

Transforming food systems under climate change: Local to global policy as a catalyst for change

Working Paper No. 271

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Tonya Rawe
Marta Antonelli
Allison Chatrchyan
Terry Clayton
Jessica Fanzo
Julian Gonsalves
Alan Matthews
Danielle Nierenberg
Monika Zurek



RESEARCH PROGRAM ON
**Climate Change,
Agriculture and
Food Security**



Working Paper

Transforming food systems under climate change: Local to global policy as a catalyst for change

Working Paper No. 271

CGIAR Research Program on Climate Change,
Agriculture and Food Security (CCAFS)

Tonya Rawe
Marta Antonelli
Allison Chatrchyan
Terry Clayton
Jessica Fanzo
Julian Gonsalves
Alan Matthews
Danielle Nierenberg
Monika Zurek

Correct citation:

Rawe T, Antonelli M, Chatrchyan A, Clayton T, Fanzo J, Gonsalves J, Matthews A, Nierenberg D, Zurek M. 2019. Transforming food systems under climate change: Local to global policy as a catalyst for change. CCAFS Working Paper no. 271. Wageningen, the Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Available online at: www.ccafs.cgiar.org.

Titles in this Working Paper series aim to disseminate interim climate change, agriculture and food security research and practices and stimulate feedback from the scientific community.

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is a strategic partnership, led by the International Center for Tropical Agriculture (CIAT). The Program is carried out with support from the CGIAR Trust Fund and through bilateral funding agreements. For details please visit <https://ccaafs.cgiar.org/donors>.

Contact:

CCAFS Program Management Unit, Wageningen University & Research, Lumen building, Droevendaalsesteeg 3a, 6708 PB Wageningen, the Netherlands. Email: ccaafs@cgiar.org

Creative Commons License



This Working Paper is licensed under a Creative Commons Attribution – NonCommercial–NoDerivs 3.0 Unported License.

Articles appearing in this publication may be freely quoted and reproduced provided the source is acknowledged. No use of this publication may be made for resale or other commercial purposes.

© 2019 CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). CCAFS Working Paper no. 271

DISCLAIMER:

This Working Paper has been prepared as an output for the *Transforming Food Systems Under a Changing Climate* initiative led by CCAFS and has not been peer reviewed. Any opinions stated herein are those of the author(s) and do not necessarily reflect the policies or opinions of CCAFS, donor agencies, or partners.

All images remain the sole property of their source and may not be used for any purpose without written permission of the source.

Abstract

Feeding and nourishing a growing and changing global population in the face of rising numbers of chronically hungry people, slow progress on malnutrition, environmental degradation, systemic inequality, and the dire projections of climate change, demands a transformation in global food systems. Policy change at multiple levels is critical for catalysing an inclusive and sustainable transformation in food systems; global and regional policy are transformative only insofar as they are translated into ambitious national action with adequate support, including both public and private investment.

Three areas of policy change show potential to be catalytic: 1) reducing emissions and increasing resilience, 2) tackling food loss and waste, and 3) shifting diets to promote nutrition and sustainability. Trade-offs mean a multi-sectoral approach to policymaking is needed, while inequalities in food systems necessitate transparent, inclusive processes and results. Gender inequality, in particular, must be addressed. Transformation demands participation and action from all actors.

Keywords

Climate change; food systems; food security.

About the authors

Tonya Rawe (coordinating author) is CARE International's Director of Global Food and Nutrition Security Advocacy. Email: tonya.rawe@care.org

Marta Antonelli is a Research Programme Manager of the Barilla Center for Food & Nutrition Foundation and a Senior Research Associate at the Euro-Mediterranean Centre on Climate Change.

Allison Chatrchyan is the Director of the Cornell Institute for Climate Smart Solutions and a Senior Research Associate in the Departments of Development Sociology and of Earth & Atmospheric Sciences at Cornell University.

Terry Clayton is the Managing Director at Red Plough International.

Jessica Fanzo is a Bloomberg Distinguished Associate Professor of Ethics and Global Food & Agriculture at the John Hopkins Berman Institute of Bioethics.

Julian Gonsalves is the Senior Program Advisor for Asia and former Vice President at the International Institute of Rural Reconstruction in the Philippines.

Alan Matthews is a Professor Emeritus of European Agricultural Policy in the Department of Social Sciences and Philosophy at Trinity College Dublin.

Danielle Nierenberg is the President of Food Tank.

Monika Zurek is a Senior Researcher at the Environmental Change Institute at the University of Oxford.

Acknowledgements

This paper was written as part of the *Transforming Food Systems Under a Changing Climate* initiative, led by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). The authors would like to thank their respective organizations and CCAFS for their support of this work.

Transforming Food Systems Under a Changing Climate:

About the initiative

Transforming Food Systems Under a Changing Climate is an initiative led by CCAFS that aims to realize a transformation in food systems by mobilizing knowledge and catalyzing action. The initiative brings together leaders in science, business, farming, policy and grassroots organizations to identify pathways for transformation. To find additional publications in this series and for more information, please visit:

<http://bit.ly/TransformingFood>.

Contents

Introduction.....	7
How policy enables transformation	8
Food system activities, drivers and outcomes.....	10
Food system typologies.....	11
National policy as a catalyst for change	13
Reducing emissions and building resilience	14
Tackling food loss and waste	17
Addressing diets for health and the environment	19
Inequality, power dynamics, and trade-offs: policy considerations	21
Global policy as a framework for change	23
Climate change & sustainable development	24
Trade	24
Finance policy as an enabler of change	25
Conclusion/recommendations	26
References.....	28
Endnotes.....	36

Acronyms

AEM	Agricultural Environmental Management
CRF	Climate Resilient Farming
GHG	Greenhouse gas
HLPE	High Level Panel of Experts
NAMAs	Nationally Appropriate Mitigation Actions
NDCs	Nationally Determined Contributions
SDGs	Sustainable Development Goals

Introduction

Our global systems are failing to deliver basic food and nutrition needs while exacting a heavy environmental cost. The number of people facing chronic hunger has increased in the last few years, progress to reduce stunting and wasting is slow, and overweight and obesity is a growing challenge everywhere, creating a heavy, double or triple burden for most countries. Precise estimates vary depending on what sectors are included in the calculation, but ‘food systems’ account for as much as 30 percent of greenhouse gas emissions. Nearly a third of the food produced is lost or wasted, resulting in lost income, lost nutrients, wasted resources, and significant greenhouse gas emissions. Looking ahead, global food systems are expected to feed and nourish a growing global population with diets shifting toward higher consumption of animal products as incomes increase. As food system value chains contribute to global warming, they in turn become increasingly vulnerable to its impacts. The Intergovernmental Panel on Climate Change (IPCC) has been clear that climate change will impact all aspects of food security.

Systemic inequality, including in food systems, traps nearly a billion people in poverty, hunger, and malnutrition, and leaves billions vulnerable to climate change. While there are over 750 million producers and 7 billion consumers, there are far fewer actors in between (processors, wholesalers, retailers) and even fewer who wield significant power in food systems and markets. Women in particular face systemic inequality within food systems in terms of equal access to land, credit, and extension training, reflecting broader inequalities in society. In poor households, they are often responsible for homestead agriculture, making them the ‘guardians’ of household food security. In some societies, women are not recognized as ‘farmers,’ so services and technologies are not designed to meet their needs. They bear a disproportionate labor burden, often in the form of unpaid care work, leaving little or no time to expand their income generation activities, to seek further education, or to participate in decision-making processes.

While the number of chronically hungry people increased in the last two years, it did fall in the early part of the 21st century. Technological advances reduced the drudgery of agricultural work, but access to technology is unequal. In many countries, progress resulted in safer food supplies and reduced the share of household budgets spent on food. However, even in countries where progress has been made, poverty,

hunger, malnutrition, and obesity still exist, and food prices do not reflect the true environmental and social costs of food.

The challenge is significant and the goals the global community has set itself are ambitious. In 2015, countries adopted the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs). SDG 2 pledges to end hunger and malnutrition and achieve food security, while SDG 13 and the Paris Agreement commit actors to building resilience and adaptive capacity and keeping the increase in global temperatures below 2°C and, ideally, below 1.5°C. All seventeen SDGs reflect the interdependence of environmental, social, economic, and political dynamics and many goals depend on or impact food systems. Achieving any one goal is not possible without progress on the others and yet in the short term, progress may entail trade-offs among them.

Feeding and nourishing a growing and changing global population in the face of current challenges and the dire projections of climate change demand a transformation in global food systems. No transformation can succeed without a robust effort to tackle and redress unequal power dynamics in food systems. The challenge we face and the goals we have set demand sustainable, resilient, climate smart, inclusive food systems that deliver affordable, culturally appropriate, healthy diets for all, today and tomorrow. To achieve these goals requires policy that will bring about genuinely transformative change.

How policy enables transformation

For a genuine transformation in food systems, policy has to remove barriers and provide incentives to shape the behaviour of actors. Policy for transformation must foster a level playing field, facilitate equitable access to resources, and ensure that the heavy lifting is done by those best able to bear the costs, while ensuring transparency and accountability. It must also mobilize and direct resources, both private and public, to priority areas.

To create systems that promote sustainability, growth, equity, and resilience, policy change is needed beyond agriculture, as food systems cut across most sectors. National policy plays a critical role in shaping food systems and must reflect varying contexts, resources, and capabilities. Subnational policy is needed to address local

challenges, catalyse citizen action, and demonstrate the potential for scaling out and up.

Global and regional policy frameworks capture commitments and standards for national and local action, which must then be translated into regional, national, and local initiatives with policy coherence to ensure coordination. National and local policy priorities in turn shape countries' engagement in multilateral processes. Figure 1 illustrates this complexity of scales and actors. Without effective coordination, communication, and collaboration, the multiple scales and actors that shape global food systems policy can lead to chaos: conflicting approaches, elite capture of benefits, and an entrenchment of poverty, hunger, and malnutrition.

