GLOBAL LAND OUTLOOK

Working Paper

United Nations
Convention to Combat Desertification

FOOD SYSTEM RESILIENCE AND LAND RESTORATION

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Food System Resilience and Land Restoration

Author: Heather Elaydi

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United Nations Convention to Combat Desertification (UNCCD)
Platz der Vereinten Nationen 1
D-53113 Bonn, Germany
Tel: +49 (0) 228 815 2873
www.unccd.int

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Key messages

Food systems consist of all the people, resources, institutions, and processes involved in the production, distribution, and consumption of food, including impacts on the environment, human rights, and local economies.

To become more resilient, conventional food systems must change. This is vital in the face of growing challenges such as climate change, economic crises, conflict, and major events including the COVID-19 pandemic. This working paper presents one overarching conclusion to building resilient food systems that contribute to land restoration:

> *States have the ability and primary responsibility to govern the environmental, economic, and social determinants of just, sustainable, and resilient food systems, using legislative, regulatory, and administrative measures. Governments at all levels —from national to local— can use the wide range of public policy tools at their disposal, including subsidies, grants, regulation, education, and social supports, to promote and maintain sustainability, equity, and resilience within food systems. Including those stakeholders most affected by and at risk within the food system in the development and implementation of such policies has multiple benefits. These include the articulation of stakeholder values, identification of areas of agreement and differences, promotion of transparency, and increase in quality and trustworthiness of the policy.*

With this in mind, there are four key messages[1] for strategies to make food systems more resilient while contributing to land restoration.

1. **Resilient, sustainable, and just food systems that contribute to land restoration require a holistic approach** that supports best agroecological practices while protecting people within the food system. Agroecology promotes synergy and complementarity between ecosystems and food systems through regenerative farming practices, and also supports the economic, political, and sociocultural needs of people. Even small-scale, low-budget agroecology initiatives have shown to yield positive results for communities' land, livelihoods, well-being, and food systems.
2. **Shorter food distribution chains and local/territorial markets improve land and ecosystem outcomes** through reduced loss and waste and lower greenhouse gas emissions. They also encourage producers to grow more indigenous varieties with minimal inputs, allow them to avoid overproduction, and garner more support from the community, often with increased profits for producers and lower prices for consumers. Cities and nearby food-producing regions can benefit from each other by integrating their approach to food systems.
3. **Protecting people is essential to ensure best practices for land restoration.** Resilient food systems are grounded in farmers who care for the land, work the fields, and take animals to pasture; vendors who sell food in local markets, and consumers whose health and well-being depend on the quality of food they consume. Security of tenure, especially for smallholders and women, leads to better care of and investment in land and soil. Enabling decent livelihoods allows producers to continue farming and enables consumers to purchase sustainably grown foods. Broad education around healthy and sustainable diets can redirect consumption patterns to fit within planetary boundaries.
4. **Changing how food is produced is key to restoring the planet.** Industrial agricultural systems that promote monocropping, excessive use of chemical inputs, and overgrazing have detrimental impacts on land, soil, and the overall health of ecosystems. Regenerative agriculture can restore degraded land and improve soil health, promote plant and soil biodiversity, protect forests and water sources, and integrate sustainable livestock rearing into broader agroecosystems for sustainable, resilient food systems.

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1. INTRODUCTION

Food systems (Box 1, Figure 1) are multiple and diverse, ranging from the very local and culturally distinct, to the all-encompassing global food system. Each food system contains a broad set of actors, from institutions such as government (which have the ability to shape policy and law that directly influence that system), to stakeholders (whose health, livelihoods, and immediate environment are closely linked to and reliant on a healthy food system). Other actors, such as large companies that have built their businesses around food, have the ability to influence food systems through lobbying and partnerships with institutions and government. The long-term viability of those businesses is also reliant on the health and sustainability of both the environment and the people within those systems. Urban dwellers are also important stakeholders within food systems, as up to 80%[2] of the world's food flows to urban centers.

BOX 1
Food systems[3]

A food system gathers all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the output of these activities, including socio-economic and environmental outcomes.[3]

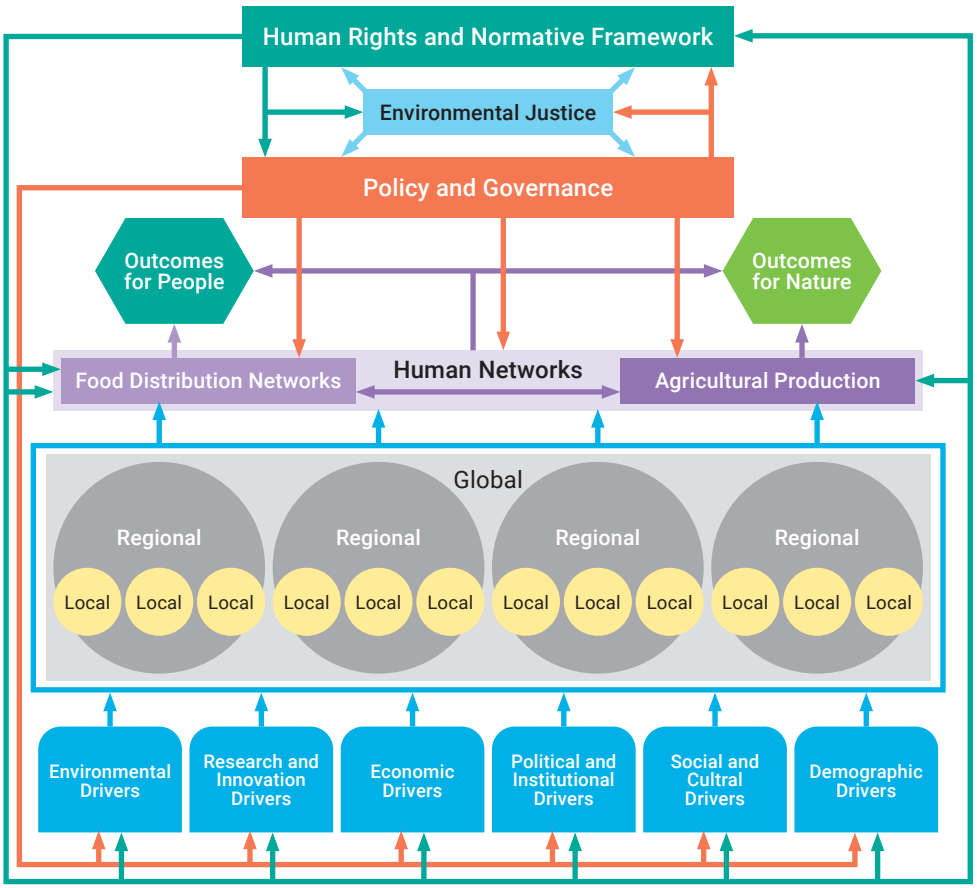
Conventionally, food systems have been defined as a set of activities along a distribution or value chain. While activities such as production, storage, distribution, and consumption are indeed parts of the food system, a more holistic understanding also encompasses crucial elements such as ecosystem health, livelihoods, and human health; it also incorporates environmental, political, sociocultural, and human rights perspectives.

Agriculture is the major user of land worldwide — accounting for roughly 37% of total global land use[5] — and is thus an important opportunity for land restoration. Current practices in food production and its rapid territorial expansion are centered around a largely intensive, industrial model that has led to adverse impacts on the health of both ecosystems and people. Human activity has severely altered and impeded natural processes on more than 75% of land worldwide.[6] Around 25% of land is already substantially degraded and less productive,[7] negatively impacting the well-being of at least 3.2 billion people.[8] Evidence shows strong links between low soil quality and poverty among farmers.[9]

Agriculture is the main driver of land degradation[10] — a largely human-induced process that decreases the ability of land to function effectively. It affects all different types of land — wetlands, rangeland and pastures, rainfed and irrigated cropland, forests and woodland — and can result in the loss of biodiversity, productivity, and ecosystem functions. The negative impacts of land degradation can also be seen in adjacent lands uses and water bodies. Land degradation has frightening implications for the future of food production, an indispensable ecosystem function that needs healthy land and soil in order to thrive. Achieving *land degradation neutrality* — a state in which we maintain or increase the amount of healthy, productive land by avoiding or reversing land degradation[11] — is key to preserving ecosystem functions.

Research shows that unsustainable practices related to agriculture contribute to land degradation.[12] These practices include the use of chemical fertilizers and pesticides, monocropping (especially on a large scale), overgrazing by livestock, deforestation, draining of wetlands, irrigation and excessive groundwater extraction, lack of groundcover for extended periods, compaction from heavy machinery, and inversion of soils through tilling. These practices often bring increased yields in the short-term, but have significant and often irreversible long-term ecological costs.

FIGURE 1
Framework for resilient food systems



Adapted from 'Sustainable food system framework', Executive summary of the HLPE Report 15: Food security and nutrition: Building a global narrative towards 2030.[4]

Increased demand for meat also plays a role, as industrial animal production can put substantially more strain on land resources. Livestock production accounts for 77% of agricultural land use when also taking into account pasture used for grazing and land used to grow feed.[13]

Long-distance food distribution or value chains can also put excessive pressure on land, primarily through food loss and waste. Greenhouse-gas emissions from food transport contribute to climate change, which in turn exacerbates land degradation.[14] Some food-distribution networks stretch around the globe, with food being produced in one country, processed in a second, and consumed in a third, sometimes in entirely different parts of the world. Longer-distance distribution chains and multiple-step processing provide more opportunities for food to spoil or be damaged,[15] contributing a large proportion of the 14% of food production that is lost or wasted globally before it even reaches the retailer.[16]

Often, the most important stakeholders in the global food system are also some of the most vulnerable. Over 600 million smallholder farmers worldwide produce much of the world's food supply,[17] including at least 70% of food in Africa and Asia, where most smallholders live.[18] Landholdings of less than 2 hectares each, together accounting for a quarter of the world's agricultural land, generally maintain rich agrobiodiversity[19] and contribute proportionately more food per unit land area than larger farms.[20] Women also play a key role in smallholder agriculture as paid and unpaid workers. In sub-Saharan Africa, for example, women comprise 50% of the agricultural labor force — a number that is trending upward — yet own only 15% of the land.[21] Protracted crises often have a big impact on farmers and other people living in rural areas, making their food security and livelihoods more vulnerable.[22]

In recent years, a grassroots push for more sustainable and just food systems has been driving positive change within food systems. This is evident in movements and initiatives that address long-standing contentious issues like sovereignty over seeds[23] and food.[24] It is also driving some companies to re-examine their corporate responsibility and engagement with food systems and begin to roll back negative processes.

This working paper uses an environmental justice-based framework for resilient food systems that includes land restoration activities based on regenerative agriculture, shortened or regionalized food distribution networks, and a shift in consumption patterns towards resource-conserving, minimally processed, and nutritionally balanced

diets. A holistic approach that goes beyond the production aspect of the food system is required to support land restoration. Thus, this paper considers the benefits of adopting agroecology and food sovereignty approaches — which encompass environmental, economic, social, cultural, and ethical dimensions — as justice-based means to transform food systems. Beyond agriculture, agroecology and food sovereignty also address human well-being and hold implications for new ways of thinking around markets and trade.

Section one of this working paper defines the central concepts around resilient food systems and presents the international standards most relevant to food systems and land restoration.

Section two uses case studies and best-practice examples from countries in both the Global South and North. It elaborates three key areas of intervention to enhance food system resilience and land restoration: sustainable food distribution networks, protection of people, and regenerative agriculture. It then draws together the critical factors for their uptake and success.

Section three describes five broad categories of policy and governance approaches: public policy and investment, advocacy and stakeholder/civil society initiatives, research and innovation, certification schemes and private sector engagement, and women as agents of change.

Last, section four presents a typology of best practices and case studies.

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2. CENTRAL CONCEPTS AND INTERNATIONAL STANDARDS

Sustainable and resilient food systems require more than shifts in production methods and increased efficiency in distribution networks. A holistic approach to food systems includes elements that encompass production methods, environmental health, and the well-being of people, all of which have implications for distribution networks and the global trade of food. Agroecology and food sovereignty, both at the forefront of global policy discussions, are discussed here as two complementary holistic approaches that align with environmental justice principles and a human-rights framework.

This section first defines four central concepts needed for a resilient food system: resilience, food sovereignty, agroecology, and environmental justice. It then presents relevant international standards, including legally binding instruments, non-binding instruments, and other useful frameworks and emerging rights that can be used to support the transition to a more resilient, sustainable, and just food system that contributes to land restoration.

The framework presented in this section will enable stakeholders, decision-makers, and other actors to identify broad strengths and weaknesses of practices and approaches in different regions, and pathways and entry points to enhance the resilience of food systems while promoting land restoration.

2.1 Concepts for a resilient food system

Resilience

Resilience is commonly defined as the capacity of a system to maintain its structure and functions in the face of shocks, disturbances, and external pressure, to quickly recover from such disruptions, to adapt to changes, and to learn from past experiences.[25] Typically, resilience focuses on the ability to adapt rather than taking action to change external factors or revert back to pre-crisis conditions.[26] Improving resiliency in food systems requires increased adaptive capacity in cropping systems, food and agricultural workers, infrastructure, and trade relationships in order to cope with short-term volatility and longer-term global changes and pressures. However, resilience also requires that attention is given to remedying the underlying issues that hinder positive change in food systems, such as poverty, perverse financial incentives, imbalanced power relations, and lack of research on agroecological approaches. The call for transformation of food systems therefore requires changes beyond the scope of adaptation, and a greater emphasis on removing the underlying issues that render many food systems stubbornly resistant to change.

Distinctions have been drawn between social and ecological resilience, and while there is a clear link between the two, ecological resilience does not always support social resilience.[27] Since people are stewards of the environment and central to food systems, focusing resilience-building adaptive and transformative actions on socio-ecological systems as a whole is essential. For this reason, it is important that resilience always be grounded in respect for human rights, social justice, and international law. Yet few definitions include concepts of inclusivity, equity, or justice, even though these are essential elements in resilient and sustainable food systems.[28] Sustainability is a term frequently used in association with resilience. However, while resilience describes the ability to recover from a shock, sustainable practices could have prevented or mitigated the disaster in the first instance.

Building on the understanding of resilience outlined above, this working paper proposes a new definition of the concept (2).

BOX 2
Resilience

Resilience is the capacity of a system to maintain its structure and multiple functions —ecological, health, social, economic, and cultural— in the face of shocks, disturbances, and external pressure, to quickly recover from such disruptions, to adapt to changes, and to learn from past experiences, without eroding the agency of human actors in that system to resist, reverse, or alter negative external factors or to advance equity, justice, and inclusivity within that system.

Food sovereignty

The concept of food sovereignty (Box 3) emerged within peasant social movements in the late 1990s as a response and challenge to the agricultural trade liberalization policies of the World Trade Organization, International Monetary Fund, and World Bank, and the imbalanced power relations, lack of widespread participation, and lack of access to production resources those policies promote.[29]

BOX 3
Food sovereignty

The right of peoples, communities, and countries to define their own agricultural, labor, fishing, food and land policies, which are ecologically, socially, economically and culturally appropriate to their unique circumstances. It includes the true right to food and to produce food, which means that all people have the right to safe, nutritious and culturally appropriate food and to food producing resources and the ability to sustain themselves and their societies.[30]

Critically, the food sovereignty movement adds elements of equity and justice to food systems and challenges the notion of food security (Box 4) as a sufficient measure of well-being or of achieving the Right to Food. Many communities, particularly Indigenous Peoples, have lost their ability to maintain traditional food systems through injustices linked to state-sanctioned loss of land.

BOX 4
Food security

Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life.[31]

Because the food sovereignty movement is positioned in opposition to many aspects of global food trade, it is often conflated with food self-sufficiency — the policy or objective of a country to rely completely on domestic production to meet its country's food needs. While food sovereignty does prioritize local, national, and regional food production and markets, the movement does not advocate the complete halting of all global trade; rather, it calls for the dismantling of a corporate-controlled food trade regime characterized by land grabs, predatory pricing for agricultural products, and chronic poverty, food insecurity, and malnutrition in many food-exporting countries.

The term 'food sovereignty' has also been used by some to describe the drive by states to plan a food system that is less reliant on other countries for their food supply, normally incorporating some degree of self-sufficiency in food production.[32] Motivation for this type of national food planning stems from concerns around price volatility, export bans, and even the use of food export depravation as a diplomatic weapon.[33] For many countries, the food price crisis of 2007-2008 reignited the drive toward greater self-sufficiency,[34] and other shocks — such as the impact that the COVID-19 pandemic has had on food distribution networks.[35] Countries that lack the natural resources to achieve food self-sufficiency sometimes pursue a policy of land acquisition in other countries.[36] In practice, this type of food planning is at odds with core principles of the food sovereignty movement, as it deprives local communities in countries where land is acquired to define their own food systems, control their own natural resources, and to benefit sufficiently from production in their own environments.[37]

Agroecology

Agroecology is often defined as the application of ecological concepts and principles to the design and management of sustainable agroecosystems.[38] However, more recent systems perspectives of agroecology commonly articulate the following 10 elements: diversity, co-creation and sharing of knowledge, synergies, efficiency, recycling, resilience, human and social values, culture and food traditions, responsible governance, circular and solidarity economy).[39] Many of these elements are reflected in the definition of agroecology provided in Box 5.

