WASTE MATTERS

OUR FARMS & THEIR BY-PRODUCTS

Besides the food generated by Singapore's farms, a range of "waste" (or "by-products" as they could still have value yet to be extracted) are also generated in the process. These agricultural "waste" are largely unsuitable for direct human consumption and can come from different sources.

RETHINKING OUR BY-PRODUCTS

The "waste" generated from the farms are often readily and conveniently dealt with through general waste disposal (except for specialised waste e.g. sludges, carcasses, manure, etc. which requires specialised treatment). But perhaps a shift in perspective by rethinking these "waste" as "by-products" could help us reconsider possible value-added pathways.

WHY DO THESE BY-PRODUCTS MATTER?

Sustainable management of agriculture by-products is crucial for maintaining a clean and green environment, especially in land-scarce Singapore. Improper management of agriculture by-products can lead to odour nuisances and unwanted pest or vermin issues.

Effectively managing/valorising these by-products would also bring us closer to our vision of a Zero Waste Nation. Furthermore, reducing losses from spoilage or "ugly foods" post-harvest can help reduce the amount of food "waste". This can help support Singapore's local food production efforts, as every morsel of food counts.

Agriculture By-Products

The types and characteristics of these by-products can vary significantly depending on the farm type and specific activities conducted. To provide a more comprehensive overview, here are some broad categories of farm by-products commonly found in Singapore. This includes by-products that do not typically enter the human food supply chain.

Agriculture/Veg Farms:
- Vegetable trimmings
- Blemished seedlings and produce
- Spent soil and substrates
- Wastewater in various forms, including spent hydroponics solution.

Aquaculture Farms:
- Aquaculture sludge/wastewater (from land-based or recirculating aquaculture systems)
- Fish trimmings
- Carcasses

Livestock Farms:
- Manure
- Carcasses
- Wastewater

WHAT CAN WE DO?

Track

Be aware of the side-streams produced in your farm and know how much is produced

Record

Keep records of how much is being generated. If there is a third-party arrangement, make sure to record it!

Ask about it

Look and ask around for ways to valorise. There might be more opportunities than you realise!

TRACK

Start tracking the by-products coming out of the farm. This helps identify by-products that could be valuable and have commercial value (e.g. cellulose/pectin extraction from vegetable trimmings for cosmetics) to companies that offer valorisation solutions.

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TRACK

For example, by-products could come from cosmetic filtering in farms. According to a Straits Times article in 2020, vegetable farms could have a 30% loss from harvest to quality-check packing, with cosmetic filtering as a major contributor. This is in line with international reports that cosmetic filtering is a significant contributor to food loss (Gustavsson et al., 2011; Porter et al., 2018).

HOW TO DO IT

Farms can identify the type of crop residues from the products.

Different types of residues can be generated from different vegetable produce. For example:

Type of Produce	By-products Generated	By-Product State
Lettuce	Spent substrates (PU Sponge, inclusive of roots)	Solid
	Product Trimmings	Solid
	Rejected Products	Solid
	Spent Hydroponics Solution	Liquid
Mushroom	Spent substrates	Solid
	Product Trimmings	Solid
	Rejected Products	Solid

RECORD

Keeping a record of the amount of by-products generated can help identify trends and seasonality in the type of by-products produced. This helps solution providers understand the availabilities of feedstock (e.g. volume and consistency of by-products produced). Records also help facilitate arrangements for offtake of such by-products.

Records of interactions with offtakers will also keep track of the movement of by-products across the value chain and will serve as important documentation to prevent illegal dumping activities.

HOW TO DO IT

1) **Farms can keep records of the invoices of services acquired from third-party offtakers.**

This ensures traceability of the by-products. In these invoices, it is advisable to include the name of the service provider and any indications of the volume or mass of by-products moved.

2) **Farms can keep internal records of the by-products generated and their downstream treatment methodology.**

This would require more initiative by farms to actively track and update the records of how much by-products are generated and how they were subsequently dealt with.