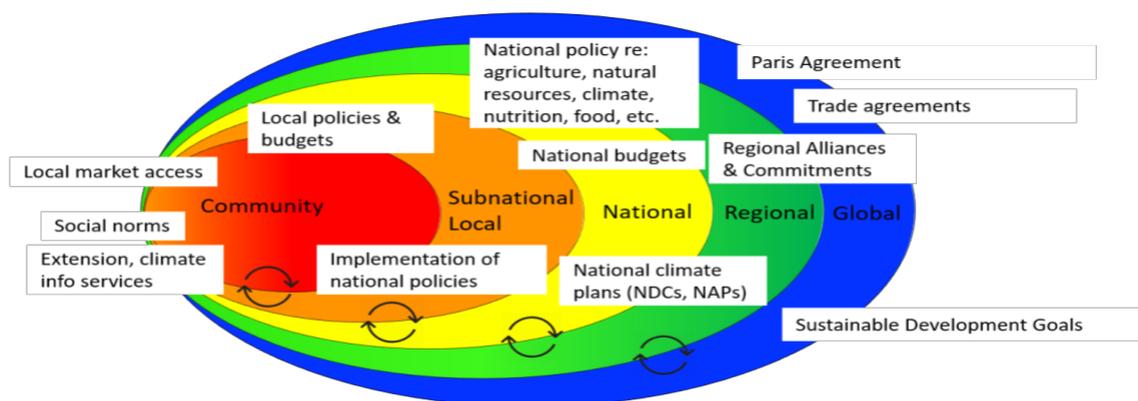


Figure 1. Global to local policies for transformational food systems.ⁱ

Policy coherence means policies are mutually reinforcing, create synergies that help achieve common objectives, and avoid or minimize duplication, contradiction, or negative consequences in other policy arenas. Transformation implies there will be trade-offs among different actors in food systems and will require that policy does not forget those left behind. There will also be trade-offs among economic, social, and environmental goals. Furthermore, in the face of unequal power dynamics in food systems and political processes, there is always the risk of policy being set by those with power at the expense of those without. Policy making for transformation must, therefore, be grounded in a commitment to equity and sustainability. Policies themselves must be inclusive, and policy processes must engage the wide range of actors in food systems, ensuring effective participation by marginalized groups.

While the concept of food systems has gained significant traction in global dialogues, policy appears to lag. Governments have not set policy and strategy to address food systems specifically, but rather tackle particular issues, challenges, or actors within

food systems, like agriculture or nutrition, farm support or marketing regulation. This piecemeal approach is much like chipping away at an iceberg. Below, we highlight examples of policies that show potential to catalyse transformation in one or more areas. This paper is not intended to be exhaustive but to share ideas and stimulate discussion of the opportunities and the imperatives for facilitating a transformation in food systems grounded in sustainability and equity.

Food system activities, drivers and outcomes

A food system includes growing, harvesting, processing, packaging, transporting, marketing, consuming, and disposing of food and food-related items by numerous food system actors, all influenced by drivers and processes determining how these activities are performed. Activities by actors in food systems result in outcomes (Figure 2) that feed information back to environmental and socioeconomic driving forces. Food systems are a continuum, and no classification can fully account for the huge diversity within each type. Multiple food systems co-exist within any given country. Typologies are useful because they illustrate the complexity of food systems and allow researchers and policy makers to consider the diversity within systems when designing policies and interventions.

For a food systems approach to be effective, those using it must be mindful that food systems are dynamic and comprise multiple actors with multiple motives who face a range of policy, market, social, technological, and biophysical environments and other drivers that influence their activities.

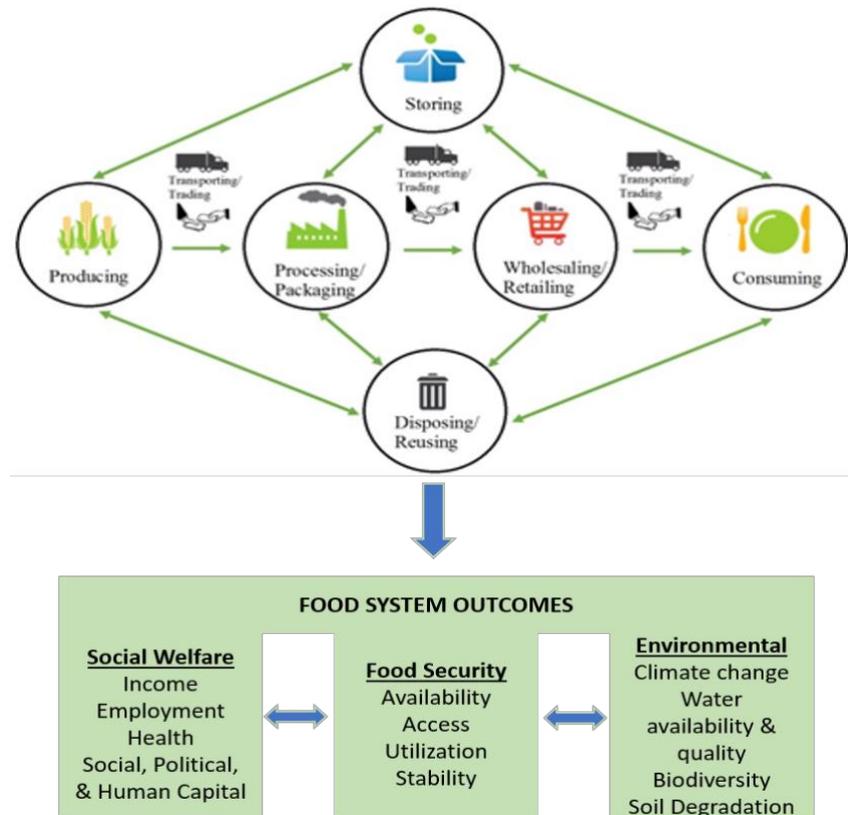


Figure 2. Food systems activities and outcomes.ⁱⁱ

Food system typologies

The 2017 High Level Panel of Experts Report on Nutrition and Food Systems (HLPE) classifies food systems as modern, mixed, and traditional. Each considers the food supply chain and food environment and classifies countries based on dietary energy in the food supply, the extent of urbanization, food affordability, and food-based dietary guidelines.ⁱⁱⁱ The HLPE is one of many such classifications and reflects the underlying reality that there is a great deal of diversity among different kinds of food systems. All such classifications imply there are different challenges and therefore different priorities for where, when, and how policy can catalyse change. While the HLPE classification does not take into account greenhouse gas emissions or climate vulnerability, it remains a useful device for framing policy considerations.

Table 1. The HLPE classification for food systems

	Modern	Mixed	Traditional
	High & high-middle income countries. e.g. Canada, the Netherlands, Australia, Brazil, Turkey, South Africa	High-middle & low-middle income countries; some high-income & low-income countries. e.g. India, Peru, Ghana, Romania, Czech Republic, Nepal	Low-income & low-middle income countries, e.g., Haiti, Nicaragua, Kenya, Cambodia, Pakistan, Tanzania
Production, Markets, Loss/Waste, & Climate Change	<p>Small- to industrial-sized farms.</p> <p>High concentration at both ends of the food supply chain (agricultural input suppliers, food processors and retailers).</p> <p>Greenhouse gas emissions from agricultural production are high on a per-hectare basis due to high input use, but low per kg of food produced (emissions intensity) due to high productivity.</p> <p>High levels of food waste also contribute greenhouse gas emissions.</p> <p>Higher temperatures, drought, flooding, & shifting seasons will increase risk of insect damage & demand for water, lead to crop losses.</p>	<p>Changes in temperature, precipitation, extreme weather, & sea level rise will affect food storage, processing, transportation & infrastructure.</p> <p>Climate impacts are expected to increase foodborne pathogens, mycotoxins,^{iv} cold storage requirements,^v risk of spoilage, loss, & waste.^{vi} Climate impacts may decrease food availability & increase food prices, which will have the greatest impact on food insecure populations.</p> <p>Greenhouse gas emissions may be low or high depending on predominate crops, livestock species, & level of input use.</p>	<p>Small land parcels, limited access to low-cost technologies, limited use of external inputs, markets often informal or lacking, subsistence livelihoods.^{vii}</p> <p>Greenhouse gas emissions tend to be low per hectare but high per kg of food produced due to low productivity, especially in livestock systems.</p> <p>Food losses are also responsible for greenhouse gas emissions.</p> <p>Climate vulnerability is high.^{viii}</p> <p>Increasing temperatures & decreased water availability will increase food spoilage and loss.^{ix}</p> <p>Reduced access to sufficient nutrient-dense foods will impair nutritional status and diminish resiliency, particularly among poorest.</p>
Consumption & Diet	<p>Wide array of foods available anywhere at any time.</p> <p>High levels of meat consumption drive greenhouse gas emissions.</p> <p>Abundance of highly processed, packaged foods high in sugar & unhealthy fats</p>	<p>Urbanization & income growth increasing demand for animal-sourced foods, processed & convenience foods, street food, & fast, ultra-processed foods.</p> <p>Low-income among some populations</p>	<p>Rural diet is largely staple grains & tubers, legumes & some seasonal vegetables & fruits, with less access to animal-sourced foods.</p> <p>Many living in poverty are small-scale farmers in rural areas, often susceptible to hunger,</p>

	<p>associated with increased risk of overweight, obesity, & non-communicable diseases.</p> <p>Consumers mainly urban.</p> <p>Small but growing population segments experience food insecurity.</p> <p>High standards & strict controls on food quality and safety.</p>	<p>limits access to healthy food.</p> <p>Increases in obesity, diabetes, cardiovascular, & other ‘lifestyle’ diseases.</p> <p>Regulation increasing the amount of information available about food & improving quality & safety of food.^x</p> <p>Increasing meat consumption drives increases in greenhouse gas emissions.</p>	<p>undernutrition,^{xi} & wasting & stunting.</p> <p>Urban consumers are increasingly exposed to street foods & highly processed, cheap packaged foods, & rely more on imported foods.</p>
Areas for policy change	<p>Policy to:</p> <ol style="list-style-type: none"> (1) incentivize & promote sustainable & resilient food production, more efficient water-use, & alternative energy; (2) reduce food loss & waste (farm to fork); (3) promote better nutrition & more sustainable diets; (4) hold actors accountable for promoting more equitable access to nutritious food (e.g. school & other institutional cafeterias; package labelling). 	<p>Policy to:</p> <ol style="list-style-type: none"> (1) build resilience of food production & food supply chains; (2) support climate-smart agriculture, in particular for smallholder farmers; (3) strengthen extension services, particularly for women; (4) promote healthier, sustainable diets; (5) ensure low-income populations are not left behind; (6) better coordinate with public health policy; (7) mandate more stringent food labelling policies. 	<p>Policy to:</p> <ol style="list-style-type: none"> (1) improve access among rural poor to productive resources, resilient livelihoods; (2) strengthen markets to connect rural producers to urban markets; (3) build adaptive capacity among the most vulnerable, & support smallholder & subsistence farmers, & women; (4) improve availability of nutritious foods; (5) better coordinate with public health policy; (6) mandate more stringent food labelling policies.