BOX 5
Agroecology

> Agroecology is a scientific discipline, a set of practices and a social movement. As a science, it studies how different components of the agroecosystem interact. As a set of practices, it seeks sustainable farming systems that optimize and stabilize yields. As a social movement, it pursues multifunctional roles for agriculture, promotes social justice, nurtures identity and culture, and strengthens the economic viability of rural areas.[40]

Agroecology includes both practices that lead to land and ecosystem restoration, and the necessary improvements to human well-being required to achieve inclusive, equitable, and just food systems. The approach described in the Nyéléni Declaration on Agroecology[41] consists of three integrated pillars: a scientific approach, an agricultural practice, and a social movement, that demands an environmentally sustainable and socially just food system. The approach promotes synergy and complementarity between ecosystems and food systems, and encompasses economic, political, environmental, and socio-cultural dimensions that have been outlined in detail by CIDSE.[42] Agroecology:

- Supports short, equitable food distribution networks
- Relies on local and traditional culture, practices, and innovation
- Promotes farmer-to-farmer knowledge-sharing
- Prioritizes sustainable livelihoods and dignity, especially of smallholders
- Strengthens local markets, employment, and economies
- Promotes sovereignty over natural resources (including land, water, and seeds) for Indigenous peoples, peasants, and other people living and working in rural areas
- Contributes to healthy and sustainable diets
- Promotes agricultural practices that maintain biodiversity, reduce/eliminate use of synthetic inputs, and support carbon sequestration and nutrient cycling.

From a production standpoint, agroecology is well aligned to regenerative agriculture, which is known to contribute to soil rehabilitation and land restoration.[43] Agroecology enhances the livelihoods of local communities, including improved economic viability and income, food and nutrition security, and socio-political empowerment, while generating more stable and sufficient yields.[44] An agroecological approach also requires that all actors have the opportunity to participate in decision-making and governance of the food system. To realize its full potential agroecology needs the support of public policy, institutions, and investment.

Environmental justice

Environmental justice is, broadly, the application of justice to environmental problems, and is an important key driver for positive change. It is strongly aligned with social justice, insofar as environmental injustices impact and highlight inequalities experienced by people. However, environmental justice also includes inter-generational justice, acknowledging that people have an obligation to future generations to ensure the long-term sustainability of the planet. It can also be applied to ecological communities (so, not only to people). Environmental justice seeks the equitable *distribution* of environmental risks and benefits; fair and meaningful *participation* in environmental decision-making and governance; and recognition of community ways of life, local knowledge, and cultural difference — especially Indigenous and other local peoples' rights of self-determination and respect.[45] Food, an essential environmental resource, is also linked to environmental justice in at least four key ways: accessibility of food, impacts of and on climate change, the global food distribution chain, and diet.[46] Advancing environmental justice within food systems—including distribution of natural resources, participation in decision-making, and recognition of rights—can also have a positive impact on land and ecosystem restoration through better use of soil, reduced waste, and lower greenhouse gas emissions. In turn, engaging in practices that lead to land restoration (such as those described throughout this paper) can advance environmental justice, especially for communities whose land has been degraded by unsustainable practices.

2.2 International standards

Social and environmental justice are not always reflected in law or other normative policy instruments. Rather, an environmental justice perspective can help identify where inequalities exist, helping to move law and policy forward. It is vital that all approaches taken to transform food systems, by states and other actors, align with human rights principles and justice-based international norms. Table 1 lists the treaties and global policy commitments that are especially relevant in considering the international standards that can support the transformation of food systems.

TABLE
International standards for food system resilience and land restoration

Emerging or under negotiation	Organization, abbreviation	Standard or agreement
General human rights		
■	ICCPR	International Covenant on Civil and Political Rights
■	ICESCR	International Covenant on Economic, Social, and Cultural Rights
□	UN	Universal Declaration of Human Rights
□	UN Committee on Economic, Social and Cultural Rights (CESCR) General Comments	18: The Right to Work 24: on State obligations under the ICESCR in the context of business activities 26: on land [*forthcoming*]
●		*Emerging* Human Right to Land[47] *Emerging* Human Right to a Healthy Environment[48] Framework Principles on Human Rights and the Environment[49]
Human health and nutrition		
□	CESCR General Comments	12: The Right to Adequate Food 14: The Right to the Highest Attainable Standard of Health 15: The Right to Water
□	Food and Agriculture Organization of the UN (FAO)	Voluntary Guidelines to support the Progressive Realization of the Right to Adequate Food in the Context of National Food Security[50]
□	Committee on World Food Security (CFS)	Policy Recommendations on Water for Food Security and Nutrition[51]
Food distribution networks		
□	UN-Habitat	New Urban Agenda[52]
□	CFS	Policy Recommendations on Connecting Smallholders to Markets[53]
□	FAO	Framework for the Urban Food Agenda[54]

■ **Legally binding instrument** □ **Non-binding instruments:** Declarations, general comments, resolutions, and negotiated policy
● **Other useful frameworks** and emerging rights

TABLE
International standards for food system resilience and land restoration *(continued)*

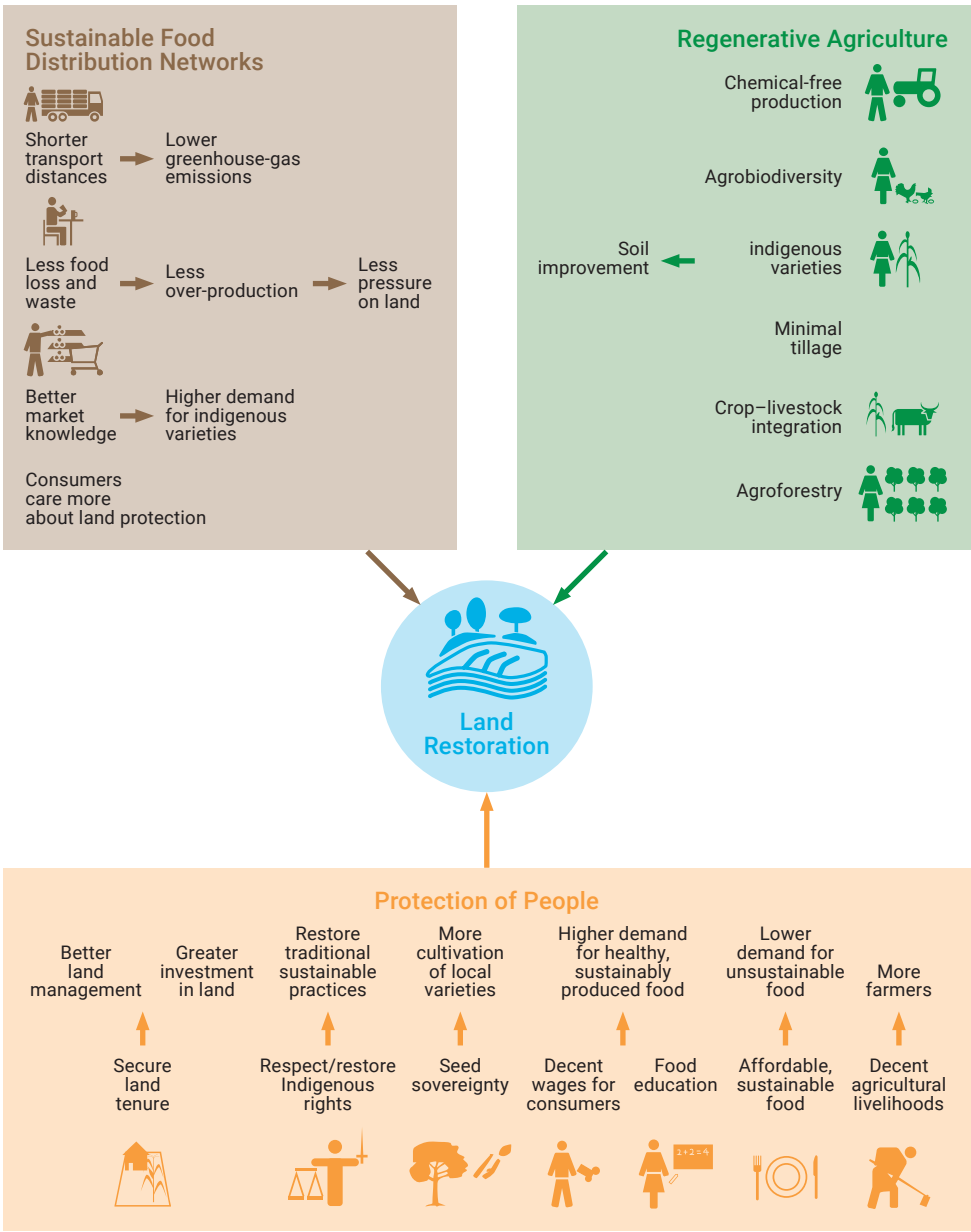
Emerging or under negotiation	Organization, abbreviation	Standard or agreement
Historically marginalized groups		
■	CEDAW	Convention on the Elimination of all Forms of Discrimination Against Women
□	UNDRIP	UN Declaration on the Rights of Indigenous Peoples
□	UNDROP	UN Declaration on the Rights of Peasants and Other People Working in Rural Areas
Agroecology and food systems		
□	FAO	Ten Elements of Agroecology[55]
□	CFS	Policy Recommendations on **Agroecology** and Other Innovative Approaches Voluntary Guidelines on Food Systems and **Nutrition**
□	SDGs	Sustainable Development Goals
●		Nyéléni Declaration on Agroecology[56]
●		Nyéléni Declaration on food sovereignty[57]
Conflict		
■		Geneva Conventions and their Additional Protocols
□	CFS FFA	Framework for Action for Food Security and Nutrition in Protracted Crises[58]
□	UN Environment	Assembly Resolution on the Protection of the Environment in Areas Affected by Armed Conflict[59]
Land tenure and sovereignty over natural resources		
■	CBD	International Covenant on Biological Diversity
		Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization
■	UNCCD	UN Convention to Combat on Desertification
□	UN-Habitat	New Urban Agenda[60]
□	UN	UN Declaration on Permanent Sovereignty over Natural Resources
□	VGGT	CFS Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security[61]

■ **Legally binding instrument** □ **Non-binding instruments:** Declarations, general comments, resolutions, and negotiated policy
● **Other useful frameworks** and emerging rights

3. KEY AREAS OF INTERVENTION TO ENHANCE FOOD SYSTEM RESILIENCE AND LAND RESTORATION

To transform food systems, make them more resilient, and ensure they contribute to land restoration, changes can be made in three key areas: sustainable food distribution networks, protection of people, and regenerative agriculture. Each of these areas of intervention can contribute to land restoration and resilient food systems in a number of ways (Figure 2). This section describes both challenges and best practices — exhibited through a variety of cases from around the world — in each of the three identified areas of intervention.

FIGURE 2
Key areas of intervention for direct and indirect impacts on land restoration in food systems



3.1 Sustainable food distribution networks

A crop or product typically goes through a set of processes in its lifetime, including pre-production (e.g., selection and preparation of seeds), production (i.e., growth), storage, transport, processing, marketing, distribution (wholesale and retail), and consumption. Loss and waste management may occur at all steps along the chain. Chains can be very short, consisting of a direct relationship between the producer and the consumer, or they can span the globe. While individual products move through a chain-like process, the overall distribution of food within a food system is not linear, but rather a complex network made up of multiple chains, as well as multiple human and environmental components.

Each activity within a food distribution network has ecological and socio-economic impacts. Unsustainable practices can both decrease the resilience of food systems and contribute to land and ecosystem degradation. Most food grown for export is intensively farmed, using input-heavy monocropping techniques that exacerbate land degradation.[62] Export markets generally demand only particular varieties of foods, which poses a threat to the survival of agrobiodiversity and indigenous varieties.[63] In some countries, scarce resources such as water are depleted to fulfil demands of the export industry.[64] Food that travels greater distances over longer periods of time also contribute more to greenhouse gas emissions — and thus climate change, which exacerbates land degradation[65] — and is more at risk of spoilage and damage,[66] putting additional unnecessary stress on land. Trade also comes with financial risk for food producers due to price volatility[67] and supply risk for import-reliant regions caused by occasional unexpected shocks, including export bans from exporting countries.[68]

Global food markets

Some of the most imbalanced power relations exist in global food trade, characterized by long-distance food chains and, increasingly, consolidation of ownership by agri-food giants.[69] For example, four agricultural commodity trading firms — Archer Daniels Midland (ADM), Bunge, Cargill, and Louis-Dreyfus — control 70% of the global grain market.[70] While only 23% of food produced worldwide is traded globally,[71] many producers interact with food systems on all scales — local, regional, and global — even if only a small portion of their goods reach the global market, meaning that most producers are still impacted by global trade.[72] Moreover, the companies that control most of this 23% of globally traded food often acquire large tracts of land in the Global South and engage in monoculture farming practices that are associated with land degradation.[73]

Food security and agricultural strategies of countries in both the Global North and the Global South often rely on international trade. Many affluent countries rely on agricultural imports to meet their needs, effectively outsourcing land and ecosystem stress to other, mostly lower-income countries.[74] Governments and international agencies and institutions often offer incentives and support for participating in global trade, such as through the World Trade Organization "Aid for Trade" program,[75] which encourages donor countries to increase their reliance on trade. Several countries in the Global South rely on cash crops or other food produced for export markets as a way to generate foreign currency,[76] and farmers often have high expectations of increased earnings — though in practice earnings do not always improve.[77] Structural imbalances are also present in the global trade regime, as many countries in the North provide significant domestic agricultural subsidies, with some then engaging in dumping,[78] which can undermine local production.[79]

Global food trade is likely to remain a part of most people's diets, and of many producers' portfolio of options. However, growing understanding of the negative impacts of global trade is leading to consumer demand for assurance that the products they purchase from the global market respects both the environment and producer livelihoods. These initiatives often revolve around third-party certification schemes, such as Fairtrade[80] and Rainforest Alliance,[81] and are visible in numerous in-store displays such as in coffee chains.[82] While these do often make a positive impact, it is often minimal and many smallholders face insurmountable barriers to participation in such schemes (see section 3.4).

Food loss and waste

Food loss and waste is also a factor in any food distribution chain and can occur at various points along the chain. Food loss generally occurs before it reaches the retail stage and is often related to factors such as weather, logistics, and infrastructure; losses after the production stage are referred to as postharvest losses. Research shows that food losses on large farms of more than 1000 hectares are almost double that of smallholder farms (7.5% of production compared to 4%).[83] Food waste is linked to retail and consumption and has more to do with consumer preferences and behavior.[84] Lost and wasted food contributes to land degradation because it puts unnecessary pressure on land and environmental resources for the production of food that is not even consumed. This pressure could be alleviated by a less wasteful distribution network.[85] Approximately 14% of food produced globally is lost between harvest and retail. This figure does not include amounts wasted at retail and consumption levels.[86]

Short chains

Short food-distribution chains are a key component of a sustainable approach to food systems and land restoration. Both food loss and waste are less likely to occur in shorter chains: more direct contact between producers and consumers, less time between harvest and consumption, less handling by fewer people, and shorter distances mean that food is more likely to arrive without spoilage or damage.[87] In southern Brazil, dairy farmers were able to avoid milk spoilage by switching to shorter distribution chains; previously, they often lost their product to spoilage if transportation was late by even one day.[88] Shorter chains can also limit surplus production, as producers tend to know their market better so are less likely to overproduce. Moreover, consumers who consciously purchase foods that are local or regional may value cosmetic factors less and other factors — such as supporting local production — more. Consumer demand also plays a role in the length of distribution chains. In many places, a greater understanding of the environmental impacts of long chains results in higher demand for more locally produced products.[89]

Based on a review of cases from across Europe, short chains also reduce resource use such as packaging and fossil fuels, support sustainable production methods, and reduce greenhouse-gas emissions and energy use, including food miles.[90] Reduced greenhouse gas emissions result in positive impacts on land, as climate change is known to exacerbate land degradation.[91] Moreover, shorter chains have a number of positive social and economic impacts for producers, consumers, and communities as a whole.[92] In an example from Italy, when milk producers shortened their supply chain their production costs rose slightly, but by minimizing their distribution costs they were able to reduce the final price to the consumer — milk dropped from USD 2.18 to USD 1.36, while cheese dropped from USD 17.68 to USD 12.24 — while the company's profits grew significantly, turnover rose by 40%, and its profit margin reached 25%.[93]

Territorial markets

The vast majority of the world's food is consumed in the same country it is produced in.[94] More than 80%[95] of the world's smallholders operate in territorial markets, which can be local, national, or even regional (multi-country) markets. Territorial markets differ from the global market in that they are located in and identify with a specific area and rely on shorter food distribution chains. They involve the participation of smaller-scale producers, processors, transporters, and traders — many of them women — to meet food demand within that territory.[96] Despite the enormous role these markets play in meeting the world's food needs and providing outlets for smallholders, they are often overlooked in data collection by different levels of government, making it difficult to compile an evidence base for policy.[97]

In 2009 France launched an initiative to foster and develop farms whose output could be marketed through *terroir* (territorial or regional) short distribution chains.[98] The state supports the entry of new farmers into short-chain markets and provides skills development in related subjects such as marketing and management of cooperatives. In 2010–11 the government enacted into law a requirement that 20% of all food purchased for public restaurants and dining rooms should be procured locally, giving preference to products marketed directly by producers. In the new National Food Program 2019–2023[99] regional food projects are considered the key lever for delivering on the three core elements of the program: social justice, combatting food waste, and food education. A core objective of the program is to "encourage the development of short distribution channels and geographical proximity between agricultural producers, processors, distributors and consumers." [100]

Regional or territorial food projects were also defined in French law in 2014 as a way to construct territorialized food systems that respect the environmental, social, and economic dimensions of sustainable development. One such project in Figeac (southwestern France) developed a rural territorial brand, *Terres de Figeac, mêlée gourmande* (Figeac lands, a tasty mix), with the objectives of improving knowledge and competencies around food, valorizing local products and local knowledge, supporting social innovation, and promoting the quality and uniqueness associated with the territory. The initiative developed its own territorial food policy incorporating producers, civil society, small-scale food businesses, retailers, restaurants, catering, and consumers in governance action. Besides the development of the brand, the project also supports the establishment of new farmers, supports collective catering projects, and organizes food events.[101]

Short food supply chains and territorial markets are also an emerging trend in many Latin American countries. In Chile, over 900 food markets held in communes and regions across the country support smallholders by providing them a place to sell their own food either directly to consumers, to stallholders in the market, or to wholesalers who supply the markets.[102] Public procurement is a principal way for governments at all levels to support and facilitate local and territorial markets. A notable example of this practice is Brazil, where at least 30% of food used to supply meals to schoolchildren is purchased from family farmers, under the country's "Zero Hunger" program.[103]

Territorial markets can be strengthened through greater direct contact between producers and consumers, which can be facilitated through farmer organizations, associations, and cooperatives. Collaboration between farmers makes local production, processing and distribution infrastructure more affordable, and enables farmers to learn more from each other and collectively develop knowledge that can benefit the local food system.[104] Cooperatives also generally bring other benefits, such as higher prices for goods, improvement in yield, and increased overall income.[105] However, cooperatives do not all inherently advance principles of equity: in some cases women are excluded from joining,[106] others deal with disputes or confusion over property rights,[107] and some experience uneven distribution of benefits related to scaling up of production.[108]

However, with knowledge that cooperatives are not a panacea for equity amongst farmers, government policy and responsible decision-making within companies seeking to work with or procure from cooperatives can have positive impacts. In Mexico, the government offered initial financial support to the development of several women-led cooperatives in the late 1990s. While some of these disbanded, others continued. In Hadaglo, the Milpa Maguey Tierno de la Mujer Cooperative, run by a group of Indigenous Otomi women, sells organic agave syrup in national markets. These women had to overcome structural barriers to participating in business because of their gender and would not have been able to start the cooperative without financial and technical help from government and NGOs. A key reason this cooperative has continued is that the women feel an ethical commitment to both the work and their contribution to the land (agave plants counter desertification by retaining water in the soil, and their collection of medicinal plants preserves biodiversity).[109]

City regions

Urban centers are also an important component of food systems and food distribution networks. Most food produced globally — at least 80%[110] — flows to urban areas, and if trends toward urbanization continue, this number is destined to rise. Increasing disconnection between urban and rural spaces has detrimental impacts on the viability and resilience of rural smallholders and urban farmers, and on the dietary health of urban dwellers. Stronger linkages along the rural-urban continuum can improve nutrition, food security, livelihoods, and environmental outcomes.

