

Review of Nationally Determined Contributions (NDC) of Vietnam from the Perspective of Food Systems

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List of Abbreviations

ADB	Asian Development Bank
AFOLU	Agriculture, Forestry and Other Land Use
AR	Assessment Report
AWD	Alternate Wetting and Drying
BAU	Business As Usual
CAT	Climate Action Tracker
CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
CO ₂	Carbon dioxide
COP	Conference of Parties
EF	Emissions Factor
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GWP	Global Warming Potential
HFCs	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
IRRI	International Rice Research Institute
LED	Light-emitting diode
LLL	Laser Land Levelling
LULUC	Land Use, Land-Use Change
LULUCF	Land Use, Land-Use Change and Forestry
MARD	Ministry of Agriculture and Rural Development
MONRE	Ministry of Natural Resources and Environment
MRV	Measurement, Reporting and Verification
MtCO ₂ eq	Million tons of carbon dioxide equivalent
NAP	National Adaptation Plan
NAPSDC	National Action Program on Sustainable Development and Consumption
NDC	Nationally Determined Contributions
NGOs	Non-governmental Organisations
NH ₄	Ammonium
SRI	System of Rice Intensification
TNC	Third National Communication
UNFCCC	United Nations Framework Convention on Climate Change

Summary

Over the past decades, Vietnam has significantly progressed and has transformed from being a food-insecure nation to one of the world's leading exporters in food commodities, and from one of the world's poorest countries to a low-middle-income country. The agriculture sector is dominated by rice and plays a vital role in food security, employment, and foreign exchange.

Vietnam submitted its updated Nationally Determined Contributions (NDC) in 2022 based on the NDC 2020. There is a significant increase in greenhouse gas (GHG) emission reduction, towards the long-term goals identified in Vietnam's National Climate Change Strategy to 2025, and efforts are being made to fulfil the commitments made at COP26.

The Agriculture Sector is the second-largest contributor of GHG emissions in Vietnam, accounting for 89.75 MtCO₂eq, which was about 31.6 percent of total emissions in 2014. Rice cultivation is the biggest source of emissions in the agriculture sector, accounting for 49.35% of emissions from agriculture. The total GHG removal from Land Use, Land Use Change and Forestry (LULUCF) in 2014 was -37.54 MtCO₂eq, of which the largest part was from the forest land sub-sector (35.61 MtCO₂eq), followed by removal from croplands (7.31 MtCO₂eq) (MONRE 2019).

Mitigation ambitions and targets: The mitigation ambitions and targets for GHG emission reduction in Vietnam's NDC 2022 have significantly increased from those in NDC 2020. In addition, Vietnam's National Climate Change Strategy (Government of Vietnam 2022b), has set the target to reach net-zero emissions by 2050 and the total emissions to not exceed 56 Mt. CO₂eq (Government of Vietnam 2022a).

The overall goal of the NDC is to reduce GHG emissions unconditionally by 15.8% compared to the Business-as-Usual (BAU) or reference scenario and by as much as 43.5% conditional on international support (Government of Vietnam 2022b). The conditional target is a cumulative one. GHG emission reduction from international support only is 28% compared to the 2030 BAU scenario.

Vietnam's NDC includes agriculture and LULUCF in general. The country intends to reduce emissions from agriculture through several measures, such as applying various technologies in rice farming, integrated crop management, organic agriculture, use of waste for fertilizer, and protection. LULUCF is the net carbon sink for Vietnam, and it is planned to increase the sink through measures such as the protection and restoration of forests and the scaling of agroforestry models, among others. Further, Vietnam intends to reduce methane emissions by 30% from 2020 levels.

The table below indicates the emissions scenario and targeted emissions reduction by 2030 for Vietnam.

Unit: MtCO₂eq

Sector	Baseline (2014)	BAU 2030	Unconditional Target	International Support target	Difference	% of Gaps
Agriculture	89.75	112.1	12.4	38.5	61.2	54.59%
LULUCF	-37.54	-49.2	-32.5	-14.1	-2.6	5.28%

Adaptation ambitions and targets: Vietnam’s goal for climate change adaptation is to reduce vulnerability to and risk from the negative impacts of climate change by enhancing resilience and adaptive capacity, reducing loss and damage, and integrating climate-change adaptation into strategic planning. The contribution to climate change adaptation as reflected in the NDC is detailed in the National Adaptation Plan (NAP), which is implemented in the medium and long term with the participation of various stakeholders for effective adaptation to climate change.

Scientific basis and data used in identifying targets: Vietnam’s updated NDC 2022 has been formulated based on NDC 2020 and showcases the efforts of the country to fulfil commitments made at COP26. The review and update have been conducted with the Ministry of Natural Resources and Environment (MONRE) taking the lead and the active participation of line ministries, experts, scientists, Non-governmental Organisations (NGOs), research agencies, and development partners through in-person working sessions and national- and sector-level consultation workshops. The NDC 2022 has evaluated, analyzed, and utilized official data, valuable experiences, lessons, and studies.

Further, the NDC indicates that the criteria for selecting GHG emission-reduction measures include (i) cost/benefit efficiency; (ii) feasibility in implementation; (iii) harmonization and co-benefits between climate-change adaptation and socioeconomic development; and (iv) consistency with national and sectoral development plans for the period 2021–2030 towards the goals of the National Climate Change Strategy to 2050.

The BAU scenario was developed based on the assumption of economic growth on the “medium economic development scenario”, energy demand, Gross Domestic Product (GDP) structure and growth by sectors, population growth, forest, and forest land planning, and quantity of livestock and arable land, in the absence of climate response policies. The BAU was developed for the period from 2014 to 2030 for five sectors — energy, agriculture, LULUCF, waste, and industrial processes (IP).

Adequacy of the targets from the food system perspective: Vietnam intends to reduce GHG emissions by 43.5% by 2030 with cumulative conditional and unconditional support. Although the country submitted an updated NDC in 2022 with stronger targets than in the previous NDC, according to the Climate Action Tracker (CAT), the overall CAT rating remains “critically Insufficient”, stating that the new targets will not drive further emission reductions (Climate Action Tracker 2022).

Both agriculture and LULUCF sectors in Vietnam have only presented aggregate data and hence do not provide further information regarding the emissions scenario and reduction potential. In addition, the action-based contributions in both these sectors are not quantified. The qualitative assessment of the food system inclusion in Vietnam’s updated NDC indicates that the NDC rates low to high across different categories. This implies that the NDC only provides generic information on actions, policies, and technology development to meet the targets of emission reduction, which makes tracking, implementation, monitoring, reporting, and verification of actions more challenging.

As mentioned earlier, Vietnam’s updated NDC does not comprehensively cover the different aspects of food systems. Vietnam largely focuses on the production side, and hence other aspects of food systems including processing, transportation, marketing and consumption, and food waste management are largely missing in Vietnam.

Feasibility of the targets relating to the food system: The activity targets for the agriculture sector are not quantified. Moreover, the activity-wise potential for emission reduction is also not included. This makes it challenging to implement, track and monitor the activities towards reaching the targets of emission reduction for agriculture and the LULUCF sector and for other sectors as well. In addition, of the total emissions target set for agriculture, only a reduction amount of 12.4 MtCO₂eq, is from unconditional support. This is only about a quarter of the total emission reduction target. The rest of the emission target is conditional on international support of US\$ 13,979.4 million. This makes it challenging to meet the agriculture sector targets if the estimated international support remains unmet.

Data gaps in the NDC: Vietnam's NDC does not include all aspects of food systems in an integrated manner. The BAU pathway in the updated NDC remains unchanged from the previous NDC (2020). The BAU scenario is developed based on "medium economic development" without clearly mentioning if it considers the dip in economic activities during the pandemic (Climate Action Tracker 2022). In addition, the outcomes of BAU and future projections of mitigation scenarios in Vietnam's NDC are only detailed for 2020 and 2030 with no information for the years in between. GHG accounting is sector-based rather than system-based. In addition, the NDC does not have quantified targeted interventions and does not account for potential emission-reduction scenarios from interventions. For example, Vietnam's updated NDC has included interventions such as mid-crop water withdrawal in rice cultivation and the application of farming technologies such as alternating wet and dry irrigation, but it does not include quantified targets and emission-reduction potential from such interventions.

Vietnam's 2014 GHG inventory provided sub-sectoral emission scenarios from enteric fermentation, rice cultivation, agricultural soils, burning of savannas, and agricultural residues. However, NDC 2022 does not include a sub-sectoral emission-reduction scenario and has only provided aggregate reduction potential from agriculture and other sectors.

Areas for improvement: Vietnam has the potential to increase its ambitions to reduce GHG emissions with additional mitigation options. Agriculture is the second-largest source of emissions in the country. Quantified, ambitious and viable interventions and emission targets in production (agriculture, aquaculture, livestock), LULUC, processing, transport, marketing and consumption, and food waste management could contribute to reaching the goal of net zero. The following are some of the key recommendations:

- **Raise ambitions in agriculture and LULUC sectors and sub-sectors:** Vietnam can raise its ambitions in the agriculture and LULUCF sectors. Agriculture has a total mitigation potential of 12.31 MtCO₂eq; forestry and agroforestry have a total mitigation potential of 20.23 MtCO₂eq; land use changes have a total mitigation potential of 282.14 MtCO₂eq; livestock has a total mitigation potential of 33.94 MtCO₂eq and rice has a total mitigation potential of 56.61 MtCO₂eq (Escobar Carbonari et al. 2019).
- **Include quantifiable actions and targets for food systems:** Vietnam has included the application of farming technologies such as the alternate wetting and drying (AWD) method in its NDC, but lacks clear details about where and how these will be applied. Without identifying suitable regions, targeting financial investments, securing international funding, and reliable Measurement, Reporting and Verification (MRV) systems, the national targets for the rice sector are unlikely to be achieved. Farmer adoption at scale and the ability to track field-level practices in rice production are still limited (Nelson et al. 2022). These could be further strengthened by having a detailed implementation strategy

including target areas, cost-benefit analysis, and modeling reduction scenarios, for example for GHG emission reduction for rice production (Nelson et al. 2022).

