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WASTEWISE

Waste Avoidance Strategies for
Environmental Sustainability

Beyond Kilograms: a Nutritional LCA Approach to Food Loss and Waste

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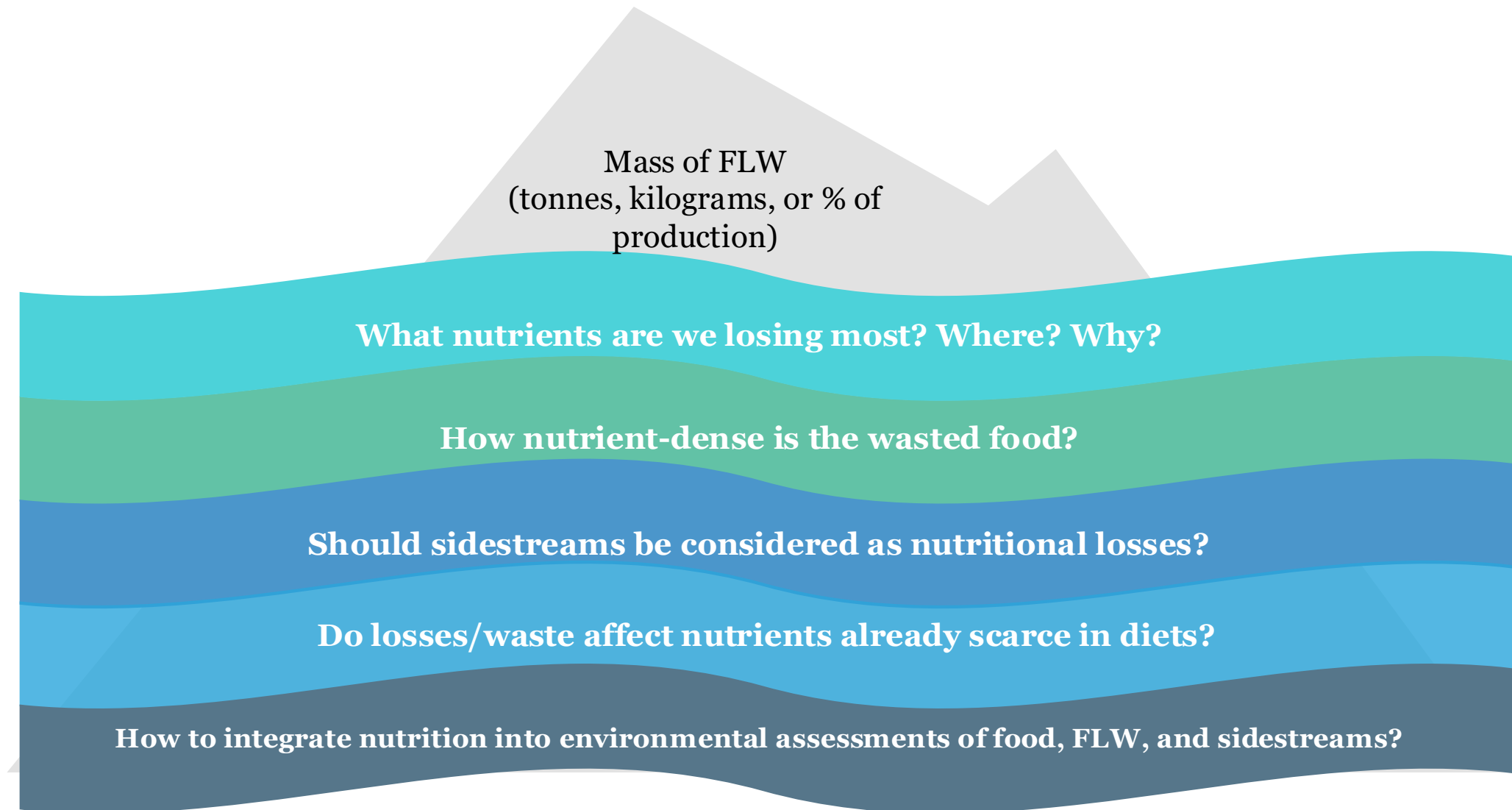
Focus Food Save 2026 – close the gaps!
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The Gap: Can FLW be measured only in kg?