BOX 6
City regions

A city region is a complex network of actors, processes and relationships to do with food production, processing, marketing, and consumption that exist in a given geographical region that includes a more or less concentrated urban center and its surrounding peri-urban and rural hinterland; a regional landscape across which flows of people, goods and ecosystem services are managed.[111]

The needs of rural communities (including remote communities) are central to ensuring food system resilience for city regions; rural areas are not seen merely as a region of service provision for urban areas. The City Region Food System (CRFS) framework provides insight into flows of resources — including food, people, and knowledge — across sectors and between rural and urban areas.[112] In doing so, it clarifies some of the policies and processes that are needed for a resilient food system that supports land and ecosystem health. As with the territorial market approach, short food distribution chains are a key component of city region food systems that contribute to land restoration through reduced waste and lower greenhouse gas emissions.

Case studies show that engaging with local government is a key component to uptake of interventions that lead to more resilient city region food systems. In Colombo, Sri Lanka, researchers developed a baseline study of the city's needs and benefits of adopting a CRSF approach. By including different levels of government in consultations, the research succeeded in shaping policy at local, regional, and national levels (see Case 1).

CASE 1
The CRFS of Colombo, Sri Lanka[113]

Project

Assessing and Strengthening the city region food system of Colombo, Sri Lanka [*initially pilot project, now in phase two*]

Objective

To foster more sustainable, resilient, integrated food systems in city regions.

Duration

Launched in 2015; ongoing

Location

Colombo, Sri Lanka

Actors

FAO; International Water Management Institute (IWMI)

Ministry of Urban Development and Housing; Ministry of Environment

Colombo Municipal Council; Western Province Ministry of Agriculture

Ecological context

Soil degradation is a key environmental concern in Sri Lanka, with over 44% of soil experiencing some level of degradation. In wet zones some farmland has high iron toxicity, while certain districts are at high to extremely high risk of soil erosion for up to 74% of the district. Studies have shown that the use of chemical fertilizer in the Western Province, where Colombo is located, has declined, but this is most likely due to reduced agricultural activity in the region. However, overuse of agrochemicals is still a main concern: Sri Lanka is ranked fifth in the world for highest chemical fertilizer use per hectare, with detrimental impacts on human health and the environment. This is particularly due to a preference for "high quality" non-native seeds that require heavy use of agrochemicals.

Institutions influencing the city region food system

At the institutional level, policy around the food system is fragmented and siloed, with various national ministries having most power in terms of action and strategy in food production, nutrition, food safety, and sufficient and timely food supply. Various public organizations that function under the ministries are tasked with implementing policies and legislation. The Western Province Ministry of Agriculture and related sectors plan and implement provincial-level projects and operations, while the local authority — the Colombo Municipal Council — enforces the Food Act, which deals largely with safety and inspections, regulates markets, and deals with water management aspects within Colombo. The private sector is also active throughout the food system, including supply of inputs and organic waste management. The government prioritizes, through the use of financial incentives, value-added processing, minimizing food waste, generating employment, and increasing exports. The project identified the involvement of public institutions and public policy interventions as key pathways to integrate a CRFS approach into Colombo's urban planning.

Project activities

- Undertook assessment of Colombo's city region food system based on measurable indicators.
- Identified priority areas for intervention: food waste and losses, food security and food safety, value chain management, natural resource management and climate change.
- Linked to existing areas of government interest, including health, food safety, food waste, and climate vulnerability, which serve as concrete entry points for further food system strategy formulation.
- Engaged with key government actors who are directly or indirectly linked to the planning and implementation of the city region food system to discuss the critical aspects of the system.
- Developed a food flow analysis of key crops within the city region food system.
- Conducting a quantitative analysis of rural – urban food flows specific to select agricultural commodities (and including other sectors; ongoing).
- Quantifying generation of food waste and use along the food distribution chain (part of a separate FAO technical cooperation project; ongoing).
- Helping to identify food chains and commodities vulnerable to climate change, including how and why those foods are affected, as well as who is affected, and suggested adaptation strategies to make urban food system more resilient (ongoing).

Context and findings

People living in urban areas in Sri Lanka exhibit a range of serious food-related challenges, including undernutrition, overweight/obesity, anemia, high blood pressure, and diabetes. People are also increasingly shifting their consumption patterns from home-cooked to processed and convenience foods and prepared meals.

Rice is the staple food in the country, and most of the paddy rice produced in Sri Lanka goes to Colombo (demand from the city is more than satisfied by domestic production). Coconut, fish, brinjal (eggplant), beans, bananas, and papayas were also selected by the study for research, as they are the most-consumed food items in the Colombo city region that also supply key macro- and micronutrients. The country also relies heavily on imported foods, especially wheat and a range of pulses — as well as sugar, onions, potatoes, palm oil, dried milk, soybeans, dried fish, canned food and fruit such as apples, grapes, and oranges. Of the seven locally-produced food items selected in phase I of the study — rice, beans, brinjal, banana, papaya, coconut, and fish — there was found to be an oversupply of all of these to the Colombo city-region. This is likely to due to higher numbers of consumers in Colombo than are officially counted as residents (i.e., a high temporary or floating population), and a large quantity of food that ultimately flows to and is consumed in the city.

The vast majority of demand for food supplies in the city of Colombo — 95% — is brought in from outer regions of Sri Lanka or imported from abroad, both through longer-distance distribution chains (remaining demand is produced in the city of Colombo, primarily in home-gardens). These distribution chains are characterized by numerous intermediaries (collectors, wholesale buyers, transporters, etc.), processes, and activities. This in turn leads to high food loss and waste — between 20 and 40% of fruits and vegetables — with almost 75% of this occurring during transportation, due to improper packaging and storage. Food loss and waste in retail shops was also found to be significant at 17–18% for fruits and vegetables and 15% for dry foods. Households also waste up to 30% of food, particular middle- and higher-income groups. Storage, transportation, food handling, and education on food use habits have all been identified as areas needing improvement.

These losses have both a serious environmental impact, and lead to lower income for producers and higher prices for consumers. Due to the large number of intermediaries in the chain, small-scale food producers have little negotiation power in pricing of their goods, and the average price increase from farmer to consumer is 300%. This contrasts with commercial-scale farming entities, which are increasingly in control of the entire distribution chain for their products. However, there is an emerging trend toward shorter-distance food-distribution networks in the Colombo city region, with farmers from neighboring areas bringing small quantities of the produce to sell directly to residents in urban and peri-urban areas. Such trends could be supported and expanded.

While there is awareness of and preference for organic foods among higher-income groups, these foods are expensive, at double the price or more of conventionally grown foods. Colombo officially has low poverty levels; however, urban poverty is a significant issue and is becoming worse, with one-third of the population experiencing food insecurity. This is likely due to a combination of high food prices, low incomes, and high cost of living. Thus, there is a possible need for research and interventions to make food produced with less agro-chemicals more affordable for consumers. While only 2.4% of Sri Lanka is certified organic, the government promotes foods produced using Good Agricultural Practices (GAP). Other non-governmental sustainability certifications are emerging; these may be more viable options in the short term.

In 2015 a new Ministry of Megapolis and Western Development was established to implement a new Megapolis and urban region in Sri Lanka's Western Province, to replace the Colombo Metropolitan Region. The "megapolis" refers explicitly to a city-region approach. As the Ministry was subsequently dissolved and efforts to form a Megapolis authority abandoned in November 2019, the opportunity to insert food and food issues into city-region planning was not realized.

Themes identified for food system improvement

- Food safety is a concern for consumers.
- Half of the waste produced in Colombo Municipal Council is from food.
- Climate change impacts the main food supply system that Colombo depends on.

Recommended policy interventions

- Facilitate a holistic and territorial approach to food systems.
- Develop physical and institutional capacity to reduce vulnerability of lower-income urban dwellers to food price fluctuations by regulating and monitoring market supply chains and strengthening urban food reserves.
- Strengthen food safety policies and enforcement.
- Better coordination, integration and implementation of waste management.
- Create an enabling environment for the private sector to engage in resource recovery and reuse for food waste.

- Create an enabling environment for household level by developing communication and awareness campaigns, and by implementing incentive (and disincentive) programs such as refunds for bottles, adding prices for single-use plastic bags, and imposing fines for not separating waste.
- Develop and implement by-laws that promote reduction of food waste in restaurants and catering.

Outcomes

1. Creation of a more robust network of policymakers and institutions that are knowledgeable of the benefits of adopting a city-region food systems approach, especially regarding the need for integrated policies and programs
2. Development of by-laws directly related to the city-region approach work to address food waste and losses, and food safety; the concept of city region food systems, along with climate change and natural resource management, included in the Food Act and relevant provincial-level policy
3. Identification of new opportunities to integrate food as a key dimension of the Colombo Megapolis, through the increased awareness of the transformative potential for a strengthened food system

Moving forward

The project is on-going, with the current phase of the project focused on building resilience of the Colombo city-region food system to climate change, in recognition that the urban response to climate shock or change can be different to rural areas. A vulnerability study revealed that actors in different phases along the food supply chain will need to develop adaptation mechanisms related to the particular shocks of climate change expected in Sri Lanka (floods, droughts, extreme rainfall events, extreme temperatures and sea-level rise). Moreover, a lack of consistent data was identified on the impact of food import and export reliance and of food waste management on CRFS vulnerability.

Urban agriculture

Urban agriculture contributes to food systems resilience, enhances food sovereignty, and has multiple co-benefits, such as promoting social inclusion and education, improved air quality, and biodiversity.[114] It can be practiced in a variety of different settings and used to restore degraded soils.[115] Thus, it has a positive effect on the health of urban communities and supports climate change adaptation and mitigation efforts by restoring land and ecosystem functions.

Local governments can support and incentivize urban agriculture in their cities and collaborate with citizens and local communities. For example, the City of Bologna in Italy developed an urban food-garden policy framework that focuses on supporting citizens' initiatives. To inspire and encourage urban farmers, the city launched a Europe-wide design competition for urban agriculture sites, awarding funding and municipal land to implement the winning projects.[116] Urban agriculture can also be used as a positive coping mechanism for communities living in particularly difficult circumstances. In the occupied Gaza Strip, a local initiative supports women in developing small businesses around urban agriculture, providing both a source of livelihood and increasing the availability of fresh food in Gaza.[117]

3.2 Protection of people

People are central to any food system; they are the decision-makers at every point in the distribution network, from production to consumption, the workers who ensure those distribution networks function, and the ultimate beneficiaries of the food provided through those networks. Thus, protecting the rights, livelihoods and diets of people is essential to the sustainability and resilience of a food system.

Most peasants and others who work in rural areas are unable to earn sufficient income to support their families, leading to rural–urban migration.[118] While a lack of access to credit is sometimes cited as a barrier, there is the even more pressing problem of small farmers relying on credit and falling into debt, resulting in an agrarian crisis in some regions.[119] Contract farmers, who lease their land to large agribusiness actors in exchange for guaranteed income, find that those actors overuse chemical inputs, further degrading their land.[120] Conditions are often worse for agricultural workers who are not landholders, both in the North, where temporary foreign workers are not given the same rights as other workers,[121] and in the South, where seasonal workers are particularly vulnerable to the abrupt loss of income and shelter, as observed during the COVID-19 pandemic.[122]

Access to land and other natural resources is a key barrier for many. Indigenous peoples regularly experience the disappearance of their traditional food systems due to state appropriation of their territory, colonial policies privileging large-scale agriculture over hunting and foraging, the loss of traditional land-management practices, and barriers to intergenerational knowledge transfer, leading to the degradation of much of their lands.[123] Women in many countries, particularly in Africa, are vulnerable to landlessness due to customary practices that prevent them from obtaining and retaining land. Even where laws are in place to protect women's land rights, they are often not enforced.[124] Both men and women smallholder farmers and pastoralists, primarily in Africa, Asia, and Latin America, are vulnerable to corporate land grabs.[125] Water is also at risk of water grabbing, which can happen at community or regional level, by private corporations[126] or by states.[127] Seed sovereignty is another key issue related to corporate control of the food system, as patents prevent farmers from sharing this traditionally public good,[128] which can be detrimental for struggling smallholders. The widespread use of "improved" seeds ushered in by the Green Revolution, which often require the use of chemical inputs that are a key contributor to land degradation, has led to a decline in the use of many traditional, indigenous varieties, some of which are now critically endangered.[129]

Many small-scale food producers in the South are, paradoxically, some of the most impacted by hunger, malnutrition (due to a lack of dietary diversity and micronutrients), and food insecurity.[130] Global trade may be more likely to facilitate the flow of food away from the hungry, exacerbating existing inequalities.[131] In other countries, lower incomes are associated with higher rates of obesity, due in part to the widespread availability of inexpensive, over-processed, calorie-dense but nutrition-light foods.[132]

Decent livelihoods and dignity

Decent livelihoods and dignity in agriculture and food-related work are essential to resilient food systems. The opportunity for all actors engaged in the food system to earn a reasonable profit from their work is a necessary component of a resilient food system. If farmers who engage in production practices that contribute to land restoration are compensated fairly for their crops, this could serve as an incentive (to them and to others) to scale out and scale up those good practices. Farmers in Brazil who have adopted agroecological practices, particularly agroforestry, have reported increased incomes with an additional value of high-quality foods they were able to consume from their own land.[133] The ability to earn a decent living also means that fewer people will be driven out of farming and rural areas, a process that is putting increasing pressure on urban and peri-urban land in some places.[134] Research shows that achieving land and ecosystem restoration depends on a system of secure livelihoods.[135]

Certain certification schemes such as Fairtrade aim to improve the livelihoods of food producers. Research on the experience of producers participating in the Fairtrade scheme show mixed results, with some benefitting but others becoming poorer over time after becoming certified.[136] Ultimately, however, systemic change is needed to ensure that all producers and those working in the food system are guaranteed a decent standard of living, without the necessity of adherence to a certification program.

Indigenous peoples

Indigenous peoples have long faced injustices in the food system, most notably against their rights to land and natural resources. Yet many sustainable agricultural practices advanced today — agroecological practices in particular — are rooted in Indigenous and traditional systems and knowledge, used for centuries before industrial agriculture took hold in much of the world. Indigenous practices have traditionally included what today would align closely with agroecological principles, working in line with nature for their food supply. Foraging and hunting played important roles in traditional food systems, with communities making only minimal impact on their environment. Respect for nature is paramount in Indigenous cultures, including respect for animals that are killed (every part of the animal is eaten or otherwise used) and for the carrying capacity of their lands, giving the earth time to renew before asking more from it.