- **Interventions on emission reduction from aquaculture:** The aquatic food system helps contribute to GHG reduction through the process of carbon sequestration. Aquatic species, such as seaweeds, clams, and oysters, can absorb and store large amounts of carbon dioxide (CO₂) in the process of growth (FAO, 2018). The NDC can be further enhanced by adopting the application of science and technology in the various stages of aquaculture including production, processing, and food waste management to reduce GHG emissions (Tu et al. 2022). Technologies include the application of solar power systems; LED light systems in fishing and aquaculture; refrigeration and freezing systems using Freon gas and NH₄ in seafood processing; and using automatic feeding systems in aquaculture to reduce feed loss and waste.
- **Interventions for reducing emissions from livestock:** The livestock sector offers opportunities for high emissions abatement with low or negative marginal cost. The updated NDC presents limited mitigation targets for this sub-sector. Different interventions can help reduce the future growth of emissions from the livestock sector, and this could be reflected in further revision of Vietnam's NDC. Feeding dairy cows with a mixed ration has a mitigation potential of 2.63 MtCO₂eq at a marginal cost of -US\$ 130.73/tCO₂eq; supplementing beef cattle diets has a mitigation potential of 1.67 MtCO₂eq at a marginal cost of -US\$ 101.9/tCO₂eq, and composting pig manure has a mitigation potential of 7.3 MtCO₂eq at a marginal cost of US\$ 1.97/tCO₂eq in the context of Vietnam (Escobar Carbonari et al. 2019).
- **Interventions to reduce land-use change and protection of natural habitats:** Vietnam's NDC could include further options such as integrating mangrove ecosystems with sustainable shrimp farming and integrated rice-shrimp farming. Mangrove forests are the natural habitat and breeding ground of shrimps. Changes in land use that disrupt ecosystems, such as mangrove deforestation, release carbon stored in trees and account for up to 20% of global carbon dioxide emissions (SNV 2015). Globally, integrated mangrove-shrimp cultivation has emerged as a potential solution to environmental problems. On average, mangroves store 3–4 times more carbon than tropical upland forests (Donato et al. 2011). If integrated shrimp culture rehabilitated 10% (0.15 million ha) of the deforested mangrove area globally, it could sequester 0.17–0.21 million tons of blue carbon annually, as mangroves sequester blue carbon at a rate of 1.15–1.39 tons per hectare per year (Bouillon et al. 2008).

Chapter 1: Aspects of Food Included in their NDC Target

1.1 Context

Vietnam is a Southeast Asian country with an extensive coastline and tropical monsoon climate. As the territory of Vietnam stretches along many latitudes and terrains, the differences in climate between regions are significant and distinct (MONRE 2019).

Vietnam's Gross Domestic Product (GDP) increased at an average annual rate of 6.3% from 2010–2019, while the agriculture and natural resources (ANR) sector sustained a modest average growth rate of 2.9% over the same period). The country has significantly progressed over the past decades and has transformed from a food-insecure nation to one of the world's leading exporters of food commodities and from one of the world's poorest countries to a low-middle-income country. The agriculture sector is dominated by rice and plays a vital role in food security, employment, and foreign exchange. Rice production employs two-thirds of the rural labor force and has been consistently positioned as one of the world's largest rice exporters (ADB 2022).

Vietnam submitted its updated Nationally Determined Contributions (NDC) in 2022 based on NDC 2020 and has significantly increased its GHG emission reduction targets towards the long-term goals identified in Vietnam's National Climate Change Strategy to 2025 and its efforts to fulfill the commitments made at COP26.

1.2 Climate Change Scenario in Vietnam

With a coastline of 3,260 km and islands, Vietnam is regarded as one of the most vulnerable countries to climate change and is at high risk of sea level rise. In Vietnam, climate extremes have been recorded with higher intensity and frequency. Between 1958 and 2018, the annual average temperature of the whole country increased by about 0.89°C, an equivalent of 0.15°C/decade; the annual average precipitation of the whole country increased by 2.1%, with the greatest increase in the South-Central Coast area and decrease in the northern and southern parts of the Central Highlands. The number of strong typhoons grew; the number of hot days and droughts increased; the number of cold days decreased; extreme rainfall increased; and average sea levels at monitoring stations increased by 2.74 mm/year, and by 3.0 mm/year from 1993–2018.

Agriculture, biodiversity, water resources, public health, residential areas, and physical infrastructure are highly vulnerable due to their high exposure and sensitivity to natural disasters and extreme weather events. Due to the impact of climate change and sea level rise, people's lives are seriously affected by flooding leading to loss of agricultural land and water for agricultural irrigation, and the contamination of water for domestic and industrial purposes with saltwater.

Climate Change Predictions

Temperature

- Under the medium scenario (RCP4.5), the annual average temperature of the whole country would increase by 1.2–1.7°C by mid-century and by 1.6–2.4°C by the end of the century.
- Under the high scenario (RCP8.5), the annual average temperature would increase by 1.7– 2.3°C by mid-century and 3.2–4.2°C by the end of the century.
- The temperature in the north would increase more than in the south, and extreme temperatures are likely to increase.

Rainfall

- Under the medium scenario, annual rainfall would generally increase by 10–5% by mid-century and 10–20% by the end of the century.
- Under the high scenario, annual rainfall would increase by 10–15% by mid-century and 10–25% by the end of the century; some regions in the northeast might witness an increase of over 40%.
- The average one-day maximum rainfall would rise across the country (by 10–70%) compared to the base period (1986–2005).

Extreme weather/climate events

The number of strong to very strong typhoons would increase. The summer monsoon would start earlier and end later. The number of severely cold days in northern provinces would decrease. The number of hot days would increase and droughts would be harsher.

Sea level rise and consequent flooding risks

Under the high scenario, by the end of the century, the average sea level along the entire coastline could increase by 73 cm. If the sea level rises by 100cm, risks of permanent flooding (% of areas) are as follows: 47.3% of the Mekong River Delta, 13.2% of the Red River Delta; 1.9% of Quang Ninh province; 1.5% of central coastal provinces; 17.2% of Ho Chi Minh City; 4.8% of Ba Ria-Vung Tau province.

1.3 Agriculture and LULUCF in Vietnam

In 2014, the total area of agricultural production in the country was about 10.23 million ha, of which the total area of paddy cultivation was about 7.8 million ha. The total cereal production in 2014, including maize production, reached nearly 50.2 million tons (MONRE 2019).

The value of agriculture, forestry, and fishery exports has increased in recent years from US\$ 22.8 billion in 2012 to US\$ 33.8 billion in 2019. Rice dominates Vietnam's agricultural exports with over 6,300 million tons being exported in 2019. Additionally, Vietnam exports coffee, pepper, cashew nuts, and green tea. Marine-captured species together with fish and shrimp produced in manufactured ponds are an important domestic food source as well as a generator of foreign exchange on export markets (ADB 2022). The sector is seen as one of the engines of growth for the overall economy. The biggest contributors to the increase in the value of agriculture, forestry, and fishery exports are fresh and processed vegetables and fruits with their value increasing fourfold.

Vietnam's rice and corn yields could decline by 8.8% and 18.7% in 2030, and by 15.1% and 32.9% in 2050 respectively due to the changing climate. If the sea level rises by 100cm, 32.2% of agricultural land is at risk of flooding. Under the climate-change scenario, if rice yield and cultivation area remain unchanged with no adaptation measures, Vietnam will run the risk of losing 21.4% of rice production by 2100.

The Ministry of Agriculture and Rural Development (MARD) has developed an action plan to respond to climate change in the agriculture and rural development sector from 2016 to 2020 with a vision for 2050. Similarly, the MARD has approved the reduction of GHG emissions in the agriculture and rural development sector up to 2020, aiming to develop green, safe, and low-carbon agriculture production towards poverty reduction and effective response to climate change. The MARD has promulgated the Green Growth Action Plan for Agriculture and Rural Development Sector up to 2020.

1.4 Mitigation Priorities and Actions for Agriculture, Food, and LULUCF Sectors

Vietnam carried out its national GHG Inventory in 2016 (MONRE, 2020). The [National GHG inventory 2016](#) indicates the country's GHG emissions as **316.7 million tons of carbon dioxide equivalent (MtCO₂eq.)** Previously, Vietnam has implemented national GHG inventories for the inventory years of 1994: Initial National Communication (INC); 2000: Second National Communication (SNC); 2010: Biennial Update Report (BUR1); 2013: Biennial Update Report (BUR2); 2014: Third National Communication (TNC); and 2020: Biennial Update Report (BUR3). The year 2014 is considered the base/reference year for the GHG inventory for Vietnam's [Third National Communication \(TNC\)](#) to United Nations Framework Convention on Climate Change (UNFCCC) and the base year for NDC 2022. As per the TNC, the GHG emissions of the country in 2014 were **284 MtCO₂eq.** A comparison with GHG emissions in 2014 indicates that total 2016 net emissions increased by 13.7 percent from 2014. Between 2012 and 2017, Vietnam's GHG emissions (including land use) per capita increased by 27.3% and reached 3.44 tCO₂e/capita in 2017 (Climate Transparency 2020).

Figure 1 below indicates the GHG emissions/removals of Vietnam by sector for the base year 2014.

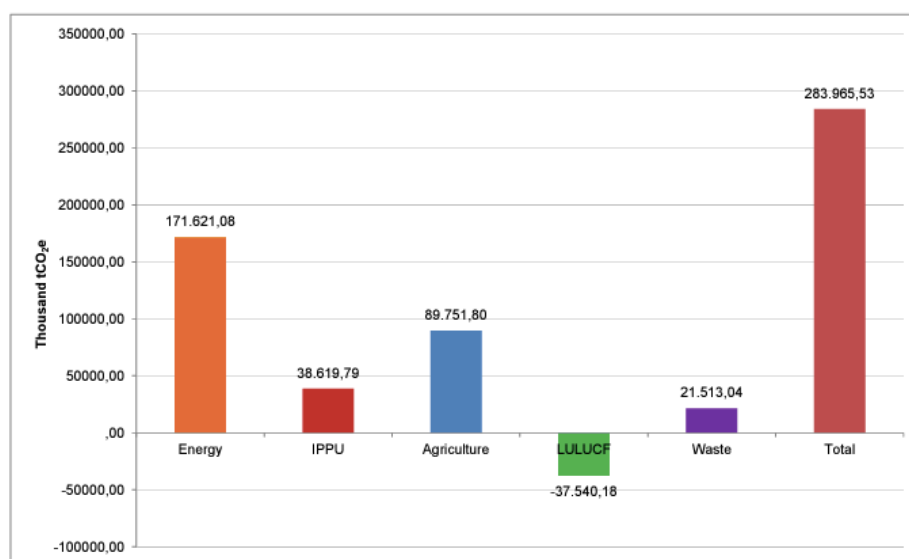


Figure 1: Vietnam's 2014 GHG emissions and removals by sectors

(Source: MONRE, 2019)

In 2014, the total emission of the agriculture sector was 89.75 MtCO₂eq. Rice cultivation was the biggest source of emission at 49.35%, followed by agricultural soils (26.69%), and the smallest source was the Prescribed Burning of Savannas at 0.001% (MONRE 2019). Other sources of emissions in agriculture include agricultural soils, enteric fermentation, manure management, and field burning of agriculture residues. **Figure 2** below shows the sources of emissions in the agriculture sector of Vietnam.

