
WWF
SOLVING THE GREAT FOOD PUZZLE:
20 LEVERS TO SCALE NATIONAL ACTION

WWF Food Practice
WWF is an independent conservation organisation, with more than 35 million followers and a global network active through local leadership in over 100 countries. WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which people live in harmony with nature, by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption. The WWF Food Practice works to transform the global food system to support WWF's mission. The Food Practice's vision is a food system which provides nutritious food to all current and future generations while protecting our planet. To help achieve this goal, the Food Practice works across Nature-Positive Food Production, Healthy and Sustainable Diets and Food Loss and Waste.

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Lead Author:
Brent Loken (WWF-International, WWF-US)

Co Author:
Peter McFeely (WWF-International)

Contributing Authors:
Peter Newton (University of Colorado Boulder USA), Hilary Brumberg (University of Colorado Boulder USA), Sebastián Dueñas-Ocampo (University of Colorado Boulder USA, Pontificia Universidad Javeriana Bogota Colombia), Waverly Eichhorst (University of Colorado Boulder USA), Margaret Hegwood (University of Colorado Boulder USA)

Editorial Team:
Peter McFeely (WWF-International): Editor-in-chief, planning and communications, proof reading,
Kate Graves (WWF-US): Communications,
Brent Loken (WWF-International, WWF-US): Planning and proof reading.

Steering Group:
Virgínia Antonioli (WWF-Brazil), Carolina Escallon Wey (WWF-Colombia), Camila Paula Cammaert Gutierrez (WWF-Colombia), Monica Cooney (WWF- Emirates Nature), Jennifer Croes (WWF-Emirates Nature), Nancy Rapando (WWF-Kenya)

Special thanks for reviewing the report:
Melissa Ho (WWF-US), Anna Richert (WWF-Sweden), Sarah Doornbos (WWF-Netherlands), João Campari (WWF-International), Corné van Dooren (WWF-Netherlands), Sarah Halevy (WWF-UK), Monica Cooney (WWF- Emirates Nature), Carolina Escallon Wey (WWF-Colombia), Camila Paula Cammaert Gutierrez (WWF-Colombia), Virgínia Antonioli (WWF-Brazil), Jennifer Croes (WWF- Emirates Nature), Nancy Rapando (WWF-Kenya)

Design and infographics by:
Clean Canvas Studio
cleancanvasstudio.co.uk

WWF International,
Rue Mauverney 28, 1196 Gland, Switzerland
Tel. +41 22 364 9111

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FOREWORD

We are in a planetary emergency. Nature loss, climate change and global food insecurity are three of our biggest challenges. If we fail to address them, future generations will inherit an unstable planet that cannot provide for everyone. Solving these issues is hard but the greatest opportunity lies where they intersect – food systems.

WWF's Living Planet Report 2022 shows that wildlife population sizes have plunged by an average of 69% from 1970 to 2018. It also emphasises that food systems are one of the largest causes of biodiversity loss - 70% of all biodiversity loss on land and 50% in freshwater is closely linked to how we produce food and what we eat. At the same time, food systems generate around 30% of all greenhouse gas emissions, significantly contributing to climate change and pollution.

Governments are faced with many decisions on where to focus climate and nature action. Add things like conflict, pandemics, supply chain disruptions and cost of living crises to the mix, and it can be very challenging to address everything. That said, what may often look like competing demands are actually overlapping issues and strategic action can help address many of them.

This requires short-term solutions to immediate problems to be aligned with long-term strategies for transformation and sustainability. Of course, this relies on there being a long-term strategy in place.

While global targets for food systems exist (for instance through Sustainable Development Goals 2 and 12) and over 150 countries committed to sustainable and equitable food systems at the United Nations Food Systems Summit in 2021, these targets can be broader and bolder. Countries need to build more robust national-level action plans, and ensure they are integrated with existing nature and climate commitments.

That's why we're developing a framework to assist policymakers and other stakeholders to identify high-impact opportunities for transformation. This report, and supporting platform, are the first step in building the framework. The development of food systems typologies and assessing the impact of different transformation levers is in its early stages. As we gather more evidence in more places, we expect the framework to evolve. We look forward to working with partners across the food system to do just that.

Transforming food systems presents us with the biggest opportunity to restore nature, limit global warming to 1.5 degrees and nourish all people within planetary boundaries. After several years of delays, the next three months are the crucial moment we've been talking about – there is an opportunity to deliver a New Deal for Nature and People and to accelerate climate action at the UN conferences for biodiversity (COP15) and climate (COP27). Food must take centre stage at these events. While it's relatively new to some of the conversations, the science is clear there's no room for debate when it comes to food. It's time for action, and with this report we hope to help deliver it.

João Campari
Global Food Practice Leader, WWF

EXECUTIVE SUMMARY

KEY POINTS

1

Significant transformations are needed throughout the global food system to meet climate, biodiversity and health objectives.

2

Food systems vary dramatically between countries with differences spanning the environment, economy and society, and there is no 'one size fits all' approach to transforming food systems across all countries.

3

The complexity of food systems poses a persistent challenge in identifying key actions to transform food systems at the national level.

4

Biodiversity and climate goals must be central when developing national-level roadmaps for food system transformation.

5

Ecological food systems hotspots are countries that are uniquely important for achieving global climate and biodiversity goals and face high rates of land conversion for food production.

6

Twenty transformation levers have been identified that are important across all countries but will have varying degrees of potential for transformation depending on food system type.

7

Brazil and Colombia are Type I food systems wherein optimizing land use, restoring biodiversity and increasing carbon storage are higher potential transformation levers.

8

Kenya is a Type II food system wherein supporting smallholder farmers, improving land tenure rights and developing research and development are higher potential transformation levers.

9

UAE is a Type III food system wherein adopting high-tech methods, developing infrastructure and supporting healthy food imports are higher potential transformation levers.

10

All countries share strengthening national-level commitments as a higher potential transformation lever, making successful implementation of this lever especially important in achieving climate, biodiversity and health goals.

Significant transformations are needed throughout the global food system to meet climate, biodiversity and health objectives. There is substantial evidence of the global need for such food system transformations but much less attention has been paid to how transformations towards more healthy and sustainable food systems might play out at the national level. Global targets and goals are necessary to provide a roadmap for change and draw attention to the urgent need for food system transformation, but global-level analyses can mask important differences between national-level food systems and the challenges and opportunities for transformation in each country. Given this, a better understanding is needed of how food system transformations may differ between countries, where commonalities lie and where a 'one size fits all' approach will not be effective.

This report adds to a critical conversation around how food system transformations may vary at the country level by putting the spotlight on four countries (Brazil, Colombia, Kenya, UAE) as illustrative examples, to demonstrate the myriad ways in which food system transformations might be similar or vary between countries. While this is not the first report on food system transformations at the national level, this report is novel in that it: 1) assesses food systems from a conservation lens to highlight important environmental dimensions and provide insights for organizations working on the ground; 2) uses a typology of food systems to reduce the complexity of analysis; 3) identifies a handful of transformation levers that can be assessed across all countries and; 4) uses a local context analysis to assess the potential of levers to transform a particular food system type and test the validity and usefulness of the typology.

Six variables informed the typology because they may have a disproportionate impact on a country's ability to achieve climate and biodiversity goals and can also influence the trade-offs that a country must contend with when implementing policy. These variables were then used to construct three food system types from the four countries studied. Finally, 20 transformation levers were used to analyse the similarities and differences in actions, and their potential impacts, across the three food system types.

From this analysis, five key observations were made in how transformation levers can be applied similarly and differently across the food system types assessed. These are:

1. All countries must strengthen national-level commitments – there is high potential for transformation by harmonizing programmes and actions across the country to create national-level commitments. This will also help deliver global climate, biodiversity and health goals.

2. Higher potential transformation levers differ significantly across food system types – certain levers offer higher potential in different systems, depending on their ecology and current production and consumption trends.

3. Sharing of certain characteristics creates overlap in some opportunities – the more characteristics food system types share, the more likely that there will be overlap in transformation levers of medium and higher potential.

4. Implementation will largely look different across systems - while shared food system characteristics lead to some shared opportunities, the inherent differences between food system types results in the need for unique methods of implementation.

5. All food system types can learn from each other – in spite of the many differences, there are several transformation levers which all three food system types can apply with similar effect. In some instances, it is possible for countries with very different characteristics to share knowledge and collaborate.

The development of food system types and the assessment of individual countries is a first step in a multi-year process for WWF to identify key actions that work in individual countries or groups of countries around the world. The goal is to reduce the complexity of the analysis of food system transformation to accelerate action at the national level. Join us in Solving the Great Food Puzzle.

CHAPTER 1
URGENT TRANSFORMATION IS NEEDED

Significant transformations are needed throughout the global food system to meet climate, biodiversity, and health goals. There is substantial evidence at the global scale of the need for such food system transformations[1,2,3,4] .The 2022 Intergovernmental Panel on Climate Change (IPCC) Working Group III report[5] and the 2019 Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Global Assessment[6] directly linked food system transformation to progress on global goals for climate and biodiversity. WWF's Living Planet Report[7] shows that species decline is rapid and accelerating in all regions of the world[8] and emphasizes that food systems lie at the heart of bending the curve on biodiversity loss (Figure 1). The Exponential Roadmap for Natural Climate Solutions (NCS) found that approximately 80% of NCS mitigation opportunity in the land sector is tightly linked to food systems (Figure 2).

These high-profile reports and many more have highlighted that, collectively, we need to shift towards healthier and more sustainable diets[1], reduce food loss and waste[10], and adopt nature-positive food production practices at scale[11]. Only by applying a food systems approach that incorporates actions in all three of these areas[12, 13] can we meet global climate commitments[14] (Figure 3), stem biodiversity loss[15], and ensure food security and healthy diets for a growing population[1].

But the potential for each action area to contribute to climate, biodiversity and health goals differs between countries[16]. It is imperative to focus attention on action at the national level, to understand where commonalities lie and where a 'one size fits all' approach will not be effective.