The same kg of food waste can have very different environmental and nutritional impacts!

A Solution: nutritional LCA approach to FLW and Sidestream

- **Material Flow Analysis as the Physical Backbone (WASTEWISE project)**
- **Matching Food and Sidestreams to Nutrient Composition Data (EUROFIR)**
- **Defining and Calculating Nutritional Losses**
 - **Absolute** – mass of nutrients lost (g, mg, µg/year)
 - **% of Dietary Reference Values (DRV)** – EFSA population-weighted nutritional requirements per day
 - **Nutritional Rich Food Index** – nutritional density of wasted material per 100 g
- **Pathways for Integrating Nutritional Indicators into Life Cycle Assessment**

What is Nutritional Life Cycle Assessment?



«a nLCA is an LCA study where the provision of nutrient(s) is considered either **the main function or one of the main functions of a food item**»
(McLaren et al., 2021)

Nutrient indices and included nutrients.

Green et al., 2020

Nutrient Index ¹	Points of differentiation: included nutrients				
	Macronutrients	Vitamins	Minerals	Disqualifying nutrients	Other ²
ONQI ³ (Katz et al., 2010)	Fiber, omega 3 (n-3) fatty acids, protein quality, fat quality	Folate, A, C, D, E, B-12, B-6	K, Ca, Zn, Mg, Fe	Saturated fat, trans fat, sodium, total/added sugar, cholesterol	Total bioflavonoids, total carotenoids
WINDS ⁴ (Arsenault et al., 2012)	Protein, fiber, unsaturated fat	C	Ca	Saturated fat, sodium, added sugar	None
NRF9.3 ⁵ (Fulgoni et al., 2009)	Protein, fiber	A, C, E	Mg, Ca, Fe, K	Saturated fat, added sugars, sodium	None
NRF9 ^{5.1}	Protein, fiber	A, C, E	Mg, Ca, Fe, K	None	None
LIM3 ^{5.2}	None	None	None	Saturated fat, added sugars, sodium	None
NBC ⁶ (Fern et al., 2015)	Fiber, protein, linoleic acid, α-linolenic acid, choline	Folate, niacin, riboflavin, thiamin, pantothenic acid, A, B-12, B-6, C, D, E, K	Ca, Cu, Fe, Mg, Mn, P, K, Se, Zn	Total fat, saturated fat, trans fat, cholesterol, total sugar, sodium	Water
QI ^{6.1}	Fiber, protein, linoleic acid, α-linolenic acid, choline	Folate, niacin, riboflavin, thiamin, pantothenic acid, A, B-12, B-6, C, D, E, K	Ca, Cu, Fe, Mg, Mn, P, K, Se, Zn	None	Water
DI ^{6.2}	None	None	None	Total fat, saturated fat, trans fat, cholesterol, total sugar, sodium	None
DNS ⁷ (Chaudhary et al., 2018a)	None	None	None	Sugar, cholesterol, saturated fat, total fat	None



Food and Agriculture
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**Integration of environment
and nutrition in life cycle
assessment of food items:
opportunities and challenges**



Impact: Supply Chains

Bread, Pasta and Pastry: Italy | FLW + SS at production/milling

- 9 nutrients: **Carbohydrates, Proteins, Dietary Fibre, Fe, Mg, P, K, Folate, Vit B1**
- FLW: manufacturing + retail + household + R&FS losses = 2,420,273 t/y
- SS: **grains to feed/seed/energy** (2,347,091 t) + **bran** (2,081,956 t) + **germ** (240,358 t) + **unsold bread to feed** (35,153 t) = 4,704,557 t/y

