





## CIRCULAR ECONOMY BUSINESS CASE STUDIES IN SOUTHEAST ASIA



## Mycotech Lab (MYCL)

-  Bandung, West Java, Indonesia
-  Biotechnology
-  mycl.bio
-  Analysis period: 2016-2023

## Using Mushrooms to Produce Sustainable Material from Agricultural Waste

## Business Spotlight

Mycotech Lab (MYCL) is a biotech business start-up based in Bandung, West Java, Indonesia. The company's core business is developing sustainable materials derived from organic raw material through fermentation-like processing using different mushroom varieties.

Since 2015, the company has developed the use of mycelium (thread part of mushroom in its early development stage) as a bio-adhesive to turn agricultural waste (e.g. left-over cassava starch, corn bark, bagasse fibre) into natural polymers that can be used as materials for buildings, home decor, and fashion. The company's signature innovations are a leather-like material called MyLea™ (mycelium leather), which is suitable as an alternative for conventional leather and faux; a composite board called BioBo™ (biodegradable board) which is suitable for buildings or shaping into various pieces of furniture. These materials are green and will naturally biodegrade after their intended product cycle.

MYCL now is a B-certified corporation (for its environmental and social responsibility performance), partnered with around 500 local farmers and 24 local suppliers, it employs 47 workers, and has set up a joint-venture company in Japan.

Moving forward, MYCL plans to explore more commercial applications and raise awareness on the use of their sustainable material.

 **Keywords**

Agriculture waste, Baglog, Biotechnology, Mushroom-grown material

 **Innovation**

Product/service design, Manufacturing, Resource circularity, Resource efficiency



## Context and baseline

Each year Indonesia generates around 51 million metric tonnes of agricultural organic waste of which only around 10% is being repurposed for some other use. At first, MYCL's founders started their business to grow mushrooms as 'super food'. They worked with local mushroom farmers who use baglog as a growing medium for different mushroom varieties. The baglog becomes waste when the mushroom thread/mycelium is no longer productive (i.e. no longer produces mushrooms), ending up in landfills. Inspired by the technique to make tempeh (Indonesian traditional food made of soybean which is glued by a mycelium net), they found that agricultural waste used in baglog can be used to grow strong and compostable material in different shapes.

Based on the findings, MYCL then pivoted itself as a biotech company with the aim of developing sustainable materials through the application of mushroom mycelium.

To further develop and refine the process and standardise the techniques, MYCL worked with research facilities both in Indonesia (e.g. National Research and Innovation Agency/BRIN) and abroad (e.g. National University of Singapore, Swiss Federal Institute of Technology/ETH Zurich). In developing its innovation MYCL gained funding support from, among others, the European Union (Horizon Award, 2020), SEED (2019), and DBS Foundation (Social Enterprise Grant, 2016).

## Innovation

MYCL is a circularity-inspired biotechnology research and development company that develops and commercialises materials and technologies to use previously discarded agricultural waste for production of valuable, sustainable materials to replace commonly used materials like leather, panel board, etc., in different applications (bags, wallets, furniture, etc.). As in tempeh, the mycelium acts as a binder for the newly created biomaterial. The process is achieved by growing mycelium substrate under controlled conditions on the agricultural waste to achieve substrates of various qualities and thicknesses that can subsequently be processed into MyLea™ (the surface or skin of the substrate becomes a leather substitute), BioBo™ (the bulk of the substrate becomes a panel board substitute) and MYCL composite (a solid composite material). The innovation has been scaled for (semi-) commercial production using waste baglogs from mushroom cultivation. The process has already been demonstrated on various other agricultural

wastes, such as empty palm oil fruit bunches, cassava pulp, coconut shells, bagasse and tapioca bark. The company has established collaboration with product and fashion designers and brands to apply its innovative materials in different products.

At its innovation factory, MYCL is continuously improving and further optimising the manufacturing processes, in particular for the further processing of the harvested mycelium substrates into its products. Through technology learning and better manufacturing practices, MYCL has been able to increase the efficiency of energy and water use in its processes, and minimising waste and effluents, which demonstrate continuous improvements in resource efficiency of the production of the company's sustainable materials.

