RMIT UNIVERSITY

Module 2: Sustainable Food Processing and Manufacturing

Module Description

Module 2 focuses on what happens once food enters the processing and manufacturing chain, and whether production systems reduce environmental impact or simply shift it elsewhere. Through Vietnamese cases, students learn to identify where energy, water, raw materials, by-products and waste (like carbon emissions) are concentrated inside food manufacturing and to assess whether proposed improvements are technically realistic, economically viable and compatible with food safety and quality.

This module builds directly on Module 1's systems thinking by moving students from value-chain analysis into plant-level decision-making. By learning how sustainability is operationalized inside food manufacturing, students are better prepared to examine packaging, waste and life-cycle trade-offs in Module 3 and to think more critically about data-driven dietary design in Module 4.

Learning Objectives

- Differentiate between efficient food processing and simply shifting environmental burdens elsewhere in the system.
- Identify plant-level hotspots in energy use, water use, wastewater, raw material loss, and by-product flows.
- Evaluate cleaner production and resource-efficiency measures for feasibility, cost, and likely impact.
- Assess how food safety, quality, shelf life, and export requirements shape sustainability decisions in manufacturing.
- Design practical process improvements that reduce waste and create value from by-products.

Module 2 Pre-class activities

Purpose: To prepare students to analyze food processing and manufacturing systems in Vietnam for resource efficiency, cleaner production, and circular value creation. The activity design is grounded in course models that focus on energy, water, waste, unit operations, and by-product utilization, as well as Vietnamese case materials on pangasius processing, brewery water reuse, cassava starch wastewater, and food-processing by-products.

Pre-class Activity 1: Choose one article or report from the list below and identify one key idea to help understand food processing in Vietnam.

- Kato, S., Kansha, Y. Comprehensive review of industrial wastewater treatment techniques. *Environmental Science and Pollution Research* **31**, 51064–51097 (2024). https://doi.org/10.1007/s11356-024-34584-0

- Jagtap, S., Garcia-Garcia, G., & Rahimifard, S. (2021). *Optimisation of the resource efficiency of food manufacturing via the Internet of Things*. *Computers in Industry, 127*, Article 103397. https://doi.org/10.1016/j.compind.2021.103397
- Van Tai, N., Minh, V. Q., & Thuy, N. M. (2023). *Food processing waste in Vietnam: Utilization and prospects in food industry for sustainability development*. *Journal of Microbiology, Biotechnology and Food Sciences, 13*(1), e9926. https://doi.org/10.55251/jmbfs.9926

Pre-class Activity 2: Short written response to a real-world case:

Pick one of the following real-world cases:

Pangasius processing and cleaner production: official Vietnamese guidance for the sector focuses on water, energy, materials, chemicals, waste reduction, and wastewater treatment, while the SWITCH-Asia SUPA project reports that it supported 225 pangasius producers, processors, and farms and reduced CO2 emissions by about 21,000 tons annually. https://www.iges.or.jp/en/publication_documents/pub/technicalreport/en/12566/pangasius_guidelines_en_final.pdf

Brewery water reuse in Da Nang: a UNIDO case on Heineken Vietnam's Da Nang brewery estimates that industrial water reuse could reduce effluent disposal and potable water use by up to 190,000 m3 per year, with an indicative payback time of 2.1 years, while also showing how regulation can slow technically feasible sustainability improvements. https://downloads.unido.org/ot/30/96/30962765/EIP-Vietnam-Heineken-Case%20Study.pdf

Cassava starch processing, wastewater, and by-product recovery: official sub-sector analysis in Vietnam notes that cassava starch factories generate high-COD/BOD wastewater, often around 10–18 m3 of wastewater per ton of cassava roots, while also producing peels, fibers, and pulp that can be valorized, with biogas recovery identified as a major opportunity. https://www.esp.org.vn/wp-content/uploads/Subsector-Analysis-Final-Report.pdf

Pick one of the questions below and write 200-250 words total and post to the online class discussion forum before the session.

- What insight does the reading give students about resource efficiency, water management, digital monitoring or by-product utilization?
- Where is the biggest vulnerable area in the case?
- Does the case suggest that the best intervention is operational, technological, managerial or regulatory?
- Which stakeholder group is most affected: plant managers, workers, farmers, regulators, buyers or surrounding communities?
- What trade-off appears between efficiency, cost, food safety, quality or market expectations?

Module 2 In-class activities

Plant "Hotspot Audit" Workshop

Goal: Use pre-class work to evaluate food manufacturing processes for credibility, feasibility and environmental impact.

In groups, each student should share their answers. Identify any overlaps. Teams select one processing case to audit.

Audit questions:

- Where are the main losses or inefficiencies in the process?
- Which hotspot is most measurable: energy, water, wastewater, raw material loss, or by-products?
- Which intervention is likely to be low-cost and operational, and which would require major investment?
- Could a waste stream be turned into a usable by-product or secondary value stream?

Output: Teams identify the top three improvement priorities and create an infographic to present to relevant stakeholders.

Waste Stream Matchmaking Activity

Goal: Help students think creatively about by-products and circularity in food processing.

Group task: Teams are given a set of waste streams from a food plant, such as fish trimmings, cassava pulp, spent grain, fruit peels, or wastewater sludge. They must match each waste stream with the most realistic reuse or recovery pathway. They then decide which option is most viable in Vietnam and which would be hardest to implement.

Output: A visual "waste-to-value map" plus a short explanation of the most realistic circular solution.

Carbon Credit Investment Simulation: "Can This Plant Earn Credits?"

Goal: Explore how food manufacturers decide whether sustainability upgrades are worth pursuing when carbon reduction, carbon credits, cost and operational feasibility are all in play.

Group task: Teams take one case from pre-class work and are given a fixed budget (lecturer to allocate) for plant improvements.

They choose from a list of possible upgrades, such as methane capture from wastewater, energy-efficient boilers, heat recovery systems, renewable electricity, reduced raw material loss or by-product recovery. Each option comes with a different cost, implementation challenge and estimated carbon reduction potential.

Teams must decide which interventions are most likely to generate meaningful emissions reductions and whether those reductions could realistically support a carbon credit strategy. They must also consider whether the upgrade is still worthwhile if carbon credit revenue is lower than expected.

Teams should justify which interventions to fund, which to delay, and which to reject, using carbon reduction potential, feasibility, food safety and economic realism.

Output: A short carbon investment pitch in which teams explain their final upgrade plan, identify which intervention has the strongest carbon-credit potential and defend whether the project should be pursued for credit generation, operational savings or both.

Post-class Reflection

Students respond to the prompt: “When does a processing improvement become genuinely sustainable rather than simply more efficient?”

Students write one key insight and one lingering question for the next module.

This reflection encourages students to distinguish between narrow process optimization and broader sustainability thinking. It also prepares them for Module 3, where they will examine packaging, waste and life-cycle trade-offs in greater depth.