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# Mitigate+: Food Loss and Waste country profile Vietnam

Estimates of Food Loss and Waste, associated GHG emissions, nutritional losses, land use and water footprints

## Urgency and call for action on FLW reduction

Theoretically, the world produces enough food to nourish the growing world population. Although precise data remains scarce, according to most recent studies, globally each year possibly as much as 30 per cent of the food produced is being lost or wasted somewhere between farm and fork. This not only represents a threat to food security but also severely and negatively impacts our food systems and natural resources. Food Loss and Waste (FLW) accounts for around 8 to 10 percent of our global Greenhouse Gas Emissions (GHGEs). Approximately a quarter of all freshwater used by agriculture is associated to the lost and wasted food. 4.4 million km² of land is used to grow food which is lost or wasted (FAO, 2019; WWF, 2021; Guo et al., 2020). The Sustainable Development Goal (SDG) Target 12.3 calls to 'halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses' (Lipinski, B. 2022). With only 7 years to go, the world is far from being on track to achieve this target.

## Way forward reducing FLW without baseline data

The UN and the Champions 12.3 Coalition launched the 'Target-Measure-Act approach' calling on all governments and companies to set FLW reduction targets, measure FLW, identify hotspots[1], and to take action to reduce FLW accordingly (Lipinski, 2020). However, with respect to primary data on FLW, much remains to be done. Just a

### Food Loss and Waste (FLW) definition

FLW refers to all food intended for human consumption that is finally not consumed by humans. Food Loss is the decrease in the quantity or quality of food resulting from decisions and actions by food suppliers from the production stage in the chain, excluding retail, food service providers and consumers. Food Waste is the decrease in the quantity or quality of food resulting from decisions and actions by retailers, food services and consumers (FAO, 2019). Under this definition, FLW does not include food that is consumed in excess of nutritional requirements nor food that incurs a decrease of market value due to over-supply or other market forces, and not due to reduced quality.

1 In this document hotspots are defined as food products or food (sub) categories, eventually in combination with a supply chain link, that show the highest scores with respect to a selected (sub)set of sustainability indicators: FLW, GHGEs, nutrition, land use and water footprint.
2 Mutton & Goat Meat is not considered for the land-use footprints due to the marginal land consideration.

handful of mainly western countries have taken action to systematically measure and reduce FLW. Lack of data make it particularly difficult for lower-and-middle-income countries (LMIC), including Vietnam, to specify the hotspot food products and chain stages, to define smart targets and to identity adequate interventions.

In order to contribute to this essential information we developed and used a mass flow model based on secondary data to derive the volume of FLW and the associated parameters accordingly (Guo et al., 2020). This approach allows to present an indicative country profile showing per food product category and chain stage not only the amount of FLW but also the GHGEs, the land-use and water footprints related to producing the FLW as well as induced nutrient losses. The sums differs per product and chain stage. Focusing on food products and chain stages which largely contribute to the aforementioned parameters can substantially lead to resource use efficiency and at the same time to climate mitigation action and nutrition security. This integrated approach towards FLW reduction can support policy makers and other food system actors taking informed decisions contributing to multiple sustainability objectives in parallel.

## Modelling country data on FLW and FLW-associated GHGEs, land-use and water footprints and nutritional losses

FLW data was generated through a bottom-up, mass-flow model (Guo et al., 2020) that combines data on production and outputs as well as imports and exports at the country level. Estimates of losses per chain stage are derived from Porter et al. (2016) to calculate the FLW in the supply chain according to the country's production and trade. The FLW-associated GHG emissions are calculated by using the GHG emission factors derived from Porter et al. (2016) to multiply the FLW at different supply chain stages.

Furthermore, a Protein and Nutrition Database developed by WUR (built on nutritional compositions derived from databases from FAO, USDA, Denmark and Japan) was used to calculate the nutritional value of the total consumed food in each country. The nutrient intakes are compared with estimated nutrition requirements per country (which is based on the composition of the population and per capita nutrient demand, according to WHO dietary recommendations).