## Circular Economy impact

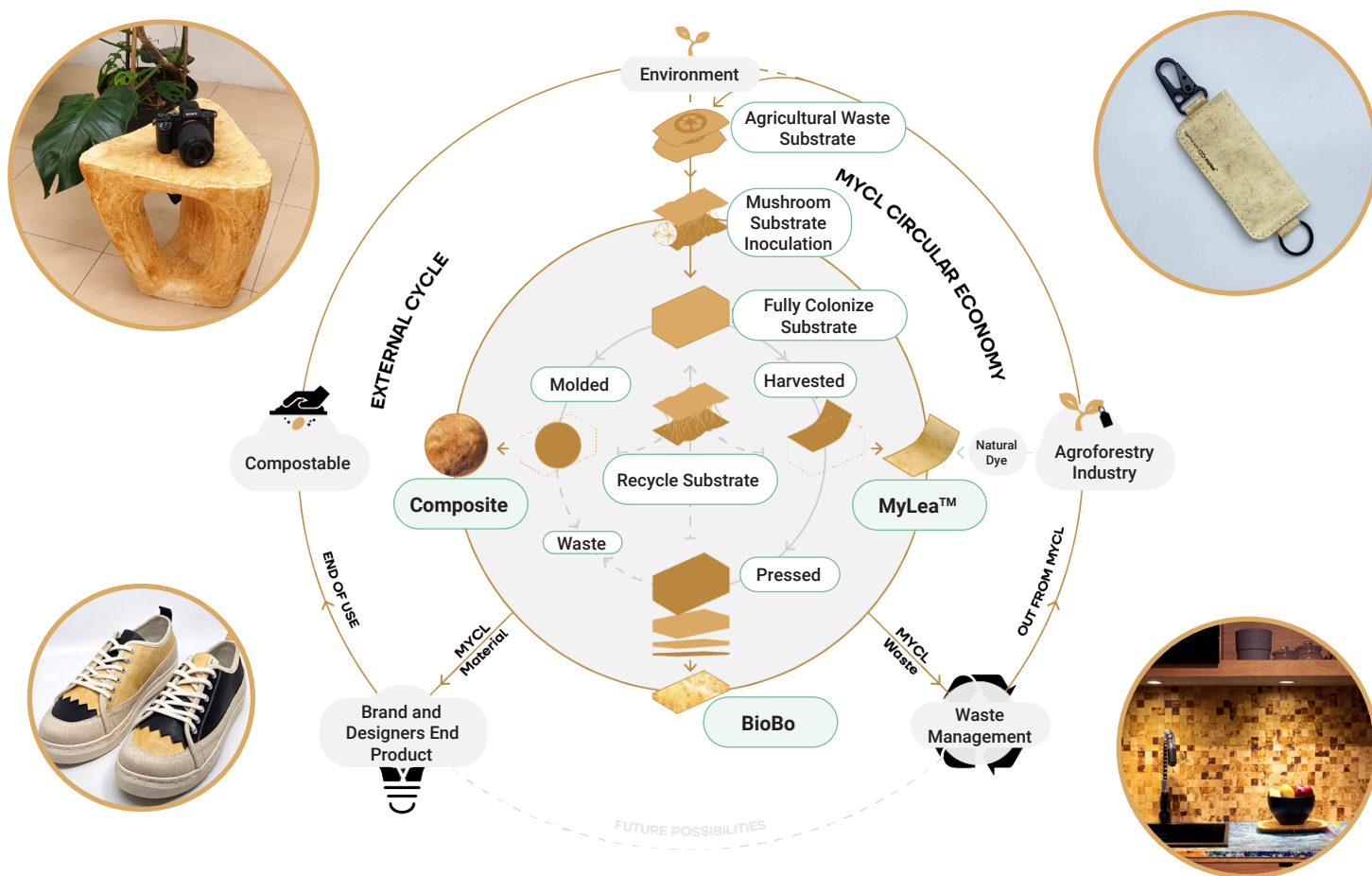
The MYCL innovations contribute principally to resource circularity and resource efficiency, and are therefore exemplary for achieving circular economy.

Resource circularity is achieved by using agricultural waste (currently mushroom cultivation baglog) as input material, currently 6000–9000 bags/month. The MYCL production processes themselves create another waste substrate, an organic waste comprising 98% of the company's waste. This waste (around 11,000 kg in 2021) is taken by a composting company to produce compost, and is thus diverted from landfill.

Resource efficiency is being achieved in the production processes, particularly in the post-treatment process. The greenhouse gas (GHG) intensity per m<sup>2</sup> of product decreased by 30% between 2019–2020 and 2020–2021 for MyLea™ and 58% for BioBo™ (which also included scope 3 emissions from reduced travel during the pandemic period).

Resource efficiency is also achieved by substitution of the traditional materials with MYCL materials. In the case of MyLea™, 67% water is saved in post treatment compared to bovine leather, and 17% of GHG emissions are avoided.

The company also works towards resource substitution by using natural dyes such as Tingi wood and Secang wood (*Biancaea sappan*) in MyLea™ post production instead of synthetic dyes. Use of natural dyes reduces the toxicity of the processing effluents and products used.