National policy as a catalyst for change

Food systems, including the consumption patterns that drive production, have a considerable role to play in mitigating climate change and are at the same time highly vulnerable to its impacts. We identify three areas where policy could: 1) reduce greenhouse gas emissions and increase resilience in food systems, 2) tackle food loss and waste, and 3) shift diets to promote nutrition and sustainability. We also reflect on

several cross-cutting policy considerations to address inequality, unequal power dynamics, and trade-offs in food systems.

Reducing emissions and building resilience

Mitigation and adaptation measures will need to respond to the unique physical, ecological, and socioeconomic circumstances of different food systems. Policies can support mitigation in the agriculture sector by incentivizing or requiring farmers to conduct greenhouse gas (GHG) emissions audits or develop plans to improve efficiency, reduce energy use in transportation and infrastructure, use renewable energy sources, manage agricultural waste, reduce emissions from livestock, and sequester carbon in soils and biomass. Policies can support adaptation by incentivizing improvements in soil health (which also help reduce GHG emissions), managing water resources more efficiently, reducing heat stress, and using Integrated Pest Management, agroforestry, and agroecology practices.^{xii}

Extension services can help farmers to reduce emissions and build resilience and can strengthen national agricultural development and local economies. Extension services are well-positioned to play a major role in disseminating accurate, timely, evidence-based climate change information and training that farmers so urgently need.^{xiii} Yet, extension services in most countries are underfunded and government-supported extension services and other agricultural knowledge resources have been lost or replaced by private sector agents in the business of selling inputs to farmers. Investment and policies for extension can also address issues of equity and equality, including equal access to services for men and women.

Beyond extension and provision of information to enable adoption of practices, regulatory and financial policy can incentivise actions and behaviours to increase resilience and/or reduce greenhouse gas emissions in food systems. These approaches include subsidies reform, pricing carbon, payment for ecosystem services, and governance improvements, among others.

Financial or market mechanisms like subsidies or payment for ecosystem services can be effective means to both incentivize action and, for farmers facing financial constraints, remove a barrier to adoption of practices. A review of ‘market-smart’ input subsidies programs Ghana, Malawi, Nigeria, Tanzania, and Zambia found them to be “generally successful in increasing input use, maize production, maize yields and food security, at least under favourable economic and weather conditions, and in promoting private rural input business.”^{xiv} Similarly, in Costa Rica, where nearly one

million hectares of forest have been part of payments for ecosystem services schemes since 1997, forest cover has returned to over 50 per cent of the country's land area, from a low of just over 20 per cent in the 1980s.^{xv}

Carbon pricing can serve as both a market-based and regulatory approach to shaping practices. Applied across food systems, carbon pricing can address emissions beyond the farm and along the supply chain, including in transport and energy sectors. In 2008, ten north-eastern states in the USA implemented a carbon cap and trade system to reduce their carbon dioxide (CO₂) emissions from the power sector by 10% by 2018. In the first two years, the Regional Greenhouse Gas Initiative (RGGI) – the first mandatory GHG emissions trading system in the United States – generated USD 789 million through the auctioning and direct sale of CO₂ emissions allowances.^{xvi}

Good governance and a level playing field are a critical foundation for the success of these financial and regulatory approaches. Land tenure is a prerequisite to incentivize the adoption of practices that can not only reduce emissions and increase resilience but also improve the health (and value) of land. The ‘greening of Sahel’ in Sub-Saharan Africa has been, in part, a response to improved land tenure policies, such as the policy in Niger that repealed a colonial era law on government ownership of trees.^{xvii} Similarly, inclusive market access is critical, particularly for small-scale food producers, to source inputs and sell the surplus from increased productivity. In Thailand, the Ministry of Agriculture and Cooperatives rolled out a productivity and marketing plan (2018) to improve the livelihoods of farmers facing low prices due to oversupply. The plan includes fostering food processing businesses through agricultural cooperatives and facilitating linkages between producers and the private sector for purchase of rice.^{xviii}

Policy examples

Modern

The Climate Resilient Farming (CRF) Program (New York, USA)^{xix} aims to support farmers to reduce greenhouse gas emissions from agriculture and to build the resilience of their farms in the face of a changing climate. Before the CRF, farmers using an Agricultural Environmental Management (AEM) framework to plan for and address environmental risks could access funding only related to water quality issues. The CRF program expands support to farmers to address both climate risks and GHG emissions, providing cost sharing for farms who complete an AEM Plan to adopt new technologies and practices such as manure storage covers. This kind of program helps farmers to address needs they have identified and provides opportunities to capitalize on potential synergies by supporting approaches that address both mitigation and adaptation needs.

Modern

The NAMA Café (Costa Rica)^{xx}. Costa Rica's Nationally Appropriate Mitigation Actions (NAMAs) for the coffee sector – NAMA Café – is part of a wider effort to attain carbon neutrality by 2021. This collaboration between the public, private, financial and academic sectors aims to reduce GHG emissions and improve resource use efficiency in the coffee sector, targeting the entire value chain from farmers to exporters. Support to coffee plantations and coffee mill operators includes capacity building and awareness raising to increase technical knowledge of low-carbon production; market studies to facilitate access to markets for differentiated coffee at favourable prices; and financial support and incentives, such as partial guarantee for low interest credit, Costa Rica's payment for environmental services systems, and subsidies for capital investment to facilitate adoption of practices and technologies. The NAMA's ten-year goal is to reach the entire coffee production area and set the stage for expansion to different agricultural systems and other sectors.

Mixed

The Women Extension Volunteer Approach (Ghana)^{xxi}. In Ghana, women farmers account for over 70 percent of total food production and are responsible for household nutrition.^{xxii} Women farmers receive only a fraction of the inputs and support their male counterparts receive.^{xxiii} This pilot program aimed to provide affordable extension delivery systems and increase service coverage to women farmers in remote areas. As a collaboration between the Ministry of Food and Agriculture and the Voluntary Service Overseas Ghana,^{xxiv} the initiative continues to have the support of VSO Ghana and local and national MoFA staff members. VSO hopes to expand the program to more communities and regions in Ghana. Given the importance of women in agriculture in middle and low-income countries, no policy can claim to be transformative without explicitly addressing gender.

Traditional

The Agricultural Sector Development Support Program (Kenya)^{xxv} scales up a participatory scenario planning approach to disseminate annual weather forecasts and enable farmers, governments, and other actors to jointly formulate action plans. This approach, developed by CARE, brings together multiple stakeholders, including the Kenya Meteorological Department as well as community members, to discuss available weather forecasts and local experience with past weather patterns. Together, stakeholders develop actionable scenarios. The approach not only builds the capacity of community members to access and interpret weather information, but also brings together scientific and local knowledge and enables collective development of climate resilient plans and advisories, thus promoting good governance and inclusivity.

The policies highlighted are not necessarily ground-breaking but represent approaches that need significantly more investment and scaling up – approaches that reach farmers directly and that meet the needs they identify in the face of climate change.

These policies can also capitalize on techniques, information, and practices that address both adaptation and mitigation. They might also tap into the tremendous potential of technology, such as mobile phone apps, to engage with small-scale farmers.^{xxvi} In all policy, gender needs continued emphasis to ensure the differential roles and needs of men and women are addressed.

Policy to further reduce emissions and build resilience would include supply chain approaches to address emissions and resilience beyond the farm and reflect the continuum from production to consumption and the role of consumption as a significant driver of production. Governments might consider price premiums for products with environmental benefits. For instance, organic agriculture is rapidly expanding but currently occupies only 1% of global cropland. At least one study shows that despite lower yields, organic agriculture can be significantly more profitable than conventional agriculture. Moreover, with its environmental benefits, organic agriculture can contribute a larger share in sustainably feeding the world.^{xxvii} From a regulatory perspective, governments might also institutionalise supply chain sustainability requirements that some private sector actors have voluntarily adopted.^{xxviii} These requirements, as regulatory mechanisms, send a clear signal to food systems actors of government priorities regarding the sustainability of food systems.

Tackling food loss and waste

Tackling food loss and food waste requires integrated, cross-sectoral action along the food supply chain and policy interventions that address the drivers of unsustainable production and consumption practices. Measures for tackling food waste can be 1) information-based (e.g. social campaigns), 2) market-based (e.g. subsidies or lower prices for blemished or ‘imperfect’ produce^{xxix}), 3) regulatory (e.g. legal requirements to donate surplus foods), 4) voluntary commitment (e.g. undertaken by companies or university campuses), and 5) ‘nudging’ (e.g. choice architecture such as putting healthy food choices within easy reach and providing take-home food bags and controlling portion size in restaurants).^{xxx}

Food loss in mixed and traditional food systems occurs mainly in the field, post-harvest, and during transport. There are hundreds of studies showing how simple, low-cost technologies reduce such losses, as well as child malnutrition and self-reported food insecurity, and increase household income. Wide-scale adoption, however, has not materialized and is often hampered by market distortions, such as a

lack of investment incentives or a lack of financial services products tailored to farmers to purchase storage equipment.

Policy Examples

Modern

The Fight Against Food Waste Law (France)^{xxxii} bans stores larger than 4,305 square feet from throwing away unsold food and makes it compulsory to donate it to charities and food banks. Failure to comply can result in fines of up to €75,000 or two years' imprisonment. This legislative step, passed unanimously, has the potential to cut food waste and benefit low-income households. The French food waste law, with its concrete legal consequences, is the first of its kind in the world, making the country a leader in the movement against food waste. Early experience indicates that food donations are higher in quantity and quality. By focusing on large supermarkets, the law targets a key pivot point in the food supply chain where waste occurs.