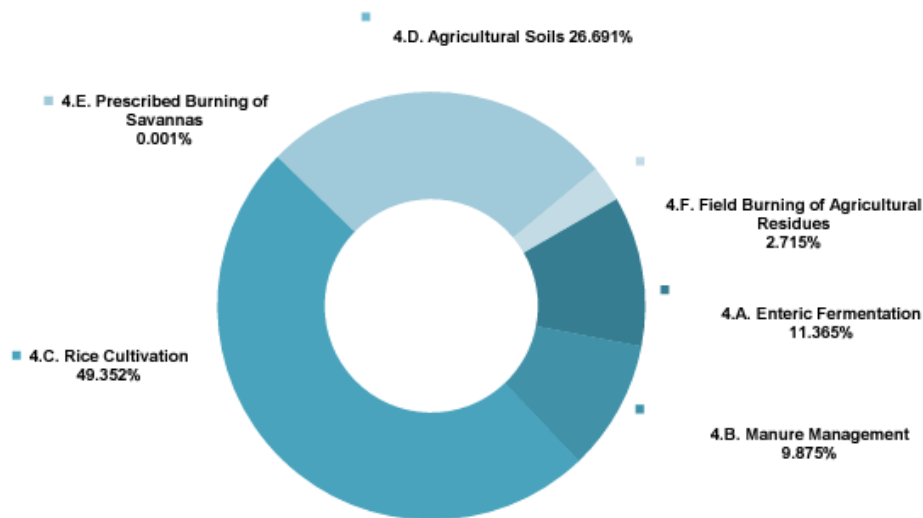


Figure 2: GHG emission shares of sub-sectors in the Agriculture Sector in 2014 (Vietnam)

(Source: MONRE, 2019)

The total GHG emission removal of the LULUCF sector in 2014 was -37.54 Mt CO₂eq. The biggest removal came from the forest land sub-sector with -35.61 Mt CO₂eq, with croplands removal as the second highest source at -7.31 Mt CO₂eq (MONRE 2019). Grasslands, wetlands, settlements, and other lands are other contributors to emissions in the LULUCF sector. **Figure 3** below shows the sources of emissions/removals in the agriculture sector of Vietnam.

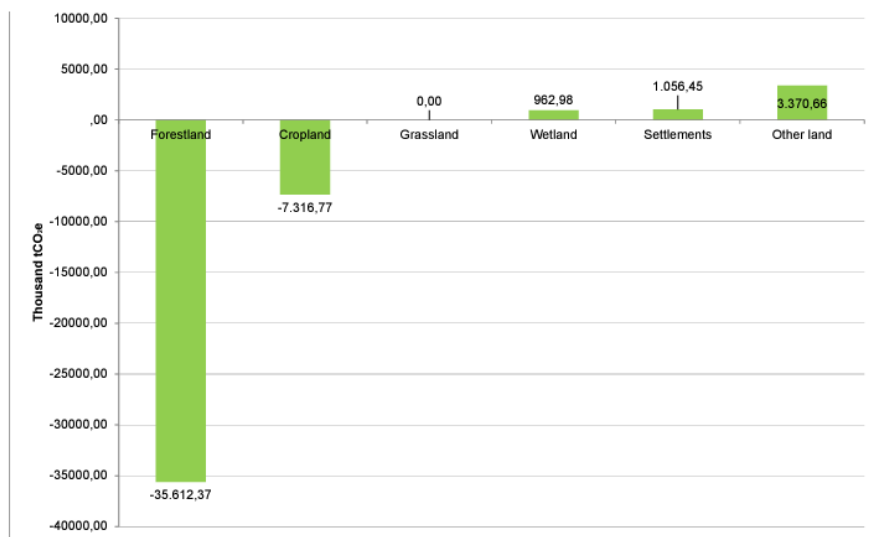


Figure 3: GHG emissions/removals shares of sub-sectors of the LULUCF sector in 2014 (Vietnam)

(Source: MONRE 2019)

Vietnam decided to update NDC 2020 and submitted the updated NDC in 2022 with raised ambitions and efforts. The contribution to GHG emission reduction in NDC 2022 towards the long-term goals identified in Vietnam's National Climate Change Strategy to 2050 (Government of Vietnam 2022b) has significantly increased compared to the contribution in NDC 2020. The

National Climate Change Strategy for 2050 has set the target to reach net-zero emissions by 2050 and the total emissions to not exceed 56 Mt. CO₂eq (Government of Vietnam 2022a).

Vietnam presents its target as a relative target, setting the target for reducing emissions compared to the Business-as-Usual (BAU) level. The overall goal is to unconditionally reduce GHG emissions by 15.8% compared to the BAU or reference scenario and by as much as 43.5% conditional on international support (Government of Vietnam 2022b). The conditional target is a cumulative one. GHG emissions reduction from international support only is 28% of the 2030 BAU scenario. **Table 1** below presents the GHG emissions for Vietnam under the BAU Scenario.

Table 1: GHG emissions under the BAU scenario

Unit: MtCO₂eq

Year	Energy	Agriculture	LULUCF	Waste	IP	Total
2014	171.6	89.8	-37.5	21.5	38.6	284
2020	347.5	104.5	-35.4	31.3	80.5	528.4
2025	500.7	109.2	-37.9	38.1	116.1	726.2
2030	678.4	112.1	-49.2	46.3	140.3	927.9

Source: Government of Vietnam, 2022b

Unconditional Contribution: The unconditional contribution in NDC 2022 has increased significantly compared to that in NDC 2020. The amount of emission reduction in NDC 2022 is 146.3 Mt CO₂eq compared to 83.9 Mt CO₂eq in NDC 2020. The ratio of emission reduction compared to BAU in NDC 2022 is 15.8% compared to 9% in NDC 2020.

Conditional Contribution (cumulative, includes unconditional and international support): The conditional contribution in NDC 2022 has significantly increased to 43.5% compared to that in NDC 2020. The conditional emission reduction in NDC 2022 is 403.7 Mt CO₂eq (the additional reduction is 153.0 Mt CO₂eq compared to NDC 2020).

Vietnam has developed the Action Plan on Methane Emissions Reduction by 2030 in line with its commitment to Global Methane Pledge at COP26. The goal of the Action Plan on Methane Emissions Reduction by 2030 is to reduce total methane emissions by 30% (not to exceed 77.9 MtCO₂eq) from crop production, animal husbandry, solid waste, water treatment, petroleum exploitation, coal mining, and fossil fuel use, compared to the emissions level in 2020. Methane emissions from crop production are not to exceed 30.7 MtCO₂eq, and animal husbandry emissions are not to exceed 15.2 MtCO₂eq in 2030 (Government of Vietnam, 2022b). **Table 2** below indicates methane-emission goals for 2025 and 2030 for Vietnam. The goal of the Action Plan on Methane Emissions Reduction informs the methane-reduction target of NDC 2022.

Table 2: Methane emissions (MtCO₂eq) inventory 2020 and goals for 2025 and 2030

S.N.	Emission Sources	2020	2025	2030
1.	Energy	15.3	15.4	10.9
2.	Agriculture, Forestry, and Other Land Use			
	Husbandry	20.3	16.8	15.2
	Biomass burning	1.9	42.2	30.7
	Rice Production	47.3		
3.	Waste	26.4	21.9	17.5
	Total	111.3	96.4	77.9

Source: Government of Vietnam, 2022b

The NDC 2022 has identified national measures to reduce GHG emissions for the period 2021–2030 in the sectors of energy, agriculture, LULUCF, waste, and industrial processes (IP). As indicated in Vietnam’s NDC 2022, the implementation of the NDC 2022 is in line with the net-zero target indicated in the National Climate Change Strategy to 2050 and the measures to implement the Action Plan on Methane Reduction by 2030, both approved in 2022.

Table 3 below reflects the mitigation priorities in the agriculture and LULUCF sectors in the NDC 2022.

Table 3: Mitigation priorities in the agriculture and LULUCF sectors in NDC 2022

Sector	Mitigation Priorities	GHG emissions reduction/removals target in 2030
Agriculture	• Application of integrated crop management solutions • Application of farming technologies such as alternating wet and dry irrigation and the System of Rice Intensification (SRI) method in areas with adequate infrastructure • Modernization of watering and fertilizing perennial plants • Mid-crop water withdrawal in rice cultivation • Conversion of inefficient rice land into dry cropland or shrimp-rice land • Composting and organic agriculture • Replacement of nitrogen fertilizers with slow-dissolving and slow-digesting fertilizers • Improvement of ruminant rations • Circulation of agricultural waste as organic fertilizer • Development of biogas use	<i>BAU in 2030:</i> 112.1 MtCO₂eq Unconditional Target: 99.7 MtCO₂eq (Financing need: US\$ 2122.8 million) Conditional Target: 61.2 MtCO₂eq (Financing need: US\$ 16,102.2 million)
	• Measures to reduce methane emissions in sub-sectors of agriculture, especially wet rice farming, and management of livestock waste and agricultural by-products to reduce methane emissions by 30% from 2020 levels by 2030.	<i>Methane Emissions:</i> 30% reduction from 2020 levels by 2030 Crop Production (Rice production and Biomass Burning): 30.7Mt CO₂eq Animal Husbandry: 15.2 Mt. CO₂eq (<i>Methane Emission reduction data is derived from Action Plan on Methane Reduction by 2030, ref: Table 2</i>)
LULUCF	• Protection of existing natural forest areas in mountainous areas, with priority given to hot spots of deforestation and forest degradation • Protection of coastal forests and special-use forests • Restoration of protection forests and special-use forests	<i>BAU in 2030:</i> -49.2 MtCO₂eq Unconditional GHG removals: -81.7 MtCO₂eq (Financing Need: US\$ 3927.4 million)

	- Improvement of the quality and carbon stock of poor natural forests - Improvement of productivity and carbon stock of large timber plantations - Scaleup of agroforestry models to improve carbon stocks and conserve soil - Sustainable forest management and forest certification	Conditional GHG removals: -95.8 MtCO ₂ eq (Financing Need: US\$ 5494.9 million)
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Figure 4 below reflects Vietnam's unconditional GHG emissions by sectors by 2030.

