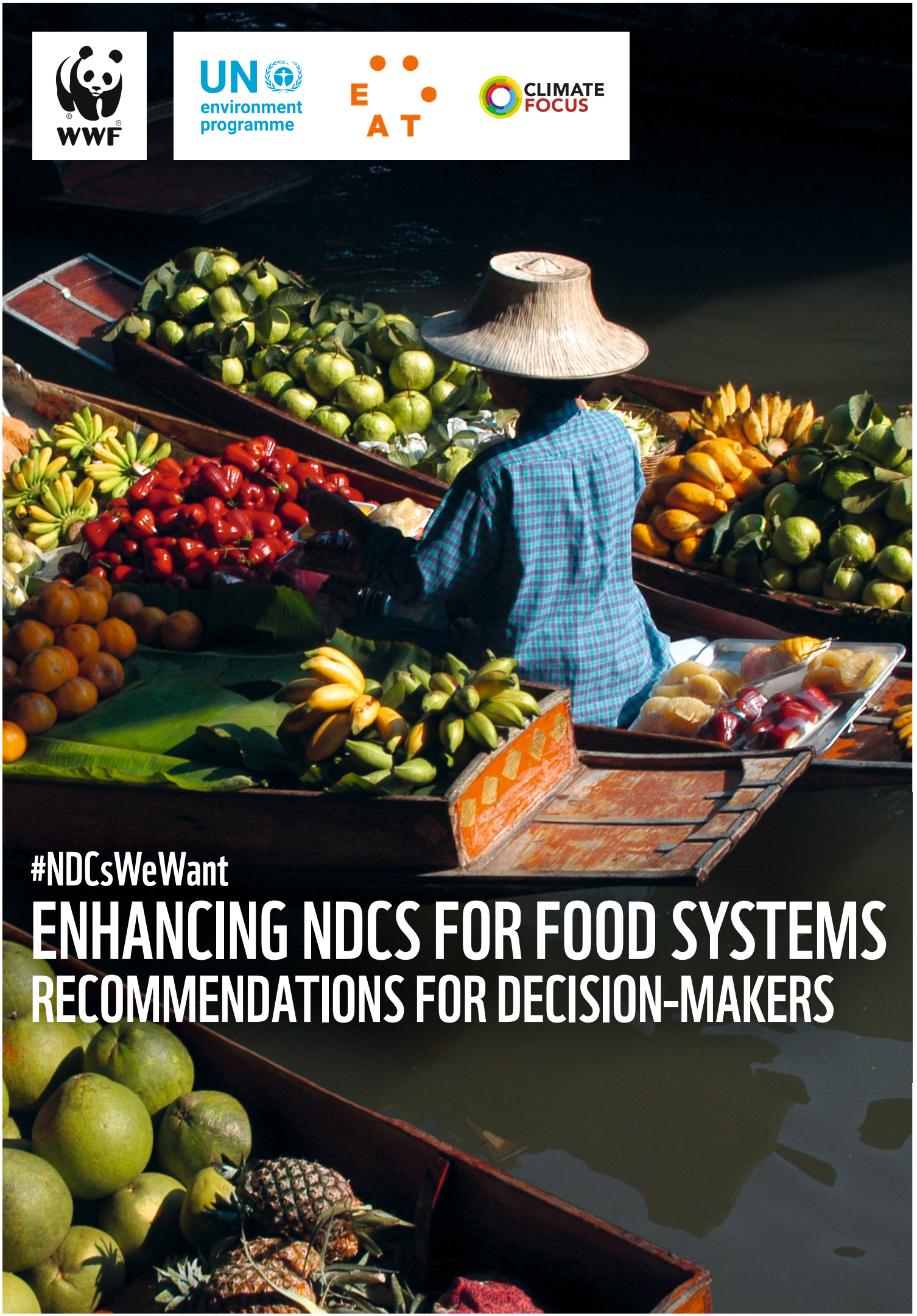

#NDCsWeWant

ENHANCING NDCS FOR FOOD SYSTEMS

RECOMMENDATIONS FOR DECISION-MAKERS

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In contribution to

One planet eat with care | Sustainable Food Systems

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1 Setting the Stage

This paper seeks to provide guidance and recommendations for policy-makers to increase ambition in Nationally Determined Contributions (NDCs) under the Paris Agreement using the climate change mitigation and adaptation potential of a transition to sustainable food systems.

The paper is structured as follows:

- **Section 1** provides an overview of the role and opportunities for the food system to contribute to climate change mitigation and adaptation (section 1.1) and summarizes how it is currently featured in NDCs (section 1.2)
- **Section 2** provides concrete suggestions of policies and measures that could be included in NDCs for activities across the food system for policymakers (section 2.1). In addition, the Section provides examples for the design of targets and indicators (section 2.2).

The guidance and recommendations provided in this paper are meant to serve as a starting point for discussions, future development and to provide a clear way towards measurable, actionable outcomes within their NDCs.

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The agriculture, forestry & land-use sectors account for nearly a quarter (24%) of total global emissions.

1.1 Food Systems and Climate Change

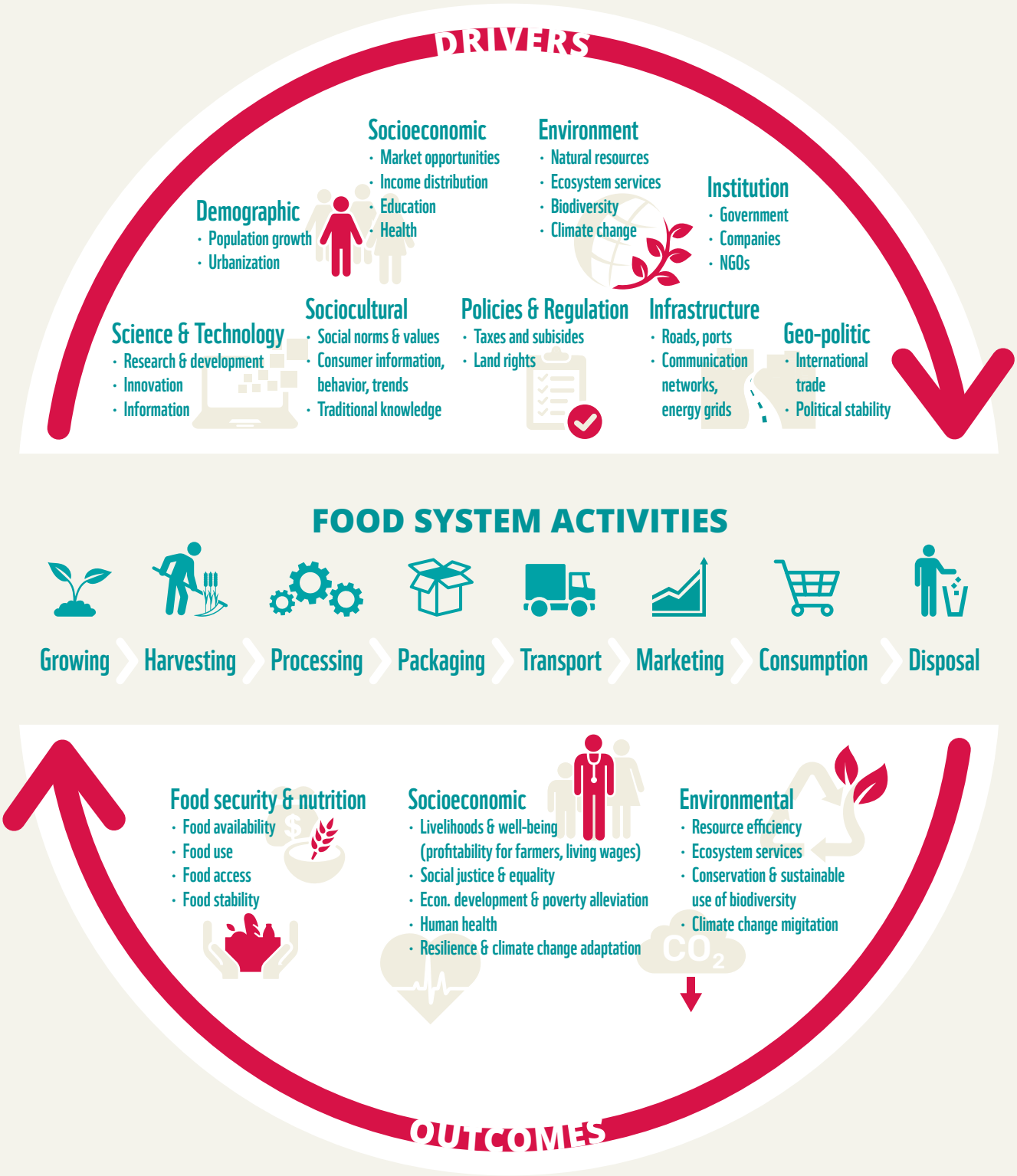
The global food system (**Box 1**) is a major driver of biodiversity loss caused by climate change, conversion of land, depletion of freshwater resources, and pollution of aquatic and terrestrial ecosystems. The agriculture, forestry & land-use sectors account for nearly a quarter (24%) of total global emissions.[1,2] Other major emitting sectors are the electricity and heat production (25%), industry in general (21%), the transportation sector (14%) and buildings and other energy use (16%).[3] If food production and consumption continue the current business-as-usual trajectory, we will exhaust the emissions budgets compatible with the 1.5° target and cross various planetary boundaries by 2050.[4] Several planetary boundaries have already been crossed.[5]