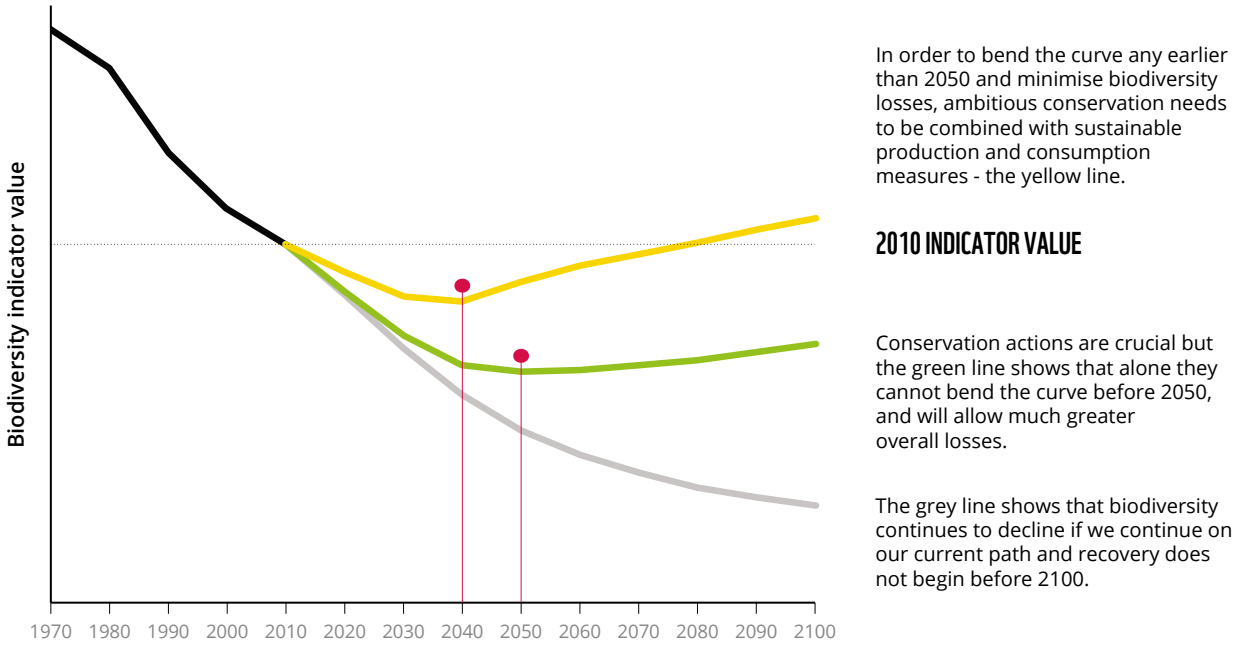

Figure 1 – Bending the curve on biodiversity loss requires increased conservation efforts combined with urgent efforts to scale more sustainable consumption and production. Source: WWF (2022)[7]

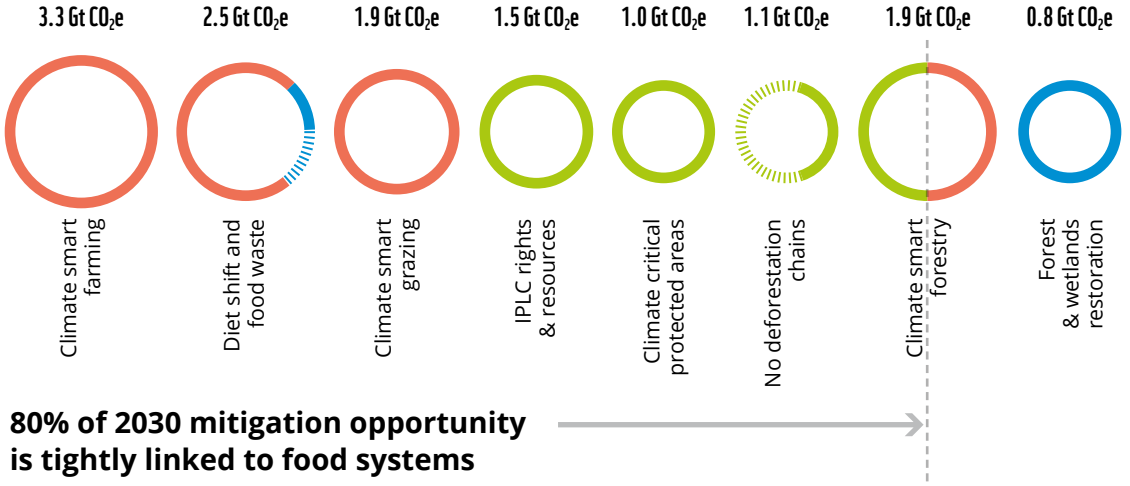

Figure 2 – Approximately 80% of Natural Climate Solution mitigation opportunities are tightly linked to food systems. Source Conservation International (2022)[9]

Adapted from 'Bending the Curve: The Restorative Power of Planet Based Diets (WWF) and Global food system emissions could preclude achieving 1.5°C and 2°C climate change targets (Clark et. al.)

For illustrative purposes only

* Assumes linear reduction to de-carbonisation in 2050 in all other sectors

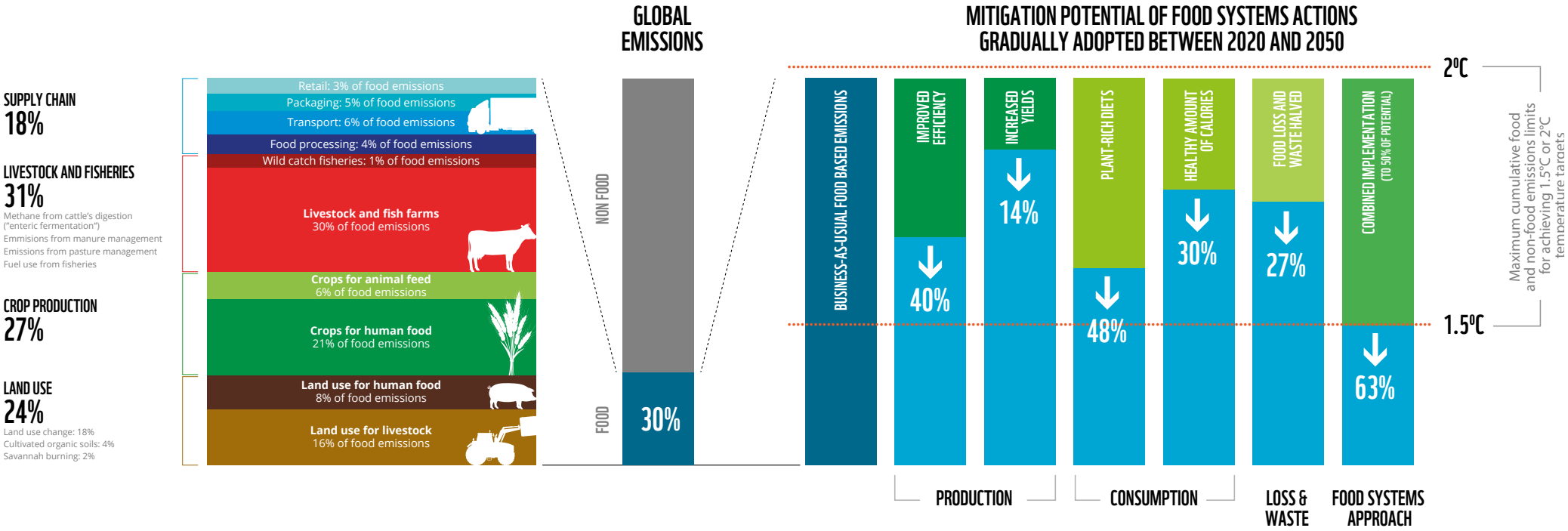

Figure 3 - Even if all other sectors decarbonize, failure to act on food systems will preclude our chances of achieving a 1.5°C future. Siloed action on production, consumption, and food loss and waste is not enough and only action on all three will ensure that food-based emissions are aligned with a 1.5°C future. Source WWF (2021)[14]

Despite the global attention on food system transformation, much less attention has been paid to how transformations towards more healthy and sustainable food systems might play out at the national level. Global targets and goals are necessary to provide a roadmap for change and draw attention to the urgent need for food system transformation but implementation of these targets and goals must take place at the national (and sub-national) level. Much of the actual change is likely to come from decisions and policies made by national governments, organizations, businesses, and citizens of individual countries[17]. More importantly, global-level analyses can mask important differences between national-level food systems and the challenges and opportunities for transformation in each country[18,19,20].

Food systems vary dramatically between countries. These differences span the environment, economy and society. Environmentally, countries vary in terms of how much land and water is available for, suitable for and devoted to food production[21], what proportion of greenhouse gas emissions come from the food system[22], and what the impacts of food production and expansion are on biodiversity[23].

Economically, nations differ in terms of the proportion of the workforce employed in food systems, the size and income of the average farm[25], the proportion of GDP for which food production accounts[26], the degree to which they are food self-sufficient or dependent on imports, and the contribution of agri-food exports to a country's trade economy.

Societally, there are large differences between countries in relation to national cuisines, traditional diets, the cultural significance of food, and the prevalence of food-related diseases, food security and hunger[27].

Given all these differences, the strategies and policies needed to shift from unsustainable trajectories to a more sustainable food future will likely differ between countries. Some strategies are likely to be more effective and hold greater relevance in certain countries than others. The relative role of governments, non-profit organizations and the private sector may vary according to need and institutional capacity. The trade-offs that result from competing objectives are also likely to differ between nations. A better understanding is needed of how food system transformations may differ between countries.

This report adds to a critical conversation around how food system transformations may vary at the country level. Some important research has been done on food system transformation at the national level. The Food, Agriculture, Biodiversity, Land-Use and Energy (FABLE) consortium assessed pathways to sustainable land use and food systems in 20 countries[28]. The results demonstrated that integrated strategies across food production, biodiversity, climate, and diets could meet the objectives of the Paris Agreement and the Sustainable Development Goals (SDGs). WWF's *Bending the Curve: The Restorative Power of Planet-Based Diets*[16] explored differing national-level impacts of shifting consumption patterns on a variety of human and environmental health dimensions. Other studies have assessed the greenhouse gas emissions of food systems from different countries and regions[29], the healthiness of National Dietary Guidelines in countries[30], and country-specific shifts to diets to tackle climate and water crises[31], while others have advocated for viewing food system transformation through the national lens[32,33]. Additionally, the United Nations Food Systems Summit convened over 600 member state dialogues to begin the process of developing national-level food system transformation pathways[34].

With this study, we build upon this work by putting the spotlight on four countries, as illustrative examples of the myriad ways in which food system transformations might be similar or vary between countries. While this is not the first report on food system transformations at the national level, this report is novel in that it combines four features not often considered under one umbrella.

1 **The report assesses food systems from a conservation lens.** In doing so, this report highlights important environmental dimensions that are often ignored, and provides insights for organizations working on these issues on the ground.

2 **The report uses a typology of food systems.** Doing so reduces the complexity of the analysis of food systems by making it easier to identify similarities and differences among food system types.