By 2030, agricultural emissions will be reduced by 43%, and total emissions will not exceed 61 MtCO₂e. Forestry and land use emissions will be reduced by 70% and increase their carbon capture by 20%, leading to the forestry sector having a total carbon capture of 95 MtCO₂e. The measures to reduce emissions applied in the LULUCF sector manifest Vietnam's determination to implement the Glasgow Leaders' Declaration on Forests and Land Use.

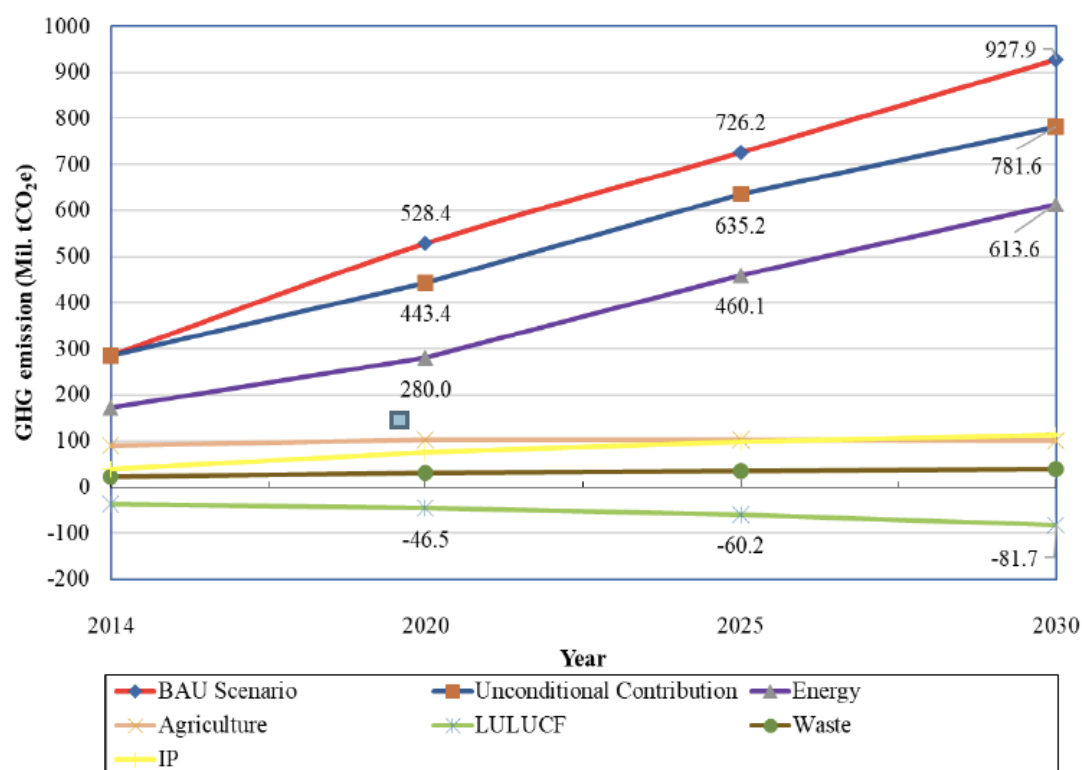


Figure 4: Vietnam's national GHG emissions (conditional and unconditional) by 2030

(Source: Government of Vietnam 2022c)

1.5 Adaptation Targets or Ambitions Reflected in the NDC

Vietnam's adaptation targets in NDC 2022 have been updated considering climate change trends and projections for the future, analysis of increased climate-change risks in addition to analysis of the inadequacies in terms of climate-change adaptation that need to be addressed. The NDC

also considers the economic and non-economic losses and damages that occurred in the past and those expected in the future.

Vietnam's goal of climate-change adaptation is to reduce vulnerability to and risk from the negative impacts of climate change by enhancing resilience and adaptive capacity, reducing loss and damage, and integrating climate-change adaptation into strategic planning. The contribution to climate-change adaptation in the NDC is detailed in the National Adaptation Plan (NAP), which is implemented in the medium and long term with the participation of various stakeholders for effective adaptation to climate change.

Table 4: Adaptation targets set by NDC

Enhancing resilience and adaptive capacity of natural, social, and economic systems for sustainable livelihoods	• Carrying out reasonable and effective extraction activities and strengthening solutions to improve and protect the soil environment • Preventing and minimizing land degradation caused by erosion, drought, and saline intrusion. • Promoting agricultural restructuring, rational crop structuring, intensive farming, and intercropping • Developing new varieties of plants and animals; implementing climate-smart agricultural solutions • Exploiting and promoting the advantages of tropical agriculture • Developing organic, ecological, environmentally friendly, and effective agriculture based on the natural advantages of each area and region • Promoting cooperation and regional linkages; developing large-scale, concentrated agricultural production in the direction of modernity; applying high technology, and scientific advances.
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1.6 Policy Measures on Adaptation and Mitigation reflected in Vietnam's NDC

Vietnam has laid out implementation arrangements for its updated 2022 NDC, including the development of policy and institution; the raising of communication and awareness; the development of human resources; the development of science and technology; the mobilization of financial resources; and the promotion of international cooperation.

The implementation arrangements for the development and completion of institution and policy on mitigation and adaptation include the following:

General Policy Priorities:

- Develop and complete institutional and legislative regulations on climate change. Review, modify and supplement specialized laws, strategies, plans, and development plans at all levels in the period from 2021 to 2030, with a vision to 2050, in accordance with the targets of climate-change adaptation and GHG-emission reductions and the requirements for climate-change integration.
- Review and finalize mechanisms, policies, and legal regulations; accelerate the simplification of administrative procedures; improve the business environment; and create favorable conditions for flows of funding and green finance investment in implementing projects to respond to climate change.

- Develop mechanisms and policies consistent with the goal of climate-change integration and promotion of adaptation activities that deliver co-benefits of sustainable socio-economic development; reduction of risks from natural disasters; reduction of GHG emissions, increase of integration of gender equality, promotion of women and youth's participation in activities for climate-change adaptation and GHG-emission reduction.

Policy measures on mitigation

- Develop an action plan to implement the Glasgow Leaders' Declaration on Forest and Land Use.
- Develop and promulgate policies that encourage investment in emission reduction in all sectors; promote sustainable production and consumption and prevent deforestation and forest degradation; encourage sustainable agriculture, ensuring food security and avoiding damaging the environment.
- Develop mechanisms and policies to institutionalize low-carbon production and circular economic models; adopt carbon pricing tools, including an emission trading scheme and carbon credit mechanisms.
- Review, amend, and supplement several tax policies, such as a natural resources tax, environmental protection tax, etc. to encourage the reuse, recycling, and treatment of waste and energy recovery from waste, reducing GHG emissions and increasing the economical and efficient exploitation and use of natural resources.
- Complete regulations, procedures, and technical guidance for a GHG inventory and a measurement, reporting, and verification system (MRV) for GHG emission reduction activities.
- Develop regulations, procedures, and technical guidelines on implementing carbon credit mechanisms; comply with international regulations on inventory and reporting; ensure environmental integrity; and promote sustainable development.

Policy measures on adaptation:

- Develop mechanisms to promote the development of the climate-risks insurance market, initially implementing climate-risk insurance activities in some high-risk sectors such as crop production and aquaculture.
- Develop and adopt tax and fee incentives and credit incentives to encourage the private sector to invest in climate-change adaptation and economic restructuring.
- Complete regulations on climate-change adaptation management; develop sets of criteria for climate-risk evaluation and the identification of projects and tasks for climate-change adaptation; monitor and evaluate (M&E) climate-change adaptation activities; develop and complete inter-regional and inter-function coordination mechanisms in climate-change response.

Chapter 2: Scientific Basis, Data, and Analysis behind NDC targets

2.1 Process Adopted

Vietnam's updated NDC 2022 has been formulated based on NDC 2020; it showcases the efforts of the country to fulfill commitments made at COP26. Vietnam's updated NDC is in accordance with Decision 1/CP.21 and Decision 4/CMA. 1. At COP26, Vietnam stated that it *“will develop and implement strong greenhouse gas emissions reduction measures with its resources along with the cooperation and support of the international community, especially developed countries, both in terms of finance and technology transfer, including implementation mechanisms under the Paris Agreement, to achieve net zero emissions by 2050”* (Government of Vietnam 2022c).

The NDC 2022 states that the review and update of Vietnam's NDC have been conducted according to the instructions of the Prime Minister, with the Ministry of Natural Resources and Environment (MONRE) taking the lead, and the active participation of line ministries, experts, scientists, NGOs, research agencies, and development partners through in-person working sessions and national and sector-level consultation workshops. The NDC 2022 has evaluated, analyzed, and utilized official data, valuable experiences, lessons, and studies.

Further, the NDC indicates that the criteria for selecting GHG emission-reduction measures include (i) cost/benefit efficiency; (ii) feasibility in implementation; (iii) harmonization and co-benefits with climate change adaptation and socio-economic development; and (iv) consistency with national and sectoral development plans for the period from 2021 to 2030 towards the goals of the National Climate Change Strategy to 2050. In addition, Vietnam's NDC targets on methane emissions reduction and the LULUC sector are manifested by its participation in the Global Methane Pledge to reduce methane emissions by 30 percent from 2020 levels by 2030, and its determination to implement the Glasgow Leaders' Declaration on Forests and Land Use to prevent and reverse deforestation and land degradation by 2030 (Government of Vietnam 2022c).