In calculating the land use footprint of plant-based food items, FAO's 'Crops and livestock products' database is utilized by combining data on yields and harvested areas. This gives a simplified estimate of how much cropland is needed to grow the produce. Country-specific land use estimates for animal-based food items are however scarce. Therefore, global estimates as published by Poore & Nemecek (2018) are used. Applying this non-differentiated data has a drawback that it not accurately takes into account country-specific farming practices. Lastly, for the water footprint the broadly recognized datasets of Mekonnen and Hoekstra are used. These cover the Green, Blue and Grey water footprint of crops and derived crop products (Mekonnen & Hoekstra, 2011), and of animals and animal products (Mekonnen & Hoekstra, 2010).

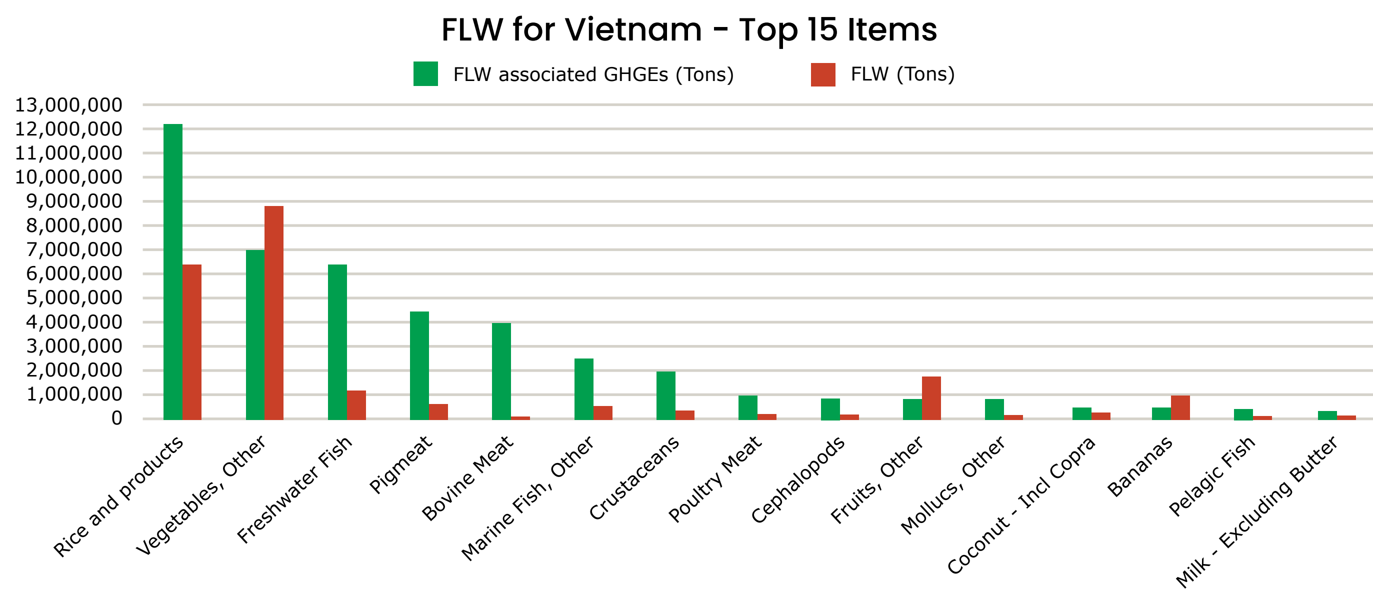


**Figure 1** Top 15 hotspot categories of food loss and waste in terms of volumes and FLW-associated GHG emissions (in CO2-eq.).