Tomato: Italy | FLW + Pomace sidestream

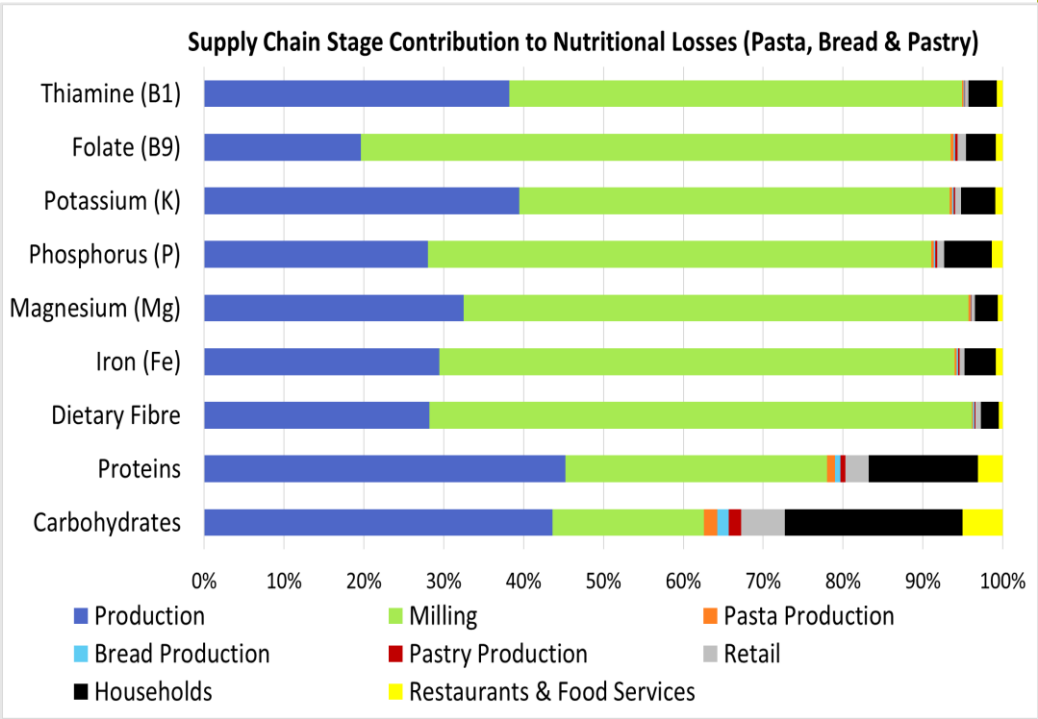
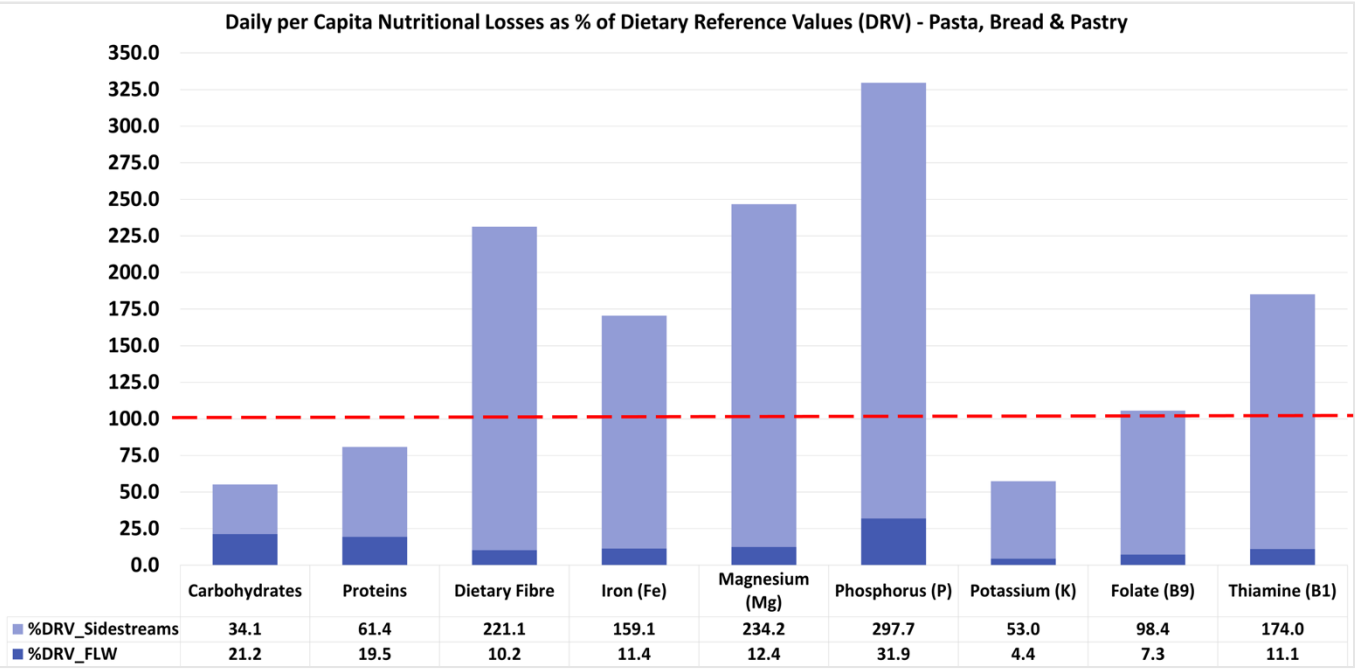
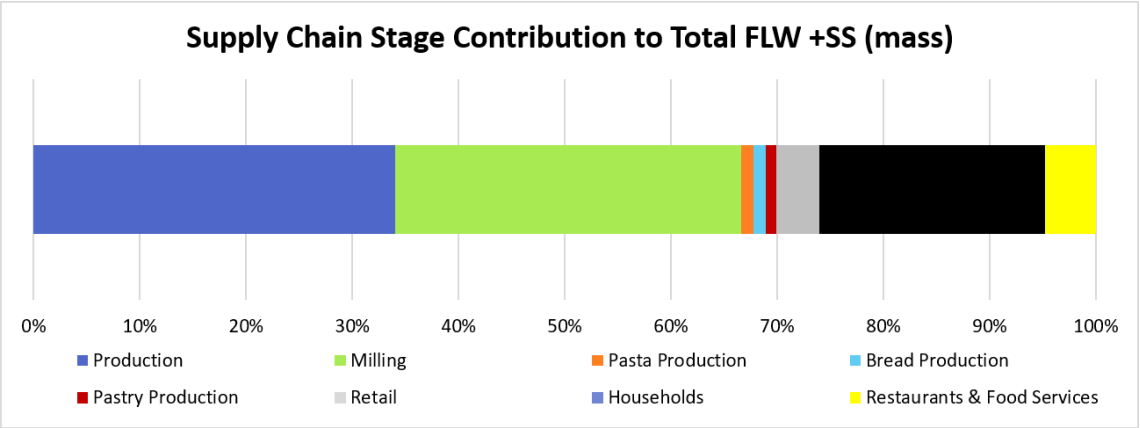
- 9 nutrients: **Dietary Fibre, K, Mg, P, Ca, Vit C, Vit A, B1, Folate**
- FLW: tomato harvest losses + sauce losses = 1,510,668 t/y
- SS: **pomace at processing (peels + seeds)** = 834,632 t/y

