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CIRCULAR ECONOMY BUSINESS CASE STUDIES IN SOUTHEAST ASIA



Nhat Tam Agricultural Services Cooperative

Dak Lak Province, Vietnam

Cocoa production and processing

Analysis period: 2018-2026

Pioneering Circular Solutions for Cocoa Production

Business Spotlight

The Nhat Tam Agricultural Services Cooperative, based in Vietnam's Central Highlands, is pioneering a regenerative, closed-loop model of cocoa production that integrates sustainable farming, post-harvest innovation and market diversification. Through their digitally-controlled irrigation systems, the transformation of agricultural waste into biochar production, the gasification of biomass waste for energy utilisation, and the conversion of waste into useful resources, the cooperative is increasing productivity while reducing environmental impacts.

The pyrolysis of agricultural residues from cocoa production generates biochar and wood vinegar (condensed pyrolysis smoke), which upon application in cocoa farming enhance soil fertility, reduce reliance on chemical farm inputs, and create new commercial products. Localised, scalable gasifier technology converts agri-byproducts into syngas that is then used as a clean fuel for drying cocoa beans, thereby cutting costs and emissions while ensuring consistent quality for dried beans. The cocoa husks and pulp are transformed into fermented beverages and animal feed as a further diversification of income streams and waste reduction.

Leveraging these local residues (cocoa husks, shells, and pulp) reduces costs, improves efficiency and minimises environmental impacts. This approach empowers farmers to manage energy needs, improve product quality and adopt sustainable practices. Nhat Tam Cooperative demonstrates that regenerative, circular solutions can simultaneously contribute to environmental sustainability, economic resilience and inclusive growth, moving from monoculture to diversified systems that strengthen climate resilience and farmer livelihoods. With targeted investment, partnerships and supportive policies, Vietnam's cocoa industry can evolve into a climate-smart, export-oriented sector and serve as a replicable model for the wider agri-food sector.

Keywords

Cocoa waste; Biochar; Animal feed; Energy; Sustainable Agriculture

Innovation

Product/service design, Manufacturing, End-of-life management, Resource circularity, Resource efficiency, Resource substitution

Analysis of Nhat Tam Agricultural Services Cooperative

Context and baseline

Vietnam produces about 5,500 tonnes of cocoa beans annually, compared to the global output of 4.8 million tonnes.[1] Because Vietnamese cocoa beans are internationally recognised for their high fermentation quality, they feed into the fine-flavour premium cocoa market segment (representing 10%–15% of global cocoa bean production). Conventional cocoa farming relies heavily on chemical fertilisers and pesticides, leading to soil degradation, biodiversity loss, and elevated water consumption.[2] Usually, cocoa processing generates large volumes of cocoa pod husks, shells and pulp, which are commonly underutilised or simply discarded or burned. This environmental waste burden produces harmful emissions and represents a missed economic opportunity.[3] Soil health, resource efficiency, and Vietnam's ability to meet international sustainability standards are all equally undermined.

To address this sustainability gap, Nhat Tam Agricultural Services Cooperative, a prominent cocoa producer organisation in Vietnam, is working towards reducing the environmental burden of producing cocoa, improving farmer livelihoods, and meeting global sustainability expectations. The Cooperative is based in the Central Highlands, with member and associated households cultivating 350 ha of cocoa beans. The annual production outputs are 500 tonnes of wet beans, 250 tonnes of dry beans and 15,000 L of fermented cocoa water. The Cooperative's fermented cocoa water products have achieved 3-star certification under the One Commune One Product (OCOP) initiative, signalling both high quality and market potential. In addition to cocoa, the Cooperative is active in macadamia production and processing, which is strengthening its market reach. The Cooperative has adopted sustainability practices in cocoa production to reduce the environmental footprint and improve long-term resilience by means of reduced waste, more efficient energy and water use, and waste-to-resource strategies.

