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INITIATIVE ON Low-Emission Food Systems

CGIAR

CIFOR

World Agroforestry

No. 399, December 2023

DOI: 10.17528/cifor-icraf/009049 | cifor-icraf.org

Opportunities for a low-emission transformation of Vietnam's food system

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Key messages

- Between 2010 and 2020, Vietnam's food system emissions increased in absolute terms, from 96.4 to 104.5 $MtCO_2eq$, although they decreased in relative terms, from 34 to 26.5% of national emissions. Still, food system emissions in Vietnam represent a significant share of national emissions.
- The main sources of food system emissions in Vietnam are, by decreasing order of importance: (i) rice cultivation (35.7 $MtCO_2eq$ in 2020; or 34% of total food system emissions); (ii) livestock management (i.e. enteric fermentation and manure together, 24.4 $MtCO_2eq$; or 23%); (iii) synthetic fertilizers (10 $MtCO_2eq$; 10%); (iv) food system waste disposal (8.6 $MtCO_2eq$; 8%); and (v) household food consumption (8.1 $MtCO_2eq$; also 8%). Reducing emissions from these sources should be the top priority for mitigation strategies in Vietnam's food system.
- Emissions beyond farmgate increased significantly (+37%) between 2010 and 2020 and should not be overlooked. These emissions could be sensibly and quite easily reduced by more efficient energy-use across food value chains, reduced food loss and waste and more sustainable consumption patterns.
- More generally, effective climate action planning should not only consider the size of sectoral emissions, but also the cost and feasibility (i.e. the 'political economy') of implementing transformative measures. Reducing GHG emissions will require a comprehensive and integrated approach, considering the whole food supply chain, from cradle to grave, as well as effective policies, financial incentives, education and capacity building, technical and organizational innovations, and strong governance mechanisms involving multiple actors, sectors and scales.
- One important aspect hindering progress along these emission reduction pathways is a substantial data gap. A considerable number of sectoral emissions have yet to be adequately quantified, including emissions from fisheries and aquaculture or emissions associated with food loss and waste at different stages of food value chains. This is crucial for effectively preparing and designing climate action strategies based on reliable evidence.

Background and introduction

A food system comprises "all elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the outputs of these, including socio-economic and environmental outcomes" (HLPE 2014). The global food system is responsible for 31% (range: 23-42%) of total net anthropogenic emissions (Babiker et al. 2022). Hence, in all countries including Vietnam, food systems need to be radically transformed, lowering their GHG emissions while continuing to produce sufficient, nutritious and healthy food.

Food system emissions in Vietnam

Vietnam's economy-wide greenhouse gas (GHG) emissions *per capita* significantly increased between 2010 and 2020, from 3.25 to 4.09 tCO_2eq per capita because of economic development but still remain significantly lower than the world average (6.63 tCO_2eq per capita in 2020). Over the same period, Vietnam's food system emissions increased in absolute terms, from 96.4 to 104.5 $MtCO_2eq$, although they decreased in relative terms, from 34 to 26.5% of national emissions (Table 1). Still, food system emissions in Vietnam represent a significant share of national emissions (Martius et al. 2023b).

Table 1. GHG emissions from food systems in Vietnam and globally

GHG emissions	2010		2020	
	Vietnam	World	Vietnam	World
Food system GHG emissions ($MtCO_2eq$/year)	96.4	15,921.3	104.5	16,138.6
Food system GHG emissions (% of total GHG emissions)	33.9%	32.7%	26.5%	31.0%

Source: FAOSTAT. Accessed 27 January 2023. https://www.fao.org/faostat/en/#data/GT

Table 2. GHG emissions from the food system in Vietnam

Sources of GHG emissions	GHG emissions ($MtCO_2eq$/year)		Percentage of total emissions (2020)	Percentage change 2010–2020
	2010	2020		
Food systems (= 1 + 2 + 3)	**96.4**	**104.5**	**100**	**8**
1. Land-use change	**0.7**	**0.7**	**1**	**4**
Fires in humid tropical forests	0.4	0.2	0	-43
Fires in organic soils	0.3	0.5	0	57
Net forest conversion	0	0	0	
2. Farmgate	**77.5**	**78.8**	**75**	**2**
Burning – crop residues	0.5	0.5	0	-7
Crop residues	2.5	2.6	2	2
Drained organic soils	4.1	4.0	4	-4
Drained organic soils (CO_2)	4.0	3.8	4	-4
Drained organic soils (N_2O)	0.2	0.2	0	-4
Enteric fermentation	13.1	13.0	12	-1
Manure applied to soils	1.6	1.8	2	12
Manure left on pasture	2.6	3.1	3	17
Manure management	7.1	6.5	6	-9
On-farm energy use	1.8	1.5	1	-18
Rice cultivation	37.0	35.7	34	-4
Savanna fires	0.3	0.1	0	-54
Synthetic fertilizers	6.6	10.0	10	52
3. Pre- and post- production	**18.2**	**25.0**	**24**	**37**
Fertilizer manufacturing	n.a.	n.a.		
Household food consumption	5.3	8.1	8	52
Food packaging	0.1	0.2	0	332
Food processing	0.1	0.3	0	249
Food retail	0.9	1.1	1	23
Food system waste disposal	8.1	8.6	8	6
Food transport	3.3	3.9	4	17
On-farm electricity use	0.4	2.7	3	517