Modern

The Resource Efficiency, Reducing Food Waste, and Improving Food Safety Resolution (European Parliament)^{xxxiii} urges a coordinated policy response to tackle food waste, including agreed definitions, measurement methodologies, and consideration of binding targets for European member states. The resolution calls on member states to take action now to achieve an EU-wide reduction in food waste of 30 percent by 2025 and 50 percent by 2030. The resolution further asks the Commission to update the list of foods exempt from “best before” labelling and to propose changes to establish tax exemptions on food donations. While work remains to translate the resolution into policy, it shows promise, given the variety of measures included for tackling food waste.

Traditional

The World Food Programme Zero Food Loss Initiative (Uganda) seeks to reduce post-harvest food losses with interventions to train farmers and deliver hermetic^{xxxiiii} (sealed/air-tight) grain storage equipment. The impact was a 90-100% reduction of post-harvest food losses, with improved technology and practices, improvement in family nutrition and health by increasing food availability and increases in household income by preventing losses and selling at more convenient times.^{xxxv} Despite these successes, WFP continues to struggle with an exit strategy, whereby government or market forces ensure the continuation of these interventions or approaches. Uganda's **Agriculture Development Strategy** does mandate support for post-harvest technologies as a strategic direction across farm sectors and for specific crops (e.g. maize, rice, and coffee) as well as livestock and fish.^{xxxvi} There appears to be a gap between programs at the local pilot scale and policy at the national level.

These policy examples highlight approaches that tackle food waste from different angles and that target different actors in food systems. However, both the food waste and loss examples reveal the need for coordination among numerous actors –

producers, consumers, retailers, investors, as well as donors and governments, in the case of addressing food loss. Externally-driven or donor-funded initiatives to address post-harvest loss are far more effective and sustainable when they fully engage governments. The Uganda case highlights the importance of securing stakeholder commitment to a clear exit strategy at the start of a project or program. Like extension services, interventions to reduce post-harvest loss require increased investment, as well as sustainable sources of support and financing, whether public or market-based. This makes coordination between donor-funded initiatives and national policy important, in order to build capacity of government institutions rather than create parallel structures and to foster long-term sustainability of programs.

Addressing diets for health and the environment

Food systems must respond to climate change and, at the same time, deliver on food and nutrition security. There is a real need for more national policies across all three food system types that support diets for both people's health and planetary health, including diets rich in diverse plant foods, moderate intake of animal-source foods, and low consumption of ultra-processed foods.

Policies that shape *food environments* to help consumers make healthy choices and improve nutrition knowledge are critical. Easy-to-understand, front-of-pack labelling of both human health and environmental health information can be transformative and effective for many consumers. Policies must also shape the *food supply*. Action is needed to reverse the trend of the growing supply of a few crops and foods that are harmful to dietary quality and the environment and instead increase productivity and support for a diversity of food items often missing in diets, namely vegetables, fruits, and legumes. Policies and investment should support farmers, particularly in traditional food systems, to diversify production. In the face of climate change impacts, climate-proofed infrastructure and transportation are critical to protect the safety and nutritional value of perishable foods and reduce food loss and waste.

Public campaigns can promote understanding of the need to incorporate sustainability into dietary guidelines. Beyond informing consumers about healthy food choices, dietary guidelines signal a government's stance on the latest dietary advice and serve as the foundation for information on food and nutrition policies and programs within a country. Furthermore, the food and beverage industry often responds to changes in dietary guidelines by reformulating products to meet new consumer demands.^{xxxvi} Finally, dietary guidelines provide a beacon to align diet policy with agriculture

policy in sustainable ways that do not overextend the natural resource base and limits. As our examples for modern food systems show, this marks a new area for dietary guidelines and shows how mechanisms in the public health domain can be used to convey sustainability information. ‘Fair trade’ and organic package labelling is indicative of a move in the same direction.

Policy Examples

Modern

Dutch Dietary Guidelines (2015)^{xxxvii} recommend people eat no more than 500 grams of meat per week and of that no more than 300 grams should be red or ‘high carbon’ meat. The new guidelines are a good example of evidence-based policy. The limit on meat consumption was based on 29 systematic reviews of English language meta-analyses in PubMed summarizing randomized controlled trials and prospective cohort studies on nutrients, foods and food patterns, and the risk of 10 major chronic diseases. The authors of the guidelines also make it explicit that, “Limiting meat consumption is also desirable from an ecological perspective...For fish consumption, it is recommended...[that fish] are cultivated in an environment-friendly manner...to limit the food-related ecological burden, measures are also needed in the production lines.”^{xxxviii}

Mixed

The Law on nutritional composition of foods and their advertising (Chile)^{xxxix} mandates food package labelling on foods high in sugar, fat, and salt and restricts marketing of these foods. Nutrition experts applaud the law, while the private sector argues that it is too strict and that the Ministry of Health has not been clear regarding the logistics of implementing the law and did not consult with industry before enacting the law.^{xl} While the Chilean labelling law has drawn criticism from industry, the labelling policy gives consumers the information they need in a very clear format. It also targets actors in the food system with significant market power. While rigorous evaluation studies have not been conducted yet, the early sense is that the policy is shifting consumer and industry behaviour substantially.^{xli}

These policy examples illustrate the promising nature of promoting environmentally sustainable diets. While dietary guidelines can serve as a signal to consumers and the food industry, they remain voluntary, and leave a question of how best to shift consumer behaviour, particularly around something as individual and culturally embedded as food. Addressing healthy diets, let alone sustainable diets, will require significant effort to raise awareness to inform consumers and to shift food industry approaches. Labelling laws so far do not address environmental considerations, but by merging certification schemes (organic, fair trade, sustainable) with health labelling, climate-smart labelling systems could provide multiple benefits for consumers and the planet. The examples cited also focus largely on the food environment and on public

campaigns about diet. While consumer demand can shift the food supply, a transformation in food systems calls for policy that also directly targets and promotes more diversified and sustainable food production, including a reduction in the heavy reliance on rice, wheat, and maize as food staples.

Inequality, power dynamics, and trade-offs: policy considerations

As noted above, inequality and unequal power dynamics in food systems shape who is hungry and malnourished and who is more vulnerable to climate change. Similarly, transformations in food systems will entail trade-offs among actors and goals. Therefore, policy must address these inequalities and improve governance to ensure that those left behind now are not left further behind in a transformation.

Trade-offs

Food systems policy cuts across multiple sectors, from agriculture and health to water and land to transport and energy to markets and gender. A whole-of-government approach enables discussion across these sectors. Engaging relevant ministries in policy making also supports more effective budgeting and management of trade-offs between sectors. Collective, coordinated effort across ministries can foster a shared sense of goals and an awareness of the value of each ministry's contribution, so budgeting is less about competing for resources and more about finding synergies. Like multi-sectoral policy making, multi-level policy helps avoid conflicts, overlaps and duplications. Multi-level policy processes, from municipal to subnational to national, can facilitate scaling up of successful municipal policies.

The experience of Peru in reducing child stunting demonstrates the value and potential impact of multi-sectoral, multi-level policy planning and implementation. After nearly a decade of little to no progress, between 2005 and 2010, child stunting in Peru dropped by five percentage points overall and ten percentage points in rural areas. An IDS paper^{xlii} argues that the critical factors in Peru's success under its coordinated National Strategy for Combating Poverty and Chronic Child Malnutrition, CRECER, included 1) the high-level leadership of the Office of the Prime Minister, 2) the horizontal coordination across numerous ministries and alignment of social programs with the national nutrition strategy, 3) the vertical integration of national, regional, and municipal government efforts, and 4) donor support and civil society advocacy for the first three.^{xliii}

In designing policies to address transformations toward low-carbon, climate resilient, equitable food systems that deliver food and nutrition security for all, trading off some level of achievement of one goal for another will be inevitable. This requires negotiation and making tough choices about priorities. The advantage of a food system perspective is that it allows for evaluation of how specific actions or decisions could affect people or dynamics, and what trade-offs are central to making decisions about moving toward more sustainable trajectories.^{xliv} What we need are new tools for visualizing trade-offs and synergies of proposed actions and innovations across all goals set by food system actors and new ways of communicating food system complexity. These tools need to include food system assessments and metrics to evaluate food status with respect to societal goals together with tools to simulate food system innovations and their effects. Only then can informed debate take place about choices and the costs societies are willing to make, not just for reaching one goal, but across all societal goals for food systems transformation.^{xlv}

Inequality

In the face of unequal power dynamics in food systems, policy processes need to be transparent and inclusive. Effective participation, particularly of those most affected by policies and consistently marginalized, requires conscious action and targeted investments. Without genuine participation, policy can entrench or exacerbate existing inequalities. Policy processes can support consultation to engage communities. Such processes can help build the capacity of governments and citizens to work together to identify and formulate policies in priority areas.

Policymakers need to be mindful that power shapes who benefits from any given food system. Applying a power lens to policy requires analysis of who a policy may benefit or harm, how policy can level the playing field, and how those left behind can be supported. And it demands acting on that analysis to craft progressive policies. While reality seldom achieves this ideal, if designed to do so, global and regional policies can offer guidance and to some extent accountability.

Addressing inequality and power dynamics determines how a policy is targeted or designed, prioritizing benefits to specific populations, such as the most vulnerable, those deepest in poverty, or consistently marginalized groups. Examples include providing support through extension to small-scale farmers over larger, industrial farmers or to women farmers to address unequal access to resources, or establishing liveable wages and greater protections or workplace standards for farm workers. Policymakers can address unequal power in food systems by requiring change by

actors with greater capacity and focusing on large-scale private sector actors in food systems rather than individual consumers or workers.

In some food systems, tackling inequality demands increased investments in neglected areas, such as in rural areas to address gaps in infrastructure and promote rural economic development and livelihood options. In other food systems, redressing inequality can require investment in neglected urban areas to establish or scale up food hubs to ensure adequate access to diverse, nutritious foods where physical access may be limited.

Closely related is the vital nature of gender-transformative policies. Gender inequality runs deep in food systems, with men and women playing different roles, experiencing climate impacts differently, and articulating different priorities. Too often, women are left behind with unequal access to productive resources, exclusion from decision-making at every level, and a disproportionate labour burden, especially for unpaid care work. If policy does not tackle this inequality head on, it cannot be called transformative. This will require ensuring adequate analysis of policy through a gender lens to identify current barriers and manifestations of inequality. Gender-transformative policy making should facilitate equal and effective participation of women and men, girls and boys.