## Land-use footprints of FLW for Vietnam - Top 15 Items

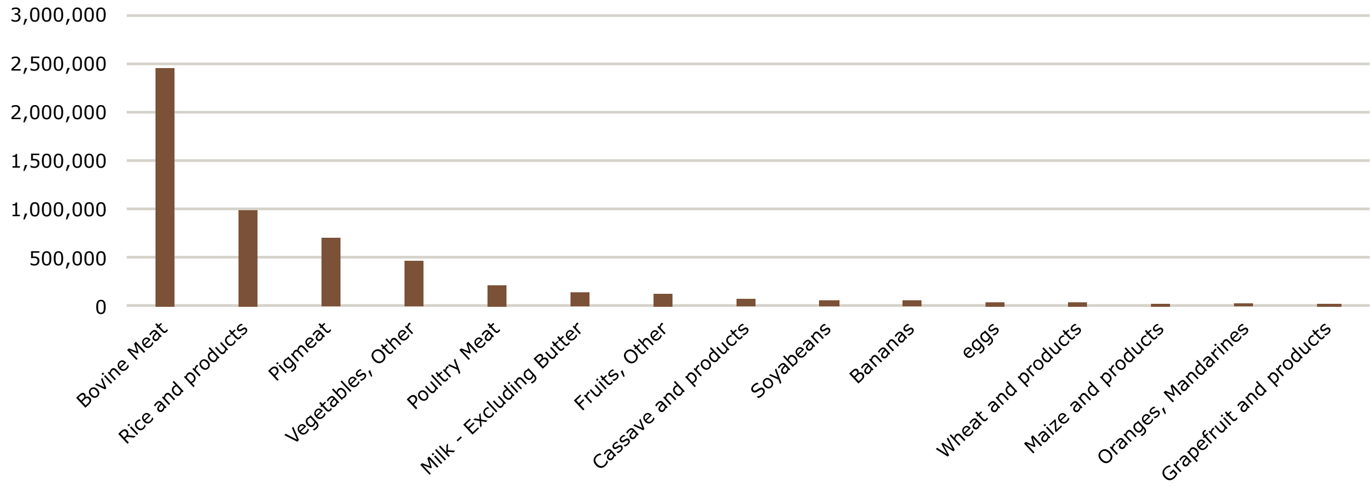


**Figure 2** Top 15 hotspot categories of the land-use footprints of FLW (in ha)

## FLW, GHGEs, nutrition, land use and water footprint country profile Vietnam

Based on the country data modelling, estimates on FLW-associated GHGEs were retrieved for Vietnam and plotted with the FLW total tonnage to visualize the two components (Figure 1). For FLW, vegetables, rice, fruits, freshwater fish, bananas are the hotspots. For FLW-associated GHGEs, the five FLW hotspot products for Vietnam are: rice, vegetables, and to a lesser extent freshwater fish, pig meat and bovine meat. From the rice chains, 6.4 million tons of FLW represents 12.2 million tons CO2-eq. of GHGEs, the highest of all. The category "vegetable, other" has by far the highest FLW in weight with 8,800,000 tons.

Figure 2 presents the top 15 items with the largest land-use footprints of FLW. Bovine meat, rice, and pig meat rank the top 3. Note that land use footprints do not apply for aquatic products.

With respect to the water footprints of the FLW, rice and pig meat rank the top 2, followed by vegetables, fruits and bovine meat (Figure 3). Here also, the indicator 'water footprint' does not apply to aquatic products.

From another perspective, taking the percentages of FLW in relation to production percentages, fruits and vegetables are identified as the main hotspots showing average FLW of 54% along the chains (Figure 4).