Source: FAOSTAT. Accessed 20 March 2023. https://www.fao.org/faostat/en/#data/GT. Food system corresponds to FAOSTAT's term 'agrifood system'. Note the units ($MtCO_2eq$/year). n.a. = not available.

Based on the FAOSTAT database, Vietnam's food system emissions can be divided in three main categories (Table 2): (i) farmgate emissions (78.8 $MtCO_2eq$ in 2020; or 75% of total food system emissions); (ii) emissions beyond farmgate, from pre- and post-production activities (25 $MtCO_2e$, or 24%); and (iii) land use change emissions (0.7 $MtCO_2eq$; or 1%)[1].

Each category is then further divided in different sources of emissions as illustrated in Table 2. The main sources of food system emissions in Vietnam are, by decreasing order of importance: (i) rice cultivation (35.7 $MtCO_2eq$ in 2020; or 34% of total food system emissions); (ii) livestock management (i.e. enteric fermentation and manure together, 24.4 $MtCO_2eq$; or 23%); (iii) synthetic fertilizers (10 $MtCO_2eq$; 10%); (iv) food system waste disposal (8.6 $MtCO_2eq$; 8%); and (v) household food consumption (8.1 $MtCO_2eq$; also 8%). Reducing emissions from these sources should be the top priority for mitigation strategies in Vietnam's food system.

Rice is, by far, the most cultivated crop in Vietnam (occupying alone 23% of national total land area) and the first source of GHG emissions. However, the past decade (2010-2020) shows a trend towards agricultural diversification with the relative share of rice decreasing from 74 to 62% of total cropland area and from 42.5% to 30% of national agricultural gross production value.

Livestock production (with large emissions from enteric fermentation and manure) is the second largest source of food system emissions in Vietnam. According to FAOSTAT, emissions from enteric fermentation and manure management remained quite stable over the period, thus Vietnam did better than, e.g., major global producers of meat and dairy whose emissions increased (FAIRR 2023).

Emissions from synthetic fertilizers use[2] drastically increased over the period (+51.5%), driven by an intensive, yet increasing fertilizer application, reaching 154.8 kg N per ha of cropland in 2020, which is more than twice the world average (72.5 kg N per ha).

Next, by size, come the two most important sources of emissions beyond farmgate: food system waste disposal and household food consumption. The former remained stable between 2010 and 2020, but the latter increased by 52%. These two emission sources represent, respectively, a sizeable 34% and 33% of pre- and post-production activities.

Fisheries and aquaculture play a vital role in Vietnam's economy, constituting approximately 5% of the national GDP and nearly 25% of the agricultural GDP in 2020 (World Bank 2021; Tu et al. 2022). Aquatic foods are particularly important in the Vietnamese diet: in 2020, they contributed 12.6% to the total daily protein intake in Vietnam, almost twice the world average of 6.9%. There are insufficient data to assess the GHG emissions from this sector. These values could be very high, due to the large emissions from mangroves deforestation and conversion to aquaculture, because large amounts of soil carbon are released to the atmosphere in this process (Kauffman et al. 2017). However, other considerations suggest lower values (Barange et al. 2018; Martius et al. 2023b).

How to address these emissions effectively?

Climate change and food system policies traditionally concentrate on farmgate emissions and land use change. Indeed, in 2020, these two categories taken together represent 76% of total food system emissions in Vietnam. However, emissions from pre- and post-production activities, comprising 24% of the total, should not be disregarded. Addressing these emissions through climate action may prove more cost-efficient, politically acceptable, and socially feasible. This approach involves identifying mitigation options that are technically, economically, politically, and socially more feasible than complex interventions targeting larger emissions sources related to rice and livestock production. We argue that such measures could be more easily developed and implemented, with simpler training requirements.

In summary, a comprehensive approach to emissions reduction should consider not only the emission magnitude but also the cost-effectiveness and political, social, and institutional feasibility of diverse pathways toward low-emission food systems. This concept aligns with the framework of 'political economy,' which focuses on institutions, policies, power dynamics and interactions among actors.