In the face of climate stresses and trade-offs, social protection can keep vulnerable populations from falling further into poverty and ensuring minimum access to food, but it is not sufficient to counter inequality nor will it end hunger and malnutrition. Leveraging policy to redress inequality and unequal power dynamics in food systems requires pushing back on the vested interests who benefit from the asymmetries in food systems. This may be uncomfortable, but it is imperative if we want to see a genuine transformation in food systems.

Global policy as a framework for change

While policy change at local and national level is critical for transformations in food systems, change at a global level is needed to establish core principles and set standards, collective goals, and directions for national and local transformations.

Climate change & sustainable development

The Paris Agreement was a significant step forward in global efforts to address climate change and reflects in its preamble the importance of food security. Under the Paris Agreement, Parties' Nationally Determined Contributions (NDCs) are the main mechanism for translating global policy goals on climate change into national policy and action. Similarly, SDGs provide another and more broad-based agenda that includes commitments to end hunger and tackle the climate crisis. The interdependence of the SDGs reflects that progress on any one goal is dependent on progress on numerous other goals on ecosystems, sustainable production and consumption, water, and inequality.

A challenge for both the Paris Agreement and the SDGs is translating high-level goals into clear national policies that can be implemented as local actions. Many developing countries require greater levels of support, including capacity building and financial resources, to enable implementation of NDCs or the SDGs.

Global policies are useful to establish goals for collective effort and articulate common frameworks and principles to inform national policy and action. The Paris Agreement represents a potential transformation in global climate policy,¹ as all parties have pledged to take action, while the SDGs in their interdependence and universality have the potential to transform how countries act to promote sustainable development. The Paris Agreement and SDGs were years in the making and provide a strong guide for national action. However, the challenge of crafting transformative global policy through multilateral negotiation among roughly 200 countries must be recognized. Global policy is transformative only insofar as it is translated into national policy and then action, as countries that need it can access adequate support, and as countries with greater capacity provide that support.

Trade

International trade plays a major role in shaping the food environment and is perhaps even more fraught with difficulty than global climate policy. It does, however, present challenges that food system policy makers must at least acknowledge. Trade greatly

¹ The architecture of the Paris Agreement, calling for regularly submitted national pledges of action, has the potential to be transformative. However, current pledges fall far short of what's needed to meet the goals of the Paris Agreement. Countries must increase ambition in order to limit the rise in average global temperatures to 1.5°C.

increases the diversity and range of products available, as well as lowering their cost. But competition from producers in other countries can make governments reluctant to raise environmental or health standards for their own food producers. International agreements to phase out particular pesticides and to limit greenhouse gas emissions are a good start on ensuring that all producers compete on a level playing field. International trade rules can also recognize the right of countries to restrict imports based on differences in production methods (process standards) where there is a legitimate environmental aim and efforts have been made to involve all principal suppliers. But, as with multilateral climate change policy, negotiating international agreements is time-consuming and challenging. In the absence of global policy, national, unilateral border measures to enforce a domestic environmental policy are highly contested (e.g. use of border carbon adjustments in the case of climate policy). Policymakers will need to grapple with developing international trade rules to clarify the circumstances in which ‘environmental tariffs’ can be justified.

A good starting point might be OECD’s Working Paper on Climate Change and Trade Policy Interaction.^{xlvi} The working paper “...examines the implications of regional climate governance for international trade and conversely the implications of regional trade governance for climate change action.” Chapter 5 outlines ways in which regional agreements can further contribute to achieving both trade and climate change goals and points to several knowledge gaps. First, although information about environmental provisions related to climate change is available, it is not always clear what the effect is of such provisions in practice, and second, although there are many ways in which climate change considerations could be incorporated into regional trade agreements, their feasibility in practice remains unclear.

Finance policy as an enabler of change

A transformation in food systems requires investment by both public and private entities. Policies discussed above can signal government priorities for investment, but policy is also needed to mobilize finance, incentivize and de-risk investment, and ensure finance reaches those who need it most.

While policy is needed to incentivize and de-risk investment across food systems, existing finance, such as farm subsidies, can be re-targeted to support and promote transformation in food systems. Worldwatch Institute reported^{xlvii} that agricultural

subsidies totalled an estimated USD 486 billion in the top 21 food-producing countries in the world. Some of that money could be redirected to incentivize farmers to adopt adaptation and mitigation measures. Subsidized crop insurance, for instance, could promote sustainable, resilient practices by providing insurance premium rebates for farmers who undertake beneficial practices; incentivizing improved soil management practices, diversified crops, and manure management; or writing soil health requirements into insurance policies.

Conclusion/recommendations

The policies we cite demonstrate the challenge of catalysing transformation in food systems through policy change. In some ways, new policy is not needed: some of the policy examples show that long-standing approaches like improving extension services have great potential to address challenges in food systems under a changing climate. What is lacking is adequate investment, implementation, and equitable approaches. For those challenges that are emerging or about which awareness is increasing, policy needs to catch up. Examples around food waste and sustainable diets reveal policy makers' growing willingness to tackle issues with hard hitting policy or to take on more intractable challenges that require changing consumer behaviour.

This innovation and boldness is encouraging. However, by and large, the policies we cite are focused on specific challenges often in a particular sector. As the need for transformation in food systems grows, so too must the realization that food systems policy will be imperative. The range of actors, activities, outcomes, and drivers that interact to shape food systems – including who benefits and who does not – are myriad, complex, and at times contradictory. Food systems policy may not be easy but only through multi-sectoral and inclusive processes and policies can a true transformation be achieved. The examples we give are a starting point for discussion of challenges, opportunities, and priorities. The considerations we offer around trade-offs and equality are fundamental to inclusive, resilient, and sustainable food systems.

No two food systems will follow the same path toward transformation. The dynamics within any given food system are unique, the challenges vary, and priorities for action will differ. One country or municipality may be ready to adopt a holistic approach that brings numerous stakeholders together for open dialogue about tough choices. Others, in the face of trade-offs, may sequence policy change to first address chronic hunger

and poverty or to close the gap between men and women farmers or small-scale and large-scale producers. Yet keeping a food systems approach in mind is important to ensure awareness of longer-term trade-offs and to craft policy that not only responds to today's challenges but also anticipates tomorrow's. Different food systems also demonstrate different capabilities and responsibilities. Layering current and historic greenhouse gas emissions onto the characteristics of food systems can inform the differentiated priority actions that some countries must take, particularly with regard to mitigation of greenhouse gas emissions.

While we have endeavoured to include a variety of policies regarding several critical issues, we have also strived for an approachable, brief paper intended to spark discussion. Undoubtedly, there are more examples of policy to support transformation and some issues warrant further discussion. We have not covered but are aware of the importance of policy to de-risk or to incentivize investment for a transformation in food systems. Deeper analysis of policies would also likely uncover challenges or areas for improvement in the policies we highlight. We have also aimed for a balance between bold action and realism.

Transformation in food systems under a changing climate – to ensure food and nutrition security for all, today and tomorrow – will demand action from all actors. Policy change can guide and catalyse that action but requires political and public will and a shift in mindsets toward a more collective and shared approach. The challenge we face is significant, but so is the imperative to address it.

References

- Adger W, Arnell N, Tompkins E. 2005. Successful adaptation to climate change across scales. *Global Environmental Change* 15(2):77-86.
- Allred S, Schneider R, and Reeder J. 2016. The Role of Natural Resource Professionals in Addressing Climate Change. *Climate* 4(3):38.
- Arndt C, Chinowsky P, Robinson S, Strzepek K, Tarp F, Thurlow J. 2012. Economic Development under Climate Change. *Review of Development Economics* 16(3):369-377.
- Barton DN. 2013. Payments for ecosystem services: Costa Rica's recipe. International Institute for Environment and Development. Guest blog. November. (Available from <https://www.iied.org/payments-for-ecosystem-services-costa-rica-s-recipe>)
- Battilani P, Toscano P, Van der Fels-Klerx H, Moretti A, Camardo Leggieri M, Brera C, Rortais A, Goumperis T, Robinson T. 2016. Aflatoxin B1 contamination in maize in Europe increases due to climate change. *Scientific Reports* 6(1).
- BCFN and MUFPP. 2018. Food & Cities. The role of cities for achieving the Sustainable Development Goals. (Available from https://www.barillacfn.com/media/material/food_cities.pdf)
- Brugger, J, Crimmins M. 2015. Designing Institutions to Support Local-Level Climate Change Adaptation: Insights from a Case Study of the U.S. Cooperative Extension System. *Weather, Climate, and Society* 7(1):18-38.
- Bulbul M, Rashid I. 2018. Developing the second National Plan of Action for Nutrition in Bangladesh. *Nutrition Exchange* 10, July 2018. p. 14. (Available from www.enonline.net/nex/10/nationalplannutritionbangladesh)
- Carlsson-Kanyama A. 1998. Climate change and dietary choices — how can emissions of greenhouse gases from food consumption be reduced?. *Food Policy* 23(3-4):277-293.
- Chatrchyan AM, Yin C, Torquebiau E, Nagothu US. 2018. Multi-level policy measures to support sustainable agriculture intensification for smallholders. In *Agricultural Development and Sustainable Intensification Technology and Policy Challenges in the Face of Climate Change*. Ed. U.S. Nagathu. London: Routledge.
- Chiang Ria Times. 2018. Thai Government Pushes Reform in Agriculture Sector. October 12. (Available from <https://www.chiangraitimes.com/thai-government-pushes-reform-in-agriculture-sector.html>)