Innovation

The Nhat Tam Agricultural Service Cooperative has developed and implemented a customised and scalable gasification and biochar production system that transforms cocoa wastes into valuable biofuel and agricultural inputs. By integrating waste-to-energy and waste-to-biochar with digitally-controlled irrigation, Nhat Tam Cooperative is demonstrating a scalable innovation for climate-resilient and resource-efficient cocoa production.

Waste to biochar: turning cocoa byproducts into 'black gold' – the Cooperative's versatile pyrolysis furnace can process cocoa shells, rice straw, coffee hulls, rice husks, branches, and leaves. After drying, this biomass is loaded into the furnace and transformed into high-quality biochar. The output biochar product is a high-quality soil amendment that improves the porosity and retention – and thus the efficiency – of water and nutrients. Biochar can reduce fertiliser use while increasing crop yields by up to 15%. The positive effects of turning waste into biochar are that it reduces waste, lowers fertiliser use and costs, improves soil health, restores microflora, and acts as a long-term carbon sink by storing carbon in the soil for decades.

Waste to energy: clean heat for drying – Nhat Tam's customised and scalable gasifier converts agri-byproducts into syngas that is used as a biofuel of cocoa bean drying and burns with minimal smoke and emissions. The Cooperative has installed a KANAI-800 rotary gasification kiln, which is a semi-automatic system with pneumatic valve control. It runs on locally available agro-residues, such as cocoa and macadamia shells, rice husks, etc. The agricultural residues are gasified into syngas, a clean-burning biogas that is used for cocoa-bean drying. The heat is transferred through an integrated heat exchanger with precise control over the drying temperatures. The gasifier with drying kiln enables 24/7 drying, independent of climate conditions. The kiln operates with a capacity of 5–15 tonnes per batch, ensuring consistent quality.

By-products from cocoa: expanding value chains – the cocoa pulp is used for the production of fermented beverages such as cocoa wine and cocoa liquor.[4] Moreover, cocoa pods are pelletised for use as livestock feed. Both fermented beverages and feed pellets diversify the Coooperative's products beyond beans, powder, and chocolate, creating additional income streams and reducing waste.

Smart irrigation: digital water & nutrient management – the adoption of a centralised irrigation system with advanced digital controls (imported from Israel) achieves efficient water

1 https://trongduccacao.vn/tong-quan-ve-nganh-ca-cao-viet-nam-n707.html
2 Khang et al. (2024) Life Cycle Assessment of Cocoa Products in Vietnam, https://doi.org/10.1007/s41660-024-00412-8.
3 Donkor et al. (2025) Cocoa byproduct utilization in the bioeconomy: a review of waste-to-resource strategies, https://doi.org/10.1080/17597269.2025.2550911
4 Cocoa liquor is a beverage produced from fermented cocoa pulp. It is distinct from chocolate liquor (or chocolate mass or paste) which is pure processed cocoa in liquid or semi-solid form, an intermediate product in chocolate production.

and fertiliser delivery and utilisation. The precision irrigation system reduces irrigation and fertiliser use, enhances crop resilience, and demonstrates climate-smart farming.

Innovations like these are reducing the environmental burden, cutting irrigation and fertiliser costs, and improving farmer livelihoods.

Circular Economy impact

The Nhat Tam Agri Cooperative provides an exemplary demonstration of circular agriculture in Vietnam. The transformation of agricultural residues into valuable resources shows that circular economy concepts can be translated into on-the-ground solutions that eliminate waste, keep materials in productive use, and restore agro-ecological systems.

Taken together the innovations contribute to the circular economy by recovering previously discarded by-products and transforming them into valuable farm inputs, which illustrates resource circularity. The more efficient use of fertilisers, water and energy, illustrates resource efficiency. The partial replacement of non-renewable fuels with renewable bio-fuel illustrates resource substitution.

Resource circularity is achieved through pyrolysis, gasification, fermentation, and the pelleting of previously discarded cocoa by-products. Pyrolysis turns cocoa husks, coffee hulls, rice straw, and macadamia shells into biochar and wood vinegar for use as farm inputs. The biochar meets the standards of the International Biochar Initiative (IBI). The KANAI-800 gasification system converts agricultural residues into syngas to be used as a clean biofuel for cocoa drying. Fermentation of cocoa pulp produces cocoa wine and liquor drinks. The pelleting of cocoa pods with cereals produces an animal feed.