In 2019, the *IPCC Special Report on Climate Change and Land* emphasized that expansion in agricultural land has supported food availability for a growing global population, yet also contributed to increasing net greenhouse gas (GHG) emissions, loss of natural ecosystems (e.g. forests, savannahs, natural grasslands, and wetlands) and declining biodiversity.[6] The report also emphasizes the contribution of the food system to climate change mitigation and recognizes practices such as reducing crop and livestock emissions, sequestering carbon in soils and biomass, consuming healthy and sustainable diets and reducing food loss and waste as major opportunities for reducing GHG emissions while also improving health outcomes.[7]

Box 1. Defining the food system
The food system includes all elements (environment, people, inputs, processes, infrastructures, institutions) and activities that relate to the production, processing, distribution, preparation and consumption of food and their socio-economic and environmental impacts.[8] For this paper, we use a food system framework to identify some of the key mitigation and adaptation measures needed to address the drivers and trends of unsustainable food production and consumption (**Figure 1**).

Food system activities including from agriculture and land use, storage, transport, packaging, processing, retail and consumption including food loss and waste are responsible for 21 to 37% of anthropogenic GHG emissions every year.[9]

Figure 1. Elements of the food system[10]



In most countries there is great potential to contribute to climate change mitigation and adaptation through food systems changes

In most countries there is great potential to contribute to climate change mitigation and adaptation through food systems changes **(Figure 2)**.[11] Globally, food production-level measures including addressing land-use change and agricultural emissions could reduce overall emissions by 7.2 Gt CO_2 eq per year while measures such as reducing food loss and waste and shifting towards sustainable and healthy diets could reduce emissions by 1.8 Gt CO_2 e eq per year, together contributing about 20% of the global mitigation needed in 2050 to deliver on the 1.5°C target.[12] Brazil, China, Indonesia, the European Union, India, Russia, Mexico, the United States of America, Australia and Colombia currently are the 10 countries and regions with the highest mitigation potential in the land sector.[13] On the demand side, the United States, European Union, China, Brazil, Argentina, and Russia have the highest potential for shifting diets to stay within planetary boundaries while significant opportunities to reduce food waste by consumers exist in North America, China, the European Union and most emerging economies. Southeast Asia and Sub-Saharan Africa have the greatest potential for preventing food loss from production.[14]

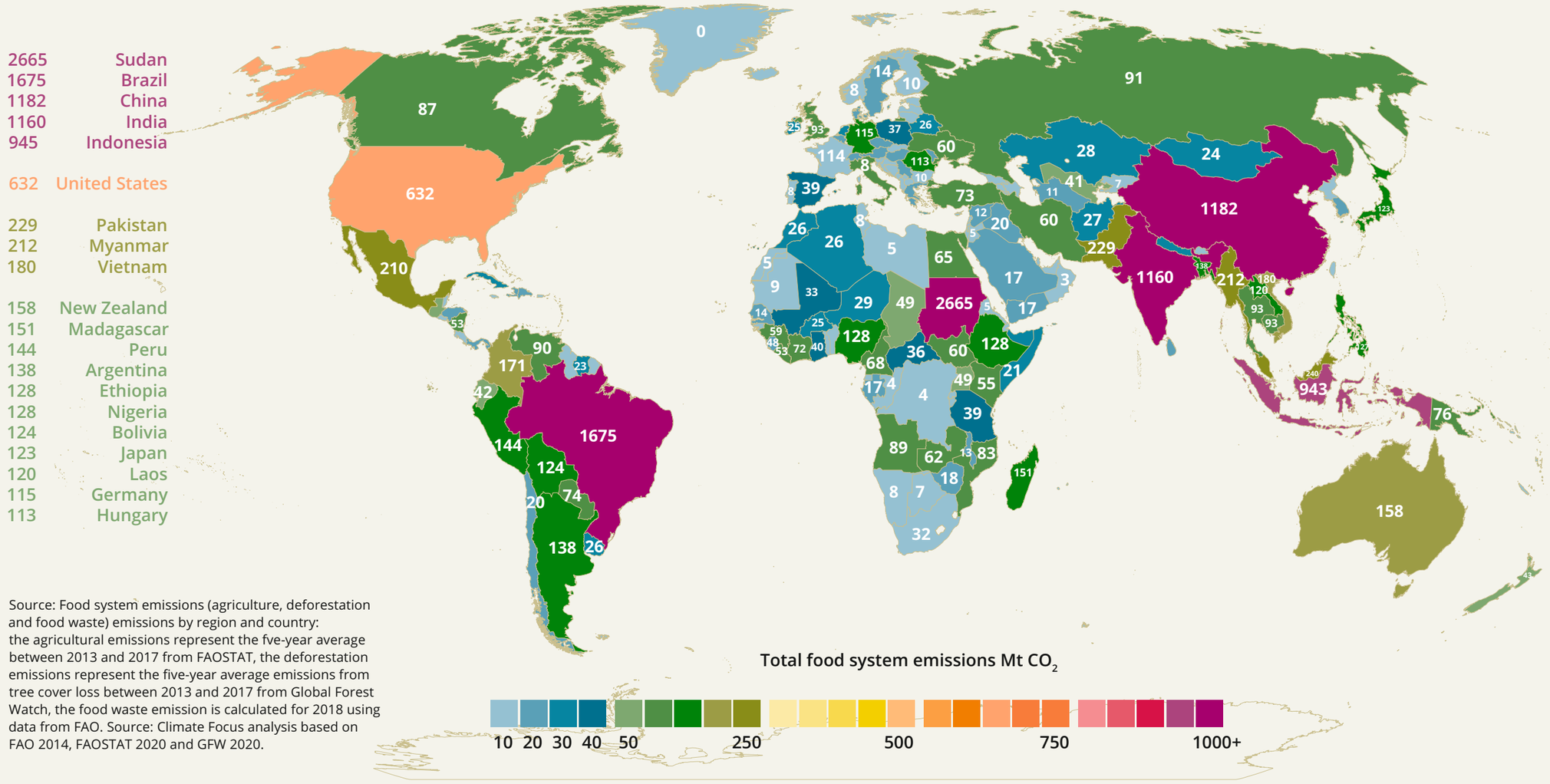
When exploring the mitigation options for individual countries, it is important to recognize that GHG emissions from the stages of the food and agriculture sectors vary markedly across different regions based on different drivers, such as the food production systems, food preferences/culture-based and urbanization process and infrastructure as well as eating habits. Similarly, co-benefits and trade-offs depend on local context and priorities set up by food actors. For example, developed countries (e.g. G20) that account for the largest shares of emissions from food consumption and waste could set more ambitious emission reduction targets in those areas. In contrast, developing countries with food insecurity will require support to build a sustainable and resilient food system.[15,16,17]