- Crowder D, Reganold J. 2015. Financial competitiveness of organic agriculture on a global scale. *Proceedings of the National Academy of Sciences* 112(24):7611-7616.
- Development Initiatives. 2018. *Global Nutrition Report: Shining a light to spur action on nutrition*. Bristol, UK: Development Initiatives. (Available from https://reliefweb.int/sites/reliefweb.int/files/resources/2018_Global_Nutrition_Report.pdf)
- Development Initiatives. 2017. *Global Nutrition Report 2017: Nourishing the SDGs*. Bristol, UK: Development Initiatives. (Available from <https://globalnutritionreport.org/reports/2017-global-nutrition-report/>)
- Duncan T, Spillman S. 2004. The Effect of Economic Crises on Nutritional Status: Evidence from Russia. IZA Discussion Paper No. 1092, 43 Pages, Posted: 22 April. (Available from <https://www.iza.org/publications/dp/1092/the-effect-of-economic-crises-on-nutritional-status-evidence-from-russia>)
- Ericksen PJ. 2008. Conceptualizing food systems for global environmental change research. *Global Environmental Change* 18: 234-245.
- European Commission. 2017. Communication for the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions. (Available from https://ec.europa.eu/agriculture/sites/agriculture/files/future-of-cap/future_of_food_and_farming_communication_en.pdf)
- European Parliament. 2017. European Parliament resolution of 16 May 2017 on initiative on resource efficiency: reducing food waste, improving food safety (2016/2223(INI)). (Available from <http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P8-TA-2017-0207+0+DOC+XML+V0//EN>)
- Evans A, Nagele RA. 2018. Lot to Digest: Advancing Food Waste Policy in the United States, *58 Nat. Resources J.* 175. (Available from <http://digitalrepository.unm.edu/nrj/vol58/iss1/7>)
- Fanzo J, McLaren R, Davis C, Choufani J. 2017 Climate Change and Variability What are the Risks for Nutrition, Diets, and Food Systems? IFPRI Discussion Paper 1645, 128 Pages, Posted: 2 September.
- Food and Agriculture Organization of the United Nations. *Climate Smart Agriculture Sourcebook*. 2013. Rome, Italy. (Available from <http://www.fao.org/docrep/018/i3325e/i3325e00.htm>)
- [FAO] Food and Agriculture Organization of the United Nations. SAVE FOOD: Global Initiative on Food Loss and Waste Reduction. Key facts on food loss

- and waste you should know. (Available from <http://www.fao.org/save-food/resources/keyfindings/en/>)
- [FAO] Food and Agriculture Organization of the United Nations. 2017. SAVE FOOD FOR A BETTER CLIMATE. Converting the food loss and waste challenge into climate action. (Available from <http://www.fao.org/3/a-i8000e.pdf>)
- [FAO] Food and Agriculture Organization of the United Nations. 2013. *Food wastage footprint and its effects on natural resources: summary report*. (Available from <http://www.fao.org/docrep/018/i3347e/i3347e.pdf>)
- [FAO] Food and Agriculture Organization of the United Nations. 2018. *The impact of disasters and crises on agriculture and food security*. Rome: Food and Agriculture Organization of the United Nations.
- [FAO] Food and Agriculture Organization of the United Nations. 2014. *Agriculture, Forestry and Other Land Use Emissions by Sources and Removals by Sinks*. Climate, Energy and Tenure Division, FAO. Rome, Italy.
- [FAO] Food and Agriculture Organization of the United Nations, IFAD, UNICEF, WFP and WHO. 2018. *The State of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition*. FAO: Rome. (Available from <http://www.fao.org/3/I9553EN/i9553en.pdf>)
- [FAO] Food and Agriculture Organization of the United Nations. 2016. *Fishery and Aquaculture Statistics*. (Available from http://www.fao.org/fishery/static/Yearbook/YB2016_USBcard/booklet/web_i9942t.pdf)
- Food Recovery Network. 2018. Website. <https://www.foodrecoverynetwork.org/>.
- Fraisse CW, Breuer NE, Zierden D, Ingram KT. 2009. From climate variability to climate change: Challenges and opportunities to Extension. *Journal of Extension* 47:2FEA9. (Available from <http://www.joe.org/joe/2009april/a9.php>)
- French Republic. 2016. Loi N. 2016-138 du février 2016 relative à la lutte contre le gaspillage alimentaire. (Available from <https://www.legifrance.gouv.fr/eli/loi/2016/2/11/AGRX1531165L/jo/texte>)
- Galafassi D, Daw T, Munyi L, Brown K, Barnaud C, Fazey I. 2017. Learning about social-ecological trade-offs. *Ecology and Society*, 22(1):2.
- Girardi Lavin G. 2018. The Chilean food labelling law – The role of parliamentary fronts in improving global nutrition. In FAO. 2018. *La ley chilena de etiquetado de alimentos – Conferencia celebrada en la Sede de la FAO sobre el papel de los frentes parlamentarios en la mejora de la nutrición en el mundo*. FAO Dialogues. Roma. p. 76.

- Government of Kenya Agricultural Sector Development Support Programme (ASDSP) Ministry of Agriculture, Livestock and Fisheries. 2014. Participatory Scenario Planning for Climate Resilient Agricultural Livelihoods: Best Practices and Success Stories. (Available from <http://asdsp.co.ke/wp-content/uploads/2016/11/PSP-Success-Stories-Magazine.pdf>)
- Government of Uganda. Ministry of Agriculture, Animal Industry and Fisheries. Agriculture Sector Strategic Plan 2015/16-2019/20 Draft. (Available from <http://npa.ug/wp-content/uploads/2016/08/ASSP-Final-Draft.pdf>)
- Gustavsson J, Cederberg C, Sonesson U. 2011. Global food losses and food waste – extent, causes and prevention. Food and Agriculture Organization (FAO) of the United Nations, Rome. (Available from <http://www.fao.org/docrep/014/mb060e/mb060e00.pdf>)
- Halloran A, Clement J, Kornum N, Bucatariu C, Magrid, J. 2014. Addressing food waste reduction in Denmark. *Food Policy* 49(1):294-301.
- Howden S, Soussana JF, Tubiello FN, Chhetri N, Dunlop M, Meinke H. Adapting agriculture to climate change. 2007. *PNAS* 2007 104(50):19691–19696.
- Hatfield R, Davies J. 2006. Global Review of the Economics of Pastoralism. Nairobi: IUCN for The World Initiative for Sustainable Pastoralism. (Available from https://cmsdata.iucn.org/downloads/global_review_ofthe_economicsof_pastoralism_en.pdf)
- Hird-Younger M, Simpson B. 2013. MEAS Case study # 2: Women Extension Volunteers (Ghana) Modernizing Extension and Advisory Services. Washington: USAID Modernizing Extension and Advisory Services (MEAS) project. (Available from <https://www.agrilinks.org/library/meas-case-study-2-women-extension-volunteers-ghana>)
- HLPE. 2017. *Nutrition and food systems*. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome.
- Ingram JSI. 2009. Food system concepts. In R. Rabbinge & A. Linneman (Eds.), *ESF/COST forward look on European food systems in a changing world*. Strasbourg: European Science Foundation.
- [IFAD] International Fund for Agricultural Development. 2016. Rural development report: fostering inclusive rural transformation. Rome.
- International Carbon Action Partnership. 2018. ETS Detailed Information USA - Regional Greenhouse Gas Initiative. 27 November. (Available from [https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems\[\]=50](https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems[]=50))

- International Trademark Association. 2016. New Food Labeling Regulations Leave a Bitter Taste. *INTABulletin*. April 1, 2016 Vol. 71 No. 6. (Available from https://www.inta.org/INTABulletin/Pages/Chile_7106.aspx)
- Jacobs A. 2018. “In Sweeping War on Obesity, Chile Slays Tony the Tiger.” *New York Times* [New York] 7 February 2018. (Available from <https://www.nytimes.com/2018/02/07/health/obesity-chile-sugar-regulations.html>)
- Kameke C, Fischer D. 2018. Preventing household food waste via nudging: an exploration of consumer perceptions. *Journal of Cleaner Production* 184:32-40. DOI: 10.1016/j.jclepro.2018.02.131.
- Kato T, Greeley M. 2016. Agricultural Input Subsidies in Sub-Saharan Africa. *IDS Bulletin*, Vol 47, No 2:33-47. (Available from https://opendocs.ids.ac.uk/opendocs/bitstream/handle/123456789/11558/IDSB_472_Complete.pdf?sequence=1)
- Kromhout D, Spaaij CJK, de Goede J, Weggemans RM. 2016. The 2015 Dutch food-based dietary guidelines, *European Journal of Clinical Nutrition*, doi: 10.1038/ejcn.2016.52 (Available from <https://www.fcrn.org.uk/research-library/2015-dutch-food-based-dietary-guidelines>)
- Lorek S, Spangernberf J, Oman I. 2008. Sustainable Consumption Policy effectiveness evaluation (SCOPE2): Conclusion. Vienna: Sustainable Europe Research Institute.
- Lowder SK, Scoet J, Raney T. 2016. The Number, Size, and Distribution of Farms, Smallholder Farms, and Family Farms Worldwide. *World Development* 87:16-29.
- Meinke H, Nelson R, Kokic P, Stone R, Selvaraju R, Baethgen W. 2006. Actionable climate knowledge: from analysis to synthesis. *Climate Research* 2006, 33:101–110.
- Mejía Acosta A. 2011 “Analysing Success in the Fight against Malnutrition in Peru.” IDS Working Paper, Issue 367.
- Melillo JM, Richmond TC, Yohe GW, Eds. 2014. Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program. p. 841.
- Morrison J. 2016. “The “Great Green Wall” Didn’t Stop Desertification, but it Evolved Into Something That Might.” *Smithsonian Magazine*. 23 August 2016. (Available from <https://www.smithsonianmag.com/science-nature/great-green-wall-stop-desertification-not-so-much-180960171/>)
- Mozaffarian D. 2016. Dietary and Policy Priorities for Cardiovascular Disease, Diabetes, and Obesity. *Circulation* 133(2):187-225.