Recent Indigenous rights movements have led to a resurgence in interest in renewing traditional food systems. In the United States the Sicangu Lakota Oyate people have embarked on a project to return to their ancestral diets and traditional sourcing methods, aiming to convert all agricultural land on their 3,702 km^2 reservation to organic production. This included regenerative practices to restore health, biodiversity, and resiliency to the land, such as rotational grazing of buffalo and cattle to help native prairie grasses (which store carbon in the soil) thrive.[137]

Some Indigenous communities may also offer new insight, understanding, and response to land health and climate change. In Ethiopia, Oromo pastoralists use community Indigenous knowledge to assess and monitor rangeland degradation, using a variety of indicators to explain the degradation.[138] Quechua farmers in Bolivia do not take a fatalistic view of climate change, but rather draw on past experiences and focus on relationships between natural phenomena and living beings to develop their own holistic solutions to increase resilience in the face of stressors.[139]

Seeds

Both states and Indigenous peoples have the right to preserve, trade, and use traditional varieties of seeds, which are usually already well suited to growing naturally in their home climate. They can often be grown with fewer inputs and therefore put less pressure on the land. Movements around seed sovereignty, to ensure that traditional seeds are preserved within communities, have grown in recent decades. Community seed-banks have been shown to increase the resilience of farmers.[140] Seed saving has become a mechanism of survival even for communities whose food systems are under tremendous pressure such as in Gaza,[141] whose people suffer from dispossession, occupation, and closure. In Ecuador, Andean communities included a strengthened seed exchange component to agricultural fairs as a way of preserving the unique agrobiodiversity of the region (see Case 3 in section 2.3).[142]

Government support can help preserve both local seeds and Indigenous practices that can lead to land restoration. In Canada, government researchers partnered with local Indigenous communities to identify and preserve ancestral seeds, study traditional intercropping methods, determine the nutritional content of harvested crops, and develop new ways of using traditional foods (see Case 2).

CASE 2

"Three sisters": Indigenous cultivation practice in Canada[143]

Project

Three Sisters value-chain: Characterization of attributes and functionalities of aboriginal corn, squash and bean varieties, preservation of genetic material and prefeasibility of new culture models.

Objectives

To study characteristics of varieties of corn, squash and beans and the products derived from them in order to develop added value for Indigenous stakeholders, while studying their health benefits.

The primary aims of the project were:

- Preserving ancestral varieties of seeds and protecting Indigenous rights and knowledge
- Cultivating the "three sisters" using Indigenous growing methods and characterizing their properties
- Evaluating the food potential of the "three sisters," including the production of new ingredients and food products

Duration

2015–18

Location

Québec, Canada

Actors

Agriculture and Agri-Food Canada; Agricultural Society for Indigenous Food Products

Mohawk, Huron-Wendat, and Abenakis peoples

Background

For centuries the Iroquois First Nations have grown ancestral varieties of maize, squash, and beans together on mounds in a traditional intercropping system. Planting these crops together has been shown to improve plant health, increase their productivity, and decrease the amount of fertilization needed.[144] These plants, called the "three sisters," are still grown together today in family and community gardens.

Collaboration began in 2013 between researchers from Agriculture and Agri-Food Canada (a government department) and the Mohawk, Huron-Wendat, and Abenakis peoples to develop processes to contribute to food security and food sovereignty for Indigenous communities. Launched in 2015, the Three Sisters project built on this collaboration together with the Agricultural Society for Indigenous Food Products. The collaboration between researchers and Indigenous communities ensured that community needs, cultures, and traditions were met and respected. Principles and mechanisms fostering transparency, participation of all, and shared decision-making at each step of the project were consulted to ensure that Indigenous people retained control of the circulation of their genetic resources and knowledge.

Seeds

Seed preservation and Indigenous seed sovereignty were a key component of the project. Seed keepers in Iroquois communities have saved and passed on ancestral varieties of maize, squash, and beans for generations. At the international level, the circulation of genetic resources and traditional knowledge has been regulated since 1992 through the Convention on Biological Diversity, the International Treaty on Plant Genetic Resources for Food and Agriculture (2004), and the Nagoya Protocol on Access and Benefit Sharing (2010), which promote fair access and equitable benefit sharing of plant genetic resources and associated knowledge. Canada is party to these treaties and takes seriously its obligations around access to genetic resources and associated traditional knowledge.

Highly important for the Indigenous communities involved is the preservation of ancestral varieties for future generations in a context of declining agriculture activities among First Nations. These ancestral varieties of maize and beans were located and obtained through Indigenous collaborators on the project. The data gathered on these seeds and their genetic diversity will help identify ways to protect and preserve these varieties.

Intercropping

The project also included a feasibility study to investigate and revisit traditional intercropping models that are sustainable, practical and culturally acceptable to Indigenous stakeholders. From 2015 to 2017 researchers cultivated different ancestral varieties of maize, squash, and beans separately and through the "three sisters" intercropping method, developing knowledge, skills, and awareness of the system among scientists, Indigenous communities, and the general public. Suitable plots in Indigenous territories have also been identified for future cultivation in the community.

Value addition

Adding value to the "three sisters" by finding new and viable ways to use the products, in response to community needs, was also a key objective. Flours derived from the maize, squash, and beans, processed using traditional methods, were used to study the bread-making potential of the three plants. Nutritional profiles of the different varieties were also evaluated.

The Three Sisters project highlights the way that government-supported research can support and revitalize Indigenous agricultural methods, help preserve indigenous seeds, find value-added ways of using the products, and support Indigenous food sovereignty.

Smallholders

Smallholders often lack access to financial capital, technology, political connections, and land tenure security, as do people using traditional, communal, and collective forms of land tenure, including pastureland, forest, and cultivated cropland. Over 8.5 billion hectares of land worldwide are held under customary tenure systems[146] which are prevalent in much of Africa and enshrined in many national constitutions. Customary tenure and other traditional land management systems can also promote sustainable land governance practices, as observed in cases in Africa[146] and the Middle East.[147]

Land tenure

Land tenure is an important component of land restoration, recognized by Parties to the UNCCD in 2019.[148] Smallholders with weaker tenure rights, especially subsistence farmers, are more prone to food insecurity, since food is so closely tied to land.[149] Moreover, farmers who lack secure tenure are less likely to invest in long-term agricultural production — such as fruit trees — even if they bring greater economic returns over time;[150] they are also less likely to actively protect their farmland against degradation or engage in soil-improving and conservation measures.[151] They are more likely to engage in practices that destroy pre-existing protections, such as crop cover.[152]

Roughly 513 million hectares globally are recognized as community forests, with local rights belonging to Indigenous peoples and local communities.[153] The rights of Indigenous and local peoples to use and access forests are embedded in tenure regimes of many countries across Latin America. Researchers there found that in places where those rights were formally recognized, communities have been significantly more successful resisting encroachment of agriculture into their forests.[154] This was echoed in a global review, which found that regardless of the *form* of tenure (communal, customary, private, protected, or public), *security* of tenure was the defining factor in achieving positive outcomes for forests.[155] Thus, secure, formalized land tenure can be used as a tool against deforestation.

In some countries in Africa, customary land titling is put forth as a solution to secure the tenure rights of the most marginalized and protect against land grabs. However, these titling schemes can also serve to reinforce injustices within communities.[156] In Latin America there is extreme caution over similar plans, as a current World Bank land-titling program in Brazil may be effectively legalizing the past land grabs of agribusiness companies.[157]

Traditional, customary, and communal systems can also have positive implications for land use. In Jordan, an initiative reinstated a traditional system of land management for rangelands, known as *hima* ("protected land" in Arabic). This involves systematically protecting areas from grazing so the vegetation can recover before flocks or herds are allowed to graze there again. This system led to both land and ecosystem restoration and positive socio-economic outcomes for the community (Case 3).

CASE 3
Reviving the traditional *hima* approach to land restoration in Jordan[158]

Project

Large-scale rangeland restoration through re-implementation of the traditional *hima* system in Jordan.

Part of the broader project Securing Rights and Restoring Lands for Improved Livelihoods (pilot project)

Objectives

To promote better management practices that will strengthen natural resource governance. The project aimed to decrease reliance on purchased feedstock and align herd size with carrying capacity of the land, thereby contributing to the long-term viability of rangelands. It also aimed to inform and influence policies to support sustainable management of drylands and rangelands.

Duration

3 years, 2011–13

Location

Northern Jordan. 109,093 ha estimated as suitable for potential *hima* restoration.

Actors

Implementer: International Union for Conservation of Nature, Regional Office for West Asia

In cooperation with: Jordan Ministry of Agriculture; Arab Women Organization

Local communities (Bani Hashem, Duleil, Hashemeyeh, and Hallabat)

Funding: European Union.

Background

Jordan is one of the most water-scarce countries in the world, and desertification is a pressing threat. The Badia, or steppe land in northern Jordan, has an arid or semi-arid climate, and land degradation is extensive. Overgrazing of rangelands and heavy groundwater extraction are the major causes of land degradation. These practices have also led to a drastic decrease in indigenous plant biodiversity.

Herding has long been practiced in Jordan and throughout the Middle East. As incomes in the region have grown over the past decades, demand for animal meat has risen, leading to livestock numbers beyond the carrying capacity of many areas.

Depletion of natural resources, primarily land and water, is often in pursuit of short-term financial gains, usually benefitting wealthier, politically connected people. However, this trend has also led Bedouin tribal families who traditionally manage shared rangelands to claim the sole ownership of tribal or government lands. Overgrazing of rangelands increased after the conversion of traditionally managed lands to State land as resource-allocation mechanisms deteriorated and customary land-use rules were not enforced, further leading to the loss of a sense of accountability in the community. Conflict often exists over land ownership and tenure.

Other factors have contributed to the deteriorating environmental and socio-economic situation, including:

- Several sudden, major population increases, largely due to refugee influxes from surrounding countries.
- The absence of national sustainable land-use policy.
- A lack of coordination between government institutions and local communities, resulting in conflicting-land management approaches.
- Weak enforcement of agricultural legislation and best-practice guidelines.
- Subsidies for animal feed (barley) outside the grazing season, which encourage pastoralists to keep large herds that exceed the rangeland carrying capacity.

Hima

Hima is a traditional land-use system that encourages the sustainable, shared use of common resources. It involves protecting areas from grazing and allowing the vegetation there to recover before animals are again permitted to graze. Over time, this system had fallen into disuse.

The project to revive the *hima* system found support among users and managers of rangelands as it is a well-known, culturally and religiously significant form of ecosystem protection. The project also had buy-in from different levels of government. This was essential as governance (especially in terms of laws) rests largely with the State.

Activities

- Extensive planning process, including multi-actor dialogue.
- Stakeholders (land users) committing to and carry out *hima*.
- Economic valuation and marketing analysis of *hima*.

Results

Over three years of the project, *hima* restoration led to both environmental and social improvements. Through improved exchange of information, social organization, and decision-making processes stakeholders were able to improve the management of grazing seasons to prevent overgrazing in protected areas. The project also reduced tribal conflict over natural resource use.

IUCN also worked with the Ministry to create an Updated Rangeland Strategy for Jordan (2013–14) to improve on the previous top-down, prescriptive strategy, which was based on the 1971 Rangeland Land Law. The new strategy recognizes the importance of *hima* for land restoration and reflects an aspiration by the government to scale up and scale out *hima*.

In its Bani Hashem pilot site, the project led to the regeneration of shrubs and grasses, including the revival of indigenous biodiversity. Stakeholders recorded 36 native plant species growing in the *hima*. They formed a cooperative society to coordinate management of the *hima*. The community recognized the role of women as key agents of change who hold knowledge and skills in reducing land degradation. Women were included in management and on the board of the cooperative society. Community members drafted and signed a tribal charter pledging to protect the rangeland from infringements of the *hima* approach. Involving the legal authorities gave this charter a legal status.

Economic valuation and marketing study

An economic study conducted by the project found the following.

- The benefits of large-scale rangeland restoration through the *hima* system outweighed the management and implementation costs.
- Scaling up the *hima* approach would deliver large economic benefits to Jordan.
- Opportunities exist for the sale of medicinal and non-medicinal herbs grown in the *hima*.

Recommendations

- Use legal mechanisms to strengthen communal management rights over rangeland in order to ensure that pastoral communities have a long-term stake in rangeland management and restoration.
- Establish mechanisms to improve coordination of planning across government departments.
- Develop protocols to bring technical rangeland extension services to *hima* development.
- Develop market-based instruments to incentivize the environmental benefits of *hima*.

Follow-up

Building on the good practices established in the *Hima* Land Restoration Project, the IUCN Regional Office for West Asia has embarked on a new Healthy Ecosystems for Rangeland Development (HERD) project. With funding from the Global Environment Facility, this USD 15.8 million, 4-year project includes both existing *hima* communities and scaling up of *hima* practices. It is being implemented in Jordan and Egypt.

Diets

Healthy and sustainable diets for all is a core objective of food systems and a necessary component of a resilient food system. Healthy diets can be achieved through agroecological practices such as agrobiodiversity,[159] which can also help restore soils. Degraded soils are characterized by a depletion of nutrients and organic matter; this depletion is reflected in the yield gaps (i.e. below their potential),[160] prevalence of plant pests and diseases, and reduced nutritional content of food, with implications for human health.[161] Research shows that micronutrient deficiencies in soil can lead to mineral deficiencies in diets, further harming human health.[162] Scientists now warn about a possible global shortage of micronutrients in agriculture, which has major implications for crop yields, livestock, and public health.[163]

Researchers in Malawi found that the adoption of agroecological practices enabled farmers to diversify their crops, thereby diversifying their diets. Overall, they found a strong association between agroecology, human health, nutrition, and food security.[164] This is important as many farmers in semi-humid tropical African countries are switching from diversified farming systems to growing, quick-maturing monoculture cereals as a way to adapt to climate change.[165] This could harm human health, as farmers tend to eat what they grow, and an overdependence on cereals have been linked to food insecurity, micronutrient deficiencies, and diseases, particularly among children and pregnant women.[166]

While most people are aware of what a healthy diet consists of, many face financial, knowledge, or availability barriers preventing them from achieving this for themselves and their families. A healthy, sustainable diet will look different for different cultures around the world.[167] However, evidence shows that essential practices include lower meat consumption, eating mostly plants, minimizing or

eliminating highly processed foods, and consuming only food that is produced in sustainable ways.[168]

In France, children are provided healthy, balanced meals at school, that are largely regionally sourced. This creates a culture of shared understanding of what a healthy, balanced diet looks like from a young age; it also instils a sense of pride in local cultivation and production.[169] Multi-actor initiatives that bring together citizens and local government have been used in Uganda, Zambia, and Bolivia to work toward policy change linking health and the food system. Through these initiatives, local food councils were developed, focusing on issues such as the detrimental impact of monoculture and lack of crop diversity on the diets and health of local communities. These councils create proposals for changes to food system policy, investment, and distribution networks. They have succeeded in shaping legislation.[170]

3.3 Regenerative agriculture

The Green Revolution that emerged in the 1960s focused on a drive for increased yields and agricultural intensification. It also brought with it a set of unsustainable practices, such as reliance on chemical fertilizers and pesticides, monocropping, irrigation, and the mechanization of farming. While the harm caused by of these practices is now known,[171] many global agri-food companies continue to use and to push Green Revolution-style input packages that farmers often accept with the (sometimes misguided) promise of short-term gain in yield and profit. Over the long term, however, these practices degrade and deplete soil, leading to productivity declines after only a few years. The importance of healthy land and soil to a resilient food system cannot be overstated.

To ensure that future generations can benefit from food systems based in healthy land and soil, broad and swift changes are needed in food production. This means moving away from the industrial agricultural model into practices that respect and work alongside the natural ecosystem. Such practices are promoted through agroecology (Section 1.1) and regenerative agriculture (Box 6). Soil management is a key concept within agroecology, and agroecological methods have been shown to help restore nutrients to soil, reverse land degradation,[172] sequester and store carbon leading to improved soil water processes and reduced CO_2 concentrations in the atmosphere, and create more resilient soil and farming systems.[173]

The benefits of this approach — and demand from consumers for more sustainable sourcing practices — led a number of multinational food-processing companies to commit in late 2019 to supporting regenerative agriculture.[175] The outcomes of this commitment are yet to be determined.

BOX 7
Regenerative agriculture

Regenerative agriculture is a production-centered approach that closely aligns with both agroecology and food sovereignty. Improving soil health is central to the approach. Regenerative agriculture includes cultivation and grazing practices that restore degraded above and below ground biodiversity, rebuild soil organic matter, increase soil fertility, promote essential nutrient cycling, increase water infiltration and retention, reduce erosion whilst ensuring clean and safe runoff, and sequester and store carbon.[174]

Essential practices for soil health within regenerative agriculture that have been proven to benefit soil health include:[176]

- No or minimal tillage
- Application of compost, mulching, and animal manure
- Use of cover crops or vegetation cover
- Crop rotations
- Cultivation of nitrogen-fixing crops.

Nitrogen — an important nutrient found in soil — is one of the most limiting factors in agricultural production.,[177] and alongside phosphorous is generally considered to underlie low crop yields across much of sub-Saharan Africa.[178] Maintaining soil rich in organic nitrogen, and matching delivery to crop needs,[179] is essential for realizing yield potential and enabling resilient food systems.

Conservation agriculture

Conservation agriculture, a production system comprised of a set of practices adapted to location-specific ecological conditions and requirements, is a similar concept. Soil health is also at the heart of conservation agriculture, which more broadly aims to preserve natural resources, water, and air.[180] The core principles of conservation agriculture align with practices within regenerative agriculture: minimal soil disturbance (no or low tillage), maintenance of permanent groundcovers, and crop system diversity and rotation.[181]
Crop diversity promotes soil biodiversity — referring to the multitude of microorganisms (i.e. bacteria, fungi) and soil fauna (microscopic and macroscopic animals) found in soil that are needed for nutrient cycling — which is crucial to maintaining soil health.

Partnerships between practitioners, researchers, and agricultural extension institutions in seven countries in sub-Saharan Africa led to a good understanding of the benefits that agroecology-based conservation agriculture can have on land restoration (see Case 4, below).

CASE 4
Conservation agriculture in Africa[182]

Project

Agroecology-based aggradation-conservation agriculture (ABACO) in semi-arid regions of Africa.

A component of the larger CA2AFRICA: Conserving Agriculture in AFRICA: Analyzing and Foreseeing its Impact — Comprehending its Adoption.