3 **The report explicitly identifies a handful of key transformation levers that can be assessed across all countries.** This allows for meaningful comparisons of a handful and manageable set of key levers for food systems that are most effective in varying contexts, thus helping policymakers to identify the policy actions needed to improve climate, biodiversity and health goals.

4 **The report uses a local context analysis to test the use of food system types.** This in-depth country analysis allows us to assess the potential of levers to transform a particular food system type and test the validity and usefulness of the typology developed, with the goal of further development as more countries are assessed.

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CHAPTER 2
FOOD SYSTEM TYPES

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BUILDING A FOOD SYSTEMS TYPOLOGY

The variation in food systems between countries poses a persistent challenge in identifying actions and key levers necessary to transform food systems, to improve human health while reducing environmental impact. These differences and the fact that food system transformations may play out very differently in different countries create a complexity that can hinder action at the national level. To reduce this complexity, typologies can be used as a useful classification tool to identify similarities and differences among food systems[35].

The generation of typologies to guide decision making is in the early stages of development. In this study we build upon the work done by Marshall et al. (2021)[35] and explore the usefulness of typologies to assess similarities and differences in actions needed in different countries. While there are many variables that can be used to inform a typology, six variables were chosen for this study given they may have a disproportionate impact on a country's ability to achieve climate and biodiversity goals (Table 1) and can also influence the trade-offs that a country must contend with when implementing policy. Previous assessments have used the environmental impacts of various food system types to validate a typology instead of being included as core variables within the typology itself[35].

Table 1.
Six variables were chosen for this study given they may have a disproportionate impact on a country's ability to achieve climate and biodiversity goals and can also influence the trade-offs that a country must contend with when implementing policy.

PRODUCTION SYSTEM[35]	SELF SUFFICIENCY[36]	FOOD SECURITY[37]
The type of production system can have a large influence on the scale of land conversion and environmental impacts. Countries can be dominated by large-scale industrialized agriculture, family farms, smallholders, fisheries and aquaculture or a mix of all types.	Having sufficient land and water resources to produce enough food to meet domestic demand has a large influence on where land conversion and environmental impacts are felt. It can also have a large influence on the type of production system needed to become less import dependent.	The levels of food security within a country can have a large influence on the priority placed on achieving either human health or environmental goals. The often competing demands many countries contend with can force difficult trade-offs between achieving either health or environmental goals in the short term.
CONSUMPTION PATTERNS[16]	**BIODIVERSITY HOTSPOT[38]**	**IRRECOVERABLE CARBON[39]**
Consumption patterns within a country are a good indicator of the level of environmental impact from a country's food system and can also indicate both current and future threats to ecosystems, both domestically and abroad.	Biodiversity hotspots are regions characterized both by exceptional levels of plant endemism and serious levels of habitat loss. These areas are important because they contain high levels of biodiversity richness and endemic species.	There are some natural places that we cannot afford to lose due to their irreplaceable carbon reserves. Irrecoverable carbon is ecosystem carbon that if lost, could not be recovered by mid-century, by when we need to reach net-zero emissions to avoid the worst climate impacts

COUNTRIES IN FOCUS

Brazil, Colombia, Kenya and **United Arab Emirates** are featured in this report, representing a range of geographies, cultures, and food system types. The differences and similarities between these four countries make for a robust comparison to inform the early stages of hypothesis testing, and development of a global food system typology and set of key transformation levers. The development of food system types and the assessment of individual countries is a first step in a multi-year process for WWF to identify key actions that work in countries or groups of countries around the world. The goal is to reduce the complexity and accelerate action at the national level.


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BRAZIL

Brazil is a large upper-middle income tropical country in South America, and home to 213 million people. Brazil contains multiple biomes - including the Amazon, Cerrado, and Atlantic Forest - that are globally significant in terms of their carbon, biodiversity and role in supporting the livelihoods of indigenous and traditional people.

The country has the most diverse flora in the world, with 55,000 species (22% of the world total) identified to date. With its vast carbon reserves, it is also of central importance to achieving global climate goals. Brazilian agriculture is predominantly run by large industrial agribusiness which occupies 75% of the land and generates 62% of agricultural output. In contrast, there are 4.4 million family farms that occupy 25% of the land but produce 70% of the food consumed in the country. Brazil is one of the largest producers of food and agricultural products in the world including beef, soy, coffee and sugarcane. It has the potential to meet domestic food demand and many of the foods produced in Brazil are consumed domestically, including 80% of beef, 70% of poultry and 82% of pork, helping to make per capita consumption of animal source foods very high. Brazil currently has the third largest per capita GHG emissions from food consumption. Despite this, hunger and malnutrition are still present and increasing.

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COLOMBIA

Colombia is a medium-size upper-middle income tropical country in South America, and home to 48 million people. Colombia is one of 12 countries with the greatest biological diversity in the world with 85 major types of ecosystems identified. Colombia is home to a wide range of cultures and traditions defined by a range of geographies from the Andean mountains to the eastern plains, the Pacific and Caribbean coasts, and the Amazonian forests.

With its large carbon reserves, it is of central importance to achieving global climate goals. Colombian agriculture is currently characterized by a mix of large industrial agribusiness and smallholder farming, but agri-businesses are on the rise. Colombian agriculture has the potential to meet domestic food demand and at the same time the country exports bananas, coffee and flowers, and is the fourth largest producer of palm oil in the world. The per capita biodiversity impacts of Colombian diets are among the top five in the world and the per capita GHG emissions are above what is required to meet 1.5˚C targets. Despite all of this, Colombia still faces persistent hunger with up to 11% of its population facing chronic malnutrition.

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KENYA

Kenya is a medium-size lower-middle income tropical country in east Africa, and home to 54 million people. Kenya is home to rich wildlife, including many globally known species, ecosystems, and landscapes. It is also culturally diverse, with at least 40 different ethnic groups. Agriculture is the backbone of Kenya's economy, contributing 33% of the Gross Domestic Product. Smallholder farming systems dominate the agricultural sector, with 75% of national food production being primarily for household level subsistence.

The main crops grown are maize, wheat, rice, potatoes and beans, with maize being the principal staple food. Kenya's agricultural exports include tea, coffee, cut flowers and vegetables. Although biodiversity loss in Kenya is high, the per capita biodiversity and GHG emissions from current food consumption patterns are relatively low compared to the other countries in this study. These impacts are expected to grow as diets change and agricultural expansion increases due to poor land use and inadequate laws and policies. Kenya continues to face significant burdens of undernutrition, with 26% facing chronic malnutrition, while also facing rising rates of obesity, especially in urban areas.

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UNITED ARAB EMIRATES

United Arab Emirates is a small high-income country on the Arabian Peninsula, and home to approximately 10 million people, nearly 90% of which are foreigners. UAE has four major varieties of ecosystem: 1) desert ecosystem (80% of the country's area); 2) mountain ecosystem (2.6% of the country's area); 3) coastal and marine ecosystem and 4) wetlands. While relatively small in geographic terms, certain parts of UAE are biodiversity rich, with nearly 3,800 species identified to date. The country has a hyper desert arid climate with only about 0.5% of total land suitable for growing crops.

Despite this, the UAE is at the top of the Global Food Security Index but has limited food sovereignty due to the harsh agro-climatic conditions, leaving the country reliant on food imports (nearly 85% of food is imported). A mix of industrial and smallholder agriculture comprises food production in the UAE with date palms being an important food produced and exported. Recently, the government has introduced initiatives to strengthen the country's food self-sufficiency, which has prompted investments into the development of new food production technologies, including indoor controlled environment agricultural systems (see Appendix 2 for examples of initiatives undertaken in the UAE). Rising rates of unhealthy conditions in the UAE's population is a growing cause for concern, with nearly half of the population considered overweight or obese. Imported processed foods, combined with unhealthy diets and sedentary lifestyles, have contributed to the rising rates of obesity and cardiovascular disease.

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FOOD SYSTEM TYPES

In addition to the clear differences in ecology and food production systems, we can see large differences in environmental impacts. While Kenya and UAE have relatively lower greenhouse gas emissions and biodiversity loss per capita, Brazil and Colombia have significantly larger impacts (Figures 4 and 5). There is also a notable difference in per capita calorie intake, with Brazil and UAE in particular exceeding Kenya (Figure 6). These charts are illustrative of how countries' food system types differ. We have identified three food system types (Table 2) for the countries studied in this report.

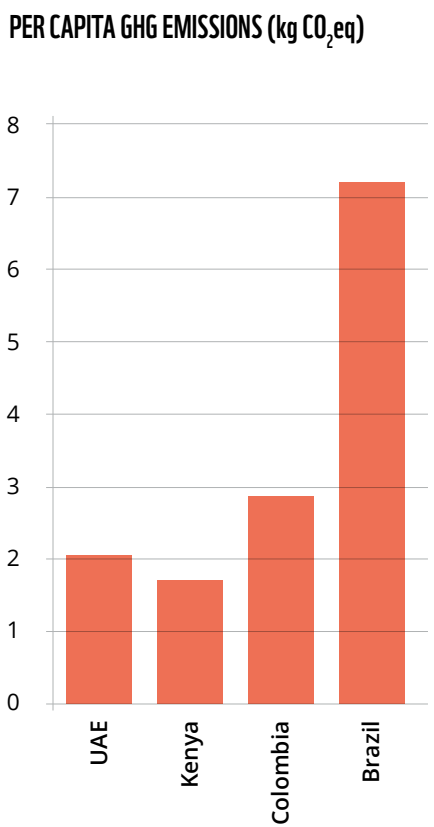

Figure 4 – Per capita food related GHG emissions in each country from farm to fork.

Source WWF (2020)[16]

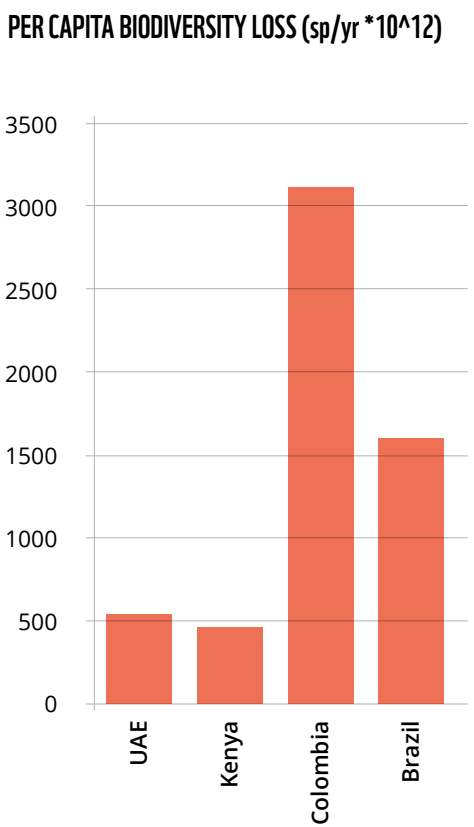

Figure 5 - Per capita biodiversity loss in each country because of current food consumption patterns.