- Nieters A, Grabs J, Jimenez G, Alpizar W. 2015. NAMA Café Costa Rica: A Tool for Low Carbon Development. NAMA Facility Technical Support Unit on behalf of German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)/ UK Department for Energy and Climate Change (DECC). (Available from http://www.namacafe.org/sites/default/files/files/NAMA_Facility_factsheet_Costa%20Rica.pdf)
- New York State Soil and Water Conservation Committee. [no date] Climate Resilient Farming (CRF) Program. (Available from <https://www.nys-soilandwater.org/programs/crf.html>)
- Nuccitelli D. 2011. A Real-World Example of Carbon Pricing Benefits Outweighing Costs. *Skeptical Science*, 5 March. (Available from <https://www.skepticalscience.com/real-world-example-carbon-pricing-benefits-outweigh-costs.html>)
- Polgreen L. [no date]. "In Niger, Trees and Crops Turn Back the Desert." *New York Times* [New York] 11 February 2007. (Available from <https://www.nytimes.com/2007/02/11/world/africa/11niger.html>)
- Principato L. 2018. Food Waste at the Consumer Level. A comprehensive Literature review. Springer Briefs in Environmental Sciences.
- Prokopy LS, Arbuckle JG, Barnes AP, Haden VR, Hogan A, Niles MT, Tyndall J. 2015. Farmers and Climate Change: A Cross-National Comparison of Beliefs and Risk Perceptions in High-Income Countries. *Environmental Management* 2015:1-13.
- Reisch L, Eberle U, Lorek S. 2013. Sustainable food consumption: an overview of contemporary issues and policies, *Sustainability: Science, Practice and Policy* 9(2):7-25, DOI: 10.1080/15487733.2013.11908111.
- Republic of Chile. 2015. Ley Núm. 20.606 Sobre composición nutricional de los alimentos y su publicidad. (Available from <https://www.leychile.cl/Navegar?idNorma=1041570>)
- Scaling Up Nutrition Movement. 2017. "Landmark moment for Bangladesh as Nutrition Council meets and approves the second National Plan of Action for Nutrition." 21 August 2017. (Available from <https://scalingupnutrition.org/news/landmark-moment-bangladesh-nutrition-council-meets-approves-second-national-plan-action-nutrition/>)
- Tirado M, Clarke R, Jaykus L, McQuatters-Gollop A, Frank J. 2010. Climate change and food safety: A review. *Food Research International* 43(7):1745-1765.
- Tobin D, Radhakrishna R, Chatrchyan A, Allred S. 2017. Addressing Climate Change Impacts on Agriculture and Natural Resources: Barriers and Priorities for

- Land-Grant Universities in the Northeastern United States. *Weather, Climate, and Society* 9(3).
- Tubiello F. 2008. Climate change adaptation and mitigation: challenges and opportunities in the food sector. Natural Resources Management and Environment Department, FAO, Rome. Prepared for the High-level conference on world food security: the challenges of climate change and bioenergy, Rome, 3-5 June 2008. Rome, Italy. Rome: Food and Agriculture Organization of the United Nations; 2012 Sep. 29.
- Ugly Produce is Beautiful. 2017. The ugly produce problem and food waste. Website. (Available from <http://www.uglyproduceisbeautiful.com/ugly-produce-problem.html>)
- Unilever Sustainable Sourcing Programme for Agricultural Raw Materials. 2018. Scheme Rules 1 September 2018 v1.6. (Available from https://www.unilever.com/Images/scheme-rules-sac-2017_tcm244-515405_1_en.pdf.)
- van Asselt H. 2017. "Climate change and trade policy interaction: Implications of regionalism", *OECD Trade and Environment Working Papers*, No. 2017/03, OECD Publishing, Paris. <https://doi.org/10.1787/c1bb521e-en>. (Available from <https://www.oecd-ilibrary.org/docserver/c1bb521e-en.pdf?expires=1546767136&id=id&accname=guest&checksum=FC368E8478B355D92E9CA12492A2819A>)
- Vermeulen SJ, Campbell BM, Ingram JSI. 2012. Climate Change and Food Systems. *Annual Review of Environment and Resources* 37(1):195-222.
- Viola A. 2017. Scaling Up Post-Harvest Losses Interventions in Uganda Through Market Forces. Master in Public Policy Political and Economic Development Concentration. Harvard University John F. Kennedy School of Government. (Available from https://www.hks.harvard.edu/sites/default/files/degree%20programs/MPP/files/17%203%20MPP_PAE_Agustin%20Viola_Scaling%20Up%20Post-Harvest%20Losses%20Interventions%20in%20Uganda%20Through%20Market%20Forces.pdf.)
- Wakeland W, Cholette S, Venkat K. 2012. Food Transportation Issues and Reducing Carbon Footprint. *Research Gate*. DOI: 10.1007/978-1-4614-1587-9_9.
- Winnow. 2018. Accessed at: <http://www.winnowsolutions.com>.
- World Bank Classification. Annex I. Low and Middle Income Countries. (Available from <https://www.espa.ac.uk/files/espa/AO-ESPA-2016-Annex%201-Low-income-countries.pdf>.)

- World Bank. 2017. Help Women Farmers 'Get to Equal'. Brief. April 18. (Available from <http://www.worldbank.org/en/topic/agriculture/brief/women-farmers-getting-to-equal>.)
- [WHO] World Health Organization Regional Office for South-East Asia. 2017. Website. “A new Action Plan for nutrition in Bangladesh.” (Available from <http://www.searo.who.int/entity/nutrition/success-stories/bangladesh/en/>)
- [WRI] World Resources Institute. 2013. *Creating a sustainable food future: a menu of solutions to sustainably feed more than 9 billion people by 2050*. World Resources Report 2013–2014: Interim findings. Washington, DC. (Available from https://www.wri.org/sites/default/files/wri13_report_4c_wrr_online.pdf.)
- WorldWatch. 2012. “Agricultural Subsidies Remain a Staple in the Industrial World”. (Available from <http://www.worldwatch.org/agricultural-subsidies-remain-staple-industrial-world-0>)
- WRAP. 2018. Food Surplus and Waste in the UK – Key Facts. Banbury. (Available from <http://www.wrap.org.uk/sites/files/wrap/Food-Surplus-and-Waste-UK-Key-Facts-23-11-18.pdf>)
- Zurek M, Hebinck A, Leip A, Vervoort J, Kuiper M, Garrone M, Havlík P, Heckelei T, Hornborg S, Ingram J, Kuijsten A, Shutes L, Geleijnse J, Terluin I, van 't Veer P, Wijnands J, Zimmermann A, Achterbosch T. 2018. Assessing Sustainable Food and Nutrition Security of the EU Food System—An Integrated Approach. *Sustainability* 10(11):4271.

Endnotes

- ⁱ Adapted from Chatrchyan, A. C. Yin, E. Torquebiau, U.S. Nagothu. 2018. Multi-level policy measures to support sustainable agriculture intensification for smallholders. In *Agricultural Development and Sustainable Intensification Technology and Policy Challenges in the Face of Climate Change*. Ed. U.S. Nagathu. London: Routledge.
- ⁱⁱ Adapted from Ericksen, P.J. (2008). Conceptualizing food systems for global environmental change research. *Global Environmental Change*, 18, 234-245; Ingram, J. S. I. (2009) Food system concepts. In R. Rabbinge & A. Linneman (Eds). *ESF/COST forward look on European food systems in a changing world*. Strasbourg: European Science Foundation.
- ⁱⁱⁱ HLPE. 2017. *Nutrition and food systems*. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome.
- ^{iv} Battilani, P., Toscano, P., Van der Fels-Klerx, H., Moretti, A., Camardo Leggieri, M., Brera, C., Rortais, A., Goumperis, T. and Robinson, T. (2016). Aflatoxin B1 contamination in maize in Europe increases due to climate change. *Scientific Reports*, 6(1); Tirado, M., Clarke, R., Jaykus, L., McQuatters-Gollop, A. and Frank, J. (2010). Climate change and food safety: A review. *Food Research International*, 43(7), pp.1745-1765.
- ^v WRI. (2013). *Creating a sustainable food future: a menu of solutions to sustainably feed more than 9 billion people by 2050*. World Resources Report 2013–2014: Interim findings. Washington, DC. https://www.wri.org/sites/default/files/wri13_report_4c_wrr_online.pdf.
- ^{vi} Arndt, C., Chinowsky, P., Robinson, S., Strzepek, K., Tarp, F. and Thurlow, J. (2012). Economic Development under Climate Change. *Review of Development Economics*, 16(3), pp.369-377; Wakeland, W., Cholette, S. and Venkat, K. (2012). Food Transportation Issues and Reducing Carbon Footprint. Research Gate. DOI: 10.1007/978-1-4614-1587-9_9.
- ^{vii} Fanzo, J., R. McLaren, C. Davis, J. Choufani. (2017) Climate Change and Variability What are the Risks for Nutrition, Diets, and Food Systems? IFPRI Discussion Paper 1645.
- ^{viii} Vermeulen et al., 2012.
- ^{ix} Vermeulen et al., 2012.
- ^x HLPE, 2017.
- ^{xi} IFAD. 2016. *Rural development report: fostering inclusive rural transformation*. Rome.
- ^{xii} FAO. (2013). *Climate Smart Agriculture Sourcebook*. (2013). Rome, Italy. Accessed at <http://www.fao.org/docrep/018/i3325e/i3325e00.htm>.
- ^{xiii} Allred, S., Schneider, R. and Reeder, J. (2016). The Role of Natural Resource Professionals in Addressing Climate Change. *Climate*, 4(3), p.38; Brugger, J. and Crimmins, M. (2015). Designing Institutions to Support Local-Level Climate Change Adaptation: Insights from a Case Study of the U.S. Cooperative Extension System. *Weather, Climate, and Society*, 7(1), pp.18-38; Fraisse, C. W., N. E. Breuer, D. Zierden, and K. T. Ingram, 2009: From climate variability to climate change: Challenges and opportunities to Extension. *J. Ext.*, 47, 2FEA9. Available online at <http://www.joe.org/joe/2009april/a9.php>.
- ^{xiv} Kato, T. and Greeley, M. (2016). Agricultural Input Subsidies in Sub-Saharan Africa. *IDS Bulletin*, Vol 47, No 2:33-47. Accessed at https://opendocs.ids.ac.uk/opendocs/bitstream/handle/123456789/11558/IDSB_472_Complete.pdf?sequence=1.
- ^{xv} Barton, D.N. 2013. Payments for ecosystem services: Costa Rica's recipe. International Institute for Environment and Development. Guest blog. November. Accessed at <https://www.ied.org/payments-for-ecosystem-services-costa-rica-s-recipe>.
- ^{xvi} Nuccitelli, D. (2011). A Real-World Example of Carbon Pricing Benefits Outweighing Costs. *Skeptical Science*, 5 March. Accessed at <https://www.skepticalscience.com/real-world-example-carbon-pricing-benefits->