Resource efficiency is achieved through improvement of soil conditions resulting from the use of biochar and wood vinegar used together with smart and efficient irrigation systems. This combination reduces fertilisers and water use, and indirectly the energy required to operate the irrigation system. The improvement of soil conditions is visible in the form of better water and nutrient retention, erosion prevention, and long-term carbon sequestration – all resulting from biochar application – and shows yield increases of up to 15%. The application of wood vinegar repels insects and regulates root growth.

Resource substitution is chiefly achieved through the use of syngas as renewable biofuel for drying cocoa beans. This process is clean and it produces stable heat with minimal smoke, which enables better control of bean drying and thus improves quality and consistency of the dried cocoa beans, resulting in a better selling price. The energy cost for syngas drying is reduced by 60%–80% compared to traditional drying.

Overall, the farmers benefit from lower fertiliser, irrigation and fuel costs, higher cocoa yields, and diversified income streams from new by-products, while the environment gains from reduced waste disposal, lower emissions and improved soil health. This integrated approach is scalable, to position Vietnam's cocoa sector as a pioneer in regenerative agriculture and the comprehensive utilisation of by-products.

Business and market impact

The circular innovations at Nhat Tam Cooperative have been economically viable, with short payback periods and the ability to attract strong market demand. Waste valorisation has created new product lines (biochar, wood vinegar, cocoa liquor, animal feed) that have diversified and increased income streams and strengthened resilience. Energy and fertiliser efficiency and yield improvements are enhancing the Cooperative's competitiveness in premium cocoa markets.

Waste-to-biochar is a profitable stream. The pyrolysis furnace cost is ~20 million VND (~ EUR 675) for 1 m³ capacity. On the market, biochar sells for 15,000 - 20,000 VND/kg (~ EUR 0.50–0.70); and wood vinegar sells for 100,000 –200,000 VND/L (around EUR 3.40–6.80). The system achieves high efficiency with 50% yields (100 kg dry raw material for ~50 kg biochar), and the double-layer 304 stainless steel body of the furnace is designed to last for over 5 years. The advantages of this system are: rugged design, simple operation, low labour requirements (a single worker can operate it), and it is smoke-free, environmentally friendly, and convenient. New revenue streams are created from waste, biochar is positioned as a premium product for soil amendment, and there is potential for niche-market expansion for wood vinegar in organic pest control applications.

The manufacturing cost for the waste-to-energy gasification plus dryer unit are about 350 million VND (around EUR 11,800) for a drying capacity of 5–15 tonnes/batch, thus saving operational costs and reducing smoke, dust and labour requirements. The drying process is improved, creating a competitive advantage in the premium cocoa market. Finally, the technology is scalable and transferable to other crops (coffee, macadamia, rice, etc.).

Moreover, the previously discarded cocoa pulp can now be fermented and used for cocoa liquor/wine, tapping into a growing demand for functional beverages and niche cocoa products. Value is added

to the by-products, waste is reduced, and farmers' incomes are increased.

This model demonstrates that circular economy solutions can deliver business impact and offer scalable opportunities for cooperatives and investors across Vietnam's agricultural sector.

Stakeholders

Nhat Tam Agri Cooperative brings together 200 members (20 full and 180 affiliated) and supports livelihoods in Vietnam's Central Highlands. Cocoa cultivation – now strengthened by innovations that are cutting costs, improving quality and generating new income streams – remains a vital income source for rural households. The waste-to-biochar practical solution has led to replication and scaling beyond Nhat Tam, with additional kilns installed at farms associated with Puratos and Marou (Dak Lak, Binh Duong, Kien Giang, Binh Dinh, Lam Dong). The model is being replicated across the coffee, cashew, coconut, and other industries, thus broadening impact beyond cocoa. Farmers gain access to affordable drying solutions and soil-enhancing biochar, which reduces input costs and boosts yields.