## Water footprints of FLW for Vietnam - Top 15 Items

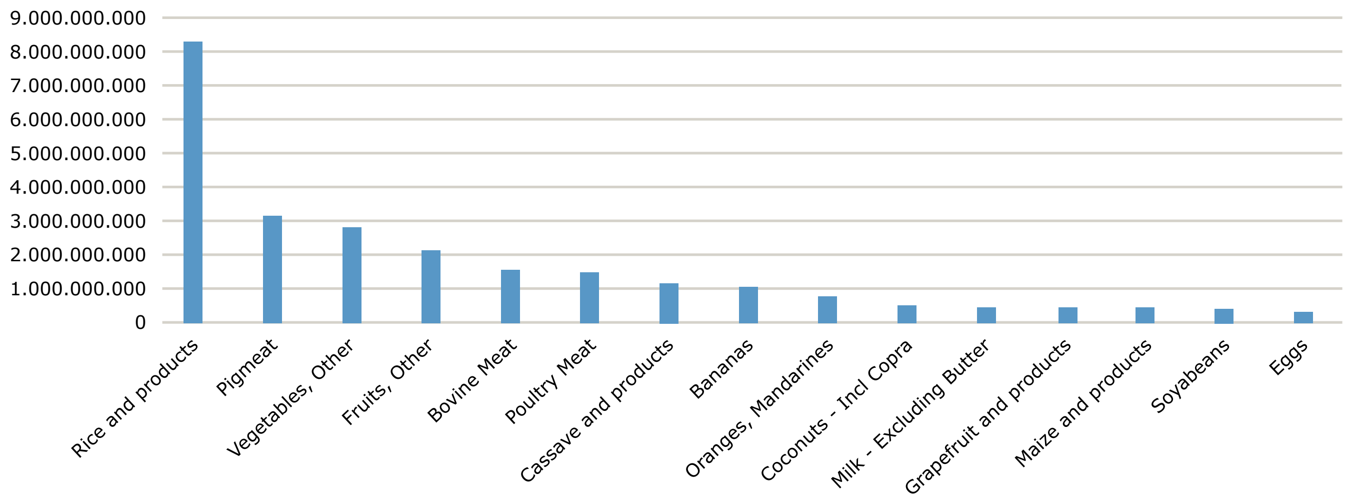


**Figure 3** Top 15 hotspot categories of the water footprints of FLW (in m3)

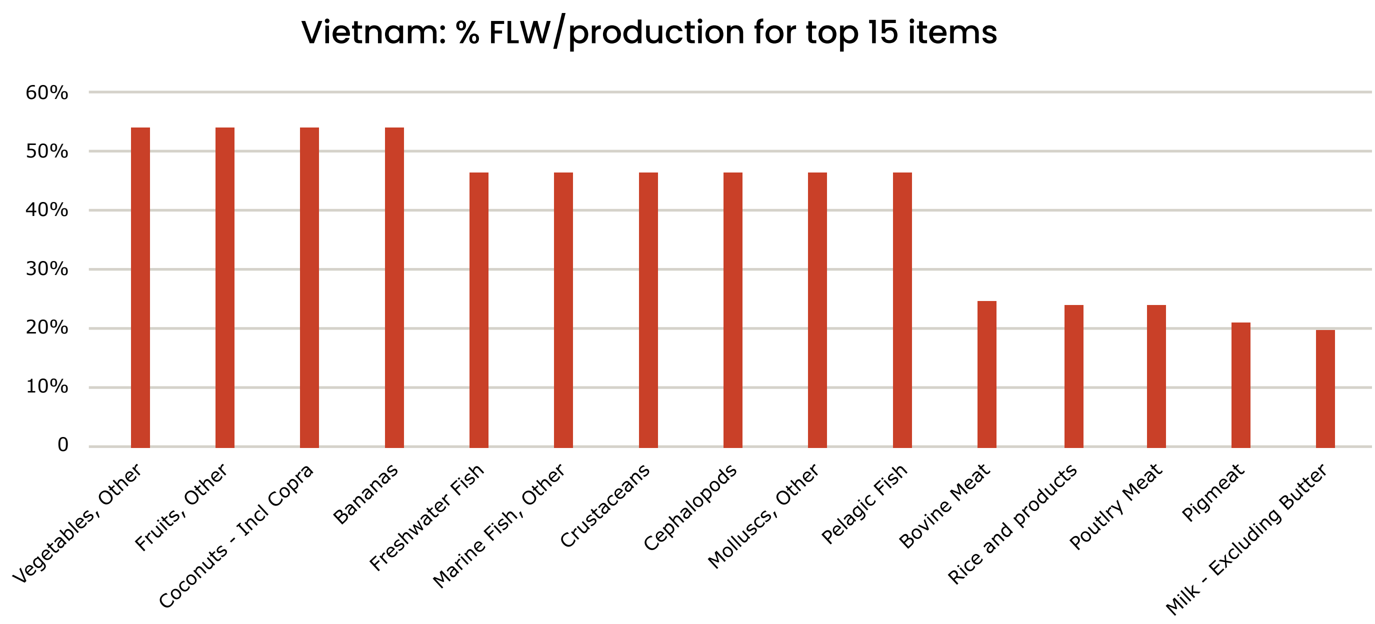


**Figure 4** Percentages of FLW per product category

Further insights in hotspots are derived from estimated distribution of the FLW along supply chains for the top hotspots in the region (Figure 5). These data suggest that the processing and packing stage of fruits and vegetables as well as the postharvest handling and storage stage of freshwater fish embodies bottlenecks.
These are focus points for more detailed data collection and analysis of causes to address potential interventions.
Smart interventions in such 'hotspots' in food supply chains can substantially contribute to GHG emission mitigation of food systems. Analysis of specificities of such chains (e.g. comparing informal and formal supply chains, and urban and rural settings) including comparison with supply chains for similar product categories may reveal promising interventions. Interventions may combine hardware (packaging, cooling, etc.), orgware (e.g. arrangements in chains) and software (knowledge, information) elements.