-
- [outweigh-costs.html](#); International Carbon Action Partnership. (2018). ETS Detailed Information USA - Regional Greenhouse Gas Initiative. 27 November. Accessed at [https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems\[\]=50](https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems[]=50).
- ^{xvii} Polgreen, L. "In Niger, Trees and Crops Turn Back the Desert." *New York Times* [New York] 11 February 2007. Accessed at <https://www.nytimes.com/2007/02/11/world/africa/11niger.html>; Morrison, J. "The "Great Green Wall" Didn't Stop Desertification, but it Evolved Into Something That Might." *Smithsonian Magazine*. 23 August 2016. Accessed at <https://www.smithsonianmag.com/science-nature/great-green-wall-stop-desertification-not-so-much-180960171/>.
- ^{xviii} Chiang Ria Times. (2018). Thai Government Pushes Reform in Agriculture Sector. October 12. Accessed at <https://www.chiangraitimes.com/thai-government-pushes-reform-in-agriculture-sector.html>.
- ^{xix} New York State Soil and Water Conservation Committee. Climate Resilient Farming (CRF) Program. Accessed at <https://www.nys-soilandwater.org/programs/crf.html>.
- ^{xx} Nieters, A., Grabs, J., Jimenez, G., Alpizar, W. (2015). NAMA Café Costa Rica: A Tool for Low Carbon Development. NAMA Facility Technical Support Unit on behalf of German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)/ UK Department for Energy and Climate Change (DECC). Accessed at http://www.namacafe.org/sites/default/files/files/NAMA_Facility_factsheet_Costa%20Rica.pdf.
- ^{xxi} Hird-Younger, M. and Simpson, B. (2013). MEAS Case study # 2: Women Extension Volunteers (Ghana) Modernizing Extension and Advisory Services. Washington: USAID Modernizing Extension and Advisory Services (MEAS) project. Accessed at <https://www.agrilinks.org/library/meas-case-study-2-women-extension-volunteers-ghana>.
- ^{xxii} Duncan, T. and S. Spillman. (2004). The Effect of Economic Crises on Nutritional Status: Evidence from Russia. IZA Discussion Paper No. 1092, 43 Pages, Posted: 22 April. Accessed at <https://www.iza.org/publications/dp/1092/the-effect-of-economic-crises-on-nutritional-status-evidence-from-russia>.
- ^{xxiii} World Bank. (2017). Help Women Farmers 'Get to Equal'. Brief. April 18. Accessed at <http://www.worldbank.org/en/topic/agriculture/brief/women-farmers-getting-to-equal>.
- ^{xxiv} Annex 1. Low and Middle Income Countries (World Bank Classification). Accessed at <https://www.espa.ac.uk/files/espa/AO-ESPA-2016-Annex%201-Low-income-countries.pdf>.
- ^{xxv} Government of Kenya. Agricultural Sector Development Support Programme (ASDSP), Ministry of Agriculture, Livestock and Fisheries. (2014). Participatory Scenario Planning for Climate Resilient Agricultural Livelihoods: Best Practices and Success Stories. <http://asdsp.co.ke/wp-content/uploads/2016/11/PSP-Success-Stories-Magazine.pdf>.
- ^{xxvi} Annex 1. Low and Middle Income Countries (World Bank Classification). Accessed at <https://www.espa.ac.uk/files/espa/AO-ESPA-2016-Annex%201-Low-income-countries.pdf>.
- ^{xxvii} Crowder, D. and Reganold, J. (2015). Financial competitiveness of organic agriculture on a global scale. *Proceedings of the National Academy of Sciences*, 112(24), pp.7611-7616.
- ^{xxviii} Unilever Sustainable Sourcing Programme for Agricultural Raw Materials. Scheme Rules 1 September 2018 v1.6. Accessed at https://www.unilever.com/Images/scheme-rules-sac-2017_tcm244-515405_1_en.pdf.
- ^{xxix} The ugly produce problem and food waste. Accessed at <http://www.uglyproduceisbeautiful.com/ugly-produce-problem.html>.
- ^{xxx} Lorek S., Spangenberg J., Oman I. (2008). Sustainable Consumption Policy effectiveness evaluation (SCOPE2): Conclusion. Vienna: Sustainable Europe Research Institute; Principato L. (2018). Food Waste at the Consumer Level. A comprehensive Literature review. Springer Briefs in Environmental Sciences; Reisch L., Eberle U., and Lorek S. (2013). Sustainable food consumption: an overview of contemporary issues and policies, *Sustainability: Science, Practice and Policy*, 9:2, 7-25, DOI: 10.1080/15487733.2013.11908111.
- ^{xxxi} French Republic. Loi N. 2016-138 du février 2016 relative à la lutte contre le gaspillage alimentaire. Accessed at <https://www.legifrance.gouv.fr/eli/loi/2016/2/11/AGRX1531165L/jo/texte>.

-
- xxxii European Parliament. (2017). European Parliament resolution of 16 May 2017 on initiative on resource efficiency: reducing food waste, improving food safety (2016/2223(INI)). Retrieved from: <http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P8-TA-2017-0207+0+DOC+XML+V0//EN>.
- xxxiii See, for instance: <http://www.knowledgebank.irri.org/step-by-step-production/postharvest/storage/grain-storage-systems/hermetic-storage-systems>.
- xxxiv Austin, V. (2017). Scaling Up Post-Harvest Losses Interventions in Uganda Through Market Forces. Accessed at https://www.hks.harvard.edu/sites/default/files/degree%20programs/MPP/files/17%203%20MPP_PAE_Agustin%20Viola_Scaling%20Up%20Post-Harvest%20Losses%20Interventions%20in%20Uganda%20Through%20Market%20Forces.pdf.
- xxxv Government of Uganda. Ministry of Agriculture, Animal Industry and Fisheries. Agriculture Sector Strategic Plan 2015/16-2019/20 Draft. Accessed at <http://npa.ug/wp-content/uploads/2016/08/ASSP-Final-Draft.pdf>.
- xxxvi Mozaffarian, D. (2016). Dietary and Policy Priorities for Cardiovascular Disease, Diabetes, and Obesity. *Circulation*, 133(2), pp.187-225.
- xxxvii Kromhout, D., Spaaij, C J K., de Goede, J., Weggemans, R M (2016), The 2015 Dutch food-based dietary guidelines, *European Journal of Clinical Nutrition*, doi: 10.1038/ejcn.2016.52 Accessed at <https://www.fcrn.org.uk/research-library/2015-dutch-food-based-dietary-guidelines>.
- xxxviii Kromhout, 2016.
- xxxix Republic of Chile. (2015). Ley Núm. 20.606 Sobre composición nutricional de los alimentos y su publicidad. Accessed at <https://www.leychile.cl/Navegar?idNorma=1041570>.
- xl International Trademark Association. (2016). New Food Labeling Regulations Leave a Bitter Taste. *INTABulletin*. April 1, 2016 Vol. 71 No. 6. Accessed at https://www.inta.org/INTABulletin/Pages/Chile_7106.aspx.
- xli Girardi Lavin, G. (2018). The Chilean food labelling law – The role of parliamentary fronts in improving global nutrition. In FAO (2018). *La ley chilena de etiquetado de alimentos – Conferencia celebrada en la Sede de la FAO sobre el papel de los frentes parlamentarios en la mejora de la nutrición en el mundo*. FAO Dialogues. Roma. 76 pp. “Our figures show that 68 percent of Chileans have changed their eating habits since the labels were introduced, and 20 percent of the food industry have altered their products, which we think is really important.” <http://www.fao.org/3/CA1962B/ca1962b.pdf>; Jacobs, A. (2018). “In Sweeping War on Obesity, Chile Slays Tony the Tiger.” *New York Times* [New York] 7 February 2018. Accessed at <https://www.nytimes.com/2018/02/07/health/obesity-chile-sugar-regulations.html>.
- xlii Mejía Acosta, A. (2011) “Analysing Success in the Fight against Malnutrition in Peru.” IDS Working Paper, issue 367.
- xliiii Bangladesh has undertaken a similar multi-level and multi-sectoral effort to combat malnutrition. See Scaling Up Nutrition Movement. “Landmark moment for Bangladesh as Nutrition Council meets and approves the second National Plan of Action for Nutrition.” 21 August 2017. Accessed at <https://scalingupnutrition.org/news/landmark-moment-bangladesh-nutrition-council-meets-approves-second-national-plan-action-nutrition/>; World Health Organization Regional Office for South-East Asia. Website. “A new Action Plan for nutrition in Bangladesh.” (2017). Accessed at <http://www.searo.who.int/entity/nutrition/success-stories/bangladesh/en/>; Bulbul, M. and Rashid, I. (2018). Developing the second National Plan of Action for Nutrition in Bangladesh. *Nutrition Exchange* 10, July 2018. p14. Accessed at www.enonline.net/nex/10/nationalplannutritionbangladesh.
- xliv Galafassi, D., Daw, T., Munyi, L., Brown, K., Barnaud, C. and Fazey, I. (2017). Learning about social-ecological trade-offs. *Ecology and Society*, 22(1).
- xlv Zurek, M., Hebinck, A., Leip, A., Vervoort, J., Kuiper, M., Garrone, M., Havlik, P., Heckeley, T., Hornborg, S., Ingram, J., Kuijsten, A., Shutes, L., Geleijnse, J., Terluin, I., van 't Veer, P., Wijnands, J., Zimmermann, A. and

Achterbosch, T. (2018). Assessing Sustainable Food and Nutrition Security of the EU Food System—An Integrated Approach. *Sustainability*, 10(11), p.4271.

^{xlvi} van Asselt, H. (2017), "Climate change and trade policy interaction: Implications of regionalism", *OECD Trade and Environment Working Papers*, No. 2017/03, OECD Publishing, Paris. <https://doi.org/10.1787/c1bb521e-en>. Accessed at <https://www.oecd-ilibrary.org/docserver/c1bb521e-en.pdf?expires=1546767136&id=id&accname=guest&checksum=FC368E8478B355D92E9CA12492A2819A>.

^{xlvii} WorldWatch. "Agricultural Subsidies Remain a Staple in the Industrial World." 2012. Accessed at <http://www.worldwatch.org/agricultural-subsidies-remain-staple-industrial-world-0>.



RESEARCH PROGRAM ON
**Climate Change,
Agriculture and
Food Security**



The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is led by the International Center for Tropical Agriculture (CIAT). CCAFS is the world's most comprehensive global research program to examine and address the critical interactions between climate change, agriculture and food security. For more information, visit us at <https://ccafs.cgiar.org/>.

Titles in this Working Paper series aim to disseminate interim climate change, agriculture and food security research and practices and stimulate feedback from the scientific community.

CCAFS is led by:



International Center for Tropical Agriculture
Since 1967 Science to cultivate change

Research supported by:



Ministry of Foreign Affairs of the Netherlands