Objectives

To combat land degradation and food insecurity, and to reduce the vulnerability of smallholder farmers to climatic variability, by promoting conservation agriculture. Specific goals included:

- Adapting conservation agriculture systems to different groups of smallholders.
- Involving farmers and researchers in co-innovation platforms to promote conservation agriculture.
- Assessing the social and economic viability and tradeoffs of implementing conservation agriculture at farm and village scales.
- Disseminating targeting conservation agriculture alternatives and approaches.
- Reinforcing existing knowledge networks on conservation agriculture, building institutional capacity, and establishing South–South and North–South research partnership.

Duration

4 years, 2011–14

Location

Semi-arid areas of Burkina Faso, Kenya, Madagascar, Mali, Mozambique, Tanzania, Zimbabwe

Actors

Implementer: African Conservation Tillage Network

Target groups: Local research and extension institutions designing/promoting conservation agriculture in semi-arid regions of Africa

Organized farmer groups (learning centers, farmer field schools)

Local NGOs

National policymakers and district policy implementers

Final beneficiaries: Smallholder farmers in semi-arid areas

Funding: European Union

Project activities

Field experiments, gender-mainstreaming of activities and gender-sensitive analyses for implementing conservation-agriculture technologies, co-innovation and action research with rural communities, participatory scenario analysis and evaluation of tradeoffs, capacity development and training, dissemination, and policy analysis and design.

Results

Farmer-adapted conservation agriculture techniques increased water productivity, mitigated climatic risks, restored and maintained soil fertility, and provided agroecological functions. The project also increased the efficiency of using natural and socio-economic resources, evaluated tradeoffs for implementing conservation agriculture, established sustainable co-innovation platforms, disseminated results and lessons, reinforced conservation-agriculture knowledge networks, created South-South and North-South partnerships, and developed policy recommendations.

The success of a medium-scale fruit tree and maize farmer in Tanzania illustrates the value of the approach. He used to harvest 7.5–10 of maize per hectare on his 24-ha farm. In 2011 he began practicing conservation agriculture, and in his first season his harvest increased to 27.5 bags per hectare.

Lessons

Conservation agriculture increased the amount of water held in the soil, which in turn improved crop growth and productivity. The new techniques reduced runoff and enabled the soil to capture rainfall more effectively. By increasing the rooting depth of (maize) crops, they improved the soil structure and allowed the plants to take up more water. This increased their drought resistance and raised yields.

In the first year of no-till farming, applying mulch helps enhance rainfall capture. But where no-till has already been established (and soil improvements can already be seen) mulching is less important, as the improved soil alone enhances rainfall capture. Cover crops, rather than mulch, can be used to enhance rainfall capture on land where no-till farming has already been established.

Low-carbon agriculture (agriculture that uses less fossil fuel) can both mitigate climate change — which is known to exacerbate land degradation[183] — and support food security. Research on possible benefits of land use change to reduce greenhouse gas emissions and has found that agroecological methods, such as restoring degraded pastureland, integrated crop-livestock-forestry systems, and no-till cropping, have the largest impacts on emissions.[184] This type of "climate-smart" regenerative agriculture can also sequester carbon in the soil, which restores degraded soils and offsets greenhouse gas emissions.[185]

Diversification

Farm diversification can improve both environmental health and livelihood outcomes. Monocropping, i.e. planting just a single crop in an area, puts stress on land and reduces the biodiversity of the entire system, including the soil. Tailoring production to land-use capability by not putting stress on land and by using plants and animals, particularly in integrated production systems, that work well with the soil type can reduce soil erosion and other types of degradation whilst supporting dietary diversity and reducing a 'hunger season'.[186] Crop rotation and intercropping, coupled with the use of varieties that are indigenous to the area, foster agrobiodiversity and strengthen the agroecosystem, supporting food production over the long term.[187]

Traditional crop varieties

Cultivating and consuming indigenous and traditional crop varieties can improve environmental impacts through reduced chemical fertilizer and pesticide use, and support local cultures and traditional knowledge. This also supports shorter food-distribution chains and leads to healthy and diverse diets for the local community.[188] It may also boost livelihoods as customers are often willing to pay more for niche, high-quality foods. Indigenous varieties have been long neglected in favor of varieties preferred by the food industry, for example in the face of over 1,000 banana varieties, virtually all bananas supplied to the US and European markets are Cavendish.[189] Without interventions and community support, many will become endangered or disappear.[190]

Research shows a number of benefits that arise from cultivating native crops:

- Promotion of genetic diversity.[191]
- Diversification of diets, income sources of producers, and commercial uses.[192]
- Well-adapted to their environment, so can survive with few inputs (water, fertilizer, pesticide) while producing higher yields and phytochemically rich foods.[193]

Indigenous crops are particularly resilient and have been found to grow more easily than foreign varieties in low-fertility soil. Because they are already adapted to local ecosystems, they are better able to cope with natural stresses. This also makes indigenous crops a good adaptive strategy option for climate change.[194]

To maintain indigenous agrobiodiversity, government support is often needed. Ecuador is one of the most biodiverse countries in the world, but that biodiversity is under threat, largely due to agricultural policy that promotes the replacement of diverse native crops with "improved" and hybrid monocrops, despite the presence of land degradation. An initiative that trained communities in agroecological practices and supported seed fairs also contributed in a significant way to the inclusion of agrobiodiversity in policy (Case 5).

CASE 5
Agrobiodiversity for improved producer livelihoods in Ecuador[195]

Project

Mainstreaming the use and conservation of agrobiodiversity in public policy through integrated strategies and *in situ* implementation in four Andean Highlands Provinces.

Duration

3-4 years (2014–18)

Actors

National Agricultural Research Institute of Ecuador (INIAP); Heifer Foundation Ecuador; FAO

Ministry of Agriculture, Livestock, Aquaculture, and Fisheries

Local community organizations, including peasants' organizations

Local and municipal governments

Funding: Global Environmental Facility

Background

The project region is dry, mountainous, and subject to soil erosion and land degradation. Water is becoming increasingly scarce. Ecuador's agrobiodiversity includes important food crops such as potatoes, beans, tomatoes, and peppers. But this diversity is endangered due to a lack of knowledge and recognition of the multiple values of native plant species and varieties,

limitations in agrobiodiversity management and conservation strategies, and insufficient inclusion of agrobiodiversity values in public policy at all levels.

Ecuador has experienced significant rural-urban migration (especially of men) due to lack of income from agriculture. Hunger, malnutrition, and rural poverty are persistent in the Andean regions.

Ecuador's national policy has failed to recognize and promote the conservation and sustainable use of agrobiodiversity. As a result, little research has been done on the benefits of native crops, their nutritional value, low cultivation costs, and low negative impact on the environment. Prior to this project, Ecuador's environmental policy did not explicitly include the conservation of plant genetic resources. Agricultural policy promotes replacing native crops and traditional practices with technology packages of improved and hybrid varieties in monoculture, often subsidized by government.

Beneficiaries

Over 4,500 local farmers and promoters completed training on the *in situ* conservation and sustainable use of agrobiodiversity, covering a total of 1,790 ha; 70% of farmers who participated were women.

Activities

- Training farmers on the use and management of agrobiodiversity, using agroecological growing methods.
- Training of teachers and inclusion of agrobiodiversity in school curricula, including establishing school gardens to promote children's learning of healthy diets and the livelihood value of seeds and crops.
- Education for decision-makers and consumers on the importance of agrobiodiversity.
- Leadership training for women to pass on knowledge of agrobiodiversity to women's groups.
- Formalization of and support to seed fairs and agroecological fairs, allowing the exchange of seeds (a culturally important and ancestral practice) as well as the sale of food and other agricultural goods.
- Implementation of a participatory guarantee system for good practices (rather than foreign third-party certification) to hold growers accountable and reassure consumers that products were grown sustainably [see Section 3.4 for details on participatory guarantee systems].
- Coordination with local and national authorities to influence policy and its implementation.

Main achievements

- The project led to the inclusion of conservation and sustainable use of agrobiodiversity in public policy. The government has since elaborated on the National Strategy of Biodiversity 2015–2030 for the management and use of natural resources under this framework, and has developed a Biodiversity Finance Plan to support the implementation of the strategy and its action plan.[196]
- Three centers for bio-knowledge and agricultural development were established. These are helping to recuperate local crops that are in danger of extinction (such as Andean yucca) in support of food sovereignty.
- The project supported the passing and registration of the Organic Law on Agrobiodiversity, Seeds and Promotion of Sustainable Agriculture in 2017. This represents progress in farmers' rights in seed production, dissemination, and control[197] (however, the law also newly allowed research in genetically modified crops in Ecuador).
- It educated decision-makers, teachers, and consumers, raising awareness about the environmental, nutritional, economic, and cultural benefits of agrobiodiversity.
- The project scaled up existing good practices, including conservation and sustainable use of agrobiodiversity, raised awareness about the role of family farming in conserving native varieties, and promoted agroecology fairs.

The project addressed the problems of land degradation and soil erosion in dry mountain areas by promoting a move away from chemical input-intensive monocultures. Environmental benefits included the restoration and conservation of local varieties, helping preserve the ecosystem while also contributing to the food and nutritional needs of the community. The study of these varieties' ability to tolerate stress promoted sustainable use by farmers in future generations. Farmer participation in identifying crop varieties with important agronomic characteristics will also encourage their use locally and prevent the adoption of foreign varieties. Biodiverse farming using local varieties also contributed directly to ecosystem functions essential to agriculture, including limiting soil erosion, increasing soil organic carbon, uptake and provision of water, pollination, and conservation of wild species.

Results for women

Peasant women were the primary beneficiaries of the project. Many women were trained as leaders of women's groups. More than 85% of the women participating in the project helped to establish and apply the participatory guarantee system. Women improved their income as a result of the activities geared toward shorter distribution chains, particularly through participation in agroecology fairs. The project also resulted in greater recognition of women as holders of knowledge on agrobiodiversity.

Agrochemicals

Reducing or eliminating use of synthetic fertilizer and pesticides is a vital component of regenerative agriculture, as these substances are particularly harmful to soil, water, and human health. Fortunately, the use of organic compost and fertilizer can at least partially restore soil quality that has been lost through unsustainable cultivation practices.[198]

In lowland areas of The Gambia, heavy use of chemical fertilizers and pesticides is one of the main threats to waterways and crop contamination. The Fangsoto Marketing Federation trained 3,500 women to make and use compost, and to make organic pesticide from locally produced neem extract. The use of chemical fertilizers declined by 8,750 kg in just one year, and the women earned additional income.[199] In Mongolia, where land degradation affects 78% of pastureland, herders and smallholder farmers were trained to produce bio-humus—an organic fertilizer made using earthworms.[200]

Cuba provides a useful example of scaling up synthetic fertilizer- and pesticide-free agroecological methods. Until the early 1990s, Cuba was a major producer of monoculture sugar crops, farmed using methods born out of the Green Revolution. After the collapse of the Soviet Union, which Cuba had relied on for imports of agrochemicals, the country found itself isolated and without the financial resources to purchase such inputs. It therefore embarked on an agricultural project that many characterize as agroecological.[201] The switch was born out of necessity rather than choice, but has proven to be a success. Today Cuba's food system continues to rely on smallholders who farm without the use of harmful chemical inputs and sell their produce in local and domestic markets.

While times of crisis may influence a country-wide shift to agroecological practices, individual farmers must consider the economic, social, informational, and political factors that impact their likely success. Research from the Andalusia region of Spain found that almond farmers were more willing to adopt an agroecological approach if they had access to subsidies, saw a high benefit-to-cost ratio, had peers that were already proponents of agroecology, and had the opportunity to be part of a community of practitioners.[202]

Water

Land degradation can also have a negative impact on hydrological conditions, as reduced vegetation results in exposed soils, reduced rainfall infiltration, increased runoff, and lower groundwater recharge.[203] In turn, water-related agricultural practices such as irrigation, groundwater depletion, and agricultural wastewater runoff can all contribute to land degradation and desertification through increased surface runoff, sediment removal,[204] waterlogging, and salination.[205] Synthetic fertilizers and pesticides are a major source of pollution, as runoff from fields contaminates both surface and groundwater. Natural infrastructure, such as forests, riparian vegetation and wetlands, and green infrastructure such as field boundaries, swales, earthen dams, and natural windbreaks[206] can help ensure clean and sufficient water supply, flood control, reduced soil erosion, and aquifer recharge.[207] In Tanzania, farmers have managed to increase water availability through terrace farming, contour ridging, and tree planting.[208]

Agroforestry

Forests are vital for maintaining land health and are also an important source of food and livelihoods. Ecologically, trees reduce rates of erosion by protecting the soil from the impact of rain, shielding it from the sun (important in arid climates), transpiring large amounts of water (important in very wet climates), and by binding soil on slopes with their roots. The use of trees in agricultural systems (also known as agroforestry) has multiple benefits for biodiversity, soil fertility, micro-climatic conditions for shade-loving species, improved diets, and farmers' livelihoods.[209] Some approaches within agroforestry are particularly beneficial in land restoration, including terracing, contour farming, alley-cropping, and cultivation of multipurpose tree species.[210] Nepal's system of agroforestry, which integrates crops, livestock, and trees has been able to restore degraded land and increase productivity while improving farmer income.[211]

Deforestation

Many food-system actors engage in harmful practices such as deforestation. Burning of the Amazon rainforest in Brazil to make room for cattle ranches and monoculture (primarily of soybean) is increasing at an alarming rate.[212] The vast majority of livestock is sold for export: Brazil is the world's

largest exporter of beef and is expected to supply nearly a quarter of all the world's beef by 2028.[213] Brazil is also the world's second-largest exporter of soy,[214] which is largely used as feed for livestock. In countries in southeast Asia, such as Malaysia, Indonesia, and Thailand, tropical forests are being destroyed in favor of plantations to produce palm oil, an ingredient present in many highly processed foods.[215]

Recent environmental movements advocate deforestation-free distribution chains.[216] In the Brazilian state of Mato Grosso, which accounts for 20% of all deforestation in the Amazon, private sector has partnered with Indigenous and other local communities to scale up the sustainable collection and commercialization of Brazil nuts, an indigenous tree crop.[217] The project both supports the food and nutrition needs of local and regional communities, but output is also sold internationally. Initiatives like this have the potential to boost the livelihoods of local communities while preserving the forest.

Livestock

Increasing consumption of meat worldwide, particularly in the Global North, has serious environmental impacts and is one of the biggest causes of land degradation. Conventional, intensified livestock farming has detrimental impacts on wide swaths of land. The destruction of natural ecosystems to make way for pastures and fields to grow livestock, overgrazing of rangelands by large numbers of animals that exceed the region's carrying capacity, and soil depletion caused by monoculture feed cultivation all contribute to land degradation. However, limited and mindful meat consumption and active support for farmers and herders that engage in responsible cattle-raising practices can help the planet. Methods of raising livestock, particularly grassland-raised livestock, can lead to soil restoration, as animal manure is essential to healthy soil and to raising healthy crops.[218] Well-managed extensive livestock production, particularly on native grasslands, can also be an important part of conserving and managing ecosystems[219] and heritage livestock breeds.[220] Such systems can also help resist land conversion to other uses, such as intensive agriculture and urban development.[221]

Integrated crop-livestock is a form of mixed production that utilizes crops (including trees) and livestock in ways that delivery complementary benefits through space and time to all components. Integrated systems, particularly those including ruminants, can close the loop of nutrients cycling through the soil, plants and the animals' manure, and improve soil fertility without the need for external inputs. Specialized agriculture — often intensive farming of a single crop or type of livestock — contributes to soil erosion, biodiversity loss, climate change, and both water and air pollution.[222] Monocropping can result in loss of organic matter and increased erosion,[223] while livestock specialization has led to nitrate pollution of water tables and loss of biodiversity, at both farm and regional scales.[224] Integrated crop-livestock systems, on the other hand, have multiple benefits for soil health, including improved nutrient cycling (especially re-coupling nitrogen and carbon cycles).[225] Highly effective integration can result in overall higher outputs per animal and per hectare.[226]

In Guadeloupe, Brazil, and Cuba, livestock-crop integration has been shown to improve the resilience of nitrogen flows—this means that even in cases where nitrogen flows are less efficient, mixed systems provide alternative pathways and therefore more flexible capacity for nitrogen flows to overcome disturbances.[227] This healthy and resilient soil is needed to ensure its continued ability to produce food for the long term. In China, systems that mix crops with forage are being considered in Tibet as a sustainable solution to feed shortages, which could simultaneously help move the region away from environmentally harmful practices associated with intensified agriculture.[228]

An understanding of what might entice farmers to engage in crop-livestock integration were identified in Brazil, where at the regional level, the practice was found to be more likely in areas with strong infrastructure, including processing facilities, research institutes that promoted and supported integration, and other distribution-chain provisions. At the individual level, access to capital, information, and technical assistance, as well as higher education levels, were also determinants in taking up mixed farming.[229] In Europe, scaling-up of crop–livestock integration systems through farm cooperation within districts increased productivity and economic performance, in addition to the environmental benefits that were observed at all levels. Such arrangements allow farmers to share costs associated with machinery and labor, and to share marketing and managerial strategies.[230]

3.4 Critical factors for uptake and success

The case studies referred to throughout this working paper (presented in table form in the Annex) reveal a number of critical factors that lead to the uptake and success of best practices for resilient food systems and land restoration. Different factors for each area of intervention identified — sustainable food-distribution networks, protection of people, and regenerative agriculture — are outlined below.

Sustainable food-distribution networks

Sustainable food-distribution networks often feature shorter food chains and local or territorial markets. They contribute to land restoration through reduced greenhouse-gas emissions from food transport, less overproduction, less loss and waste along the chains, and higher demand for soil-friendly indigenous varieties.