2.2 Scientific Basis and Data Adopted

The NDC 2022 states that Intergovernmental Panel on Climate Change (IPCC) guidelines along with the national statistical yearbook, national socio-economic development plan, and sector activity data related to programs, plans, and schemes on GHG emission reduction have been used to estimate GHG emissions data, as per Vietnam's NDC 2022. The revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories and the 2000 IPCC Good Practice Guidance have been used to calculate and forecast GHG emissions to 2030. The IPCC Good Practice Guidance for the LULUCF sector in 2003 has been used to calculate and forecast GHG emissions/removals to 2030 in the LULUCF sector.

The BAU scenario was developed based on the assumption of economic growth on the “medium economic development scenario”; energy demand; GDP structure and growth by sectors; population growth; forest and forest land planning; and the quantity of livestock and arable land; in the absence of climate response policies. The BAU was developed for the period from 2014 to 2030 for five sectors including energy, agriculture, LULUCF, waste, and industrial processes.

The year 2014 is considered the base/reference year for the GHG inventory for Vietnam's [Third National Communication \(TNC\)](#) to UNFCCC and the base year for NDC 2022. As per the TNC, the GHG emissions of the country in 2014 were **284 Mt. CO₂eq** (MONRE, 2019). The TNC

indicates that the baseline data for the agriculture sector in 2014 used the Tier 1 method, apart from the sub-sectors on manure management and rice cultivation, which used Tier 2 as per the 1996 IPCC guidelines. For the LULUCF sector as well, the Tier 1 method was used, except for the sub-sectors on forest land and cropland that used Tier 2 according to 1996 IPCC Guidelines. **Table 5** below elaborates on the method and data sources used for Vietnam's 2014 National GHG Inventory for the Agriculture and LULUCF sectors.

Table 5: Methods and data sources used for the 2014 National GHG Inventory for Agriculture and LULUCF sectors

Sector	Method	Data Sources		
		Activity Data	Emissions Factor (EF)	Other Parameters
Agriculture	All sub-sectors used Tier 1 according to the 1996 IPCC Guidelines. Only sub-sector 4.B. on Manure Management and 4.C. on Rice cultivation used Tier 2 according to 1996 IPCC Guidelines	Statistical Yearbook 2014, General Statistics Office 2015. - Statistical Yearbook of Agriculture and Rural Development in 2014, MARD 2015. - Data from scientific research and programs. - United Nations Food and Agriculture Organization (FAO)	IPCC default values for EF. - Country-specific values for rice cultivation and manure management	The default value of the IPCC. - Fraction of manure handled using manure system in livestock of Vietnam. - Fraction of Continuously Flooded Rice.
LULUCF	- All sub-sectors used Tier 1 according to the 1996 IPCC Guidelines. - Only sub-sector 5.A. on Forest land and 5.B.1 on Cropland used Tier 2 according to 1996 IPCC Guidelines	- Statistical Yearbook 2014, General Statistics Office 2015. - Statistical Yearbook of Agriculture and Rural Development in 2014, MARD 2015. - Land Use Matrix in the period of 2010–2014, General Department of Land Administration, Ministry of Natural Resources and Environment. - Data from scientific research and programs.	IPCC default values for EF.	- IPCC default values. - Results from studies.

Source: Third National Communication Report, Government of Vietnam (2014)

The NDC uses the Global Warming Potential (GWP) values from the IPCC's Fourth Assessment Report (AR4). Further, the assumptions used in calculating emission reductions have been updated based on the approved plans of ministries and sectors to implement Vietnam's commitments at COP26, considering the emissions of the air conditioning and refrigeration sub-sector under Services and Trade, and conversion of the use, recovery, and partial destruction of hydrofluorocarbons (HFCs) in industrial processes.

2.3 Analytics behind NDC Targets

a. Adequacy of mitigation targets

Vietnam intends to reduce GHG emissions by 43.5% by 2030 with cumulative conditional and unconditional support. The conditional contribution could reduce emissions by 15.8% and with international support there could be an additional reduction of 27.7%. The unconditional and conditional contributions in NDC 2022 have increased significantly compared to those in NDC 2020. The NDC 2020 intended to reduce emissions by 9% (unconditional target) and 27% (conditional target) by 2030. The updated NDC has therefore raised its ambitions to reduce GHG emissions. The type of contribution can be classified as “deviation from business-as-usual” (BAU). The overall goal of Vietnam's 2022 NDC is to reduce the level of GHG emissions to 524.2 Mt CO₂eq by 2030. In addition, the country has set the ambition to reduce methane emissions by 30% from 2020 levels by 2030.

Although the country submitted an updated NDC in 2022, with targets stronger than in the previous NDC, according to the Climate Action Tracker (CAT), the overall CAT rating remains “Critically Insufficient” stating that the new targets will not drive further emission reductions. The new targets are still aligned with 4°C of warming and require no additional effort beyond current policies (Climate Action Tracker 2022).

Table 6: Analysis of the NDC in terms of adequacy of the food systems targets

Unit: MtCO₂eq

Sector	Baseline (2014)	BAU 2030	Unconditional Target	International Support target	Difference	% of Gaps
Agriculture	89.75	112.1	12.4	38.5	61.2	54.59%
LULUCF	-37.54	-49.2	-32.5	-14.1	-2.6	5.28%

The agriculture and LULUCF sectors in Vietnam do not provide further information regarding emission reductions in sub-sectors. Vietnam has included rumen digestion, organic fertilizer management, and rice cultivation as sub-sectors of agriculture in the NDC. However, the emission-reduction potential from these are not included, only aggregated emission reductions for the agriculture sector have been presented. Similarly, in the LULUCF sector, the sub-sectors include forest land, cultivation land, grassland, wetland, and others, but disaggregated emission-reduction targets from these sub-sectors have not been presented. In addition, the action-based contributions from both the agriculture and LULUCF sectors are not quantified.

The qualitative assessment of the food system inclusion in Vietnam's updated NDC (detailed in **Table 7**) indicates that the NDC rates low to high across different categories. This implies that the NDC only provides generic information on actions, policies, and technology development to meet the targets of emission reduction. The generic information makes the tracking, implementation, measurement, reporting, and verification of actions more challenging.

Vietnam's NDC does not cover the different aspects of food systems comprehensively; Vietnam largely focuses on the production side, with generic actions not indicating policies and institutions required for actions, thus, giving a “high” rating for this category. Vietnam has set different measures in place for enhancing agricultural production through measures like crop management and irrigation facilities. The measures focus on enhancing rice production, which is the primary production and economic contributor for Vietnam. Measures for livestock are not well included. The NDC includes measures such as the conversion of inefficient rice land to dry cropland or shrimp-rice land, restoration of forests, and scaling up of agroforestry models to improve carbon stocks and conserve soil in the LULUCF sector.

The review indicates that other aspects of food systems including processing, transportation, marketing and consumption, and food waste management are largely missing in Vietnam's updated NDC. No actions or policy interventions have been mentioned for processing and transportation, thus ranking “low” for this category. For marketing and consumption, the NDC has set the action of climate-risk insurance for high-risk sectors including crop production and aquaculture. However, despite the well-documented evidence on the role of diets and nutrition (**FELD 2022**), Vietnam's NDC does not incorporate food security and healthy diets.

The NDC has not considered the whole-of-food system approach and is largely focused on the food production stage, and not the later stages. In addition, the NDC does not include specific and measurable activities for achieving GHG targets. This could pose challenges for monitoring and evaluation and make accounting for the progress of the GHG targets unclear.

Table 7: Qualitative assessment of food systems inclusion in NDC

Systems	What is included	Adequacy of the NDC (High, Medium Low)
Production activities	• Application of integrated crop management solutions • Application of farming technologies such as alternating wet and dry irrigation and SRI in areas with adequate infrastructure • Modernization of watering and fertilizing perennial plants • Mid-crop water withdrawal in rice cultivation • Replacement of nitrogen fertilizers with slow-dissolving and slow-digesting fertilizers • Improvement of ruminant rations • Composting and organic agriculture • Measures to reduce methane emissions in sub-sectors of agriculture, especially wet rice farming and management of livestock waste and agricultural by-products to reduce methane emission by 30% from 2020 levels by 2030.	The NDC lists essential actions but does not include specific commitments, strategies, or funding, related to the critical transition. Overall Rating: High

Food processing, transportation	There is no specific information on food processing and transportation.	The NDC does not mention any specific information on policy interventions for the critical transition. Overall Rating: Low
LULUC	- Conversion of inefficient rice land into dry cropland or shrimp-rice land - Restoration of protection forests and special-use forests - Scaleup of agroforestry models to improve carbon stocks and conserve soil - Sustainable forest management and forest certification	NDC has identified essential actions, however, it does not include specific commitments, strategies, or funding, related to the critical transition. Overall Rating: Medium
Marketing and consumption	- Develop mechanisms to promote the development of the climate-risks-insurance market, initially implementing climate-risk insurance activities in some high-risk sectors such as crop production and aquaculture. - Different aspects of food marketing and consumption are not clearly articulated.	The NDC has specified essential actions, specific commitments, strategies, or funding, related to the critical transition. Overall Rating: Medium
Reducing food loss and waste management	- Circulation of agricultural waste as organic fertilizer - Development of use of biogas - Production of compost and refuse-derived fuel (RDF) - Development of mechanisms and policies to institutionalize circular economic models. Review, amend, and supplement several tax policies, such as natural resources tax, environmental protection tax, etc. to encourage the reuse, recycling, and treatment of waste and energy recovery from waste, reducing GHG emissions, economical and efficient exploitation, and use of natural resources. - Measures to reduce methane emissions in sub-sectors of agriculture, especially wet rice farming, and management of livestock waste and agricultural by-products by 30% from 2020 levels in 2030.	The NDC lists essential actions, including specific commitments, strategies, or funding, related to the critical transition. The NDC has mentioned aspects of waste in general but does not particularly discuss food waste management. Overall Rating: Medium

Note: High: Highly sufficient and highly adequate interventions proposed; Medium: adequate; Low: inadequate and insufficient

Vietnam's NDC provides the unconditional contribution and international support required to meet emission-reduction targets in all sectors including agriculture and the LULUCF. Further, the NDC has made efforts to elaborate on potential sources of international funding and potential areas where international funding could be mobilized. Although the NDC has included policies required to support the transitions envisioned, the policy targets relevant to the agriculture and LULUCF sector are not clearly and specifically defined.

b. Adequacy of Adaptation targets

Vietnam's goal towards climate-change adaptation is to reduce vulnerability to and risk from the negative impacts of climate change by enhancing resilience and adaptive capacity, reducing loss and damage, and integrating climate-change adaptation into strategic planning. The contribution to climate-change adaptation in the NDC is detailed in the National Adaptation Plan (NAP), which is to be implemented in the medium and long term with the participation of various stakeholders for effective adaptation to climate change. Climate-change trends and projections for the future and analysis of increased climate risks are considered for setting up Vietnam's adaptation targets.