In addition, the food system offers important opportunities for climate change adaptation. The current system is under increasing pressure due to climate change impacts and greater frequency of extreme weather events.[18] Hundreds of millions of people depend on agriculture for subsistence and livelihoods, in particular in developing countries, and are at risk of being pushed further into poverty due to climate change. Activities such as supporting nature-based solutions, agroecological approaches, including climate-smart, regenerative, conservation agriculture, organic and others, diversifying the food system and adopting healthy and sustainable diets, not only offer potential to reduce emissions but also contribute to food system resilience.[19,20,21,22]

These mitigation and adaptation options also provide co-benefits in the context of broader sustainability objectives such as the Sustainable Development Goals (SDGs) and Convention on Biological Diversity (CBD). Beyond climate action (SDG 13), many of these opportunities contribute to the activities that are needed for the sector to continue feeding a growing global population while working to eradicate hunger (SDG 2).

They also directly contribute to working towards responsible consumption and production patterns (SDG 12) and indirectly as intensifying agricultural production through land sparing can prevent deforestation and ecosystems conversion and facilitate restoration (SDG 15). Specifically SDG 12.3 as food loss and waste which, on its own, generates 8% of global greenhouse emissions.[23]

Figure 2. Food system emissions (cropland, livestock, deforestation and food loss and waste) emissions by country



Source: Food system emissions (agriculture, deforestation and food waste) emissions by region and country: the agricultural emissions represent the five-year average between 2013 and 2017 from FAOSTAT, the deforestation emissions represent the five-year average emissions from tree cover loss between 2013 and 2017 from Global Forest Watch, the food waste emission is calculated for 2018 using data from FAO. Source: Climate Focus analysis based on FAO 2014, FAOSTAT 2020 and GFW 2020.

1.2 The State of the Food System in NDCs

Only a handful of NDCs refer to the food system approach, but these mostly remain focused on the stage of food production and not the later stages where large emissions from food loss and waste and diets and consumption occur.

While many countries mention the agriculture sector in their NDCs[24], very few set targets in relation to other stages of the food system, such as food loss and waste reduction, sustainable diets or food consumption. Only eleven countries currently mention food loss in their NDCs, and not one country makes reference to food waste.[25] Opportunities to reduce global emissions of the food systems sector remain largely untapped due to a lack of comprehensive coverage of the opportunities that exist in the food system, on the one hand, and vagueness and unspecificity of NDC targets, on the other. Overall, only a handful of NDCs refer to the food system approach, but these mostly remain focused on the stage of food production and not the later stages where large emissions from food loss and waste and diets and consumption occur.

Close to 89 percent (168 out of 189 countries) that have submitted NDCs include agriculture and/or land-use change and forestry in their climate change commitments. [26] The sector is, however, mostly included in the overall economic or broader targets of these countries,[27] while most NDCs do not elaborate on specific activities for achieving their GHG targets. And only a few countries mention sectoral targets for the agriculture stage.

Similarly, an analysis of 36 countries and the European Union – selected for their relevance to WWF – indicates that the mitigation and adaptation potential of agriculture is a prominently acknowledged country commitment, but these references lack detail and specificity (**Table 1**). While developed countries recognize agriculture as a source of GHG emissions, they do not provide sector-specific mitigation opportunities such as sustainable (agricultural) production, a reduction of food loss and waste or a transition toward sustainable diets (**Box 2)**. In contrast, developing countries or economies in transition tend to refer to approaches such as sustainable or climate-smart agriculture. Some of these countries have also have also referenced food value chain food value chain components in their intended NDC submissions, which have relevance for food loss and waste prevention. These include references to post-harvest loss reduction, as well as the prioritization of different post-harvest technologies along the value chain for food preservation (processing, storage, cooling, etc).[28] However, reduction of food waste at the retail and consumption stage remains absent in these NDCs.

Table 1. Examples of food system-related activities in current NDCs
(Source: WWF Analysis (2019) not published)

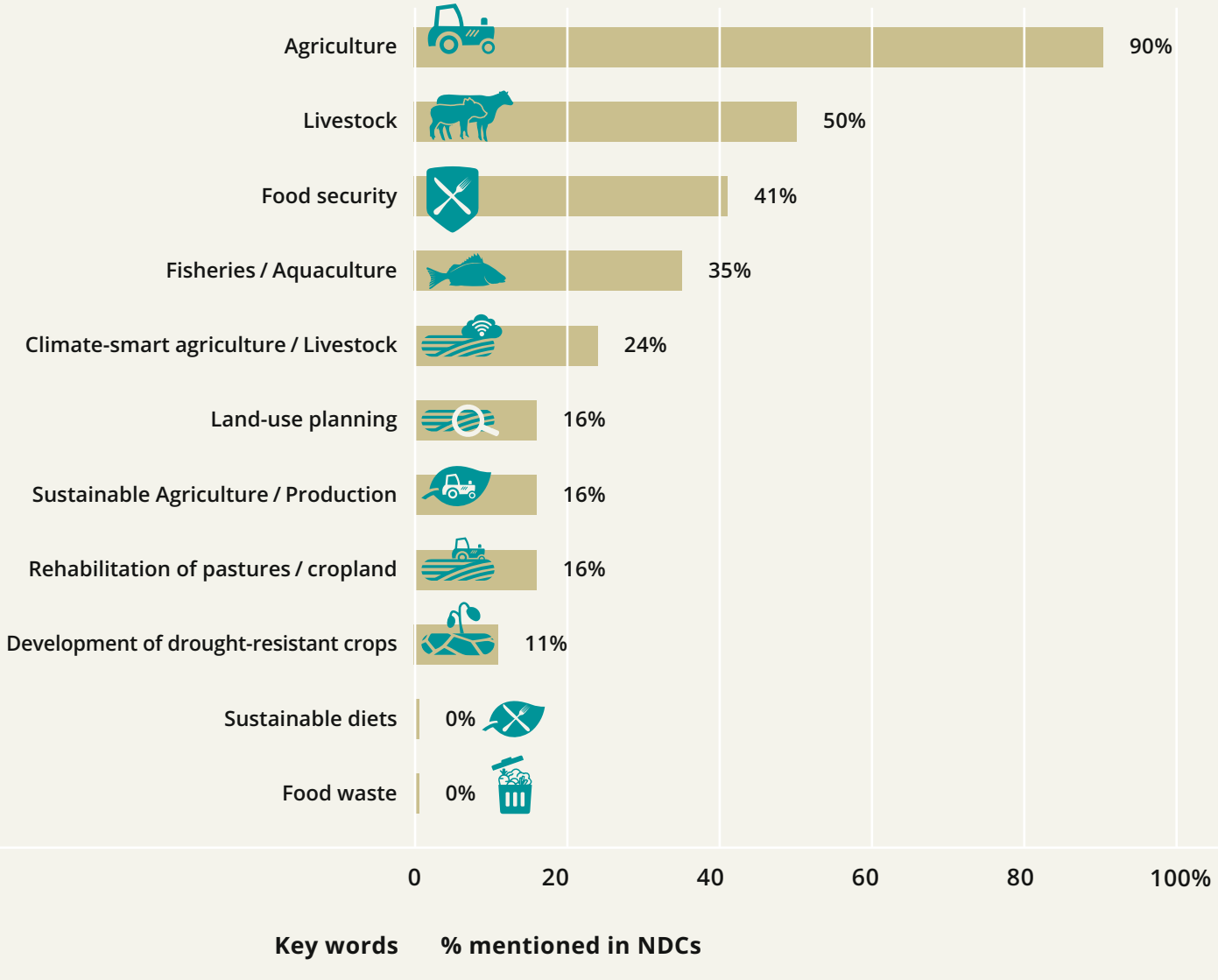
Country	Stage	Example of a mitigation activity	Example of an adaptation activity
Cameroon	Food production	Promote agriculture-livestock integration, agroforestry and conservation agriculture especially at the level of communities and private plantations	Reduce vulnerability of livestock to the effects of climate change: management of pastures, watering spots
Kenya	Food production	Climate-smart agriculture	Enhance the resilience of the agriculture, livestock and fisheries value chains by promoting climate-smart agriculture and livestock development
India	Waste	Increase the waste-to-energy capacity. The Government is also encouraging conversion of waste to compost by linking it with the sale of fertilizers and providing market development assistance	National Food Security Mission for Integrated Development of Horticulture, National Mission for Sustainable Agriculture (crop breeding, food security)
Mongolia	Livestock production	Maintain livestock population at appropriate levels according to the pasture carrying capacity	Implement sustainable pasture management. Regulate head-counts of animals to manage pasture carrying capacities
Colombia	Food production	Sectorial Mitigation Action Plans (SMAPs) that aim to maximize the carbon efficiency of economic activities at national and sectoral levels	1 million producers receiving agro-climatic information to facilitate decision-making in agricultural activities
Ecuador	Waste	Compost of organic waste from markets and garden waste	Promote initiatives aimed at responsible consumption of agricultural (products) resilient to the effects of climate change