Source WWF (2020)[16]

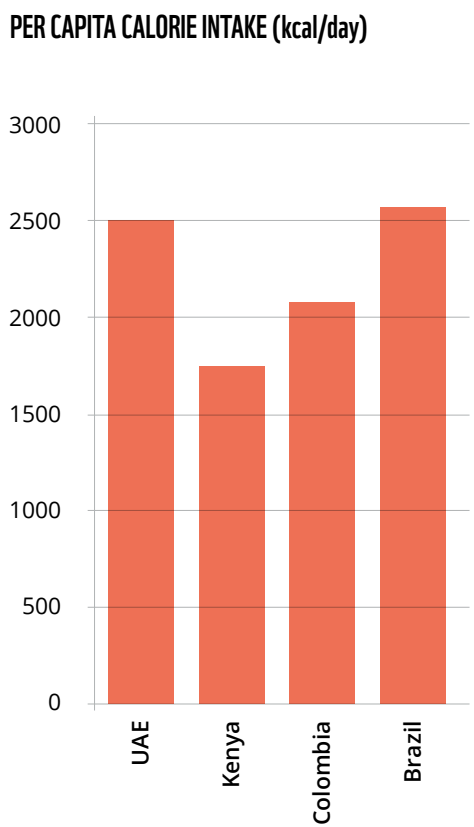

Figure 6 - Per capita calorie intake in each country based on current food consumption patterns.

Source WWF (2020)[16]

Table 2. Overview of how the three food system types were identified using the six variables chosen for this study to inform the typology.

VARIABLES	TYPE I BRAZIL AND COLOMBIA	TYPE II KENYA	TYPE III UAE
Production System	Most of the land/waters are dominated by industrial food production with a smaller share farmed/fished by smallholders and artisans.	Most of the land/waters are farmed/fished by smallholders and artisans, although some industrial food production may exist.	Most of the land/waters are dominated by industrial food production with a smaller share farmed/fished by smallholders and artisans.
Self-Sufficiency	Sufficient land and water resources exist to produce enough food to meet domestic demand. Food may still be imported but this is not driven by land and resource constraints.	Sufficient land and water resources exist to produce enough food to meet domestic demand. Food may still be imported but this is not driven by land and resource constraints.	Insufficient land and water resources exist to produce enough food to meet domestic demand. A high percentage of food needs to be imported to meet demand.
Food Security	Although enough food can be produced domestically, a large percentage of the population remain food insecure due to internal problems related to access, availability, and affordability of food.	Although enough food can be produced domestically, a large percentage of the population remain food insecure due to agricultural inefficiencies and internal problems related to access, availability, and affordability of food.	Most individuals are food secure through having physical and economic access to sufficient safe and nutritious foods to meet their dietary needs.
Consumption Patterns	Although a high level of food insecurity exists, the per capita impacts from food consumption are above planetary boundaries, mainly driven by high levels of per capita intake of animal-source foods.	The per capita impacts from food consumption are below planetary boundaries. Intake of certain foods may need to be increased to tackle burdens of undernutrition.	The per capita impacts from food consumption are above planetary boundaries, mainly driven by high levels of per capita intake of animal source foods and overconsumption of calories.
Biodiversity Hotspot	High levels of biodiversity richness are found in much of the country, with large areas considered biodiversity hotspots.	High levels of biodiversity richness are found in much of the country, with large areas considered biodiversity hotspots.	Low to moderate levels of biodiversity richness are found in the country, with no areas considered biodiversity hotspots.
Irrecoverable Carbon	High levels of carbon reserves can be found in the country with large areas containing high density reserves of irrecoverable carbon.	Moderate levels of carbon reserves can be found in the country with little to no areas containing high density reserves of irrecoverable carbon.	Low levels of carbon reserves can be found in the country with little to no areas containing high density reserves of irrecoverable carbon.

An **Ecological Food System Hotspot** is a country that has some of the richest and the most threatened reservoirs of carbon, plant, and animal life on earth. Although all countries must transform their food system, these "hotspots" represent countries that are uniquely important for achieving global climate and biodiversity goals yet continue to face increasing rates of nature conversion for food production. Brazil and Colombia can be considered as ecological food system hotspots given their significant levels of food production and high levels of both biodiversity richness and irrecoverable carbon reserves.

In this report, we explore the potential for using the above food system types to identify actions that may be more relevant or of higher priority in some countries than others, depending on local context. This is an important step in advancing work on food system transformation at the national level by starting the process of building a suite of tools and actions that work in various countries.


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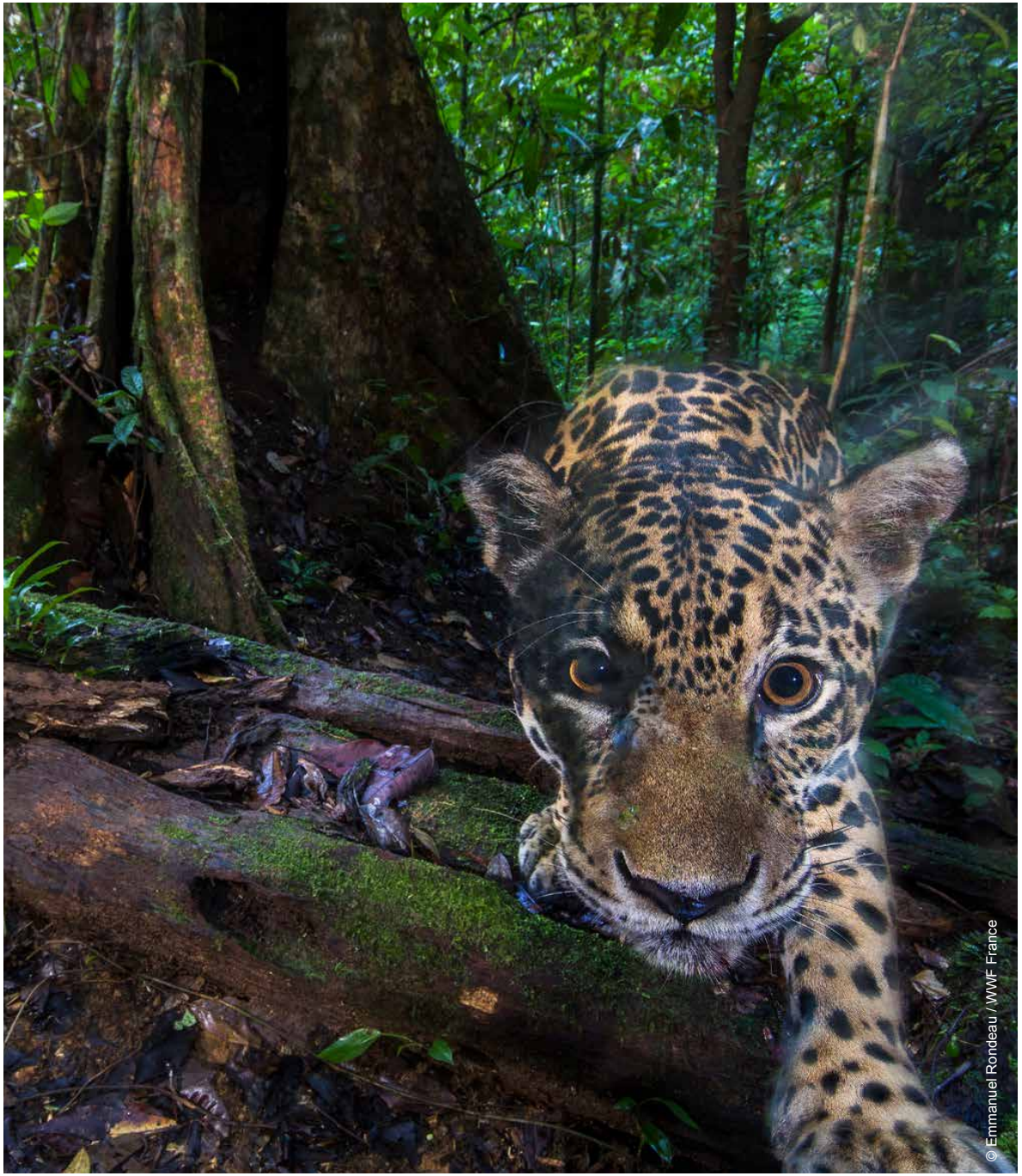
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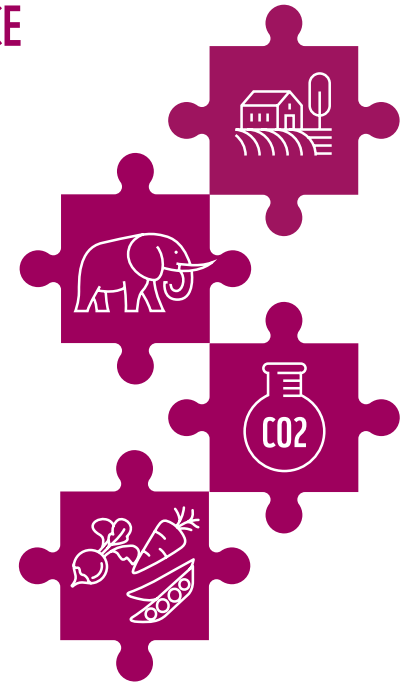
CHAPTER 3
KEY TRANSFORMATION LEVERS

There is no 'one size fits all' approach to transforming food systems across all countries. A wide range of actions could help achieve national-level food system transformations. However, to effectively analyse the similarities and differences in actions needed, and their potential impacts, across food system types, we have identified 20 transformation levers (Table 3) which need to be applied in all types of food systems across all three action areas (diets, food loss and waste, and production). The transformation levers were developed through an in-depth analysis which included interviews with stakeholders across each of the national food systems studied, consultation with food systems experts and an extensive literature review. This list is not exhaustive and continued refinement is needed as additional national-level analyses are conducted. The list does, however, align closely with the 42 policies and actions outlined in Hawkes et al[40].

Table 3 – Twenty transformation levers that have been identified as having a high degree of potential to transform food systems. These levers are important across all food system types but their potential for transformational change varies across food system types.

