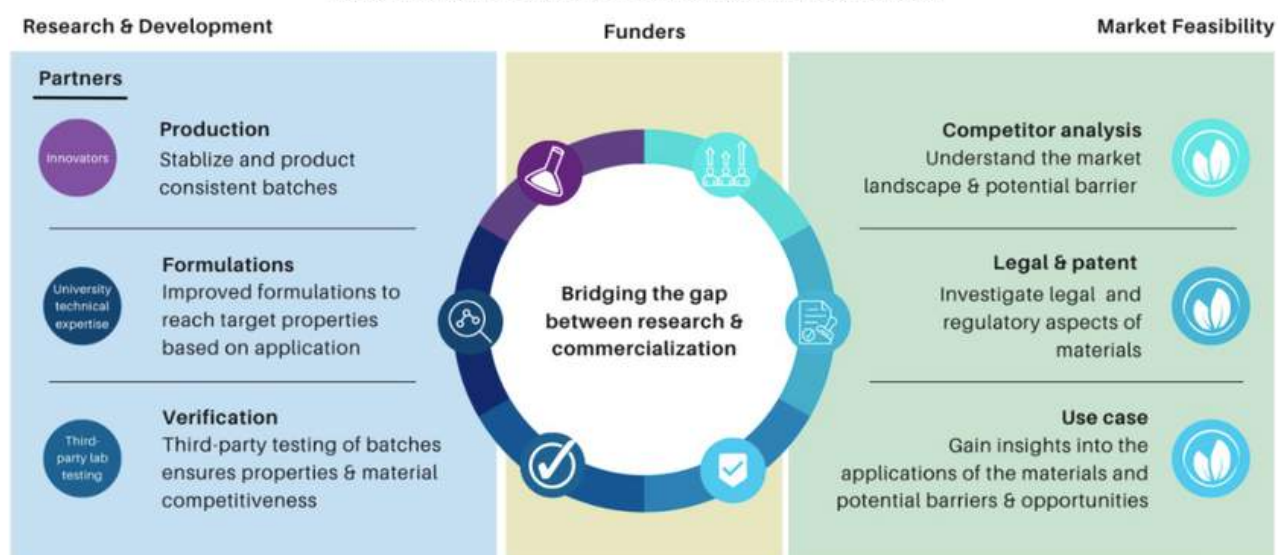
The Materials Lab framework and the intended pilot results

Combining the ICM Falk Foundation's work with local universities via their Circular Innovation Grant program and Evergreen Labs' track record in establishing local social ventures, the Materials Lab team piloted a 3-month project with compensated university-based innovators and their materials prototypes.

With a lack of mainstream bioplastic suppliers offering 100% natural and renewable materials, university researchers in Vietnam remain innovative in the search for locally available materials to replace traditional bioplastic offerings.

THE MATERIALS LAB PILOT FRAMEWORK

Tools and cooperation required for successful innovation to scale



The pilot aimed to test an open innovation model with a collaborative approach between funders, implementers, and researchers, both working remotely across Vietnam and from a physical lab space in Ho Chi Minh City from February to May 2023.

The intended pilot results aimed to demonstrate:



Feasible framework with high-potential partnerships, R&D dynamics (i.e., speed, capacities, etc.).



Improved formulation development of pre-selected materials together with innovators and university partners.



Evaluation of the materials' **market feasibility** through targeted and dedicated market research.



Selection of promising material (based on formulation results and commercial feasibility) for further research, commercial production, and market testing including the development of a scorecard for final evaluation.

The Materials Lab pilot is the 2nd phase of the overall Venture Lab approach which spans over **21-24 months** from idea sourcing through venture scaling:

	Phase 0 Sourcing	Phase 1 Materials validation	Phase 2 Material commercialization	Phase 3 Market piloting	Phase 4 Scaling
	Prototyping new materials in lab	Market deep-dive with improved prototypes	Production partnerships	Market launch	Market growth
	Stabilize lab-scale product + Validate prototype	Define market and stable production	Validate product-market fit	Launch and scale production	Scale and stabilize production

The ultimate goal of the framework is to **give autonomy to the program** where the innovation pipeline can be easily replicated and monetized (through paid services or pay-it-forward schemes), working in close partnership with universities, entrepreneurs/innovators, and corporates.

Solutions created and developed by the Materials Lab would have a better market survival rate thanks to this unique partnership approach for Vietnam, and self-sufficient funding schemes.

Pilot outcomes with cassava-based materials

With a clear market need for renewable and natural alternatives to SUP, our team selected **starch-based materials** that went through previous incubation support in 2021 and demonstrated commercial viability with paying customers of their proof-of-concept:

Material #1

Nursery bags for plants made from cassava starch (dry application)

Material #2

Edible and dissolvable film made from cassava starch (wet application)

Innovators and the Materials Lab team worked together based on a **hybrid model** with one technician at the physical lab space for weekly sprints of experimentations and two remote researchers – one for experimentation planning and deep dives and one for market research.

	February 2023	March 2023	April 2023	May 2023
Technical activity	Scientific literature review Experiment planning	Material testing and improvement rounds > Baseline quality results from external lab		Final improvements > Endline quality results from external lab
Business activity	Market research (competitors, patents)			Final evaluation of project



Student and technician innovator, Hoàng Minh Hương, and Evergreen Labs' Director, Dr. Kasia Weina photographed together with improved materials at the lab space.



Hoàng Minh Hương photographed with the latest improvement of her material initially developed in 2021.