## Business and market impact

Since its start in 2015, MYCL has developed and started production of two signature products, namely MyLea™ and BioBo™. MYCL is seeking to scale up the usage of MyLea to enter the fashion market in Japan. Currently, MYCL is able to produce 60x60 cm MyLea™ sheets which are more flexible for fashion use (less materials wastage as compared to odd-shaped natural leathers). MYCL has set up a strategic partnership with mushroom traders and producers in the Nagano Prefecture in Japan. Using the Nagano producers' machinery, they can scale up the leather-like material to mass production.

In 2022, MYCL secured sales contracts amounting USD 10 million until 2024. The contract includes several well-known brands, such as Under Armour, Decathlon, and Camper. Further market expansion is expected, given the prediction that global demand for alternative leathers is projected to reach USD 90 billion globally by 2025.

By 2022, MYCL had successfully secured seed funding and pre-series A funding totaling USD 1.75 million (investors include Temasek Foundation, Fashion for Good, Agfunder). In 2023, it released fund-raising Series A targeting for USD 4 million. The company plans to use these funds to expand their current facilities, both in Indonesia and Japan. It is foreseen to expand the production capacity in Indonesia from 2000 m<sup>2</sup> to 50,000 m<sup>2</sup>, and the facility in Japan from 400 m<sup>2</sup> to 20,000 m<sup>2</sup>.

## Stakeholders

In its business process, MYCL maintains relations with the local community and local suppliers. Since 2015, the company has partnered with 500 local farmers living close to their factory who supply the baglog and mushroom seeds. The long-term partnership provides decent livelihoods for the surrounding community. Around 79% of the agricultural waste material use for baglog is sourced from suppliers within the West Java area, making it possible for MYCL to reduce their scope 3 GHG emissions from transportation. Moving forward, MYCL plans to have a Supplier Code of Conduct to ensure integration of sustainability aspects within its supply chain.

The company had in 2022 47 employees: half of them are women, including both researchers and operators for their mushroom production facility. Even though it still operates only on a small scale, MYCL is committed to providing a safe, equitable, working environment.

## Implementation

As one of the early players in the field of sustainable materials development, the challenges that MYCL faced include the lack of definite benchmarks, limited funding for biotechnology innovations, and the weak systems for Intellectual Property (IP) protection in Indonesia. Awareness of local markets

using sustainable materials still remaining low, was another challenge for the company, and thus MYCL has been dependent on international demand to develop its business.

Addressing these challenges, MYCL has sought collaboration with counterparts both locally and abroad. For instance, in the early stages of product development, the company worked with local researchers from BRIN to assess its techniques and the quality of its products. However, not all the tests could be undertaken in Indonesia as demand grew. MYCL then sought collaboration with researchers abroad. For instance, the company is working with ETH Zurich and Karlsruhe Institute to develop techniques for smart building walls and leather-like textures.

Despite its potential, biotechnology is not viewed as promising by financiers in Indonesia, who mostly assume that technology is limited to 'digitalisation'. MYCL therefore actively seeks grants to fund its business. They have managed to receive grants from prestigious philanthropic institutions, impact investors, and even from crowd-funding platforms. Aside from financial support, the grants also provide for capacity-building and networking with related partners abroad.

For a research-based start-up, IP protection is important. At the beginning, MYCL had only limited awareness about what information need to be shared, and how patents can be an added value to grow a business. And as a grantee of the DBS Foundation, MYCL benefitted from the capacity-building provided through Intellectual Property of Singapore (IPOS).

As market acceptance holds a key for expanding the business, MYCL understands the need to raise local market awareness about the benefits of sustainable products, even though the company has a niche market abroad. The company hopes to target the younger generation, which has a better appreciation of sustainable lifestyles. MYCL thus actively promotes the use of sustainable materials with local designers from shoe brands (Hijack, Brodo), architecture studios (Od Studio, Space Available), to high-end design furniture galleries (PITA Collections).

The MYCL idea to use mushrooms to grow sustainable materials has been replicated by mushroom growers in the Nagano Prefecture of Japan. Nagano was once known as a mushroom producer, but the production declined over the years, leaving many production sites idle. In 2022, MYCL set up a joint venture with three Japanese companies with established production facilities in Japan, specifically to develop a large-scale production of mushroom-grown materials for the fashion industry.

## Takeaways

MYCL has successfully developed its science-based business using mushroom mycelium, backed with Intellectual Property protection for the innovation, which has in turn facilitated partnerships with premium brands and products.

In scaling up the business, MYCL is committed to ensuring efficiency and social impact in Indonesia.

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## Disclaimer

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