NATURAL RESOURCE MANAGEMENT



Optimize land-use

Use all agricultural lands to their maximum potential including optimizing crop yields through better food production practices that more efficiently use water and fertilizers, preserve ecosystem functions, and contribute to resilient landscapes.

Restore biodiversity

Develop and implement food production practices that restores biodiversity in active agricultural land and restores less productive areas to natural habitat for biodiversity conservation.

Increase carbon storage

Develop and implement food production practices that increase carbon stores in soils and in above ground biomass.

Increase diversity

Support the production and consumption of nutritious indigenous crops through agrobiodiverse cropping systems.

GOVERNANCE AND INSTITUTIONS

Support smallholder farmers

Redesign agricultural development and extension programs to provide financial assistance, infrastructure, and education to support farmers to grow and market nutritious and indigenous crops and access markets.

Improve land tenure rights

Improve land tenure rights and develop actions that encourage collective ownership and indigenous land rights.

Strengthen national level commitments

Coordinate and strengthen national-level commitments on shifting to healthy diets, reducing food loss and waste, and scaling nature-positive food production.

Raise ambition of National Dietary Guidelines

Develop National Dietary Guidelines that emphasize both human health and environmental sustainability, and encourage a diverse consumption of foods including indigenous crops.

EDUCATION AND KNOWLEDGE

Strengthen research and development

Increase research and development opportunities in domestic universities and with food producers, into food production methods that support production of healthy foods using nature-positive food production practices.

Improve data collection and measurement

Improve data collection and measurement of progress on national level commitments towards meeting health and environmental goals that are aligned with international health, climate, and biodiversity targets.

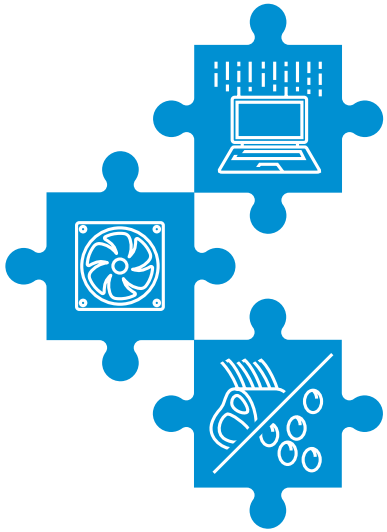
Increase public awareness

Launch engaging and compelling mass media and behaviour change communication campaigns about healthy eating and reducing food loss and waste.

Promote traditional foods

Promote traditional food cultures associated with good nutrition by supporting and protecting traditional foods, providing information about traditional dishes and public awareness campaigns.

TECHNOLOGY



Adopt high-tech methods

Adopt high-tech food production methods such as the sustainable use of non-conventional water sources and controlled environments for food production.

Develop infrastructure

Develop innovative infrastructure and post-harvest storage technologies, packaging and processing techniques for nutritious foods to reduce loss and waste of nutritious foods.

Develop alternative proteins

Develop and promote alternative proteins such as plant-based meat alternatives and algal species high in nutritional value.

TRADE

Support healthy food imports

Design trade policies to prioritize the supply of nutritious foods over foods manufactured high in fats, sugars and salt.

Develop nature-positive supply chains

Develop trade policies that support nature-positive food production, such as trade agreements and traceability tools, and changes in markets.

FINANCE

Redirect subsidies to improve production

Redirect agri-food subsidies from staple crops and harmful production practices to increasing nature-positive production of nutritious foods.

Finance school food and public procurement programmes

Finance school food and public procurement programmes that promote and enable supply and consumption of healthy and sustainable foods.

Provide financial incentives and taxes to improve consumption

Provide financial support that increases the availability, affordability and appeal of nutritious foods, and implement taxes that decrease the affordability of foods high in fats, sugars and salt.

CHAPTER 4
IMPLEMENTATION OF TRANSFORMATION LEVERS

Table 4 (Page 27) shows the relative potential of each transformation lever to transform a particular food system type. It is important to note that all 20 levers are key for national-level food system transformation and achieving climate, biodiversity and health goals. However, unless significant resources are available to invest in full implementation of all levers, a means of assessing the potential impact of individual levers in a particular food system type can be useful for policymakers as they develop national roadmaps for action.


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Table 4:
The potential of individual transformation levers to transform different food systems types.

		BRAZIL	COLOMBIA	KENYA	UAE
NATURAL RESOURCE MANAGEMENT	Optimise land-use				
	Restore biodiversity				
	Increase carbon storage				
	Increase diversity				
GOVERNANCE AND INSTITUTIONS	Support smallholder farmers				
	Improve land tenure rights				
	Strengthen national level commitments				
	Raise ambition of National Dietary Guidelines				
EDUCATION AND KNOWLEDGE	Strengthen research and development				
	Improve data collection and measurement				
	Increase public awareness				
	Promote traditional foods				
TECHNOLOGY	Adopt high-tech methods				
	Develop infrastructure				
	Develop alternative proteins				
TRADE	Support healthy food imports				
	Develop nature-positive supply chains				
FINANCE	Redirect subsidies to improve production				
	Finance school food and public procurement programs				
	Provide financial incentives and taxes to improve consumption				

Lower potential of lever to transform a particular food system type
Medium to lower potential of lever to transform a particular food system type
Medium potential of lever to transform a particular food system type
Medium to higher potential of lever to transform a particular food system type
Higher potential of lever to transform a particular food system type

FIVE KEY OBSERVATIONS

Through our analysis we have made five key observations in how transformation levers can be applied similarly and differently across food system types assessed. **These are:**

All countries must strengthen national-level commitments

- there is high potential for transformation by harmonizing programmes and actions across the country to create national-level commitments. This will also help deliver global climate, biodiversity and health goals.

Higher potential transformation levers differ significantly across food system types

- certain levers offer higher potential in different systems, depending on their ecology and current production and consumption trends.

Sharing of certain characteristics creates overlap in some opportunities

- the more characteristics food system types share, the more likely that there will be overlap in transformation levers of medium and higher potential.

Implementation will largely look different across systems

- while shared food system characteristics lead to some shared opportunities, the inherent differences between food system types result in the need for unique methods of implementation.

All food system types can learn from each other

- in spite of the many differences, there are several transformation levers which all three food system types can apply with similar effect. In some instances, it is possible for countries with very different characteristics to share knowledge and collaborate.

1 ALL COUNTRIES MUST STRENGTHEN NATIONAL-LEVEL COMMITMENTS

Our analysis shows that, across all three food system types assessed, there is high potential to transform national food systems by **strenghtening national-level commitments.** Rather than relying on individual programmes, all four country governments can mobilize and coordinate multiple stakeholders to create or revitalize national strategies across consumption, loss and waste, and production. Coordinating municipal efforts would be an important element of this.

Furthermore, if these commitments are integrated into national biodiversity, climate mitigation and climate adaptation plans, this lever would directly assist in delivering global biodiversity and climate goals.

Currently, each country in this study is a signatory to the UN Convention on Biological Diversity (UNCBD) and the Paris Agreement. They have submitted National Biodiversity Strategies and Action Plans (NBSAPs) and Nationally Determined Contributions (NDCs) to the UN Framework Convention on Climate Change (UNFCCC).

Although each country has NBSAPs (Table 5) and NDCs (Table 6), and there are targets related to the impacts of food systems, not all countries have a specific mention of and direct integration of food systems. Indeed globally, integration of food systems is lacking. Given the rapid rate of biodiversity loss in each country and rising GHG emissions, it is imperative for all countries to take a food systems approach to **strengthening national-level commitments** and include actions on consumption, loss and waste and production in NDCs[41] and NBSAPs.

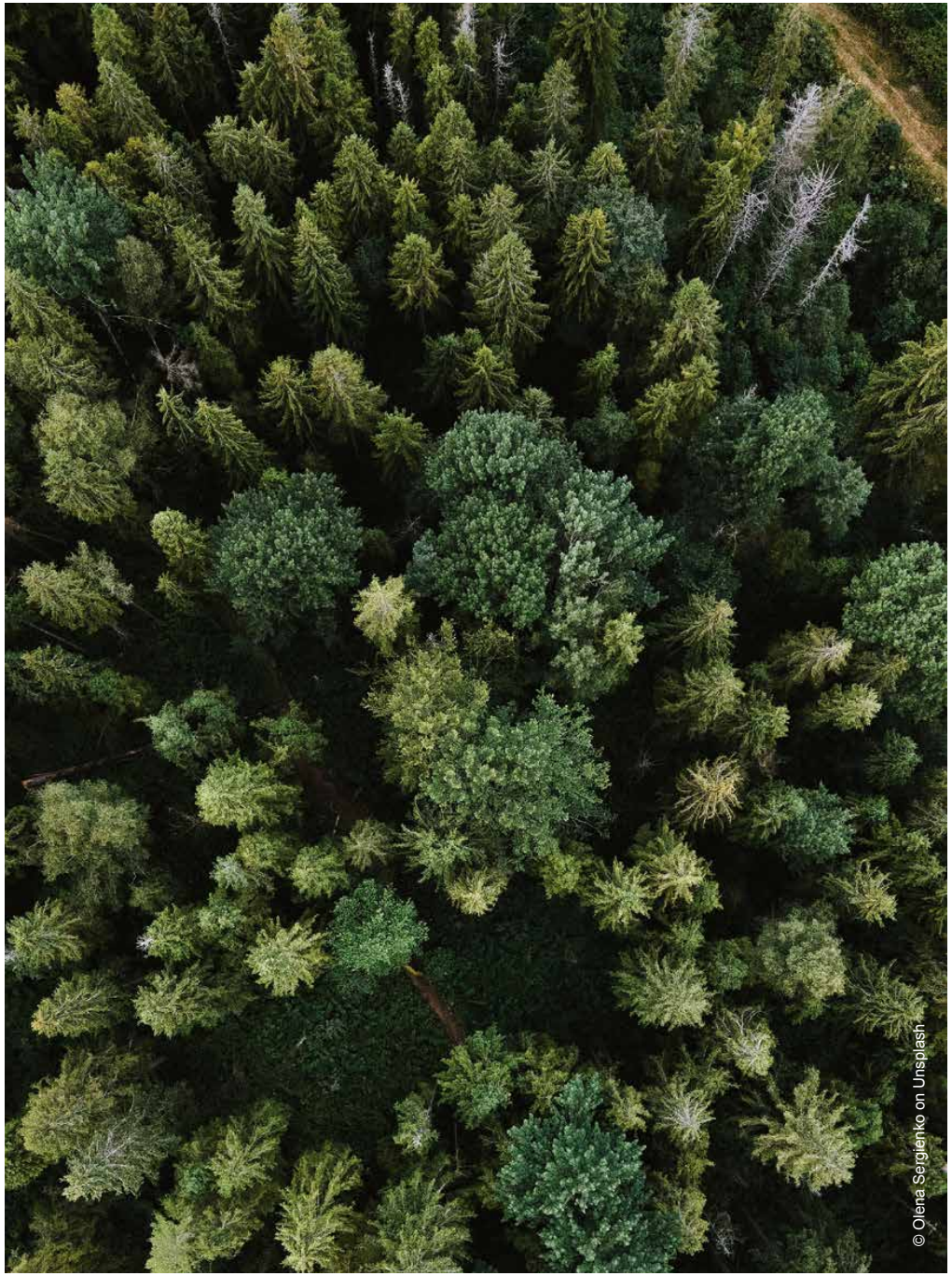
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Table 5. Examples of existing NBSAP targets (pending targets being updated with the Post 2020 Biodiversity Framework)

COUNTRY	NBSAP TARGET	RELATION TO FOOD SYSTEMS IMPACTS
Brazil	5	By 2020, the rate of loss of native habitats is reduced by at least 50% (in comparison with the 2009 rate) and, as much as possible, brought close to zero, and degradation and fragmentation is significantly reduced in all biomes[28].
Colombia	III.5	By 2020, sustainable production systems that combine production and conservation actions to generate local development will be identified. Sustainable production systems will be rolled out in municipalities that are highly biodiverse and affected by the armed conflict[28].