Box 2. Integration of the food system in 37 NDCs analyzed by WWF

An analysis conducted by WWF of 36 selected countries and the EU reveals that 50% of all NDCs mention GHG emissions from livestock, while 41% mention food security and 35% fisheries and aquaculture. Food waste and loss and sustainable diets is not mentioned in the analyzed NDCs (**Table 2**).

Table 2. Food system elements mentioned in NDCs

(Source: WWF Analysis (2019) - not published)



2 Opportunities to Leverage Food Systems for NDCs

By 2021, countries are expected to revise or re-submit their NDCs. Without measurable commitments to address food system solutions as part of national climate strategies, there is little incentive for countries to do so. This revision process provides important opportunities for governments to address the food system more comprehensively and concretely in their climate targets, plans and measures.[29] In doing so, countries could have the opportunity to leverage the food system to meet significant shares of their commitments under the Paris Agreement.

Policymakers should consider applying a "food system approach" to frame their NDCs more holistically.

As the food system is highly complex, dynamic and concerns different policy agendas, policymakers should consider applying a "food system approach" to frame their NDCs more holistically.[30] This means examining food systems as a whole rather than in separate parts, valuing outcomes over processes, and embracing a variety of voices instead of individual perspectives.[31] This approach can help policymakers identify and assess impacts and feedback between food system activities, and maximize possible synergies between climate objectives, health co-benetits and socio-economic priorities. It entails effectively analyzing food system activities, their food security and environmental outcomes and outlining their potential positive and negative trade-offs. Multi-stakeholder governance collaboration and improved regulatory and institutional processes are essential for bringing about these food system interdependencies (**Box 3**).[32]

Generally, policymakers should note that:

- Accelerating the success of NDCs requires adoption of an integrated approach and **coherence with existing policies** such as medium and long-term national development plans and baselines for assessing progress
- The legitimacy, quality and implementation capacity of NDCs are enhanced by collaborating with **stakeholders** from different sectors including subnational governments and local and indigenous communities in the process of adjusting NDCs
- **Smallholders** should be given special attention when considering the needs and perspectives of different stakeholders
- Effort should be made to ensure the representation of **women** in negotiation processes
- **Finance is an important enabler** for transitioning to new and efficient practices; high-income countries should support lower-income countries by engaging in international climate finance mechanisms. National budgets need to be allocated for sectoral

Ambitious food NDCs, from sustainable production to sustainable consumption

NDC implementation, which requires the involvement of Ministries of Finance and Planning in the formulation and implementation phase of the NDCs

- **Ambitious food NDCs from sustainable production to sustainable consumption** including Food Loss and Waste and Planetary Health Diets[33] should become critical conditions for the countries' and global food systems recovery and resilience

Specifically, to understand what mitigation and/or adaptation activities are appropriate for their countries, policymakers should consider:

- The position (power) and role of the country in the global food system (e.g. exporter vs. importer)
- **The types of food system activities** in their country (e.g. type of commodity, production or processing)
- **Food consumer habits** of their population (e.g. eating habits/ food preference, household levels of food waste and local culture, context and values)
- The direct and indirect **emissions and mitigation potential** from those activities
- The economic and technological status of the sector
- International (e.g. SDGs, CBD) and national **policy priorities** and potential co-benefits or trade-offs of the proposed activities and institutions and food actors that influence the food systems

Box 3. Checklist for collaborative food system transformations

Formulating, implementing and integrating policies at different stages of the food systems and across actors can be challenging. To guide policymakers through this process and to ensure coherence in their activities, the following checklist can be used.[34] Ultimately, this process helps policymakers to establish a food system approach that connects elements of policy agendas of global challenges such as food insecurity, resource conservation and climate change. Furthermore, links of the food system to other "systems" (e.g. tourism or energy) and their mitigation options are important to recognize in order to maximize co-benefits.

1. **Identify food system advocates and build momentum for a change**

- Estimate the level of "buy-in" from the government
- Respect different levels of food systems (international, national and sub-national)
- Keep in mind the current understanding of the food system and potential resistance to changes
- Conduct awareness-raising activities and training on the food systems approach

2. **Conduct an assessment of the existing food system and its emissions, its actors and institutions and potential opportunities**

- Apply a system-based problem framework, establishing links between different food systems issues and outcomes
- Consider food system trends and challenges (e.g. urbanization, population growth)

3. **Introduce a multi-stakeholder platform to enable dialogue and collaboration across agendas and at different levels, define priority areas and connect different interventions**

- Define good governance principles, inclusiveness, transparency and accountability
- Engage in maximizing trade-offs for stakeholder inputs
- Create measurable indicator and monitoring mechanisms

4. **Assess and strengthen institutional capacity and governance**

- Analyze the institutional agreements, policy planning and implementation and governance systems regarding their effectiveness and coherence. If it has not already happened, establish a coordination system across ministries esp. at technical level, while also taking sub-national priorities and opportunities into account.

5. **Develop an action plan in order to achieve transformational change in food systems and enhance climate change mitigation and adaptation opportunities. It is important to consider the following cross-cutting principles in developing and implementing NDCs:**

- Focus on long-term change to achieve resilient food system impacts
- Consider the benefits of climate, integrated food, health and land policies to save resources, support ecological restoration and social resilience
- Address emerging trends in food production and consumption
- Facilitate platforms for collaboration among food system actors
- Promote a common narrative and approach across relevant government bodies

2.1 Guiding Questions for Policymakers

This section provides an approach for policymakers to identify and develop their options for including food system-based mitigation and adaptation activities in their NDCs. Each sub-section outlines a few high-level opportunities, followed by a table presenting examples of activities that can be considered to implement the high-level opportunities (**Tables 3, 4,** and **5)**, for example through the provision of technical (e.g. training and inputs) and financial (e.g. redirecting funds) support (see **section 2.2.1, Figure 4**).