- Governments can foster shorter food chains through regulations (law and policy) that encourage or mandate procurement of locally or nationally produced food.[231]
- Creating various territorial markets within a country can make it easier for small-scale farmers to sell their output and bring consumers in closer contact with producers.[232]
- Cooperatives can help farmers access markets, increase yield, and earn higher incomes.[233] Governments can facilitate access to cooperatives for women and other marginalized people.[234]
- Comprehensive research studies with targeted follow-up that engages multiple food-system actors, including all levels of government, can lead to uptake of positive approaches into municipal, regional, and national law and policy.[235]
- Local governments can foster urban agriculture.[236]

Research on dairy farming in Italy and Brazil identified nine areas where aligning with consumer expectations could promote the success of products sold via short food chains:[237]

- Relationships between producers and consumers should be direct and ethical.
- Food should be organic, or produced without the use of synthetic fertilizers, sprays, pesticides, and chemicals.
- Food should be associated with supporting local work, cooperation, and pride.
- Food should be safe and traceable (transparency/full knowledge of every stage of the distribution chain).
- The cultural heritage of the food should be understood.
- Operations should be environmentally friendly, specifically through reduced impact on land and water, reduced energy use, and no use of chemical fertilizers.
- Food should be produced locally or territorially.
- Food should positively impact consumer's health.
- The origin of food should be identifiable.

Protection of people

Restoring land can help protect people's health, livelihoods, and culture. Conversely, measures to protect people can also help restore land.

- Secure land tenure rights can help prevent deforestation, regardless of the form of land tenure (communal, customary, private, protected, or public).[238] People with secure land tenure are also more likely to invest in land (by planting trees, etc.) and less likely to engage in practices that cause degradation.[239]
- Adopting agroecological approaches, including agroforestry and agrobiodiversity, can lead to better livelihoods and healthier, more diverse diets for smallholders.[240]
- Renewing Indigenous people's sovereignty over their food systems can lead to re-adoption of traditional production methods and cultivation of indigenous varieties.[241]
- Renewing traditional land-management systems engages the community in good practices through familiar, culturally respected, and context-specific methods.[242]
- Research funded by government can help identify and preserve ancestral seeds, determine the nutrient benefits of ancestral varieties, support Indigenous rights, and promote Indigenous food systems.[243]
- Community-driven initiatives that engage local government can influence law and policy that improve health of community members, production practices, and livelihoods.[244]

Regenerative agriculture

Production methods associated with regenerative agriculture can result directly in land restoration. These methods include low or chemical-free production, agrobiodiversity, cultivation of indigenous varieties, minimal tillage, crop-livestock integration, and agroforestry. They are also associated with the holistic food-system approach of agroecology.

- The involvement of different levels of government (including traditional governance institutions) can influence law and policy that support the adoption and implementation of regenerative agricultural practices.[245]
- Strengthening tenure rights can support agroforestry and increase forest cover, agricultural production, and income for farmers.[246]
- Collaboration between farms in close proximity leads to better economic outcomes in agroecological practices such as crop-livestock integration, as farmers are able to share costs associated with machinery and labor, as well as marketing and managerial strategies.[247]

- Involving women in training on agroecological methods, including leadership training for women to teach, can lead to positive results and uptake.[248]
- Partnerships between communities and different levels of government and local or international organizations, as well as mobilizing private-sector engagement, are useful ways to implement and scale up good-practice initiatives.[249]
- Adding educational components to agroecology initiatives that target teachers, students, and policymakers promotes scaling out and scaling up.[250]
- Participatory guarantee systems hold growers accountable for good production practices and give consumers reassurance that products were sustainably grown, without adding certification cost barriers that might exclude the poorest farmers.[251]
- Bottom-up information and training methods, such as reinforcing existing knowledge networks, engaging in South – South and North – South research partnerships, and farmer-to-farmer knowledge sharing, are more inclusive for farmers than top-down approaches.[252]

Research has also identified several factors that influence farmers' willingness to engage in agroecological approaches:[253]

- High benefit-to-cost ratio of the practice
- Availability of subsidies
- Peers who are already engaging in and proponents of agroecology
- Ability to be part of a community of practitioners
- Strong regional infrastructure, including processing facilities and food distribution network provisions
- Research institutes that promote and support crop–livestock integration nearby (access to information and technical assistance)
- Relatively low capital requirement and access to capital to facilitate switching production systems.

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4. POLICY AND GOVERNANCE

At the international level, public policy and law currently lack sufficient measures to safeguard both the environment and the most vulnerable actors in the global food system. The World Trade Organization, the main intergovernmental body responsible for facilitating the reform of agricultural trade, has faced repeated difficulty in making progress toward a new agreement.[254] Current regulatory frameworks support large processed-food companies in production and trade, facilitating the movement of highly- and ultra-processed foods globally, which are then sold cheaply around the world.[255] Stakeholders in the food system whose livelihoods, immediate environments, and health will be most impacted by a new global trade agreement are not provided a seat at the table to share their concerns or ideas on how to move forward.[256]

At country level, few governments—national or local—use the tools at their disposal to address negative practices within the food system. In some countries, such as the United States of America, agricultural subsidies disproportionately benefit large-scale producers[257] and sometimes inadvertently encourage harmful practices, such as monocropping, the use of chemical inputs, and intensive animal farming.[258] Some countries lack the regulation, monitoring, and enforcement of pesticide use needed to ensure foods are healthy and sustainable.[259] Consumers are often held responsible for unhealthy food choices, but many live in places where fresh, healthy foods are unavailable ("food deserts"),[260] where prices for sustainably produced foods are high,[261] or where marketing of or exposure to highly processed, convenience, and otherwise unhealthy foods is excessive.[262]

Without government intervention, companies are often left to regulate themselves. In response to consumer demand, private-sector actors often look to certification schemes as a way to quickly and easily identify themselves as fair and sustainable. However, there is some criticism over their inability to bring the poorest and most marginalized farms into the fold due to restrictive certification methods and high costs.[263] There is also growing skepticism among consumers and other stakeholders that some companies or industries are merely engaging in greenwashing, particularly with recent controversies around products like "sustainable" palm oil.[263]

4.1 Public policy and investment

Governments at all levels — from national to local — have the ability and primary responsibility to govern the environmental, economic, and social determinants of just, sustainable, and resilient food systems, using the legislative, regulatory, and administrative measures at their disposal. A range of policy tools, including regulations, subsidies, and social supports, can enable change within each of the three areas of intervention outlined in this working paper. Including those stakeholders most affected by and at risk within the food system in the development and implementation of such policies has multiple benefits. These include the articulation of stakeholder values, identification of areas of agreement and differences, promotion of transparency, and increase in quality and trustworthiness of the policy.[265]

Sustainable food-distribution networks

In many countries, border closures and supply chain disruptions caused by the COVID-19 pandemic have led countries to re-examine the resiliency of their food-distribution networks, including by seeking ways to strengthen their domestic production and markets.[266] A similar scenario occurred after the 2007–2008 food-price crisis. In sub-Saharan Africa, for example, the crisis caused a sharp drop in incentives for crop exports.[267] Strengthening domestic food production and distribution is a key way to ensure that countries can create food systems that are resilient to shocks at the global level. Public policy and investments could be used to protect, strengthen, and expand local and territorial markets, as seen in the cases of France and Brazil.[268]

Support for shorter distribution networks can have a myriad of positive results (see Section 2.1): easier product traceability, lower costs, higher profitability and ecological production methods.[269]

Rural–urban linkages and partnerships

Rural – urban linkages across space — through flows of goods, people, and money — and between sectors are essential to consider in food-system and land governance. A city-region food-system approach involves and empowers local governments to manage local resources and strengthens the connectivity between urban centers and their surrounding areas.

Partnerships between rural and urban government entities can support both food-system resilience and socio-economic development. For example, such partnerships can enable the creation of development and land-use policy that supports landscape preservation, sustainable resource management, and larger and more integrated markets.[270] The latter can increase employment in rural areas, which reduces rural–urban migration. This, in turn, reduces pressure on urban land and reduced urban expansion and informal settlement, all of which contribute to land degradation.[271]

An example of a successful rural–urban partnership focused on food production and agriculture is the Nuremberg Metropolitan Region, comprising of urban and rural administrative districts. The partnership led to enhanced local productive linkages, better management of natural resources, increased financial resources, improved dialogue with other government levels, improved access, quality and economic viability of services, improved local government capacity to carry out tasks, and aligned priorities for economic development.[272]

Agroecology and regenerative agriculture

Uptake of agroecology in national policy and law is possible, though those who have tried have met with only partial success. The case of France reveals that the concept of agroecology is translated differently when brought into policy, creating a "hybridization" of the approach.[273] In 2012 the French Ministry of Agriculture and Food initiated a program that would see the institutionalization of agroecology,[274] based on the recognition of a "need for policies that support a transition towards a locally relevant, sustainable and productive agriculture."[275] French law describes agroecology as a set of sustainable agricultural techniques and good practices, including local food networks and short distribution chains.[276] However, the essential human and transformational dimensions of agroecology are largely absent, and some stated objectives in the law do not align with the agroecology approach,[277] leading to criticism from civil society.[278] France's experience underscores the need for widespread participation of the most-impacted stakeholders in policy- and decision-making within the food system.

At present, governments appear to be more receptive to the type of piecemeal support for specific methods that fit within the agroecological production model seen in France rather than taking on the holistic, multidimensional agroecology approach. Context-specific environmental and health data, along with community concern, can help convince governments to take action. In Zambia, for example, stakeholders concerned about the ecological and health impacts of widespread maize monocropping persuaded the government to amend policies to ensure that farmers who cultivate crops other than maize also receive subsidies, with triple impacts on the environment, health, and farmer livelihoods.[279]

Healthy and sustainable diets

Consumption choices are made for a variety of reasons, largely based on knowledge, availability, and financial accessibility. Governments have the ability to control marketing, availability, and cost of unhealthy and highly processed foods. For example, 16 countries currently regulate the marketing of unhealthy food to children,[280] including Chile[281] and the United Kingdom,[282] with successful results. Governments can also support education around food in schools, including through provision of healthy, sustainable school lunches, such as in France and Japan.[283]

Cost is one of the biggest barriers to many in acquiring healthy, sustainably produced foods.[284] Public policy targeting the production sector can directly impact and support access to healthy and sustainable food by making it easier for farmers using sustainable methods to sell and market their products cheaply, such as in Germany[285] and India.[286] Local governments can also address the phenomenon of food deserts by amending zoning laws or offering incentives for greengrocers or farmers' markets to move to these areas, such as in Portland (United States).[287] Many governments use disincentives in the form of taxes or outright bans on some unhealthy foods to limit consumption. For example, local government in New York City banned trans-fats in restaurants in 2006, with positive health benefits for residents in the city;[288] at the regional level. The state of Kerala in India introduced a hefty tax to certain fast foods.[289] At the national level, Mexico's tax on sugary drinks has led to a fall in consumption.[290]

4.2 Advocacy and stakeholder/ civil society initiatives

Through advocacy, producers, consumers, and other civil-society actors in the food system can influence government policy around food systems both bilaterally and at the international level. States can also play a role in financially and logistically supporting these stakeholders in their efforts.

The food price crash of 2007–8 that left so many people without secure access to food or the ability to earn a living from agriculture also represented a turning point in the international policy system. It led to the 2009 reform of the UN Committee on World Food Security, which sought greater legitimacy by becoming a more inclusive platform.[291] Critically, it opened a space for stakeholders such as smallholders, Indigenous peoples, pastoralists, consumers, and other members of civil society who previously did not have a seat at the decision-making table with the establishment of the CFS Civil Society and Indigenous Peoples' Mechanism.[292] This body participates in negotiations with states, and while it does not have a vote, it has been able to influence global policy related to food and agriculture, including the Voluntary Guidelines on the Responsible Governance of Tenure[293] and the Framework for Action for Food Security and Nutrition in Protracted Crises.[294]

All cases presented throughout this working paper included civil-society stakeholders either as architects of best-practice initiatives, or as active participants in projects initiated by other actors. This shows the key role that civil society can play in the development and scaling out of approaches that contribute to land restoration and resilient food systems.

4.3 Research and innovation

Research is modest on subjects such as the benefits of territorial markets, living wages for producers and consumers, and agroecological practices. More is needed. Such an evidence base is vital to help shape public policy. Government, in turn, can redirect aid budgets to research aimed at supporting a transition towards social-ecological sustainability.[295]

In Brazil, a legal analysis was developed to show how the agroecological approach aligns with the Brazilian constitution and other laws, as well as where improvements to law need to be made.[296] A similar exercise was conducted in the United States, reviewing current national food and agricultural policy, and identifying what needs to be amended in order to support a just and sustainable food system.[297] Such targeted, technical approaches can help convince policymakers at local and national levels to support a larger transition toward agroecology.

Some sustainable, innovative technologies can complement regenerative agriculture. Hydroponics, for example, enables food production indoors, without soil, and with minimal use of water and chemical fertilizers, taking pressure off land and other natural resources. It also enables more sustainable food-distribution networks and allows the inclusion of new actors — urban dwellers — in food production, which in turn can foster food-system education and facilitate healthier food choices. For example, in the densely populated Gaza Strip, which suffers from land and soil degradation,[298] FAO-funded trials and pilot projects provided inputs and technical training in establishing and managing small-scale, commercial, low-tech hydroponic farms. These contributed to the establishment of agricultural businesses for smallholder farmers, allowing them to earn higher incomes while contributing to year-round food availability and an overall more resilient food system in the Gaza Strip, without putting additional stress on already-fragile land and water resources.[299]

4.4 Certification schemes and private sector engagement

Certification schemes

Certification schemes are one key way that the private sector has responded to consumer demand for more just and sustainable sourcing practices. Overall, certification leads to higher incomes for certified farmers, though workers' wages do not usually benefit,[300] and there is generally a lack of evidence to show a positive environmental impact of such schemes, especially in the long term.[301] However, where government regulation is lacking, third-party certification can act as an extra layer of land and ecosystem governance.

Certain schemes, such as various country-specific organic/bio labels, non-genetically modified, Rainforest Alliance, and others belonging to the Global Ecolabelling Network,[302] aim to support just and/or sustainable production methods or sourcing practices. While the impacts of such systems are often limited, most are generally positive.[303] Related projects, such as LIFEBioStandards,[304] aim to integrate missing sustainability components — in this case biodiversity conservation — into existing standards and labels in the food industry. Research on the experience of producers participating in the Fairtrade scheme shows mixed results. Many of the poorest certified producers still fall below the poverty line and are unable to break even, while those who benefit tend to be already well-off.[305]

The Voluntary Sustainability Standards, initiated by the United Nations Forum on Sustainability Standards, can be developed by the public sector, businesses, or non-profit NGOs.[306] They are also gaining popularity, but this trade-oriented scheme risks leaving out smallholders and also faces compliance challenges.[307]

Alternative schemes also exist, whereby stakeholders are able to define a locally specific, sustainable, and just system of standards. Case 2 in Ecuador describes a participatory guarantee system used. These systems are not oriented to export markets, include simple verification processes, generate minimal costs (and none direct to the producer), require minimal administration, and can include an educational component for both producers and consumers.[308] This allows communities to adapt the guarantee system to local ecological, political, economic, and cultural contexts and needs. Farmers have more flexibility to diversity their production compared to those with third-party certification for one particular product, like coffee. This leads to more resilient livelihoods and better outcomes for land preservation and restoration, as farmers can more readily rotate crops.[309] While participatory guarantee systems have been shown to have more beneficial outcomes for smallholders, uptake remains relatively low compared to third-party certification schemes. This is largely because the time, effort, and community-building needed to ensure these systems function well falls on producers, whereas in larger schemes much of the administrative burden is taken care of by separate certifying bodies.[310]

Private-sector engagement and partnerships

In some cases, private-sector engagement in new and pre-existing food and agricultural initiatives may be a pathway to more sustainable and resilient food systems. Producers, government, and other actors can sometimes benefit from private-sector expertise and capacity for product and service development, marketing, and logistics.[311] For example, a partnership between two public universities in the United States and a regional supermarket chain facilitated and promoted the sourcing of local products. The collaboration included capacity-building workshops for growers and consumers, networking opportunities, peer-learning and research activities, and piloting and evaluation of new distribution techniques — all of which all contribute to more resilient food systems.[312] Research from Rwanda and Ghana shows that engaging in public–private partnerships can sometimes enable public-sector actors to shape governance within the food system. This can improve procedural justice attributes for small farmers, such as bilateral communication channels, transparency of policies and decisions, and conflict resolution mechanisms.[313]

The initiative in Brazil to promote the sustainable harvesting of Brazil nuts (Section 2.3) mobilized roughly USD 3 million in private-sector funds. The cooperative involved was able to improve its sales and marketing strategies, engage in mapping and monitoring of its lands, and has been able to positively impact 1.4 million hectares of land.[314]

4.5 Women as agents of change

Several initiatives find success through a focus on women as agents of change. In particular, women play a vital role as food producers in engaging with and scaling out agroecology, both for land and ecosystem restoration and for a more just and equitable food system.[315] In turn, the holistic agroecology approach has the ability to empower women as traditional keepers of seeds, as in Gaza,[316] cultivators using practices that positively impact land health, as in The Gambia,[317] and carriers of knowledge and teachers of agroecological practices, as in Ecuador.[318] In Mexico, an initially government-funded women-led agricultural cooperative that cultivates agave — a plant that counters land degradation — has continued its work for decades largely due to the ethical commitment the women have to caring for the land of their community.[319] In New Zealand, Indigenous Māori women are leaders of community farms and gardens that facilitate access to healthy, sustainably produced local food, including for those who may not otherwise be able to afford it. These initiatives counter the land and ecosystem degradation and depletion of natural resources that impact Māori lands. Moreover, they promote food sovereignty, revive traditional agroecological methods that support land restoration, and bring attention to the essential role of Indigenous women in local food systems.[320]

5. CASE TYPOLOGY

As seen throughout this paper, best-practice examples in food systems can be found in multiple countries around the world, both in the global North and South. An annotated bibliography of all cases reviewed (see the Annex) describes the interventions, along with their location, context, project description, selected key elements, results, and recommendations. Each case exhibits good practices in at least one of the three key areas of intervention to enhance resilient food systems discussed throughout this working paper: sustainable food distribution networks, protection of people, and regenerative agriculture.