Table 6. Summary table of illustrative examples of how food systems are represented in each country's NDCs. For the complete analysis and list of targets and actions please see Appendix 3. For more analysis, please see WWF's Enhancing NDCs for Food Systems[42] and the upcoming reports on Food System Adaptation in NDCs and National Action Plans (NAP) and the updated assessment of food systems and NDCs.

COUNTRY	UPDATED NDC	FOOD IN NUMERICAL MITIGATION TARGETS	FOOD IN MITIGATION ACTIONS
Brazil	2022	Specific reference or information not found	Specific reference or information not found
Colombia	2020	The stated mitigation target envisages a reduction in emissions from deforestation equivalent to reducing the rate of deforestation to 50,000 ha/year by 2030.	A range of actions are presented, including reducing GHG emissions generated in livestock production, increasing carbon removals from agro-ecosystems dedicated to cattle ranching, implementing agroforestry systems on coffee farms, increasing planting densities of crops with free exposure, and efficient use of fertilizers.
Kenya	2020	Plant 350,000 agro-forestry trees in farmlands established	Making progress towards achieving a tree cover of at least 10% of the land area of Kenya. Making efforts toward achieving land degradation neutrality. Scaling up Nature-based Solutions for mitigation. Enhancements of REDD+ activities.
UAE	2022	Various numerical mitigation targets, for instance: reducing food loss and waste by 50% by 2030, in line with the United Nations SDG 12.3	In order to tackle the challenges climate change poses for food production, the UAE is adopting sustainable and controlled-environment agricultural systems, reducing food waste, and diversifying sources of food imports.

2 HIGHER POTENTIAL TRANSFORMATION LEVERS DIFFER SIGNIFICANTLY ACROSS FOOD SYSTEM TYPES

The high biodiversity and climate value of land in TYPE I (Brazil and Colombia) countries is reflected in the importance of actions to better manage natural resources and shift finance and markets to more sustainable production methods. The highest potential comes from **optimizing land use, restoring biodiversity, increasing carbon storage, developing nature-positive supply chains** and **redirecting subsidies to improve production.**

Brazil and Colombia can both decouple agricultural production from ecosystem degradation through improved tracing programmes that ensure products are deforestation-free and align production practices to sustainability standards of major importing regions, such as the European Union's deforestation-free supply chain initiative. This needs to be accompanied by enforcement of policies and monitoring programs, and implementation of biodiversity-friendly farming practices. Through the ABC+ program, Brazil has already invested heavily in promoting the adoption of low-carbon agricultural practices, such as integrated crop-livestock-agroforestry systems, pasture restoration, and the planting of commercial forests. In Colombia, taxes on unproductive land, facilitating land holdings to landless producers, disincentivizing land grabs, and incentivizing specific types of production (e.g. agroecological practices like agroforestry) can catalyse conservation.


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The importance of smallholders to the TYPE II (Kenya) food system leads to an emphasis in skills enhancement, and providing financial assistance and infrastructure to aid in implementation; a combination of education and governance. A higher level of potential comes in **supporting smallholder farmers, improving land tenure rights** and **strengthening research and development.**

In Kenya, smallholders would benefit from national and county governments expanding the geographical range of extension providers, and increasing the training available to farmers[43,44]. Additionally, the national government can better coordinate private and public extension services through improved monitoring and regulation of private extension services[45]. Given there is a clear linkage between land tenure management and sustainable development, efforts should be taken to develop actions that encourage collective ownership and land rights in Kenya[46]. Financial assistance can make tools to reduce post-harvest loss, such as hermetic storage bags and produce crates, more affordable to farmers[47], and guaranteed contracts with food processors can provide steady income and high-quality storage facilities for farmers' produce[48], helping to reduce losses.

Given TYPE III (UAE) food systems rely heavily on imports and have limited natural resources with which to increase domestic production, transformation is being accelerated through actions on trade and technology. The highest potential is in **adopting high-tech methods, developing infrastructure** and **supporting healthy food imports.**

For instance, in the UAE, the adoption of controlled environment agriculture offers opportunity to sustainably increase food sovereignty. At the same time, accessing or developing saline-heat- and drought-tolerant crop varieties as well as inputs such as nitrogen-fixating, salt-tolerant, plant growth promoting bacteria could help enhance the productivity of more traditionally produced plants facing salt-stress[49,50]. Similarly, the UAE has limited access to freshwater but has abundant access to seawater. Developing sustainable desalinisation and purification technologies that improve usability of unconventional water sources and reduce water extraction[51] could help conserve limited freshwater resources.

3 SHARING OF CERTAIN CHARACTERISTICS CREATES OVERLAP IN SOME OPPORTUNITIES

Perhaps unsurprisingly, the more characteristics that food system types share, the more likely that there will be overlap in transformation levers between medium and higher potential. Some higher priority levers in TYPE II (Kenya) food systems are also of importance in TYPE I (Brazil and Colombia) and TYPE III (UAE) food systems.

In TYPE I (Brazil and Colombia) and TYPE III (UAE) food systems. For instance, there are significant numbers of smallholders in Brazil, Colombia, and Kenya (notwithstanding the largely industrialised nature of TYPE I food systems) so we see shared opportunities in the transformation levers **supporting smallholder farmers** and **improving land tenure rights.**

Separately, Kenya and the UAE, share opportunity to apply the transformation levers of **promoting traditional foods** and **supporting healthy food imports** as both countries import large amounts of food.

Conversely, TYPE I and TYPE III food systems vary more significantly (see Table 1) and therefore several of the transformation levers providing higher potential in Brazil and Colombia have lower potential in the UAE, and vice versa.

4 IMPLMENTATION WILL LARGELY LOOK DIFFERENT ACROSS SYSTEMS

While overlapping characteristics lead to some shared opportunities, the inherent differences between food system types results in the need for unique methods of implementation in each food system type. As such, for many levers, countries will learn most from the experiences of other countries with the same food systems type.

TYPE I (Brazil and Colombia) and TYPE II (Kenya) food systems can both benefit from **providing financial incentives and taxes to improve consumption**, but different interventions are required. More than half of Brazilian households face some level of food insecurity[52] and consequently tend to eat more ultra-processed foods, as they are less expensive than fresh food[53]. Therefore, policies to make fresh, healthy foods more affordable and accessible to diverse populations could be implemented. On the other hand, in rapidly growing urban areas like Kenya's capital city Nairobi, where prices frequently fluctuate, consumers can benefit from government programmes that decrease and/or stabilize the price of food.

Likewise, Kenya and UAE would implement **support for healthy food imports** differently. Subsistence farming in Kenya is supplemented by a localised market economy and some imports. However, many are increasingly reliant on food aid[54] and approximately one quarter of the Kenyan population is undernourished[55]. Increasing imports of healthy foods can alleviate hunger and undernourishment, especially where consumption is dominated by maize, rice, wheat and sorghum. Meanwhile, nearly 90 per cent of the UAE population lives in urban areas and food purchasing decisions are influenced by the physical food purchasing environment (e.g. prevalence of fast food chains and vending machines), lack of time, access to supermarkets and reliance on delivery services. Improving the food environment by making healthy food available and accessible in all urban areas will be critical to achieving healthy diets for all people[56,57]. UAE is making important strides in supporting healthy food imports and these efforts should continue in the future.


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5 ALL FOOD SYSTEM TYPES CAN LEARN FROM EACH OTHER

In spite of the notable differences in levers with medium to higher potential across food system types, there are several transformation levers which all three food system types can apply with similar impact. As such, in some instances it is possible for countries with very different characteristics to share knowledge and collaborate.

Increasing diversity provides all countries with significant opportunity to increase production and consumption of nutritious and indigenous crops suitable for cultivation in local environments.

Adopting agrobiodiverse cropping systems could also preserve or revitalize historic food production practices. Across all countries, funding and investment is required to promote and protect the domestic use of indigenous and environmentally-resilient crops. For instance, to support 'non-conventional edible plants', which have nutritional, medicinal and cultural value, in Brazil and to champion the production and consumption of staple crops suitable for growth in marginal environments, such as quinoa, in the UAE[58,59,60].

While food environments and choices available to consumers are essential in establishing widespread adoption of healthy and sustainable diets, and reducing food waste, **increasing public awareness** is also critical. Increasing consumer knowledge of issues and solutions provides all countries with higher potential to transform their food systems.

The dietary shifts required or the ways in which food is wasted may differ across countries and systems, but the means to engage consumers (such as communications campaigns, retail promotions and championing by celebrity chefs) can be the same. Particularly when it comes to behaviour change, the nudges and subtle shifts in retail, dining and disposal that have been successfully implemented can be leveraged across systems and countries.

Similarly, while dietary patterns are very different from country to country, what remains constant is the fact that different social and cultural groups within countries have different consumption patterns and dietary requirements. If ministries harmonize efforts to **raise ambition of National Dietary Guidelines,** with the needs of different groups in mind, advice will be easier to follow.

For guidelines to have impact, it is essential they are supported by communications campaigns, economic incentives, market measures and other programmes. Across systems, countries can learn both from consultation mechanisms to develop guidelines, and the supporting programmes implemented.