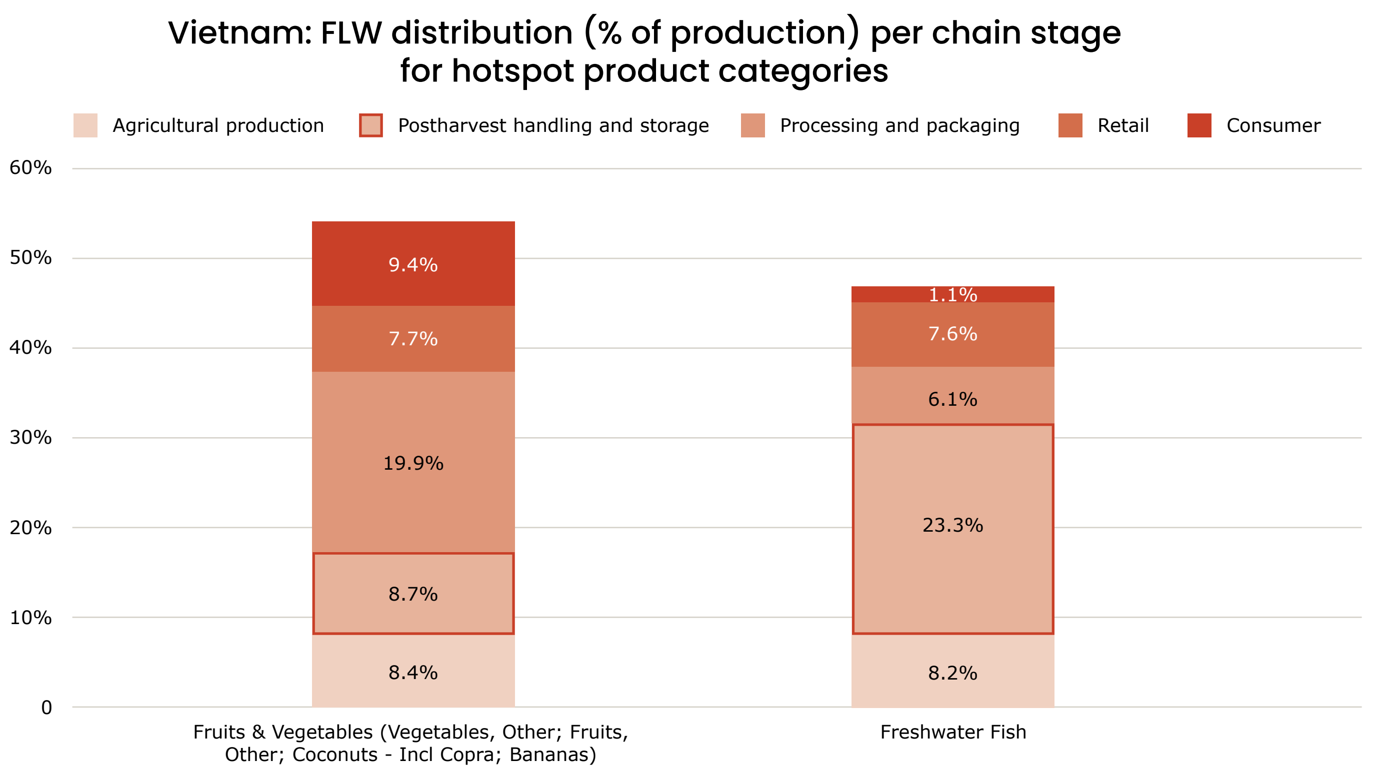


**Figure 5** Percentages of FLW per stage in the supply chain for top hotspot products
*Remark: Agricultural production does not include any potential yield gaps and focuses on actual production and harvest losses.*