A typology of cases was developed based on the type of action or intervention that may act as a pathway to achieving resilient food systems. Seven distinct types of interventions have been identified:

1. Mobilization of private sector support
2. Community engagement (initiated by actors outside of the community)
3. Public-policy interventions
4. Legal and policy analysis
5. Tool/solution development by stakeholders (from within the impacted community or region)
6. Research/scoping
7. Supporting or adding value to traditional or Indigenous models

A key finding in the review is that most cases either explicitly include good practices in more than one of the three areas of intervention, or resulted in a positive outcome for more than one area of intervention. The vast majority of cases focused primarily on regenerative agriculture with direct implications for land restoration, but also had impacts on the protection of people, mostly through positive health outcomes or enhanced livelihoods. Most cases that focused on sustainable food distribution networks also included (explicitly or implicitly) good practices or outcomes in regenerative agricultural and ecosystem-restoration practices and in protection of people (usually related to livelihood gains and healthy diet due to better quality food).

Likewise, most of the cases examined followed more than one of the seven pathways concurrently. For example, two of the cases categorized as mobilizing significant private-sector support were also solutions developed and controlled by stakeholders (food producers or community members). Both supported traditional agricultural models. One also included a policy-influencing component. The third case in the private-sector-support category was a partnership with public universities and funded by a government department. One of the cases categorized as supporting or adding value to traditional or Indigenous models was also a research intervention funded by a public institution.

Most cases reviewed did not mention the cost of the project, though interventions categorized as community engagement were most likely to include this. This is likely due to the involvement of development agencies and large donors. Of those that disclosed cost of intervention, the range was wide, from USD 24,000 to USD 7,846,000 for fixed projects. An annual budget of USD 1.5 billion was reported for state school feeding in Brazil. The project cost did not appear to determine the success of the intervention, although the scale of outcome was dependent on budget in some cases. While the project with the highest budget was able to make significant impact on national policy (related to agrobiodiversity and practices that lead directly to land restoration), significantly smaller-scale projects also demonstrated success in influencing policy on national and international levels.

Cultivated agricultural land was by far the most prevalent land type addressed within the cases reviewed. Other land types targeted included forests and mixed systems (crop-livestock integration).

Only one rangeland case was reviewed. Of the cases that revealed causes of land degradation experienced, most were due to monocropping, use of chemical fertilizers or deforestation. The impact of livestock was also a prevalent cause, and only one context faced deliberate land degradation (in a situation of military occupation). Both land type and cause of degradation were mentioned primarily in interventions that focused on regenerative agriculture. Some cases that focused on the protection of people also indicated the land type and cause of degradation, while only one intervention that focused on sustainable food distribution networks stated the predominant land type and causes of degradation.

Interventions most frequently targeted smallholders as beneficiaries, while many also targeted consumers. Few cases explicitly included women as key stakeholders or beneficiaries; most of these were initiated by development actors, and with two initiated by community members and one by the state. Similarly, few cases explicitly included Indigenous peoples as key beneficiaries, and only one state-led intervention explicitly targeted the poorest households. Three cases benefitted people under occupation. There was also overlap in some cases (e.g., women who are also smallholders; smallholders who are also consumers), and in other cases, the multiple identities of beneficiaries were not provided (e.g., some smallholders may also be Indigenous, but were not identified as such).

Several interventions sought to influence the legal, regulatory or institutional framework, either as a primary or secondary objective. These were primarily interventions that were development by stakeholders (including one stakeholder initiative categorized as mobilizing private-sector support), research/scoping, and to a lesser extent community engagement. Only the very large-scale and long-term development actor and large donor-funded community engagement interventions included this objective, though the policy changes they succeeded in making had direct implications for land restoration (through waste reduction, rangeland management, and agrobiodiversity). Scale and duration of stakeholder-developed solutions were not a factor: all managed to succeed in influencing law or policy to different degrees. Research/scoping interventions were an exception (the impact of the research is unknown).

The review of cases shows a variety of viable pathways to initiating, implementing, or scaling up food-system initiatives that enable land restoration. It is important to note that public policy has the ability to support or influence all of the above pathways. Moreover, research, scoping, and legal and policy analysis are significant pathways, as they often directly influence public policy interventions and can also mobilize private sector support.

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ANNEX
Typology of cases: Pathways to achieving resilient food systems and land restoration

Intervention	Location, context	Project description, key elements	Results, recommendations
Mobilization of private sector support			
Sustainable collection and commercialization of Brazil nuts[321]	Brazil — Juruena, Mato Grosso State: • accounted for 20% of all deforestation in the Amazon in 2017; 89% of this was deforested illegally	• Sustainable harvesting of Brazil nuts on two Indigenous lands that are at risk of deforestation for ranching/ other agriculture • Sale of nuts, nut oil, and nut meal locally, regionally, internationally Local cooperative Cooperativa dos Agricultores do Vale do Amanhecer (COOPAVAM): • Supports food and nutrition of 42,000 at-risk people in 8 municipalities through its production • Based on solidarity economy principles In collaboration with Partnerships for Forests (P4F): • Conduct Territorial and Environmental Management Plans of Indigenous lands (ethno-zoning, ethno-mapping, monitoring, surveillance mechanisms) to strengthen forest protection • improve sales and marketing strategies	• Mobilized £2,888,000 private sector funds as of 2020 • 4000 people supported • Impacts 1.4 million hectares of land
Tree planting and support for farmers living under occupation[322]	Occupied Palestine: • Occupying Israeli forces and settlers regularly uproot or burn olive, citrus, and other fruit-bearing trees • Farmers' land under constant threat of appropriation • Results in high levels of food insecurity and unemployment	Through the Million Tree Campaign Jordanian-Palestinian civil society organization Arab Group for Protection of Nature helps farmers: • replant trees (primarily native olive trees) • rehabilitate land • restore agricultural infrastructure • develop technical skills to manage and sustain their lands The organization also engages in advocacy and has successfully influenced policy on food, agriculture, and the environment at national, regional, and international levels • Funding: mix of private sector support (corporate social responsibility initiatives) and community donations, with some foundation grants	Between 2001-2019: • Cultivated 12,600 ha of land • Planted 2.4 million olive, citrus, and other fruit-bearing trees • Planted over 400,000 vegetable seedlings • Rehabilitated 41.4 ha of land • Constructed 58 water-collection wells • 42,140 kg (42 tons) local seeds distributed and planted by farmers • More than 212,000 people supported, including more than 27,000 farmers • Project is ongoing

Intervention	Location, context	Project description, key elements	Results, recommendations
Sourcing local products for supermarkets[323]	United States of America — North Carolina	Partnership between two public universities and a regional supermarket chain to facilitate and promote sourcing of local products. Collaboration also included: • Capacity-building workshops for growers and consumers • Networking opportunities • Peer-learning and research activities • Piloting and evaluation of new distribution techniques • 6 years (2013-2018) • Funded by United States Department of Agriculture • Led by Center for Environmental Farming Systems	Produced research on several topics relevant to local food supply chain stakeholders, and support materials, including: • Tips for produce growers marketing fresh produce retail grocers • Financial and business resources for food entrepreneurs • Local food and strategies for councils of government
Community engagement (initiated from outside the community)			
Agroecology, healthy food systems, and vulnerable farming households[324]	Malawi	• Farmers adopted agroecological production methods such as intercropping, mulching, and incorporating legume residues to improve soil health, which also support crop nutrient uptake • Assessed relationship between agroecology and human health among smallholder farmers, including those facing health vulnerabilities such as HIV/AIDS and child under-nutrition	Key Outcomes: • Adoption of agroecology improved human health, nutrition, food security, and household well-being • Enabled farmers to diversify crops leading to more nutritionally diversified diets, which are associated with stronger immune systems
Producing organic vegetables using natural compost[325]	Gambia: • Use of chemical fertilizers and pesticides major threat in lowlands • Has led to water pollution and crop contamination, posing health and environmental risks	Purpose: Phase out use of chemical fertilizers and pesticides by promoting use of compost and organic pesticide made from neem tree extracts – considered safe, reliable and inexpensive while enhancing soil productivity and pest control in horticulture • Trained women on making compost from animal waste, plant material and locally produced pesticides • 1 year (2016-2017) • Funding: $50,000 (including in-kind)	Results: • Reduced use of chemical fertilizer by 8,750 kg in one year • Generated additional income of USD 3,371/ha plus savings of USD 53/ha (due to the lower cost of organic fertilizers) • 3,500 people supported (largely women)
Improving agricultural soil with bio-humus[326]	Mongolia: • Land degradation pressing environmental concerns • 78% of pastureland degraded affecting 121 million hectares • results from both human-induced and natural causes	Conducted 3 trainings on production of high quality organic fertilizer using compost and using worms to make bio-humus from livestock manure • trained people from forest communities and small holder vegetable farmers and herders • 8 months (2016) • Funding: USD 23,549 (including in-kind)	Results: • 124 community members produced 230 tons of organic fertilizer worth USD 93,500 • Some sold at local markets/ trade fairs, some applied fertilizer to own farms (40 hectares of vegetable fields in total) • Scaled up to 400 farmers and planning 3 additional field trainings • 6,000 people supported

Intervention	Location, context	Project description, key elements	Results, recommendations
Improving water management through reforestation[327]	Tanzania: • land degradation (desertification, soil erosion and nutrient depletion, deforestation, forest degradation) in almost all agroecological zones	Trained 250 smallholder farmers on soil and water conservation, including how soil erosion in highland areas and periodic flooding in lowlands can be controlled through • construction of traditional micro-dams (Ndivas), bench terraces, and contour ridges • intercropping crops and trees (agroforestry) • planting trees around water sources to reduce evapotranspiration • using mulch horticulture • 5 years (2012-2017) • Funding: USD 162,044 (including in-kind)	Results: • 228 ha land rehabilitated (by 60% on average) • Increased water availability • Improved crop production and yields up to 200% • Influenced local government to pass regulation requiring all farms using micro dam to terrace their farms and plant trees along contour (enforced by village level authorities) • 1,095 people supported • All households achieved food self-sufficiency
Traditional rangeland management[328]	Jordan — Badia region: • Water scarce • Increasing desertification • Extensive land degradation • Overgrazing of rangeland • Heavy groundwater extraction	Large-scale rangeland restoration through re-implementation of the traditional *Hima* system (pilot project), engaging local communities in Bani Hashem, Duleil, Hashemeyeh, and Hallabat • 3 years • Implemented by International Union for Conservation of Nature (IUCN) Regional Office for West Asia in cooperation with the Jordan Ministry of Agriculture and Arab Women Organization • Funded by EU IUCN also worked with Ministry to create the Updated Rangeland Strategy for Jordan (2013-2014)	• Environmental and social improvements • Improved exchange of information, social organization, and decision-making processes • Better management of grazing seasons to prevent overgrazing in protected areas • Led to reduced tribal conflict over natural resource use • Updated Rangeland Strategy recognizes importance of *Hima* for land restoration and reflects government aspiration to scale-up and scale-out *Hima* approach
Agroecology-based Conservation Agriculture[329]	Kenya, Tanzania, Mali, Burkina Faso, Zimbabwe, Mozambique, Madagascar	Project goals included: • adapting conservation agriculture (CA) systems to different groups of smallholders • involving farmers and researchers in co-innovation platforms to promote CA • assessing the social and economic viability and tradeoffs of implementing CA at farm and village scales • disseminating targeting CA alternatives and approaches • reinforcing existing knowledge networks on CA, building institutional capacity, and establishing South-South and North-South research partnerships • 4 years (2011-2014) • Project is component of larger CA2AFRICA: Conserving Agriculture in AFRICA: Analyzing and Foreseeing its Impact – Comprehending its Adoption • Funded by EU; USD 1,372,000 budget (for larger project)	Findings: Farmer-adapted Conservation Agriculture techniques resulted in • increased water productivity • mitigation of climatic risks • restoration and maintenance of soil fertility • provision of agroecological functions

Intervention	Location, context	Project description, key elements	Results, recommendations
Agrobiodiversity for improved livelihoods[330]	Ecuador — Andean region: • Dry-land, mountainous region • Experiencing soil erosion and land degradation • Water increasingly scarce • One of world's most biodiverse countries	Project activities included: • Training farmers on use and management of agrobiodiversity, using agroecological growing methods • Training of teachers and inclusion of agrobiodiversity in school curriculum • Education for decision-makers and consumers on the importance of agrobiodiversity • Leadership training for women, to pass on knowledge of agrobiodiversity to groups of other women • Formalization of and support to seed fairs and agroecological fairs, which allowed for the exchange of seeds, as well as the sale of food and other agricultural goods • Implementation of a Participatory Guarantee System for good practices • Coordination with local and national authorities to positively influence policy and its implementation • 4 years (2014-2018) • Budget: USD 7,846,235	Main Achievements: • Led to the inclusion of conservation and sustainable use of agrobiodiversity in public policy • Established three centers for bio-knowledge and agricultural development, which are helping to recuperate local crops that are in danger of extinction • Training benefitted 4.509 local farmers and promoters; 70% of farmers were women • Impacted 1,790 hectares of land
Hydroponic farming for enhance food security under closure	Gaza Strip (occupied Palestine): • Under long term Israeli and Egyptian closure and blockade • Experiencing land and soil degradation • Water scarcity and poor water quality • Densely populated, including many refugees and camps • Suffers periodic military attacks	Beneficiaries received inputs and technical training to establish and manage small-scale, commercial, low-tech hydroponic farms • Four experimental trials were conducted • Technical manual on low-tech hydroponic farming in the Gaza Strip was produced • Funded by FAO and Osprey Foundation • Budget: USD 73,000 • Partners: Al Azhar University, smallholder farmers, and fishers	Results of trials: • Low-tech hydroponic lettuce outperformed conventional, soil-based techniques for yield • Large fruiting vegetables with more complex nutrients demands (such as tomatoes) were technically feasible using low-tech hydroponic systems • Contributed to the realization of water-efficient agribusiness ventures for smallholder farmers and boosted farmers' incomes • Contributed to availability of fresh food in the Gaza Strip

Intervention	Location, context	Project description, key elements	Results, recommendations
Public policy interventions			
Support of territorial markets and short food supply chains[331]	France	Since 2009 France has aimed to foster and develop farms whose output could be marketed through short food supply chains through: • Increased knowledge of 'terroir', short chain marketing • Supporting farmers' entry into short chains with technical and economic [advice] • Supporting the development of farmers' skills in product transformation, marketing, and management (especially human resources management and management of cooperatives) • Created training platform on short chains for restaurant sector • Enacted law that 20% of food in public restaurants and dining rooms should be procured locally (2010) • Specified in law that preference should be given to products marketed directly by producers (2011)	Recommendations: • The State, including local governments, should create a legal and institutional framework that supports the development of short food supply chains • The State should promote short food supply chains through direct measures including public procurement of local foodstuffs for schools, hospitals, prisons, and other institutions • Develop nutrition education programs, which are key to encouraging the acceptance of more wholesome diets • Recognize and attribute value to local cultural and nutritional features of products, considering the relationship of the food with the territory • Provide training for all stakeholders in the food distribution network • Establish partnerships and networks for diverse purposes (e.g., scaling out/up, adding value, improving logistics efficiency, diversifying supply)
Short food supply chains in public procurements for school meals[332]	Brazil, Peru	Brazil's National School Nutritional Program, with annual USD 1.5 billion budget, became decentralized in 1994, prioritizing procurement from family farms. Legislation enacted in 2009 states that: • at least 30% of State funds for school feeding must support family farms • prioritizes purchasing from agrarian reform settlements, and from Indigenous groups/Quilombola communities (descendants of slaves living in rural communities) • includes mechanisms for paying a price premium for agroecological and organic products In Peru, the Qali Warma ("thriving child") program provides school meals to children between the ages of 3-12: • different foods eaten in different parts of the country to reflect regional culinary identity, products, and consumption habits	

Intervention	Location, context	Project description, key elements	Results, recommendations
Agroforestry as land degradation management: Community leasehold approach[333]	Nepal: • Land degradation due to overuse of chemical fertilizers, shifting cultivation, steep slope farming, deforestation, overgrazing, and overuse of forest resources • Results in low agricultural productivity, leading to poverty, poor health and nutrition	The restoration approach of the hill forest ecosystem in Nepal includes the government initiated leasehold forestry program, to improve livelihoods of the poorest households in forest communities. Leasehold groups protect the land from grazing and fire, and restore degraded land through natural regeneration and using agroforestry methods, including: • Variety of multi-purpose tree species • Relay-cropping • Terracing • Contour cultivation • Strip and alley cropping Leasehold groups co-exist with pre-existing participatory community forest programs.[334]	Results: • Increased forest cover up to 70% • Increased land productivity • Increased income levels Recommendations: • Holistic, needs-based approach based on active participation of farmers in planning and implementation can make initiative more effective • Clarify legal status • Increase technical support, especially on biophysical interaction of crops and trees • Provide market and finance (mortgage) support
Short milk and dairy distribution chains[335]	Italy and Brazil	EU provided funding in support of shorter food distribution chains • Study looked at twelve farms (6 in Italy, 6 in Brazil) • Identified key factors for success of shorter food distribution chains based on consumer expectations	Farms shortened food distribution chains, eliminated chemical preservatives, and introduce product traceability. Results: • Production costs rose but distribution costs fell • Final cost of product to consumer fell while profits increased
State supported women-run cooperatives[336]	Mexico — Hadaglo	Government provided initial support to women-led cooperatives Milpa Maguey Tierno de la Mujer Cooperative, run by Indigenous Otomi women sells organic agave syrup in national markets and collect medicinal herbs: • agave plants counter desertification as they retain water in the soil • collection of medicinal plants preserves biodiversity	• This and some other cooperatives continued after government support ended • Initial financial and technical support enabled women to overcome structural barriers due to their gender • Women felt moral obligation to both the work and caring for the land
Legal And Policy Analysis			
Using law to support agroecology and sustainable farming[337]	Brazil: • Deforestation for export-oriented monocropping • High use of chemical inputs degrades land • Exploitation of farm workers, high rural unemployment, decline of traditional livelihoods based on forest resources	Analysis of how current Brazilian laws supports different aspects of sustainable farming, and what needs to be strengthened using existing international norms. Topics include: • organic farming (replacement of chemical inputs with biological ones) • Right to Food • food sovereignty • seeds and saplings (law does not support smallholders) • social function of land/rural property • traditional knowledge Agroecology is presented as a way to implement human rights by adopting a sustainable agricultural approach.	Key message: • Defense of agroecology, and consequently human rights, • must start with instruments offered by the legal structure and current normative framework • alternative use of law and legal pluralism can develop agroecology as sustainable practice