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CHAPTER 5
CROSS-AGENDA ACCELERATORS AND TRADE-OFFS

In Chapter 4, we provided analysis of the potential of transformation levers in each food system type, based on their direct impacts and relative to the direct impacts of other levers. However, it is also necessary to consider indirect impacts of applying transformation levers. Some levers can enable and accelerate the implementation of others, while some could create trade-offs that need to be carefully managed to achieve environmental, health and social goals. As such, it is important for countries to consider which transformation levers to apply alongside those with the most potential for direct impact, and how to mitigate any potential side-effects of implementing levers.

ACCELERATORS

In all countries, **increasing diversity** is a higher potential transformation lever. There is a clear reciprocal relationship between this lever, from a production perspective, and **promoting traditional foods** from a diets perspective. Diminishing dependency on imported food and expanding the production of indigenous or environmentally appropriate crops directly supports the consumption of fresher and more diverse foods from local and regional food systems. Vice versa, demand-side shifts will increase the market for food producers to invest in these foods. **Providing financial incentives and taxes** to support healthy and sustainable eating, can therefore also lead to **increased diversity.**

Although **strengthening research and development** is a medium to lower potential lever in TYPE I (Brazil and Colombia) countries, they may consider investing in it, particularly around food loss and waste and healthy and sustainable diets, given it can help accelerate **optimizing land use, restoring biodiversity, increasing carbon storage** and **developing nature-positive supply chains.** Where food producers are more aware of food loss and waste, they may be more likely to adopt nature-positive production practices in which unsold or spoiled food can be reused as fertilizer. As above, increased consumer awareness of the make-up of a healthy and balanced diet, can create demand and a market for more sustainably produced foods.

HEALTH AND SOCIAL CO-BENEFITS

There are also many human health and social co-benefits that can be delivered in all food system types by implementing certain levers.

At the global level and in many individual countries there is considerable opportunity for an environmental and health win-win from shifting to healthier and more sustainable diets, which ensure no overconsumption of animal-source foods[61]. With that in mind any combination of dietary levers, perhaps most particularly **increased public awareness, providing financial incentives and taxes to improve consumption** and **raising ambition of National Dietary Guidelines,** can help deliver benefits for health and social goals, both in terms of reducing premature mortality[16] and reduced incidence of diet-related disease[62]. That said, there is considerable variation between countries to the extent to which each of these improvements would result from a shift in diets[20].

Many actions to improve production practices would also provide social benefits, such as increasing farmer profits and reducing food insecurity. **Increasing carbon storage**, through pasture restoration in Brazil for example, can reduce emissions and land use, and increase profitability[63]. Nature-positive production practices would not only benefit biodiversity and climate but would also improve other ecosystem services that support people's livelihoods and wellbeing.

Applying levers to reduce food loss and waste, like **strengthening research and devleopment** and **improving data collection and measurement** can also help deliver health and social goals. Reducing loss and waste can increase the availability of food and help tackle malnutrition in TYPE II food systems and for others suffering from individual underconsumption of calories.

TRADE-OFFS

The application of some levers could have unforeseen impacts on biodiversity and climate goals if not carefully managed.

INCREASED EMISSIONS

Application of certain **high-tech methods** intended to reduce agricultural land use could increase emissions in other ways. Artificial lighting for vertical farming[64] controlled environment agriculture cooling systems[65] and cultured meat[66,67] are all energy-intensive practices which, if adopted widely, could lead to increased electricity demand. In TYPE III countries (UAE), where the lever presents high opportunity, this could negate the extent to which **strengthening national commitments** helps achieve national and global climate goals.

Likewise, **developing infrastructure** to tackle food loss and waste, specifically scaling up critical cold storage technologies, could increase greenhouse gas emissions. The majority of the energy needed to run cold storage infrastructure is derived from fossil fuels. For example, although solar-powered cold storage technologies are being developed and successfully tested, few are widely available or equipped to supply power to meaningfully-sized storage facilities in TYPE II countries (Kenya) [68].

As such, **adopting high-tech methods** and **developing infrastructure** should be accompanied by a transition to clean, renewable or low-emission energy sources[69,70]. This could mitigate the trade-off in terms of increased emissions.

INCREASED FOOD LOSS AND WASTE

Although **promoting traditional foods, financing school food and public procurement programs** and **providing financial incentives and taxes to improve consumption** can help improve health and reduce agricultural land use, the levers could lead to an increase in food loss and waste. This is because a higher proportion of fresh fruits and vegetables, and other plant-based foods like bread and grains, goes uneaten than meat and other animal products[71]. Though often less healthy, heavily processed goods are also less prone to damage or decay in the supply chain than fresh foods.

One benefit of shifting to diets with a higher proportion of plant-based foods is the reduced need for land-use change. However, if food loss and waste were to increase, production may still need to intensify and habitat conversion continue, in order to provide enough healthy and nutritious food for everyone. As such, levers to improve consumption, which have particularly high opportunity in TYPE II countries (Kenya) should be accompanied by actions to reduce food loss and waste to mitigate potential challenges.

HEALTH AND SOCIAL TRADE-OFFS

Even if some levers advance nature, climate and health goals, there could be trade-offs in areas including culture, tradition, food security, jobs, livelihoods, equity and wellbeing.

JOB LOSSES

As discussed above, applying a combination of levers can reduce the overconsumption of animal-sourced foods, in particular meat. However, the livestock sector plays a significant role in food systems worldwide, so such a change could lead to a loss of jobs, livelihoods, income and community wellbeing, especially for livestock farmers and rural communities in low- and middle-income economies[20,72]. That said, the growing demand for plant-based protein could create new economic opportunities for farmers and ranchers working in intensive systems. Additional training and capacity-building, through the lever of **strengthening research and development**, would likely be needed to prepare them for alternative production[73,74].

INCREASED CONSUMPTION LEADING TO INCREASED EMISSIONS IN SPECIFIC SETTINGS

In food system types that under-consume calories at an individual level (e.g. in TYPE II), achieving a healthy diet may require a slight increase in the consumption of resource- and emissions-intensive foods - specifically meat and dairy[16]. In Kenya, for example, adopting a healthy, flexitarian diet would mean a net increase in per capita meat consumption. This is especially true for low income households that currently rely on staple grains. Other opportunities to **increase carbon storage** would need to be applied to help offset this – including through action outside food systems.

DECREASES IN FOOD AVAILABILITY AND AFFORDABILITY

Where producers are shifting production practices and making changes on their farms and in their supply chains, for instance to **restore biodiversity** or **increase diversity,** or are receiving **redirected subsidies** to produce different foods, there could be adverse impacts on short-term food availability. Yields could be reduced and the quantity, affordability and accessibility of food could be affected, with supplies being concentrated in wealthier countries or communities who can afford to pay more. Long-term, the adoption of nature-positive production practices could lead to certain nutrient-dense foods becoming more expensive. This would be a particular issue if production shifts occur in a limited amount of countries, for instance in TYPE I food systems (Brazil and Colombia). If these countries reduce their production, and therefore their export, of certain foods, TYPE II and III countries (Kenya and UAE respectively) who rely on food imports may struggle to source enough nutritious food for their citizens.

As such, food-producing countries – in particular TYPE I (Brazil and Colombia), where these levers have high potential - should consider **providing financial incentives and taxes to improve consumption** to ease any adverse impacts. Countries reliant on imports (Type II and III, Kenya and UAE) should consider **improving diversity** and **promoting traditional foods**, as well as **strengthening research and development** and applying other levers to reduce food loss and waste, to safeguard themselves against changing dynamics in global markets.

CHAPTER 6
RECOMMENDATIONS

A full range of stakeholders will be required to implement national-level food systems transformation - including policymakers, the private sector, scientists, non-governmental organisations, the private sector and individuals. Explicitly, smallholder farmers, women, youth, indigenous people, local communities and other historically-marginalized and vulnerable people need to be involved in shaping transformations. **Specific action that different stakeholders can take include:**

POLICYMAKERS CAN:

1. Feature food system transformation prominently in national climate, biodiversity and health plans. This includes embracing a food systems approach that incorporates all parts of the food system in Nationally Determined Contributions (NDC), National Adaptation Plans (NAPs), National Biodiversity Strategy and Action Plans (NBSAPs) and any other relevant national climate and biodiversity policies.

2. Develop country-specific roadmaps to inform the design and implementation of effective policies and initiatives. These roadmaps can be informed by the key levers outlined in this study and others, and build upon the existing work done by the FABLE consortium, UNFSS Food Systems Dialogues and UNFSS Coalitions of Action.

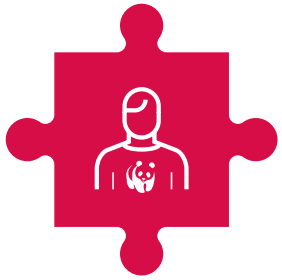
3. Mobilize and coordinate expertise and stakeholders to align action on food systems at the country-level, which to date is often siloed and fragmented. This aligned action should also seek to facilitate peer-to-peer learning within and between countries that share similar food system types. The UNFSS Coordination Hub can help to facilitate this process.

THE PRIVATE SECTOR CAN:

1. Ensure that investments are made in higher potential transformation levers in the countries they are operating. This will ensure that investments are strategically targeted to deliver the most impact in the shortest time possible.

2. Commit to including all food-based emissions into science-based targets (SBTs). To date, many companies are setting SBTs and reporting their emissions publicly. However, few account for AFOLU emissions or removals in their targets or disclosures. The newly released Forest, Land and Agriculture (FLAG) targets from the Science Based Targets Initiative will help companies to develop more robust SBTs using a food systems approach.

3. Commit to including biodiversity targets in SBTs. Most SBTs focus on GHG emissions and few include biodiversity goals. More research on setting biodiversity targets needs to be done but companies can begin by working with organizations, such as WWF, to set initial targets.



SCIENTISTS CAN:

1. Help build a robust body of scientific work to better understand food system transformation at the national level. This includes helping to build and refine a global typology of food systems and continue testing this concept through additional research and local context analysis.

2. Scale research on the cultural, political and social elements of food system transformation. In addition, research on how systems thinking can be applied in the national context is needed to ensure feasibility of implementation of actions.

3. Develop research agendas to better understand food system impacts on biodiversity and how this can be measured. This will also assist countries in the setting of national-level biodiversity targets and companies in setting science-based targets (SBTs) that include biodiversity.