These guiding questions and recommendations are not exhaustive, rather they highlight categories of activities, areas, and broad examples for opportunities to increase food system targets in NDCs. They should be adapted to meet the needs of the country context.

Furthermore, the tables in this section include information on the emissions, mitigation potential and adaption impacts for each activity, as relevant, in addition to the recommendations, select SDG linkages, and co-benefits, including for the CBD. These figures are intended to be illustrative and it may not be possible to compare them between activities.

2.1.1 Production

Policymakers can aim to enhance and integrate food system-based mitigation and adaptation activities in NDCs by exploring the following opportunities at this stage of food production:

Prevent any further natural habitat conversion, revitalize ecological systems and enhance resilience

- Promote activities that **prevent any further natural habitat conversion, revitalize ecological systems and enhance resilience**, that aim to conserve natural resources and reduce the excessive use of emission-intensive inputs like synthetic fertilizers and chemicals pesticides
- **Consider principles of sustainable agriculture such as agroecology**, climate-smart, regenerative, conservation agriculture, organic and others, which include diversification of farming systems by promoting mixtures of crop varieties intercropping systems, agro-forestry and ailvo pastural systems
- Protect and support the recovery of **agrobiodiversity**, pollinators and organisms critical for soil fertility and soil heath and invest in large scale **soil restoration and rehabilitation**
- Redirect finance and subsidies to support more sustainable land-use practices
- Support a transition to **renewable energy-efficient water use and improved efficiency** measures, especially in the production of inputs
- Invest in **digital technology** including better weather information, traceability of supply chains, early warning of pest and disease outbreak

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Table 3. Food system-based activity at the production stage

Food system activities: reduced land-use change and conversion of natural habitats

Emissions	Mitigation potential	Adaptation impacts	Co-benefits
Conversion of forests and savannahs for food and animal feed production contributed to 19% (2.67 Gt CO_2e) of all GHG emissions from the food sector in 2010[35]	Reduced land-use change (deforestation, forest degradation, peatland conversion and coastal wetland conversion) has a mitigation potential of 4.6 Gt CO_2e per year[36] While being converted at even higher rate than forests, natural grasslands and savannahs store at least 470 Gt, (i.e. one fifth of the total carbon contained in vegetation and topsoil worldwide)[37] Restoring grasslands and savannahs remove resilient carbon efficiently from the atmosphere as it is stored underground and protected from droughts and catastrophic fires[38]	Reduced vulnerability of natural ecosystems systems and their services to climate change threats and improved social resilience	Contribution to biodiversity; contribution to ecosystem services; improved livelihoods in local communities; improved trade with markets demanding sustainable products, reduced risk of zoonoses

Does your country have high rates of conversion of natural habitats like savannahs, natural grasslands, peatlands, natural forests and wetlands?

If yes, please consider:

- Adopting or/and enhancing ecosystem conservation incentives, laws and policies
- Improving management of protected areas such as national parks and reserves and improving monitoring and detection of illicit activities
- Improving land governance and law enforcement at local, regional and national levels including land tenure,
- Supporting soil rehabilitation and restoration activities
- Supporting land-use planning to build traceable and transparent, deforestation and conversion-free agriculture and forestry supply chains
- Promoting incentives for sustainable rural economies by creating diversified sources of income for local communities and reducing poverty
- Implementing public procurement policies that favor sustainably produced commodities based on robust sustainability standards and frameworks
- Repurposing subsidies to enhance sustainable land-use practices and integrated land-use planning
- Providing and scaling up technical and financial support for sustainable agricultural production focusing on agroecological approaches and sustainable forest management

Food system activities: efficient cropland management (e.g. crop rotation and cover crops)

Mitigation potential

Soil carbon enhancement in agriculture, e.g. via crop management, can contribute 1.3 Gt CO_2e per year of the total annual mitigation potential from land sector globally[39]

Cover crops for, example, would sequester about 0.44 Gt CO_2 per year if applied to 25% of global cropland[40]

Adaptation impacts

Improved soil fertility and water-holding capacity increases climate resilience

Co-benefits

Increased soil fertility and water-holding capacity leading to higher yields and increased climatic resilience; biodiversity conservation and enhancement of natural ecosystems; less soil erosion; reduction of chemical pesticides due to soil cover; improved and diversified farm income; increased food security for communities

Does your country seek opportunities to improve the quality of cropland (e.g. to make better use of underutilized arable land or close significant gaps in yield)?

If yes, please consider:

- Restoring degraded and marginal lands by planting and rehabilitating with perennial crops
- Promoting agroecological approaches of crop production (e.g. organic, conservation agriculture,) on small and large-scale farms through improved inputs and training (esp. strengthening extension services)
- Enhancing soil carbon through improved crop and grassland management and regenerative agriculture practices
- Encouraging improved land-management strategies, e.g. planting cover crops to reduce bare fallow, soil erosion, and nutrient leaching; to improve water-holding capacity and increase carbon storage
- Implementing policies to improve land management, e.g. prohibiting burning of crop residues in fields
- Promoting crop diversification and increasing crop varieties, introducing agroforestry systems or enhancing legume and pulses cultivation, optimizing soil carbon sequestration

Food system activities: reduced emissions from rice paddies

Emissions

11% of the global N_2O emissions come from rice cultivation alone[41]

Mitigation potential

Early-season drainage in combination with mid-season drainage can reduce CH4 emissions up to 90%[42]

Adaptation impacts

Contribute to farmers livelihood resilience to climate change and improved food security

Co-benefits

Improved water conservation by minimizing water runoff and evaporation; boosted yields, improved livelihoods

Is your country a major producer of rice?

If yes, please consider:

- Providing water and residue management of rice fields by enabling access to new technologies
- Promoting early-season drainage with mid-season drainage systems
- Encouraging improved management practices, e.g. alterative wetting and drying practices; system of rice intensification (SRI)
- Increasing the use of lower-methane rice and flood-tolerant varieties by farmers
- Promoting public procurement of sustainable rice, based on sustainable rice production standards
- Developing collaborative activities to reduce loss and waste of rice, as a GHG hotspot (high methane emissions during production coupled with high waste at consumer level)[43]

Food system activities: agroforestry systems[44]

Mitigation potential

Agroforestry and forest management have a combined technical mitigation potential of 0.55-7.78 Gt CO_2e per year globally[45]

Adaptation impacts

Improved soil and water conditions, and microclimate, increase climate resilience

Co-benefits

Increased combined yields and diversified livelihoods of farmers; enhanced soil carbon sequestration, soil enrichment and overall improved farm productivity[46] and enhancement of biodiversity; high adaptation potential due to improved water-holding capacity, less soil erosion, improved microclimate; reduction of chemical pesticides due to higher diversification of host plants

Are there national efforts to balance conservation outcomes with livelihoods and production priorities?

If yes, please consider:

- Redirecting agriculture subsidies to agro-forestry systems
- Support the implementing of agroforestry in smallholder-dominated commodity crops like rubber, banana, cocoa or coffee and others
- Adopting agroforestry in agricultural lands through silvo-pasture, silvo-arable, hedgerows and riparian buffer strips and at landscape level
- Promoting intercropping of short- and long-term trees with crops and/or livestock
- Encouraging the integration of leguminous trees which grow during fallow periods between two cropping seasons

Food system activities: improved synthetic fertilizer production and use

Emissions

Fertilizer production is the most energy-intensive pre-production activity and has the largest GHG impact[47]

Between 1970 and 2010, global fertilizer use increased over 200%[48]

Mitigation potential

Improved synthetic fertilizer production has a technical mitigation potential of 0.1–0.16 Gt CO_2e per year globally[49]

In China, updating technologies in the production of N fertilizer can abate more than 161 million tons of CO_2 by 2030[50]

Adaptation impacts

Decreased reliance on fossil fuels increases resilience to climate change

Co-benefits

Improved water quality; reduced pollution and minimization of hazardous chemicals from untreated wastewater; access to energy services; less use of fossil fuels; improved health of communities close to production sites; increased resource efficiency

Does your agricultural sector have emissions from synthetic fertilizer production?