Table 8: Analysis of the adequacy of adaptation targets

Category	Overall Rating
A. Future Climate Risk and Vulnerability in the Agriculture Sector (2030)	Overall Rating: Very high (5) The NDC indicates the future climate risk and vulnerability in various sectors including forestry, land resources, and agriculture. Further, it has detailed the impacts on cultivation and husbandry. <i>Land resources:</i> Prolonged heat and droughts increase the risk of arid soil, reducing soil quality. Increased droughts during the dry season and increased rainfall during the rainy season cause a rise in erosion and landslides in riverside and upland areas. Flooding due to sea level rise is one of the major threats to land resources of the delta and coastal areas. <i>Cultivation:</i> Vietnam's rice and corn yields could decline by 8.8% and 18.7% in 2030, and by 15.1% and 32.9% in 2050, respectively. If the sea level rises by 100cm, 32.2% of agricultural land is at risk of flooding. Under the climate-change scenario, if rice yield and cultivation area remain unchanged with no adaptation measures, Vietnam will run the risk of losing 21.4% of rice production by 2100. <i>Husbandry:</i> Impacts of climate change on husbandry include changes in the production and quality of animal feed and an increase in disease outbreaks. Pig farming is expected to decrease by about 8.2% in terms of headcount. <i>Forestry:</i> Climate change and extreme weather events will increase the risk of forest fires, especially in the Northwest,

	North Central, and Central Highlands; affect the distribution of biodiversity in sensitive forests such as dipterocarp forests, mangroves, evergreen broadleaf forests; increase the risk of developing forest pests and diseases; affect the productivity and suitability of planted forests; change the distribution and risk of biodiversity loss, especially for species with a narrow ecological distribution. <i>Aquaculture:</i> Saline intrusion will significantly reduce areas of freshwater aquaculture, affecting the ecological environment and changing biodiversity.
B. Adaptation target ambitions for 2030	Overall Efforts rating: Medium (3) Vietnam's NDC briefly mentions the adaptation ambitions and has indicated that the country's NAP further elaborates the adaptation efforts for the medium and long term. One of the objectives of the NAP is to enhance the resilience and adaptive capacity of natural, social, and economic systems for sustainable livelihoods. Adaptation measures for agriculture and the LULUCF sector include preventing land degradation; promoting agricultural restructuring; intensive farming; intercropping; developing new varieties of plants and animals; climate-smart agriculture; organic, ecological, and environmentally friendly agriculture, among others. In addition, promoting cooperation and regional linkages for large-scale agriculture and the application of high technology is also incorporated as an adaptation target.
Differences in the degree of risk and level of adaptation efforts = Gap	Overall Gap rating: Low (2)

Rating: Very high (5), high (4), moderate (3), low (2), very low (1)

The actionable gap is “low” for Vietnam, which indicates that Vietnam has adequate adaptation actions to enhance the resilience and adaptive capacity of natural, social, and economic systems for sustainable livelihoods. Like the mitigation actions, the adaptation actions are non-quantifiable, which would make it challenging to account for targets, implement actions, and ensure monitoring and evaluation.

c. Feasibility of Achieving the Targets for Food Systems

The feasibility of the targets set by Vietnam's NDC for the food system is assessed in terms of activities and emission reduction targets, and financial requirements.

Activity and Emission Reduction Targets: Vietnam's NDC has set activities including the application of integrated crop management solutions, application of farming technologies such as alternative wet and dry irrigation, SRI, conversion of inefficient rice land to dry cropland or shrimp-rice land, and composting of agricultural waste, among others. Similarly, for the LULUCF sector,

activities such as protection and restoration of forest areas and scale up of agroforestry models have been proposed (See Table 3 for detailed list of activities).

However, these activity targets are not quantified. Moreover, the activity-wise emission reduction potential is also not included. This makes it challenging to implement, track, and monitor the activities towards reaching the target of emission reduction by the agriculture and LULUCF sectors and by other sectors as well.

Financial Requirements: Of the total emissions target set for agriculture, only a reduction amount of 12.4 MtCO₂eq, is from unconditional support. This is only about a quarter of the total emission-reduction target. The rest of the emission target is conditional on international support of US\$ 13,979.4 million. This makes it challenging to meet the targets of the agriculture sector if the estimated international support remains unmet.

However, in the case of the LULUCF emissions target, an emissions removal of 32.5 MtCO₂eq is from unconditional support, which is 69.74% of the total emission removal target set for this sector. The targets set for the LULUCF sector, therefore, seem somewhat viable given that the larger share of the reduction is from domestic resources.

Table 9 below indicates the GHG emission-reduction targets for the agriculture and the LULUCF sectors with unconditional and international support.

Table 9: GHG Emission Reduction Target by 2030 from Unconditional and International support

Sector	Unconditional Support		International Support		Conditional Support (cumulative unconditional and international support)	
	Reduction Amount (MtCO ₂ eq)	Financial Need (millions USD)	Reduction Amount (MtCO ₂ eq)	Financial Need (millions USD)	Reduction Amount (MtCO ₂ eq)	Financial Need (millions USD)
Agriculture	12.4	2,122.8	38.5	13,979.4	50.9	16,102.2
LULUCF*	32.5	3,927.4	14.1	1,567.4	46.6	5,494.9

**Increasing GHG removal*

Chapter 3: Missing data gaps

As discussed in earlier sections, Vietnam's NDC has been developed with a scientific basis and accounting methodologies that have considered some elements of food systems. The country's updated NDC, however, does not include all aspects of food systems in an integrated manner.

The BAU pathway in the updated NDC remains unchanged from the previous 2020 NDC. The BAU scenario was developed based on “medium economic development” without clearly mentioning if the dip in economic activities during the pandemic was considered (Climate Action Tracker 2022). In addition, the outcomes of the BAU and future projections of mitigation scenarios in Vietnam's NDC are only detailed for 2020 and 2030 with no information for the years between.

Further, GHG accounting is sector-based rather than system-based. While the country's National Inventory Reports have analyzed GHG emissions at the sub-sectoral level, the NDC lacks data on sub-sectoral emission-reduction potential. For example, in the case of the agriculture sector, Vietnam's 2014 GHG inventory has provided sub-sectoral emission scenarios from enteric fermentation, rice cultivation, agricultural soils, burning of savannas, and agricultural residues. However, NDC 2022 does not include a sub-sectoral emission reduction scenario and has only provided an aggregate reduction potential from agriculture and other sectors. In addition, the NDC does not have quantified targeted interventions and does not account for potential emission-reduction scenarios from the interventions. For example, Vietnam's updated NDC has included interventions such as mid-crop water withdrawal in rice cultivation and the application of farming technologies such as alternating wet and dry irrigation; however, it does not include quantified targets and the emission-reduction potential from such interventions. As the agriculture sector contributes nearly half of Vietnam's emissions, Vietnam must strengthen data on emissions reduction potential and projection emission reduction scenarios in sub-sectors such as rice production and enteric fermentation, among others.

In terms of specific data on the sub-sectors of the food system, the NDC is weak. Vietnam has excluded food processing, transport, marketing, consumption, and food loss and waste on its mitigation target. Vietnam's NDC has not fully accounted for emissions associated with food imports, particularly those related to deforestation and the conversion of ecosystems. Although the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement applies the “territorial principle” to GHG emissions — that is, only those emissions and removals that take place within national jurisdictions are to be managed and reported internationally by countries — there is scope in NDCs to put forward measures that consider the full extent of the impacts caused by food systems.

One of the most critical aspects needed to improve the quality of information on emissions and removals in both agriculture and land use sectors is the lack of information. For example, in the case of Agriculture, Forestry and Other Land Use (AFOLU), information on carbon stocks and flows in different ecosystems and, consequently, emission factors, help evaluate the impact of the food system transformation on food system emissions and its impact on land use categories.

Table 10 below analyses the data and information reflected in Vietnam's NDC.

Table 10: Analysis of the data and information reflected in Vietnam's NDC

Data and information management	Focus of NDC
Availability of information to estimate targeted GHG emission levels of sectors	Vietnam's NDC has sufficient information to estimate the targeted GHG emission level in sectors; however, it does not include the targets at the sub-sector level. The NDC includes the targeted absolute level of GHG emissions.
Followed the guidance in information to facilitate clarity, transparency, and understanding of NDCs in Decision 4/CMA.1	Vietnam followed the Decision 4/CMA.1 guidance on transparency to some extent. Most of the information is included in the NDC; however, it does not fully comply with the structure. The NDC presents the information in tabular format; however, the sub-sectors emission-reduction targets are not included for all sectors, including agriculture and the LULUCF.
Accounting modalities	Vietnam's NDC has not adequately outlined the accounting modalities. The NDC uses the GWP values from the IPCC's Fourth Assessment Report (AR4). Vietnam's NDC has used the 2000 IPCC Good Practice Guidance to calculate and forecast GHG emissions to 2030. Further, it states that the national statistical yearbook, national socio-economic development plan, sector activity data related to program planning, and schemes on GHG emission reduction have been used to estimate GHG emission targets. The IPCC Good Practice Guidance for the LULUCF sector in 2003 has been used to calculate and forecast GHG emissions/removals to 2030 in the LULUCF sector. The NDC has not clearly described how emissions were calculated and forecasted for other sectors.
Digital Revolution	Vietnam's NDC has included "science and technology development" under implementation arrangements. The NDC indicates the need to identify GHG emission-reduction technologies and to develop technologies to assist in implementing climate solutions. It includes promoting technology transfers, prioritizing high technology, new technology, and innovations in the sectors such as developing climate-smart crops and livestock varieties. The NDC also envisions effectively applying cloud computing, big data, Internet of Things, artificial intelligence, block chain, etc. in estimating and forecasting climate change impacts on nature and society to support stakeholders in enhancing climate-response capacity. It also states the development of an online system for MRV.