Bovine Meat: Switzerland | FLW + Offal and blood SS

- 13 nutrients: **Proteins, Fe, K, Mg, P, Se, Zn, Vit B6, B12, B2, B3, B5, B1**
- FLW: fresh and processed meat wasted at processing + retail + household + R&FS = 21'231.77 t/y
- SS: **liver/kidney/tripe** (8,010 t) + **heart/lung** (2,717 t) + **intestines** (34,337 t) + **fat** (12,351 t) + **blood** (9,881 t) = 67,296 t/y

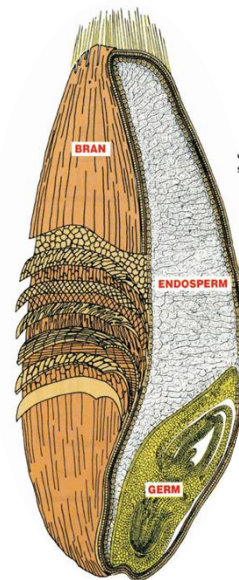
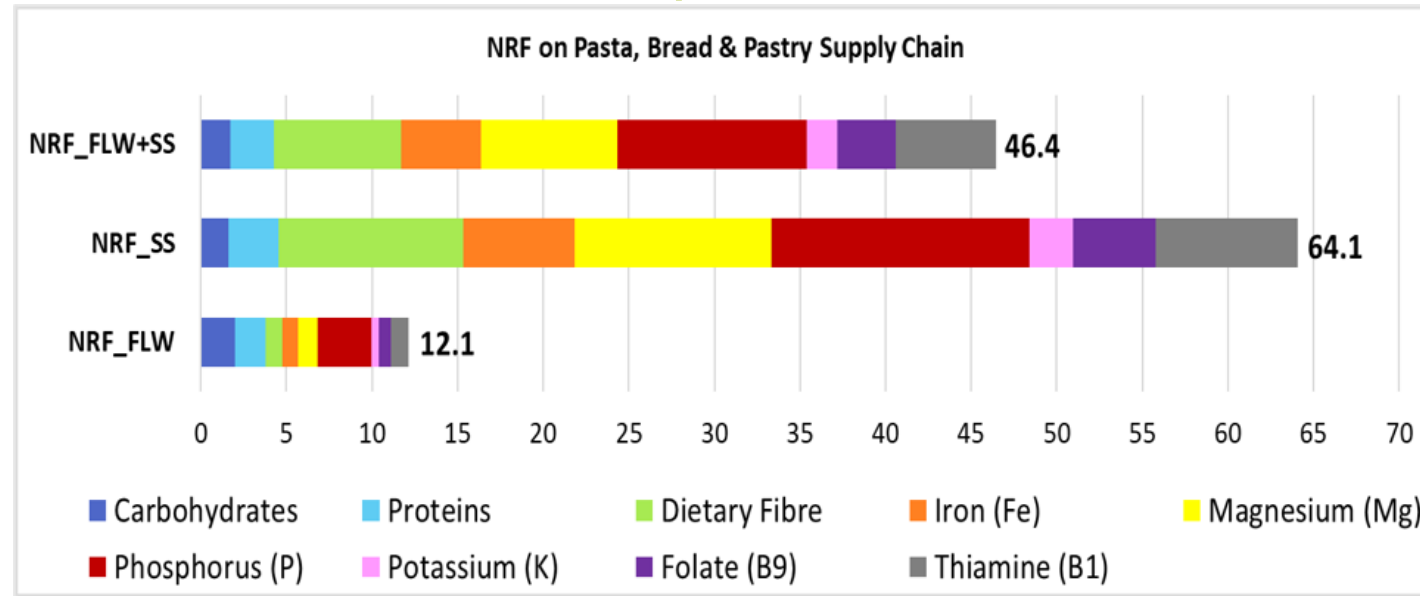
Different supply chains → different characterising nutrients!

Pasta, Bread and Pastry (IT)



- Stage:** Production leads for Carbohydrates and Proteins; Milling dominates micronutrients and Fibre.
- Nutrients:** SS alone exceeds 100% Italian daily DRV for P, Mg, Fibre, Thiamine, Fe and Folate; Fibre intake is suboptimal in Italy.

Pasta, Bread and Pastry (IT)



➤ **NRF_SS > NRF_FLW.**

- Sidestreams (bran, germ, whole grains) are much more nutrient dense than FLW (pasta, bread and pastry).
- Wheat bran and germ are nutrient-rich ingredients that can support healthier diets and **functional food development**.

Take-home messages

✓ Mass metrics miss the full picture

Substantial NLs in FLW and sidestreams across all chains.

✓ Sidestreams are hidden NLs

Bran/germ, tomato pomace, bovine offal and blood tend to dominate NLs in the investigated chains, yet they remain invisible to conventional FLW accounting.

✓ Hotspot vary by chain and nutrient considered

But processing and production are consistently the dominant ones in our case-studies.

✓ Lost nutrients could contribute to fill population dietary gaps

Fibre and folate (Italy); Fe and B12 (Switzerland).

✓ Sidestream valorisation is a win-win solution

To retain nutrients and reduce environmental impacts.

✓ Nutritional Indicators to Inform Research, Policy, Industry

Useful to translate complex NL data into a single score; Easy to be integrated as functional unit / allocation criteria/ impact indicator in nLCA frameworks.