An example of how such by-products could be tracked is as follows:

S/N	Date	Product	By-product Generated	Volume of By-Product Generated (kg)	Treatment Method	Offtaker Engaged
e.g.	23 Jan 2024	Lettuce	Vegetable Trimmings	XX	Offsite Composting	XXX Pte Ltd
e.g.	23 Jan 2024	Lettuce	Spent Substrates	XX	General Disposal	YZ Pte Ltd (if farm knows)

If there are practices to retain the by-products within the farm premises for treatment or reuse (e.g. composting or organic by-products), tracking these volumes and their fates can also be done in a similar format.

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ASK ABOUT IT

Below includes a review of food waste valorisation technologies (A*STAR).

For solution providers, SFA had previously conducted a broad landscape study of available by-products that could help guide approaches in providing valorisation solutions

REVIEW OF FOOD WASTE VALORISATION TECHNOLOGIES

To provide some ideas of what are certain valorisation pathways that could be undertaken, A*STAR had previously provided a broad overview of such possibilities. This include pectin and cellulose for fruits and vegetable waste, collagen, fish oil for fish waste.

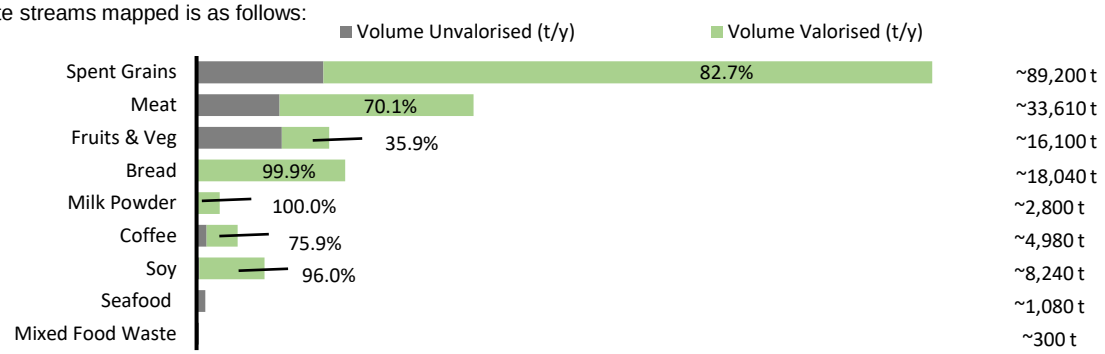
For more information on the materials, please reach out to us via info@sifbi.a-star.edu.sg.

CHARACTERISTIC DATA OF FOOD & FARM WASTE

"Food Waste from Local Food Systems"

To better understand food waste and support circularity in food systems, the Singapore Food Agency (SFA), with the support of the National Environment Agency (NEA), commissioned a study. The study surveyed local food processing companies between August 2022 and June 2023.

In total, the study surveyed data from 74 companies and mapped ~174,300 tonnes of homogeneous food waste. A high-level summary of the waste streams mapped is as follows:



The findings include a broad overview of the valorisation rates of the studied waste streams, the homogeneous food waste treatment approaches in 2022-2023, and material flow analyses (MFAs) of some of these waste streams.

To request for the detailed study findings, please reach out to **food_waste@nea.gov.sg**.

"Farm Waste Characterisation and Alternative Routes for their Reuse in Singapore (FW4Reuse)"

In order to map out the types of agriculture by-products being generated from farms in Singapore, the Singapore Food Agency (SFA) commissioned a study that surveyed Singapore farms between September 2022 and June 2023. The study was in collaboration with the Nanyang Environment and Water Research Institute (NEWRI), Nanyang Technological University (NTU).

The study included the characterisation of solid and liquid by-products from the farms, with the following analyses conducted:

- Proximate, Ultimate Analysis and Calorific Values
- Total Elemental Analysis
- Toxicity Characteristic Leaching Procedure (TCLP)
- Electrical Conductivity (EC), pH and Anion Content
- Total Carbon and Total Nitrogen
- Nutritional Content

The results represent averages of the by-products studied. The complete characterisation of the by-products serve to inform users that intend to valorise such by-products on possible pathways.

For more information on the study, please reach out to us via https://csp.sfa.gov.sg/feedback.

Let us know your thoughts

About the Author

Chao Yu De is from the Agri-Technology and Food Innovation Department of the Urban Food Solutions Division. His background is in animal nutrition & management and has worked on agri-waste management, waste-to-feed valorisation and related initiatives.

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