If yes, please consider:

- Supporting agroecological approaches including reduction of the use of synthetic fertilizer
- Promoting research and development of technology to increase energy efficiency of fertilizer production
- Developing policies and regulations to protect and monitor nutrients runoff
- Reallocating subsidies for synthetic fertilisers to other sustainable agriculture practices

Food system activities: reduced or zero tillage[51]

Emissions

Tilled soil produces 20% greater net global warming than zero tilled soil[52]

Mitigation potential

Some mitigation potential through reduced soil carbon losses

Adaptation impacts

Increased soil fertility and higher water-holding capacity increases climate resilience

Co-benefits

Increased yields and soil fertility over the long term by increasing water-holding capacities of soils

Does your country have disturbed soil structures, increased surface runoff and soil erosion?

If yes, please consider:

- Encouraging farmers to distribute soil residues evenly on soil surface; practicing minimum/no-till
- Promoting crop rotation as a sustainable land management approach
- Supporting use of cover crops and regenerative agricultural practices

Food system activities: diversified crop systems

Adaptation impacts

Diversification can complement a number of other sustainable food system activities

Specifically, it can reduce the pressure on degradation of land from monoculture or intensive crop systems

It can also shift farmers (subsistence farmers) away from production activities of commodities linked to deforestation or unsustainable practices towards alternative livelihoods

Leads to carbon storage in the soil due to humus formation

Increased resilience to climate variability such as prolonged droughts or seasonal shifts of rainfall

Co-benefits

Improved crops stabilize and increase yields; increased crop resilience to climatic variability and improved varieties may increase soil carbon storage; food security and nutrition; employment and livelihoods; poverty alleviation; enhancement of biodiversity; sharing of economic risk; less need for chemical pesticides due to higher diversification of host plants

Is the crop production in your country particularly threatened by climate change (e.g. due to prolonged periods of drought, seasonal shifts in rainfall)?

If yes, please consider:

- Supporting crop and agricultural diversity to build resilience
- Increasing awareness of the potential of orphan/indigenous crops and seeds to contribute to crop diversification
- Promoting the use of improved crop varieties by farmers (e.g. early-maturing, drought-tolerant), which could also increase soil carbon storage
- Promoting research on and participatory breeding of drought- and climate-resilient crops
- Creating local and regional markets for products and crops and promoting shorter supply chains, including improved links between urban and rural areas and between producers and consumers
- Supporting kitchen garden and smallholder garden activities by providing diverse crop varieties (agrobiodiversity) and training

Food system activities: reduce emissions from livestock (enteric fermentation and manure)

Emissions

Enteric fermentation and manure management cause 2.9–5.3 Gt CO_2e per year globally[53]

Mitigation potential

Reducing enteric fermentation has a technical mitigation potential of 0.12–1.18 Gt CO_2e per year globally[54]

Manure management has a technical mitigation potential of up to 0.26 Gt CO_2e per year globally[55]

Manure management and enteric fermentation account for 42% of mitigation potential from agriculture by 2050[56]

Adaptation impacts

Diversified sources of feed increase climate resilience

Improved breeds might tolerate warmer climate conditions

Co-benefits

Does your livestock sector have beef/dairy cattle populations and low-intensity systems?

If yes, please consider:

- Testing and promoting good practices on natural and non-natural grasslands (e.g. regenerative management and appropriate nitrogen management) through education and awareness measures
- Improving livestock feed (e.g. shrubs with high protein content, improved pasture diversity and management)
- Increasing dairy cow and beef productivity through sustainable crossbreeding systems, considering genetically specialized breeds with local species adapted to climate
- Promoting good practices in natural grasslands management, including the supply of forage, regenerative management and appropriate nitrogen management, by supporting outreach and extension programs

Food system activities: reduce emissions from livestock (enteric fermentation and manure)

Emissions

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Mitigation potential

Reducing enteric fermentation has a technical mitigation potential of 0.12–1.18 Gt CO_2e per year globally[58]

Manure management has a technical mitigation potential of up to 0.26 Gt CO_2e per year globally[59]

Manure management and enteric fermentation account for 42% of mitigation potential from agriculture by 2050[60]

Adaptation impacts

Diversified sources of feed increase climate resilience

Improved breeds might tolerate warmer climate conditions

Co-benefits

Does your livestock sector have large beef/dairy cattle populations and high-intensity systems?

If yes, please consider:

- Promoting regulation of stocking rates (including for chicken and pigs) to ensure they stay within environmental limits for water, soil, and air quality
- Improving animal health and welfare
- Supporting improved breeding in cattle herds, thereby reducing GHG emissions from cattle production
- Promoting the efficiency of manure management, e.g. measures to improve the storage and handling of manure
- Improving animal diets by adopting feed alternatives, improving forage quality for cattle herds, using locally produced feedstuff and changing feeding times and frequency (with no negative effects on animal welfare)

Food system activities: improved management of pasture and grazing land

Emissions

Expansion of pasture and feed crop land accounts for 0.64 Gt CO_2e per year[61]

Mitigation potential

Pasture management has a technical mitigation potential of 0.31-0.43 Gt CO_2e per year[62]

Adaptation impacts

Improved quality and quantity of forage/fodder increases climate resilience, farm productivity and is beneficial for farmers livelihoods

Co-benefits

Biodiversity conservation; restoration of forests and other ecosystems, animal health and welfare

Are your livestock systems pastoral or do they have large areas of grazing land?

If yes, please consider:

- Rehabilitating and restoring overgrazed lands by considering rotational grazing and regulating the amount of stocking density or promoting integrated, no-tillage, crop-livestock systems
- Promoting silvo-pastoral restoration to increase tree and shrub cover and CO_2 fixation in soil and biomass
- Improving the management and productivity of marginally productive (already converted) grazing lands
- Enhancing pasture management on (already converted) non-natural grasslands by incorporating trees, improving plant species, legume interseeding

2.1.2 Processing, storage, and transport

Policymakers can aim to enhance and integrate food system-based mitigation and adaptation activities into NDCs by exploring the following opportunities at the stages of processing, storage and transport:

- Investing in **supply chain infrastructure and storage facilities** to reduce post-harvest food loss including equipment and techniques
- Supporting **short supply chain management** (e.g. transport to local markets; urban-rural links; and connection between food producers and consumers)
- In hot countries, **investing** in renewable energy and **energy-efficient cold chains**
- Adopting and implementing policies that **target food loss and waste** reduction

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Table 4. Food system-based actions at the processing, storage and transport stages

Food system activities: improved handling and storage of food

Emissions	Mitigation potential	Adaptation impacts	Co-benefits
Around 15% of food emissions are from losses in the supply chain due to poor storage and handling techniques or 6% of global GHG emissions[63]	Reducing food and agriculture waste can contribute 6% (0.76–4.5 Gt CO_2e) per year of the mitigation potential from the land sector globally[64]	Contributes to food security and green industrialization, increasing resilience to climate change[65]	Promotion of industrialization; reduction of waste generation; improved scientific and technological capacity of developing countries; increased food security and broader infrastructure development

Does your country experience major food loss due to technological limitations along the supply chain?