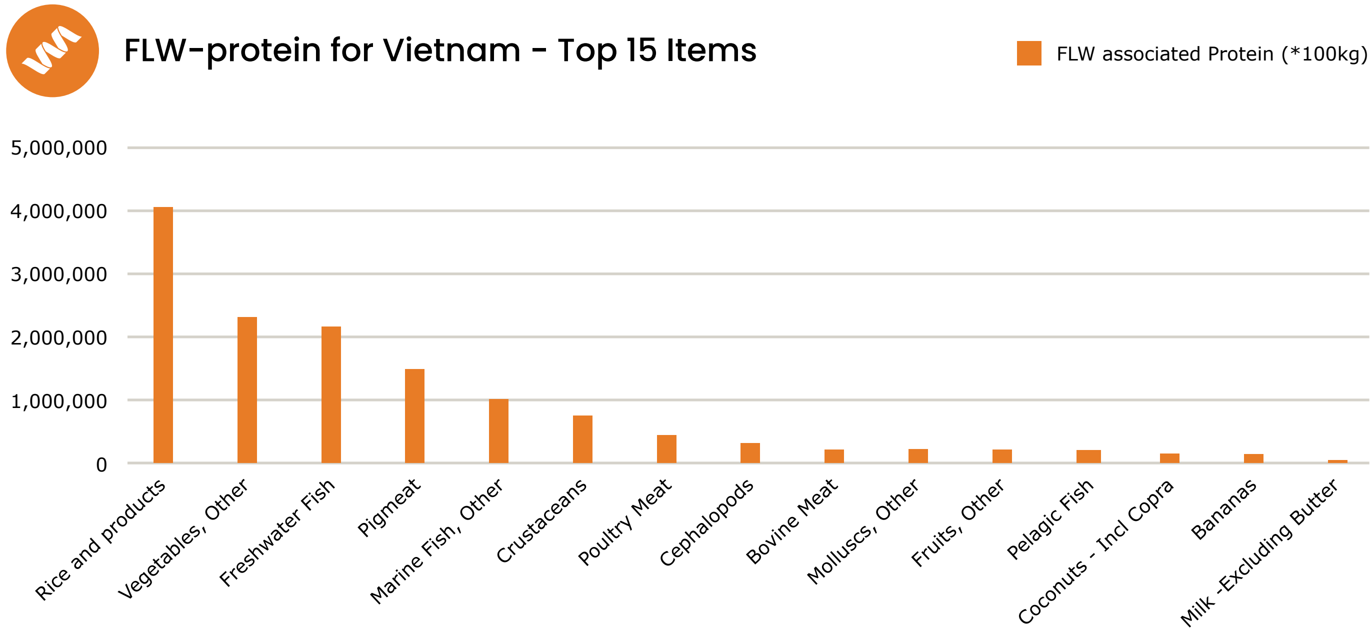


**Figure 6** Top 15 hotspot categories of loss of proteins associated with FLW

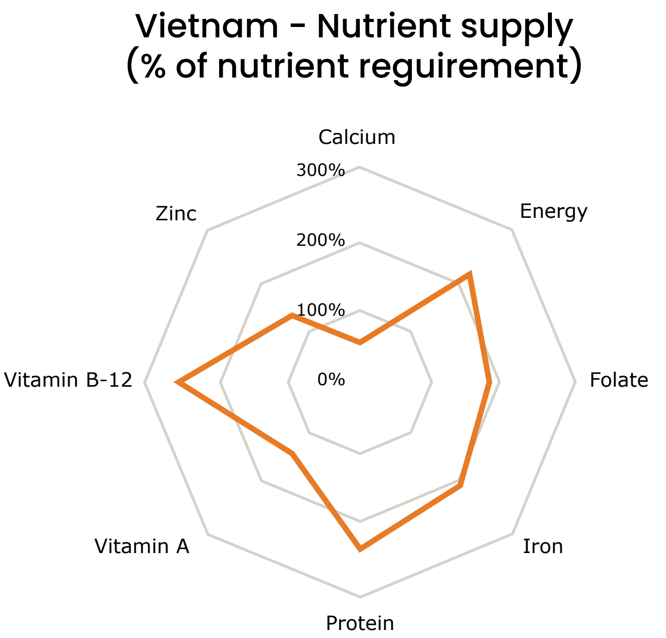


**Figure 7** Average provision of nutrients per capita relative to WHO dietary recommendations
*Remark: because of uneven distribution of food over the population, parts of the population will suffer more insufficiencies than this diagram implies.*

Figure 6 shows the protein losses associated with FLW where rice, vegetables, freshwater fish, pig meat and marine fish are the top five items. Finally, the food supply and FLW data were used to assess nutrient supply per capita in the Vietnamese population in relation to recommended nutrient intake (Figure 7). These are average number, and it is not likely that nutrients are evenly distributed across Vietnam. Hence, there will be parts of the populations that suffer insufficiencies of calcium, vitamin A, and zinc.
From nutrition security perspective, efforts for mitigating FLW in rice and freshwater fish would contribute the most to population nutrient gains (Table 1).

**Table 1** Food product categories for which the FLW have highest share for the most critical nutrients.

| Critical nutrients | FLW categories with highest loss of the nutrient (highest first) |
|---|---|
| **Calcium** | Rice, freshwater fish, crustaceans, marine fish, soybeans |
| **Vitamin A** | Poultry meat, freshwater fish |
| **Zinc** | Rice, pig meat, mollusks, crustaceans, freshwater fish |

## Value loss

Money is an important driver for change. Hence, converting the FLW weight to currency may trigger stakeholder to invest in FLW reduction interventions.

According to a website summary of a report from CEL consulting on FLW in Vietnam[2] the food value loss in the first two stages (until processing) was 3.9 billion USD in 2018.