1

Over the course of the 4 months and several rounds of experimentation, **water absorption was a key mechanical property to improve for both materials**. Our technician innovator and remote researcher accomplished the intended goal of improving the materials' formulations as follows:

	Material #1	Material #2
	Nursery bags for plants made from cassava starch	Edible and dissolvable film made from cassava starch
GOAL	Water absorption needs to be minimal to improve shelf life	Water absorption needs to be maximal to improve dissolution in hot water
SOLUTION	Replace cassava starch with another type of starch (more renewable)	Add natural additives to the formulation to improve

Formulations have been improved despite the short duration, but remain not yet market ready as formulations need more expertise counseling (ideally from a commercial partner with heavy R&D capacities).

2

Despite promising improvements, **functional and external challenges in the materials' formulations** remain a major barrier to competing in the SUP replacement sector.

	Material #1	Material #2
	Nursery bags for plants made from cassava starch	Edible and dissolvable film made from cassava starch
POTENTIAL APPLICATIONS	Agriculture (plant bags, fisheries)	Wet food and non-food for home use
CHALLENGES	Water absorption still too high to be practical in a sub-tropical climate such as Vietnam	Food safety regulatory issues once fully dissolved and ingested

Commercial outcomes

As a key component of our framework, this project intended to explore not only the technical feasibility with R&D but also the commercial viability of the materials. The market in Vietnam is considered nascent with limited competition – both in terms of companies and solutions, while innovation opportunities are plentiful for local organizations and entrepreneurs to explore.

- 1 Competitors are large plastic manufacturers producing **composite plastic-bio blends** and have limited (or no) offering of 100% natural/renewable products
- 2 Most alternative materials being produced are focused on SUP **specifically for the food and beverage industry** (F&B) with other market application fields still overlooked
- 3 **Minimal patents** were found related to the alternative material sector in Vietnam indicating little competition domestically

Conclusion

Overall the pilot has shown positive outcomes from both collaborative and technical perspectives and established an initial set of guidelines for similar deployments; however, more support is needed in order to complete the outstanding challenges in Phase 2 – Material commercialization:

- 1 Validation needed for **input sources** (volume, availability) for starch products in Vietnam/region
- 2 Stark improvements are needed for **mechanical properties** (ie., water absorption, thickness, and strength)
- 3 Testing for **stabilized formulations in a commercial setting** (packaging manufacturing)
- 4 Validation and further testing for **certifications** regarding food safety and biodegradability
- 5 Detailed calculations of **costs and pricing** determined with commercial partners (suppliers, manufacturers)



Key takeaways



Simplified and outsourced R&D pipeline for businesses

By working with the Materials Lab team, new materials' sourcing and validation processes are streamlined with both technical and commercial considerations.

- 1 **Defined standard operating procedures** with clear project management templates for Phase 1 from roles and responsibilities to proven material sourcing pipelines and overall engagement with technical stakeholders.
- 2 **Market research with standardized rating cards** to assess business cases and the technical feasibility of these early-stage materials.
- 3 Abundant network of **adequate commercial partners** (SME manufacturers) based in Ho Chi Minh City for quick trials.



Partnerships with innovators as a key development tool for Vietnam

Shifting the usual paradigm in local innovation processes, the Materials Lab team engaged with Vietnamese innovators and universities to boost their internal capacities and structured a consolidated process to support solutions' go-to-market process.

- 1 Win-win partnerships with **fair and transparent outcomes** (compensation, research papers, etc.) for successful technical transfer from an academic setting to a commercial one (viable intellectual property).
- 2 Available **mentorship/support program** for young entrepreneurs-innovators.
- 3 **Distinct university-based innovation programs** for technical researchers and students.



Small-ticket funding for flexible, low-risk innovation programs

The pilot project was designed as a fair and transparent process with the ultimate goal of becoming a self-sustaining program where funding would allow flexibility for innovators to test and fail, while benefiting from corporate and external experts' support.

- 1 Feasible low-cost but efficient pilots** within short time frames as proof-of-concepts of larger programs.
- 2 Better penetration** with hyperlocal and overlooked innovators, coupled with more creative solutions for the R&D pipeline and better technical support from external experts.
- 3 Outsourced management** with experienced implementation team.

For innovators and researchers, the ecosystem has unlimited opportunities for innovation, especially regarding the development of **100% natural and renewable materials** that can be offered at **competitive prices** for various sectors and application fields including F&B, agriculture, packaging, etc.

In parallel, supportive regulatory frameworks that promote circular economy solutions and set transparent standards for the industry will come into place in the near future, bolstering a promising business environment for truly sustainable materials.

Together with better consumer awareness, an ecosystem promoting upstream solutions creating a no-waste future will be possible with the right type of partnerships and funding.

Future of the Materials Lab

After the successful completion of this pilot project (Phase 1 of the MLP framework – Materials Validation), further **funding and research** are needed in order to transfer the two highly promising starch-based materials from the lab to the market.

Despite the improvements over a short pilot period, in order to bring the materials from this project and other materials currently in the pipe to the commercialization stage, we are seeking:



Technical expertise to further improve the formulations of the materials including mechanical properties and stabilization.



Improved access to reliable agriculture waste feedstock to be used for the production of pre-selected materials.



Evaluation of the non-starch-based materials' **market feasibility** through targeted and dedicated market research.



Production partnerships to test and pilot materials in commercial production settings.

The Materials Lab project framework can be applied to various research and development settings where innovation meets commercialization. The path to commercialization can be challenging for universities to navigate and this pilot highlights the importance of multi-stakeholder partnerships, innovative financing, and technical knowledge sharing. By creating a diverse ecosystem, innovation can thrive and grow towards successful commercialization.



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