NON-GOVERNMENTAL ORGANIZATIONS CAN:

1. Integrate food systems into all climate and biodiversity conservation targets and goals in countries where the NGO is present. This includes more alignment on how conservation goals (e.g. tiger conservation) are connected to action on food systems.

2. Participate in the UNFSS Coalitions of Action and help to integrate conservation and environmental goals with and across the existing coalitions.

3. Adopt and help refine the concept of **Ecological Food System Hotspots** and scale action and commitments on food system transformation in those areas.

INDIVIDUALS CAN:

1. Depending on availability and affordability, consider their own food choices and act upon those choices. The food that one chooses to eat may be the single most important and impactful environmental action that can be taken by an individual. Tools, such as WWF's Impact Action Calculator, can help individuals to assess the impact of their diets based on the country where they live.

2. Advocate for policies that have the most impact in their country. This report can serve as a guide for identifying key levers of action depending on a country's food system type. This will help to ensure that mobilized action will have the most impact depending on local context.

3. Buy from farmers, retailers, restaurants and businesses who are actively working to reduce the impact of food systems on climate and biodiversity. When identified, spread the word and mobilize others to support organizations that are committed to making choices that are good for people and planet.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APPENDICES

APPENDIX 1. CAVEATS AND LIMITATIONS

1. **There are limits to a national-level approach to food system transformations.** Thinking of food systems at the national level can help reveal important insights about the role of national policy in food system transformations. However, there are important limitations to this approach, both in failing to capture *intra-country heterogeneity* and also the globalized nature of food systems.

    a. **First, food policy also needs to account for sub-national variance in food systems within each country.** Just as there is considerable variation between the food system challenges, solutions and trade-offs between countries, so there exists considerable variation within each country. Some stakeholders in each country think about multiple food systems within their focal countries, based on sub-regions that have very different characteristics. So, while researchers and others are correct to point to the limitations of a global-level analysis of food system needs, that does not make a national approach a perfect level of analysis.

    b. **Second, national food systems are part of a globalized food system.** No country is completely food self-sufficient or independent, nor is it clear that that would be a desirable goal in terms of food security or environmental goals. Some foods grow optimally in other parts of the world, and are better transported from one country to another. When analyzing food system transformations as we do here, it is important to remain cognizant of the complex and necessary global trade (both imports and exports) and reliance on other countries.

2. **The use of a food systems typology is in the early stages of development and more work needs to be done.** There is an important need to reduce the analytical complexity of identifying policy actions that are needed to improve both human health and environmental sustainability in countries around the world. UNFSS Coalitions of Action are ramping up efforts to work with individual countries to transform various aspects of their food systems and a shared framework for doing so would help to facilitate these efforts. We encourage all stakeholders to help in the efforts of building a robust global food systems typology and identifying a set of key levers that work across countries. **In this study, we humbly propose an analytical framework and initial set of key levers to guide this development and welcome all suggestions for improvement.**

APPENDIX 2.

Additional examples of initiatives undertaken in the UAE in recent years to strengthen both food security and food sovereignty.

https://mbrsgcdn.azureedge.net/cmsstorage/mbrsg/files/85/859ddec7-f5ed-48dd-99dd-4e1b8f326112.pdf

https://u.ae/en/information-and-services/environment-and-energy/food-security

https://www.mdpi.com/2071-1050/14/10/6375

https://www.biosaline.org/sites/default/files/publicationsfile/paper-jebas-2017-uae.pdf

https://u.ae/en/about-the-uae/strategies-initiatives-and-awards/federal-governments-strategies-and-plans/the-uae-water-security-strategy-2036

https://hbr.org/sponsored/2022/04/how-the-uaes-water-innovations-are-helping-to-build-a-more-sustainable-future

APPENDIX 3. COMPLETE FOOD SYSTEM NDC ASSESSMENT

For the full assessment of food systems in NDCs and NAPs please use the following link.

APPENDIX 4. DEFINITIONS OF ACTION AREAS

Improved production practices. A shift in agricultural practices could take many forms but, in this report, we adopt the definition of improved production practices used by EAT-Lancet (2019)[1] as "closing of yield gaps to about 75%; rebalancing nitrogen and phosphorus fertilizer application between over and under-applying regions; improving water management; and implementation of agricultural mitigation options that are economic at the projected social cost of carbon in 2050."

Reduced food loss and waste. Definitions of food loss and waste have varied over time. We use the definition for food loss and waste from the Food and Agriculture Organization's 2019 State of Food and Agriculture Report, which aligns with SDG Goal 12.3 (Sustainable Consumption and Production). Using these definitions, food loss "occurs along the food supply chain from harvest/slaughter/catch up to, but not including the retail level" and food waste "occurs at the retail and consumption level" (FAO 2019)[71].

Shift towards healthier diets. A healthy diet can be defined in many ways. In this report, we adopt the EAT-Lancet (2019)[1] definition as "diets that have an optimal caloric intake and consist largely of a diversity of plant-based foods, low amounts of animal-source foods, contain unsaturated rather than saturated fats, and limited amounts of refined grains, highly processed foods and added sugars."

APPENDIX 5. LITERATURE REVIEW

We reviewed the literature to identify ways in which food system transformations may share commonalities or may manifest differently across the four focal countries. We reviewed peer-reviewed journal articles and the gray literature (e.g., reports, websites). In both cases, we used keyword searches and snowball citations to identify relevant literature to inform the report. Keyword searches included the focal countries, strategies, and outcomes of interest. We also communicated with relevant stakeholders in each country to seek recommendations for and access to additional publications that could inform our research. We began with the WWF country offices and our own networks in each country and used a snowball approach from there. We used the literature to inform our characterization of each country's food system, the potential for each strategy to be effective and relevant in each country, and to identify policies and programmes that are attempting to transform each country's food system. We also used the literature as citable published evidence to further support the ideas expressed in the interviews.

SEMI-STRUCTURED INTERVIEWS

We conducted semi-structured interviews with 68 key stakeholders in Brazil (N = 20), Colombia (N = 16), Kenya (N = 21), and the United Arab Emirates (N = 11) (Table S1). These interviews were conducted and analysed by the contributing authors HB, SDO, WE, MH, and PN. The interviews helped to inform those parts of the report written by those contributing authors. Interviewees all had expertise in agriculture and/or food systems at the national level in one or more of the four countries. They all had expert knowledge that related to the question: To what degree and in what ways might food system transformations vary between countries? They included researchers, representatives of governmental agencies, representatives of non-profit organizations and representatives of private sector organizations. Some interviewees drew on their experiences working in multiple sectors throughout their careers.

Interviews were primarily conducted by Zoom. Interviews were structured around a common set of core questions (Appendix 6). The core questions related to the three focal strategies (shifting towards healthier diets, reducing food loss and waste, and improving production practices); interviewees could choose to respond to questions related to one, two or all three strategies depending on their expertise. Follow-up questions were asked to individual interviewees, depending on their responses to the core questions. Before each interview, each interviewee was provided with background information about the study and the definitions being used. The primary objective of the interviews was to collect qualitative data on the interviewees' perceptions of: some of the main barriers to food systems transformation; some of the main solutions that have been or could be or should be pursued; and any notable trade-offs involved. We used the qualitative interview data to characterize stakeholder perceptions of the opportunities, barriers, and trade-offs involved in pursuing each strategy in each country.

Table S1
Interviewees, broken out by country and sector. Note that only the sector in which the interviewee was currently employed is indicated. Many interviewees had extensive experience from across multiple sectors throughout their careers.

Sector	Brazil	Colombia	Kenya	UAE	Total
Private	2	1	4	6	13
Public	5	6	3	1	15
Non-profit	8	6	10	3	28
Academia	5	3	4	1	13
Total	**20**	**16**	**21**	**11**	**68**

ANALYSIS

We reviewed the data from the literature review and semi-structured interviews and selected six broad categories of transformational levers where there were high-level commonalities. These broad categories enable us to ask: What role could *natural resource management, governance and institutions, education and knowledge, technology, trade* and *finance* play in achieving a food system transformation in each country? These categories are commonly used in the literature when considering potential levers to effect systems change. In Chapter 4, we drew on the literature and interviews to describe and illustrate how the potential of a lever to transform a particular food system type may differ on the ground and in practice, depending on the specific context of each country (i.e. food system type). In aggregate, we selected categories and actions to cover as much of the content of the literature review and interviews as possible, under as few subsections (combinations of categories and actions) as possible.

APPENDIX 6. SEMI-STRUCTURED INTERVIEW SCRIPT

The interview will take the form of an informal conversation. We hope to structure this conversation around the following questions, though we can focus on those topics that are most relevant to your expertise. We can also discuss related issues that arise.

1. Could you please introduce yourself and describe your relevant expertise with regard to food systems and food systems transformations in [country]?
2. We are interested in how food system transformations may vary between countries. What characteristics relevant to food system transformations are unique to, or characteristic of, [country]?

Improved production practices

3. What are the 2-3 main barriers to transforming the food system by improving production practices in [country]?
4. What are the 2-3 main solutions that [country] has pursued or is pursuing to transform the food system by improving production practices? This could include the main strategies, policies, programmes, or initiatives.
5. What are the 2-3 main solutions that [country] could or should pursue to transform the food system by improving production practices?
6. Are there any notable trade-offs that would result from reducing greenhouse gas emissions, conserving biodiversity or improving food security through improved production practices in [country]?

Food loss and waste

7. What are the 2-3 main barriers to transforming the food system by reducing food loss and waste in [country]?
8. What are the 2-3 main solutions that [country] has pursued or is pursuing to transform the food system by reducing food loss and waste? This could include the main strategies, policies, programmes, or initiatives.
9. What are the 2-3 main solutions that [country] could or should pursue to transform the food system by reducing food loss and waste?
10. Are there any notable trade-offs that would result from reducing greenhouse gas emissions, conserving biodiversity or improving food security through reduced food loss and waste in [country]?

Healthier diets

11. What are the 2-3 main barriers to transforming the food system by shifting towards healthier diets in [country]?
12. What are the 2-3 main solutions that [country] has pursued or is pursuing to transform the food system by shifting towards healthier diets? This could include the main strategies, policies, programmes, or initiatives.
13. What are the 2-3 main solutions that [country] could or should pursue to transform the food system by shifting towards healthier diets?
14. Are there any notable trade-offs that would result from reducing greenhouse gas emissions, conserving biodiversity or improving food security through shifting towards healthier diets in [country]?

Other opportunities, barriers, and trade-offs

15. Are there other barriers, solutions and/or trade-offs that you consider critical to achieve food systems transformations in [country] and that should be considered?
16. Who else do you recommend we talk with about this issue?

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