## Validation

There was no formal literature found on FLW data for the whole country. The website from CEL mentioned above mentions an estimate for food loss until processing in Vietnam of 8.8 Mt in 2018. In this study the total FLW equals 25.6 Mt. Looking at Figure 5 at the food category with the largest FLW (fruits and vegetables) the ratio of the first two supply chain processes is similar to the ratio of the FLW data 8.8 and 25.6 MT. Since it is unclear what methodology or definition is used by CEL Consulting a proper validation is not possible.

## Overall conclusions and suggestions for the next steps

Figure 8 displays a comprehensive ranking of hotspot food products based on five criteria. While there are nine hotspot food products identified, a closer examination reveals notable variations in the ranking of the nine hotspot products across different categories. Among these products, rice, vegetable, pig meat and freshwater fish emerge as extremely critical food products. Rice and vegetable take the lead as the extremely critical products, ranking high for all five categories, followed by pig meat. Bovine meat follows positioned as a hotspot for three categories and classified as a very critical product. In the next tier of hotspot products, fruits stand out among the top five hotspots for two categories, falling into the category of moderately critical products. Poultry, marine fish, banana hold a rank in only one hotspot category, classifying them as slightly critical food products.

It is important to highlight that for freshwater fish and marine fish the criteria of land-use footprints and water footprints do not apply. Therefore, freshwater fish is ranked under the extremely critical products. An argument could be made for re-evaluating the classification of marine fish as moderately critical rather than slightly critical, given the unique considerations surrounding their land-use and water footprints.