There are opportunities for filling the data gaps in the future. The country can standardize data segregation for the emission scenarios of sub-sectors and sectors, including quantified targets in the coming years, while updating and reviewing the NDC.

Vietnam has plans to review and evaluate its NDC every two years at the national level. The Ministry of Natural Resources and Environment is the focal point for monitoring and evaluation at the national level and is responsible for leading and coordinating with ministries, ministerial-level agencies, and provincial-level stakeholders in monitoring and evaluating the NDC's implementation. MONRE is responsible for developing and operating a national online database on MRV; synthesizing and developing monitoring and evaluation reports for governmental management of climate change and reports as regulated by UNFCCC, the Biennial Transparency Report, and other national reports on climate change in accordance with the provisions of international treaties to which Vietnam is a signatory.

Vietnam's NDC states that the country has developed the Measurement, Reporting, and Verification (MRV) system for the monitoring and evaluation of the GHG emissions reduction targets. In addition, the NDC elaborates a comprehensive approach to implementing and monitoring the NDC. The NDC considers the development and completion of policy and institution; communication, raising awareness and community engagement; human resource development; science and technology development; financial resource mobilization for climate response; and promoting international cooperation as key measures to promote the implementation of the NDC. The NDC also elaborates on implementation responsibilities, financial resources for implementation, and monitoring and evaluation of GHG emission targets, adaptation targets, and climate-change resources.

Chapter 4: Additional Mitigation Options and their abatement potential for the potential update of NDC

4.1 General Recommendations

1. **Further increasing ambitions in the 1.5-degree world:** The Climate Action Tracker (CAT) indicates that Vietnam's climate policies, targets, and commitments are not consistent with the Paris Agreement's 1.5°C temperature limit. Indeed, CAT states that Vietnam's 2030 emissions-reduction target is consistent with over 4°C of warming compared with modeled domestic pathways and the extent of emission reductions with international support. Vietnam has strengthened its ambitions in the updated NDC and has committed to reaching net zero by 2050 at COP26 and in its National Climate Change Strategy to 2050; however, these are not enough to drive real-world emission reductions beyond its current level of climate action. With the current policies, emissions will reach around 603–692 MtCO₂e by 2030 (excluding LULUCF) whereas Vietnam needs to reach 350 MtCO₂e by 2030 for the 1.5°C pathway (Climate Action Tracker 2022). CAT has rated the updated targets as “Critically Insufficient”. Vietnam should set more ambitious targets and develop and implement stringent policies for emission reductions, to be consistent with meeting the global goals of the 1.5°C temperature limit.
2. **Set quantifiable and disaggregated actions:** The GHG emissions-reduction actions and measures across the sectors to reach the target are non-quantifiable and not clearly defined. For example, in the agriculture sector, Vietnam plans the application of integrated crop management solutions and farming technologies such as alternative wet and dry irrigation, but it is unclear where and how much area of land these actions would cover. Such actions would make it challenging for Vietnam to drive real actions, and to monitor and evaluate if Vietnam is on track to reach its ambitions. It is recommended that Vietnam should set quantifiable actions to accelerate actions toward reducing emissions. More disaggregated options represent better heterogeneity within the sector and support the translation of findings into practice (Eory et al. 2018).
3. **Stronger alignment with national policy documents:** Vietnam could further align its actions with other sectoral policy documents such as the National Action Program on Sustainable Development and Consumption (NAPSDC) 2021–2030 (2020), and the Scheme on Developing Organic Agriculture from 2020 to 2030 (2018). The NAPSDC includes interventions such as applying sustainable linkage models in food processing and other sectors; developing, disseminating, and replicating eco-innovation models in the sectors of food processing, beverages, and other economic sectors; and a 5–8% decrease in resources and materials used for production sectors such as seafood processing. The action program also suggests the use of eco-friendly means of transport and promoting a circular economy for waste including agricultural waste (Government of Vietnam 2020).

4.2 Recommendations for Adopting Additional Mitigation Options

Vietnam has the potential to increase its ambitions to reduce GHG emissions with additional mitigation options. Agriculture is the second largest source of emissions in the country. Quantified, ambitious and viable interventions and emissions targets in production (agriculture, aquaculture, livestock), LULUCF, processing, transport, marketing and consumption, and food waste management could contribute to reaching the goal of net zero. Specific recommendations include:

1. **Raise ambitions in agriculture and LULUCF sectors and sub-sectors:** Vietnam can raise ambitions in agriculture and LULUCF sectors as there is huge potential. For example, a study by Escobar and Carbonari et al. (2019), suggests that for Vietnam, agriculture has a total mitigation potential of 12.31 MtCO₂eq; forestry and agroforestry have a total mitigation potential of 20.23 MtCO₂eq; land use changes have a total mitigation potential of 282.14 MtCO₂eq; livestock has a total mitigation potential of 33.94 MtCO₂eq, and rice has a total mitigation potential of 56.61 MtCO₂eq.
2. **Include quantifiable actions and targets for food systems:** Vietnam has included the application of farming technologies such as the alternate wetting and drying (AWD) method in its NDC but lacks clear details of where and how this will be applied. Without identifying suitable regions, targeting financial investments, securing international funding, and reliable MRV systems, the national targets for the rice sector are unlikely to be achieved. Farmer adoption at scale and the ability to track field-level practices in rice production are still limited (Nelson et al. 2022). These could be strengthened further by having a detailed implementation strategy including target areas, cost-benefit analysis, and by modeling reduction scenarios, for example, for GHG emissions-reduction for rice production (Nelson et al. 2022).
3. **Interventions on the application of low-emission technologies in rice production:** Vietnam could benefit by using various technologies such as alternate wetting and drying (AWD), laser land leveling, solar-bubble dryers, machine transplanting, and water sensors in the agriculture sector to reduce emissions. The International Rice Research Institute (IRRI) indicates that the combined use of Laser Land Levelling (LLL), and machine transplanting with methods like AWD would further increase yields, resulting in lower emissions.
 - The AWD process has been proven to reduce GHG emissions in rice production by 30 to 70 percent without affecting yields (Carrijo et al. 2017). Depending on baseline conditions, this could range from 1 to 5 tCO₂eq per ha per season compared to the continuous flooding practice (Vo et al 2020). Co-benefits of AWD include lower use of water, fertilizer, and seed, and higher resistance to some pests, diseases, and lodging damage.
 - Climate-smart rice cultivation, including straw and fertilizer management, could further reduce GHG emissions from the paddy rice fields.
 - Initial estimates using the International Rice Research Institute's investment model suggest that investing US\$ 1.4 billion to implement AWD and related techniques could reduce emissions from rice production by 6.8 MtCO₂e relative to BAU by 2030 (World Bank 2022b).
 - Laser land leveling (LLL) reduces GHG emissions by saving on energy, reducing cultivation time, and improving input-use efficiency such as water and fertilizer.
 - Machine transplanting of rice seedlings also reduces cultivation time and improves water-use efficiency, which contributes to reduced GHG emissions.
4. **Promote *Mot Phai, Nam Giam* (1 Must, 5 Reductions) approach to rice production:** The package of improved cultivation techniques named '1 Must-do, 5 Reductions' (1M5R), integrating AWD and other advanced techniques, can save up to 11 tons of CO₂eq per hectare per year compared to conventional farming (measured by the World Bank's Vietnam Sustainable Agriculture Transformation project). The 1M5R program was also certified in 2013 by the Vietnam Ministry of Agriculture and Rural Development as a

national approach to promoting best management practices in lowland rice cultivation (Tho, et al. 2021). The 1M5R focuses on the use of good-quality seed (the 1 must-do) and the reduction of seed rates, pesticide use, fertilizer inputs, water use, and postharvest losses.

5. **Interventions on emissions reduction from aquaculture:** Aquatic food systems help contribute to GHG reduction through a process of carbon sequestration. Aquatic species, such as seaweeds, clams, and oysters, can absorb and store large amounts of carbon dioxide (CO₂) in the process of growth (FAO, 2018). Aquaculture is increasingly becoming an important food production sector for Vietnam, especially in rural and coastal areas, with increasing global demand. However, the application of more-intensive farming including feed, seed, and materials/energy for processing is contributing to GHG emissions. It is recommended to use the application of science and technology in the various stages of aquaculture, including production, processing, and food waste management, to reduce GHG emissions (Tu et al. 2022). Technologies include the application of solar power systems, LED light systems in fishing and aquaculture, refrigeration and freezing systems using Freon gas and NH₄ in seafood processing, and using automatic feeding systems in aquaculture to reduce feed loss and waste.
6. **Interventions for reducing emissions from livestock:** The livestock sector offers high emissions abatement potential with low or negative marginal cost when income elasticity is considered. The livestock sub-sector will be a key source of future emissions, with ruminants being the main emission source (Escobar Carbonari et al. 2019). It is estimated that the sub-sector will represent 27% of the total emissions from agriculture by 2030 (Springmann et al. 2018). The updated NDC presents limited mitigation options and targets for this sub-sector. Different interventions could help reduce the future growth of emissions from the livestock sector. Feeding dairy cows with a mixed ration has a mitigation potential of 2.63 MtCO₂eq at a marginal cost of -US\$ 130.73/tCO₂eq; supplementing the diet of beef cattle with green fodder and concentrate has a mitigation potential of 1.67 MtCO₂eq at a marginal cost of -US\$ 101.9/tCO₂eq, and composting pig manure has a mitigation potential of 7.3 MtCO₂eq at a marginal cost of US\$ 1.97/tCO₂eq in the context of Vietnam (Escobar Carbonari et al. 2019).
7. **Include interventions to reduce land-use change and protection of natural habitats:** Vietnam's NDC could be further enhanced by including options like integrating mangrove ecosystems with sustainable shrimp farming and integrated rice-shrimp farming to reduce GHG emissions. Mangrove forests are the natural habitat and breeding ground of shrimp. On average, mangroves store 3–4 times more carbon than tropical upland forests (Donato et al. 2011). If integrated shrimp culture rehabilitates 10% (0.15 million ha) of the deforested mangrove area globally, it could sequester 0.17–0.21 million tons of blue carbon annually, as mangroves sequester blue carbon at a rate of 1.15–1.39 tons per hectare per year (Bouillon et al. 2008).
8. **Promote the conservation and management of agroforestry and agrobiodiversity:** Interventions such as protecting and supporting the recovery of agrobiodiversity, pollinators, and organisms critical for soil fertility, and sustainable land-use practices can contribute to reducing emissions. Interventions in agroforestry such as intercropping coffee with avocado and durian have mitigation potentials of 0.22 MtCO₂eq and 0.13 MtCO₂eq, respectively (Escobar Carbonari et al. 2019). In addition, agroforestry in coffee cultivation increases the amount of carbon sequestration per area compared to monoculture coffee.