The Nhat Tam Agri Cooperative has benefitted from a strategic partnership with the EU SWITCH-Asia Circular Economy Cocoa Project[5] implemented by Helvetas. The Project supported Nhat Tam in completing technical processes and the commercialisation of cocoa wine products. The co-creation model with Helvetas contributed USD 13,000 to engineer a localised, scalable gasifier at one-third the cost of an imported device, with Nhat Tam mobilising local resources for co-funding. The market linkages show that the Nhat Tam Agricultural Services Cooperative is now a trusted supplier to Puratos and Marou Chocolate, globally recognised for single-origin fine-flavour cocoa products.

The community benefits from affordable services, capacity building and livelihood outcomes. Nhat Tam rents its dryer to members and neighbouring farmers at 20% of the market service rate, slashing post-harvest costs while generating steady cooperative revenue. Training programmes empower farmers, workers, and the cooperative members with skills in resource efficiency, waste minimisation and environmentally friendly practices. Farmers' livelihoods have improved with lower production costs, increased household income, reduced environmental footprints, and the improved productivity of cocoa plantations.

Implementation

Some of the barriers for implementation included limited awareness, insufficient technical know-how, restricted access to solutions, and market pressures. Many farmers remain unfamiliar with circular-economy concepts and the benefits of regenerative practices. Practical knowledge of advanced technologies (biochar, gasification furnaces, digital irrigation) is still scarce at the grassroots level. Relatively high upfront costs and limited financing options have slowed the adoption of sustainable technologies. International buyers increasingly demand low-emission, ethically sourced cocoa, but smallholders face challenges in meeting these standards without external support.

Nhat Tam Agri Cooperative has demonstrated a holistic approach for moving beyond raw cocoa-bean sales. The sector can embrace regenerative production models that valorise waste streams and diversify product lines. The partnerships for scaling, financing and training with development organisations such as Helvetas, in collaboration with the Community Development Centre and funded by the EU SWITCH-Asia Programme, has bridged the gap and enabled implementation in practice. The local innovation by Nhat Tam Cooperative demonstrates that waste-to-biochar and waste-to-energy systems, along with side-product valorisation (cocoa wine and liquor) can be implemented on a cooperative scale. The market differentiation of specialty products like cocoa wine, positioned as local premium gifts and offerings in tourism, is creating new revenue streams while strengthening Vietnam's reputation as a sustainable supplier.



These efforts directly support Vietnam's National Strategy on Environmental Protection and the National Green Growth Strategy, whilst also ensuring compliance with strict EU environmental and social standards. Vietnam is well-placed to fill a niche in the premium sustainable cocoa market, as it can offer stable, high-quality, and ethically sourced cocoa to international buyers.

5 https://www.switch-asia.eu/project/circular-economy-cocoa-from-bean-to-bar/

Takeaways

Cocoa production at Nhat Tam Agri Cooperative illustrates that circular economy practices can build resilient value chains to reduce environmental impacts, strengthen competitiveness, and empower producers and consumers alike. By transforming agri-waste into bio-products, renewable energy, animal feed and specialty fermented beverages, Nhat Tam Agri Cooperative has created and demonstrated a scalable blueprint for climate-smart agriculture. Circular economy innovations at Nhat Tam are anchored in partnerships that are co-funded, co-created, and community-driven. The cooperative's model lowers costs, raises incomes and diversifies products, which directly improves rural livelihoods. Trusted partnerships with global chocolate brands and development agencies has facilitated both market access and technical resilience. This approach demonstrates that stakeholder collaboration can facilitate the transformation of waste into value while it scales regenerative practices across multiple agricultural sectors in Vietnam.

Circularity in this cooperative in Vietnam is redefining the market relationship as it moves from raw cocoa bean sales to premium dried beans, along with waste-to-resource strategies and regenerative agriculture practices. With targeted investment, partnerships and policy support, these interconnected solutions lower costs, raise incomes and meet strict global standards, positioning Vietnam as a premium, sustainable supplier while advancing the green transition in agriculture.



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