It is suggested to develop FLW reduction actions, with synergy on GHGEs mitigation, nutrition, land-use and water footprints. The above analysis underlines that, if one considers sustainability in the context of these five selected indicators, the greatest impact can be achieved by concentrating efforts on reducing FLW related to rice, vegetables, pig meat, freshwater fish, and bovine meat compared to focusing on other food products.

Since the results are not on product level, it is not immediately clear, where to start your intervention. Our suggestion to develop FLW reduction actions, with synergy on GHGEs mitigation, nutrition, land-use and water footprints, is to implement monitoring or/and gather primary data for hotspot-supply chains of the country. The results in this document guide stakeholders by focusing on the top four food (sub)categories in combination with the indicative results on FLW per supply chain link. To research interventions, it is necessary to go to product level, which can be based on production or trade data in the country. The next step is to identify business cases for FLW reduction. For this purpose, WUR's EFFICIENT protocol[3] and WUR's FLW cause and intervention tool[4] can be used.

2 https://www.cel-consulting.com/post/2018/08/10/food-losses-in-vietnam-the-shocking-reality#:~:text=Total%20losses%20are%20estimated%20at,is%209%25%20of%20total%20Vietnam. Viewed 6-1-2023

3 https://edepot.wur.nl/556214 and https://sites.google.com/iastate.edu/phlfwreduction/home/efficient-food-loss-waste-protocol

4 The FLW cause & intervention tool (the-efficient-protocol.azurewebsites.net)

## Vietnam: Hotspot food products evaluated across five criteria

| | FLW tons | GHGEs | Land-use footprints | Water footprints | Protein Losses | Conclusions |
|---|---|---|---|---|---|---|
| Rice | 2 | 1 | 2 | 1 | 1 | Extremely critical |
| Vegetables | 1 | 2 | 4 | 3 | 2 | Extremely critical |
| Pigmeat | | 4 | 3 | 2 | 4 | Extremely critical |
| Freshwater fish | 4 | 3 | ○ | ○ | 3 | Very critical |
| Bovine Meat | | 5 | 1 | 5 | | Very critical |
| Fruits | 3 | | | 4 | | Moderately critical |
| Poultry | | | 5 | | | Moderately critical |
| Marine Fish | | | ○ | ○ | 5 | Slightly critical |
| Banana | 5 | | | | | Slightly critical |

● Extremely critical ● Very critical ● Critical ● Moderately critical ● Slightly critical ○ Not applicable

**Figure 8** Ranking of hotspot product across five criteria

## References

FAO. 2019. The State of Food and Agriculture 2019. Moving forward on food loss and waste reduction. Rome. Licence: CC BY-NC-SA 3.0 IGO.

FAO, I., UNICEF, WFP and WHO., In Brief to The State of Food Security and Nutrition in the World 2021 - Transforming food systems for food security, improved nutrition and affordable healthy diets for all. 2021: p. 40.

Guo, X.; Broeze, J.; Groot, J.J.; Axmann, H.; Vollebregt, M. 2020. A Worldwide Hotspot Analysis on Food Loss and Waste, Associated Greenhouse Gas Emissions, and Protein Losses. *Sustainability*, 12, 7488.

Lipinski, B., Champions 12.3: SDG Target 12.3 on food loss and waste: 2022 progress report. 2022: p. 12.

Mekonnen, M., & Hoekstra, A. Y. (2010). The green, blue and grey water footprint of animals and animal products. (Value of water research report 48; No. 48).

Mekonnen, M. M., & Hoekstra, A. Y. (2011). The green, blue and grey water footprint of crops and derived crop products. Hydrology and Earth System Sciences, 15(5), 1577-1600.

Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. Science, 360(6392), 987-992.

Porter, S. D., Reay, D. S., Higgins, P., & Bomberg, E. 2016. A half-century of production-phase greenhouse gas emissions from food loss & waste in the global food supply chain. *Science of the Total Environment*, 571, 721-729.

WWF, Driven to waste: The global impact of food loss and waste on farms. 2021: p. 24.

## Colophon

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