9. **Integrate actions on processing food, food loss, and waste:** Interventions like modern milling systems, reducing the burning of rice straw, adequate drying facilities at the farm level, and applying cogeneration methods in sugar mills and food/foodstuffs processing plants could help to reduce food loss and waste. Modern milling systems can achieve 70 percent milling recovery, which could result in significant reductions in losses and waste in the rice system and generate GHG savings equal to about 3.15 MtCO₂e of GHG emissions annually, assuming an intensity of 0.9 kg GHG emissions per kg of paddy. Investing in adequate drying facilities at the farm level could reduce the moisture content from about 27 percent to 14 percent and dried paddy (a lower weight) could be transported to the mill (World Bank 2022b).
10. **Integrate actions on handling and storing food:** Different interventions on food handling and storing could contribute to reducing emissions. The interventions include the use of natural refrigerants; promoting infrastructure and technology investment to prevent post-harvest losses (e.g. use of simple hermetic storage); aiding agricultural research in the development of technologies to reduce post-harvest food waste; constructing and supplying low-cost storage silos for small-scale farmers to store their harvest; increasing infrastructure investment; promoting urban-rural connections and connecting farmers to markets; repurposing unused food as animal feed; and reusing organic or agricultural waste to generate energy, such as biogas.
11. **Include targets and interventions to reduce consumption of emissions-intensive food:** The food consumption pattern in Vietnam has largely changed over the years: meat's contribution increased from 26% of total diet GHG emissions in 1971 to 44% in 2011. Vietnam (Heller et al. 2019). The inclusion of such consumption-oriented perspectives is vital to addressing the challenges of emissions reduction. Interventions such as stricter guidance for government procurement; mandating food labels and sustainable labeling frameworks to increase consumer awareness and transparency; advancing research into alternative proteins (for example, algae); taxing animal proteins to discourage consumption; food education, including making school gardens; and promoting public procurement of food for schools to promote more sustainable and healthy diets, with a focus on plant-rich diets, could be some of the potential interventions for Vietnam.
12. **Include interventions that help to reduce food waste by consumers and retailers:** Food loss and waste emit 4.4 Gt CO₂eq of greenhouse gases (GHGs), accounting for 8% of total anthropogenic GHG emissions annually. Developing separate food waste collection systems, for example by using a pay-as-you-throw system; incentivizing food waste recycling; implementing educational programs to avoid and reduce food waste; encouraging the reuse of food waste for animal feed and organic fertilizer; promoting the conversion of food waste into biogas through composting and energy recovery; and developing waste recycling programs and improved technologies, could all help in reducing emissions.
13. **Include specific options for MRV systems:** Measurement, Reporting, and Verification (MRV) is an important aspect of Vietnam's NDC implementation process; however, a national standardized and transparent protocol for reporting emission reductions across sectors remains weak (Nelson et al. 2022). In line with the national target, the International Rice Research Institute (IRRI) is supporting the establishment of an MRV system for mitigation actions in the rice sector through the development of a provincial rice production statistical reporting system called RiceMo. This MRV system is specific to the Vietnamese rice context, and similar mechanisms are of relevance to other sectors and sub-sectors as well.

References

- ADB. 2022. Vietnam 2021-2025: Agriculture, Natural Resources and Rural Development Sector Assessment, Strategy and Road Map. In *adb.org*. Asian Development Bank. <https://www.adb.org/sites/default/files/institutional-document/763181/viet-nam-2021-2025-agriculture-sector-assessment-strategy-road-map.pdf>
- Bouillon, S., Borges, A.V., Castañeda-Moya, E., Diele, K., Dittmar, T., Duke, N.C., Kristensen, E., Lee, S.Y., Marchand, C., Middelburg, J.J. and Rivera-Monroy, V.H., 2008. Mangrove production and carbon sinks: a revision of global budget estimates. *Global biogeochemical cycles*, 22(2).
- Carrijo, D.R., Lundy, M.E. and Linquist, B.A., 2017. Rice yields and water use under alternate wetting and drying irrigation: A meta-analysis. *Field Crops Research*, 203, pp.173-180.
- Climate Action Tracker. 2022. <https://climateactiontracker.org/countries/vietnam/>
- Climate Transparency. 2020. Climate Transparency Report: Vietnam's Climate Action and Responses to the Covid-19 Crisis.
- Donato, D.C., Kauffman, J.B., Murdiyarso, D., Kurnianto, S., Stidham, M. and Kanninen, M., 2011. Mangroves among the most carbon-rich forests in the tropics. *Nature geoscience*, 4(5), pp.293-297.
- Eory, V., Pellerin, S., Garcia, G.C., Lehtonen, H., Licite, I., Mattila, H., Lund-Sørensen, T., Muldowney, J., Popluga, D., Strandmark, L. and Schulte, R., 2018. Marginal abatement cost curves for agricultural climate policy: state-of-the art, lessons learnt and future potential. *Journal of Cleaner Production*, 182, pp.705-716.
- Escobar Carbonari, D., Grosjean, G., Läderach, P., Nghia, T.D., Sander, B.O., McKinley, J., Sebastian, L. and Tapasco, J., 2019. Reviewing Vietnam's nationally determined contribution: a new perspective using the marginal cost of abatement. *Frontiers in Sustainable Food Systems*, 3, p.14.
- Food and Agriculture Organization [FAO]. 2018. *Impacts of climate change on fisheries and aquaculture Synthesis of current knowledge, adaptation, and mitigation options* (M. Barange, T. Bahri, M. C.M. Beveridge, S. Funge-Smith, & F. Poulain, Eds.; No. T627). Food and Agriculture Organisation (FAO). <http://www.fao.org/3/i9705en/i9705en.pdf>
- FELD (Food, Environment, Land, and Development) Action Tracker. 2022. FOLU Brief. 2022 Update: From Global Commitments to National Action: A Closer Look at Nationally Determined Contributions from a Food and Land Perspective. Sustainable Development Solutions Network (SDSN), Paris.
- GHG Mitigation in Rice - Vietnam*. (n.d.). <https://ghgmitigation.irri.org/focus-countries2/vietnam>
- Government of Vietnam. 2022a. National Climate Change Strategy to 2050.
- Government of Vietnam. 2022b. *Action Plan for Methane Emissions Reduction by 2030*. <https://gain.fas.usda.gov/Download.aspx?p=1807&q=c96dcbfa-3c45-40fc-b5cc-73ef8cb01e16>
- Government of Vietnam. 2022c. *Nationally Determined Contribution (NDC) (Updated in 2022)*. https://unfccc.int/sites/default/files/NDC/2022-11/Viet%20Nam_NDC_2022_Eng.pdf
- Government of Vietnam. 2020. *Vietnam National Action Plan on Sustainable Consumption and Production (2021-2030)* (No.: 889/QD-TTg). Government of Vietnam. https://www.switch-asia.eu/site/assets/files/2533/national_action_plan_on_scp_vietnam_pdf.pdf
- Heller, M.C., Walchale, A., Heard, B.R., Hoey, L., Khoury, C.K., De Haan, S., Burra, D.D., Duong, T.T., Osiemo, J., Trinh, T.H. and Jones, A.D., 2020. Environmental analyses to inform transitions to sustainable diets in developing countries: case studies for Vietnam and Kenya. *The International Journal of Life Cycle Assessment*, 25, pp.1183-1196.

- MONRE. 2019. The Third National Communication of Vietnam to the United Nations Framework Convention on Climate Change. Ministry of Natural Resources and Environment.
- MONRE. 2020. *Vietnam National GHG Inventory for 2016*. Ministry of Natural Resources and Environment (MONRE).
https://unfccc.int/sites/default/files/resource/Vietnam_NIR2016.pdf
- Nelson, K.M., Yen, B.T. and Sander, B.O., 2023. Achieving ambitions: roadmap to implementing nationally determined contributions for agriculture emission reduction in Vietnam. *Development in Practice*, pp.1-12.
- SNV. 2015. *SNV integrates shrimp aquaculture with mangrove protection in Ca Mau, Vietnam*.
<http://snv.org>. <https://snv.org/update/snv-integrates-shrimp-aquaculture-mangrove-protection-ca-mau-vietnam> accessed on February 5, 2022
- Springmann, M., Clark, M., Mason-D'Croz, D., Wiebe, K., Bodirsky, B.L., Lassaletta, L., De Vries, W., Vermeulen, S.J., Herrero, M., Carlson, K.M. and Jonell, M., 2018. Options for keeping the food system within environmental limits. *Nature*, 562(7728), pp.519-525.
- Tho, L. C. B., Dung, L. C., & Umetsu, C. 2021. "One must do, five reductions" technical practice and the economic performance of rice smallholders in the Vietnamese Mekong delta. *Sustainable Production and Consumption*, 28, 1040–1049.
<https://doi.org/10.1016/j.spc.2021.07.018>
- Tu T Q, Tran N, Cao L Q, Phan P T, Le T T H. 2022. Greenhouse gas emissions reduction in aquatic food systems: How it is featured in NDC and climate change mitigation in Vietnam. Penang, Malaysia: WorldFish
- Vo T B T, Wassmann R, Mai V T, Vu D Q, Bui T P L, Vu T H, Dinh Q H, Yen B T, Asch F and Sander B O. 202). Methane emission factors from Vietnamese rice production: pooling data of 36 field sites for meta-analysis Climate 8 74 World Bank. (2022a). Vietnam Country Climate and Development Report. Washington, DC: World Bank Group.
- World Bank. 2022b. Spearheading Vietnam's Green Agricultural Transformation: Moving to Low-Carbon Rice. Washington, DC: World Bank



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