Intervention	Location, context	Project description, key elements	Results, recommendations
Food system policy, public health, and human rights[338]	United States of America: • food system is largely unhealthy, inequitable, and environmentally damaging • not sufficiently resilient to cope with impacts of climate change, resource depletion, and population increases	Review examines role that federal policy plays in defining food system, particularly with regard to agriculture and challenges of making the food supply safe, nutritious, and sustainable, while respecting the rights to food and health. • Current food system in United States is enabled by policies that perpetuate harmful practices and allow externalization of some of the true costs of production • Policy is one of the most viable avenues for making improvements to the food system • Agroecology is presented as a holistic systems-based approach to support a just and sustainable food system	Several policy recommendations are presented, including: • Provide tax breaks, support for accessing land, and other incentives to farmers using agroecological methods • Ensure that trade agreements do not inhibit or degrade the expansion of agroecology • Prohibit the marketing to children of foods low in nutritional value • Prioritize regional, local, and sustainably produced foods in purchasing requirements for government programs and institutions
Tool/solution development by stakeholders (initiated from within affected community)			
'Free fairs' as short food supply chain market access mechanism for family farmers[339]	Chile	Over 900 'free fairs' are held in different communes and region, supporting smallholders: • Cash transaction facilitates participation of small-scale farmers • Consolidate small supply of several family farmers • Provides a place to sell food directly to consumers, to market stallholders, or to wholesalers who supply the markets • Supports small farmers to meet requirements of formal marketing channels (volume, payment methods, logistics, receipts) In 2013 institutions/organizations involved in free fairs formed a corporation with the purpose of developing and shortening value chains in the domestic fresh foods market. It fosters productive, commercial, and institutional relationships among stallholders, artisanal fisherfolk, peasant farmers, consumers, and their respective organizations.	Recommendations: • Create networks that linking producers, consumers, and people/institutions that can support financing • Provide technical support; help develop farmers' management, marketing, and commercialization skills • Identify, connect, and strengthen local supply and local demand • Create information systems for farmers, potential buyers of local products (families, consumer organizations, restaurants, hotels, catering services, schools, and others)
Food Parliament for sustainable diets[340]	Uganda: • Negative impacts of monoculture (mostly sugarcane) in food production • Multinational sugar companies entered verbal contracts with farmers and would not allow farmers to switch back to food production on their own land	• Multi-actor initiative for policy change focused on healthy and diverse diets; linking small farmers with markets; nutritious and diverse production • Organized around concerns about the sugarcane industry to influence local government • Held 4 town hall meeting-style events involving citizens, local government, teachers, media, and former members of (Slow Food) Food Communities discussed issues around production and consumption of diverse local foods	Key Outcomes: • Led to the district council signing a resolution restricting sugarcane growing, specifying: 1) sugarcane can only be grown if a plot is bigger than 3 acres 2) at least 70% of that land should be dedicated to food production 3) agricultural extension officers given authority to promote food diversification with smallholder farmers. • Resulted in plan to formulate a food security and nutrition ordinance, which is a legally binding and enforceable law

Intervention	Location, context	Project description, key elements	Results, recommendations

Food Change Lab for sustainable diets[341]	Zambia:
	• Lack of crop diversity resulting in widespread undernourishment
	• Maize monocropping is prevalent
		• Multi-actor initiative for policy change focused on healthy and diverse diets; linking small farmers with markets; nutritious and diverse production
		• Mapped the food system and formed groups to investigate:
		  • Influencing the government to move away from maize
		  • Raising youth awareness
		  • general awareness-raising on food issues
		  • Building capacity of food marketers in food handling
		• Held 2 local-level events to assess local agricultural practices and dietary patterns, and 2 national-level events on the national food system involving a wider range of actors
			Key Outcomes:
			• Led to government providing subsidies to farmers for crops other than maize
			• Mobilized youth around farming and healthy diets
			• Formed partnership with Lusaka City Council to coordinate efforts around the food system
			• Provided training to vendors in the informal food sector on food handling practices and nutrition

Food Council for sustainable diets[342]	Bolivia: • Fragmented approach to all components of the food system	• Multi-actor initiative for policy change focused on healthy and diverse diets; linking small farmers with markets; nutritious and diverse production • Set up Food Councils in La Paz, Sucre, and Tarija • Conducted and shared research on food security and the need to strengthen food systems • Held monthly committee meetings between local government, universities, and NGOs and experience-sharing workshop with all Food Councils	Key Outcomes: • Created proposals for legislation on policy and investment, logistics, and supply systems, and ensured follow-up • Food Councils supported drafting of the 2018 La Paz Municipal Law on the Promotion of Urban Food Gardens and drafted the 2018 Sucre Municipal Law for Food and Nutrition Security
Convivência com o semiárido (living with the semiarid region): Agroecology and agroforestry[343]	Brazil — Pernambuco	*Centro Sabiá* (Sabiá Center), a civil society organization based in Recife, works directly with more than 6,000 families to implement agroecology and agroforestry through: • Technical assistance and agricultural extension • Capacity building • Commercialization of agricultural products • Support for building groups, associations, and cooperatives • Spaces for preserving indigenous seeds *Centro Sabiá* supports agroforestry practices that: • Combine annual crops and trees in the same area • Replicates the biome and native vegetational structure • Includes diverse species important for nature and of economic value to farmers	Results: • Stakeholders unanimously reported that implementing agroecology was a major factor in improving their diets, particularly increasing variety and consumption of fruits and vegetables, and decreasing health problems • Farmers saw increased income from agricultural sales and value of home consumption • Agroecological interventions were shown to be particularly pro-poor

Intervention	Location, context	Project description, key elements	Results, recommendations
Sustainable traditional New Nordic Diet[344]	Norway, Denmark, Sweden, Finland	• Nordic chefs created the diet in 2003 as the New Nordic Cuisine Manifesto • Builds on and shares principles of the Mediterranean diet • incorporates health, food culture, palatability, and environment • Essential components: variation in produce, organic, local production, and seasonality • agricultural biodiversity important (plant and animal varieties, wild and domesticated sources) • Contributes to preservation of local landscape/sea, and health of consumers	Outcomes: • Nordic Council of Ministers adopted Manifesto in 2005 as ideology behind New Nordic Food Programme • analysis of environmental impacts showed diet reduced environmental impact relative to average Danish diet • consumption of beef/ruminant products biggest contributor to land use change compared to new Nordic diet
Environmental benefits of crop-livestock integration at different scales[345]	France, Switzerland, Ireland, Spain, Netherlands: • Numbers of mixed crop-livestock farms steadily declining in Europe • Lack of knowledge in how to reintegrate crops and livestock at the farm and local level	• Reviews of 24 case studies of existing networks of farms or individual farms from different agricultural regions of Europe, and 3 additional cases in France, that had implemented innovative mixed farming practices and systems at farm and/or district levels • Networks were self-organized; some farms were supported by the CANTOGETHER initiative to promote crop-livestock integration • Ecological objective to optimize energy, carbon, and nutrient flows that conserve natural resources and maximize production	Findings – individual level: • Ecological improvements observed, but productivity did not often improve Findings – district level: • Partnership agreements and cooperation between farms led to increased access to local resources such as land, labor, feed, machinery, nutrients, and marketing/managerial strategies • Ecological improvements were retained, productivity and economic performance rose Recommendations: • Concrete guideline on how to reintegrate crops and livestock • Exchanges between specialized crop farmers and livestock farmers can help redevelop integration • Decision support systems • Locally adapted scenarios
Territorial market and brand development[346]	France — Figeac (southwest)	Community members developed a rural territorial brand "Terres de Figeac, Mêlée gourmande" (*Figeac lands, a tasty mix*). Objectives: • improving knowledge and competencies around food • valorizing local products and local knowledge • supporting social innovation • promoting quality and uniqueness associated with the territory	• supports the establishment of new farmers, supports collective catering projects, and organizes food events • developed own territorial food policy incorporating producers, civil society, small-scale food businesses, retailers, restaurants, catering, and consumers in governance action

Intervention	Location, context	Project description, key elements	Results, recommendations
Supporting women-led urban and peri-urban agriculture businesses[347]	Gaza Strip (occupied Palestine): • Under long term Israeli and Egyptian closure and blockade • Experiencing land and soil degradation • Water scarcity and poor water quality • Densely populated, including many refugees and camps Suffers periodic military attacks	Overall objective: Promoting and strengthening urban and peri-urban food production and processing based on sustainable approaches and integrate urban and peri-urban agriculture into agriculture and food policies and city development and resilience plans. • Women are target beneficiaries • Provides training in urban agricultural practices and processing (drying and preserving) • Provides entrepreneurship training, such as marketing • Keeps and distributes traditional seeds • Developed and implemented by Gaza Urban and Peri-Urban Agriculture Platform • Funder: MADRE	Participants and community members reported enhanced food security resilience thanks to the project, as they were able to find fresh food closer to their home, which has been particularly important during pandemic-related lockdowns.
Indigenous women-led agroecological community gardens[348]	New Zealand — Māori lands • Impacted by land and ecosystem degradation, natural resource depletion	Study of four Māori women-led community farms and gardens: • Objective: to address food poverty • One of the farms is located on previously degraded land • All initiatives use techniques that align with agroecology • 3-year study, but initiatives are ongoing Important themes in the initiatives (in order of importance): • Community • Traditions and ancestors (including cultural protocol and traditional medicine) • Family and future generations • Gardens, wellness, and connecting to the land • Agroecological and natural farming techniques • Issues, ups and downs, obstacles, outcomes • Food sovereignty	The farm located on previously degraded land is now a thriving permaculture farm. Results confirm that community gardens are effective for improving access to culturally appropriate, ecologically produces fresh fruits and vegetables Policy implications: • two-pronged approach, with both bottom-up and top-down change, is needed • support women in agriculture, particularly those practicing sustainable agroecological practices

Intervention	Location, context	Project description, key elements	Results, recommendations
Research/ scoping			
Determinants of crop-livestock integration at household and regional levels[349]	Brazil — Mato Grosso State: • Environmental degradation, rapid land cover change due to deforestation for export-oriented agriculture (grains, beef/cattle)	Objective: what determines adoption of crop-livestock integration? Findings (household level): • Farmers with higher capital availability and access to information more likely to adopt method • Farmers with higher debt less likely to adopt method • farmers who adopted method had significantly higher average education level and access to technical assistance Findings (regional level): • Areas with more supply chain infrastructure, greater economic development, established agricultural history, access to information more likely to adopt method • Producers who practiced method highly clustered, near research stations and processing facilities, in regions with higher GDP per capita	Recommendations: • Invest in education, training, and technical support in mixed systems • Financial incentives, such as tax exemptions for supply chain actors to establish themselves in areas that could support new crop-livestock integration, and targeted credit for ranchers Result is improvement in land use (does not regenerate lost forest)
Crop-livestock integration determines the agroecological performance of mixed farming systems[350]	Guadeloupe, Brazilian Amazonia, Cuba	• Compares 17 mixed farming systems combining 2-8 productions (minimum 1 crop and 1 livestock) per farm • 3 contrasting socioeconomic regions • Studied nutrient flow networks • Agroecological performance evaluated in terms of efficiency, resilience, productivity, and dependency of nitrogen flow networks	Results: • Crop-livestock integration increases productivity • Promotes resilience (better, more flexible capacity of nitrogen flows to overcome stress) • Brazil: very high nitrogen efficiency (231%-3303%) • Cuba: high efficiency • Even with less efficiency adaptive capacity was higher
Agroecology in almond farming[351]	Spain — Andalusia: • Rural-urban migration resulted in expansion of monocropping • Almond is the most popular monoculture crop		Findings: Farmers indicated these to be most important factors affecting adoption of agroecological practices: • understanding of the ecosystem • cost-benefit ratio • subsidies • peer pressure • community of practitioners
Sustainable food systems through diversification and indigenous vegetables[352]	Tanzania — Arusha: • declining soil fertility • significant misuse of agrochemicals • high levels of malnourishment • low dietary diversity	Findings of analysis of barriers to advancement of indigenous varieties at policy level: • Fragmented and incoherent food system policies • Food system diversification is not supported, promoted, or present in policy • Government efforts to address food insecurity focus on increasing staples production • Consumers lack awareness of importance of vegetable consumption for better nutrition • Widespread concern about food safety hazards from pesticide residue	Recommendations: 1. Stronger value chain governance through a multi-stakeholder platform 2. Better informed farmers' choices by including indigenous vegetables in extension officers' curricula 3. Improved food safety and reduced loss along the chain 4. Greater food knowledge about indigenous vegetables through information campaigns

Intervention	Location, context	Project description, key elements	Results, recommendations
Crop-livestock integration as a feeding solution via crop-forage rotation[353]	Tibet — Southern Tibetan Plateau: • Specialized, intensified monocrop and forage production • Environmental degradation • Population growth • Increasing livestock Shortage of forage	• Assessed feasibility of crop-forage rotation and crop-livestock integration as solution for feed shortages • Determined livestock carrying capacity of region Findings: • Livestock exceeded carrying capacity provided by rangeland and crop residues from 2000-2015 • Only slight improvement over that period despite implementation of national project to restore degraded rangeland • Growing season suitable for forage growth after crop harvest Findings mean forage self-sufficiency and relief from grazing pressure possible	Recommendation: • Policy guidance is needed to encourage farmers to adopt crop-livestock integration Market factors also play a role
City Region Food Systems baseline study[354]	Sri Lanka — Colombo: • 44% of land in Sri Lanka is degraded • Overuse of agro-chemicals • High risk of soil erosion in many districts	Project activities: • undertook assessment of Colombo's city region food system (CRFS) based on measurable indicators • identified priority areas for intervention: food waste and losses; food security and food safety; value chain management; natural resource management and climate change • linked to existing areas of political interest, including health, food safety, food waste, and climate vulnerability, which serve as concrete entry points for further food system strategy formulation • engaged with key government actors who are directly or indirectly linked to city region food system planning and implementation to discuss the critical aspects of the city region food system • developed a food flow analysis of key crops within the city region food system • conducting a quantitative analysis of rural-urban food flows specific to select agricultural commodities (and including other sectors; ongoing) • helping to identify food chains and commodities vulnerable to climate change, including how and why those foods are affected, as well as who is affected, and suggested adaptation strategies to make urban food system more resilient (ongoing)	Recommended Policy Interventions: • facilitate holistic and territorial approach to food systems • develop physical and institutional capacity to reduce vulnerability of lower-income urban dwellers to food price fluctuations • strengthen food safety policies and enforcement • better coordination, integration and implementation of waste management • create enabling environment for private sector and household level to engage in resource recovery and reuse for food waste • develop and implement by-laws that promote reduction of food waste in restaurants and catering
Suppporting or adding value to traditional or Indigenous models			
The Three Sisters Project[355] intercropping of indigenous varieties of maize, squash, and corn	Canada	• Government-funded research in collaboration with Indigenous communities • Characterized properties of indigenous seed varieties • Studied cultivation of the Three Sisters using Indigenous growing methods • Studied nutritional content of the foods grown and processed into flour, using Indigenous methods	• Helped protect Indigenous rights, knowledge, and sovereignty over natural resources • Preserves ancestral seed varieties • Developed options for new value-added products and use

Intervention	Location, context	Project description, key elements	Results, recommendations
Restoring and supporting food sovereignty in Indigenous communities[356]	United States of America — Sicangu Lakota Oyate territory (Rosebud Indian Reservation), South Dakota • 3,702 km^2 • Restricted access to traditional lands due to settler-colonialism leading to loss of traditional food system • Prevalence of food insecurity and diet-related diseases	Purpose of project is to facilitate: • Return to ancestral diets of nutrient-dense plant-based sources and ethically sourced bison/other wild game • Understanding of food as medicine for physical and spiritual healing • Connection to Lakota identity • Highly informed consumption decisions • Access to affordable, high quality foods The project uses regenerative agricultural practices to restore health, biodiversity, and resiliency to the land. Project is in initial phase. Funding: winner of OpenIDEO Food System Vision Prize 2020	Project components include: • Converting all agricultural land to organic production • Rotational grazing of buffalo and cattle to restore soil health and help native prairie grasses (good carbon stores) flourish • Creating home, school, and community gardens • Providing traditional, freshly prepared school meals • Developing year-round farmers' market accessible to all communities through delivery service • Incorporating agricultural skills into the curriculum • establishing nature areas with responsible harvesting practices in order to restore natural biodiversity

Endnotes

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