If yes, please consider:

- Promoting investment in infrastructure and technology to prevent post-harvest losses
- Supporting agricultural research to develop technologies to reduce post-harvest food loss
- Building and providing low-cost storage silos for small-scale farmers to store their harvest
- Increasing investment in building infrastructure, promoting urban-rural links, connecting farmers to markets
- Investing in energy-efficient storage and cold chains
- Diverting unused food to animal feed
- Reutilizing organic or agricultural waste for energy production, e.g. through biogas

Food system activities: reduced food waste

Emissions

Around 15% of food emissions are from losses in the supply chain due to poor storage and handling techniques

Mitigation potential

Food loss and waste generates 4.4 Gt CO_2 eq per year or 8% of global GHG emissions[66]

Adaptation impacts

Increased resilience to climate change through reliance on fewer resources use through recycling

Co-benefits

Reduction of food costs to households and businesses through efficiency gains[67], reduction of waste management costs to local authorities, reduced pressure on existing landfills; reduced land and water pollution; improved health for local communities

All countries can consider:

- Adopting SDG 12.3 to cut food waste in half at retail and consumer level and reducing food loss along the supply chain as a national target
- Measuring national food loss and waste baseline to understand the scale of the problem as well as the opportunity for cost savings and GHG reductions and to identify hotspots of loss and waste along the value chain
- Developing a national strategy through a multi-stakeholder process to prioritize policies, measures, awareness-raising and educational programs[68]
- Supporting voluntary agreements in the food retail and manufacturing sectors to collaborate on system-wide food loss and waste reductions
- Developing separate food waste collection systems, for example using a pay-as-you-throw system
- Incentivizing food waste recycling
- Implementing educational programs to avoiding 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
- Developing waste recycling programs and improved technologies

2.1.3 Consumption and diets

Policymakers can aim to enhance and integrate food system-based mitigation and adaptation activities into NDCs by exploring the following opportunities at the stage of consumption:

- Implementing policy measures and awareness programs to **promote healthy and sustainable diets** that include promoting plant-rich diets among populations with consumption levels of animal-sourced foods above dietary recommendations to accelerate health and environmental benefits
- Piloting and evaluating behavioral changes interventions that reduce
- consumer food waste generation; developing policy measures and awareness-raising activities based on country-specific research
- Supporting voluntary agreements in the retail and manufacturing sectors to deliver SDG 12.3 and encourage these food businesses to help consumers reduce food waste
- Implementing consumer information programs and training
- Understanding and addressing local "food environments" and implement activities to facilitate consumption of healthy and sustainable foods

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Table 5. Food system-based activities at the consumption stage

Food system activities: reduce food waste by consumers and retailers

Emissions	Mitigation potential	Adaptation impacts	Co-benefits
Around 9% of total global GHG emissions are attributed to food discarded by consumers and retailers[69]	Reducing food and agriculture waste can contribute 6% (0.76-4.5 Gt CO_2e) per year of the mitigation potential from the land sector globally[70]	Increased responsible food consumption and waste disposal in societies; promote a culture of recycling and sharing[71]	Sustainable and inclusive cities; improved procurement practices; increased awareness of sustainable lifestyles; contribution to food security and social justice

Does your country have a high rate of food waste?

If yes, please consider:

- Adopting SDG 12.3, measuring food waste and developing a national level and develop a national strategy to reduce food waste
- Implementing policies to clarify food date labelling
- Promoting research on energy-efficient cooling technologies to reduce food waste during transportation and storage in retail, food service and households
- Including food waste reduction in school curricula and culinary training programs
- Promoting the inclusion of procurement criteria in food service venues (including schools and workplace cafeterias) that reduce food waste such as staff training on food waste prevention, offering flexible portion sizes, smaller plates, elimination of trays and customer messaging to take only as much as they can eat in order to reduce food waste
- Piloting and evaluating behavioral changes that reduce consumer food waste generation
- Developing consumer awareness campaigns around reducing food waste that take into account regional and cultural specialities
- Facilitating or improving infrastructure for the distribution of unused food to foodbanks
- Developing measures to use inedible food waste as compost
- Training and encouraging health inspectors to explain processes for safe food donation when conducting health inspections of food service venues[72]

Food system activities: relevant for foods with high-imported emissions

Emissions

29% (0.8 Gt CO_2 per year) to 39% (1.0 Gt CO_2 per year) of deforestation-related emissions is accounted for by international trade, especially to Europe and China[73]

Palm oil, soy, cattle, and wood production in 7 tropical countries accounted for 40% of total deforestation and conversion globally in between 2001 and 2011; a third of these impacts can be attributed to the export of these commodities[74]

Mitigation potential

Green consumer activities could reduce the carbon footprint of the EU by 25%, a quarter of which could be attributed to reduced emissions from imports[75]

Adaptation impacts

Strengthening of local alternatives to soy and beef with low emissions and climate resilience

Co-benefits

Biodiversity conservation; prevented deforestation, conversion and degradation; improved procurement practices; integration of sustainability into company reporting cycles

Does your country import high deforestation or conversion risk commodities such as soy, palm oil or beef?

If yes, please consider:

- Adopting and implementing due diligence laws requiring importing companies to ensure conversion and deforestation-free supply chains
- Promoting sustainable practices in producer countries and reducing associated emissions
- Implementing public procurement policies that favor sustainably produced commodities based on robust sustainability standards and frameworks and healthy and sustainable diets[76] that exclude land conversion and deforestation
- Developing awareness-raising activities on the health and sustainability benefits of plant-rich diets

Food system activities: reduce consumption of emissions-intensive food

Emissions

Latin America and the Caribbean have the highest share of GHG emissions from livestock with 1.3 Gt CO_2 per year[77]

Western Europe and North America have lower GHG emissions from livestock production (about 0.6 Gt CO_2 a year)[78]

In North America two-thirds of livestock emissions are related to beef production[79]

Mitigation potential

Shifting to healthy diets can reduce emissions from the land sector by 0.7–8 Gt CO_2e per year globally[80]

If half of the global population adopted diets restricted to 60g of meat protein per day, we could reduce GHG emissions by 2.2 Gt CO2e every year[81]

Adaptation impacts

Healthier societies decrease pressure on health systems[82]

Supporting research can lead to faster innovation in alternative meat products[83]

Co-benefits

Improved health; reduced costs on healthcare systems,

Is the per capita national consumption of red meat higher than national dietary guidelines?

If yes, please consider:

- Developing awareness-raising activities on the health and sustainability benefits of plant-rich diets
- Including recommendations for red meat consumption that address public health issues as well as stricter guidance for public procurement
- Mandating food labels and sustainable labelling frameworks to increase consumer awareness and transparency
- Promoting research on alternative proteins (e.g. algaes)
- Taxing animal proteins to disincentivize consumption
- Providing sustainable dietary training for all medical professionals to enable education of patients
- Promoting food education including school gardens
- Promoting food public procurement for schools that foster more sustainable and healthy diets with special emphasis on plant-rich diets

Food system activities: increase consumption of healthy and sustainable food

Emissions

Latin America and the Caribbean have the highest share of GHG emissions from livestock with 1.3 Gt CO_2 per year[84]

Western Europe and North America have lower GHG emissions from livestock production (about 0.6 Gt CO_2 a year)[85]

In North America two-thirds of livestock emissions are related to beef production[86]

Mitigation potential

Shifting to healthy diets can reduce emissions from the land sector by 0.7–8 Gt CO_2e per year globally. The diet has to be high in coarse grains, pulses, fruits and vegetables and nuts and seed and low in energy-intensive animal-sourced foods old[87]

Adaptation impacts

A shift to healthy diets will have enormous economic and social benefits as pressure on health systems decreases. The annual economic gain from dietary shifts is estimated to be $1.285 trillion by 2030 and $1.920 trillion by 2050[88]

Co-benefits

Reduction in malnutrition rates including micronutrient deficiency, stunting, obesity, and diet-related, non-communicable disases, e.g. cardiovascular diseases.