Based on the analysis presented above, we suggest the following priorities for action to reduce food system emissions in Vietnam: (i) reducing emissions from rice production; (ii) addressing emissions from enteric fermentation and manure management; (iii) reducing emissions from synthetic fertilizer production and use;

1 This small figure may rather reflect a problem of reporting in FAOSTAT database for this specific emission category than the reality on the ground. This figure can be compared for instance to the carbon sink of -37.5 reported for the year 2014 for land use, land use change and forestry (LULUCF) in Vietnam's Third National Communication (MNRE 2019).

2 Data are lacking in FAOSTAT database for the emissions related to synthetic fertilizer manufacturing in Vietnam.

Drying algae. Photo by Terry Sunderland/CIFOR

and (iv) improving the data situation to understand and pinpoint the focus areas to address emissions from household food consumption and food loss and waste (See Martius et al. 2023b for more details).

Rice mitigation strategies include various approaches for the management of efficiency of water, fertilizer and residue use such as: alternative wetting and drying, aerobic rice cultivation ('dry rice'), systems of rice intensification, improved fertilizer management (e.g. slow-dissolving fertilizers), breeding of more resilient, less methane-emitting rice varieties, improved management of nutrients, cover crops and residues, and approaches such as conversion of unproductive rice areas into non-rice cropland or integrated rice-shrimp farming. Much of this is already part of Vietnam's updated NDC (Socialist Republic of Viet Nam 2022). More training and extension services are needed to integrate and support these approaches. By way of co-benefits, these strategies could reduce emissions while also improving agricultural production efficiency and farm income as well as reducing soil degradation and water pollution.

Beyond reducing meat consumption and, hence, the number of living animals, a basket of approaches can be used to reduce livestock emission intensity and thus contribute not only to reduce emissions from enteric fermentation and manure management but also to improve productivity. These approaches include: improving feed quality and animal health, optimizing animal nutrition as well as manure and livestock management practices. The use of dietary supplements, such as feed additives, methane inhibitors, enzymes, probiotics, and essential oils, can help reduce enteric methane emissions, and alternative feed sources, such as legumes, can reduce the amount of methane produced from manure management. Manure management mitigation strategies also include anaerobic digestion, and composting. Manure emits GHG, but its sustainable use can replace synthetic fertilizers (see next paragraph). Such strategies could reduce emissions while also improving soil health, providing clean and renewable energy, and reducing fertilizer costs.

Reducing emissions from synthetic fertilizer manufacturing and application requires: improving production processes and reducing the use of synthetic fertilizer use by optimizing application and by increasing instead the use of organic fertilizers and promoting composting. Actions may include reducing the use of energy, hazardous chemicals and the amount of waste generated during

production, implementing closed-loop systems, or capturing carbon dioxide and using it in other processes.

Addressing food loss and waste across food value chains, from production to consumption, will require foremost a better assessment of the situation with primary, disaggregated data collection to enable the identification of priority areas on which to focus efforts. Based on more accurate data, it will become possible to devise technical solutions to reduce the largest food loss and waste hotspots. Food loss and waste mitigation strategies shall also include improved storage, preservation and processing; composting food waste; and using food waste for animal feed. These strategies could reduce emissions, save money for producers and consumers, and reduce food insecurity. Technological, institutional and organizational innovations can help improve energy and resource-use efficiency at all stages of the food production chain.

Reducing emissions from household food consumption requires significant changes in consumption patterns. Information and education campaigns, labels and certification schemes, taxes and economic incentives, more efficient logistic and cold chain at retail and consumption stages, are all strategies that can contribute to change individual and collective behaviours and support more sustainable consumption patterns.

Enhancing carbon sinks has also been identified as a priority in Vietnam's updated NDC (Socialist Republic of Viet Nam 2022). To do so, Vietnam can reduce deforestation, and increase forest restoration, sustainable land management practices that reduce pressure on forestland. Rehabilitating and protecting areas of natural forests, including mangroves along the coast and in the Mekong Delta are essential in Vietnam.

Avoiding and reducing emissions will require effective policy formulation, financial incentives, education and capacity building, technical and organizational innovations, and strong governance mechanisms involving multiple actors, sectors and scales. Vietnam already supports research and development of new technologies and practices to reduce emissions from all sub-sectors of the food system, and can collaborate with the Mitigate+ program to strengthen emission reduction in food systems.

One important aspect hindering progress along these pathways is a substantial data gap. A considerable number of sectoral emissions have yet to be adequately quantified, including emissions from fisheries and aquaculture in Vietnam. FAOSTAT relies on national reporting, and limited quantification of food loss and waste data, seems to be the norm in many countries (Martius et al. 2023a, 2023b, 2023c; Song et al. 2023). Therefore, it is essential to prioritize greater transparency regarding the methodologies employed and to make increased efforts towards direct data collection. This is crucial for effectively preparing and designing climate action strategies based on reliable evidence.

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