Sustainable and healthy diets, would improve food security, climate and socio-economic conditions[89]

Does your country suffer from any form of malnutrition, e.g. obesity, micronutrient deficiency or undernutrition?

If yes, please consider:

- Realigning susbsidies to promote production, processing and consumption of healthy and sustainable foods
- Introducing environment sustainability elements into your national dietary guidelines and integrating them into public food procuerment policies
- Increasing the affordability and accessibility of healthy and sustainable food through taxes, incentives, subsidies and social protection mechanisims
- Supporting development of front-of-pack nutrition and sustainable food labelling
- Banning advertising and marketing of unhealthy and ultra-processed foods especially, the ones that target children and youth
- Embedding sustainable food systems and the Planetary Health Diet in school curricula
- Adopting a multi-sectoral approach and forging new partnerships that span all levels of governance and includes representation from a broad range of actors in the food system

2.2 Examples of the Food System in NDCs

There is a clear process for governments to enhance NDCs and set standards for the specific elements that are needed for NDCs. **(see below)**[90].

Important elements include:

- The most explicit component outlined in Article 4.2 of the Paris Agreement is the **mitigation contribution**
- Article 3 and other calls for action have apealed for the inclusion of **adaptation components** in addition to financial support, technology transfer, capacity building and transparency
- Ideally, they should include **quantifiable information for a baseline and information on the investment needed for implementation of targeted activities, time frames for implementation, scope** as well as details about the planning process, assumptions and methodological approaches
- **Measurable indicators and targets** as well as enhanced **monitoring and reporting processes** to ensure activities are transparent and credible

Figure 3. Steps to enhance NDCs[91]

1 Take stock of progress to date	2 Take stock of long-term objectives	3 Idetify options for improvement	4 Aggregate, repeat and refine	5 Reflect improvements in NDC
• GHG, sectoral and socio-economic projections • National policies • Subnational and non-state commitments • Development objectives • Migitation finance	• Global and sectoral mitigation benchmarks • SDGs and other global frameworks • Long-term, low GHG emission development strategies • Long-term national development plans	• Align more closely with Paris Agreement • Reflect new developments, innovation and best pratice • Maximize benefits • Fill in gaps • Address finance and implementation issues	• Aggregate impact on GHG emissions and other select indicators • Repeat to refine list of socio-economic options	• GHG target • Sectoral, non-GHG target(s) • Policies and measures • Alignment with long-term goals

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2.2.1 Examples of measurable indicators and targets

As outlined in the last step of **Figure 3**, there are opportunities to enhance NDCs by setting targets that encompass various policies and measures. These activities, outlined in **Tables 3, 4,** and **5**, can be implemented using a variety of mechanisms **(Figure 4)**. It is important to develop measurable indicators across input, output and outcome levels to capture intermediate and step-by-step progress in implementing NDC activities **(Figures 4** and **5)**.

The strengthening of measurement, reporting and verification capacities (MRV) of countries is important as it influences the communication efficiency among decision-makers.[92] In addition, designing new policies and access to reliable, relevant and comprehensive data to track progress and ensure accountability also depend on functioning MRV.

Figure 4. Broad examples for input, output and outcome indicators for different policies and measures

Measures to change existing or support new practices	Indicators		
	Inputs	**Outputs**	**Outcomes**
Create, expand or adjust education and training programs	Adopt SDG 12.3 as a national target and measure food loss and waste baseline	Created or expanded [#/%] programs for support or campaigns	**Sectoral, non-GHG** Changed or adopted new [specific] practices for/by [#/%] of citizens, animals, inputs, production, consumption, land, operations, etc.
Create or redirect technical support and financial incentives	Invest or redirect [#/%] funds or other resources in the implementation of the policy or measure	Established [#/%] trees, structures, institutions, etc.	Reduced food waste by [#/%]
Introduce new or reform existing laws and regulations	Distribute [#] technological tools, leaflets, etc.	[#] of school food education programs and/or gardens developed	Improved productivity by [#/%]
Support targeted research and development	Change or adopt laws and regulations to enable policy or measures	Reached [#/%] citizens, animals, production, consumption, land, operations, etc. through programs	Increased production efficiency by [#/%]
Develop or adjust existing campaigns for awareness and advocacy	Initiate policy process to enable policy or measure	Reformed, adopted and enforced policies, laws and regulations	**GHG** Reduced GHG emissions quantities from activity by [#t CO_2e; #/%]
			Reduced emissions intensity by [#/%]

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Figure 5. Specific examples for input, output and outcome indicators for selected policies and measures outlined in section 2.1

Measures to change existing or support new practices	Indicators		
	Inputs	Outputs	Outcomes (Sectoral and GHG)
Provide education and training in improved land management strategies	Invest or redirect funds to agricultural extension services to support capacities for training staff, material, strategies and outreach	[#] farmers trained in improved land management strategies, e.g. by considering rotational grazing or integrated no-tillage livestock systems [#] hectares ([#]%) of overgrazed lands rehabilitated by [year] [#] hectares of depleted soil restored [#] of agroforestry plots established [#] hectares applying no-till practices [#] of organic fertilizer used	GHG emissions quantities from degradation or conversion of natural ecosystems reduced by [#t CO_2e; #%] by [year]
Accelerate research and innovations for a sustainable food system	Invest in [#] of studies/start-ups to enable access to new technologies and strategies for [#] farmers	[#] innovations made and successfully applied in the field	Production efficiency improved by [#]% by [year]
Restructure agricultural support and promote the use of lower-methane, flood-tolerant rice varieties and drought resistant varieties	Redirect or create [#] financial or in-kind (e.g. inputs) support programs	[#] farmers enabled to use genetically specialized breeds with local species adapted to climate [#] and extent of climate-resilient crop adoption	Water and residue management of rice fields improved by [#]% by [year] GHG emissions quantities from rice production reduced by [#t CO_2e; #%]

Measures to change existing or support new practices	Indicators		
	Inputs	Outputs	Outcomes (Sectoral and GHG)
Collaborate, train and provide farmers with the necessary tools to prevent food loss at farm level Engage with private food companies to accelerate investments in their food supply infrastructure	Redirect [#]% of subsidies or increase investment in infrastructure and technology by [#]% in developing countries	[#] kg of food loss at farm level prevented [#] farmers engaged to prevent food loss	GHG emissions quantities from post-harvest food loss and waste reduced by [#t CO_2e; #%] by [year]
Introduce or improve regulations for recycling and reuse of food	[#] of laws that ban the dumping of unexpired food [#] of separate collection of food waste [#] of investments in recycling facilities [#] of initiatives supported that promote the sharing of surplus food	Distribution of unused food to foodbanks by [#]% [#] tons of food waste collection for composting or other recycling	Food waste reduced by [#]% by [year] GHG emissions quantities from food waste reduced by [#t CO_2e; #%] by [year]
Collaborate with health and medical professionals to develop new programs or campaigns	Redesign nutritional recommendations combining health considerations and the the GHG footprint of food products	[#] people or [#] schools reached	New practices adopted by [#/%] of citizens
Introduce new laws and policies, e.g. on dietary recommendations or for food labels; invest in low GHG food product innovations	Implement a certification label indicating the GHG footprint of a food product	[#] of food products labelled [#] of low GHG emitting food products	GHG emissions quantities from imported commodities reduced by [#t CO_2e; #%] by [year]

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Why we are here
To stop the degradation of the planet’s natural environment and to build a future in which humans live in harmony with nature.

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